FANUC AC SERVO MOTOR αi series
FANUC AC SERVO MOTOR βi series
FANUC LINEAR MOTOR LiS series
FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR DiS series

PARAMETER MANUAL

B-65270EN/08

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Should you wish to export or re-export these products, please contact FANUC for advice.

In this manual we have tried as much as possible to describe all the various matters.
However, we cannot describe all the matters which must not be done, or which cannot be done, because there are so many possibilities.
Therefore, matters which are not especially described as possible in this manual should be regarded as ”impossible”.

■General Safety Precautions

- When an abnormality such as an alarm or a hardware failure occurs, the operations described in the specifications are not guaranteed unless otherwise specifically noted. When action corresponding to the abnormality is specifically described, take the action. When no action is described, please contact FANUC.
- The signals and functions described in the specifications cannot be used separately for safety functions unless otherwise described as being usable for the safety functions. Their specifications are not assumed to be used as the safety functions in this case, an unexpected danger may be caused. For information about the safety functions, please contact FANUC.
  Generally, the safety functions represent functions that protect the operators from machine danger.
- A wrong device connection or setting can lead to unpredictable operation. When starting to operate the machine for the first time after assembling the machine, replacing components, or modifying parameter settings, exercise the greater care by, for example, reducing the torque limit value, error detection level, or operating speed or by operating the machine in such a way that an emergency stop can be made quickly.

DEFINITION OF WARNING, CAUTION, AND NOTE

This manual includes safety precautions for protecting the user and preventing damage to the machine. Precautions are classified into Warning and Caution according to their bearing on safety. Also, supplementary information is described as a Note. Read the Warning, Caution, and Note thoroughly before attempting to use the machine.

⚠ WARNING

Applied when there is a danger of the user being injured or when there is a damage of both the user being injured and the equipment being damaged if the approved procedure is not observed.

⚠ CAUTION

Applied when there is a danger of the equipment being damaged, if the approved procedure is not observed.

NOTE

The Note is used to indicate supplementary information other than Warning and Caution.

- Read this manual carefully, and store it in a safe place.

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APPENDIX

1 OVERVIEW

This manual describes the servo parameters of the CNC models using FANUC AC SERVO MOTOR α*i*S, α*i*F, β*i*S, β*i*F, L*i*S, and D*i*S series. The descriptions include the servo parameter start-up and adjustment procedures. The meaning of each parameter is also explained.

Chapter 1, "OVERVIEW", consists of the following sections:

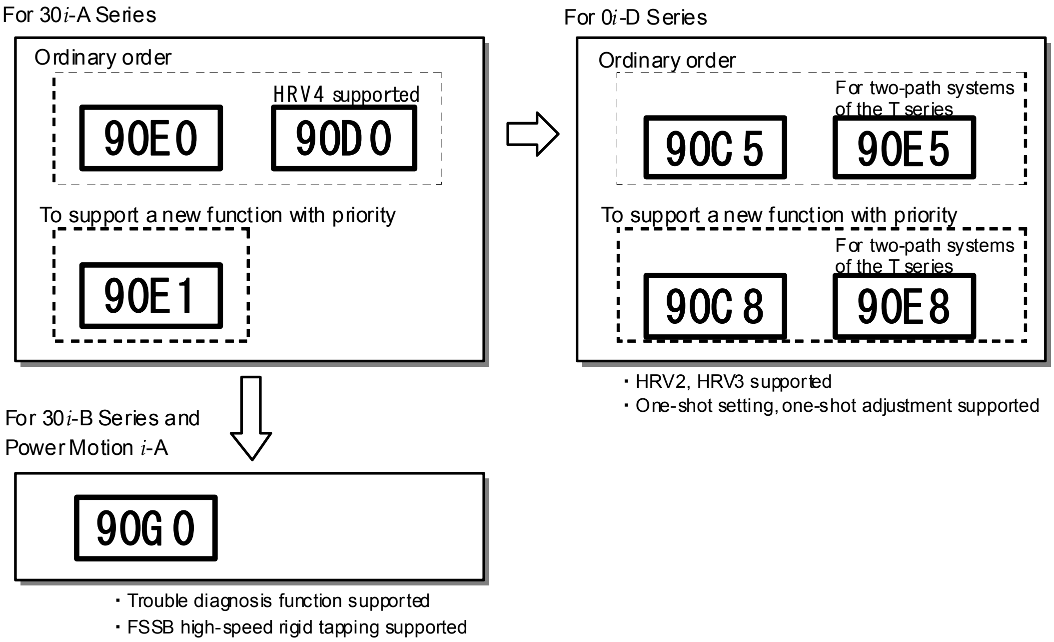
1.1 NC MODELS AND APPLICABLE SERVO SOFTWARE

NC product name	Series and edition of applicable servo software	NC product name
Series 30*i*-MODEL B Series 31*i*-MODEL B Series 32*i*-MODEL B Series 35*i*-MODEL B Power Motion *i*-MODEL A	Series 90G0/03.0 and subsequent editions	For SERVO HRV2,3,4 control (Note 3)
Series 30*i*-MODEL A Series 31*i*-MODEL A Series 32*i*-MODEL A	Series 90D0/A(01) and subsequent editions	For SERVO HRV4 control (Note 1) (Note 3)
	Series 90E0/A(01) and subsequent editions	For SERVO HRV2,3 control (Note 2)
	Series 90E1/01.0 and subsequent editions	For SERVO HRV2,3 control (Note 2)
Series 0*i*-MODEL D Series 0*i* Mate-MODEL D	Series 90C5/01.0 and subsequent editions	For SERVO HRV2,3 control (Note 4)
	Series 90C8/01.0 and subsequent editions	For SERVO HRV2,3 control (Note 4)
	Series 90E5/01.0 and subsequent editions	For SERVO HRV2,3 control (Note 4)
	Series 90E8/01.0 and subsequent editions	For SERVO HRV2,3 control (Note 4)

NOTE

1. When using servo HRV4 control with Series 30*i*-A and 31*i*-A, use Series 90D0.
2. The servo software Series 90E0 is applied with an ordinary order. If you want to use a new function with priority, select Series 90E1.
3. With the Series 32*i*, 35*i*-B, and Power Motion *i*-A, servo HRV4 control cannot be used.
4. The servo software Series 90C5 and 90E5 are applied with an ordinary order. If you want to use a new function with priority, select the Series 90C8 or 90E8.

Servo software series map



1.2 ABBREVIATIONS OF THE NC MODELS COVERED BY THIS MANUAL

In this manual, the NC product names are abbreviated as follows.

NC product name	Abbreviations		
FANUC Series 30*i*-MODEL B	Series 30*i*-B	30*i*-B Series	30*i* Series and so on 30*i* Series etc. FS30*i* and so on FS30*i* etc.
FANUC Series 31*i*-MODEL B	Series 31*i*-B		
FANUC Series 32*i*-MODEL B	Series 32*i*-B		
FANUC Series 35*i*-MODEL B	Series 35*i*-B		
Power Motion *i*-MODEL A	Power Motion *i*-A	---	
FANUC Series 30*i*-MODEL A	Series 30*i*-A	30*i*-A Series	
FANUC Series 31*i*-MODEL A	Series 31*i*-A		
FANUC Series 32*i*-MODEL A	Series 32*i*-A		
FANUC Series 0*i*-MODEL D	Series 0*i*-D	0*i*-D Series	FS0*i*-D and so on FS0*i*-D etc.
FANUC Series 0*i* Mate-MODEL D	Series 0*i* Mate-D		

1.3 RELATED MANUALS

The following manuals are available for FANUC AC SERVO MOTOR α*i* or β*i* series, LINEAR MOTOR L*i*S series, or SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series.
In the table, this manual is marked with an asterisk (*).

Table 1.3 Related manuals

Document name	Document number	Major contents	Major usage	
FANUC AC SERVO MOTOR α*i* series DESCRIPTIONS	B-65262EN	• Specification • Characteristics • External dimensions • Connections	• Selection of motor • Connection of motor	
FANUC AC SERVO MOTOR β*i* series DESCRIPTIONS	B-65302EN			
FANUC LINEAR MOTOR L*i*S series DESCRIPTIONS	B-65222EN			
FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series DESCRIPTIONS	B-65332EN			
FANUC SERVO AMPLIFIER α*i*SV series DESCRIPTIONS	B-65282EN	• Specifications and functions • Installation • External dimensions and maintenance area • Connections	• Selection of amplifier • Connection of amplifier	
FANUC SERVO AMPLIFIER β*i*SV series DESCRIPTIONS	B-65322EN			
FANUC AC SERVO MOTOR α*i*S series FANUC AC SERVO MOTOR α*i* series FANUC AC SPINDLE MOTOR α*i* series FANUC SERVO AMPLIFIER α*i* series MAINTENANCE MANUAL	B-65285EN	• Start up procedure • Troubleshooting • Maintenance of motor	• Start up the system (Hardware) • Troubleshooting • Maintenance of motor	
FANUC SERVO MOTOR β*i*S series FANUC AC SPINDLE MOTOR β*i* series FANUC SERVO AMPLIFIER β*i* series MAINTENANCE MANUAL	B-65325EN			
FANUC AC SERVO MOTOR α*i* series FANUC AC SERVO MOTOR β*i* series FANUC LINEAR MOTOR L*i*S series FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series PARAMETER MANUAL	B-65270EN	• Initial setting • Setting parameters • Description of parameters	• Start up the system (Software) • Turning the system (Parameters)	*
FANUC AC SPINDLE MOTOR α*i* series FANUC AC SPINDLE MOTOR β*i* series FANUC BUILT-IN SPINDLE MOTOR B*i* series PARAMETER MANUAL	B-65280EN			

Other manufactures' products referred to in this manual

* IBM is registered trademark of International Business Machines Corporation.
* MS-DOS and Windows are registered trademarks of Microsoft Corporation.

All other product names identified throughout this manual are trademarks or registered trademarks of their respective companies.

Supplementary note

In this manual, the servo parameters are explained using the following notation:

(Example)

Parameter No.	Servo parameter function name, function bit							
2021	Load inertia ratio							
	#7	#6	#5	#4	#3	#2	#1	#0
2000				PGEX			DGPR	PLC0

The following α*i*/β*i* Pulsecoders are available.

Pulsecoder name	Resolution	Type
α*i*A16000	16,000,000 pulse/rev	Absolute
α*i*A1000	1,000,000 pulse/rev	Absolute
α*i*I 1000	1,000,000 pulse/rev	Incremental
β*i*A128	131,072 pulse/rev	Absolute
β*i*A64	65,536 pulse/rev	Absolute

When parameters are set, these pulse coders are all assumed to have a resolution of 1,000,000 pulses per motor revolution.

2 SETTING PARAMETERS OF αiS/αiF/βiS/βiF SERIES SERVO MOTOR

Chapter 2, " SETTING PARAMETERS OF αiS/αiF/βiS/βiF SERIES SERVO MOTOR ", consists of the following sections:

2.1 INITIALIZING SERVO PARAMETERS

2.1.1 Before Servo Parameter Initialization

Before starting servo parameter initialization, confirm the following:

<1> NC model (ex.: Series 30i-B)
<2> Servo motor model (ex.: αiF8/3000)
<3> Pulsecoder built in a motor (ex.: αiA1000)
<4> Is the separate position detector used? (ex.: Not used)
<5> Distance the machine tool moves per revolution of the motor (ex.:10 mm per one revolution)
<6> Machine detection unit (ex.:0.001 mm)
<7> NC command unit (ex.:0.001 mm)

2.1.2 Parameter Initialization Flow

Use the procedure below to initialize the servo parameters.
For details of each setting item, see Subsection 2.1.3.

Preparation
- Turn on the power in the emergency stop state.
- Enable parameter writing.
- Display the servo setting screen. → See 2.1.3 (1).

↓

Servo parameter setting

Description of setting	Reference item
Initialization bit	→ 2.1.3 (2)
Motor ID No. setting	→ 2.1.3 (3)
AMR setting	→ 2.1.3 (4)
CMR setting	→ 2.1.3 (5)
Flexible feed gear setting	→ 2.1.3 (6)
Motor rotation direction setting	→ 2.1.3 (7)
Setting of the number of velocity pulses and the number of position pulses	→ 2.1.3 (8)
Reference counter setting	→ 2.1.3 (9)
Full-closed system setting	→ 2.1.3 (10)
Servo loop gain setting	→ 2.1.3 (11)

↓

CNC restart → 2.1.3 (12)

↓

Absolute position detector setting → 2.1.3 (13)

↓

Completion of servo parameter initialization

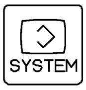
2.1.3 Servo Parameter Initialization Procedure

(1) Preparation

Switch on the NC in an emergency stop state.
Enable parameter writing (PWE = 1).
Initialize servo parameters on the servo setting screen.
For the Power Motion *i*-A or another model with no display, specify a value for the number corresponding to each item on the SERVO SETTING screen. See Fig. 2.1.3.
To display the servo setting screen, follow the procedure below, using the key on the NC.

SYSTEM

● 0*i*-D Series

Press the 

function key several times until the PARAMETER SETTING SUPPORT screen appears.

Press soft key [(OPRT)], move the cursor to the SERVO SETTING item, and press [SELECT] to display the PARAMETER SETTING SUPPORT screen.

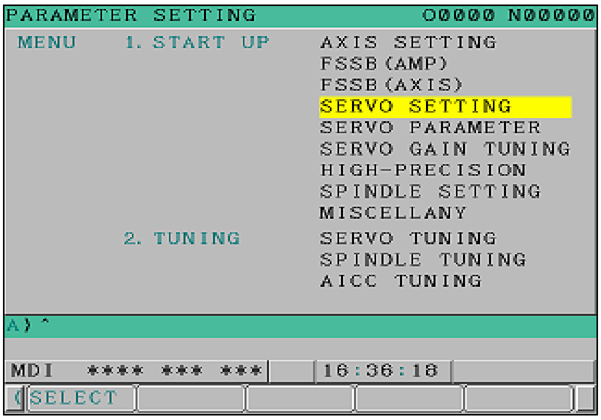


Fig. 2.1.3(a) PARAMETER SETTING SUPPORT screen

With 0*i*-D Series, two types of servo setting screens are available: the standard screen and the conventional compatible screen. Initialization can be performed by using either of the screens.
For the standard screen, refer to Subsection 2.1.4, "Servo Parameter Initialization Procedure for the Series 0*i*-D". This Subsection describes the method of setting using the **conventional compatible screen**.

(Standard screen) **(Conventional compatible screen)**

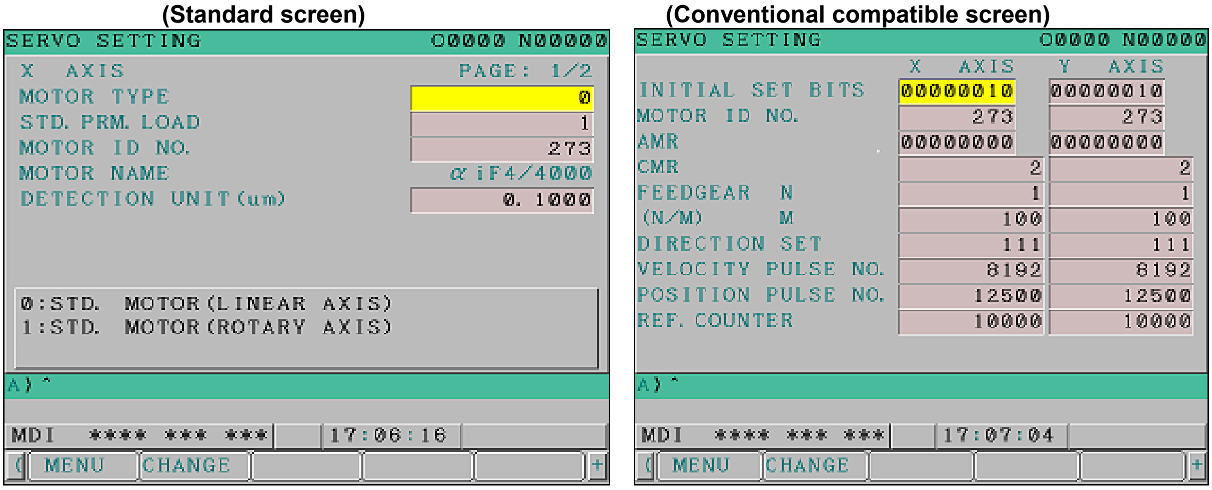
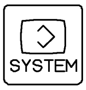


Fig. 2.1.3(b) 0*i*-D Series Servo tuning screen

When the servo setting screen (standard screen) is displayed, the servo setting screen (conventional compatible screen) can be displayed by operating the soft keys as follows:
[(OPRT)] → [▷] → [CHANGE]

● 30*i* Series



→ [SYSTEM] → [▷] → [SV-PRM]

If no servo screen appears, set the following parameter as shown, and switch the NC off and on again.

	#7	#6	#5	#4	#3	#2	#1	#0
3111								SVS

SVS (#0) 1: Displays the servo screen.
When the following screen appears, move the cursor to the item you want to specify, and enter the value directly.

Servo set		X axis	01000 N0000 Z axis	Corresponding parameter number
INITIAL SET BITS		00000010	00000010	No.2000
Motor ID No.		16	16	No.2020
AMR		00000000	00000000	No.2001
CMR		2	2	No.1820
CMR	N	0	0	No.1822
(N/M)	M	0	0	No.1823
Feed gear	N	1	1	No.2084
(N/M)	M	100	100	No.2085
Direction Set		111	111	No.2022
Velocity Pulse No.		8192	8192	No.2023
Position Pulse No.		12500	12500	No.2024
Ref. counter		10000	10000	No.1821

Fig. 2.1.3 (a) 30*i* Series Servo setting screen

> **NOTE**
> CMR(N/M) is displayed when arbitrary command multiplier (option) is enabled.

(2) Initialization

Start initialization. **Do not power off the NC until step (12).**

	#7	#6	#5	#4	#3	#2	#1	#0
2000							**DGPR**	**PLC0**

Reset initialization bit 1 (No.2000) to 0.
DGPR(#1)=0

(3) Motor ID No. setting

Specify the motor ID number.
Select the motor ID number of a motor to be used according to the motor model and motor specification (the middle four digits in A06B-****-B***) listed in the following tables.
The mark "☐" indicates a value that varies depending on the used options.
The mark "-" indicates that automatic loading of standard parameters is not supported as of November, 2012. Alternatively, this mark indicates an invalid combination.

> **NOTE**
> For linear motors and synchronous built-in servo motors, see Chapter 3, "SETTING PARAMETERS OF LINEAR MOTOR AND SYNCHRONOUS BUILT-IN SERVO MOTOR".

α*i*S series servo motor

Motor model	Motor specification	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
α*i*S 2/5000	0212	262	03.0	A	01.0	A	A
α*i*S 2/6000	0218	284	03.0	G	01.0	A	A
α*i*S 4/5000	0215	265	03.0	A	01.0	A	A
α*i*S 4/6000	0210	466	03.0	28.0	04.0	D	A
α*i*S 8/4000	0235	285	03.0	A	01.0	A	A
α*i*S 8/6000	0232	290	03.0	G	01.0	A	A
α*i*S 12/4000	0238	288	03.0	A	01.0	A	A
α*i*S 12/6000	0230	462	03.0	27.0	01.0	D	A
α*i*S 22/4000	0265	315	03.0	A	01.0	A	A
α*i*S 22/6000	0262	452	03.0	Q	01.0	A	A
α*i*S 30/4000	0268	318	03.0	A	01.0	A	A
α*i*S 40/4000	0272	322	03.0	A	01.0	A	A
α*i*S 50/2000	0042	468	03.0	28.0	04.0	D	A
α*i*S 50/3000	0275-B□0□	324	03.0	B	01.0	A	A
α*i*S 50/3000 FAN	0275-B□1□	325	03.0	A	01.0	A	A
α*i*S 60/2000	0044	470	03.0	28.0	04.0	D	A
α*i*S 60/3000 FAN	0278	328	03.0	28.0	04.0	D	A
α*i*S 100/2500	0285-B□0□	335	03.0	A	01.0	A	A
α*i*S 100/2500 FAN	0285-B□1□	330	03.0	P	01.0	A	A
α*i*S 200/2500	0288-B□0□	338	03.0	A	01.0	A	A
α*i*S 200/2500 FAN	0288-B□1□	334	03.0	P	01.0	A	A

α*i*S series servo motor (for 200-V driving, multiple windings)

Motor model	Motor specification	Number of windings	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
α*i*S 300/2000	0292	2	342	03.0	B	01.0	A	A
α*i*S 500/2000	0295	2	345	03.0	A	01.0	A	A

α*i*F series servo motor

Motor model	Motor specification	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
α*i*F 1/5000	0202	252	03.0	A	01.0	A	A
α*i*F 2/5000	0205	255	03.0	A	01.0	A	A
α*i*F 4/4000	0223	273	03.0	A	01.0	A	A
α*i*F 8/3000	0227	277	03.0	A	01.0	A	A
α*i*F 8/4000	0228	492	18.0	-	-	-	-
α*i*F 12/3000	0243	293	03.0	A	01.0	A	A
α*i*F 22/3000	0247	297	03.0	A	01.0	A	A
α*i*F 22/4000	0248	494	18.0	-	-	-	-
α*i*F 30/3000	0253	303	03.0	A	01.0	A	A
α*i*F 40/3000	0257-B□0□	307	03.0	A	01.0	A	A
α*i*F 40/3000 FAN	0257-B□1□	308	03.0	A	01.0	A	A

αiS series servo motor (for 400-V driving)

Motor model	Motor specification	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
αiS 2/5000HV	0213	263	03.0	A	01.0	A	A
αiS 2/6000HV	0219	287	03.0	G	01.0	A	A
αiS 4/5000HV	0216	266	03.0	A	01.0	A	A
αiS 4/6000HV	0214	467	03.0	28.0	04.0	D	A
αiS 8/4000HV	0236	286	03.0	A	01.0	A	A
αiS 8/6000HV	0233	292	03.0	G	01.0	A	A
αiS 12/4000HV	0239	289	03.0	A	01.0	A	A
αiS 12/6000HV	0237	463	03.0	27.0	01.0	D	A
αiS 22/4000HV	0266	316	03.0	A	01.0	A	A
αiS 22/6000HV	0263	453	03.0	Q	01.0	A	A
αiS 30/4000HV	0269	319	03.0	A	01.0	A	A
αiS 40/4000HV	0273	323	03.0	A	01.0	A	A
αiS 50/2000HV	0043	469	03.0	28.0	04.0	D	A
αiS 50/3000HV	0276-B□0□	327	03.0	B	01.0	A	A
αiS 50/3000HV FAN	0276-B□1□	326	03.0	A	01.0	A	A
αiS 60/2000HV	0045	471	03.0	28.0	04.0	D	A
αiS 60/3000HV FAN	0279	329	03.0	28.0	04.0	D	A
αiS 100/2500HV	0286-B□0□	336	03.0	B	01.0	A	A
αiS 100/2500HV FAN	0286-B□1□	331	03.0	P	01.0	A	A
αiS 200/2500HV	0289-B□0□	339	03.0	B	01.0	A	A
αiS 200/2500HV FAN	0289-B□1□	337	03.0	P	01.0	A	A
αiS 300/2000HV	0293	343	03.0	B	01.0	A	A
αiS 300/3000HV (Note)	0290	344	03.0	28.0	04.0	F	A
αiS 500/2000HV	0296	346	03.0	B	01.0	A	A
αiS 500/3000HV (Note)	0297	347	03.0	28.0	04.0	F	A

NOTE

A servo amplifier (αiSV or αiPS) corresponding to voltage information is required. For details, see Section 2.2, "SETTING PARAMETERS FOR LARGE SERVO MOTORS".

αiS series servo motor (for 400-V driving, multiple windings)

Motor model	Motor specific ation	Number of windings	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
αiS 1000/2000HV	0298	2	348	03.0	B	01.0	A	A
αiS 1000/2000HV (Note)	0098	2	458	03.0	28.0	04.0	F	A
αiS 1000/3000HV (Note)	0099	4	350 (PDM)	-	-	-	D	A
			465	03.0	28.0	04.0	-	-
αiS 2000/2000HV (Note)	0091	4	454 (PDM)	-	-	-	D	A
			459	03.0	28.0	04.0	-	-
αiS 2000/2000HV (Note) For spindle use	0091	4	476	12.0	33.0	10.0	F	D
αiS 3000/2000HV (Note)	0092	4	455 (PDM)	-	-	-	D	A
			460	03.0	28.0	04.0	-	-

NOTE

A servo amplifier (αiSV or αiPS) corresponding to voltage information is required. For details, see Section 2.2, "SETTING PARAMETERS FOR LARGE SERVO MOTORS".
The number followed by (PDM) is used as the motor number in a configuration in which a PWM distribution module (PDM) is used.

αiF series servo motor (for 400-V driving)

Motor model	Motor specification	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
αiF 4/4000HV	0225	275	03.0	A	01.0	A	A
αiF 8/3000HV	0229	279	03.0	A	01.0	A	A
αiF 8/4000HV	0220	493	18.0	-	-	-	-
αiF 12/3000HV	0245	295	03.0	A	01.0	A	A
αiF 22/3000HV	0249	299	03.0	A	01.0	A	A
αiF 22/4000HV	0240	495	18.0	-	-	-	-
αiF 30/3000HV	0255	304	12.0	33.0	10.0	F	C
αiF 40/3000HV	0259-B□0□	309	12.0	33.0	10.0	F	C
αiF 40/3000HV FAN	0259-B□1□	479	12.0	33.0	10.0	F	C

αCi series servo motor

Motor model	Motor specification	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
αC4/3000i	0221	271	03.0	A	01.0	A	A
αC8/2000i	0226	276	03.0	A	01.0	A	A
αC12/2000i	0241	291	03.0	A	01.0	A	A
αC22/2000i	0246	296	03.0	A	01.0	A	A
αC30/1500i	0251	301	03.0	A	01.0	A	A

βiS series servo motor

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
βiS0.2/5000	0111	4A	260	03.0	A	01.0	A	A
βiS 0.3/5000	0112	4A	261	03.0	A	01.0	A	A
βiS 0.4/5000	0114	20A	280	03.0	A	01.0	A	A
βiS 0.5/6000	0115	20A	281	03.0	G	01.0	A	A
βiS 1/6000	0116	20A	282	03.0	G	01.0	A	A
βiS 2/4000	0061 (Note 1,2)	20A	253	03.0	B	01.0	A	A
		40A	254	03.0	B	01.0	A	A
βiS 4/4000	0063 (Note 1,2)	20A	256	03.0	B	01.0	A	A
		40A	257	03.0	B	01.0	A	A
βiS 8/3000	0075 (Note 1,2)	20A	258	03.0	B	01.0	A	A
		40A	259	03.0	B	01.0	A	A
βiS 12/2000	0077 (Note 1,2)	20A	269	03.0	K	01.0	A	A
		40A	268	03.0	P	01.0	A	A
βiS 12/3000	0078 (Note 2)	40A	272	03.0	B	01.0	A	A
		80A	477	12.0	33.0	10.0	F	C
βiS 22/2000	0085 (Note 2)	40A	274	03.0	B	01.0	A	A
		80A	478	12.0	33.0	10.0	F	C
βiS 22/3000	0082	80A	313	03.0	Q	01.0	A	A
βiS 30/2000	0087	80A	472	03.0	29.0	05.0	F	A

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
βiS 40/2000	0089	80A	474	03.0	29.0	05.0	F	A

βiS series servo motor (for 400-V driving)

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
βiS 2/4000HV	0062	10A	251	03.0	J	01.0	A	A
βiS 4/4000HV	0064	10A	264	03.0	J	01.0	A	A
βiS 8/3000HV	0076	10A	267	03.0	J	01.0	A	A
βiS 12/3000HV	0079	20A	270	03.0	J	01.0	A	A
βiS 22/2000HV	0086	20A	278	03.0	J	01.0	A	A
βiS 22/3000HV	0083	40A	314	03.0	Q	01.0	A	A
βiS 30/2000HV	0088	40A	473	03.0	29.0	05.0	F	A
βiS 40/2000HV	0090	40A	475	03.0	29.0	05.0	F	A

βiS series servo motor (dedicated to FS0i)

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90C5 90E5	90C8 90E8
βiS 2/4000	0061-B□□6	20A	306	A	A
		40A	310	A	A
βiS 4/4000	0063-B□□6	20A	311	A	A
		40A	312	A	A
βiS 8/3000	0075-B□□6	20A	283	A	A
		40A	294	A	A
βiS 12/2000	0077-B□□6	20A	298	A	A
		40A	300	A	A
βiS 22/1500	0084-B□□6	20A	302	A	A
		40A	305	A	A

The motor models above can be driven only with Series 90C5, 90E5, 90C8, or 90E8 for the 0*i*-D Series.

NOTE
A βiSVSP servo amplifier is assumed to be used for a combination in which an amplifier with higher power is used.

βiSc series servo motor (dedicated to FS0i Mate-TD)

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90C5 90E5	90C8 90E8
βiSc 2/4000	0061-B□□7	20A	306	A	A
		40A	310	A	A
βiSc 4/4000	0063-B□□7	20A	311	A	A
		40A	312	A	A
βiSc 8/3000	0075-B□□7	20A	283	A	A
		40A	294	A	A
βiSc 12/2000	0077-B□□7	20A	298	A	A
		40A	300	A	A

The motor models above can be driven only with Series 90C5, 90E5, 90C8, or 90E8 for the 0*i*-D Series.

NOTE
A βiSVSP servo amplifier is assumed to be used for a combination in which an amplifier with higher power is used.

βiF series servo motor

Motor model	Motor specification	Amplifier driving	Motor ID No. (HRV2)	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
βiF 4/3000	0051	20A	483	18.0	-	-	-	04.0
		40A	484	18.0	-	-	-	04.0
βiF 8/2000	0052	20A	485	18.0	-	-	-	04.0
		40A	486	18.0	-	-	-	04.0
βiF 12/2000	0053	20A	487	18.0	-	-	-	04.0
		40A	488	18.0	-	-	-	04.0
βiF 22/2000	0054	40A	489	18.0	-	-	-	04.0
		80A	490	18.0	-	-	-	04.0
βiF 30/1500	0055	80A	491	18.0	-	-	-	04.0

NOTE
A βiSVSP servo amplifier is assumed to be used for a combination in which an amplifier with higher power is used.

(4) AMR setting

Set, as AMR, a setting value of following table.

Motor type	AMR setting
αiS/αiF/βiS/βiF motor (other than αiS2000HV and αiS3000HV)	00000000
αiS2000HV and αiS3000HV	00001000

(5) CMR setting

Set, as CMR, a specified magnification for the amount of movement from the NC to the servo system.
CMR = Command unit / Detection unit

CMR 1/2 to 48	Setting value = CMR × 2

Usually, set CMR with 2 to parameter No. 1820, because command unit = detection unit (CMR = 1).

If the detection unit may be a special value, you can enable arbitrary command multiplier (option) and specify numerator N denominator M of command-unit/detection unit = N/M for parameters Nos. 1822 and 1823, respectively. A value of 1 or greater must be specified for parameters Nos. 1822 and 1823.

Valid data range of CMR when arbitrary multiplication is enabled

CMR 1/9999 to 9999/1	Setting value = CMR

(6) Flexible feed gear setting

Specify the flexible feed gear (F·FG). This function makes it easy to specify a detection unit for the leads and gear reduction ratios of various ball screws by changing the number of position feedback pulses from the Pulsecoder or separate detector. It converts the incoming number of pulses from the position detector so that it matches the commanded number of pulses. When using a linear motor, set F·FG according to the description in Section 3.1, "LINEAR MOTOR PARAMETER SETTING". When using a synchronous built-in servo motor, set F·FG according to the description in Section 3.2, "SYNCHRONOUS BUILT-IN SERVO MOTOR PARAMETER SETTING".

(a) Semi-closed feedback loop

Setting for the αi Pulsecoder

$$\frac{\text{F·FG numerator } (\leq 32767)}{\text{F·FG denominator } (\leq 32767)} \stackrel{\downarrow \text{(Note 1)}}{=} \frac{\text{Necessary position feedback pulses per motor revolution}}{1{,}000{,}000 \leftarrow \text{(Note 2)}} \quad \text{(as irreducible fraction)}$$

NOTE

1 For both F·FG numerator and denominator, the maximum setting value (after reduced) is 32767.
2 αi Pulse coders assume one million pulses per motor revolution, irrespective of resolution, for the flexible feed gear setting.
3 If the calculation of the number of pulses required per motor revolution involves π, such as when a rack and pinion are used, assume π to be approximately 355/113.

Example of setting

If the ball screw used in direct coupling has a lead of 5 mm/rev and the detection unit is 1 μm

The number of pulses generated per motor turn (5 mm) is:
5/0.001 = 5,000 (pulses)
Because the αi Pulsecoder feeds back 1,000,000 pulses per motor turn:
FFG = 5,000 / 1,000,000 = 1 / 200

Other FFG (numerator/denominator) setting examples, where the gear reduction ratio is assumed to be 1:1

Detection unit	Ball screw lead					
	6mm	8mm	10mm	12mm	16mm	20mm
1μm	6 / 1000	8 / 1000	10 / 1000	12 / 1000	16 / 1000	20 / 1000
0.5μm	12 / 1000	16 / 1000	20 / 1000	24 / 1000	32 / 1000	40 / 1000
0.1μm	60 / 1000	80 / 1000	100 / 1000	120 / 1000	160 / 1000	200 / 1000

Example of setting

If the gear reduction ratio between the rotary axis motor and table is 10:1 and the detection unit is 1/1,000 degrees

The table rotates through 360/10 degrees when the motor makes one turn.
The number of position pulses necessary for the motor to make one turn is:
360/10 ÷ (1/1000) = 36,000 pulses

$$\frac{\text{F·FG numerator}}{\text{F·FG denominator}} = \frac{36{,}000}{1{,}000{,}000} = \frac{36}{1{,}000}$$

Example of setting

If the gear reduction ratio between the rotary axis motor and table is 300:1 and the detection unit is 1/10,000 degrees

The table rotates through 360/300 degrees when the motor makes one turn.
The number of position pulses necessary for the motor to make one turn is:
360/300 ÷ (1/10,000) = 12,000 pulses

$$\frac{\text{F·FG numerator}}{\text{F·FG denominator}} = \frac{12{,}000}{1{,}000{,}000} = \frac{12}{1{,}000}$$

Example of setting

If a rack and pinion are used in direct coupling, the radius of the pinion is 10 mm, and the detection unit is 1 μm

The rack moves by 20π mm when the motor makes one turn.

The number of pulses generated per motor turn is $20\pi/0.001 \fallingdotseq (20 \times 355/113)/0.001 = 7{,}100{,}000/113$ (pulses)

$$\frac{\text{F·FG numerator}}{\text{F·FG denominator}} = \frac{7100{,}000}{1{,}000{,}000 \times 113} = \frac{71}{1{,}130}$$

(b) Full-closed feedback loop

Setting for use of a separate detector (full-closed)

$$\frac{\text{F·FG numerator } (\leq 32767)}{\text{F·FG denominator } (\leq 32767)} = \frac{\text{Number of position pulses corresponding to a predetermined amount of travel}}{\text{Number of position pulses corresponding to a predetermined amount of travel from a separate detector}}$$

(as irreducible fraction)

Example of setting

To detect a distance of 1-μm using a 0.5-μm scale, set the following:
(L represents a constant distance.)

$$\frac{\text{Numerator of F·FG}}{\text{Denominator of F·FG}} = \frac{L/1}{L/0.5} = \frac{1}{2}$$

Other FFG (numerator/denominator) setting examples

Detection unit	Scale resolution			
	1 μm	0.5 μm	0.1 μm	0.05 μm
1 μm	1 / 1	1 / 2	1 / 10	1 / 20
0.5 μm	-	1 / 1	1 / 5	1 / 10
0.1 μm	-	-	1 / 1	1 / 2

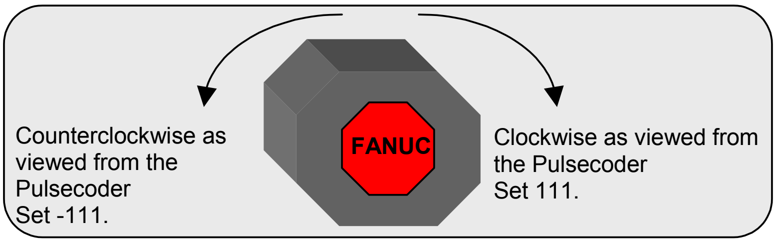
NOTE

The maximum rotation speed allowable with servo software depends on the detection unit. (See Appendix D, "VELOCITY LIMIT VALUES IN SERVO SOFTWARE".) Select a detection unit that enables a requested maximum rotation speed to be realized. When a speed of up to 6000 revolutions is used as a live tool in the direct motor connection mode, in particular, use a detection unit of 2/1000 deg (IS-B setting, CMR=1/2, flexible feed gear=18/100).

(7) Motor rotation direction setting

Set the direction in which the motor is to turn when a positive value is specified as a move command. For linear motors, set the parameter according to the description in Section 3.1, "LINEAR MOTOR PARAMETER SETTING". For synchronous built-in servo motors, set the parameter according to the description in Section 3.2, "SYNCHRONOUS BUILT-IN SERVO MOTOR PARAMETER SETTING".

111	Clockwise as viewed from the Pulsecoder
−111	Counterclockwise as viewed from the Pulsecoder



(8) Specify the number of velocity pulses and the number of position pulses.

Set the number of velocity pulses and the number of position pulses according to the connected detector. For linear motors, set these parameters according to the description in Section 3.1, "LINEAR MOTOR PARAMETER SETTING". For synchronous built-in servo motors, set these parameters according to the description in Section 3.2, "SYNCHRONOUS BUILT-IN SERVO MOTOR PARAMETER SETTING".

(a) Number of velocity pulses

Set the number of velocity pulses to 8192.

αiS/αiF/βiS/βiF motor	8192

(b) Number of position pulses

(b)-1 Number of position pulses for semi-closed feedback loop

Set the number of position pulses to 12500.

Number of position pulses (αiS/αiF/βiS/βiF motor, semi-closed feedback loop)	12500

(b)-2 Number of position pulses for full-closed feedback loop (See Subsections 2.1.5 and 2.1.6)

Set the number of position pulses to the number of pulses fed back from the separate detector when the motor makes one turn. (The flexible feed gear has nothing to do with the calculation of the number of position pulses).

Number of position pulses (full-closed feedback loop)	Number of pulses fed back from the separate detector when the motor makes one turn

When using a serial rotary scale with a resolution of 1,000,000 pulses per revolution, set the value obtained using the following formula:

Number of position pulses (full-closed feedback loop) (*) 1,000,000 pulses / rev	12,500 ×(motor-table gear reduction ratio)

Example 1:
Parallel type, serial linear scale
If the ball screw used in direct coupling has a lead of 10 mm and the separate detector used has a resolution of 0.5 μm per pulse
Number of position pulses = 10 / 0.0005 = 20,000

Example 2:
Serial rotary scale
If the motor-table gear reduction ratio is 10:1,
Number of position pulses = 12,500 × (1/10) = 1,250

Example 3:
Serial rotary scale
If the motor-table gear reduction ratio is indivisible by 7:1,
Number of position pulses = 12,500 × (1/7) = 1785.714286 ≒ 1786 (rounded to the nearest integer)

NOTE

If the calculated number of position pulses is not an integer, set the nearest integer.
Let the calculated value be P and its nearest integer be P'. Then, the position gain and feed-forward coefficient are multiplied by P/P'. If the gear reduction ratio is large and the calculated value is small, they are largely affected. If there is a problem, make a fine adjustment by specifying an appropriate value for the position gain (parameter No. 1825) and feed-forward coefficient (parameter No. 2092).

(b)-3 If the setting for the number of position pulses is larger than 32767

If the number of position pulses exceeds 32767, set the number of position pulses with a product of two parameters, using the conversion coefficient for the number of position feedback pulses.

2185	Conversion coefficient for the number of position feedback pulses

→ See Supplementary 3 of Subsection 2.1.9.

NOTE

By setting initialization bit 0 of No. 2000 to 1, the number of velocity pulses and the number of position pulses can be internally increased by a factor of 10. Usually, however, set bit 0 of No. 2000 to 0. If the number of position pulses is beyond the setting range, use a position pulse conversion coefficient (parameter No. 2185). Only in the situations indicated below, set bit 0 of No. 2000 to 1, set the number of velocity pulses to one-tenth of the value to be originally set, and also set the number of position pulses to one-tenth of the value to be originally set.

- When the number of velocity pulses exceeds 32767 because a high-resolution detector is used with a linear motor or synchronous built-in servo motor

(9) Reference counter setting

Specify the reference counter.
The reference counter is used in making a return to the reference position by a grid method.

(a) Semi-closed loop

(Linear axis)		
Count on the reference counter	=	Number of position pulses corresponding to a single motor revolution or the same number divided by an integer value
(Rotary axis)		
Count on the reference counter	=	Number of position pulses corresponding to a single motor revolution/N, or the same number divided by an integer value
* When the motor-table gear reduction ratio is N/D (N and D are integers, and N/D is a fraction that is reduced to lowest terms.)		

NOTE

1 If the calculation above results in a fraction, a setting can be made with a fraction. See Item (a)-1.

2 If the number of revolutions of the motor is not an integer multiple of the number of revolutions of the table on the rotary axis, the reference counter capacity needs to be set so that the point (grid point) where the reference counter equals 0 appears at the same position relative to the table. So, with the rotary axis, the number of position pulses per motor revolution needs to be multiplied by 1/N.

Example of setting

α*i* Pulsecoder and semi-closed loop (1-μm detection)

Ball screw lead (mm/revolution)	Necessary number of position pulses (pulse/revolution)	Reference counter	Grid width (mm)
10	10000	10000	10
20	20000	20000	20
30	30000	30000	30

When the number of position pulses corresponding to a single motor revolution does not agree with the reference counter setting, the position of the zero point depends on the start point.
In such a case, set the reference counter capacity with a fraction to change the detection unit and eliminate the error in the reference counter.

Example of setting

System using a detection unit of 1 μm, a ball screw lead of 20 mm/revolution, and a gear reduction ratio of 1/17
To eliminate the error of the reference counter, two methods of setting are available:
(a)-1 Method that sets a reference counter capacity with a fraction
(a)-2 Method that changes the detection unit
An example of each setting method is explained below.

(a)-1 Method of specifying the reference counter capacity with a fraction

The number of position pulses necessary for the motor to make one turn is: 20000/17
Set the following parameter as stated below.

1821	Reference counter capacity (numerator)

[Valid data range] 0 to 99999999
Set the numerator of a fraction for the reference counter capacity.

2179	Reference counter capacity (denominator)

[Valid data range] 0 to 100
A value up to around 100 is assumed to be set as the denominator of the reference counter capacity. If a larger value is set, the grid width becomes too small, which makes it difficult to perform reference position return by grid method. In addition, the processing time of the servo software increases, which may causes a system alarm. For this reason, if a value of 101 or greater is set as the denominator, an invalid ordinary parameter alarm (detail No. 1793) is issued.
The denominator parameter is not indicated in the servo setting screen, so it must be set in the parameter screen.
In this example, set the numerator and denominator, respectively, to 20000 and 17.

> **NOTE**
> Even if a setting is made with a fraction, set the number of position pulses per motor revolution/M for a semi-closed loop rotary axis when the reduction ratio is N/D.
> Reference counter =
> Number of position pulses per motor revolution/N, or
> The same number divided by an integer

If you want to set a value greater than 100 as the reference counter capacity (denominator), you can set the following parameter to disable invalid parameter detection.

	#7	#6	#5	#4	#3	#2	#1	#0
2299			IGNRFA					

INGRFA(#5) The detection of an invalid parameter set for the denominator of the reference counter capacity is:
0 : Performed.
1 : Not performed.
* If this parameter is set, the power must be turned off before operation is continued.

> **NOTE**
> If an invalid parameter alarm (detail No. 1793) may be issued according to the status, setting IGNRFA to 1 may cause a system alarm. In this case, set IGNRFA to 0.

(a)-2 Method of changing the detection unit

The number of position pulses necessary for the motor to make one turn is: 20000/17
In this case, increase all the following parameter values by a factor of 17, and set the detection unit to 1/17 μm.

Parameter modification		Series 30*i*, 0*i*-D, Power Motion *i*-A and so on
FFG	× 17	Servo screen
CMR	× 17	Servo screen
Reference counter	× 17	Servo screen
Effective area	× 17	No. 1826, 27
Position error limit in traveling	× 17	No. 1828
Position error limit in the stop state	× 17	No. 1829
Backlash	× 17	No. 1851, 52

Changing the detection unit from 1 μm to 1/17 μm requires multiplying each of the parameter settings made for the detection unit by 17.

> ⚠ **CAUTION**
> In addition to the above parameters, there are some parameters that are to be set in detection units. For details, see Appendix B.

Making these modifications eliminates the difference between the number of position pulses corresponding to a single motor revolution and the reference counter setting.
Number of position pulses corresponding to a single motor revolution = 20000
Reference counter setting = 20000

(b) Full-closed loop (See Subsections 2.1.5 and 2.1.6)

Reference counter setting	=	Z-phase (reference-position) interval divided by the detection unit, or this value sub-divided by an integer value

> **NOTE**
> If the separate detector-table rotation ratio for the rotary axis is not an integer, it is necessary to set the reference counter capacity in such a way that points where reference counter = 0 (grid points) appear always at the same position for the table.

Example of setting

Example 1) When the Z-phase interval is 50 mm and the detection unit is 1 μm:
Reference counter setting = 50,000/1 = 50,000

Example 2) When a rotary axis is used and the detection unit is 0.001 degrees:
Reference counter setting = 360/0.001 = 360,000

Example 3) When a linear scale is used and a single Z phase exists:
Set the reference counter to 10000, 50000, or another round number.

If the calculated value of the reference counter capacity is not an integer, the reference counter capacity can be set as a fraction as in the case of a semi-closed loop. For details of parameters, see (a)-1.

> **NOTE**
> The following value can be set as a reference counter capacity:
> (For linear axis)
> Number of position pulses corresponding to the Z-phase interval of a separate detector (or the same number divided by an integer)
> (For rotary axis)
> Number of position pulses per revolution of a separate detector/N (or the same number divided by an integer)
> (*) When the rotation ratio between the table and separate detector is N/D (N and D are integers, and N/D is a fraction that is reduced to lowest terms.)

(10) Full-closed system setting (go to (11) if a semi-closed system is in use)

For a full-closed system, it is necessary to set the following function bit.

	#7	#6	#5	#4	#3	#2	#1	#0
1815							OPTX	

OPTX(#1) The separate position detector is:
0: Not to be used
1: To be used

↑ To be specified for every CNC.

If you want to connect the separate detector signal in the reverse direction, use the following parameter:

	#7	#6	#5	#4	#3	#2	#1	#0
2018								RVRSE

RVRSE (#0) The signal direction of the separate detector is:
0: Not reversed.
1: Reversed.

For a full-closed system, the use of the function for monitoring the difference in error between the semi-closed and full-closed modes is recommended. This function monitors the difference between the motor position and scale position.

2118	Dual position feedback: Level on which the difference in error between the semi-closed and full-closed modes becomes too large

[Setting value] Level on which the difference in error is too large (μm)/detection unit (μm) or level on which the difference in error is too large (μm)

[Setting unit] Detection unit or 1 μm (→ See the explanation of bit 7 of parameter No. 2420.)

If the difference between the Pulsecoder and the separate detector is greater than or equal to the value specified for the parameter, the abnormal status is assumed and an alarm is issued.
Set a value two to three times as large as the backlash. When a value of 0 is set, the detection is disabled.

2078	Dual position feedback conversion coefficient (numerator)

2079	Dual position feedback conversion coefficient (denominator)

[Setting value] Reduce the following fraction and use the resulting irreducible fraction.

$$\text{Conversion coefficient} \left(\frac{\text{Numerator}}{\text{Denominator}} \right) = \frac{\text{Number of position feedback pulses per motor revolution (Value multiplied by the feed gear)}}{\text{1 million}}$$

(Example)

When the α*i* Pulsecoder is used with a tool travel of 10 mm/motor revolution (1 μm/pulse)

$$\text{Conversion coefficient} \left(\frac{\text{Numerator}}{\text{Denominator}} \right) = \frac{10 \times 1000}{1{,}000{,}000} = \frac{1}{100}$$

	#7	#6	#5	#4	#3	#2	#1	#0
2420	SFUMSET							

SFUMSET (#7) The unit of data for the level on which the difference in error between the semi-closed and full-closed modes becomes too large (parameter No. 2118) is:

0: Detection unit

1: 1 μm

* Use this parameter when the detection unit is too small to set a necessary value within the valid data range for parameter No. 2118.

NOTE

With the 30*i*–B Series, when an analog input separate detector interface unit is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is automatically enabled. If the level on which the difference in error between the semi-closed and full-closed modes is too large (parameter No. 2118) or a conversion coefficient (parameter No. 2078 or 2079) is not set, an invalid parameter alarm (detail No. 1183) is issued. Be sure to set these parameters when using an analog input separate detector interface unit.
However, the monitoring function cannot be enabled in the following system. In this case, disable the alarm detection (set bit 0 of parameter No. 2565 to 1).

- The gear reduction ratio between the motor and detector greatly changes according to the machine position.
- The belt or another part between the motor and detector can slip.

(11) Servo loop gain setting

Set a value other than 0 as a servo loop gain. Usually, set an initial value of 3000 (30 [sec^{-1}]). (This initial value is adjusted later as needed.)

Servo loop gain	3000 (guideline)

[Setting unit] 0.01 [sec^{-1}]

NOTE

1. When a servo loop gain of 0 is set, an illegal servo parameter setting alarm is issued.
2. If there is a problem such as vibration occurring at the time of motor rotation after the NC is started, perform servo tuning according to Chapter 4.

(12) NC restart

Switch the NC off and on again.
After the NC is switched off and on again, bit 1 of parameter No. 2000 (DGPR) is set to "1".
This completes servo parameter initialization.
If an illegal servo parameter setting alarm occurs, go to Subsec. 2.1.9.
If a servo alarm related to Pulsecoders occurs for an axis for which a servo motor or amplifier is not connected, specify the following parameter.

	#7	#6	#5	#4	#3	#2	#1	#0
2009								DMY

DMY (#0) The serial feedback dummy function is: (See Appendix H.1, “SERIAL FEEDBACK DUMMY FUNCTIONS” for function detail)
0 : Not used
1 : Used

(13) Absolute position detector setting

When you are going to use an αi/βi Pulsecoder as an absolute Pulsecoder, use the following procedure.

Procedure

1. Specify the following parameter, then switch the NC off.

	#7	#6	#5	#4	#3	#2	#1	#0
1815			APCx					

APCx (#5) The absolute position detector is:
0: Not used
1: Used

2. After making sure that the battery for the Pulsecoder is connected, turn off the CNC.
3. A request to return to the reference position is displayed.
4. Cause the servo motor to make one turn by jogging.
5. Turn off and on the CNC.

⇦ These steps were added for the αi/βi Pulsecoder. (steps 3–5)

6. A request to return to the reference position is displayed.
7. Do the reference position return.

NOTE

1 When using a FANUC absolute Pulsecoder as an absolute position detector and making a setting so that the machine coordinate values on a rotary axis are rounded to 0° to 360° [rotary axis (A-type)], set bit 6 of parameter No. 1815 (RON) to 0.

2 If you want to use a detector with no speed data for a rotary encoder supplied by a vendor other than FANUC for absolute position detection, refer to "CORRESPONDENCE OF ROTARY SCALE WITHOUT ROTARY DATA" in "FANUC Series 30*i*/31*i*/32*i*-MODEL B CONNECTION MANUAL (FUNCTION) (B-64483EN-1)" and make an appropriate setting according to the detector. (See also Subsection 2.1.5, "Setting Servo Parameters when a Separate Detector for the Serial Interface Is Used".)

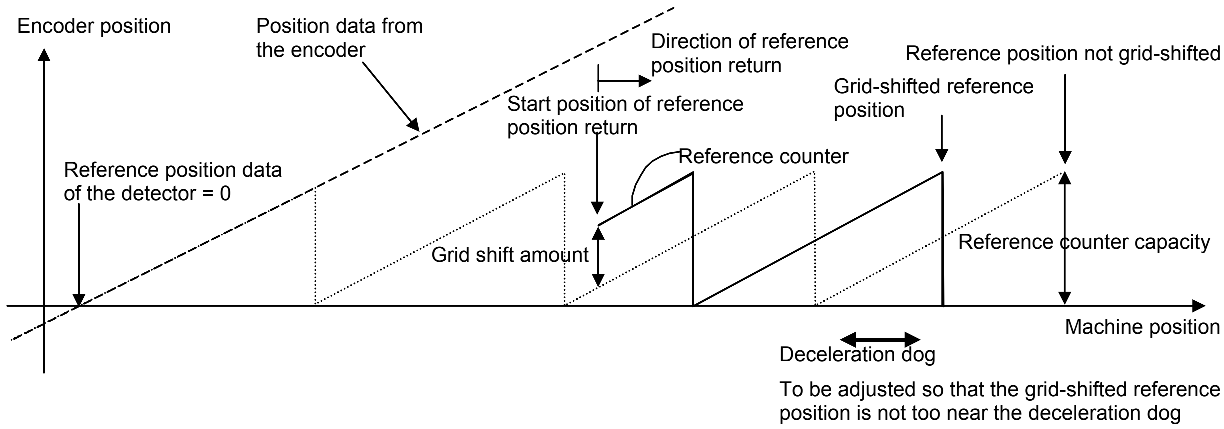
3 If the correct setting is not made, the machine coordinates are not established correctly at power-on.

(a) Reference position return when a serial type separate detector is used as an absolute-position detector

When a serial type separate detector is used as an absolute-position detector, the phase-Z position must be passed once before a reference position return is performed. Then, turn the CNC off then back on to allow reference position return.

(This description does not apply if a detector that does not require battery backup is in use.)

When reference position return is performed, adjust the deceleration dog so that the grid-shifted reference position is not too near the deceleration dog.



2.1.4 Servo Parameter Initialization Procedure for the Series 0*i*-D

2.1.4.1 PARAMETER SETTING SUPPORT screen (SERVO SETTING)

(1) Displaying the SERVO SETTING screen and entering a value for each setting item

On the PARAMETER SETTING SUPPORT screen, select "SERVO SETTING" to display the SERVO SETTING screen.

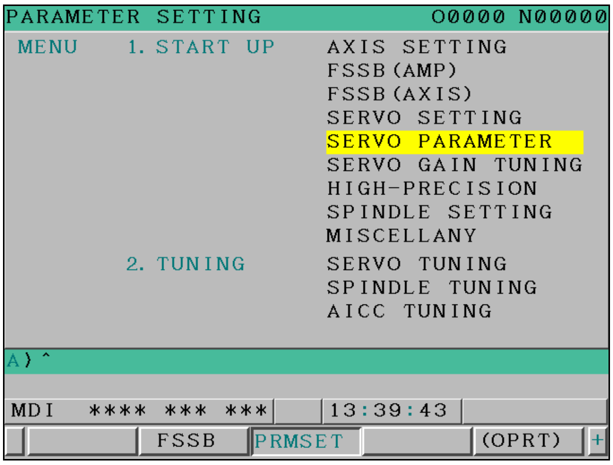


Fig. 2.1.4.1 (a) 0*i*-D PARAMETER SETTING SUPPORT screen

The SERVO SETTING screen consists of two pages. Enter physical constants including the gear ratio and ball screw lead according to the help message. For the motor number, see "(3) Motor ID No. setting" in Subsection 2.1.3.

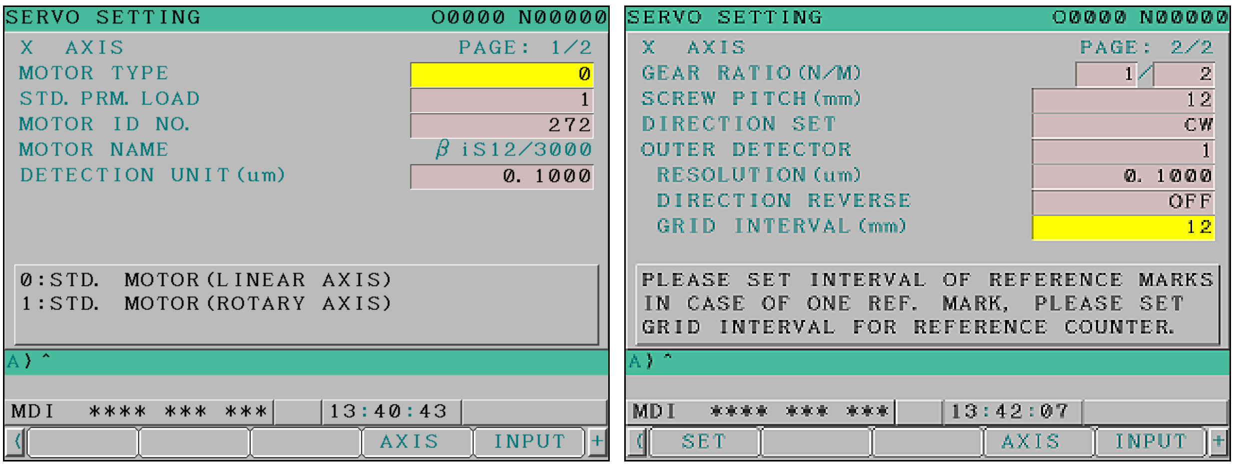


Fig. 2.1.4.1 (b) 0*i*-D PARAMETER SETTING SUPPORT screen (SERVO SETTING)

After you have entered values for all items, press soft key [SET]. The flexible feed gear, number of position pulses, number of velocity pulses, and other values are calculated and they are automatically set for the parameters listed in the table below.

(Parameters to be set)

Parameter No.	Description	Parameter No.	Description
No.2000#1	Initialization bit	No.2022	Direction of movement
No.2020	Motor ID number	No.2023	Number of velocity pulses
No.2001	AMR	No.2024	Number of position pulses (numerator)
No.1820	CMR	No.2185	Position pulses conversion coefficient
No.2084	FFG (numerator)	No.1821	Reference counter (numerator)
No.2085	FFG (denominator)	No.2179	Reference counter (denominator)
No.2274#0	Interpolation magnification		

When the setting is completed, soft key [SET] disappears.

Then, press soft key [AXIS] to select another axis and enter values for the axis in the same way.
After you have entered values for all axes, switch the NC off and on again.

NOTE
When the motor number or another item is set, alarm PW0000, "PLEASE TURN OFF POWER" may be issued and the alarm screen may be displayed. In this case, you do not need to turn the power off every time the alarm is issued. Display the SERVO SETTING screen again and set the remaining items.

2.1.4.2 SERVO SETTING screen: Setting items

The following table lists the setting items on the SERVO SETTING screen and the help messages displayed when these items are selected.

Item name	Help message	Remarks
MOTOR TYPE	0: STD. MOTOR(LINEAR AXIS) 1: STD. MOTOR(ROTARY AXIS)	
STD.PRM.LOAD	0: STD. PARAMETER LOADING IS EXECUTED AFTER POWER OFF/ON 1: STD. PARAMETER LOADING IS COMPLETED	
MOTOR ID NO.	000-150:HRV1 α,β,LINEAR 151-250:HRV1 α*i* ,β*i* 251-350:HRV2 α*i* ,β*i*	For the Series 0*i*-D and 30*i* series CNC, select the motor number for HRV2.
DETECTION UNIT(μm)	DETECTION UNIT IS LEAST RESOLUTION OF POSITION FEEDBACK PULSES THAT CNC USESFOR POSITION CONTROL.	
GEAR RATIO(N/M)	OUTPUT AXIS(MACHINE SIDE) ROTATES N REVOLUTION WHEN INPUT AXIS(MOTOR SIDE)ROTATES M REVOLUTION.	
SCREW PITCH(mm)	BALL SCREW PITCH IS DISTANCE PER 1 REVOLUTION OF BALL SCREW.	
MOTOR DIRECTION	CW :MOTOR ROUNDS CLOCKWISE FROM A SIGHT OF PULSE CODER BY PLUS MCMD CCW:MOTOR ROUNDS COUNTERCLOCKWISE	
OUTER DETECTOR	0:NONE 3:SDU+SERIAL CIR.(X2048) 1:ONLY SDU 4:ANALOG SDU 2:SDU+SERIAL CIR.(X512)	

Item name	Help message	Remarks
RESOLUTION (μm)	PLEASE SET RESOLUTION OR SIGNAL PITCH OF LINEAR SCALE.	These items are displayed when a value other than 0 is set for OUTER DETECTOR and the value indicating a standard motor (linear axis) is set for MOTOR TYPE.
DIRECTION REVERSE	ON: SIGN OF FEEDBACK PULSES FROM OUTER SCALE IS REVERSED OFF:SIGN IS NOT REVERSED	
GRID INTERVAL(mm)	PLEASE SET INTERVAL OF REFERENCE MARKSIN CASE OF ONE REF. MARK, PLEASE SET GRID INTERVAL FOR REFERENCE COUNTER.	
COUNT (BIT, λ)	PLEASE SET BIT NUMBER(ABS) OR LINE COUNT(INC) OF OUTER ROTARY ENCODER.	These items are displayed when a value other than 0 is set for OUTER DETECTOR and the value indicating a standard motor (ROTARY AXIS) is set for MOTOR TYPE.
UNIT OF COUNT	0:PULSE/REV. 1:BIT/REV.	
DIRECTION REVERSE	ON: SIGN OF FEEDBACK PULSES FROM OUTER SCALE IS REVERSED OFF:SIGN IS NOT REVERSED	

2.1.4.3 PARAMETER SETTING SUPPORT screen (SERVO PARAMETER)

On the PARAMETER SETTING SUPPORT screen, position the cursor on "SERVO PARAMETER" and press soft key [(OPRT)]. Soft key [INIT] appears. Execute soft key [G_INIT] to set recommended values for time constant, feed-forward, backlash acceleration, and other servo parameters for all axes.

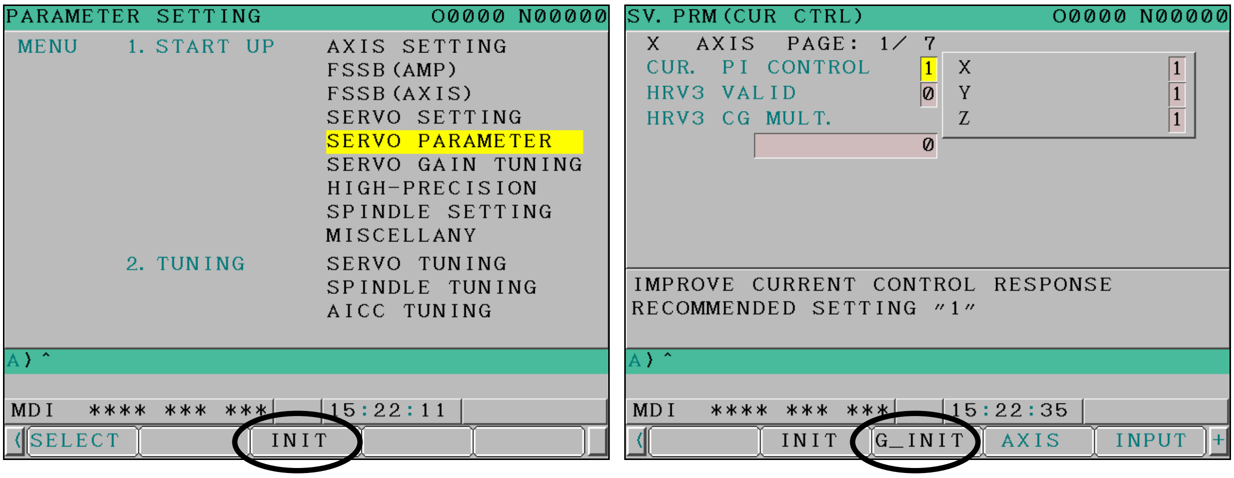


Fig. 2.1.4.3 (a) 0*i*-D PARAMETER SETTING SUPPORT screen (SERVO PARAMETER)

You can also select "SERVO PARAMETER" to display the SERVO PARAMETER screen and set recommended values for each axis.

(Parameters to be set)

Item name	Parameter No.	Setting value
CUR. PI CONTROL	No.2203#2	1
HRV3 CG MULT.	No.2334	150
PI CONTROL	No.2003	1
HIGH CYCLE PROP	No.2017#7	1
LATEST SPEED FB	No.2006#4	1
VG DOWN AT STOP	No.2016#3	1
STOP LEVEL	No.2119	2 / detection unit (μm)
VEL. GAIN	No.2021	100
TCMD FILTER	No.2067	1166

Item name	Parameter No.	Setting value
CUT/RPD VG SW	No.2202#1	1
VG MULT FOR CUT	No.2107	150
HRV3 VG MULT.	No.2335	200
POSITION GAIN	No.1825	5000
FF VALID	No.2005#1	M series:1, T series :0
RAPID FF VALID	No.1800#3	0
ADV. FF COEFF.	No.2092	10000
VEL. FF COEFF.	No.2069	50
BL COMP.	No.1851	1
FULL BL COMP.	No.2006#0	Full-closed system: 1 Semi-closed system: 0
BL ACC. VALID	No.2003#5	1
BL ACC. STOP	No.2009#7	1
BL ACC IN CUT 1	No.2009#6	1
BL ACC IN CUT 2	No.2223#7	1
2 STAGE BL ACC.	No.2015#6	0
BL ACC. VAL.	No.2048	50
BL ACC STOP VAL	No.2082	5 / detection unit (μm)
BL ACC. TIME	No.2071	20

2.1.4.4 PARAMETER SETTING SUPPORT screen (SERVO GAIN TUNING)

On the PARAMETER SETTING SUPPORT screen, select "SERVO GAIN TUNING ". The SERVO GAIN TUNING screen appears.

This screen shows the value set for the velocity control gain for each axis and the automatic adjustment status. Select soft key [ALL_AX] to start velocity gain adjustment sequentially from the axis displayed on the top row.

When the adjustment is completed, "TUN. FINISH " is displayed under TUN. STATUS.

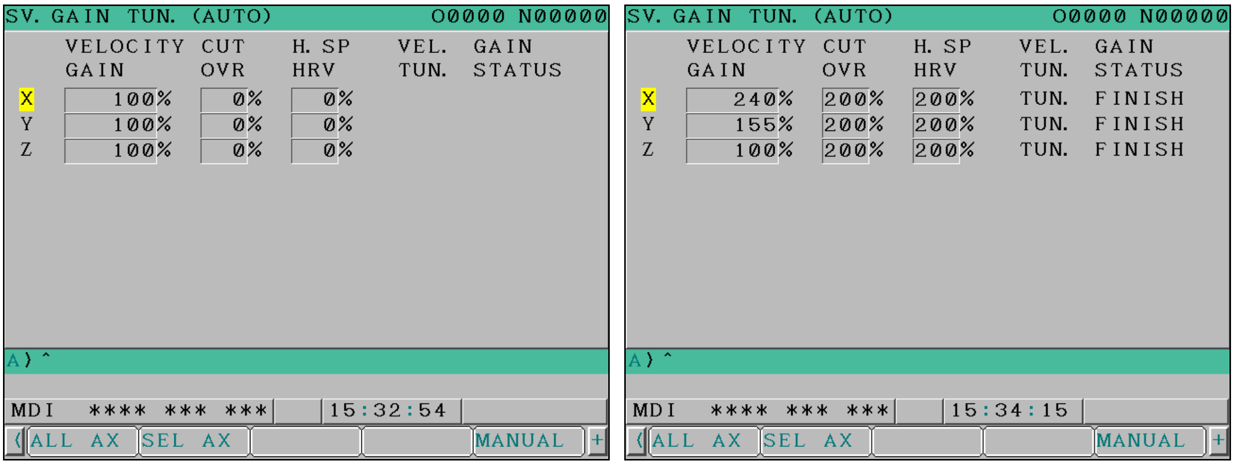


Fig. 2.1.4.4 (a) 0*i*-D PARAMETER SETTING SUPPORT screen (SERVO GAIN TUNING)

You can also select soft key [SEL_AX] to perform the adjustment for an axis at a time.

> **NOTE**
> For details of the PARAMETER SETTING SUPPORT screen of the Series 0*i*-D, refer to "FANUC Series 0*i*/0*i* Mate- MODEL D START-UP MANUAL (B-64304EN-3)".

2.1.5 Setting Servo Parameters when a Separate Detector for the Serial Interface is Used

(1) Overview

This subsection describes the setting of servo parameters for using a separate detector of serial output type. Perform parameter setting as described below according to the classification (model and configuration) of the serial detector used.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Classification of serial detectors and usable detector examples

Usable separate detectors for the serial interface are classified into six major types as shown below. Note that parameter settings vary with these types.

(a) Linear encoder (serial output type)

	Minimum resolution (μm)	Model	Backup
Mitutoyo	20/4096 0.05 0.1	AT555 AT353, AT553 ST753	Not required
HEIDENHAIN	0.05(0.01)	LC193F, LC493F	Not required
	0.01(0.05) 0.0125 (0.00125)*	LC195F, LC495F	Not required
Magnescale	0.01	SR87, SR77	Not required

(*) Indicates the resolution when the α*i* interface is used. The software editions usable for the α*i* interface are Series 90G0/19.0 and subsequent editions.

(b) Linear encoder (analog output type) + high-resolution serial output circuit

	Signal pitch (μm)	Model	Backup
Mitutoyo	20	AT402E	Not allowed
HEIDENHAIN	20 4	LS487(C), LS187(C) LF485, LF185	Not allowed
Renishaw	20 40	RG2 RG4	Not allowed

(c) Rotary encoder (serial output type)

	Number of counts/rev*	Model	Backup
FANUC	2^{20} pulses	αA1000S	Required
HEIDENHAIN	2^{23} pulses 2^{27} pulses	RCN223F RCN227F,RCN727F RCN827F	Not required
Mitsubishi Heavy Industries	2^{23} pulses	MPRZ + ADB20J70	Not required

	Number of counts/rev*	Model	Backup
Magnescale	2^{23} pulses	RU77-4096GA	Not required
Renishaw	2^{23} pulses, 2^{27} pulses	RESOLUTE	Not required

(*) The number of counts of a rotary encoder is the number of counts by the encoder itself. For the FANUC systems, however, set parameters with regarding the number of pulses/rev as follows:
One million pulses/rev for 2^{20} counts/rev
Eight million pulses/rev for 2^{23} counts/rev
Eight million pulses/rev for 2^{27} counts/rev

(d) Rotary encoder (analog output type) + interpolation circuit supplied by a vendor other than FANUC

	Number of counts/rev*	Model			Backup
		Signal interval (λ)	Encoder	Interpolation circuit	
HEIDENHAIN	2^{27} pulses 2^{27} pulses 2^{27} pulses 2^{26} pulses 2^{25} pulses 2^{24} pulses	32768 16384 8192 4096 2048 1024	ERA4280 ERA4280, ERA4480 ERA4480, ERA4880 ERA4880 ERM280 ERM280	EIB192F EIB392F EIB1592F	Not allowed

(*) For the FANUC systems, set parameters with regarding eight million pulses/rev.

(e) Non-binary encoder + position detection circuit for a synchronous built-in servo motor

	Signal interval (λ)/rev	Encoder	Backup
FANUC	768	αiCZ 768A	Not allowed
HEIDENHAIN	12000, 20000, 20000, 40000, 52000	ERN4280	Not allowed
	6000, 10000, 14000, 20000, 26000	ERN4480	
	3000, 5000, 7000, 10000, 13000	ERN4880	

(4) Setting parameters

Set the following parameters according to the type of the detector (described in the previous item).

(a) Parameter setting for a linear encoder (serial output type) (1/2)

(Parameter setting method)

In addition to the conventional settings for a separate detector (bit 1 of parameter No. 1815 and FSSB), note the following parameters:

[Flexible feed gear]
Parameter Nos. 2084 and 2085
Flexible feed gear (N/M) = Minimum resolution of detector [μm] / controller detection unit [μm]

[Number of position pulses]
Parameter No. 2024
Number of position pulses =
Amount of movement per motor revolution [mm] / detection unit of the sensor [mm]

* If the result of the above calculation does not fall in the setting range (0 to 32767) for the number of position pulses, use "position feedback pulse conversion coefficient" to specify the number of position pulses according to the following procedure.
Number of position pulses to be set = A × B
Select B so that A is within 32767. Then, set the following:

No.2024 = A: Position pulses parameter (32767 or less)
No.2185 = B: Position pulses conversion coefficient parameter

(Example of parameter setting)

[System configuration]

- A linear encoder with a minimum resolution of 0.1 μm is used.
- The least input increment of the controller is 1 μm.
- The amount of movement per motor revolution is 16 mm.

[Parameter setting]

- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M) = 0.1 μm/1 μm = 1/10:
  No. 2084 = 1 and No. 2085 = 10
- Calculate the number of position pulses.
  Number of position pulses = 16 mm/0.0001mm = 160000
  Because this result does not fall in the setting range (0 to 32767), set A and B, respectively, with the "number of position pulses" and "position pulses conversion coefficient" by assuming:
  160,000 = 10,000 × 16 → A = 10,000 and B = 16
  No.2024 = 10,000, No.2185 = 16

(a) Parameter setting for a linear encoder (serial output type and α*i* interface) (2/2)

When linear encoder LC195F or LC495F manufactured by HEIDENHAIN is used with a 30*i*-B Series CNC, the minimum resolution can be extended.

(Series and editions of applicable servo software)

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	19.0 and subsequent editions	

(Parameter setting method)

	#7	#6	#5	#4	#3	#2	#1	#0
2437				AILIN				

AILIN(#4) By using LC195F or LC495F, the minimum resolution of the scale is:
0: Not extended.
1: Extended.

NOTE

1 Even when this function bit is set, the resolution used for setting the number of position pulses, flexible feed gear, and other items is 0.05 μm/0.01 μm. If you want to use the minimum resolution of the detector as the detection unit, set AILIN to 1 and also set the flexible feed gear as listed below.

Minimum resolution setting	Minimum resolution of the detector (*)	FFG setting to use the minimum resolution of the detector as the detection unit
0.05μm	0.0125μm	4/1
0.01μm	0.00125μm	8/1

2 If bit 4 of parameter No. 2437 is set to 1 on hardware which does not support this function, an invalid parameter alarm (detail No. 4374) is issued.
3 When using this function bit, set bit 0 of parameter No. 2274 to 0. If this bit is set to 1, an invalid parameter alarm (detail No. 4374) is issued.
4 If this parameter is changed, the CNC must be switched off and on again.

(b) Parameter setting for a linear encoder (analog output type) + high-resolution serial conversion circuit

(Parameter setting method)

In addition to the settings for a separate detector (bit 1 of parameter No. 1815 and FSSB), note the following parameters:

First, check the type of the high-resolution serial conversion circuit to be coupled to the linear encoder, and then determine the setting of the following function bit.

[Function bit]

Circuit	Specification	Interpolation magnification	HP2048
High-resolution serial output circuit	A860-0333-T501	512	0
High-resolution serial output circuit H	A860-0333-T701	2048	1
High-resolution serial output circuit C	A860-0333-T801	2048	1

	#7	#6	#5	#4	#3	#2	#1	#0
2274								HP2048

HP2048(#0) The 2048-magnification interpolation circuit (high-resolution serial output circuit H or C) is:

0: Not to be used

1: To be used

NOTE

1 When high-resolution serial output circuit H is used, set the setting pin SW3 inside the circuit to "Setting B" usually.

2 If this bit is specified, the minimum resolution setting of the detector is assumed to be:
Encoder signal pitch/512 [μm]
If the minimum resolution (signal pitch/2048 [μm]) is necessary as the detection unit, specify:
Flexible feed gear = 4/1

3 When high-resolution serial output circuit H is used, and the input frequency 750 kHz needs to be supported, set the following:
- Set the setting pin SW3 to "Setting A".
- Set the bit 0 (HP2048) of parameter No.2274 to 1.
- Set the minimum resolution of the detector as: Encoder signal pitch/128 [μm]
(Related report: TMS03/16E)

4 When high-resolution serial output circuit C is used, no function is available which can change an interpolation magnification according to a set-up pin. (Fixed at a magnification of 2048)
High-resolution serial output circuit C is connected to the scale with an absolute address origin.

[Minimum resolution of the detector]

In the following calculation of a flexible feed gear and the number of position pulses, the minimum detector resolution to be used is:

(Linear encoder signal pitch/512 [μm])

(Specifying the above function bit appropriately makes it unnecessary to take the difference in the interpolation magnification among the high-resolution serial output circuits into account. So always use 512 for calculations.)

[Flexible feed gear]
Parameters Nos. 2084 and 2085
Flexible feed gear (N/M) = minimum resolution of the detector [μm] /detection unit of controller [μm]

[Number of position pulses]
Parameter No. 2024
Number of position pulses =
Amount of movement per motor revolution [mm] / minimum resolution of the detector [mm]

* If the result of the above calculation does not fall in the setting range (0 to 32767) for the number of position pulses, use “position feedback pulse conversion coefficient” to specify the number of position pulses according to the following procedure.
Number of position pulses to be set = A × B
Select B so that A is within 32767. Then, set the following:
No.2024 = A: Position pulses parameter (32767 or less)
No.2185 = B: Position pulses conversion coefficient parameter

(Example of parameter setting)

[System configuration]
- A linear encoder with a signal pitch of 20 μm is used.
- The linear encoder is coupled with high-resolution serial output circuit H.
- The least input increment of the controller is 1 μm.
- The amount of movement per motor revolution is 16 mm.

[Parameter setting]
- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- To use high-resolution serial output circuit H, set bit 0 of parameter No. 2274 to 1.
  Minimum resolution of the detector = 20 μm/512 = 0.0390625 μm
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M)=(20/512μm)/1μm=5/128
  No.2084=5, No.2085=128
- Calculate the number of position pulses.
  Number of position pulses = 16 mm/(20/512μm) = 409,600
  Because this result does not fall in the setting range (0 to 32767), set A and B, respectively, with the "number of position pulses" and "position pulses conversion coefficient" by assuming:
  409,600 = 25,600 × 16 → A = 25,600, B = 16
  No.2024 = 25,600, No.2185 = 16

(c) Parameter setting for a rotary encoder (serial output type) (1/2)

For a serial output rotary encoder whose number of pulses is 2^{20} pulses, set parameters with the number of position feedback pulses assumed to be 1 million pulses per revolution.

(Parameter setting method)

In addition to the settings for a separate detector (bit 1 of parameter No. 1815 and FSSB), note the following parameters:

[Flexible feed gear]
Parameters Nos. 2084 and 2085
Flexible feed gear (N/M) =
(Amount of table movement [deg] per detector revolution) / (detection unit [deg]) / 1,000,000

[Number of position pulses]
Parameter No. 2024

Number of position pulses = 12500×(motor-to-table reduction ratio)

* If the result of the above calculation does not fall in the setting range (0 to 32767) for the number of position pulses, use "position feedback pulse conversion coefficient" to specify the number of position pulses according to the following procedure.
Number of position pulses to be set = A × B
Select B so that A is within 32767. Then, set the following:
No.2024 = A: Position pulses parameter (32767 or less)
No.2185 = B: Position pulses conversion coefficient parameter

(Example of parameter setting)

[System configuration]

- The least input increment of the controller is 1/1000 degrees.
- The amount of movement per motor revolution is 180 degrees (reduction ratio: 1/2)
- Table-to-separate-encoder reduction ratio = 1/1

[Parameter setting]

- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M)=360 degrees /0.001 degrees /1,000,000 =36/100
  No.2084=36, No.2085=100
- Calculate the number of position pulses.
  Because number of position pulses = 12500 × (1/2)=6250
  No.2024=6250

(c) Parameter setting for a rotary encoder (serial output type) (2/2)

For a rotary encoder for which parameters are set with the number of position feedback pulses assumed to be eight million pulses per revolution, the following settings are required.

(Series and editions of applicable servo software)

For a serial output rotary encoder whose number of counts is 2^{27} pulses, a high-resolution interface with eight million pulses assumed for setting parameters is used regardless of the number of counts by the rotary encoder. Servo control software supporting this interface is required.

[Series and editions applicable to high-resolution interfaces]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	J(10) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

[Rotary encoders using a high-resolution interface]

- HEIDENHAIN: RCN227F, RCN727F, RCN827F

(Parameter setting method)

In addition to the settings for a separate detector (bit 1 of parameter No. 1815 and FSSB), note the following parameters:

[Function bit]
Set the following function bit to 1.

	#7	#6	#5	#4	#3	#2	#1	#0
2275							RCNCLR	800PLS

800PLS (#0) A rotary encoder with eight million pulses per revolution is:
1: To be used.

RCNCLR (#1) The number of revolution is:
1: To be cleared.
This function bit is to be set in combination with the number of data mask digits, described below.

2394	Number of data mask digits

[Settings] 8 (For a rotary encoder with eight million pulses per revolution)
The value to be set in this parameter depends on the detector. At present, only the above detectors require clearing the speed data.
This parameter is to be set in combination with RCNCLR, described above.

NOTE
The speed data of the RCN223F, 227F, 727F, or 827F is maintained while the power to the separate detector interface unit is on. The data, however, is cleared when the unit is turned off. Since the speed data becomes undetermined depending on where the power is turned off, it is necessary to make a setting to clear the speed data. In addition, for this reason, the CN223F, 227F, 727F, and 827F cannot be used with a linear axis.

The following explains how to calculate the parameter values when a rotary encoder with eight million pulses per revolution is used.

[Flexible feed gear]
Parameters Nos. Nos. 2084 and 2085
Flexible feed gear (N/M) =
(Amount of table movement [deg] per detector revolution) / (detection unit [deg]) / 8,000,000

When the number of counts is 2^{23}, it corresponds to eight million position feedback pulses per revolution. So, for the RCN727F with 2^{27} counts, the flexible feed gear can be set to 1/1 or greater to set the detection unit to 1/8,000,000 revolutions or less. (If the flexible feed gear is set to 8/1, the detection unit is 64,000,000 pulses per revolution.)

[Number of position pulses]
Parameter No. 2024
Number of position pulses = 100,000×(motor-to-table reduction ratio)

* If the result of the above calculation does not fall in the setting range (0 to 32767) for the number of position pulses, use “position feedback pulse conversion coefficient” to specify the number of position pulses according to the following procedure.
Number of position pulses to be set = A × B
Select B so that A is within 32767. Then, set the following:
No2024 = A: Position pulses parameter (32767 or less)
No2185 = B: Position pulses conversion coefficient parameter

[Reference counter capacity]
Parameter No. 1821
Specify the number of feedback pulses per table turn (detection unit).

* If bit 0 of parameter No. 2275 is 0, specify the number of pulses per table turn divided by 8 as the reference counter capacity. In this case, eight grid points occur per table turn.

(Example of parameter setting)

[System configuration]

- The rotary encoder RCN223F made by HEIDENHAIN is used.
- The least input increment of the controller is 1/10,000 degrees.
- The amount of movement per motor revolution is 180 degrees (reduction ratio: 1/2)
- Table-to-separate-encoder reduction ratio = 1/1

[Parameter setting]

- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- To use the detector RCN223, set bit 0 of parameter No. 2275 to 1, bit 1 of this parameter to 1, and parameter No. 2394 to 8.
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M) =
  (360 degrees /0.0001 degrees)/8,000,000=9/20
  No.2084=9, No.2085=20
- Calculate the number of position pulses.
  Number of position pulses = 100,000 × (1/2) = 50,000
  Because this result does not fall in the setting range (0 to 32767), set A and B, respectively, with the "number of position pulses" and "position pulses conversion coefficient" by assuming:
  50,000 = 12,500 × 4 → A = 12,500, B = 4
  No.2024 = 12,500, No.2185 = 4
- Calculate the reference counter capacity.
  Reference counter capacity = 360 degrees/0.0001 degrees = 3,600,000

(About speed limit)

When a rotary encoder with eight million pulses per revolution is used as a separate detector, the maximum permissible speed that can be controlled may be 937 min^{-1} (7500 min^{-1} for the Series 30*i*-B). (*) (See Item (2) in the Appendix E.)

(*) The above maximum speed does not include hardware limitations. For the maximum permissible speed of the detector itself, refer to the specifications of the detector.

(Notes on a rotary encoder with no speed data)

For absolute position detectors with no speed data (data to be counted by 1 for every revolution of the detector) including those listed below, if parameters are not set correctly, the machine coordinates are not established correctly at power-on.

- HEIDENHAIN : RCN223F,RCN727F and so on
- Magnescale : RU77 and so on
- Mitsubishi Heavy Industries : MPRZ series and so on
- Renishaw : RESOLUTE (rotary encoder) and so on

* For the detector you use, be sure to contact the manufacturer of the detector.

According to the axis type you use, set the following parameters.

1. Rotary axis (A-type)

	Parameter No.						
	1815#1	1815#6	1815#0	1817#3	1868	2275#1	2394
Semi-closed mode	0	1	0	0	0	*1	*1
Full-closed mode	1	1	0	0	0	*1	*1

2. Rotary axis (B-type)

	Parameter No.						
	1815#1	1815#6	1815#0	1817#3	1868	2275#1	2394
Semi-closed mode	0	0	*2	*2	*2	*1	*1
Full-closed mode	1	0	*2	*2	*2	*1	*1

*1) Set a value appropriate for the detector to be used. For details, see the item described above (Parameter setting) and refer to "CORRESPONDENCE OF ROTARY SCALE WITHOUT ROTARY DATA" in "FANUC Series 30*i*/31*i*/32*i*-MODEL B CONNECTION MANUAL (FUNCTION) (B-64483EN-1)".

*2) Set a value appropriate for the movable range of the rotary axis. For details, refer to "CORRESPONDENCE OF ROTARY SCALE WITHOUT ROTARY DATA" in "FANUC Series 30*i*/31*i*/32*i*-MODEL B CONNECTION MANUAL (FUNCTION) (B-64483EN-1)".

NOTE

If you want to use a detector with no speed data for a rotary encoder supplied by a vendor other than FANUC on a rotary axis (A-type), set bit 6 of parameter No. 1815 (RONx) to 1.
For other cases, set this bit to 0. If the correct setting is not made, the machine coordinates are not established correctly at power-on. (See FANUC Series 30*i*/31*i*/32*i*-MODEL B CONNECTION MANUAL (FUNCTION) (B-64483EN-1).)

(d) Parameter setting for a rotary encoder (analog output type) + interpolation circuit supplied by a vendor other than FANUC

For a rotary encoder for which parameters are set with the number of position feedback pulses assumed to be eight million pulses per revolution, the following settings are required.

(Series and editions of applicable servo software)

For a analog output rotary encoder whose number of counts is 2^{24} pulses or larger, a high-resolution interface with eight million pulses assumed for setting parameters is used regardless of the number of counts by the rotary encoder. Servo control software supporting this interface is required.

[Series and editions applicable to high-resolution interfaces]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	J(10) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

[Rotary encoders using a high-resolution interface]

- HEIDENHAIN: Rotary encodes (such as the ERA4280, ERA4480, ERA4880, and ERA280) using a HEIDENHAIN interpolation circuit such as the EIB192F whose number of counts is at least 2^{24}

When a high-resolution interface is used, the number of counts is assumed to be eight million pulses per revolution. For details of parameter setting, see "(c) Parameter setting for a rotary encoder (serial output type (2/2)".

(e) Parameter setting for a rotary encoder (analog output type) + high-resolution serial output circuit

(Parameter setting method)

In addition to the settings for a separate detector (bit 1 of parameter No. 1815 and FSSB), note the following parameters:

First, check the type of the FANUC high-resolution serial output circuit to be coupled to the rotary encoder (analog type), and then determine the setting of the following function bit.

[Function bit]

Circuit	Specification	Interpolation magnification	HP2048
High-resolution serial output circuit	A860-0333-T501	512	0
High-resolution serial output circuit H	A860-0333-T701	2048	1
High-resolution serial output circuit C	A860-0333-T801	2048	1

	#7	#6	#5	#4	#3	#2	#1	#0
2274								HP2048

HP2048(#0) The 2048-magnification interpolation circuit (high-resolution serial output circuit H or C) is:

0: Not to be used

1: To be used

NOTE

1 For a configuration of a rotary encoder (analog output type) and high-resolution serial output circuit, when an input frequency of 750 kHz needs to be supported, make the following settings:
- Set the setting pin SW3 to "Setting A".
- Set the bit 0 (HP2048) of parameter No.2274 to 1.
- Set the value λ/4 for AMR conversion coefficient 1.

2 When high-resolution serial output circuit C is used, no function is available which can change an interpolation magnification according to a set-up pin. (Fixed at a magnification of 2048)
High-resolution serial output circuit C is connected to the scale with an absolute address origin.

(Example of parameter setting)

- The non-binary encoder ERA4480 manufactured by HEIDENHAIN is used.
- Signal interval (λ/rev) is 60,000.
- The interpolation magnification of the high-resolution serial output circuit is 2048.
- The least input increment of the controller is 1/1000 degrees.
- The amount of movement per motor revolution is 180 degrees. (Reduction ratio: 1/2)
- Table-to-separate-encoder reduction ratio = 1/1

[Parameter setting]

- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- The interpolation magnification of the high-resolution serial output circuit is 2048, so set bit 0 of parameter No. 2274 to 1.
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M)= (360 degrees /0.001 degrees)/(60,000×512)=15/128
  No.2084 = 151, No.2085 = 128
- Calculate the number of position pulses.
  Number of position pulses = 60,000× 512/2＝1,536,000
  Because this result does not fall in the setting range (0 to 32767), set A and B, respectively, with the "number of position pulses" and "position pulses conversion coefficient" by assuming:
  1,536,000 = 60,000 × 256 → A = 60,000, B = 256
  No.2024＝60,000, No.2185=256
- Calculate the reference counter capacity.
  Reference counter capacity = 360 degrees/0.0001 degrees = 3,600,000

2.1.6 Setting Servo Parameters when an Analog Input Separate Detector Interface Unit is Used

(1) Overview

An analog input separate detector interface unit (analog SDU) can be connected directly to an encoder having an analog output signal of 1 Vp-p. This subsection explains parameter settings to be made when this unit is connected to a separate detector. After performing the initialization procedure (full-closed loop) described in Subsection 2.1.3, change the setting described below according to the signal pitch of the detector.

Configuration where analog SDU is used

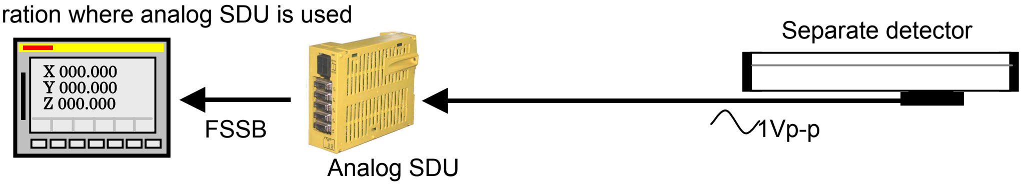


Fig. 2.1.6 (a) Configuration where an analog SDU is used

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	J(10) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

After performing the initialization (full-closed loop) described in Subsection 2.1.3, change the following setting according to the signal pitch of the detector:

[Setting the flexible feed gear]

2084	Numerator of flexible feed gear
2085	**Denominator of flexible feed gear**

Set the flexible feed gear according to the following equation.
(Equation for parameter calculation)

$$\text{Flexible feed gear (N/M)} = \frac{\text{Detector signal pitch [}\mu\text{m]/512}}{\text{Detection unit of controller [}\mu\text{m]}}$$

[Setting the number of position pulses]

2024	Number of position pulses (PPLS)

Set the number of position pulses according to the following equation:
(Equation for parameter calculation)

$$\text{Number of position pulses} = \frac{\text{Amount of movement per motor revolution [mm]}}{\text{Detector signal pitch [mm]/512}}$$

If the calculation result is greater than 32767, use the following position pulse conversion coefficient (PSMPYL) to obtain the parameter setting (PPLS).

2185	Position pulse conversion coefficient (PSMPYL)

This parameter is used when the calculation result of the number of position pulses is greater than 32767.
(Equation for parameter calculation)
Set this parameter so that the following equation is satisfied:
Number of position pulses = PPLS × PSMPYL
(→ See Supplementary 3 in Subsection 2.1.9.)

(Example of parameter setting)

[System configuration]

- The Series 30*i* is used.
- A linear scale with a signal pitch of 20 μm is used.
- The least input increment of the controller is 1 μm.
- The amount of movement per motor revolution is 16 mm.

[Parameter setting]

- To enable a separate detector, set bit 1 of parameter No. 1815 to 1.
- Calculate the parameters for the flexible feed gear.
  Because flexible feed gear (N/M)=(20/512μm)/1μm=5/128
  No.2084=5, No.2085=128
- Calculate the number of position pulses.
  Number of position pulses = 16 mm/(0.02 mm/512)= 409,600
  Because this result does not fall in the setting range (0 to 32767), set A and B, respectively, with the "number of position pulses" and "position pulses conversion coefficient" by assuming:
  409,600 = 25,600 × 16 → A = 25,600, B = 16
  No.2024 = 25,600, No.2185 = 16

2.1.7 Setting Parameters when an α*i*CZ Sensor is Used

(1) Overview

The α*i*CZ sensors are classified into two major groups according to their application as follows:
<1> Used as a built-in detector for a synchronous built-in servo motor (α*i*CZ ***A)
<2> Used as a separate detector (α*i*CZ ***AS)
When the differences in resolution are considered, six types of sensors are available as indicated below.

For built-in detector (A860-2162-Txxx)	For separate detector (A860-2164-Txxx)	Signal interval	Number of pulses at setting
α*i*CZ 512A	α*i*CZ 512AS	512 λ /rev	500,000pulse/rev
α*i*CZ 768A	α*i*CZ 768AS	768 λ /rev	750,000pulse/rev
α*i*CZ 1024A	α*i*CZ 1024AS	1024 λ /rev	1,000,000pulse/rev

NOTE
When α*i*CZ 768A/AS is used as a built-in detector with a synchronous built-in servo motor, the sensor can be used only for the purpose of finite rotation (within ±1 revolution).

(2) Series and editions of applicable servo software

When the α*i*CZ 768A is used as a built-in detector with a synchronous built-in servo motor ((3)-(a)), the servo software indicated bellow is needed.

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	J(10) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

(a) Used as the detector for a synchronous built-in servo motor)

If you want to use this sensor as the detector for a synchronous built-in servo motor, see Subsection 3.2.1, "Procedure for Setting the Initial Parameters of Synchronous Built-in Servo Motors".

(b) Used as a separate detector

After performing the initialization procedure (full-closed loop) described in Subsection 2.1.3, change the settings described below according to the signal pitch of the detector.

[Setting flexible feed gear]

2084	Flexible feed gear (numerator) (N)

2085	Flexible feed gear (denominator) (M)

Set a value listed in the following table according to the detector used.

Detector	Flexible feed gear
α*i*CZ 512AS	$\frac{\text{Amount of movement per motor revolution [deg]/detection unit [deg]}}{500{,}000}$
α*i*CZ 768AS	$\frac{\text{Amount of movement per motor revolution [deg]/detection unit [deg]}}{750{,}000}$
α*i*CZ 1024AS	$\frac{\text{Amount of movement per motor revolution [deg]/detection unit [deg]}}{1{,}000{,}000}$

[Setting number of velocity pulses]

2023	Number of velocity pulses (PULCO)

Set the number of velocity pulses to 8192.

[Setting number of position pulses]

2024	Number of position pulses (PPLS)

Set a value listed in the following table according to the detector used.

Detector	Number of position pulses
α*i*CZ 512AS	6250 × (gear reduction ratio from the motor to table)
α*i*CZ 768AS	9375 × (gear reduction ratio from the motor to table)
α*i*CZ 1024AS	12500 × (gear reduction ratio from the motor to table)

If the calculation result is greater than 32767, use the following position pulse conversion coefficient (PSMPYL) to obtain the parameter value (PPLS).

2185	Conversion coefficient for the number of position feedback pulses (PSMPYL)

This parameter is used when the calculated number of position pulses is greater than 32767.

(Equation for parameter calculation)

Set this parameter so that the following equation is satisfied:

Number of position pulses = PPLS × PSMPYL

(→ See Supplementary 3 in Subsection 2.1.9.)

[Setting reference counter capacity]

1821	Reference counter capacity

Set one of the following values according to the detector.

Detector	Reference counter capacity
α*i*CZ 512AS	Set the number of pulses per revolution of the detector installed separately (detection unit) or a value obtained by dividing that number by an integer.
α*i*CZ 768AS	Set the number of pulses per 120-degree revolution (one-third revolution) of the detector installed separately (detection unit) or a value obtained by dividing that number by an integer.
α*i*CZ 1024AS	Set the number of pulses per revolution of the detector installed separately (detection unit) or a value obtained by dividing that number by an integer.

(Example of parameter setting)

[System configuration]

- The Series 30*i* is used.
- The detector used is the α*i*CZ1024AS
- The least input increment of the controller is 1/1000 deg.
- Gear ratio 1:1

[Parameter setting]

Flexible feed gear (N/M) = 360,000/1,000,000＝9/25,
so parameter No. 2084 = 9, and parameter No. 2085 = 25
Number of position pulses = 12500
Reference counter capacity = 360,000

2.1.8 Setting Parameters When an Acceleration Sensor or Temperature Detection Circuit Is Used

(1) Overview

The flow indicated below is used to make a connection and setting for using an acceleration sensor (α*i*GS0.1-3D) or temperature detection circuit.

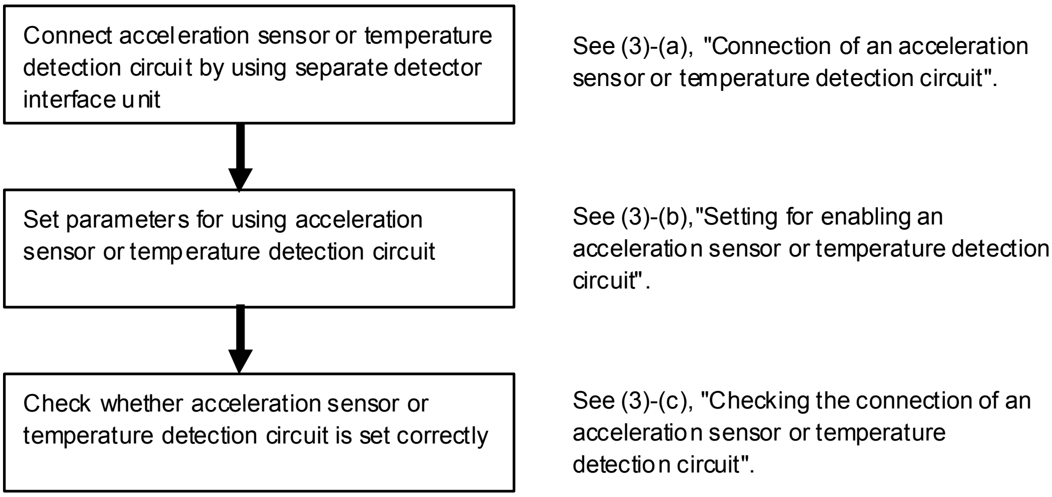


Fig. 2.1.8 (b) Setting procedure for an acceleration sensor or temperature detection circuit

(2) Series and editions of applicable servo software

- Acceleration sensor and temperature detection circuit

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	P(16) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting method

(a) Connection of an acceleration sensor or temperature detection circuit

An acceleration sensor or temperature detection circuit is connected to a separate detector interface unit. From one separate detector interface unit, only one data item can be read per axis. So, when an additional acceleration sensor or temperature detection circuit is to be used in a full-closed system, one more separate detector interface unit is required in addition to the separate detector interface unit used for a separate position detector.

- When an acceleration sensor or temperature detection circuit is to be added to an axis of a semi-closed system
  Add a separate detector interface unit for an acceleration sensor or temperature detection circuit.

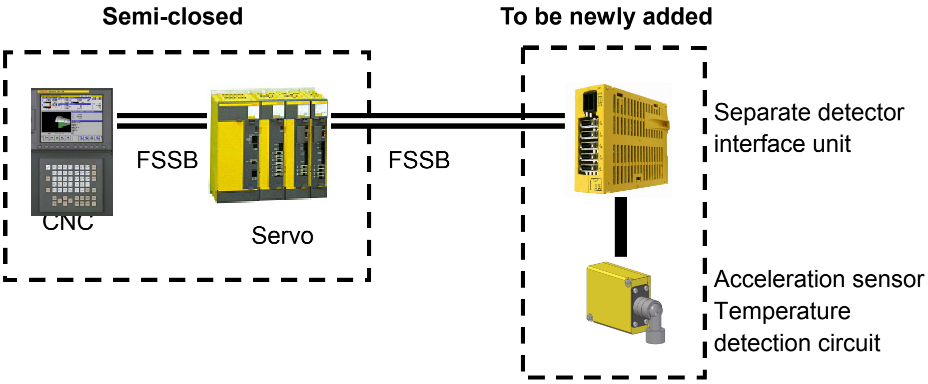


Fig. 2.1.8 (c) Semi-closed system configuration

- When an acceleration sensor or temperature detection circuit is to be added to an axis of a full-closed system
  Add a separate detector interface unit for an acceleration sensor or temperature detection circuit

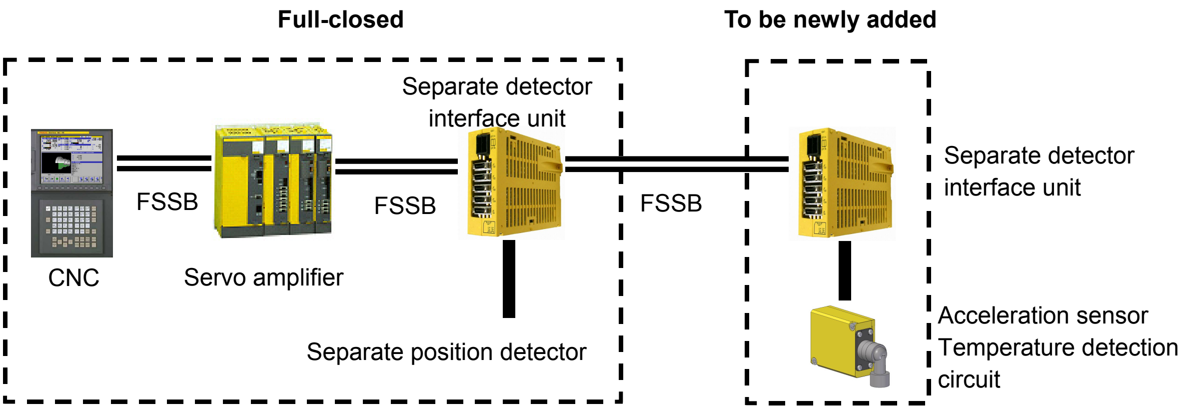


Fig. 2.1.8 (d) Full-closed system configuration

NOTE
1 When an acceleration sensor or temperature detection circuit is added to an axis of a full-closed system, the acceleration sensor may not be connected to a free connector of the separate detector interface unit to which a separate position detector is connected.
2 Both of the first and third separate detector interface units cannot be used with one axis. Similarly, both of the second and fourth separate detector interface units cannot be used with one axis.
3 For the FSSB setting, refer to the parameter manual of the CNC.

(b) Setting for enabling an acceleration sensor or temperature detection circuit

<1> Setting for enabling an acceleration sensor

The setting for enabling an acceleration sensor is described below.
An acceleration sensor can detect acceleration in one of three directions.
Select and set one of the three function bits below according to the direction of acceleration to be used.

	#7	#6	#5	#4	#3	#2	#1	#0
2277	ACC1ON	ACC2ON	ACC3ON					

(Power-off parameter)

ACC1ON(#7) Specify whether acceleration feedback in the first direction is used or not.
0: Not used
1: Used

(Power-off parameter)

ACC2ON(#6) Specify whether acceleration feedback in the second direction is used or not.
0: Not used
1: Used

(Power-off parameter)

ACC3ON(#5) Specify whether acceleration feedback in the third direction is used or not.
0: Not used
1: Used

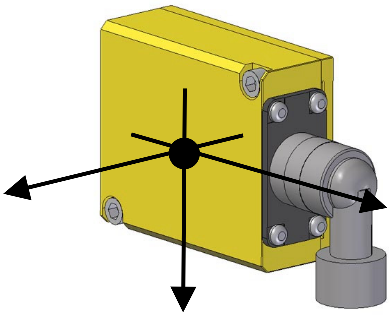


Fig. 2.1.8 (e) Directions in which an acceleration sensor detects acceleration

* When the machine is accelerated in the arrow direction, positive acceleration is detected.
* The output direction of acceleration data can be inverted. (This function is described later.)

> **NOTE**
> Acceleration feedback in one direction can be used per axis. Do not set two directions or more per axis.

Set the function bit below according to the ordinal number, counted from the CNC, of the separate detector interface unit to which an acceleration sensor is connected.

	#7	#6	#5	#4	#3	#2	#1	#0
2278				PM2ACC				

(Power-off parameter)

PM2ACC(#4) 0: Acceleration sensor data is read from the first or third separate detector interface unit counted from the CNC, or no acceleration sensor is used.
1: Acceleration sensor data is read from the second or fourth separate detector interface unit counted from the CNC.

To adjust the sign of acceleration feedback, observe position feedback (POSF) and acceleration feedback (ACC) with SERVO GUIDE at rapid traverse acceleration/deceleration time.
Set the sign bit ACCNEG for acceleration feedback below so that the sign of the second-order differential of position feedback (POSF indicated by Diff2(AT) operation) equals the sign of acceleration feedback (ACC).

> **NOTE**
> The observation of ACC is supported by SERVO GUIDE version 3.20 or later.

	#7	#6	#5	#4	#3	#2	#1	#0
2277				ACCNEG				

ACCNEG(#4) The sign of acceleration feedback is:
0 : Not inverted
1 : Inverted

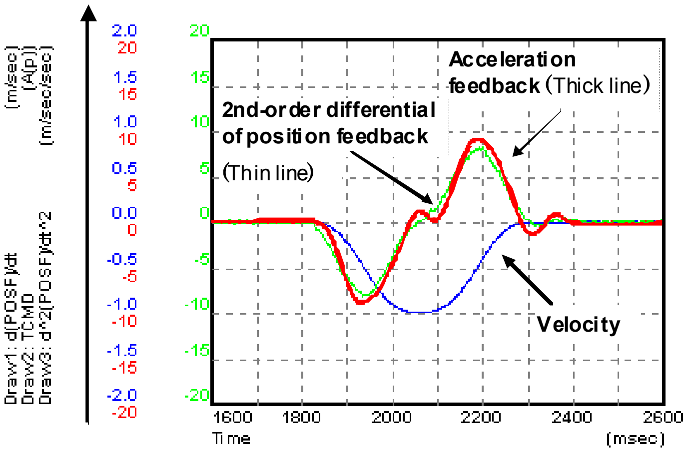


Fig. 2.1.8 (f) Acceleration feedback

<2> Setting for enabling a temperature detection circuit

The setting for enabling a temperature detection circuit is described below.
Set the function bits below according to the ordinal number, counted from the CNC, of the separate detector interface unit to which a temperature detection circuit is connected.

	#7	#6	#5	#4	#3	#2	#1	#0
2278							PM2TP	PM1TP

(Power-off parameter)
PM1TP(#0) With the first or third separate detector interface unit, a temperature detection circuit is:
0 : Not used
1 : Used

(Power-off parameter)
PM2TP(#1) With the second or fourth separate detector interface unit, a temperature detection circuit is:
0 : Not used
1 : Used

(c) Checking the connection of an acceleration sensor or temperature detection circuit

On diagnosis screen No. 350#2/#1 or No. 351#2/#1, check whether an acceleration sensor or temperature detection circuit is connected correctly.

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.350						PM1TMP	PM1ACC	

PM1ACC(#1) With the first or third separate detector interface unit, an acceleration sensor is:
1 : Connected
0 : Not connected

PM1TMP(#2) With the first or third separate detector interface unit, a temperature detection circuit is:
1 : Connected
0 : Not connected

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.351						PM2TMP	PM2ACC	

PM2ACC(#1) With the second or fourth separate detector interface unit, an acceleration sensor is:
1 : Connected
0 : Not connected

PM2TMP(#2) With the second or fourth separate detector interface unit, a temperature detection circuit is:
1 : Connected
0 : Not connected

(4) Example of setting an acceleration sensor or temperature detection circuit

An example of adding an acceleration sensor (X-axis, Y-axis, Z-axis) and temperature detection circuit (X-axis) to a system with a semi-closed axis (X-axis) and two full-closed axes (Y-axis, Z-axis) is described below.

<Connection>

CNC⇔X-axis amplifier⇔Y-axis amplifier⇔Z-axis amplifier

⇔ Separate detector interface unit
(Separate detector interface units for the Y-axis and Z-axis are connected to the first and second connectors.
A temperature detection circuit for the X-axis is connected to the third connector.)

⇔ Separate detector interface unit
(Acceleration sensors for the X-, Y-, and Z-axes are connected to the first, second, and third connectors.)

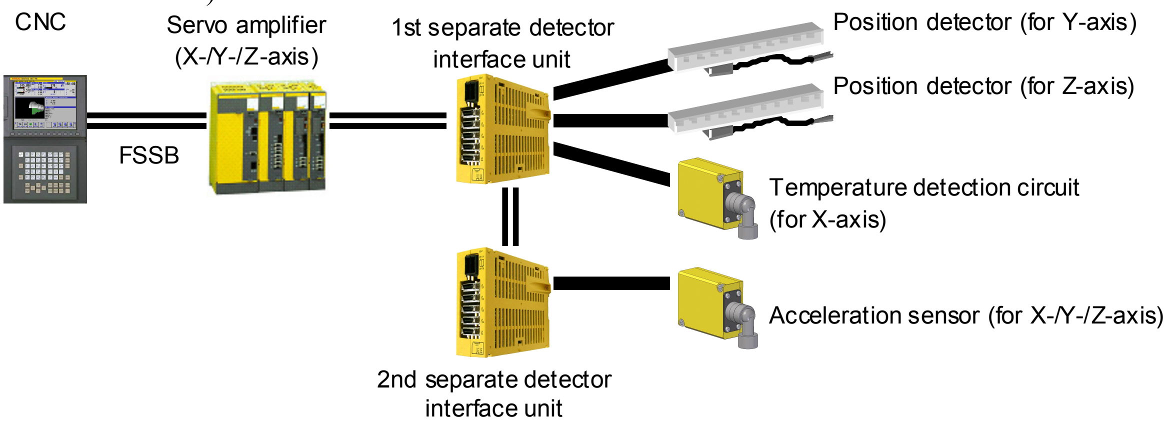


Fig. 2.1.8 (g) Example of connecting a temperature detection circuit and acceleration sensors

<Setting>

Parameter No.	Description	Setting		
		X-axis	Y-axis	Z-axis
Bit 1 of No. 1815	Enables a separate position detector.(*1)	0	1	1
Bits 7, 6, 5 of No. 2277	Enables an acceleration sensor (including the setting of direction).	100	010	001
Bit 4 of No. 2278	Sets the ordinal number of the separate detector interface unit to which an acceleration sensor is connected.(*2)	1	1	1
Bits 1, 2 of No. 2278	Sets the ordinal number of the separate detector interface unit to which a temperature detection circuit is connected.(*3)	01	00	00

*1 Bit 1 of No. 1815 =
1: Full-closed
0: Semi-closed
*2 Bit 4 of No. 2278 =
1: An acceleration sensor is used with the second or fourth separate etector interface unit.
0: An acceleration sensor is used with the first or third separate detector interface unit.
*3 Bits 1, 0 of No. 2278 =
0,0: A temperature detection circuit is unused.
0,1: A temperature detection circuit is used with the first or third separate detector interface unit.
1,0: A temperature detection circuit is used with the second or fourth separate detector interface unit.

(5) Alarms

Alarms related to an acceleration sensor

When an error is detected with an acceleration sensor, the following alarm is issued and the axis with which the alarm is issued is brought to a feed-hold stop:

DS651: Acceleration sensor error

When the CNC software does not support the display of the alarm above, the following alarm is issued and a dynamic brake stop occurs:

SV385: Serial data error (separate) or
SV447: Hardware disconnection alarm (separate)

If a separate detector and acceleration sensor are used at the same time, diagnosis screen No. 350#5 can be used to identify with which detector the alarm has been issued.

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.350			ALMACC					

ALMACC(#5) 0 : An alarm is issued with a separate detector.
1 : An alarm is issued with an acceleration sensor.

Alarms related to a temperature detection circuit

When an error is detected with a temperature detection circuit, the following alarm is issued and a dynamic brake stop occurs:

SV652: Temperature sensor error

When the CNC software does not support the display of the alarm above, the following alarm is issued and a dynamic brake stop occurs:

SV385: Serial data error (separate) or
SV447: Hardware disconnection alarm (separate)

If a separate detector and temperature detection circuit are used at the same time, diagnosis screen No. 350#6 can be used to identify with which detector the alarm has been issued.

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.350		ALMTMP						

ALMTMP(#6) 0 : An alarm is issued with a separate detector.
1 : An alarm is issued with a temperature detection circuit.

Series and editions of system software that support the display of alarms

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	15 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	15 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the Series 30*i*/31*i*/32*i*/35*i* -B and Power Motion *i*-A, all series and editions support the display of alarms.

2.1.9 Actions for Illegal Servo Parameter Setting Alarms

(1) Overview

When a setting value is beyond an allowable range, or when an overflow occurs during internal calculation, an invalid parameter setting alarm is issued.
This section explains the procedure to output information to identify the location and the cause of an illegal servo parameter setting alarm.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Illegal servo parameter setting alarms that can be displayed in parameter error detail display

Illegal servo parameter setting alarms detected by the servo software can be displayed. Alarms detected by the system software cannot be displayed here.
To check whether the servo software detects an alarm, check the following:

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.203				PRM				

0: Alarm detected by the system software (Identification is possible using diagnosis No.280.)

1: Alarm detected by the servo software (See the descriptions of detailed display provided later.)

Whether the servo software detects an alarm can also be determined by checking bit 4 of alarm 4 on the servo tuning screen.

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.280		**AXS**		**DIR**	**PLS**	**PLC**		**MOT**

MOT(#0) 1: As the motor number in parameter No. 2020, a value not within the specifiable range is set.

The table given below lists the valid motor ID numbers for each series.
If a number beyond the indicated range is set, an illegal servo parameter setting alarm is issued.
(In this case, keep PRM = 0.)

Servo software series/edition	Motor ID No.
Series 90G0 /03.0 and subsequent editions	1 to 909
Series 90D0,90E0/B(02) and subsequent editions	1 to 550 (edition 28.0 or earlier), 1 to 909 (edition 29.0 or later)
Series 90E1 /01.0 and subsequent editions	1 to 550 (edition 04.0 or earlier), 1 to 909 (edition 05.0 or later)
Series 90C5,90E5/A(01) and subsequent editions	1 to 550(edition D or earlier), 1 to 909(edition E or later)
Series 90C8,90E8/A(01) and subsequent editions	1 to 909

PLC(#2) 1: As the number of velocity feedback pulses per motor revolution in parameter No. 2023, an invalid value such as a number equal to or less than 0 is set.

PLS(#3) 1: As the number of position feedback pulses per motor revolution in parameter No. 2024, an invalid value such as a number equal to or less than 0 is set.

DIR(#4) 1: As the motor rotation direction in parameter No. 2022, a correct value (111 or -111) is not set.

AXS(#6) 1: Parameter No. 1023 (servo axis number) is set incorrectly. A duplicate servo axis number is set, or a value exceeding the number of controlled axes of the servo card is set.

(4) Method

When an illegal servo parameter setting alarm detected by the servo software is issued, analyze the cause of the alarm by following the procedure explained below.

* When more than one alarm is issued, one of the causes of these alarms is displayed. Analyze the alarms one by one.

Procedure for displaying detail information about an illegal servo parameter setting alarm

On the diagnosis screen, search for No. 352. Check the number written in No. 352.

Analyzing illegal servo parameter setting alarms in detail

The detail alarm data basically consists of two to five digits as shown:

0	0	4	3	4

Location where an alarm was caused (0 0 4 3) — Cause of the alarm (4)

Upper four digits:

Indicate the location where an alarm was caused.
Table 2.1.9 lists the displayed numbers and corresponding parameter numbers.

*1 Basically, the low-order three digits of the 4-digit parameter number indicate the location where an alarm was caused. (When an alarm is due to more than one parameter, these digits and parameter numbers do not sometimes match.)

*2 When the digits are displayed on the diagnosis screen, 0s in high-order digits are not displayed.

Lowest digit:

Indicates the cause of an alarm.

The displayed numbers and their meanings are explained below:

2: The set parameter is invalid. The corresponding function does not operate.

3: The parameter value is beyond the setting range. Alternatively, the parameter is not set.

4 to 9: An overflow occurred during internal calculation.

Table 2.1.9 Detail analysis of illegal servo parameter setting alarms

Alarm detail No.	Parameter No.	Cause	Action
83	2008	Parameter settings related to learning control are illegal → See Supplementary 1.	Change the parameter settings so that they fall in the applicable range.
92	2009#2	A function which is not supported by the 30*i*-B Series is used.	Set bit 2 of parameter No. 2009 to 0.
233	2023	When initialization bit 0 is set to 1, the number of velocity pulses exceeds 13100.	Correct the number of velocity pulses so that it is within 13100.
234	2023	When a DD motor is used, a value smaller than 512 is set as the number of velocity pulses.	Set 512 or a greater number as the number of velocity pulses, or disable the DD motor. No.2300#2=0→ See Supplementary 4.
243	2024	When initialization bit 0 is set to 1, the number of position pulses exceeds 13100.	Use the conversion coefficient for the number of position feedback pulses (parameter No. 2185) to correct the number of position pulses (parameter No. 2024) so that it is within 13100. → See Supplementary 3.
346	2034	An overflow occurred in the vibration-damping control setting.	Check whether correct values are set for the number of velocity pulses, number of position pulses, and FFG.
434 435	2043	The internal value of the velocity loop integral gain overflowed.	Decrease the value of the velocity loop integral gain parameter.
443 444 445	2044	The internal value of the velocity loop proportional gain overflowed.	Use the function (No.2200#6) for changing the internal format of the velocity loop proportional gain. Alternatively, decrease the parameter setting. → See Supplementary 5.
474 475	2047	The internal value of the observer parameter (POA1) overflowed.	Correct the setting to (−1) × (desired value)/10.
523	2052	An attempt was made to use a velocity command or torque command according to the analog voltage input for a pulse input type DSA, but parameter No. 2052 is not set.	Set parameter No. 2052 (parameter for the excess speed alarm).
534 535	2053	The internal value of a parameter related to dead zone compensation overflowed.	Decrease the setting to the extent that the illegal servo parameter setting alarm is not caused.

Alarm detail No.	Parameter No.	Cause	Action
544 545	2054	The internal value of a parameter related to dead zone compensation overflowed.	Decrease the setting to the extent that the illegal servo parameter setting alarm is not caused.
686 687 688	2068	The internal value of the feed-forward coefficient overflowed.	Decrease the feed-forward coefficient.
694 695 696 699	2069	The internal value of the velocity feed-forward coefficient overflowed.	Decrease the velocity feed-forward coefficient.
754 755	2075	The setting for this parameter has overflowed.	This parameter is not used at present. Set 0.
764 765	2076	The setting for this parameter has overflowed.	This parameter is not used at present. Set 0.
843	2084	A positive value is not set as the flexible feed gear numerator. Alternatively, the numerator of the feed gear is greater than the denominator × 16.	Set a positive value as the flexible feed gear numerator. Alternatively, correct the parameter so that the numerator of the feed gear is less than or equal to the denominator × 16. (For other than parallel type separate detectors)
853	2085	A positive value is not set as the flexible feed gear denominator.	Set a positive value as the flexible feed gear denominator.
883	2088	For an axis with a serial type separate detector, a value exceeding 100 is set as the machine velocity feedback coefficient.	For an axis with a serial type separate detector, the upper limit of the machine velocity feedback coefficient is 100. Correct the coefficient so that it does not exceed 100.
884 885 886	2088	The internal value of the machine velocity feedback coefficient overflowed.	Decrease the machine velocity feedback coefficient. Alternatively, use the vibration-damping control function that has an equivalent effect.
926	2092	The internal value of the advanced preview feed-forward coefficient overflowed.	Decrease the advanced preview feed-forward coefficient.
953	2095 2140 2395	The internally set value of the feed-forward timing adjustment coefficient is ±12800 or over.	If nano interpolation is not used, this alarm can be avoided by the following setting: No.2224#5=1
994 995 996	2099	The internal value for N pulse suppression overflowed.	Disable the N pulse suppression function. No.2003#4=0 Alternatively, decrease the parameter setting so that no overflow will occur.
1033	2103	There is a difference in retract distance under unexpected disturbance torque between the position tandem master and slave axes. (if the same-axis retract function is in use).	Set the same value.
1123	2112	Although a linear motor is used, the AMR conversion coefficient parameter is not input.	Set the AMR conversion coefficient.
1182	2118 2078 2079	The dual position feedback conversion coefficient has not been specified.	Specify the dual position feedback conversion coefficient.

Alarm detail No.	Parameter No.	Cause	Action
1183	2118	Although an analog SDU is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is disabled.	Set the level on which the difference in error between the semi-closed and full-closed modes becomes too large (parameter No. 2118). If the monitoring function cannot be enabled due to the machine configuration, enable the bit for disabling the function for monitoring the difference in error between the semi-closed and full-closed modes (bit 0 of parameter No. 2565).
1284 1285	2128	When a small value is set as the number of velocity pulses, the internal value of a parameter related to current control overflows.	Decrease the value in this parameter to the extent that the alarm is not caused.
1294 1295	2129	When a large value is set as the number of velocity pulses, the internal value of a parameter related to current control overflows.	When the value set in this parameter is resolved to the form (a) × 256 + (b), set a smaller value in (a) again.
1393	2139	The AMR offset value of a linear motor exceeds ±45.	Keep the setting of this parameter within ±45. Alternatively, set bit 0 of parameter No. 2270 to 1 to increase the setting range of the AMR offset, and then specify the parameter anywhere within ±60.
1446 1447 1448	2144	Feed-forward coefficient for cutting overflowed.	Decrease the feed-forward coefficient for cutting.
1454 1455 1456 1459	2145	Velocity feed-forward coefficient for cutting overflowed.	Decrease the velocity feed-forward coefficient.
1493	2149	A value greater than 6 is specified in this parameter.	Only 6 or less can be specified in this parameter. Change the setting to 6 or below 6.
1503	2150	A value equal to or greater than 10 is set.	Set a value less than 10.
1786	2178	Bit 6 of No. 2212 or bit 6 of No. 2213 is set to 1, and No. 2621=0 is set.	Set bit 6 of No. 2212 or bit 6 of No. 2213 to 0.
1793	2179	A negative value or a value greater than the setting of parameter No. 1821 is set. A value of 101 or greater is set.	Set a positive value less than the setting of parameter No. 1821. Set a value of 100 or less. Bit 5 of parameter No. 2299 can be set to 1 so that an invalid parameter alarm is not detected, but a system alarm may be issued when a reference position return is performed. In this case, set bit 5 of parameter No. 2299 to 0.
1853	2185	A negative value or a value greater than the below value is set. No. 2023/4 (No.2000#0=0) or No.2023*10/4(No.2000#0=1)	Eliminate the causes shown at left.

Alarm detail No.	Parameter No.	Cause	Action
2113	2211#7	For driving a motor with four windings (when bit 7 of parameter No. 2211 is set to 1) <1> Bit 7 of parameter No. 2211 is not set to 1 for all of the four axes. <2> The motor numbers for the four axes are not the same. <3> HRV3 is set. (bit 0 of No.2013=1)	<1> Set bit 7 of parameter No. 2211 to 1 for all axes. <2> Use the same motor number and same standard parameters. <3> Disable HRV3.
2203	2220#0	If pole detection is enabled (bit 7 of No. 2213=1) and a non-binary detector is enabled (bit 0 of No. 2220=1), an illegal servo parameter setting alarm is issued when any of the following is set: - AMR conversion coefficient 1 ≤ 0 - AMR conversion coefficient 2 ≤ 0 - AMR conversion coefficient 2 > 512 (The settable range is 1 (2 poles) to 512 (1024 poles).)	Set the AMR conversion coefficients correctly.
2242	2224#5	This alarm is issued when a setting is made to neglect the invalid setting of the parameter for the feed-forward timing adjustment function (bit 5 of No. 2224=1) and a command for nano interpolation is issued.	Use either one.
2632	2263	When the lifting function against gravity is enabled (bit 7 of No. 2298=1) or the post-servo-off travel distance monitor function is enabled (bit 5 of No. 2278=1), the function for enabling the CNC software to post the detection unit to the servo software is not supported and the setting of the detection unit (No. 2263) is disabled.	Take one of the following actions: 1) Set a value in parameter No. 2263. → See Supplementary 7. 2) Disable the lifting function against gravity and the post-servo-off travel distance monitor function. 3) Use CNC software that supports the function for enabling the detection unit to be posted to the servo software.
2780	1905#6 2277#5,6,7 2278#0,2,4	When the first SDU unit is not used, a setting is made to connect a detector (acceleration sensor, temperature detection circuit, or servo check interface unit) to the first SDU unit. - Bit 6 of No.1905 (30*i*-A Series, 0*i*-D Series) - No.24096 (30*i*-B Series)	For the first SDU unit, check the FSSB setting (bit 6 of parameter No. 1905 and parameter No. 24096) or the detector setting (bits 0, 2, and 4 of parameter No. 2278).
2781	1905#7 2277#5,6,7 2278#1,3,4	When the second SDU unit is not used, a setting is made to connect a detector (acceleration sensor, temperature detection circuit, or servo check interface unit) to the second SDU unit. - Bit 7 of No.1905 (30*i*-A Series, 0*i*-D Series) - No.24097 (30*i*-B Series)	For the second SDU unit, check the FSSB setting (bit 7 of parameter No. 1905 and parameter No. 24097) or the detector setting (bits 1, 3, and 4 of parameter No. 2278).

Alarm detail No.	Parameter No.	Cause	Action
2782	1905#6 2277#5,6,7 2278#0,4	Any of the following settings is made: 1 For use with the first SDU unit, both of an acceleration sensor and temperature detection circuit are enabled. 2 Settings are made to use the first SDU unit, disable an acceleration sensor (bits 5, 6, 7 of No. 2277=0,0,0), and read acceleration data from the second unit (bit 1 of No. 2278=1).	Check the settings of the acceleration sensor and temperature detection circuit.
2783	1905#7 2277#5,6,7 2278#1,4	Any of the following settings is made: 1 For use with the second SDU unit, both of an acceleration sensor and temperature detection circuit are enabled. 2 Settings are made to use the second SDU unit, disable an acceleration sensor (bits 5, 6, 7 of No. 2277=0,0,0), and read acceleration data from the second unit (bit 1 of No. 2278=1).	Check the settings of the acceleration sensor and temperature detection circuit.
2784	1815#1 2277#5,6,7 2278#0,1,4	At the time of full-closed system setting, a detector other than a separate position detector is connected (with the first/second SDU unit).	Modify the setting of the detector.
2785	1815#1 2277#5,6,7 2278#0,4	At the time of full-closed system setting, a detector other than a separate position detector is connected (with the first SDU unit).	Modify the setting of the detector.
2786	1815#1 2277#5,6,7 2278#1,4	At the time of full-closed system setting, a detector other than a separate position detector is connected (with the second SDU unit).	Modify the setting of the detector.
2787	2278#0,#1	A setting is made to connect two temperature detection circuits.	Only one temperature detection circuit can be connected. Modify the setting so that data is read from one of the first and second SDU units.
3002	2300#3,#7	The αiCZ detection circuit and linear motor position detection circuit do not support overheat signal connection.	Replace the αiCZ detection circuit and linear motor position detection circuit with those circuits that support overheat signal connection. Alternatively, modify the setting so that the overheat signal is read from a DI signal. Bit 3 of No. 2300=0
3012	2301#2,#7	• When bit 2 of No. 2301=1 Hardware (PS, SV) that does not support DC link voltage information output is connected, but bit 2 of No. 2301 is set to 1. • When bit 7 of No. 2301=1 The CNC software does not support the torque control setting range extension function.	• When bit 2 of No. 2301=1 Set bit 2 of No. 2301 to 0. • When bit 7 of No. 2301=1 Use CNC software that supports the function. (→ See Supplementary 6.)

Alarm detail No.	Parameter No.	Cause	Action
3553 3603	2355	The value 4 or a smaller number is set.	Set the value 5 or a greater number.
3603	2113 2360 2363 2366	The value 95 or smaller number is set.	Set the value 96 or a greater number. Alternatively, if no resonance elimination filter is used, set all of the center frequency, band width, and dumping value to 0.
3603 3663	2366	The value 4 or a smaller number is set.	Set the value 5 or a greater number.
3722	2372	The EGB exponent setting is made.	Set 0 for the EGB exponent setting (parameter No. 2372).
4024 4025 4029	2402	The internal value of the torsion torque compensation coefficient overflowed.	Decrease the torsion torque compensation coefficient.
4291	2429#1	An attempt was made to use FSSB high-speed rigid tapping with either of the following functions. Bit 1 of parameter No. 2429 is set to 1. - HRV4 (Bit 0 of parameter No. 2014 is set to 1.) - Dual position feedback function * With series 90G0/13.0 or later edition, the dual position feedback function can be used together.	FSSB high-speed rigid tapping cannot be used together with these functions. Disable the function (set bit 1 of parameter No. 2429 to 0).
4374	2437#4	The linear scale supporting the αi interface cannot be used. The possible causes are: - In the semi-closed mode, 2.73M communication is not used in the semi-closed side. Alternatively, a linear motor is not used. - In the full-closed mode, 2.73M communication is not used in the full-closed side. - The 2048-magnification interpolation circuit (bit 0 of parameter No. 2274) is enabled.	Eliminate the causes shown at left.
4553	2455	A negative value is set.	Set the value 0 or a greater number.
4563	2456	A value not within 0 to 12 is set.	Set a value within 0 to 12.
5573	2557	The value specified for parameter No. 2557 (PS control axis specification) is not within the valid data range.	Correct the value within the valid data range (between 0 and 255). For details of PS control axis setting, refer to the maintenance manual of the relevant servo amplifier.
5720 5721 5722 5723 5724 5725 5726 5727	2572	A setting for a PS control axis is made for a non-PS control axis. (No.2572)	For other than a PS control axis, set this parameter to 0.

Alarm detail No.	Parameter No.	Cause	Action
5730 5731 5732 5733 5734 5735 5736 5737	2573	A setting for a PS control axis is made for a non-PS control axis. (No.2573)	For other than a PS control axis, set this parameter to 0.
6063	2606 2292#6 2293#6	A setting for moving axis number of interactive force compensation. (No.2606)	Set this parameter to (Axis number of second moving axis) * 100 +(Axis number of first moving axis).
6114 6115 6116 6119	2611	The internal value of the velocity feed-forward coefficient for FSSB high-speed rigid tapping overflowed.	Decrease the velocity feed-forward coefficient for FSSB high-speed rigid tapping.
6713 6723 6733 6743 6753 6763 6773 6783 6793 6803 6813 6823 6833 6843 6853	2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685	A setting for a PS control axis is made for a non-PS control axis. (Nos.2671 to 2685)	For other than a PS control axis, set this parameter to 0.
8213	1821	A positive value is not set in the reference counter capacity parameter.	Set a positive value in this parameter.
8254 8255 8256	1825	A position gain of 0 is set, or the internal position gain value has overflowed.	• Set a value other than 0 (when setting = 0). • Use the function for automatic format change for position gain or the function for expanding the position gain setting range (when setting ≠ 0). → See Supplementary 5.
9053	1815#1 1905#7,#6 2016#4	A separate interface unit is not set when the full-closed mode, analog servo adapter, or servo spindle synchronization setting is set.	Set a separate detector interface unit.
10010 10016 10019	2200#0	The internal value of the parameter related to feedback mismatch detection has overflowed.	Check whether correct values are set for the flexible feed gear, number of position pulses, and number of velocity pulses and the counting direction of separate detector data is correct. When there is no problem with them, disable "feedback mismatch detection". (bit 0 of No.2200=1)
10024 10025		An overflow occurred in internal calculation on the separate detector serial feedback extrapolation level.	When servo software Series 90B0 is used, change the software edition to edition D(04) or a later edition. (For series other than 90B0, the software edition need not be changed.)

Alarm detail No.	Parameter No.	Cause	Action
10033	2004	Illegal control cycle setting This error occurs if automatic modification is carried out for the control cycle.	Correct this parameter related to interrupt cycle setting.
10053	2018#0	When a linear motor is used, the scale reverse connection bit is set.	When the linear motor is used, the scale reverse connection bit cannot be used.
10062	2209#4	The amplifier used does not support the HC alarm prevention function.	When you use the current amplifier continuously, set the function bit shown to the left to 0. When using the HC alarm prevention function, use an appropriate amplifier that supports the function.
10092 10093	2004 2013#0 2014#0	This alarm is issued when an invalid control cycle is set.	Change the control cycle setting to HRV2, HRV3 or HRV4. → See Supplementary 2.
		Different control cycles are set within one servo CPU.	Set the same control cycle for axes controlled by one servo CPU. → See Supplementary 2.
		When HRV4 is enabled, a detector that does not support HRV4 is used. (Series 30*i* only)	Replace the detector with a detector supporting HRV4. Alternatively, disable HRV4. → See Supplementary 2.
		When HRV4 is enabled, a servo amplifier that does not support HRV4 is connected. (Series 30*i* only)	Replace the servo amplifier with a servo amplifier supporting HRV4. Alternatively, disable HRV4. → See Supplementary 2.
10103	2004 2013#0	HRV1 is set. Alternatively, although a current control cycle of 250 μs is set, HRV3 is specified.	The 30*i*-A Series and 0*i*-D Series or later do not allow HRV1 setting. Set HRV2, HRV3, or HRV4. Alternatively, when a current control cycle of 250 μs is set, set HRV2 or disable HRV3. → See Supplementary 2.
10113	2013#0	Current cycle mismatch alarm. This alarm is issued if the specified current cycle does not match the actual setting.	An axis for which HRV3 is specified exists on the same FSSB cable. Review the placement of the amplifier, or disable HRV3. → See Supplementary 2.
10123	2013#0	Alarm for indicating the disability of HRV3 setting. This alarm is issued when the axis supports HRV3 but the other axis of the pair does not support HRV3.	Eliminate the cause of the disability in setting the other axis. Alternatively, cancel the HRV3 setting. → See Supplementary 2.
10123	2013#0 2014#0	When HRV4 is set, this alarm is issued if any of the following conditions is met. - Servo software not supporting HRV4 is used. - The same FSSB system includes axes with HRV4 setting and axes with HRV2 or HRV3 setting. - The limitation in the number of axes is not observed. (In HRV4 control, one axis/DSP is set.)	Eliminate the causes listed on the left. Alternatively, cancel the HRV4 setting. → See Supplementary 2.

Alarm detail No.	Parameter No.	Cause	Action
10133	2013#0 2014#0	This alarm is issued when HRV3 or HRV4 is set, but the amplifier does not support these control types.	HRV3 or HRV4 is unusable for the axis on which the alarm was issued. → See Supplementary 2.
10202	2277#5,6,7 2278#0,2,4	The ID of the detector connected to the first SDU unit differs from the parameter setting.	Check the detector-related parameter or the state of detector connection.
10212	2277#5,6,7 2278#1,3,4	The ID of the detector connected to the second SDU unit differs from the parameter setting.	Check the detector-related parameter or the state of detector connection.
10221	2292#6,7 2293#6	The interactive force compensation function is used, but the CNC does not support detection unit information.	Set the detection unit. → See Supplementary 7.

Supplementary 1: Details of illegal settings of learning control parameters

For alarm detail No. 83, details of the cause can be checked as follows. For the 30*i*-B Series and so on, set parameter No. 2115 to 0 and parameter No. 2151 to 5316. For the 30*i*-A Series and so on, set parameter No. 2115 to 0 and parameter No. 2151 to 6265. Then, check the value of information No. 353 on the Diagnosis screen. Change the value to binary form. If a resulting binary bit is 1, the bit indicates the details cause as listed in the table below.

For part machining learning control A and B, see the alarm details on the dedicated screen.

In addition to alarm detail No. 83, alarm detail Nos. 2206, 4442, 4452, 5162, 5172, and 5272 indicate invalid parameter alarms related to learning control. For details, refer to "Learning Control Operator's Manual (Angle Based Learning Control)".

Bit	Cause
B0	The band stop filter setting (No. 2512) is out of the valid range.
B1	The profile number setting (No. 2511) is out of the valid range.
B2	The command data cycle setting (Nos. 2517, 2519, 2521, 2523, and 2525) is out of the valid range.
B3	The total of the profiles (No.2510) is out of the valid range.
B4	G05 was started during memory clear processing.
B5	The profile number (No. 2511) was 0 when the total of profiles (No. 2510) is nonzero.
B6	An automatically set value for thinning-out shift was out of the valid range because of a long command data cycle.

NOTE

If the value of information No. 353 on the Diagnosis screen is 0, a transfer error occurred when learning data was received from the PC to the servo. Set parameter No. 2151 to 6609 (30*i*-B) or 1313 (30*i*-A). You will find that B11 of information No. 353 on the Diagnosis screen is set to 1.

Supplementary 2: Control cycle setting

There are three different types of control cycle setting used with the 30*i*-A Series, 30*i*-B Series, and 0*i*-D Series (HRV2, HRV3, and HRV4). Their settings are explained below. With the 0*i*-D Series, HRV4 cannot be used.

HRV2: No.2004=0X000011, No.2013#0=0, No.2014#0=0
HRV3: No.2004=0X000011, No.2013#0=1, No.2014#0=0
HRV4: No.2004=0X000011, No.2013#0=0, No.2014#0=1

When an invalid value is set in control cycle related parameters, the following alarm messages are indicated on the CNC:

Alarm detail No.	Alarm number	Message
10092 10093	456	Invalid current control cycle setting
10103	457	Invalid High-speed HRV setting
10113	458	Invalid current control cycle setting
10123	459	High-speed HRV setting not allowed
10133	468	High-speed HRV setting not allowed (amplifier)

Supplementary 3: Setting the number of position pulses

If the resolution of the separate detector is high and the number of position pulses becomes greater than 32767, take the following measure.

Use "position pulse conversion coefficient" to make settings.
Number of position pulses = A × B
Select B so that A is within 32767.
A: Number of position pulses set in the parameter (less than or equal to 32767)
B: Conversion coefficient for the number of position pulses

2024	Number of position pulses (PPLS)

2185	Conversion coefficient for the number of position pulses (PSMPYL)

(Example of setting)

If the linear scale used has a minimum resolution of 0.1 μm and the distance to move per motor turn is 16 mm
Assume that A is 10000 and B is 16 because:
Number of position pulses = distance to move per motor turn (mm)/detector minimum resolution (mm) = 16 mm/0.0001 mm = 160000 (> 32767) = 10000 × 16
Set A as the "number of position pulses" and B as the "conversion coefficient for the number of position pulses".

> **NOTE**
> If the detector on the motor is an αi Pulsecoder (number of velocity pulses = 8192), select a value raised to the second power (2, 4, 8, ...) as the conversion coefficient as much as possible (so the position gain used within the software becomes more accurate).

Supplementary 4: Setting the number of velocity pulses

If the number of velocity pulses becomes greater than 32767, take the following measure.

(i) If the number of velocity pulses is in a range from 32,768 to 131,000

Parameter No. 30*i* Series,0*i*-D Series, and so on	Method for changing parameters
2000#0	1
2023	(Setting target)/10
2024	(Setting target)/10

(ii) If the number of velocity pulses is larger than 131,000
Change the parameters according to the following table.
In this table, letter E satisfies:
Number of velocity pulses/10/E < 13100

Parameter No. 30*i* Series,0*i*-D Series, and so on	Method for changing parameters
2000#0	1
2023	(Setting target)/10/E
2024	(Setting target)/10/E
2043	(Setting target)/E
2044	(Setting target)/E
2047	(Setting target)×E
2053	(Setting target)×E
2054	(Setting target)/E
2059	(Setting target)×E

NOTE
When a setting is made using this method, the actual speed multiplied by E is displayed on the servo screen.

Supplementary 5: Function for changing the internal format of the velocity loop proportional gain

An overflow may occur in the velocity loop proportional gain during internal calculation by the servo software. This can be avoided by setting the parameter shown below.

	#7	#6	#5	#4	#3	#2	#1	#0
2200		P2EX						

P2EX (#6) 0: Uses the standard internal format for the velocity loop proportional gain.
1: Changes the internal format of the velocity loop proportional gain to prevent an overflow.

Supplementary 6: Support for the torque control setting range extension function

To use the torque control setting range extension function (bit 7 of No. 2301), CNC software that supports the function is required. The following series and edition of CNC software support the function (as of June 2012):

CNC	System software	
	Series	Edition
Series 30*i*-A	G004, G014, G024	11 and subsequent editions
Series 31*i*-A5	G124, G134	11 and subsequent editions
Series 31*i*-A	G104, G114	11 and subsequent editions
Series 32*i*-A	G204	11 and subsequent editions

* For the 0*i*-D Series, there is no system software that supports the function.

For the Series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support the display of alarms.

Supplementary 7: Setting detection unit information

If you want to use a function which uses information related to the detection unit, but the CNC software does not support the function, you can set the detection unit for the following parameter to use the function.

2263	Detection unit setting

[Setting unit] 1nm

Detection unit	10μm	1μm	0.1μm	0.01μm	0.001μm	0.05μm
Setting value	10000	1000	100	10	1	50

2.1.10 Notes on Using the Control Axis Detach Function

(1) Overview

Servo software automatically identifies the type of detector connected to an axis, when the power to the CNC is turned on. When the control axis detach function is used, however, servo software cannot identify the type of detector in a case where the power to the CNC is turned on with the detector detached from the controlled axis. (An alarm such as a communication alarm is issued.)
Such an alarm can be avoided by setting the parameter indicated below.

(2) Series and editions of applicable servo software

[α*i*/β*i* Pulsecoder supported]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	O(15) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	O(15) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

[Separate serial linear supported]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	U(21) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	U(21) and subsequent editions	HRV4
Series 0*i*-D	90C5	-	
	90C8	-	
	90E5	-	
	90E8	-	

(3) Setting parameters

Set the following parameter for such an axis where the detector on the semi-closed side may be disconnected from the servo amplifier:

	#7	#6	#5	#4	#3	#2	#1	#0
2017					COMSRC			

COMSRC(#3) The detector on the semi-closed side is:
0: Automatically identified.
1: α*i*/β*i* pulse coder at all times.

> **NOTE**
> 1 When this parameter is set, the power must be turned off before operation is continued.
> 2 Do not set this parameter when the control axis detach function is not used.

	#7	#6	#5	#4	#3	#2	#1	#0
2277						SRLLIN		

SRLLIN(#2) The detector on the full-closed side is:
0: Automatically identified.
1: Linear serial interface at all times.

> **NOTE**
> 1 A separate detector interface unit is determined to be a rotary serial interface when the detector is detached.
> 2 When this parameter is set, the power must be turned off before operation is continued.
> 3 Do not set this parameter when the control axis detach function is not used.

2.1.11 Alarm Detection When an Error Occurs (Function for Monitoring the Difference in Error between the Semi-Closed and Full-Closed Modes and Dynamic Error Monitoring)

2.1.11.1 Function for monitoring the difference in error between the semi-closed and full-closed modes

(1) Overview

This function monitors the difference in detection position between the detector built into the motor and separate detector. If the difference between the Pulsecoder and the separate detector is greater than or equal to the value specified for the parameter, the abnormal status is assumed and alarm "EXCESS ERROR (SEMI-FULL)" is issued. The function is useful for checking normal operation of the separate detector and monitoring any slip between the motor and machine.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	13.0 and subsequent editions*	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions* 01.0 and subsequent editions*	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

* The following series and editions of servo software support the setting of the level on which the difference in error between the semi-closed and full-closed modes becomes too large in units of μm:
Series 90E0/31.0 and subsequent editions
Series 90E1/08.0 and subsequent editions
Series 90G0/13.0 and subsequent editions

(3) Notes

- For a full-closed configuration, the use of this function is recommended.
- With the Series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, when an analog input separate detector interface unit is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is automatically enabled. If the level on which the difference in error between the semi-closed and full-closed modes is too large (parameter No. 2118) or a conversion coefficient (parameter No. 2078 or 2079) is not set, invalid parameter alarm SV0417 (detail No. 1183) is issued. Be sure to set these parameters when using an analog input separate detector interface unit.
  However, the monitoring function cannot be enabled in the following system. In this case, disable the alarm detection (set bit 0 of parameter No. 2565 to 1).
  - The gear reduction ratio between the motor and detector greatly changes according to the machine position.
  - The belt or another part between the motor and detector can slip.

(4) Setting parameters

To enable the function for monitoring the difference in error between the semi-closed and full-closed modes, set the following parameters:

2118	Level on which the difference in error between the semi-closed and full-closed modes is too large

[Setting value] Level on which the difference in error is too large (μm)/detection unit (μm) or level on which the difference in error is too large (μm)

[Setting unit] Detection unit or 1 μm (→ See the explanation of bit 7 of parameter No. 2420.)

If the difference between the Pulsecoder and the separate detector is greater than or equal to the value specified for the parameter, the abnormal status is assumed and an alarm is issued.
Set a value two to three times as large as the backlash. When a value of 0 is set, the detection is disabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2420	SFUMSET							

SFUMSET(#7) The unit of data for the level on which the difference in error between the semi-closed and full-closed modes becomes too large (parameter No. 2118) is:
0: Detection unit
1: 1 μm

	#7	#6	#5	#4	#3	#2	#1	#0
2565								SFEROFF

SFEROFF(#0) For a machine in a full-closed configuration in which an analog input separate detector interface unit is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is:
0: Enabled.
1: Disabled.

For an axis in a full-closed configuration in which an analog input separate detector interface unit is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is automatically enabled. If the level on which the difference in error between the semi-closed and full-closed modes becomes too large (parameter No. 2118) is not set, invalid parameter alarm SV0417 (detail No. 1183) is issued.
When the function for monitoring the difference in error between the semi-closed and full-closed modes cannot be used for a machine due to the configuration, use this function bit to disable the function.

2078	Conversion coefficient (numerator)

2079	Conversion coefficient (denominator)

[Setting value] Calculate the coefficients using the following formula:

$$\text{Conversion coefficient}\left(\frac{\text{Numerator}}{\text{Denominator}}\right)=\frac{\text{Number of position feedback pulses per motor revolution (Value multiplied by the feed gear)}}{\text{1 million}}$$

(Example)

When the α*i* Pulsecoder is used with a tool travel of 10 mm/motor revolution (1 μm/pulse)

$$\text{Conversion coefficient}\left(\frac{\text{Numerator}}{\text{Denominator}}\right)=\frac{10\times 1000}{1{,}000{,}000}=\frac{1}{100}$$

2.1.11.2 Detection of excessive error between the estimated position and actual position (dynamic error monitoring)

(1) Overview

An excessive error alarm is detected by estimating the position of the feed axis based on position commands, position gain, and feed-forward setting and monitoring the difference between the estimated position and actual position. This function has an effect that the alarm level of excessive error automatically drops when the feedrate is low. It can reduce the time to detect an excessive error alarm when an error occurs.

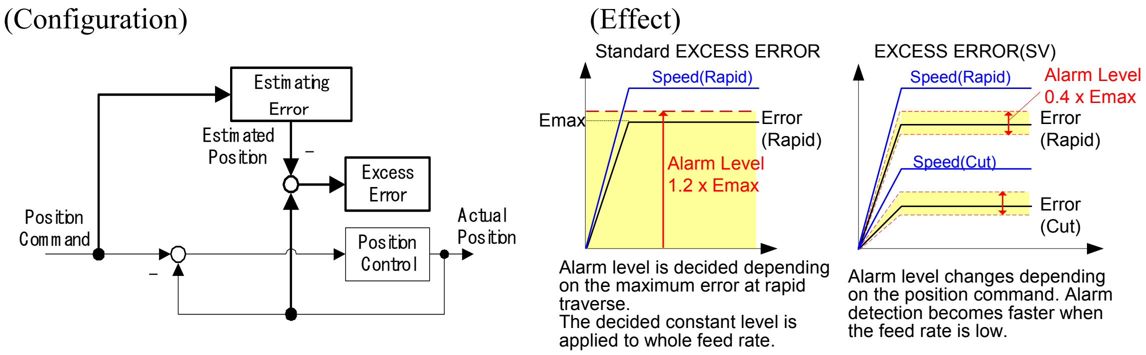


Fig. 2.1.11.2 (a) Outline of the detection of excessive error between the estimated position and actual position

(2) Series and editions of applicable servo software

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	05.0 and subsequent editions*	
Series 30*i*/31*i*/32*i*-A	90E0	28.0 and subsequent editions*	
	90E1	03.0 and subsequent editions*	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5	-	
	90C8	-	
	90E5	-	
	90E8	-	

* The dual position feedback function is supported by Series 90G0/05.0 and subsequent editions, Series 90E0/30.0 and subsequent editions, and Series 90E1/6.0 and subsequent editions.

[Series and editions of applicable system software]

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	41 and subsequent editions
	G004,G014,G024	02 and subsequent editions
Series 31*i*-A5	G12C,G13C	41 and subsequent editions
	G124,G134	02 and subsequent editions
Series 31*i*-A	G103,G113	41 and subsequent editions
	G104,G114	02 and subsequent editions
Series 32*i*-A	G203	41 and subsequent editions
	G204	02 and subsequent editions
Series 0*i*-MD	D4F1	05 and subsequent editions
Series 0*i*-TD	D6F1	05 and subsequent editions
Series 0*i* Mate-MD	D5F1	05 and subsequent editions
Series 0*i* Mate-TD	D7F1	05 and subsequent editions

For the Series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support the function.

(3) Notes

- When an alarm is detected, SV0653, "EXCESS ERROR (SV)" is displayed.
- To use this function together with the dual position feedback function, supporting servo software is required.

(4) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2419 (FS30*i*)							DYNTQL	DYNERR

DYNERR(#0) The detection of excessive error (SV) is:
0: Disabled.
1: Enabled.

DYNTQL(#1) The detection of excessive error in the torque limit mode is:
0: Enabled.
1: Disabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2420 (FS30*i*)				DUDYN				

DUDYN(#4) When the dual position feedback function is enabled, the detection of excessive error (SV) is:
0: Disabled.
1: Enabled.

2458 (FS30*i*)	Excessive error detection level

[Setting unit] Detection unit
[Valid data range] 0 to 32767
[Typical setting] 0.2 times of position error in rapid traverse

$$\text{Setting value} = \frac{\text{Rapid traverse rate [mm/min]}}{60 \times \text{position gain [1/s]} \times \text{detection unit [mm]}} \times 0.2$$

NOTE

1. When the dual position feedback function is used together, since the characteristics of dual position feedback are not considered during the estimation of the position, estimation error is generated according to the time constant of dual position feedback and a mechanical torsion. For this reason, the alarm level must be increased by the amount of error.
2. If system software does not support this function, setting bit 0 (DYNERR) of parameter No. 2419 to 1 causes invalid parameter alarm SV417 (detail No. 4190).
3. With Series 90G0, the dual position feedback function can be used by default. (Bit 4 (DUDYN) of parameter No. 2420 does not need to be set.)

(5) Example of tuning the detection of an excessive error alarm (SV)

In general, the excessive error alarm level is set to 1.2 times of estimated position error in rapid traverse. The level of an excessive error alarm detected by servo software is set based on the value observed as position error. To set the same alarm level, set the detection alarm level 0.2 times of estimated position error in rapid traverse.

$$\text{Setting value} = \frac{\text{Rapid traverse rate [mm/min]}}{60 \times \text{position gain [1/s]} \times \text{detection unit [mm]}} \times 0.2$$

If a smaller value must be set, observe position error and set the level from the observed value to the above setting value. Note that if the setting value is too small, it becomes easier to detect the alarm even in normal movement.

(a) Setting the parameter to enable the detection of excessive error
Set function bit 0 of parameter No. 2419 to 1 and set parameter No. 2458 (alarm level) to 30000. (To determine the alarm level, first set this level large anough to avoid an alarm.)

(b) Observing position error
Observe position error using SERVO GUIDE.
SERVO GUIDE channel setting:
Axis : Axis for which to enable the detection of excessive error
Kind : ERR
Unit/Conv. Coef. : Detection unit
Conv. Base : 1
Origin Value : 0

With the above setting, position error can be observed in acceleration and deceleration.
Fig. 2.1.11.2 (b) below shows the relationships between the speed and ERR (position error). You can see a difference of about 13 μm at the maximum feedrate.

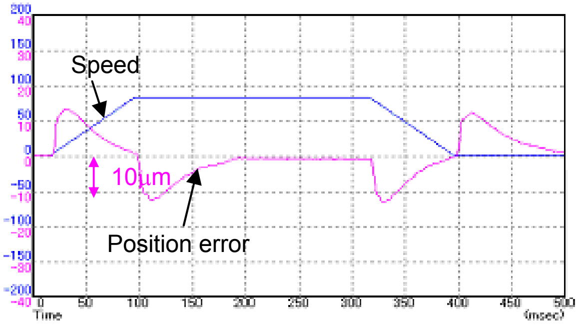


Fig. 2.1.11.2 (b) Relationships between the speed and position error

(c) Setting the alarm level
Set the alarm level from thee observed value (13 μm) to the value 0.2 times of position error estimated in rapid traverse.

2.2 SETTING PARAMETERS FOR LARGE SERVO MOTORS

2.2.1 Motor Models and System Configurations

To drive a large servo motor, multiple amplifiers may be used.
A system configuration is determined according to the motor model used and CNC (table below).

Table 2.2.1 (a) Motor models and system configurations

Motor model	Number of amplifiers	System configuration		
		30*i*-B Series	30*i*-A Series	0*i*-D Series
α*i*S 300/2000 α*i*S 500/2000 α*i*S 1000/2000HV	2	Motor with two windings*1	Torque tandem*4	Torque tandem*4
α*i*S 1000/3000HV α*i*S 2000/2000HV α*i*S 3000/2000HV	4	Motor with four windings*2	Motor with four windings*3	PWM distribution module (PDM*5)

*1 With the Series 30*i*-B, the motor is driven in the two-winding mode (bit 6 of parameter No. 2211 is set to 1).
*2 With the Series 30*i*-B, the motor is driven in the four-winding mode (bit 7 of parameter No. 2211 is set to 1).
*3 To drive a motor in the four-winding mode (bit 7 of parameter No. 2211 is set to 1) with the Series 30*i*-A, the tandem control option (J733) is required.
*4 The tandem control option (J733) is required.
*5 PDM stands for PWM Distribution Module. For details, refer to "PWM Distribution Module Descriptions (A-72562E-029)".

2.2.2 Parameter Setting for the Four-Winding and Two-Winding Modes

(1) Overview

This subsection describes the parameter setting for the four-winding mode (PLW4) and two-winding mode (PLW2) for the Series 30*i*. Since the current is controlled for each winging, four or two servo controlled axes are required.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	U(21) and subsequent editions 01.0 and subsequent editions	

(3) Setting parameters

After you have set the standard parameters for the servo motor to be used for all axes to be used by the motor with plural windings, set PLW4 or PLW2 according to the number of windings.

	#7	#6	#5	#4	#3	#2	#1	#0
2211	PLW4	PLW2						

(30*i*-B Series)

PLW2 (#6) The motor with two windings is:
0 : Not used.
1 : Used.

(30*i* -A,B Series)

PLW4 (#7) The motor with four windings is:

0 : Not used.

1 : Used.

2022	Direction of motor rotation (DIRCT)

* Set the same direction as the direction of motor rotation for a motor with two or four windings.

+111 When the positive direction is specified, the rotor rotates in the forward direction.

-111 When the positive direction is specified, the rotor rotates in the reverse direction.

NOTE

1 Set PLW4 or PLW2 for all axes to be used by the motor with plural windings.
2 When PLW4 or PLW2 is set, the current command and feedback from the Pulsecoder are copied from the main axis to the sub-axis.
3 When PLW2 is used, set the servo axis numbers (parameter No. 1023) to 2n+1,2 (30*i*-A), 8n+1,2, 8n+3,4, or 8n+5,6 (30*i*-B).
4 When PLW4 is used, set the servo axis numbers (parameter No. 1023) to 4n+1,2,3,4 (30*i*-A) or 8n+1,2,3,4 (30*i*-B).
5 When PLW4 is used with the Series 30*i*-A, servo HRV3 control cannot be used.
6 With the Series 30*i*-A, the tandem control option (J733) is required.
7 The motor feedback sharing bit (bit 7 of parameter No. 2018) and separate feedback sharing bit (bit 1 of parameter No. 2200) are not required.

(4) Invalid parameter setting alarm

In the following cases, an invalid parameter alarm is issued. (detail No. DGN352 = 2113)

[Four windings]

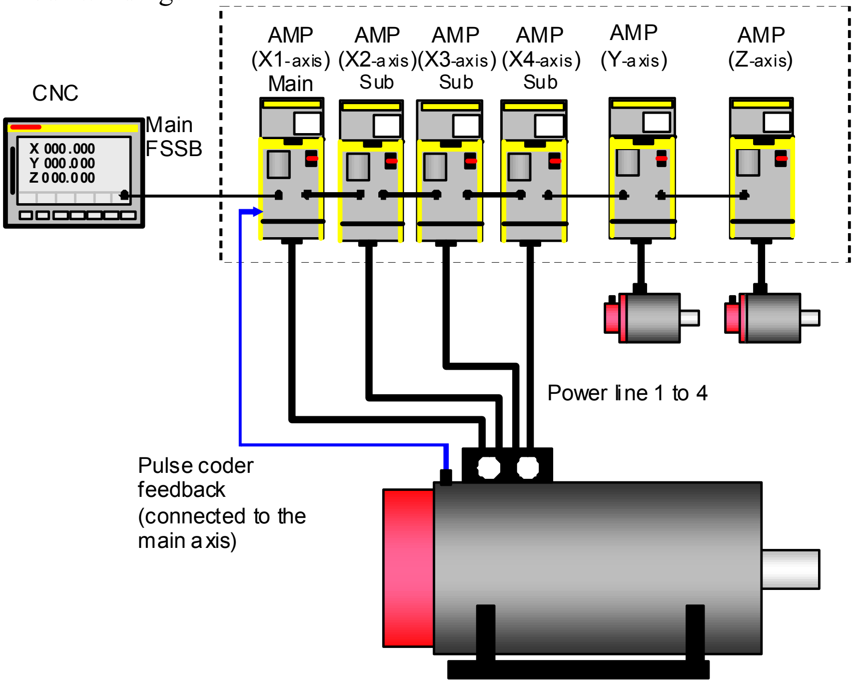
- The tandem option is not used. (No detail No. is displayed only in this case.) 30*i*-A
- Bit 7 of parameter No. 2211 is not set to 1 for all of the four axes consecutively specified for parameter No. 1023.
- The motor number is not the same for all of the four axes consecutively specified for parameter No. 1023.
- HRV3 is used. (for the Series 30*i*-A CNCs)

[Two windings]

- The tandem option is not used. (No detail No. is displayed only in this case.) 30*i*-A
- Bit 6 of parameter No. 2211 is not set to 1 for all of the two axes consecutively specified for parameter No. 1023.
- The motor number is not the same for all of the two axes consecutively specified for parameter No. 1023.
- HRV4 is used.

(5) Example of parameter setting

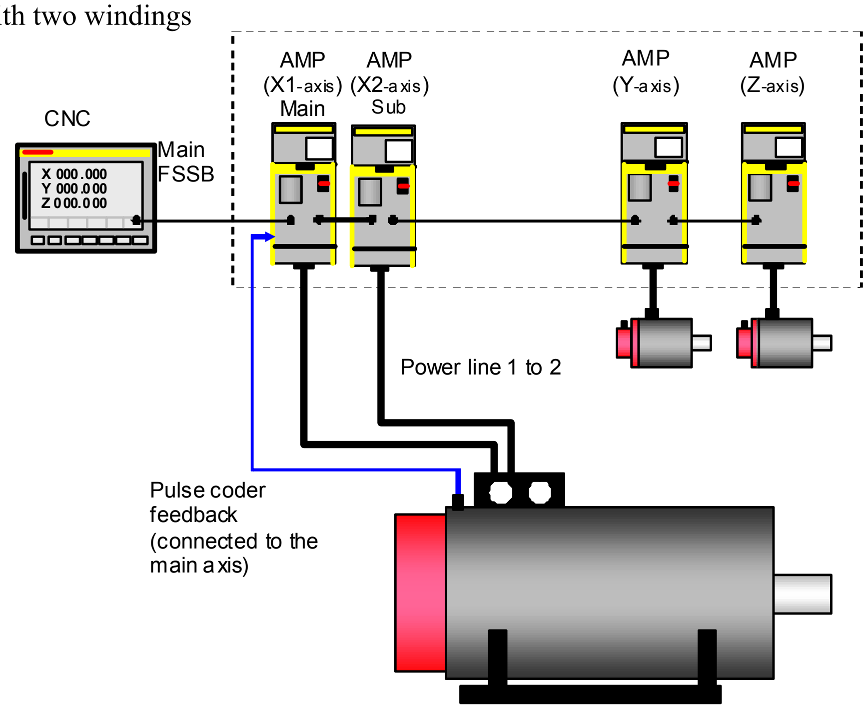
- Motor with four windings



Servo motor with four windings (such as αiS1000/3000HV)

Axis name	Axis name No.1020	Second axis name No.1025	Servo axis number No.1023	Four-winding mode No.2211#7
X1	88	1	1	1
X2	88	2	2	1
X3	88	3	3	1
X4	88	4	4	1
Y	89	0	5	0
Z	90	0	6	0

- Motor with two windings



Servo motor with two windings (such as αiS1000/2000HV)

Axis name	Axis name No.1020	Second axis name No.1025	Servo axis number No.1023	Two-winding mode No.2211#6
X1	88	1	1	1
X2	88	2	2	1
Y	89	0	3	0
Z	90	0	4	0

NOTE

The axis name (parameter No. 1020) or second axis name (parameter No. 1025) must be changed for each axis used for a motor with two or four windings.
If the same axis name is used, the actual feedrate becomes lower than the specified speed.

(5) Others

- Position control is performed for the main axis. No position command is required for the sub-axis.
- In general, set the same value for each parameter for the main axis and sub-axis.
- To use the control axis detach function, input the detach signal to all axes.
- To use a resonance elimination filter, set the same value for each filter parameter for the main axis and sub-axis.
- You can measure frequency characteristics on SERVO GUIDE by specifying the main axis as the measurement target.

2.2.3 Setting Parameters in the Torque Tandem Configuration

(1) Overview

To drive a motor with two windings in a torque tandem configuration, it is necessary to make settings for torque tandem control and for enabling the feedback copy function.

> **NOTE**
> 1 Torque tandem control is an optional function.
> 2 When a large motor is used in the torque tandem configuration, two CNC axes are occupied per motor.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

> **NOTE**
> Servo HRV4 control exercises control on one axis per CPU, so this configuration cannot be used together with servo HRV4 control.

(3) Setting parameters

<1> Of the two amplifiers connected to a motor, assign one amplifier to the main axis and the other to the sub-axis used for torque tandem control, and enable torque tandem control.

	#7	#6	#5	#4	#3	#2	#1	#0
1817		TANDEM						

TANDEM(#6) 1: Enables torque tandem control. (Set this parameter for each of the main axis and sub-axis.)

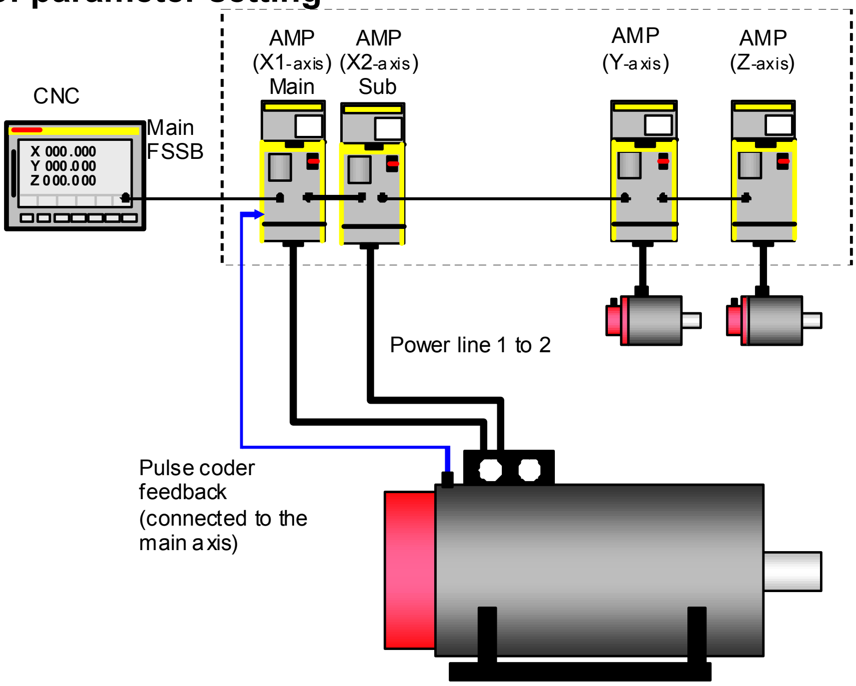
To make settings related to torque tandem control, see Subsection 5.10.4, "TORQUE TANDEM CONTROL FUNCTION".

<2> Make the parameter setting indicated below for the sub-axis to enable the feedback sharing function. The feedback cable from the motor is connected to the amplifier on the main axis.

	#7	#6	#5	#4	#3	#2	#1	#0
2018	PFBCPY							

PFBCPY(#7) 1: Uses feedback to the main axis for the sub-axis as well. (Set this parameter only for the sub-axis.)

(4) Example of parameter setting



Servo motor with two windings (such as αiS1000/2000HV)

Axis name	Servo axis number No.1023	Tandem control No.1817#6	Feedback copy No.2018#7
X1	1	1	0
X2	2	1	1
Y	3	0	0
Z	4	0	0

2.2.4 Parameter Setting for a 16-Pole Motors (αiS2000/2000HV, αiS3000/2000HV)

For an axis on which any of the servo motors listed below is used, set the parameters for using a 16-pole servo motor.

Servo motor name	Motor specification
αiS2000/2000HV	0091
αiS3000/2000HV	0092

	#7	#6	#5	#4	#3	#2	#1	#0
2220			P16					

P16(#5) 1: Does not use a 16-pole servo motor.

	#7	#6	#5	#4	#3	#2	#1	#0
2001	0	AMR6	AMR5	AMR4	AMR3	AMR2	AMR1	AMR0

AMR0 to 6 (#0 to 6) Set the AMR value corresponding to the number of motor poles.

AMR							Number of motor poles
6	5	4	3	2	1	0	
0	0	0	1	0	0	0	16-pole servo motor
0	0	0	0	0	0	0	Other than 16-pole servo motors (8-pole motor)

3 SETTING PARAMETERS OF LINEAR MOTOR AND SYNCHRONOUS BUILT-IN SERVO MOTOR

Chapter 3, " SETTING PARAMETERS OF LINEAR MOTOR AND SYNCHRONOUS BUILT-IN SERVO MOTOR ", consists of the following sections:

3.1 LINEAR MOTOR PARAMETER SETTING

3.1.1 Procedure for Setting the Initial Parameters of Linear Motors

(1) Overview

The following describes the procedure for setting the digital servo parameters to enable the use of a FANUC linear motor.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	(*1)
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	(*1) HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(*1) Servo software edition P(16) or later is required to use the linear motor position detection circuit (A860-2033-T201, -T202, -T301, or -T302).

(3) Warning

⚠ **WARNING**

1 The linear motor can make an unpredictable movement, resulting in a very dangerous situation, if an error is made in linear motor assembly, power line cabling, detector installation direction setting, or basic parameter setting.

> ⚠ **WARNING**
>
> 2 It is recommended to take the following actions until normal operation is confirmed:
> - Lower the excessive error level so that an alarm is issued immediately when an unpredictable movement is made.
> - Lower the torque limit value to disable abrupt acceleration.
> - Ensure that the emergency stop switch can be pressed immediately.

(4) Linear encoders

The position and velocity of the linear motor are detected using a linear encoder. Two types of linear encoders are available: incremental type and absolute type. The parameter setting and connection vary according to the type of encoder.

For incremental type

The linear encoder of incremental type is connected to a servo amplifier via a position detection circuit (A860-0333-T*** or A860-2033-T***) for linear motor manufactured by FANUC. Values to be set in parameters vary depending on the signal pitch of the linear encoder. Therefore, check the signal pitch of the encoder first.

Table 3.1.1 (a) lists examples of usable incremental linear encoders.

Table 3.1.1 (a) Examples of usable linear encoders (incremental)

Encoder maker	Signal pitch (μm)	Model
HEIDENHAIN	20	LS487(C), LS187(C), LS388(C), LS688(C), LIDA483, LIDA485, LIDA487, LIDA489, etc.
	40	LB382(C) , etc.
	2	LIP481R
	4	LF485, LF185, LIP581R, LIP581C, LIF481R, LIF181R, LIF181C, etc.
	0.512	LIP281R
Mitutoyo	20	AT402E
Renishaw	20	RG2, TONiC, SIGNUM
	40	RG4
	2000	LM10

When a linear encoder of incremental type is used, a linear motor pole detector (A860-0331-T001,-T002 or A860-2031-T001,-T002) is also needed.

For absolute type

The linear encoder of absolute type is directly connected to a servo amplifier. Depending on the resolution of an encoder used, the parameter setting varies. First, check the resolution. Table 3.1.1 (b) lists examples of absolute type linear encoders currently usable.

Table 3.1.1 (b) Usable linear encoders (absolute)

Encoder maker	Resolution (μm)	Model
HEIDENHAIN	0.05 (0.01)*1	LC193F, LC493F
	0.05 (0.01)*1,2 0.0125 (0.00125)*3,4	LC195F, LC495F
Mitutoyo	20/4096	AT555
	0.05	AT353, AT553
	0.1	ST758
Renishaw	0.001, 0.05	RESOLUTE
Magnescale	0.01, 0.05, 0.1, 0.5, 1.0	SR87, SR77
NEWALL	0.5, 1.0, 5, 10	SHG-AF
FAGOR	0.05, 0.1	LAF, GAF, SAF, SVAF

*1 Encoders with resolutions of 0.05 μm and 0.01 μm are available.
*2 Resolution for the α interface (communication via the α interface (two-pair communication) is automatically used for a scale that does not response to the αi interface (one-pair communication).)
*3 Resolution for the αi interface
*4 The software edition that supports the αi interface is 90G0/19.0 or later.

NOTE

1. For details of the linear encoders usable with FANUC linear motors, refer to "FANUC LINEAR MOTOR L*i*S series DESCRIPTIONS (B-65382EN)".
2. For details of the linear encoders, contact the manufacturer of each linear encoder.
3. To use servo HRV4 control with a linear motor, a detector that supports servo HRV4 control is needed. See "(d) Detector" in "(4) Servo HRV4 control hardware" of Subsection 5.2.2.

(5) Parameter settings

Set the parameters according to the procedure below. Note the points below when setting the parameters.

[Cautions for using incremental linear encoders]

The following parameter setting procedure involves a parameter to be specified according to the resolution of the linear encoder. If an incremental linear encoder is to be used, convert the encoder signal pitch to the resolution for parameter calculation, using the following equation.
Resolution [μm] = Encoder signal pitch [μm] / 512

Parameter setting procedure (1)

Procedure (1) can be used to initialize the parameters (such as current gain) necessary to drive a linear motor. After initialization, parameters depending on the linear encoder resolution (or the value obtained by dividing the signal pitch of the linear encoder by the interpolation magnification of the position detection circuit) must be set. Set these parameters by following parameter setting procedure (2).

Parameters related to initialization
For incremental type, For absolute type

	#7	#6	#5	#4	#3	#2	#1	#0
2000							DGPR	PLC0

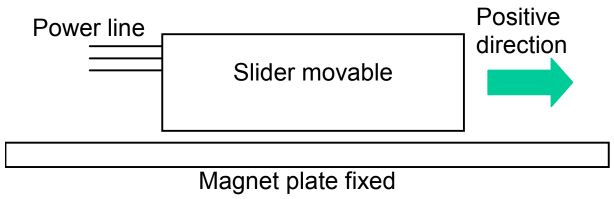
DGPR(#1) Set 0. (After initialization, this bit is set to 1 automatically.)
For PLCO (#0), see Table 3.1.1 (d) and Table 3.1.1 (e).

2001	AMR

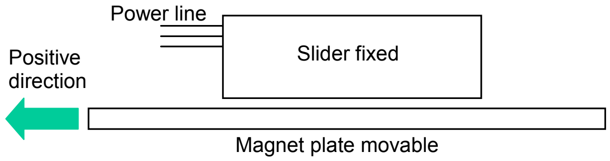
Specify 00000000.

2022	Movement direction

(a) When the coil slider is movable:
+111: When the positive direction is specified, the slider moves in the positive direction.
-111: When the positive direction is specified, the slider moves in the reverse direction.



(b) When the magnet plate is movable:
+111: When the positive direction is specified, the magnet plate moves in the positive direction.
-111: When the positive direction is specified, the magnet plate moves in the reverse direction.



Motor ID number

For incremental type, For absolute type

2020	Motor ID number

Standard parameters are prepared for the linear motors listed below as of March, 2013. The servo software shown in Table 3.1.1 (c) is required to automatically load the standard parameters shown in Section 9.4. To automatically load the parameters, set bit 1 of parameter No. 2000 to 0, set the motor number, make the following basic settings, and restart the CNC. Upon completion of automatic loading, bit 1 of parameter No. 2000 is automatically set to 1. When the servo software used does not support automatic loading, set the parameters with reference to the parameter list shown in this manual.

Table 3.1.1 (c) Motor ID numbers of linear motors and servo software that can be loaded automatically

[200-V driving]

Motor model	Motor specification	Motor ID No.	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
L*i*S 300A1/4	0441-B200	351	03.0	G	01.0	A	A
L*i*S 600A1/4	0442-B200	353	03.0	G	01.0	A	A
L*i*S 900A1/4	0443-B200	355	03.0	G	01.0	A	A
L*i*S 1500B1/4	0444-B2□0	357	03.0	G	01.0	A	A
L*i*S 3000B2/2	0445-B1□0	360	03.0	G	01.0	A	A
L*i*S 3000B2/4	0445-B2□0	362	03.0	G	01.0	A	A
L*i*S 4500B2/2	0446-B1□0	364	03.0	G	01.0	A	A
L*i*S 4500B2/4	0446-B2□0	366	07.0	31.0	08.0	F	B
L*i*S 6000B2/2	0447-B1□0	368	03.0	G	01.0	A	A
L*i*S 6000B2/4	0447-B2□0	370	03.0	G	01.0	A	A
L*i*S 7500B2/2	0448-B1□0	372	03.0	G	01.0	A	A
L*i*S 7500B2/4	0448-B2□0	374	03.0	G	01.0	A	A
L*i*S 9000B2/2	0449-B1□0	376	03.0	G	01.0	A	A
L*i*S 9000B2/4	0449-B210	378	03.0	G	01.0	A	A
L*i*S 3300C1/2	0451-B1□0	380	03.0	G	01.0	A	A
L*i*S 9000C2/2	0454-B1□0	384	03.0	G	01.0	A	A
L*i*S 11000C2/2	0455-B1□0	388	03.0	G	01.0	A	A
L*i*S 11000C2/4	0455-B220	390	07.0	31.0	08.0	F	B
L*i*S 15000C2/2	0456-B1□0	392	03.0	G	01.0	A	A
L*i*S 15000C2/3	0456-B2□0	394	03.0	G	01.0	A	A
L*i*S 10000C3/2	0457-B1□0	396	03.0	G	01.0	A	A
L*i*S 17000C3/2	0459-B1□0	400	03.0	G	01.0	A	A

[400-V driving]

Motor model	Motor specification	Motor ID No.	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
L*i*S 1500B1/4	0444-B2□0	358	03.0	G	01.0	A	A
L*i*S 3000B2/2	0445-B1□0	361	03.0	G	01.0	A	A
L*i*S 4500B2/2HV	0446-B0□0	363	03.0	G	01.0	A	A
L*i*S 4500B2/2	0446-B1□0	365	03.0	G	01.0	A	A
L*i*S 6000B2/2HV	0447-B0□0	367	03.0	G	01.0	A	A
L*i*S 6000B2/2	0447-B1□0	369	03.0	G	01.0	A	A
L*i*S 7500B2/2HV	0448-B0□0	371	03.0	G	01.0	A	A
L*i*S 7500B2/2	0448-B1□0	373	03.0	G	01.0	A	A
L*i*S 9000B2/2	0449-B1□0	377	03.0	G	01.0	A	A
L*i*S 3300C1/2	0451-B1□0	381	03.0	G	01.0	A	A
L*i*S 9000C2/2HV	0454-B0□0	383	07.0	31.0	08.0	F	B
L*i*S 9000C2/2	0454-B1□0	385	03.0	G	01.0	A	A
L*i*S 11000C2/2HV	0455-B0□0	387	03.0	G	01.0	A	A
L*i*S 11000C2/2	0455-B1□0	389	03.0	G	01.0	A	A
L*i*S 15000C2/3HV	0456-B0□0	391	03.0	G	01.0	A	A
L*i*S 15000C2/2	0456-B1□0	393	18.0	-	-	-	D
L*i*S 10000C3/2HV	0457-B0□0	395	03.0	29.0	05.0	F	A
L*i*S 10000C3/2	0457-B1□0	397	03.0	G	01.0	A	A
L*i*S 17000C3/2HV	0459-B0□0	399	03.0	28.0	04.0	D	A
L*i*S 17000C3/2	0459-B1□0	401	03.0	G	01.0	A	A

The motor ID numbers are for SERVO HRV2. Loading is possible with the servo software of the series and edition listed above or subsequent editions.

After parameter initialization, check that the function bit for linear motor control is set to 1 (linear motor control is enabled).

	#7	#6	#5	#4	#3	#2	#1	#0
2010						LINEAR		

LINEAR(#2) Linear motor control is:
0: Disabled
1: Enabled

When using position detection circuit or position detection circuit C for linear motor

For incremental type

When a position detection circuit (-T201, -T202, -T301, or -T302) having an interpolation magnification of 2048 is used with an incremental type linear encoder, the parameter shown below must be set to maintain both the maximum feedrate and high resolution. Set the parameter before proceeding to procedure (2).

	#7	#6	#5	#4	#3	#2	#1	#0
2274								HP2048

HP2048(#0) A circuit having an interpolation magnification of 2048 (position detection circuit or position detection circuit C for linear motor) is:
0: Not used
1: Used

NOTE

1 Setting this parameter(No.2274(FS30*i*,16*i*) or No.2687(FS15*i*)) to "enable" lets you make the basic parameter settings as explained in Procedure (2).
2 Changing this parameter results in a power-off alarm being raised.
3 When this parameter is set, the detection unit in the case of FFG=1/1 is (signal pitch/512 [um]).
If a minimum detection unit (signal pitch/2048 [μm]) is necessary, specify:
FFG = 4/1
4 If nano interpolation is applied, a resolution as high as (signal pitch/2048 [μm]) is applied as decimal-part feedback.
5 When a linear encoder of incremental type is used, a linear motor pole detector is needed.
6 With position detection circuit for linear motor, the interpolation magnification can be changed using setting pin SW3. (The setting at the time of shipment is Setting B.)
Setting A: The interpolation magnification is 512.
Setting B: The interpolation magnification is 2048.
Setting A enables up to high-speed operation, and Setting B enables high resolution feedback acquisition.

	Setting A	Setting B
HP2048	1	1
Resolution [μm] (*1)	λ[μm]/128 (*2)	λ [μm]/ 512 (*2)
Maximum velocity [mm/min]	λ [μm]×122880 (*2)	λ [μm] ×30720 (*2)

(*1)The resolution values in the table above are used for calculation of various parameters.
(*2)λ [mm] represents a linear scale signal pitch.
7 When the position detection circuit C for linear motor is used, no function is available which can change an interpolation magnification according to a set-up pin. (Fixed at a magnification of 2048)
Linear motor position detection circuit C is connected to the scale with an absolute address origin.

Parameter setting procedure (2)

For incremental type, For absolute type

Procedure (2) makes parameter settings that depend on the resolution of the linear encoder (hereafter simply called "the resolution"). Set the parameters according to Table 3.1.1 (e), (f).

When using an incremental type linear encoder, calculate as follows:
Resolution [μm] = encoder signal pitch [μm] / 512

	#7	#6	#5	#4	#3	#2	#1	#0
2000								PLC0

PLC0(#0) The number of velocity pulses and the number of position pulses are:
0: Used without being modified.
1: Used after being multiplied by 10
If the number of velocity pulses is lager than 32767, set the parameter to 1.
If the number of position pulses exceeds 32767, use the following position pulse conversion coefficient.

2023	Number of velocity pulses (PULCO)

(Parameter calculation expression)
Number of velocity pulses = 3125 / 16 / (resolution [μm])
If the calculation result is greater than 32767, set up PLC0 = 1, and set the parameter (PULCO) with a value of 1/10.

2024	Number of position pulses (PPLS)

(Parameter calculation expression)
Number of position pulses = 625 / (resolution [μm])
If the calculation result is greater than 32767, determine the parameter setting (PPLS), using the following position pulse conversion coefficient (PSMPYL).

2185	Position pulses conversion coefficient (PSMPYL)

This parameter is used if the calculated number of position pulses is greater than 32767.
(Parameter calculation expression)
PLC0 = 0 → The parameter is set so that the following equation holds: (the number of position pulses) × (position pulses conversion coefficient) = 625/resolution [μm].
PLC0 = 1 → The parameter is set so that the following equation holds: 10 × (the number of position pulses) × (position pulses conversion coefficient) = 625/resolution [μm].
(→ See Supplementary 3 of Subsection 2.1.9.)

	#7	#6	#5	#4	#3	#2	#1	#0
2013	APTG							

APTG(#7) α pulse coder software disconnection is:
0: Not neglected.
1: Neglected.
Set this parameter to 1 when using an absolute type linear encoder.

2112	AMR conversion coefficient 1

2138	AMR conversion coefficient 2

Setting AMR conversion coefficients
Calculate the number of feedback pulses per pole-to-pole span of the linear motor, and find AMR conversion coefficients 1 and 2 expressed by the equation shown below.
Number of pulses per pole-to-pole span
= pole-to-pole span [mm] × 1000/resolution [μm]
= (AMR conversion coefficient 1) × $2^{\text{(AMR conversion coefficient 2)}}$

Supplementary)

If AMR conversion coefficient 1 = (pole-to-pole span [mm]/ resolution [μm]) is an integer and a multiple of 1024, setting of only AMR conversion coefficient 1 is needed. In this case, the following are assumed:
AMR conversion coefficient 1
= (pole-to-pole span [mm]/resolution [μm])
AMR conversion coefficient 2 = 0
The pole-to-pole span depends on the motor model as indicated in the table below.

Table 3.1.1 (d) List of pole-to-pole spans

Classification	Pole-to-pole span (D)	Motor model
Small motors	30mm	L*i*S300A, L*i*S600A, L*i*S900A
Medium-size and large motors	60mm	Model other than the above

2084	Flexible feed gear numerator

2085	Flexible feed gear denominator

Use a unified detection unit for the flexible feed gear (FFG) parameters according to Tables3.1.1 (e) and 3.1.1 (f).
(Parameter calculation expression)
FFG = (resolution [μm]) / (detection unit [μm])

Table 3.1.1 (e) Parameter setting when an incremental type linear encoder is used

[Medium-size and large motors] (pole-to-pole span: 60mm)

Signal pitch [μm]	PLC0 (2000#0)	Number of velocity pulses / Number of position pulses, Conversion coefficient (No.2023 / No.2024, 2185)	AMR conversion coefficient 1 or 2 (No.2112, 2138)	FFG(No.2084/No.2085)	
				1-μm detection	0.1-μm detection
20	0	5000 / 16000, 0	3000, 9	5 / 128	50 / 128
40	0	2500 / 8000, 0	1500, 9	5 / 64	50 / 64
2	1	5000 / 8000, 2	30000, 9	1 / 256	10 / 256
4	1	2500 / 8000, 0	15000, 9	1 / 128	10 / 128
40.513167	0	2468 / 7899, 0	1481, 9	301 / 3804	3010 / 3804

[Small motors] (pole-to-pole span: 30mm)

Signal pitch [μm]	PLC0 (2000#0)	Number of velocity pulses / Number of position pulses, Conversion coefficient (No.2023 / No.2024, 2185)	AMR conversion coefficient 1 or 2 (No.2112, 2138)	FFG(No.2084/No.2085)	
				1-μm detection	0.1-μm detection
20	0	5000 / 16000, 0	1500, 9	5 / 128	50 / 128
40	0	2500 / 8000, 0	750, 9	5 / 64	50 / 64
2	1	5000 / 8000, 2	15000, 9	1 / 256	10 / 256
4	1	2500 / 8000, 0	7500, 9	1 / 128	10 / 128
40.513167	0	2468 / 7899, 0	1481, 8	301 / 3804	3010 / 3804

Table 3.1.1 (f) Parameter setting when an absolute type linear encoder is used

[Medium-size and large motors] (pole-to-pole span: 60mm)

Resolution 能 [μm]	PLC0 (2000#0)	Number of velocity pulses / Number of position pulses, Conversion coefficient (No.2023 / No.2024, 2185)	AMR conversion coefficient 1 or 2 (No.2112, 2138)	FFG(No.2084/No.2085)	
				1-μm detection	0.1-μm detection
0.1	0	1953 / 6250, 0	9375, 6	1/10	1/1
0.05	0	3906 / 12500, 0	9375, 7	1/20	1/2
0.01	0	19531 / 6250, 10	23438, 8	1/100	1/10
0.005	1	3906 / 12500, 0	23438, 9	1/200	1/20
20/4096	1	4000 / 12800, 0	24000, 9	20/4096	200/4096

[Small motors] (pole-to-pole span: 30mm)

Resolution [μm]	PLC0 (2000#0)	Number of velocity pulses / Number of position pulses, Conversion coefficient (No.2023 / No.2024, 2185)	AMR conversion coefficient 1 or 2 (No.2112, 2138)	FFG(No.2084/No.2085)	
				1-μm detection	0.1-μm detection
0.1	0	1953 / 6250, 0	9375, 5	1/10	1/1
0.05	0	3906 / 12500, 0	9375, 6	1/20	1/2
0.01	0	19531 / 6250, 10	23438, 7	1/100	1/10
0.005	1	3906 / 12500, 0	23438, 8	1/200	1/20
20/4096	1	4000 / 12800, 0	24000, 8	20/4096	200/4096

(Cautions)
If the encoder signal pitch is larger than 200 μm, various coefficients used in the servo software may overflow to raise an alarm on invalid parameters, because the setting for the number of velocity pulses becomes very small.
In this case, change the corresponding parameter by referencing Subsection 2.1.9, "Measures for Alarms on Illegal Servo Parameter Settings."

Parameter setting procedure (3)

When a linear motor is used, the linear encoder must be installed so that the Z phase of the linear encoder matches the origin of the activating phase. Otherwise, the specified motor characteristics cannot be obtained. (For details of installation positions, refer to "FANUC LINEAR MOTOR L*i*S series DESCRIPTIONS (B-65382EN)".)

Procedure (3) describes the method of adjusting the activating phase origin (AMR offset adjustment) when it is difficult to install a linear encoder at a specified position with a specified precision.

Setting the AMR offset
For incremental type, For absolute type

- When the learning control function is used, see "Learning Function Operator's Manual".
- When the learning control function is not used, set the AMR offset as follows:

2139	AMR offset

Specifies an activating phase (AMR offset) for phase Z.
[Unit of data] Degrees
[Valid data range] -45 to +45 (*)

(*) Extended AMR offset setting range (-60 degrees to +60 degrees) can be specified by setting the parameter below. So, if the AMR offset value does not lie within the range -45 degrees to +45 degrees in adjustment processing, set the bit below. (Usually, set the bit below to 0.)

	#7	#6	#5	#4	#3	#2	#1	#0
2270								AMR60

AMR60 (#0) Changes the AMR offset setting range.
0: -45 degrees to +45 degrees (standard setting range)
1: -60 degrees to +60 degrees (extended setting range)

The procedure for AMR offset adjustment is described below. The procedure varies according to whether an incremental type linear encoder or absolute type linear enable is used. Before starting an adjustment, check the type of linear encoder used.

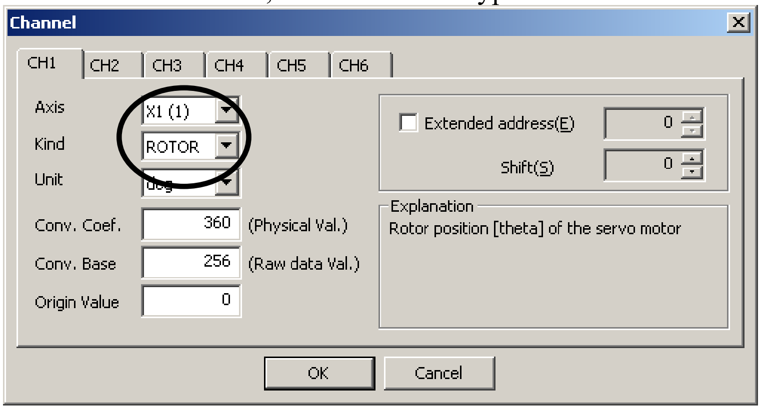
> ⚠ **CAUTION**
> Note that if an incorrect AMR offset value is input, the thrust of the motor can decrease or the motor can make an unpredictable motion.
> After setting a correct AMR offset value, never rewrite the set value manually.

Incremental type

The procedure for AMR offset adjustment when an incremental type linear encoder is used is described below. When using an absolute type linear encoder, see the item of Absolute type described later.
Make a fine activating phase adjustment according to the procedure below.

Measuring the activating phase

(1) Connect SERVO GUIDE to the CNC, and set channel data as shown below.
Select the target axis for measurement, and set the data type to "ROTOR".



* For a linear motor, a value from 0 to 360 degrees is read each time a motion is made over the distance of a pair of the N pole and S pole of the magnet (pole-to-pole span).

(2) Run the linear motor using a JOG operation for example, and observe the behavior of the activating phase (AMR) before, at the moment, and after phase Z is captured. (See Figs. 3.1.1 (a) and (b).)
The activating phase changes to 0 (or 360) degrees at the moment phase Z is captured. Measure the value just before it changes, and let this value be A.

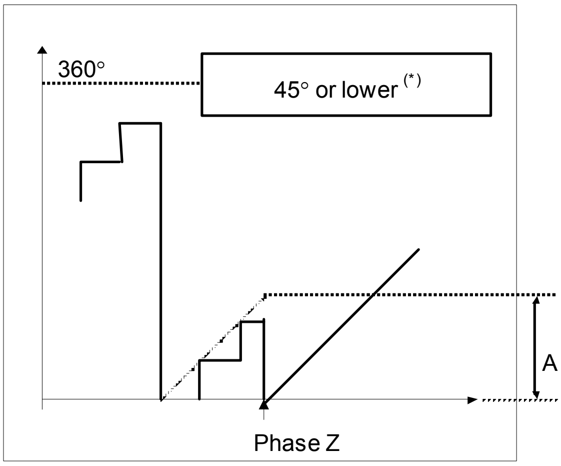


Fig. 3.1.1 (a) If the offset is set with a positive number (before AMR offset adjustment)

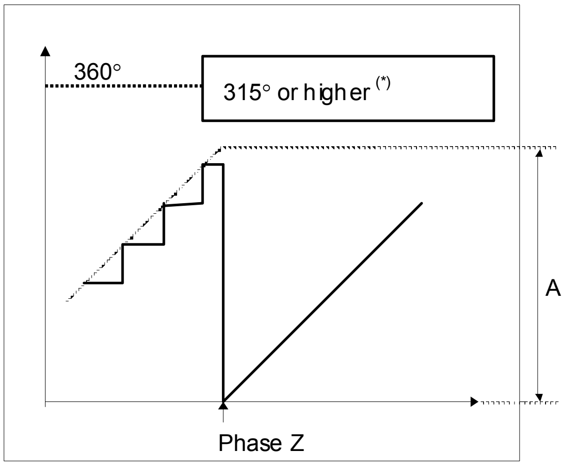


Fig. 3.1.1 (b) If the offset is set with a negative number (before AMR offset adjustment)

(*) The figures above provide examples where AMR60=0. When AMR60=1, the values should read 60° or lower and 60° or higher.

If a linear scale with absolute addressing reference marks is used, the activating phase is determined when three reference marks are detected. Set the amount of change in the activating phase at this time as the AMR offset value. The determination timing can be found because the resolution of activation phase data changes after the determination of the activation phase. The values before and after the determination of the activation phase depend on the scale position, but the mount of change is constant.

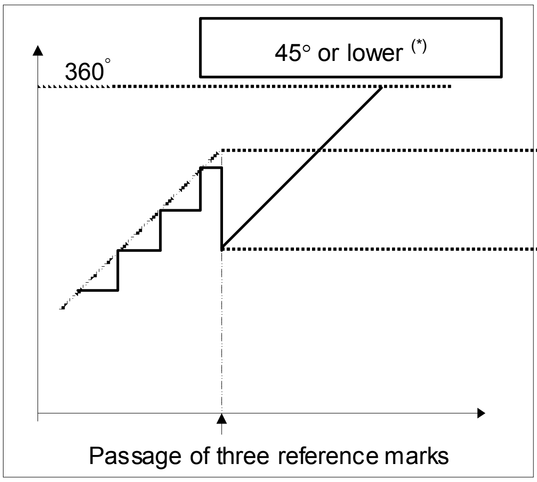


Fig. 3.1.1 (c) If the offset is set with a positive number (with absolute addressing reference marks, before adjustment of the AMR offset)

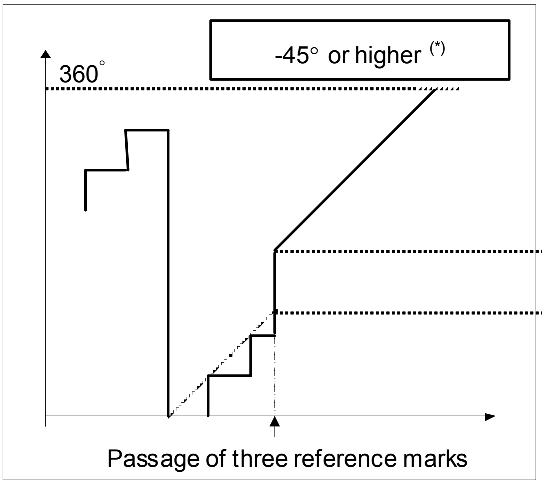


Fig. 3.1.1 (d) If the offset is set with a negative number (with absolute addressing reference marks, before adjustment of the AMR offset)

(3) Set the AMR offset parameter with A (or A - 360).
* The parameter setting range is:
-45 degrees to +45 degrees (when AMR60 = 0)
-60 degrees to +60 degrees (when AMR60 = 1)
When the value of A does not lie within the setting range, the installation position of the linear encoder needs to be readjusted.

(4) Switch the power off and on again. Now parameter setting is completed.

(5) Observe the activating phase (AMR) again according to step (2) above, and check that the activating phase changes continuously in the phase Z rising portion.

(6) Switch the power off and on again. This completes parameter setting.

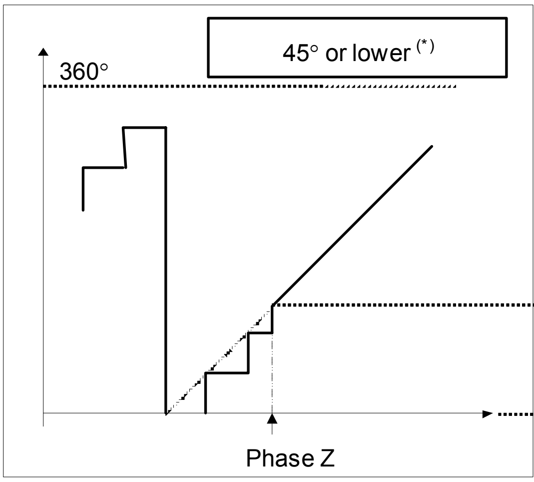


Fig. 3.1.1(c) If the offset is set with a positive number (after AMR offset adjustment)

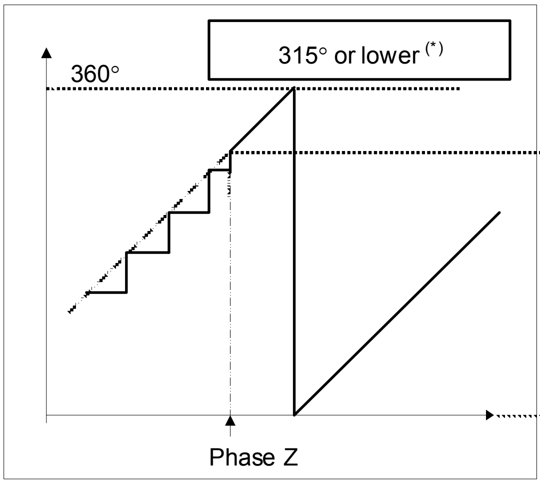


Fig. 3.1.1(d) If the offset is set with a negative number (after AMR offset adjustment)

(*) The figures above provide examples where AMR60=0. When AMR60=1, the values should read 60° or lower and 300° or higher.

Absolute type

The procedure for AMR offset adjustment when an absolute type linear encoder is used is described below. When using an incremental type linear encoder, see the item of Incremental type described earlier.

Make a fine activating phase adjustment according to the procedure below.

> ⚠ **CAUTION**
> In this adjustment, the linear motor is driven by current fed from the DC power supply. So, the CNC does not exercise position control. For safety, move the coil slider of the linear motor to near the stroke center and make an adjustment. (Activation by the DC power supply moves a medium-size or large linear motor for up to about 60 mm, and moves a small linear motor for up to about 30 mm.)

(1) Displaying of phase data
Phase data is displayed on the diagnosis screen (No. 762). A display data (phase data) value of 256 is equivalent to an activating phase of 360 degrees. This means that a displayed phase data value is converted to an activating phase [degrees] according to the following expression:
Activating phase [degrees] = Displayed phase data value × 360/256

(2) Turn off the power to the CNC and servo amplifier.

(3) Detach the linear motor power line from the servo amplifier, then connect the power line to the DC power supply.
Connect the + terminal of the DC power supply to phase U of the power line, and connect the - terminal of the DC power supply to phase V and phase W of the power line.

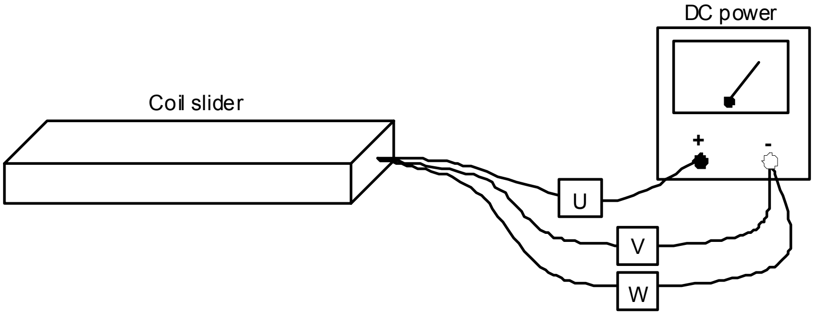


Fig. 3.1.1(g) Connection of DC power supply

(4) In the emergency stop state, turn on the power to the CNC and servo amplifier.

(5) Display phase data on the diagnosis screen of the CNC then turn on the DC power supply. Next, increase the current gradually (DC activation).
When the force of the linear motor produced by current supplied from the DC power supply exceeds static friction, the linear motor starts moving, and the linear motor automatically stops at a position where activation phase = 0.
A position where activating phase = 0 is present at intervals of 60 mm with medium-size and large linear motors, or at intervals of 30 mm with small linear motors.

> ⚠ **WARNING**
> If a large current flows abruptly, the motor produces a large force, resulting in a very dangerous situation. When making this adjustment, be sure to increase the current value gradually starting from current value = 0 [Ap].

(6) Read the value of phase data on the CNC screen in the state where the linear motor rests. Immediately after reading the value, turn off the DC power supply.

* Change the DC excitation start position within one pole (60 mm for the medium-sized/large type or 30 mm for the small type) then make measurements of (5) or (6). Repeat this procedure several times to determine average phase data.

(7) Based on activating phase data measured with up to step 6) above, set the AMR offset parameter as described below.

Measured phase data value	AMR offset setting
0 to 32 (42)	−1 × (measured phase data value) × 360/256
224 (214) to 255 (255)	360 − (measured phase data value) × 360/256
33 (44) to 223 (213)	In this case, a soft phase alarm is issued when phase Z is passed. Adjust the linear encoder installation position according to "FANUC LINEAR MOTOR L*i*S series DESCRIPTIONS (B-65382EN)". After adjustment, make an AMR offset adjustment again from step (1).

(*) A value enclosed by parentheses assumes that ARM60 is set to 1.

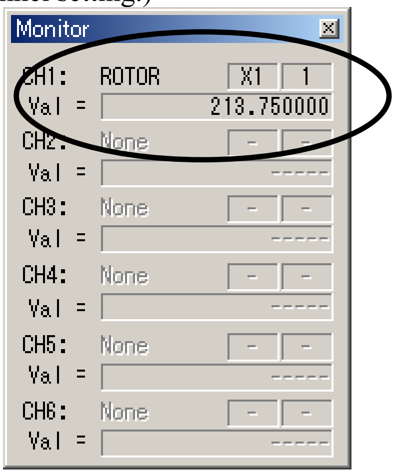
(8) Turn off then turn on the power to the CNC.

(9) Perform steps (5) and (6) again, and check that the activating phase data at a stop position is about 0 or 255.

(10) Turn off the power to the CNC and servo amplifier. Next, connect the power line of the linear motor to the servo amplifier. Then, turn on the power to the CNC and servo amplifier again.

(11) Decrease the torque limit and excessive error alarm level and use jog feed to check that feed operation is normal. If feed operation is normal, return the torque limit and excessive error alarm level to their original values. This completes the setting.

The activating phase can also be observed by connecting SERVO GUIDE to the CNC and selecting "Monitor" from the "Communication" menu of the graph window.
(Set "ROTOR" as the data type in channel setting.)



Parameter setting procedure (4)

Procedure (4) explains how to set up parameters for using a linear scale with a distance-coded reference marks in linear motor position detection circuit C (A860-0333-T301, -T302 or A860-2033-T301, -T302).

- This function is optional.
- For details of parameter setting, refer to the relevant CNC manual or specifications.

Setting procedure

(1) Enable the linear scale with a distance-coded reference marks.

	#7	#6	#5	#4	#3	#2	#1	#0
1815						DCLx		

DCLx (#2) The linear scale interface with absolute address referenced mark is:
0: Not used as a position detector
1: Used as a position detector ← To be set

	#7	#6	#5	#4	#3	#2	#1	#0
1818					SDCx			

SDCx (#3) The linear scale with a distance-coded reference marks is:
0: Not used
1: Used ← To be set

1821	Reference counter capacity

Specify a round figure, such as 10000 or 50000, as the reference counter capacity.

1240	Coordinate of the first reference position in the machine coordinate system for each axis

Specify 0.

1883	Distance 1 from the scale mark origin to the reference position

Specify 0.

1884	Distance 2 from the scale mark origin to the reference position

Specify 0.

(2) Turn the CNC power off and on again.

(3) Follow this procedure to establish a reference position at an appropriate point.
Select the JOG mode, and set the manual reference position return signal ZRN to "1".
Set a feed axis direction selection signal (+J1, -J1, +J2, -J2,...) for an axis for which a reference position is to be established to "1" and issue the signal.
When an absolute position on the linear scale is detected, the axis stops, causing the reference position-established signal (ZRF1, ZRF2,...) to be set to "1".
If an overtravel alarm is issued in establishing a reference position, try to establish a reference position by disabling a stored stroke check.

(4) In the JOG or handle feed mode, place the machine accurately on the reference position.

(5) Using the following steps, perform the automatic setting of parameter No. 1883.

	#7	#6	#5	#4	#3	#2	#1	#0
1819						DAT		

DAT (#2) At a manual reference position return, the automatic setting of parameter No. 1883 is:
0: Not performed
1: Performed ← To be set

After setting this parameter to "1", perform a manual reference position return.
When the manual reference position return is completed, parameter No. 1883 is specified, and this parameter is automatically reset to "0".

(6) If you want to disable a stored stroke check in establishing a reference position, re-set the necessary parameters to the original setting.

(7) Specify parameter No. 1240 as required.

1240	Coordinate of the first reference position in the machine coordinate system for each axis

Set up the coordinate of the first reference position in the machine coordinate system.

(8) This is the end of setting.

Parameter setting procedure (5)

Procedure (5) can be used to set parameters according to the cooling method used for linear motors. Change the following parameters as listed in Table 3.1.1 (g). For self-cooling linear motors, the parameters need not be set here, because they are set up at initialization in procedure (1).

2062	OVC alarm parameter (POVC1)

2063	OVC alarm parameter (POVC2)

2065	OVC alarm parameter (POVCLMT)

2086	Current rating parameter (RTCURR)

2161	OVC magnification in stop state (OVCSTP)

> ⚠ **CAUTION**
> If the correct values corresponding to the cooling method are not set in the parameters above, expected thermal protection cannot be provided. Use care.

Table 3.1.1 (g) Setting OVC and current rating parameters by cooling method

[200-V driving]

Model	Motor specification	Cooling method	Continuous force (N)	POVC1 No.2062	POVC2 No.2063	POVCLMT No.2065	RTCURR No.2086	OVCSTP No.2161
L*i*S300A1/4	0441-B200	No cooling	50	32720	596	589	564	0
		Water cooling	100	32578	2380	2357	1129	0
L*i*S600A1/4	0442-B200	No cooling	100	32720	596	589	564	0
		Water cooling	200	32578	2380	2357	1129	0
L*i*S900A1/4	0443-B200	No cooling	150	32721	583	1326	847	0
		Water cooling	300	32582	2328	5303	1694	0
L*i*S1500B1/4	0444-B2□0	No cooling	300	32698	873	2590	1184	0
		Water cooling	600	32490	3481	10358	2368	0
L*i*S3000B2/2	0445-B1□0	No cooling	600	32711	719	2131	1074	0
		Water cooling	1200	32539	2867	8523	2148	0
L*i*S3000B2/4	0445-B2□0	No cooling	600	32698	873	2590	1184	0
		Water cooling	1200	32490	3481	10358	2368	0
L*i*S4500B2/2	0446-B1□0	No cooling	900	32707	758	1199	805	0
		Water cooling	1800	32526	3023	4794	1611	0
L*i*S4500B2/4	0446-B2□0	No cooling	900	32707	768	1214	810	0
		Water cooling	1800	32527	3018	4787	1610	0
L*i*S6000B2/2	0447-B1□0	No cooling	1200	32711	719	2131	1074	0
		Water cooling	2400	32539	2867	8523	2148	0
L*i*S6000B2/4	0447-B2□0	No cooling	1200	32708	753	2233	1184	0
		Water cooling	2400	32528	3003	8932	2368	140

Model	Motor specification	Cooling method	Continuous force (N)	POVC1 No.2062	POVC2 No.2063	POVCLMT No.2065	RTCURR No.2086	OVCSTP No.2161
L*i*S7500B2/2	0448-B1□0	No cooling	1500	32707	765	832	671	0
		Water cooling	3000	32524	3053	3329	1342	0
L*i*S7500B2/4	0448-B2□0	No cooling	1500	32687	1010	799	658	0
		Water cooling	3000	32446	4026	3197	1316	0
L*i*S9000B2/2	0449-B1□0	No cooling	1800	32707	758	1199	805	0
		Water cooling	3600	32526	3023	4794	1611	0
L*i*S9000B2/4	0449-B210	No cooling	1800	32696	895	1151	789	0
		Water cooling	3600	32482	3570	4604	1579	0
L*i*S3300C1/2	0451-B1□0	No cooling	660	32708	749	1184	801	0
		Water cooling	1320	32529	2987	4738	1602	0
L*i*S9000C2/2	0454-B1□0	No cooling	1800	32729	489	1112	776	0
		Water cooling	3600	32612	1953	4448	1552	0
L*i*S11000C2/2	0455-B1□0	No cooling	2200	32723	560	1661	948	0
		Water cooling	4400	32589	2236	6644	1897	0
L*i*S11000C2/4	0455-B220	No cooling	2200	32729	492	1311	842	0
		Water cooling	4400	32598	2119	5246	1685	0
L*i*S15000C2/2	0456-B1□0	No cooling	3000	32729	483	621	579	0
		Water cooling	7000	32558	2623	3378	1352	0
L*i*S15000C2/3	0456-B2□0	No cooling	3000	32732	452	1340	852	0
		Water cooling	7000	32572	2455	7296	1988	140
L*i*S10000C3/2	0457-B1□0	No cooling	2000	32722	582	1719	964	0
		Water cooling	4000	32583	2314	6875	1929	0
L*i*S17000C3/2	0459-B1□0	No cooling	3400	32711	709	981	729	0
		Water cooling	6800	32542	2829	3925	1458	0

[400-V driving]

Model	Motor specification	Cooling method	Continuous force (N)	POVC1 No.2062	POVC2 No.2063	POVCLMT No.2065	RTCURR No.2086	OVCSTP No.2161
L*i*S1500B1/4	0444-B2□0	No cooling	300	32698	873	2590	1184	0
		Water cooling	600	32490	3481	10358	2368	0
L*i*S3000B2/2	0445-B1□0	No cooling	600	32711	719	2131	1074	0
		Water cooling	1200	32539	2867	8523	2148	0
L*i*S4500B2/2HV	0446-B0□0	No cooling	900	32714	681	1549	915	0
		Water cooling	1800	32551	2718	6194	1831	0
L*i*S4500B2/2	0446-B1□0	No cooling	900	32707	758	1199	805	0
		Water cooling	1800	32526	3023	4794	1611	0
L*i*S6000B2/2HV	0447-B0□0	No cooling	1200	32706	774	688	610	0
		Water cooling	2400	32521	3085	2753	1221	0
L*i*S6000B2/2	0447-B1□0	No cooling	1200	32711	719	2131	1074	0
		Water cooling	2400	32539	2867	8523	2148	0
L*i*S7500B2/2HV	0448- B0□0	No cooling	1500	32714	680	1075	763	0
		Water cooling	3000	32551	2713	4301	1526	0
L*i*S7500B2/2	0448- B1□0	No cooling	1500	32709	739	658	596	0
		Water cooling	3000	32532	2949	2631	1193	0
L*i*S9000B2/2	0449- B1□0	No cooling	1800	32709	737	947	716	0
		Water cooling	3600	32533	2940	3788	1432	140

Model	Motor specification	Cooling method	Continuous force (N)	POVC1 No.2062	POVC2 No.2063	POVCLMT No.2065	RTCURR No.2086	OVCSTP No.2161
L*i*S3300C1/2	0451- B1□0	No cooling	660	32708	749	1184	801	0
		Water cooling	1320	32529	2987	4738	1602	0
L*i*S9000C2/2HV	0454- B0□0	No cooling	1800	32729	489	1112	776	0
		Water cooling	3600	32614	1925	4383	1540	0
L*i*S9000C2/2	0454- B1□0	No cooling	1800	32728	494	879	689	0
		Water cooling	3600	32610	1972	3514	1379	0
L*i*S11000C2/2HV	0455- B0□0	No cooling	2200	32723	560	1661	948	0
		Water cooling	4400	32589	2236	6644	1897	0
L*i*S11000C2/2	0455- B1□0	No cooling	2200	32730	474	1312	843	0
		Water cooling	4400	32616	1894	5250	1686	140
L*i*S15000C2/3HV	0456- B0□0	No cooling	3000	32730	471	1396	869	0
		Water cooling	7000	32563	2557	7601	2029	140
L*i*S15000C2/2	0456- B1□0	No cooling	3000	32729	483	621	578	0
		Water cooling	7000	—	—	—	—	—
L*i*S10000C3/2HV	0457- B0□0	No cooling	2000	32722	576	1707	961	0
		Water cooling	4000	32584	2298	6828	1923	0
L*i*S10000C3/2	0457- B1□0	No cooling	2000	32720	597	1358	857	0
		Water cooling	4000	32577	2384	5432	1715	140
L*i*S17000C3/2HV	0459- B0□0	No cooling	3400	32711	709	981	729	0
		Water cooling	6800	32542	2829	3925	1458	0
L*i*S17000C3/2	0459- B1□0	No cooling	3400	32711	709	981	729	0
		Water cooling	6800	32542	2829	3925	1458	0

[Conventional linear motors]

Model	Motor specification	Cooling method	Continuous force (N)	POVC1	POVC2	POVCLMT	RTCURR
1500A/4	0410	No cooling	300	32698	873	2590	1184
		Air cooling	360	32667	1257	3729	1421
		Water cooling	600	32490	3481	10358	2369
3000B/2	0411	No cooling	600	32698	873	2590	1184
		Air cooling	720	32667	1257	3729	1421
		Water cooling	1200	32490	3481	10358	2369
3000B/4	0411-B811	No cooling	600	32698	873	2590	1184
		Air cooling	720	32667	1257	3729	1421
		Water cooling	1200	32490	3481	10358	2368
6000B/2	0412	No cooling	1200	32698	873	2590	1184
		Air cooling	1440	32667	1257	3729	1421
		Water cooling	2400	32490	3481	10358	2369
6000B/4 (160-A driving)	0412-B811	No cooling	1200	32706	777	2304	1117
		Air cooling	1440	32679	1118	3317	1340
		Water cooling	2400	32520	3098	9215	2234
9000B/2 (160-A driving)	0413	No cooling	1800	32729	491	1457	888
		Air cooling	2160	32711	707	2098	1065
		Water cooling	3600	32611	1962	5827	1776
9000B/4 (360-A driving)	0413-B811	No cooling	1800	32737	388	1151	789
		Air cooling	2160	32723	559	1657	947
		Water cooling	3600	32644	1551	4604	1579

Model	Motor specification	Cooling method	Continuous force (N)	POVC1	POVC2	POVCLMT	RTCURR
15000C/2 (360-A driving)	0414	No cooling	3000	32751	209	621	579
		Air cooling	3600	32744	301	894	695
		Water cooling	7000	32677	1139	3378	1352
15000C/3	0414-B811	No cooling	3000	32732	452	1340	852
		Air cooling	3600	32716	651	1930	1022
		Water cooling	7000	32572	2455	7296	1988

(6) Illegal servo parameter setting alarms when linear motors are used

The following illegal servo parameter setting alarms are checked additionally when linear motors are used (they are not issued for rotary motors).

Table 3.1.1 (d) Parameter error alarm detail numbers during use of the linear motor

Parameter error alarm detail No.	Description
10043	No separate detector can be used for linear motors. Full-closed loop setting results in an alarm being issued.
1123	If no AMR conversion coefficient is set, an alarm is issued. Even when the linear encoder is not relocated after the motor is replaced, the AMR conversion coefficients must be re-set, because initialization accompanying motor replacement causes the AMR coefficients to be erased.
1393	The valid AMR offset data range is below : -45 (degrees) and +45 (degrees) : (AMR60=0) -60 (degrees) and +60 (degrees) : (AMR60=1) If a value out of this range is specified in the parameter, an invalid-parameter alarm is issued.

⚠ **CAUTION**

When an AMR conversion coefficient is not set, an alarm is issued. If it is set, but incorrect, no alarm is issued. In this case, the linear motor fails to drive correctly immediately after it passes phase Z. It may move within one pole-to-pole span (60 mm or 30 mm) in the worst case.

(7) Notes on using high-speed HRV current control or the cutting /rapid velocity loop gain switching function

In general, a higher velocity loop gain (load inertia ratio) is set for a linear motor than for a rotary motor. So, if high-speed HRV current control and the cutting /rapid velocity loop gain switching function are used at the same time to achieve an even higher velocity loop gain, an overflow can occur in the internal value of the post-override velocity load proportional (PK2V: parameter No. 2044). (The parameter error detail number is 443). In this case, set the parameter indicated below. Whether an overflow occurs or not can be checked using Fig. 3.1.1 (h).

	#7	#6	#5	#4	#3	#2	#1	#0
2200		P2EX						

P2EX(#6) The format of velocity loop proportional gain (PK2V) is:

0: Standard format.

1: Converted. ← To be set

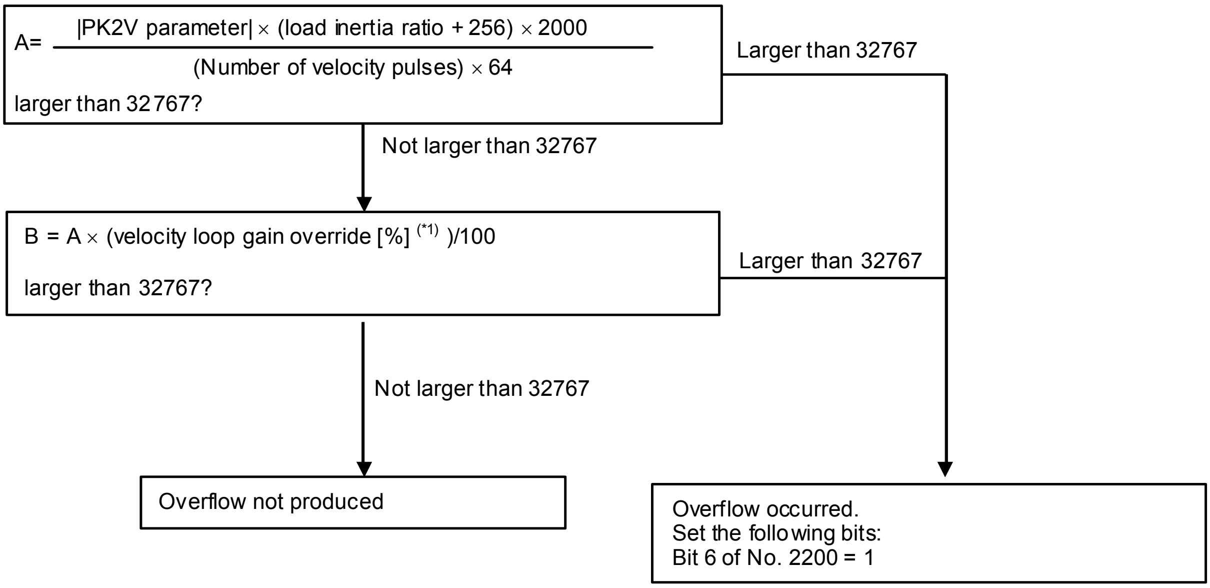


Fig. 3.1.1 (h) PK2V overflow check

> ⚠ **CAUTION**
> *1 In the flowchart above, the velocity loop gain override is represented by one of the following parameters:
> Velocity gain magnification when high-speed HRV current control is enabled
> → (No. 2335)
> Velocity gain override when the cutting feed/rapid traverse switchable velocity loop gain function is enabled
> → (No. 2107)

3.1.2 Smoothing Compensation for Linear Motor

(1) Overview

Smoothing compensation for linear motors improves the smoothness in feed of a linear motor by producing a sinusoidal compensation torque with a cycle of 1/2, 1/4, or 1/6 of the pole-to-pole span produced by servo software and by applying such a torque to the current command. Compensation torque can be generated for each motor by setting gain and phase for each component.

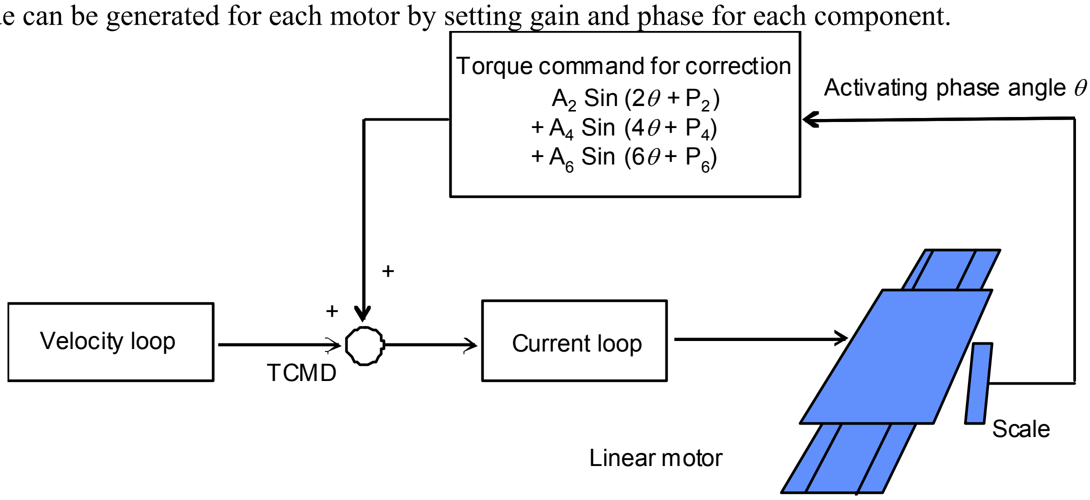


Fig. 3.1.2 (a) Diagrammatic drawing showing smoothing compensation

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

Setting of the smoothing compensation in the positive direction

2130	Smoothing compensation performed twice per pole pair	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

2131	Smoothing compensation performed four times per pole pair	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

2132	Smoothing compensation performed six times per pole pair	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

Setting of the smoothing compensation in the negative direction

If the correction gain of the following parameters is set to a non-zero value, it is possible to set a value different value in the negative direction that is different from a value in the positive direction. To set the same value between the negative direction and the positive direction, set the correction gain of the following parameters to 0.

2369	Smoothing compensation performed twice per pole pair (negative direction)	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

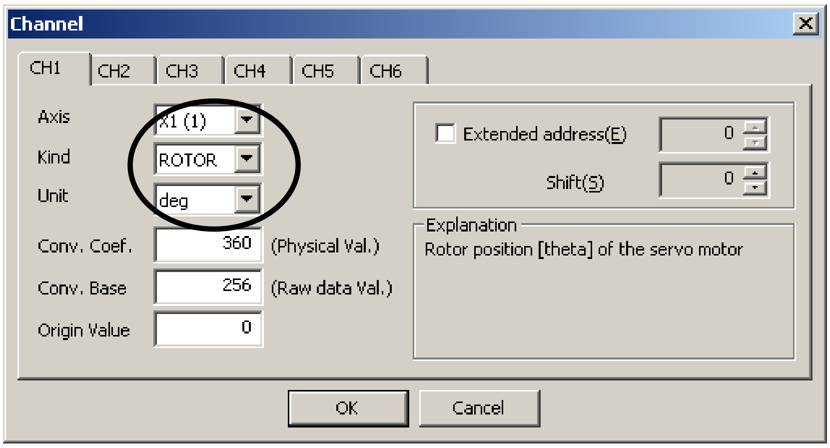
2370	Smoothing compensation performed four times per pole pair (negative direction)	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

2371	Smoothing compensation performed six times per pole pair (negative direction)	
	Correction gain (high-order 8 bits)	Correction phase (low-order 8 bits)

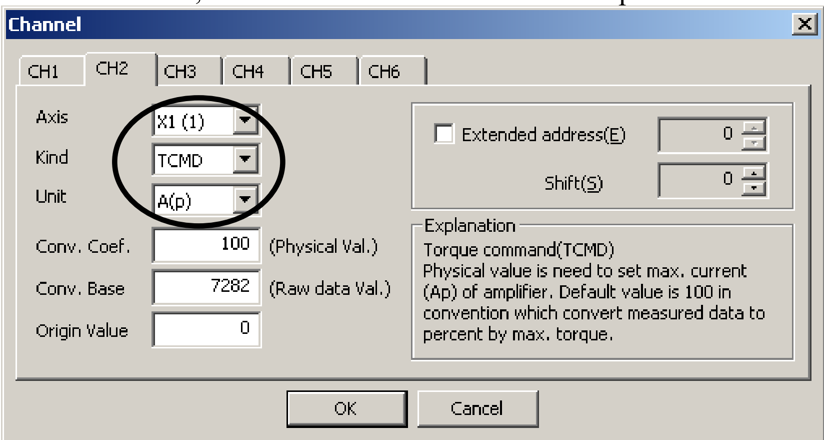
Since the compensation parameters differ from motor to motor (depending on the motor rather than the model), these parameters must be determined for each motor assembled.
In principle, variation in torque command that is generated when the motor is fed at a low speed depends on the position. The application of smoothing compensation cancels this position-dependent characteristic, allowing the motor to move smoothly.

By using SERVO GUIDE, these parameters can be determined easily. Follow the procedure below to measure the activating phase and torque command, which are required to determine the compensation parameters.

<1> Set channels as follows:
Channel 1: Activating phase
Select the target axis for measurement, and set "ROTOR" as the data type.



Channel 2: Torque command
Select the target axis for measurement, and set "TCMD" as the data type.
As the conversion coefficient, set the maximum current of the amplifier used for the target axis.

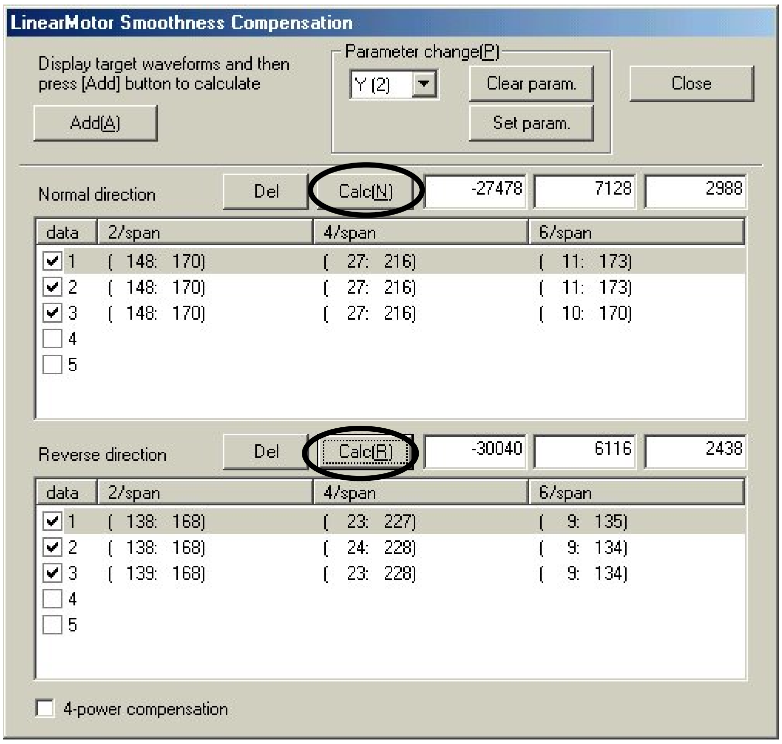


<2> Create a program that performs back and forth motion at a feedrate of F1200 (mm/min).
If the distance of movement is shorter than the pole-to-pole span, it is impossible to automatically calculate smoothing compensation parameters. Therefore, it is recommended that the distance of movement be at least 200 mm for large linear motors or at least 100 mm for small linear motors. For the number of measurement points, provide an enough time to obtain data during one back and forth motion of the motor. (About 15000 to 20000 points in 1-ms sampling)

<3> When making measurements, lower the velocity gain to such an extent that hunting does not occur.

<4> From the "Tools" menu, select "Smoothness compensation calc.".
(The shortcut is [Ctrl] + [L].)

<5> In the displayed dialog box, press the [Add] button. Then waveform data is analyzed, and candidates of the compensation parameters are registered.



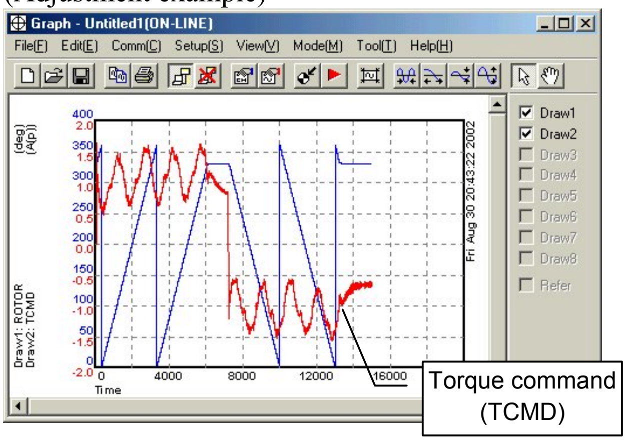
<6> The compensation parameters slightly vary depending on the measurement situation. So, repeat a data measurement and a press of the [Add] button several times in a similar manner while keeping the dialog box open. (Up to five candidates can be registered.)
If the displayed values include an extremely different value, check the corresponding check box on the leftmost side of the list so that the value is not taken into account in the final compensation calculation.

<7> Finally, press the [Calc] button for each of the forward and backward directions. Then, smoothing compensation parameters are displayed.

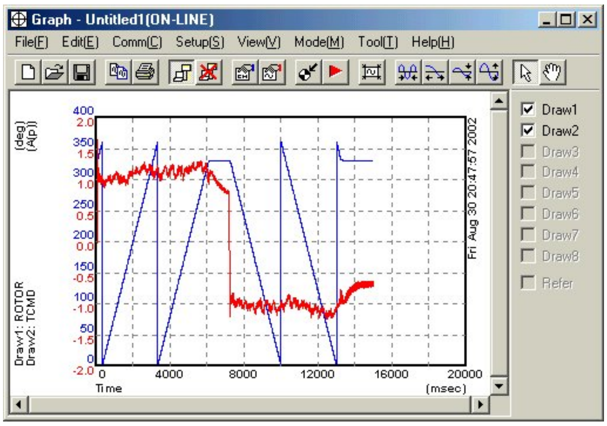
<8> When the target axis for parameter transfer is selected in "Parameter change", and the [Set param.] button is pressed, the presented parameters are set in the CNC.

<9> Measure TCMD again to confirm the effect of smoothing compensation.

(Adjustment example)



Before smoothing compensation adjustment



After smoothing compensation adjustment

(*) For details on the use of SERVO GUIDE, refer to the help of SERVO GUIDE.

3.2 SYNCHRONOUS BUILT-IN SERVO MOTOR PARAMETER SETTING

3.2.1 Procedure for Setting the Initial Parameters of Synchronous Built-in Servo Motors

(1) Overview

The following describes the procedure for setting the digital servo parameters to enable the use of a FANUC synchronous built-in servo motor.
To drive a synchronous built-in servo motor, the optional pole detection function is required.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Warning

⚠ WARNING

1 A synchronous built-in servo motor can make an unpredictable movement or vibration if the basic parameters for pole detection and so forth are not set correctly.

2 Take the following actions until the synchronous built-in servo motor is confirmed to operate normally:
- Lower the excessive error level so that an alarm is issued immediately when an unpredictable movement is made.
- Lower the torque limit value to disable abrupt acceleration.
- Ensure that the emergency stop switch can be pressed immediately.

(4) Rotary encoder

A rotary encoder is used to detect the position and speed of a synchronous built-in servo motor.
Table 3.2.1 (a) lists examples of usable rotary encoders.

Table 3.2.1 (a) Examples of usable rotary encoders

Rotary encoder	Number of pulses for parameter setting (*1)	Remarks
α*i*CZ 512A	500,000 p/rev	Manufactured by FANUC
α*i*CZ 768A(*2)	750,000 p/rev	Manufactured by FANUC
α*i*CZ 1024A	1,000,000 p/rev	Manufactured by FANUC
RCN223F, RCN723F, RCN727F(*3)	8,000,000 p/rev	Manufactured by HEIDENHAIN
Analog encoder (binary type) and synchronous built-in servo motor position detection circuit(*4)	$\lambda \times$ 512p/rev	λ: Number of sine waves per detector revolution

Rotary encoder	Number of pulses for parameter setting (*1)	Remarks
Analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit(*2) (*4)	$\lambda \times$ 512p/rev	λ: Number of sine waves per detector revolution

(*1) Number of pulses for parameter setting, which differs from an actual resolution.

(*2) The following servo software is required to use the αCZ 768A analog encoder (non-binary type) and the synchronous built-in servo motor position detection circuit as a rotary encoder for the synchronous built-in servo motor in the 30i-A Series.
Series 90D0, 90E0/J(10) and subsequent editions
The following servo software is required to use the synchronous built-in servo motor position detection circuit (A860-2033-T601) in the 30i-A Series.
Series 90D0, 90E0/P(16) and subsequent editions

(*3) The following servo software is required to use the RCN727F as a rotary encoder for the synchronous built-in servo motor in the 30i-A Series.
Series 90D0, 90E0/J(10) and subsequent editions

(*4) Analog encoder (binary type) :
Encoder that outputs an analog signal (sine wave, 1Vp-p) and represents number λ per revolution as a binary number (power of 2)
Analog encoder (non-binary type) :
Encoder that outputs an analog signal (sine wave, 1Vp-p) and represents number λ per revolution as a binary number (which is not a power of 2)

NOTE

1 For details of rotary encoders usable with FANUC synchronous built-in servo motors, refer to "FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series Descriptions (B-65332EN)".
2 For detailed specifications of a rotary encoder supplied by a vendor other than FANUC, contact the manufacturer of the rotary encoder.

⚠ CAUTION

Keep the following in mind when the synchronous built-in servo motor is combined with the structure including the analog encoder (non-binary type) and the synchronous built-in servo motor position detection circuit.
1 Absolute setting is disabled.
2 The movable range is within ±1 detector revolution.
(Use assuming infinite revolution is disabled.)
3 Each time the power to the NC is turned on, pole position detection must be performed without fail.

3.2.1.1 Parameter Setting Procedure (1) (Initialization)

In parameter setting procedure (1), parameters for the current gain etc. required to drive the synchronous built-in servo motor are initialized. After setting DGPR to 0, set the motor ID number. For the connection and setting method for the overheat signal (thermostat signal), see Section 3.3, "DETECTION OF AN OVERHEAT ALARM BY SERVO SOFTWARE WHEN A LINEAR MOTOR AND A SYNCHRONOUS BUILT-IN SERVO MOTOR ARE USED".

(1) Setting the standard parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2000							DGPR	

DGPR(#1) This parameter is set to 0. (Upon completion of automatic loading, this parameter is automatically set to 1.)

2020	Motor ID No.

Table 3.2.1 (b) indicates the synchronous built-in servo motors for which the standard parameters are available as of March, 2013. The servo software shown in Table 3.2.1(b) is required to automatically load the standard parameters described in Section 9.4. To perform automatic loading, set bit 1 of parameter No. 2000 to 0, set the motor ID number, make the following basic settings, and restart the CNC. Upon completion of automatic loading, bit 1 of parameter No. 2000 is automatically set to 1. When the servo software used does not support automatic loading, set the parameters manually with reference to the parameter list shown in this manual. The parameters to be loaded automatically are those for non-cooling. For liquid cooling, set the OVC parameters manually with reference to Subsection 3.2.1.3 after detecting the magnetic pole.

Table 3.2.1 (b) Motor ID numbers of the synchronous built-in servo motors and servo software that can be loaded automatically

[200-V driving]

Motor model	Motor specification	Motor ID No.	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
D*i*S 400/250	0485-B20□	419	05.0	30.0	07.0	F	B
D*i*S 22/600	0482-B10□	421	03.0	P	01.0	A	A
D*i*S 85/400	0483-B20□	423	03.0	N	01.0	A	A
D*i*S 110/300	0484-B10□	425	03.0	N	01.0	A	A
D*i*S 260/300	0484-B30□	427	03.0	N	01.0	A	A
D*i*S 260/600	0484-B31□	429	03.0	P	01.0	A	A
D*i*S 370/300	0484-B40□	431	03.0	N	01.0	A	A
D*i*S 800/250	0485-B40□	433	05.0	30.0	07.0	F	B
D*i*S 1200/250	0485-B50□	435	03.0	P	01.0	A	A
D*i*S 1500/200	0486-B30□	437	03.0	N	01.0	A	A
D*i*S 2100/150	0487-B30□	439	03.0	N	01.0	A	A
D*i*S 3000/150	0487-B40□	441	03.0	N	01.0	A	A
D*i*S 85/1000	0483-B22□	443	03.0	P	01.0	A	A
D*i*S 110/1000	0484-B12□	445	03.0	P	01.0	A	A
D*i*S 260/1000	0484-B32□	447	03.0	P	01.0	A	A
D*i*S 22/1500	0482-B12□	449	03.0	Q	01.0	A	A
D*i*S 15/1000	0492-B100	551	05.0	30.0	07.0	F	B
D*i*S 60/400	0493-B200	553	05.0	30.0	07.0	F	B
D*i*S 70/300	0494-B100	555	05.0	30.0	07.0	F	B
D*i*S 150/300	0494-B300	557	05.0	30.0	07.0	F	B
D*i*S 200/300	0494-B400	559	05.0	30.0	07.0	F	B
D*i*S 250/250	0495-B200	561	05.0	30.0	07.0	F	B
D*i*S 500/250	0495-B400	563	05.0	30.0	07.0	F	B
D*i*S 1000/200	0496-B300	565	12.0	33.0	10.0	F	C
D*i*S 1500/100	0497-B300	567	12.0	33.0	10.0	F	C
D*i*S 2000/100	0497-B400	569	12.0	33.0	10.0	F	C
D*i*S 2000/150	0497-B490	571	12.0	33.0	10.0	F	C
D*i*S 60/2000	0493-B220	577	19.0	-	-	-	-
D*i*S 70/1500	0494-B120	579	19.0	-	-	-	-
D*i*S 150/1500	0494-B320	581	19.0	-	-	-	-
D*i*S 500/1000	0495-B420	583	19.0	-	-	-	-

[400-V driving]

Motor model	Motor specification	Motor ID No.	90G0	90D0 90E0	90E1	90C5 90E5	90C8 90E8
D*i*S 400/250	0485-B20□	420	05.0	30.0	07.0	F	B
D*i*S 22/600	0482-B10□	422	03.0	P	01.0	A	A
D*i*S 85/400	0483-B20□	424	03.0	N	01.0	A	A
D*i*S 110/300	0484-B10□	426	03.0	N	01.0	A	A
D*i*S 260/300	0484-B30□	428	03.0	N	01.0	A	A
D*i*S 260/600	0484-B31□	430	03.0	P	01.0	A	A
D*i*S 370/300	0484-B40□	432	03.0	N	01.0	A	A
D*i*S 800/250	0485-B40□	434	05.0	30.0	07.0	F	B
D*i*S 1200/250	0485-B50□	436	03.0	P	01.0	A	A
D*i*S 1500/200	0486-B30□	438	03.0	N	01.0	A	A
D*i*S 2100/150	0487-B30□	440	03.0	N	01.0	A	A
D*i*S 3000/150	0487-B40□	442	03.0	N	01.0	A	A
D*i*S 15/1000	0492-B100	552	05.0	30.0	07.0	F	B
D*i*S 60/400	0493-B200	554	05.0	30.0	07.0	F	B
D*i*S 70/300	0494-B100	556	05.0	30.0	07.0	F	B
D*i*S 150/300	0494-B300	558	05.0	30.0	07.0	F	B
D*i*S 200/300	0494-B400	560	05.0	30.0	07.0	F	B
D*i*S 250/250	0495-B200	562	05.0	30.0	07.0	F	B
D*i*S 500/250	0495-B400	564	05.0	30.0	07.0	F	B
D*i*S 1000/200	0496-B300	566	05.0	30.0	07.0	F	B
D*i*S 1500/100	0497-B300	568	12.0	33.0	10.0	F	C
D*i*S 2000/100	0497-B400	570	12.0	33.0	10.0	F	C
D*i*S 2000/150	0497-B490	572	05.0	30.0	07.0	F	B
D*i*S 5000/50	0488-B400	573	12.0	33.0	10.0	F	C
D*i*S 60/2000	0493-B220	578	19.0	-	-	-	-
D*i*S 70/1500	0494-B120	580	19.0	-	-	-	-
D*i*S 150/1500	0494-B320	582	19.0	-	-	-	-
D*i*S 500/1000	0495-B420	584	19.0	-	-	-	-

The motor ID numbers are for SERVO HRV2. Automatic loading is possible with the servo software of the series and edition listed above or subsequent editions.

After the parameters are loaded automatically, make sure that the function bit for synchronous built-in servo motor control is enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2300						DD		

DD(#2) Synchronous built-in servo motor control is:
- 0: Disabled
- 1: Enabled

(2) Setting the rotation direction

2022	Movement direction

+111 When the positive direction of the table matches the positive direction of the rotary encoder, specification of the positive direction turns the table in the positive direction.

-111 When the positive direction of the table matches the positive direction of the rotary encoder, specification of the positive direction turns the table in the reverse direction.

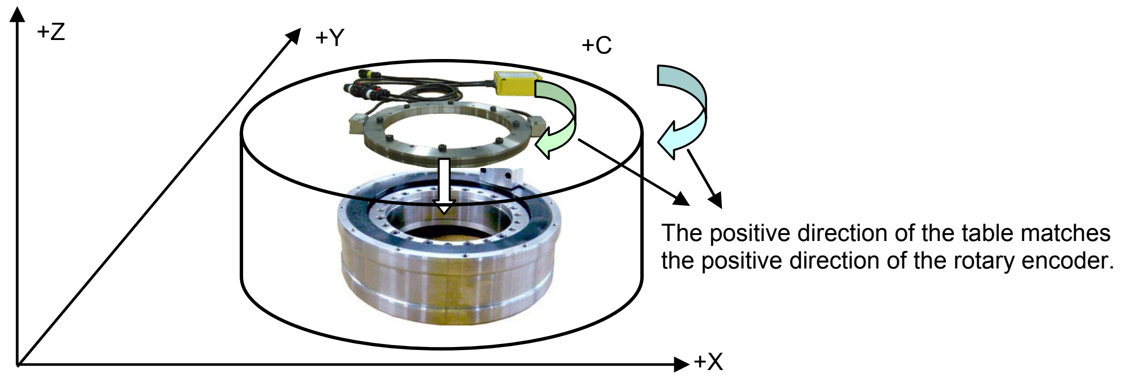


Fig. 3.2.1 (a) Relationship between the table and the rotary encoder

(3) Setting of parameters related to feedback

The necessary parameters are set depending on the type of a rotary encoder to be used.

	#7	#6	#5	#4	#3	#2	#1	#0
2000								PLC0

PLC0(#0) The number of velocity pulses and the number of position pulses are:
0: Used without being modified.
1: Used after being multiplied by 10
If the number of velocity pulses is lager than 32767, set the parameter to 1.

2023	Number of velocity pulses (PULCO)

2024	Number of position pulses (PPLS)

2185	Position pulses conversion coefficient (PSMPYL)

This parameter is used if the calculated number of position pulses is greater than 32767. When this parameter is set to 0, PSMPYL=1 is assumed for processing.

(Parameter calculation expression)
When PLC0=0
→ Set so that Number of position pulses = PPLS × PSMPYL.
When PLC0=1
→ Set so that Number of position pulses = 10 × PPLS × PSMPYL

Table 3.2.1 (c) Setting the number of velocity pulses and number of position pulses

Rotary encoder	PLC0 (No.2000#0)	PULCO (No.2023)	PPLS (No.2024)	PSMPYL (No.2185)
α*i*CZ 512A	0	4096	6250	0
α*i*CZ 768A	0	6144	9375	0
α*i*CZ 1024A	0	8192	12500	0
RCN223F, RCN723F, RCN727F	1	6554	10000	0
Analog encoder (binary type) and synchronous built-in servo motor position detection circuit	(*1)			
Analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit	(*2)			

(*1) When a set of an analog encoder (binary type) and synchronous built-in servo motor position detection circuit is used, the number of velocity pulses and the number of position pulses are calculated according to the following expressions:

Number of velocity pulses＝2×λ
Number of position pulses＝3125×λ/1024
(λ: Number of sine waves per detector revolution)

(*2) When a set of an analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit is used, the number of velocity pulses and the number of position pulses are calculated according to the following expressions:

Number of velocity pulses＝2×λ
Number of position pulses＝32×λ/5
(λ: Number of sine waves per detector revolution)

2084	Flexible feed gear numerator

2085	Flexible feed gear denominator

(Parameter calculation expression)

$$FFG = \frac{No.2084}{No.2085} = \frac{\text{Number of pulses per motor revolution (detection unit)}}{\text{Number of pulses per rotary encoder revolution}}$$

For the number of pulses per rotary encoder revolution, see Table 3.2.1 (a).

1821	Reference counter capacity

Set the number of pulses per motor revolution (detection unit) or the same number divided by an integer.
With α*i*CZ 768A, however, set the number of pulses per one-third of one motor revolution (detection unit) or the same number divided by an integer.

	#7	#6	#5	#4	#3	#2	#1	#0
2275							RCNCLR	800PLS

800PLS (#0) A rotary encoder with eight million pulses per revolution is:
0: Not to be used.
1: To be used. (To use the RCN223F, 723F, or 727F, set the bit to 1.)

RCNCLR (#1) The number of revolution is:
0: Not to be cleared.
1: To be cleared. (To use the RCN223F, 723F, or 727F, set the bit to 1.)
This function bit is to be set in combination with the number of data mask digits, described below.

2394	Number of data mask digits (DMASK)

[Settings] 8. (To use the RCN223F, 723F, or 727F)
This parameter need not be set for an α*i*CZ sensor. (When using an α*i*CZ sensor, set this parameter to 0.)
Set this parameter together with RCNCLR above.

Setting of an AMR conversion coefficient

	#7	#6	#5	#4	#3	#2	#1	#0
2001	0	AMR6	AMR5	AMR4	AMR3	AMR2	AMR1	AMR0

Set the value that matches the type of a rotary encoder used, according to Table 3.2.1 (d).

Table 3.2.1 (d) Setting AMR

Rotary encoder	AMR6-AMR0
α*i*CZ 512A	Set the number of motor poles/2 in binary.
α*i*CZ 768A	Set the number of motor poles/2 in binary.
α*i*CZ 1024A	Set the number of motor poles/2 in binary.

Rotary encoder	AMR6-AMR0
RCN223F, RCN723F, RCN727F	Set the number of motor poles/2 in binary.
Analog encoder (binary type) and synchronous built-in servo motor position detection circuit	Set the number of motor poles/2 in binary.
Analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit	Set 0.

NOTE

In PARAMETER MANUAL B-65270EN/07 or earlier, parameter No. 2001 was set to the number of poles when some rotary encoders are used. Although the number of motor poles may be set as before except high speed models, this version of PARAMETER MANUAL or later recommends that parameter No. 2001 be set to the number of motor poles divided by two for consistency of the setting. If the number of motor poles divided by two is set when the following two conditions are satisfied, smoothing compensation may not function correctly. In this case, use the conventional setting (set the number of motor poles).

- The αiCZ 512A is used.
- The servo software 90G0/03.0 to 17.0 is used.

The settings of parameter No. 2001 and parameter No. 2138 need to be changed together. (Only one of these parameters cannot be set to a conventional value.)

	#7	#6	#5	#4	#3	#2	#1	#0
2220								DECAMR

Set the value that matches the type of a rotary encoder used, according to Table 3.2.1 (e).

Table 3.2.1 (e) Setting DECAMR

Rotary encoder	Setting DECAMR
αiCZ 512A	Set 0.
αiCZ 768A	Set 1.
αiCZ 1024A	Set 0.
RCN223F, RCN723F, RCN727F	Set 0.
Analog encoder (binary type) and synchronous built-in servo motor position detection circuit	Set 0.
Analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit	Set 1.

2112	AMR conversion coefficient 1 (AMRDL)

2138	AMR conversion coefficient 2 (AMR2)

Set the value that matches the type of a rotary encoder used, according to Table 3.2.1 (f).

Table 3.2.1 (f) Setting AMRDL and AMR2

Rotary encoder	AMR conversion coefficient 1 (AMRDL : No.2112)	AMR conversion coefficient 2 (AMR2 : No.2138)
αiCZ 512A	Set 0.	Set 1. (*1)
αiCZ 768A	Set 768.	Set the number of motor poles/2.

Rotary encoder	AMR conversion coefficient 1 (AMRDL : No.2112)	AMR conversion coefficient 2 (AMR2 : No.2138)
αiCZ 1024A	Set 0.	Set 0.
RCN223F, RCN723F, RCN727F	Set 0.	Set -3. (*2)
Analog encoder (binary type) and synchronous built-in servo motor position detection circuit	Set 0.	0 (4096 λ/revolution) (*3) -1 (8192 λ/ revolution) -2 (16384 λ/ revolution)
Analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit	Set λ. (*4)(*5)	Set the number of motor poles/2.

(*1) When parameter No. 2001 is set to the number or motor poles, set parameter No. 2138 to 0.
(*2) When parameter No. 2001 is set to the number or motor poles, set parameter No. 2138 to -4.
(*3) Set AMR conversion coefficient 2 using 4096λ as reference (0). For example, AMR conversion coefficient 2 is set to 1 in the case of 2048λ or -1 in the case of 8192λ.
(*4) When λ exceeds 32767, find an AMR conversion coefficient 1 value less than 32767 by dividing AMR conversion coefficient 1 and AMR conversion coefficient 2 by a common divisor and set the found value in the parameter.
(*5) If "support for the input frequency 750 kHz" is specified when a set of an analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit is used (SW3 = A and bit 0 of parameter No. 2274 = 1), set the value λ/4 as AMR conversion coefficient 1.

Setting for using only a set of an analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit (This parameter need not be set for any other configurations.)

	#7	#6	#5	#4	#3	#2	#1	#0
2010						LINEAR		

When using a set of an analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit, set LINEAR to 1.

Setting only for the structure including analog encoder (binary type) and synchronous built-in servo motor position detection circuit or analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit

	#7	#6	#5	#4	#3	#2	#1	#0
2274		DD2048						HP2048

HP2048(#0) A 2048-time interpolation circuit (synchronous built-in servo motor position detection circuit) is :
0: Not used.
1: Used.

DD2048(#6) In the Dis motor, bit HP2048 is:
0: Disabled.
1: Enabled.
* Supported in 90E0, D0/21.0 and subsequent editions and 90G0/03.0 and subsequent editions.
Generally, set bits 0 and 6 of parameter No. 2274 to 1.

(4) Examples of setting parameters for each rotary encoder type

Tables 3.2.1 (g), (h), (i), (j), (k), (l), and (m) provide summarized examples of parameter setting according to the type of rotary encoder. Set parameters according to the types of a rotary encoder and synchronous built-in servo motor used.

For the number of poles of each motor model, see Table 3.2.1 (n).

Table 3.2.1 (g) For α*i*CZ 512A

Symbol name	Parameter number	Parameter setting	
		Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	0	0
AMR2	2138 (*1)	1	1
PLC0	2000#0	0	0
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	4096	4096
PPLS	2024	6250	6250
REFCOUNT	1821	360000	3600000
FFG	2084	36	36
FFG	2085	50	5
PSMPYL	2185	0	0
DECAMR	2220#0	0	0

(*1) When parameter No. 2001 is set to the number or motor poles, set parameter No. 2138 to 0.

Table 3.2.1 (h) For α*i*CZ 768A

Symbol name	Parameter number	Parameter setting	
		Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	768	768
AMR2	2138	Number of poles/2	Number of poles/2
PLC0	2000#0	0	0
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	6144	6144
PPLS	2024	9375	9375
REFCOUNT	1821	120000	1200000
FFG	2084	36	360
FFG	2085	75	75
PSMPYL	2185	0	0
DECAMR	2220#0	1	1

Table 3.2.1 (i) For α*i*CZ 1024A

Symbol name	Parameter number	Parameter setting	
		Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	0	0
AMR2	2138	0	0
PLC0	2000#0	0	0
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	8192	8192
PPLS	2024	12500	12500
REFCOUNT	1821	360000	3600000
FFG	2084	36	36
FFG	2085	100	10
PSMPYL	2185	0	0
DECAMR	2220#0	0	0

Table 3.2.1 (j) For RCN223F,RCN723F,RCN727F

Symbol name	Parameter number	Parameter setting	
		Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	0	0
AMR2	2138(*1)	-3	-3
PLC0	2000#0	1	1
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	6554	6554
PPLS	2024	10000	10000
REFCOUNT	1821	360000	3600000
FFG	2084	9	9
FFG	2085	200	20
PSMPYL	2185	0	0
DECAMR	2220#0	0	0
800PLS#0	2275#0	1	1
800PLS#1	2275#1	1	1
DMASK	2394	8	8

(*1) When parameter No. 2001 is set to the number or motor poles, set parameter No. 2138 to -4.

Table 3.2.1 (k) For analog encoder (binary type) and synchronous built-in servo motor position detection circuit (1)

Symbol name	Parameter number	Parameter setting			
		4096 λ/revolution		8192 λ/revolution	
		Detection unit 1/1000deg	Detection unit 1/10000deg	Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	0	0	0	0
AMR2	2138	0	0	-1	-1
PLC0	2000#0	0	0	0	0
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	8192	8192	16384	16384
PPLS	2024	12500	12500	25000	25000
REFCOUNT	1821	360000	3600000	180000	1800000
FFG	2084	9	90	9	90
FFG	2085	25	25	50	50
PSMPYL	2185	0	0	0	0
DECAMR	2220#0	0	0	0	0
800PLS#0	2275#0	0	0	0	0
LINEAR	2010#2	0	0	0	0
HP2048	2274#0	1	1	1	1
DD2048	2274#6	1	1	1	1

Table 3.2.1 (l) For analog encoder (binary type) and synchronous built-in servo motor position detection circuit (2)

Symbol name	Parameter number	Parameter setting			
		16384 λ/revolution		32768 λ/revolution	
		Detection unit 1/1000deg	Detection unit 1/10000deg	Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	0	0	0	0
AMR2	2138	-2	-2	-3	-3
PLC0	2000#0	1	1	1	1
AMR	2001	Number of poles/2 (binary)	Number of poles/2 (binary)	Number of poles/2 (binary)	Number of poles/2 (binary)
PULCO	2023	3277	3277	6554	6554
PPLS	2024	5000	5000	10000	10000
REFCOUNT	1821	90000	900000	360000	3600000
FFG	2084	9	90	9	90
FFG	2085	100	100	200	200
PSMPYL	2185	0	0	0	0
DECAMR	2220#0	0	0	0	0
800PLS#0	2275#0	0	0	1	1
LINEAR	2010#2	0	0	0	0
HP2048	2274#0	1	1	1	1
DD2048	2274#6	1	1	1	1

Table 3.2.1 (m) For analog encoder (non-binary type) and synchronous built-in servo motor position detection circuit

Symbol name	Parameter number	Parameter setting	
		Detection unit 1/1000deg	Detection unit 1/10000deg
AMRDL	2112	λ	λ
AMR2	2138	Number of poles/2	Number of poles/2
PLC0	2000#0	0	0
AMR	2001	00000000	00000000
PULCO	2023	2λ	2λ
PPLS	2024	$32\lambda/5$	$32\lambda/5$
REFCOUNT	1821	360000	3600000
FFG	2084	Reduction of $\frac{360000}{\lambda \times 512}$	Reduction of $\frac{3600000}{\lambda \times 512}$
FFG	2085		
PSMPYL	2185	0	0
DECAMR	2220#0	1	1
LINEAR	2010#2	1	1
HP2048	2274#0	1	1
DD2048	2274#6	1	1

Table 3.2.1 (n) Number of poles and number of pole pairs of each motor model

Motor model	Motor specification	Number of poles	Number of pole pairs (number of poles/2)
D*i*S 15/1000	0492-B100	16	8 (00001000)
D*i*S 22/600	0482-B10□	24	12 (00001100)
D*i*S 22/1500	0482-B12□		
D*i*S 60/400	0493-B200		
D*i*S 60/2000	0493-B220		
D*i*S 70/300	0494-B100	32	16 (00010000)
D*i*S 70/1500	0494-B120		
D*i*S 85/400	0483-B20□		
D*i*S 85/1000	0483-B22□		
D*i*S 150/300	0494-B300		
D*i*S 150/1500	0494-B320		
D*i*S 200/300	0494-B400		
D*i*S 110/300	0484-B10□	40	20 (00010100)
D*i*S 110/1000	0484-B12□		
D*i*S 260/300	0484-B30□		
D*i*S 260/600	0484-B31□		
D*i*S 260/1000	0484-B32□		
D*i*S 370/300	0484-B40□		
D*i*S 250/250	0495-B200	48	24 (00011000)
D*i*S 500/250	0495-B400		
D*i*S 500/1000	0495-B420		
D*i*S 400/250	0485-B20□	56	28 (00011100)
D*i*S 800/250	0485-B40□		
D*i*S 1200/250	0485-B50□		
D*i*S 1000/200	0496-B300	64	32 (00100000)
D*i*S 1500/200	0486-B30□	72	36 (00100100)
D*i*S 1500/100	0497-B300	88	44 (00101100)
D*i*S 2000/100	0497-B400		
D*i*S 2000/150	0497-B490		
D*i*S 2100/150	0487-B30□		
D*i*S 3000/150	0487-B40□		
D*i*S 5000/50	0488-B400	128	64 (01000000)

3.2.1.2 Parameter setting procedure 2 (pole position detection) (optional function)

To drive a synchronous built-in servo motor, the pole detection function (option) is required. This subsection describes the pole detection function.

(1) Overview

The pole detection function detects the pole position of a motor to be driven when the relationship between the pole position of the motor and the phase of the detector is unknown.

⚠ **WARNING**

1 When the correct pole position cannot be detected in some detection conditions, the motor can make an unpredictable movement. To avoid this dangerous situation, the following conditions must be satisfied until completion of detection:
<1> The torque limit parameter (parameter No. 2060) must be set to a value equal to or less than 150% of the continuous current.
<2> The setting of excessive error at stop time must be 100 μm or 0.1 deg or less. Moreover, the setting of excessive error at move time must be 120% of the logical positional deviation or less.
<3> While pole position detection is in progress and a subsequent move operation is specified, the protection doors must be closed.
If these conditions are not satisfied and pole detection operation is not terminated normally, the motor can make an unpredictable movement with the maximum torque until the NC detects an excessive error alarm.

For safety, create the following sequence with the PMC by using the pole detection state signal:
<1> When the protection doors are open, pole detection is not started.
<2> If a protection door is opened during pole detection (Fn158=1), a reset is made.
<3> When pole detection is uncompleted (Fn159=0), no command is issued to relevant axes.
<4> When pole detection is uncompleted (Fn159=0), the brake for the vertical axis is not released. (For brake operation, monitor not only the SA signal but also the pole detection completion signal (Fn159).)

In general, this function cannot be applied to the following motors and conditions:
<1> Linear motor
<2> Axis for which the control axis detach function (detach function) is used (See Item (8) in this section.)
<3> When the joint rigidity between the motor and detector is low
<4> State where the axes are locked completely
However, if this function needs to be unavoidably applied to the linear motor in some conditions, the application is allowed only when the absolute detector is used with sufficient consideration given to safety.

2 After replacing the detector, be sure to set the AMR offset (parameter No. 2139) to 0 to perform pole detection again.

⚠ CAUTION

1 When each of two axes for which tandem control or feed axis synchronous control is made has a detector (encoder), perform pole detection one by one by setting the axis for which no pole detection is made in the servo-off state. For tandem control, turn off the servo alarm 2-axis simultaneous monitor function during detection (bit 0 of parameter No. 2007 is set to 0).

2 When using the motor feedback sharing function (No. 2018#7) under tandem control, start pole detection simultaneously for the two axes to avoid incorrect detection.

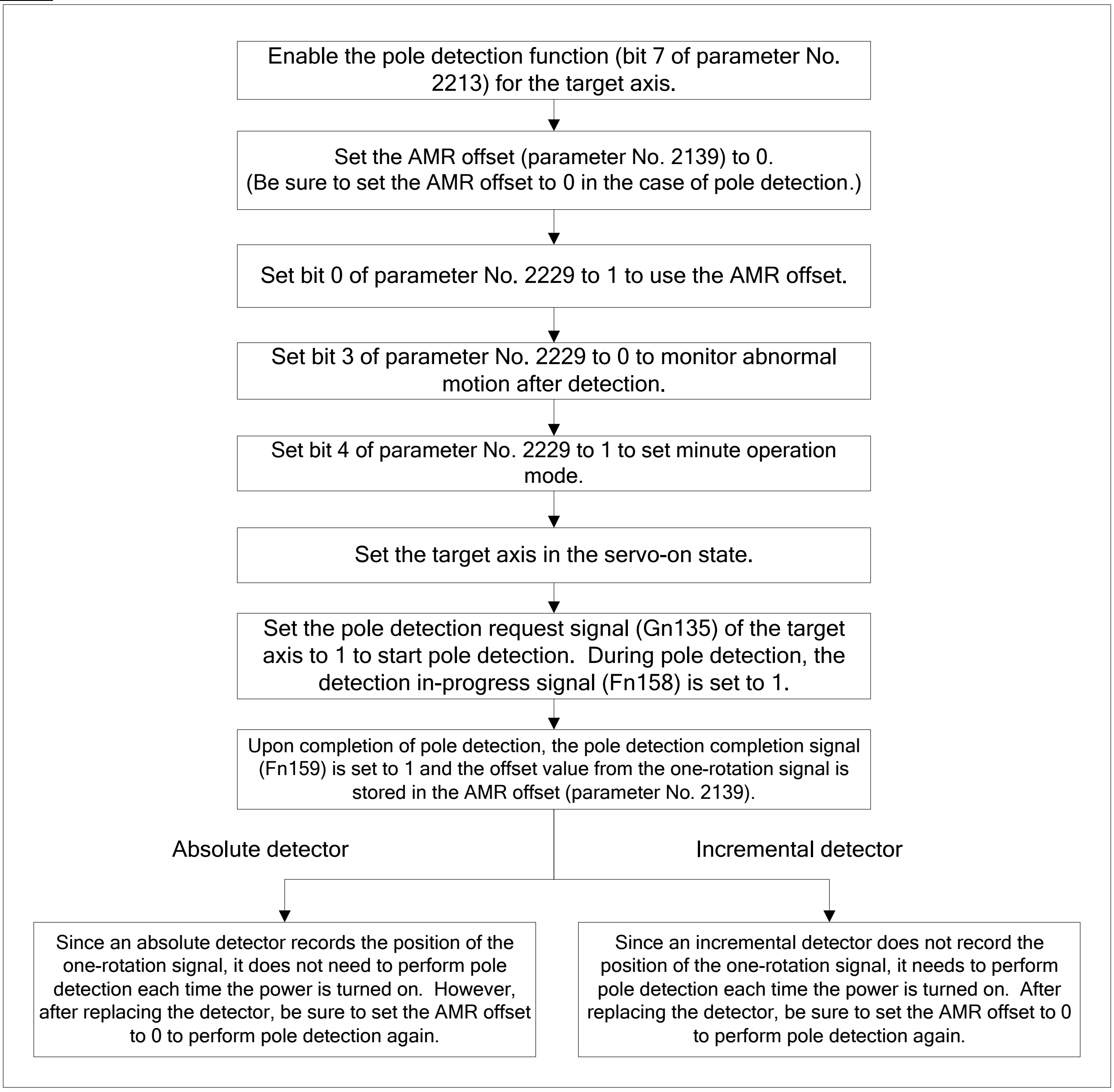
3 For a detector to be applied, note the following:
1) Use an absolute detector whenever possible.
2) If the use of an incremental detector is unavoidable, an incremental detector with a one-rotation signal is recommended.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	J(10) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Pole detection procedure

Flow



Remarks

- Enable the parameter (No. 2213#7) for a target axis. Pole detection is performed only for an enabled axis. For an axis not enabled, the pole detection request signal (Gn135) is ignored.
- Set the servo-on state. Note that releasing the brake before the pole detection completion signal (Fn159) is set to 1 causes the tool to drop vertically.
- Do not perform a pole detection operation in the servo-off state. Moreover, do not set the servo-off state during pole detection operation.
- When the pole detection request signal (Gn135) is set to 1, pole detection is started, and the pole detection in-progress signal (Fn158) is set to 1.
- Once a pole detection operation is started, the detection operation is continued even when the pole detection request signal is set to 0.
- Motor operation during pole detection is not under control of the CNC. During this period, the CNC performs a follow-up operation.

- If pole detection is terminated abnormally due to a mechanical cause, detection error alarm SV0454 is issued.
- Detection error alarm SV0454 cannot be released by a reset. Turn off the power then turn on the power again.
- When a reset is made during pole detection, the pole detection is stopped. To restart pole detection, set the pole detection request signal (Gn135) to 0 then set the same signal to 1 again.
- Once a pole detection operation is completed, no additional pole detection operation can be performed until the power is turned off except using the control axis detachment.
- Be sure to set bit 0 of parameter No. 2229 to 1. When pole detection is completed and the motor one-rotation signal is received, the result of detection is saved in parameter No. 2139. When an absolute detector is used, pole detection does not need to be performed each time the power is turned on.
- In the MDI, MEM, or EDIT mode, the result of detection is reflected on the screen immediately. In the REF or JOG mode, the result of detection is reflected on the screen when the reset key is pressed or the mode is switched to the MDI mode.
- To perform pole detection again, set parameter No. 2139 to 0 and then turn off the power and back it on again.

NOTE

1. When an absolute detector is used and the parameter (No. 2229#0) is set to 1, the pole detection completion signal (Fn159) is set to 1 immediately after power-on if the parameter (No. 2139) is not set to 0.
2. Create logic for confirming the pole detection completion signal (Fn159) before specifying a move command immediately after power-on.
3. If an alarm such as a count error alarm is issued for a detector fault, the pole detection completion signal (Fn159) is returned to 0. In this case, perform another pole detection operation.

(4) Parameters for pole position detection function

When this parameter has been modified, the power to the CNC must be turned off before operation is continued.

	#7	#6	#5	#4	#3	#2	#1	#0
2213	OCM							

OCM(#7) 0: The pole detection function is disabled.
1: The pole detection function is enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2229				FORME	WATRA			ABSEN

ABSEN(#0) 0: AMR offset (No. 2139) is not used.
1: AMR offset (No. 2139) is used.

Be sure to set this bit to 1.

When an absolute detector is used, the result of detection is saved to the AMR offset (parameter No. 2139). Therefore, pole detection does not need to be performed when the power is turned on the second and subsequent times.

If an incremental detector is used, the result of detection is saved to the AMR offset (No.2139) when the one-rotation signal is detected. In this case, pole detection needs to be performed each time the power is turned on. After the one-rotation signal is detected, however, the value saved to the AMR offset (No.2139) is used, so that an influence due to pole detection variation can be eliminated.

WATRA(#3) 0: After pole detection, an abnormal movement is monitored.
1: After pole detection, no abnormal movement is monitored.

If a detection error occurs, protection against an abnormal operation is provided. Operation is monitored until a command after detection is issued. If an abnormal operation is detected, detection error alarm SV0454 is issued.
Generally, set this bit to 0.

FORME(#4) 0: Automatic selection mode
1: Minute operation mode
Be sure to set this bit to 1.

2139	AMR offset (AMROFS)

[Unit of data] Degrees
[Valid data range] 1 to 360
[Initial setting] 0
When bit 0 (ABSEN) of parameter No. 2229 is set to 1, the result of detection is saved to this parameter upon completion of detection.
Only when detection is performed again, manually set this parameter to 0 and turn off the power and back it on again.

> ⚠ **WARNING**
> After pole determination, never rewrite the value of this parameter manually.

2182	Current A for pole detection (DTCCRT_A)

[Unit of data] 7282 is the maximum amplifier current value.
[Valid data range] 0 to 7282
[Standard setting] 0
Set a current value for pole detection. If this parameter is set to “0”, pole detection is performed according to the value of the rated current parameter (No. 2086). If the friction of the machine is large, and the pole detection error alarm SV0454 is issued during detection, increase current A for pole detection. The maximum value of this parameter is limited by the torque limit (No. 2060).

2268	Allowable travel distance magnification (MFMPMD)

[Unit of data] % unit
[Valid data range] -1000 to 1000
[Standard setting] 0 (100% internally)
During pole detection, the motion of the rotor is limited to within an allowable travel distance of 5 degrees. If the value of this parameter is positive, set an allowable travel distance by specifying a percentage relative to the default 5 degrees (100%). If the detection error alarm SV0454 is issued during pole detection, and no improvement is made by changing the current value A (No.2182) for pole detection, set a value greater than 100% in this parameter. For example, to set an allowable travel distance of 10 degrees, set 200%.
On the other hand, if the value of this parameter is negative, change the speed evaluation criteria that determine the detection sensitivity. The speed evaluation criteria represent the percentage to the default value 3.7 min^{-1} (100%). If detection error alarm SV0454 occurs in a detector with a coarse resolution, increase the speed evaluation criteria (to approximately -200 to -500). On the other hand, if detection error alarm SV0454 occurs in a detector with a fine resolution, reduce the speed evaluation criteria (to approximately -10 to -20).

(5) Signals for pole position detection function

Pole detection request signal
RPREQ1 to RPREQ8

[Classification] Input signal

[Function] Requests pole detection. This signal is available for each controlled axis, and the suffix at the end of each signal name indicates a controlled axis number.

[Operation] Pole detection is started by setting this signal to 1. Once a pole detection operation is started, the operation is continued even when this signal is set to 0.

Pole detection in-progress signal
RPDET1 to RPDET8

[Classification] Output signal

[Function] Posts that pole detection is being performed. This signal is available for each controlled axis, and the suffix at the end of each signal name indicates a controlled axis number.

[Output condition] This signal is set to 1 in the following case:

- When pole detection is being performed

This signal is set to 0 in one of the following cases:

- When pole detection is completed
- When pole detection is terminated abnormally
- When pole detection is stopped by a reset

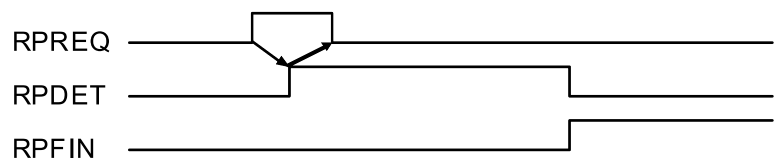
Pole position detection completion signal
RPFIN1 to RPFIN8

[Classification] Output signal

[Function] Posts that pole detection is completed. This signal is available for each controlled axis, and the suffix at the end of each signal name indicates each controlled axis number.

[Output condition] This signal is set to 1 in the following case:

- When pole detection is completed after pole detection is started by setting the pole detection request signal to 1



> **NOTE**
> 1 If an absolute detector is used, this signal remains set to 1 even when the power is turned off then back on after completion of pole detection performed by setting the parameter (No. 2229#0) to 1. When the power is turned off then back on after setting the parameter (No. 2139) to 0, this signal is set to 0.
> 2 If an incremental detector is used, the pole detection completion signal is set to 0 when the power is turned off.

Signal address

	#7	#6	#5	#4	#3	#2	#1	#0
Gn135	RPREQ8	RPREQ7	RPREQ6	RPREQ5	RPREQ4	RPREQ3	RPREQ2	RPREQ1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn158	RPDET8	RPDET7	RPDET6	RPDET5	RPDET4	RPDET3	RPDET2	RPDET1
Fn159	RPFIN8	RPFIN7	RPFIN6	RPFIN5	RPFIN4	RPFIN3	RPFIN2	RPFIN1

(6) Action for trouble for pole position detection function

Table 3.2.1.2 (a) Action against trouble for pole position detection

Symptom	State	Detection request (Gn135)	During detection (Fn158)	Detection completion (Fn159)	Cause	Action
[Before detection completion]						
Detection is not started.	The motor does not operate at all.	OFF	OFF	OFF	The pole detection request signal is turned off.	Turn on the pole detection request signal.
		ON	OFF	OFF	The pole detection function is disabled.	Check bit 7 of No. 2213 or the option.
					Servo-off	Set the servo-on state.
Detection is not completed.	The motor operates slightly, but detection is not completed and no alarm occurs.	ON	ON	OFF	The detector resolution is low: 100 million/rev or lower	Set the stop speed decision value (No. 2268) to a value from -200 to -500.
					Velocity feedback noise	Take action for noise protection.
					The friction is very small, so that activation causes a vibration to disable stop decision initiation.	Decrease detection current A (No. 2182) to find an optimal value.
	During detection, an abnormally large motion is made and detection is not completed.				The resolution of the detector is too fine.	Set the stop speed decision value (No. 2268) to a value from -10 to -20.
Excessive error at stop time	During detection, the excessive error alarm at stop time is issued.	ON	ON →OFF	OFF	The friction is small.	Increase the setting of excessive error at stop time or set detection current A (No. 2182) to the rated current or lower.
Detection error alarm (SV0454)	The pole detection error alarm is issued.	ON	ON →OFF	OFF	The friction is large.	Set detection current A (No. 2182) to the rated current or higher.
					The current gain is small.	Set a proper current gain.

Symptom	State	Detection request (Gn135)	During detection (Fn158)	Detection completion (Fn159)	Cause	Action
[After detection completion]						
Vibration		-	OFF	ON	The phase order of the power line does not match the direction of the detector.	Change the phase order of the power line.
					Detector setting error	Set the parameters of the detector correctly.
					The number of poles is not set correctly.	Set the correct number of motor poles.
					The velocity gain is high.	Adjust the velocity gain to a proper value.
Excessive error at stop time or excessive error at move time	An unpredictable movement is made, or no movement is made in response to an issued command, so that an excessive error alarm is issued.	-	OFF	ON	The phase order of the power line does not match the direction of the detector.	Change the phase order of the power line.
					Detector setting error	Set the parameters of the detector correctly.
					The number of poles is not set correctly.	Set the correct number of motor poles.
					Synchronous built-in servo motor position detection circuit C with a referenced mark	Use the 90D0, 90E0/10 or later
The AMR offset does not change.	After detection completion, the result of detection is not written to the AMR offset.	-	OFF	ON	No.2229#0=0	Set bit 0 of No. 2229 to 1.
					The mode is not the MDI mode.	The display is updated in the MDI mode.
					Incremental detector,αiCZ sensor	The motor needs to make one or more revolutions.
Detection error alarm (SV0454)	After detection completion, the pole detection error alarm is issued.	-	OFF	ON →OFF	The velocity mode is used for operation.	Set bit 3 of parameter No. 2229 to 1 to avoid detection error.
[After restart]						
No motion	The AMR offset is not 0, but no movement is made in response to an issued command.	-	-	-	Incremental detector	Pole detection needs to be performed each time a start-up operation is performed.
					Detector alarm	Pole detection needs to be performed again.

Symptom	State	Detection request (Gn135)	During detection (Fn158)	Detection completion (Fn159)	Cause	Action
Detection result variation	The value of the AMR offset varies in each detection operation.	-	-	-	The friction is large.	Set detection current A (No. 2182) to the rated current or higher.
					The phase order of the power line does not match the direction of the detector.	Change the phase order of the power line.
					The detector is not set correctly.	Set the detector correctly.
					The number of poles is not set correctly.	Set the number of poles correctly.

(7) Detection of the pole position detection request alarm

No torque occurs on an axis on which pole position detection is not completed (servo-off state). For this reason, conventionally, the customer's ladder needs to monitor the pole position detection completion signal (Fn159) to determine whether to release the brake of an axis or to specify a move command for an axis.

The servo software and CNC software indicated below execute the following processing when pole position detection is not completed [pole position detection enabled (bit 7 of No. 2213=1) and the pole position detection completion signal is off (Fn159=0)]:

1) The interlock state is set. (Interlock is applied onto each axis. "INTER/START LOCK ON" on the diagnosis screen No. 0000 displays 1.)
2) The servo ready signal SA is turned off (the SA signal for all axes is turned off.)
3) Alarm DS0650 is displayed (cleared by a reset).

Safety is thus ensured even if the user's ladder processing is not performed.

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	M(13) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	M(13) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

[Series and editions of applicable system software]

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	04 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	04 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

The alarm number and message are indicated below.

Number	Message	Description
DS0650	POLE DETECTION REQUEST	With an absolute detection axis (bit 5 of No. 1815=1), pole detection is not completed (Fn159=0). With a non-absolute detection axis (bit 5 of No. 1815=0), pole detection is once completed then the state is changed to the pole detection uncompleted state (Fn159=0).

With the parameters below, operation to be performed when pole position detection is not completed can be changed.

	#7	#6	#5	#4	#3	#2	#1	#0
1809							PAO	SAN

[Input type] Parameter input
[Data type] Bit path

SAN (#0) When the pole position detection function is used, pole position detection is enabled (bit 7 of No. 2213=1), and pole position detection is not completed (Fn159=0) with an axis, the servo ready signal SA <Fn000.6> of the path to which the axis belongs and the servo ready signals SA8 to SA1 <Fn186.7 to Fn186.0> for all axes that belong to the path are:
0: Not set to 0.
1: Set to 0.

> ⚠ **CAUTION**
> When applying pole position detection to a gravity axis, basically release the brake after confirming pole position detection completion (Fn159=1) and the servo ready signal. When releasing the brake by checking the servo ready signal alone for an avoidable reason, set this parameter to 1.

PAO(#1) When the pole position detection function is used, pole position detection is enabled (bit 7 of No. 2213=1), and pole position detection is not completed (Fn159=0) with an axis:
0: Alarm DS0650 (POLE DETECTION REQUEST) is issued.
1: Alarm DS0650 (POLE DETECTION REQUEST) is not issued.

NOTE

1 The issue condition of alarm DS0650 varies, depending on whether the axis in question is an absolute detection axis, as described below.
   - The alarm is issued with an absolute detection axis (bit 5 of No. 1815=1) when pole detection is not completed (Fn159=0).
   - The alarm is issued with a non-absolute detection axis (bit 5 of No. 1815=0) when pole detection is once completed then the state is changed to the pole detection uncompleted state (Fn159=0).

2 If this alarm is issued, detect a pole position again. After a pole position is detected again, this alarm is cleared by a reset.

(8) Using the pole detection function and control axis detach function (detach function) together

When the pole detection function is used with an axis of a synchronous built-in servo motor, motor switching using the control axis detach function is conventionally impossible. However, the servo software and CNC software of the series and editions indicated below enable the pole detection function and control axis detach function to be used at the same time.

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	M(13) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	M(13) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

[Series and editions of applicable system software]

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	04 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	04 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

⚠ **CAUTION**

1 When switching is made by using the detach function among those motors that need the pole detection function, the motors and detectors need to be of the same type.
2 The control axis detach function is supported only by a combination of the CNC software and servo software indicated above. When CNC software and servo software not listed above are used, the pole detection function and control axis detach function cannot be used at the same time.

When the control axis detach function is used, the relationship of the Z phase of the detector with the pole position of the motor may vary. So, pole position detection needs to be performed again or the AMR offset (No. 2139) needs to be rewritten to a proper value. To perform pole position detection again and rewrite the AMR offset, however, the conventional specification requires that the power to the CNC be turned off then back on. With the servo software and CNC software listed above, the power to the CNC need not be turned off then back on to perform pole position detection again and rewrite the AMR offset.

When detaching a control axis to which pole position detection is applied, use the procedure below.

- Start detaching a control axis (detach) with Gn124 or bit 7 of parameter No. 12.
  (Pole position detection completion signal Fn159=0)
- Rewrite the AMR offset (No. 2139) to a proper value manually or by using G10(*1)
- Release the detachment of the control axis.
- Pole detection request alarm DS0650 is issued(*2).
- If an absolute detector is used and the AMR offset value is other than 0, the alarm can be canceled by a reset to enable operation (pole detection completion signal Fn159=1).
- If an absolute detector is used and the AMR offset value is 0, the alarm can be canceled by a reset after executing pole detection to enable operation (pole detection completion signal Fn159=0 changed to Fn159=1 after pole detection completion).
- If an incremental detector is used, the alarm can be canceled after pole detection to enable operation (pole detection completion signal Fn159=0 changed to Fn159=1 after pole detection completion).

*1 : By setting bit 0 of No. 1809 to 1, the servo ready signal SA can be turned off when pole position detection is not completed.
*2 : By setting bit 1 of No. 1809 to 1, alarm display can be disabled even when pole position detection is not completed.

If the AMR offset is rewritten not during control axis detach operation, a power-off request is issued. When performing pole detection with an absolute detector after cancellation of control axis detach operation, set the AMR offset value to 0.

3.2.1.3 Parameter setting procedure 3 (OVC alarm parameters)

This subsection can be used to set parameters according to the cooling method used for synchronous built-in servo motors.
In the case of no cooling, the parameters are set by initialization according to Subsection 3.2.1.1, so that the parameters need not be modified.
In the case of liquid cooling only, modify the parameters according to Table 3.2.1 (a) and Table 3.2.1 (b).

2062	First OVC alarm parameter (POVC1)

2063	First OVC alarm parameter (POVC2)

2065	First OVC alarm parameter (POVCLMT)

2086	Current rating parameter (RTCURR)

2161	OVC magnification in stop state (OVCSTP)

2162	Second OVC alarm parameter (POVC21)

2163	Second OVC alarm parameter (POVC22)

2164	Second OVC alarm parameter (POVCLMT2)

⚠ CAUTION

If the correct values corresponding to the cooling method are not set in the parameters above, expected thermal protection cannot be provided. Use care.

Table 3.2.1.3 (a) Setting OVC and current rating parameters by cooling method [200-V driving]

Motor model		D*i*S 400/250		D*i*S 22/600		D*i*S 85/400		D*i*S 110/300		D*i*S 260/300	
Motor specification		0485-B20□		0482-B10□		0483-B20□		0484-B10□		0484-B30□	
Cooling method		**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**
Continuous torque [Nm]		65	140	6	10	17	35	25	45	55	105
POVC1	No.2062	32743	32646	32689	32523	32683	32427	32682	32427	32682	32427
POVC2	No.2063	308	1528	988	3069	1069	4258	1069	4260	1069	4260
POVCLMT	No.2065	903	4290	2826	8170	3172	12689	3173	12694	3173	12694
RTCURR	No.2086	753	1641	1237	2104	1310	2621	1310	2621	1310	2621
OVCSTP	No.2161	120	120	0	0	0	0	0	0	0	0
POVC21	No.2162	0	0	0	0	0	0	0	0	0	0
POVC22	No.2163	0	0	0	0	0	0	0	0	0	0
POVCLMT2	No.2164	0	0	0	0	0	0	0	0	0	0

Motor model		D*i*S 260/600		D*i*S 370/300		D*i*S 800/250		D*i*S 1200/250		D*i*S 1500/200	
Motor specification		0484-B31□		0484-B40□		0485-B40□		0485-B50□		0486-B30□	
Cooling method		**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**
Continuous torque [Nm]		55	105	75	150	160	320	240	480	300	600
POVC1	No.2062	32679	32360	32705	32518	32713	32529	32677	32352	32682	32427
POVC2	No.2063	1111	5100	782	3121	690	2989	1113	5196	1069	4259
POVCLMT	No.2065	1710	6848	2322	9287	1200	4801	1940	7743	3173	12692
RTCURR	No.2086	963	1926	1121	2242	868	1737	1028	2033	1310	2621
OVCSTP	No.2161	0	102	0	0	0	107	0	107	0	162
POVC21	No.2162	0	0	0	0	0	0	0	0	0	0
POVC22	No.2163	0	0	0	0	0	0	0	0	0	0
POVCLMT2	No.2164	0	0	0	0	0	0	0	0	0	0

Motor model		D*i*S 2100/150		D*i*S 3000/150		D*i*S 85/1000		D*i*S 110/1000		D*i*S 260/1000	
Motor specification		0487-B30□		0487-B40□		0483-B22□		0484-B12□		0484-B32□	
Cooling method		**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**
Continuous torque [Nm]		375	750	500	1000	-	40	-	53	-	95
POVC1	No.2062	32682	32427	32682	32427	-	32346	-	32434	-	32580
POVC2	No.2063	1069	4259	1069	4259	-	5276	-	4174	-	2354
POVCLMT	No.2065	3173	12693	3173	12693	-	15735	-	12437	-	6423
RTCURR	No.2086	1310	2621	1310	2621	-	2919	-	2595	-	1865

Motor model		D*i*S 2100/150		D*i*S 3000/150		D*i*S 85/1000		D*i*S 110/1000		D*i*S 260/1000	
Motor specification		0487-B30□		0487-B40□		0483-B22□		0484-B12□		0484-B32□	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		375	750	500	1000	-	40	-	53	-	95
OVCSTP	No.2161	0	162	0	162	-	0	-	0	-	0
POVC21	No.2162	0	0	0	0	-	0	-	0	-	0
POVC22	No.2163	0	0	0	0	-	0	-	0	-	0
POVCLMT2	No.2164	0	0	0	0	-	0	-	0	-	0

Motor model		D*i*S 22/1500		D*i*S 15/1000		D*i*S 60/400		D*i*S 70/300		D*i*S 150/300	
Motor specification		0482-B12□		0492-B100		0493-B200		0494-B100		0494-B300	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		-	9	8.7	16	24	65	35	75	73	170
POVC1	No.2062	-	32439	32675	32401	32675	32275	32684	32449	32714	32391
POVC2	No.2063	-	4109	1160	4589	1160	6169	1056	3986	679	4717
POVCLMT	No.2065	-	10559	3300	11603	1856	8321	2178	7432	1419	8580
RTCURR	No.2086	-	2576	1440	2700	845	2294	1005	2159	944	2201
OVCSTP	No.2161	-	0	0	125	0	127	0	120	0	120
POVC21	No.2162	-	0	0	32601	0	32581	0	32629	0	32599
POVC22	No.2163	-	0	0	2091	0	2337	0	1735	0	2118
POVCLMT2	No.2164	-	0	0	8308	0	5958	0	5321	0	6143

Motor model		D*i*S 200/300		D*i*S 250/250		D*i*S 500/250		D*i*S 1000/200		D*i*S 1500/100	
Motor specification		0494-B400		0495-B200		0495-B400		0496-B300		0497-B300	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		98	240	120	225	210	520	470	840	750	1400
POVC1	No.2062	32721	32368	32707	32487	32723	32454 (32465)	32677	32344 (32465)	32682	32384 (32453)
POVC2	No.2063	590	5004	761	3513	567	3923 (3783)	1135	5300 (3782)	1078	4796 (3942)
POVCLMT	No.2065	1237	9014	2196	9212	1646	10144 (9830)	3231	13083 (9827)	3076	12041 (10187)
RTCURR	No.2086	881	2201	1175	2201	1062	2606 (2259)	1421	2606 (2259)	1390	2606 (2259)
OVCSTP	No.2161	0	123	0	110	0	110	0	110	0	112
POVC21	No.2162	0	32594	0	32623	0	32596 (32600)	0	32686 (32700)	0	32686 (32700)
POVC22	No.2163	0	2172	0	1813	0	2156 (2103)	0	1027 (852)	0	1024 (853)
POVCLMT2	No.2164	0	6454	0	6595	0	7263 (7038)	0	9367 (7036)	0	8621 (7294)

Motor model		D*i*S 2000/100		D*i*S 2000/150		D*i*S 60/2000		D*i*S 70/1500		D*i*S 150/1500	
Motor specification		0497-B400		0497-B490		0493-B220		0494-B120		0494-B320	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		940	2080	920	2200	-	60	-	70	-	170

Motor model		D*i*S 2000/100		D*i*S 2000/150		D*i*S 60/2000		D*i*S 70/1500		D*i*S 150/1500	
Motor specification		0497-B400		0497-B490		0493-B220		0494-B120		0494-B320	
Cooling method		**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**
Continuous torque [Nm]		940	2080	920	2200	-	60	-	70	-	170
POVC1	No.2062	32709	32366 (32465)	32707	32369	-	32517	-	32467	-	32438
POVC2	No.2063	740	5019 (3782)	763	4992	-	3235	-	3761	-	4128
POVCLMT	No.2065	2136	12508 (9827)	1739	9838	-	4529	-	5409	-	5864
RTCURR	No.2086	1176	2606 (2259)	1045	2492	-	2293	-	2506	-	2610
OVCSTP	No.2161	0	110	0	110	-	106	-	106	-	0
POVC21	No.2162	0	32713 (32705)	0	32705	-	32633	-	32678	-	32643
POVC22	No.2163	0	687 (789)	0	792	-	1683	-	1130	-	1558
POVCLMT2	No.2164	0	8955 (7036)	0	7044	-	1389	-	1024	-	515

Motor model		D*i*S 500/1000	
Motor specification		0495-B420	
Cooling method		**No cooling**	**Liquid cooling**
Continuous torque [Nm]		-	450
POVC1	No.2062	-	32567
POVC2	No.2063	-	2517
POVCLMT	No.2065	-	3427
RTCURR	No.2086	-	1995
OVCSTP	No.2161	-	0
POVC21	No.2162	-	32630
POVC22	No.2163	-	1719
POVCLMT2	No.2164	-	323

(*) When 2-axis amplifier α*i*SV80/160 or α*i*SV160/160 is used, set values enclosed in parentheses.

Table 3.2.1.3 (b) Setting OVC and current rating parameters by cooling method [400-V driving]

Motor model		D*i*S 400/250		D*i*S 22/600		D*i*S 85/400		D*i*S 110/300		D*i*S 260/300	
Motor specification		0485-B20□		0482-B10□		0483-B20□		0484-B10□		0484-B30□	
Cooling method		**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**	**No cooling**	**Liquid cooling**
Continuous torque [Nm]		65	140	6	10	17	35	25	45	55	105
POVC1	No.2062	32743	32646	32689	32523	32683	32427	32682	32427	32682	32427
POVC2	No.2063	308	1528	988	3069	1069	4258	1069	4260	1069	4260
POVCLMT	No.2065	903	4290	2826	8170	3172	12689	3173	12694	3173	12694
RTCURR	No.2086	753	1641	1237	2104	1310	2621	1310	2621	1310	2621
OVCSTP	No.2161	120	120	0	0	0	0	0	0	0	0
POVC21	No.2162	0	0	0	0	0	0	0	0	0	0
POVC22	No.2163	0	0	0	0	0	0	0	0	0	0
POVCLMT2	No.2164	0	0	0	0	0	0	0	0	0	0

Motor model		D*i*S 260/600		D*i*S 370/300		D*i*S 800/250		D*i*S 1200/250		D*i*S 1500/200	
Motor specification		0484-B31□		0484-B40□		0485-B40□		0485-B50□		0486-B30□	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		55	105	75	150	160	320	240	480	300	600
POVC1	No.2062	32679	32360	32705	32518	32713	32529	32678	32352	32700	32498
POVC2	No.2063	1111	5095	782	3121	690	2989	1130	5196	845	3369
POVCLMT	No.2065	1351	5406	2322	9287	948	3793	1529	6118	2507	10029
RTCURR	No.2086	856	1712	1121	2242	772	1544	914	1807	1165	2330
OVCSTP	No.2161	0	0	0	0	0	0	0	0	0	109
POVC21	No.2162	0	0	0	0	0	0	0	0	0	0
POVC22	No.2163	0	0	0	0	0	0	0	0	0	0
POVCLMT2	No.2164	0	0	0	0	0	0	0	0	0	0

Motor model		D*i*S 2100/150		D*i*S 3000/150		D*i*S 15/1000		D*i*S 60/400		D*i*S 70/300	
Motor specification		0487-B30□		0487-B40□		0492-B100		0493-B200		0494-B100	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		420	840	600	1200	8.7	15	24	60	35	73
POVC1	No.2062	32682	32427	32682	32427	32675	32401	32675	32275	32684	32449
POVC2	No.2063	1069	4259	1069	4259	1160	4589	1160	6169	1056	3986
POVCLMT	No.2065	3173	12693	3173	12693	3300	11603	1856	8321	2178	7432
RTCURR	No.2086	1310	2621	1310	2621	1440	2595	845	2108	1005	2108
OVCSTP	No.2161	0	122	0	122	0	125	0	127	0	120
POVC21	No.2162	0	0	0	0	0	32601	0	32581	0	32629
POVC22	No.2163	0	0	0	0	0	2091	0	2337	0	1735
POVCLMT2	No.2164	0	0	0	0	0	8308	0	5958	0	5321

Motor model		D*i*S 150/300		D*i*S 200/300		D*i*S 250/250		D*i*S 500/250		D*i*S 1000/200	
Motor specification		0494-B300		0494-B400		0495-B200		0495-B400		0496-B300	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		73	160	98	230	120	215	210	520	470	1000
POVC1	No.2062	32714	32391	32721	32368	32707	32487	32723	32454	32677	32286
POVC2	No.2063	679	4717	590	5004	761	3513	567	3923	1135	6024
POVCLMT	No.2065	1419	8580	1237	9014	2196	9212	1301	8015	2553	11469
RTCURR	No.2086	944	2108	881	2108	1175	2109	944	2317	1266	2760
OVCSTP	No.2161	0	120	0	123	0	110	0	110	0	110
POVC21	No.2162	0	32599	0	32594	0	32623	0	32596	0	32686
POVC22	No.2163	0	2118	0	2172	0	1813	0	2156	0	1029
POVCLMT2	No.2164	0	6143	0	6454	0	6595	0	5738	0	8212

Motor model		D*i*S 1500/100		D*i*S 2000/100		D*i*S 2000/150		D*i*S 5000/50		D*i*S 60/2000	
Motor specification		0497-B300		0497-B400		0497-B490		0488-B400		0493-B220	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		750	1500	940	2200	920	2200	2000	4500	-	60
POVC1	No.2062	32682	32384	32709	32366	32707	32369	32731	32559	-	32517
POVC2	No.2063	1078	4796	740	5019	763	4992	459	2617	-	3235
POVCLMT	No.2065	2430	9514	1688	9883	1739	9838	1337	7076	-	4529
RTCURR	No.2086	1235	2445	1045	2497	1045	2492	916	2097	-	2293

Motor model		D*i*S 1500/100		D*i*S 2000/100		D*i*S 2000/150		D*i*S 5000/50		D*i*S 60/2000	
Motor specification		0497-B300		0497-B400		0497-B490		0488-B400		0493-B220	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		750	1500	940	2200	920	2200	2000	4500	-	60
OVCSTP	No.2161	0	112	0	110	0	110	0	110	-	106
POVC21	No.2162	0	32686	0	32713	0	32705	0	32722	-	32633
POVC22	No.2163	0	1024	0	687	0	792	0	569	-	1683
POVCLMT2	No.2164	0	6812	0	7076	0	7044	0	5066	-	1389

Motor model		D*i*S 70/1500		D*i*S 150/1500		D*i*S 500/1000	
Motor specification		0494-B120		0494-B320		0495-B420	
Cooling method		No cooling	Liquid cooling	No cooling	Liquid cooling	No cooling	Liquid cooling
Continuous torque [Nm]		-	70	-	170	-	450
POVC1	No.2062	-	32467	-	32438	-	32567
POVC2	No.2063	-	3761	-	4128	-	2517
POVCLMT	No.2065	-	5409	-	4633	-	3427
RTCURR	No.2086	-	2506	-	2320	-	1995
OVCSTP	No.2161	-	106	-	0	-	0
POVC21	No.2162	-	32678	-	32643	-	32630
POVC22	No.2163	-	1130	-	1558	-	1719
POVCLMT2	No.2164	-	455	-	181	-	116

3.2.2 Smoothing Compensation for Synchronous Built-in Servo Motor

(1) Overview

Smoothing compensation for synchronous built-in servo motor is a function to improve the feed smoothness of a synchronous built-in servo motor by applying, to the torque command, a sine wave compensation torque 1.5 times and 3 times per pole pair. By setting a compensation gain and phase with parameters for each component, a compensation torque matching each motor can be obtained. A value to be set in a parameter for compensation is automatically calculated using SERVO GUIDE.

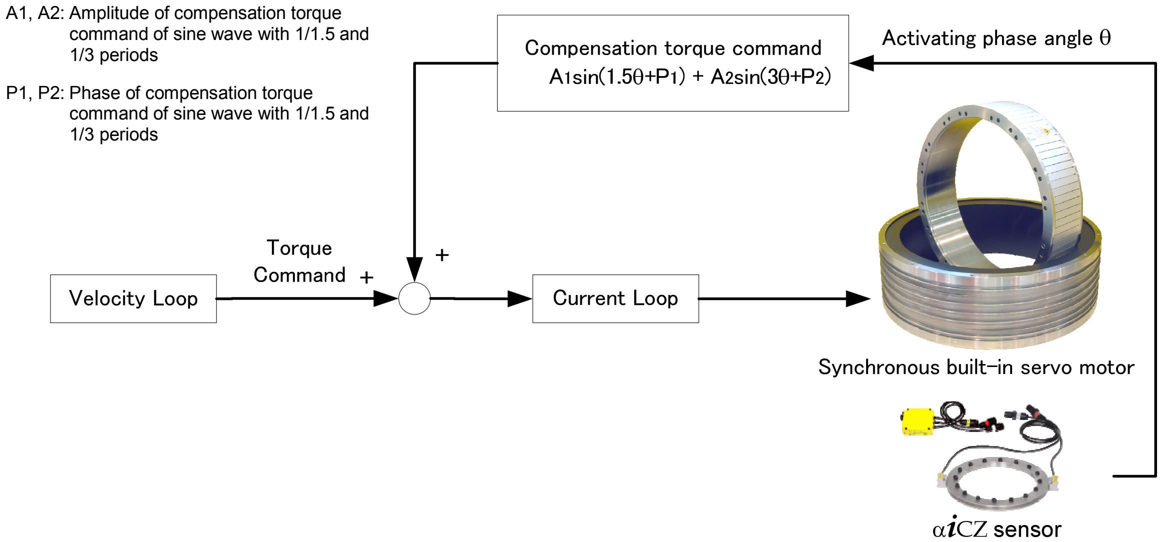


Fig. 3.2.2 (a) Diagrammatic drawing showing smoothing compensation

NOTE
This function is supported only when using the structure including an encoder that uses 8,000,000 pulses/rev. or below for parameter setting (such as the RCN223 or RCN727 manufactured by HEIDENHAIN) or an analog encoder (binary type or non-binary type) and the synchronous built-in servo motor position detection circuit.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	L(12) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	L(12) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2300						DD		

DD(#2) Synchronous built-in servo motor control is:
0: Disabled.
1: Enabled. (Smoothing compensation for synchronous built-in servo motor is also enabled.)

Setting of the smoothing compensation in the positive direction

2377	Smoothing compensation performed 1.5 times per pole pair

Correction gain (high-order 8 bits) **Correction phase (low-order 8 bits)**

2380	Smoothing compensation performed three times per pole pair

Correction gain (high-order 8 bits) **Correction phase (low-order 8 bits)**

Setting of the smoothing compensation in the negative direction

If the correction gain of the following parameters is set to a non-zero value, it is possible to set a value different value in the negative direction that is different from a value in the positive direction. To set the same value between the negative direction and the positive direction, set the correction gain of the following parameters to 0.

2378	Smoothing compensation performed 1.5 times per pole pair (negative direction)

Correction gain (high-order 8 bits) **Correction phase (low-order 8 bits)**

2381	Smoothing compensation performed three times per pole pair (negative direction)

Correction gain (high-order 8 bits) **Correction phase (low-order 8 bits)**

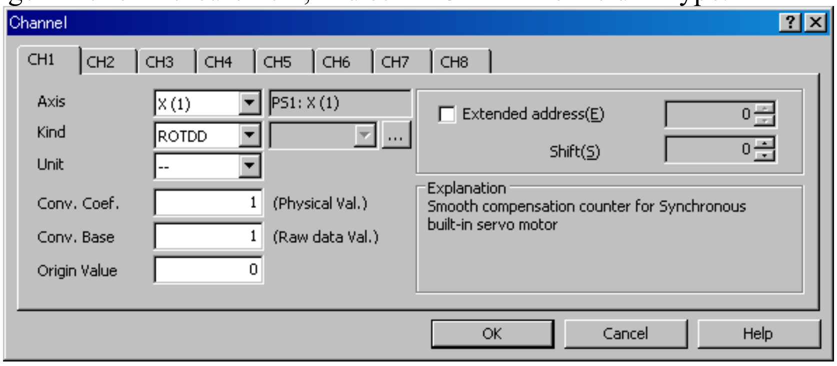
An optimal value varies from one motor to another (not from one motor model to another). So, compensation parameters need to be determined for each assembled motor. A torque command variation generated when the motor is fed at low speed is dependent on the position. The application of smoothing compensation cancels this position-dependent characteristic, allowing the motor to move smoothly.

The measuring instruments that can be used to determine these parameters include "SERVO GUIDE" (Ver. 3.20 or later).
By using SERVO GUIDE (Ver. 3.20 or later), these parameters can be determined easily.
Follow the procedure below to measure the activating phase and torque command, which are required to determine the compensation parameters.

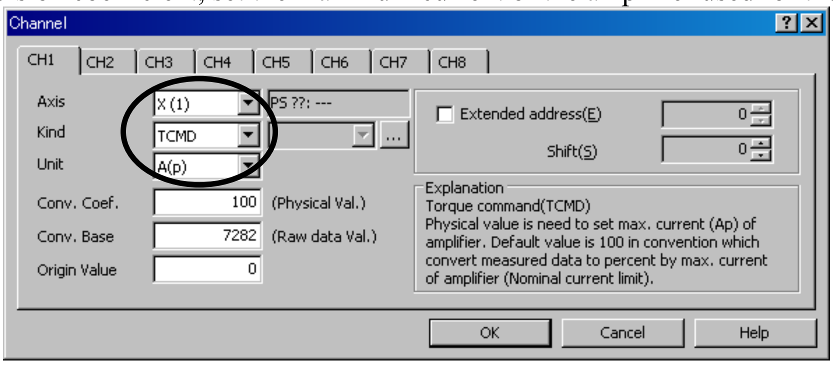
(4) Adjustment procedure

<1> Set channels.

Channel 1: Counter for smoothing compensation for synchronous built-in servo motor
Select the target axis for measurement, and set "ROTDD" as the data type.



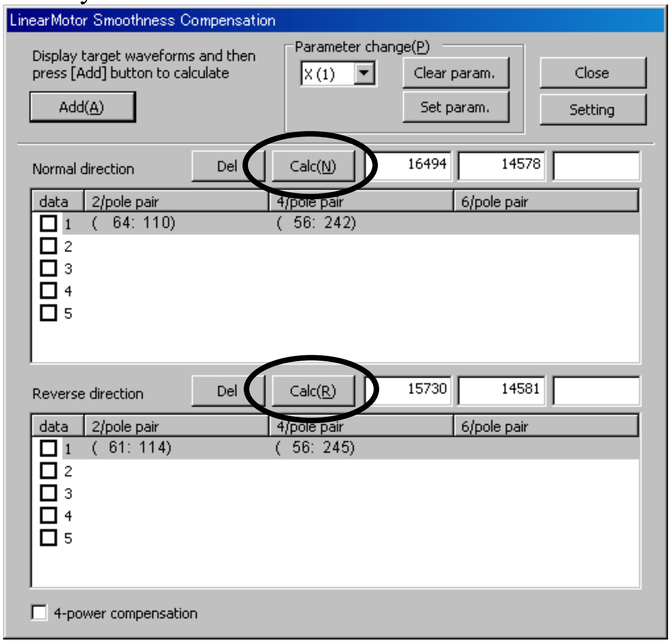
Channel 2: Torque command
Select the target axis for measurement, and set "TCMD" as the data type.
As the conversion coefficient, set the maximum current of the amplifier used for the target axis.



<2> With this setting, make bidirectional movements by about ±90 deg at about F (14400/number of poles) deg/min for data measurement. At the time of data measurement, ensure that all smoothing compensation values are set to 0. Smoothing compensation for linear motors may be used. Check this point as well.
Parameters for synchronous built-in servo motor:
No.2377, No.2378, No.2380, No.2381
Parameters for linear motor:
No.2130, No.2131, No.2132, No.2369, No.2370, No.2371
When making measurements, lower the velocity gain to such an extent that hunting does not occur.

<3> From the "Tools" menu, select "Smoothness compensation calc.".
(The shortcut is [Ctrl] + [L].)

<4> Pressing the [ADD] button on the displayed dialog box analyzes waveform data and registers compensation parameter candidates. The "1.5/pole pair" item and "3.0/pole pair" item correspond to smoothing compensation performed 1.5 times per pole and smoothing compensation performed 3 times per pole, respectively.

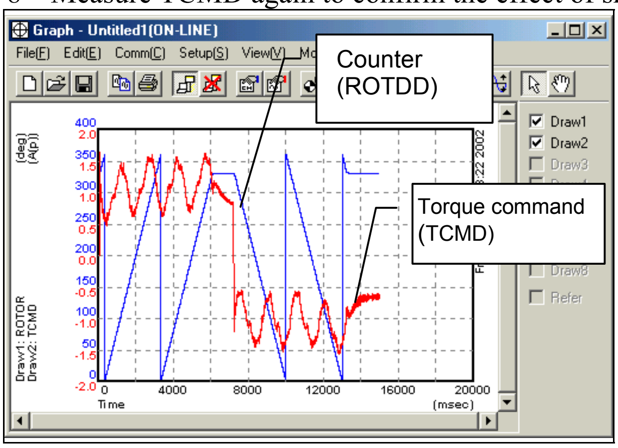


<5> The compensation parameters slightly vary depending on the measurement situation. So, repeat a data measurement and a press of the [Add] button several times in a similar manner while keeping the dialog box open. (Up to five candidates can be registered.)
If the displayed values include an extremely different value, check the corresponding check box on the leftmost side of the list so that the value is not taken into account in the final compensation calculation.

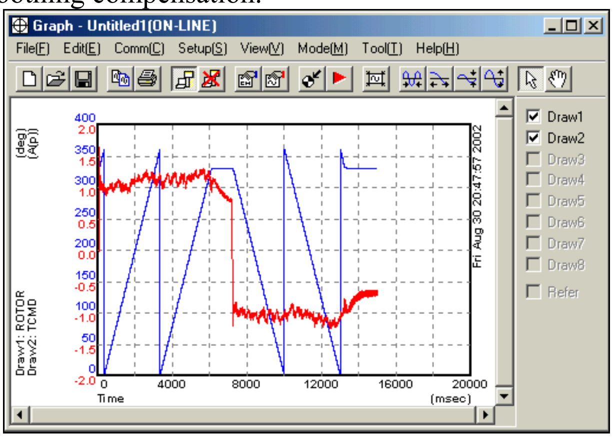
<6> Finally, press the [Calc] button for each of the forward and backward directions. Then, smoothing compensation parameters are displayed.

<7> By pressing the [Set param] button, the smoothing compensation parameters are set in the CNC.

<8> Measure TCMD again to confirm the effect of smoothing compensation.



Before smoothing compensation adjustment



After smoothing compensation adjustment

(*) For details on the use of SERVO GUIDE, refer to the help of SERVO GUIDE.

3.3 DETECTION OF AN OVERHEAT ALARM BY SERVO SOFTWARE WHEN A LINEAR MOTOR AND A SYNCHRONOUS BUILT-IN SERVO MOTOR ARE USED

(1) Overview

When a linear motor or synchronous built-in servo motor is used, the overheat signal (thermostat signal) of the motor can be connected in one of three ways:

Configuration 1 : Connected to the PMC signal

Configuration 2 : Connected to the αiCZ detection circuit (A860-2162-T***)
Connected to the linear motor or the synchronous built-in servo motor position detection circuit (A860-2033-T***)

Configuration 3 : Connected to the temperature detection circuit (A860-2091-T301)

For details on the hardware components, refer to the following specifications.

FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series DESCRIPTIONS (B-65332EN)

FANUC LINEAR MOTOR L*i*S series DESCRIPTIONS (B-65382EN)

This section describes these methods of connection and setting.

If the overheat signal is connected using a method described in this subsection and an overheat alarm is issued, quick stop processing (quick stop function based on a command specifying a velocity of 0) is also usable. (For details, see Subsection 5.8.8, "Quick Stop Function at OVC and OVL Alarm".)

In configuration 2 and configuration 3, temperature information can be observed on the CNC screen by using the temperature information signal (thermistor signal) built into a linear motor or synchronous built-in servo motor.

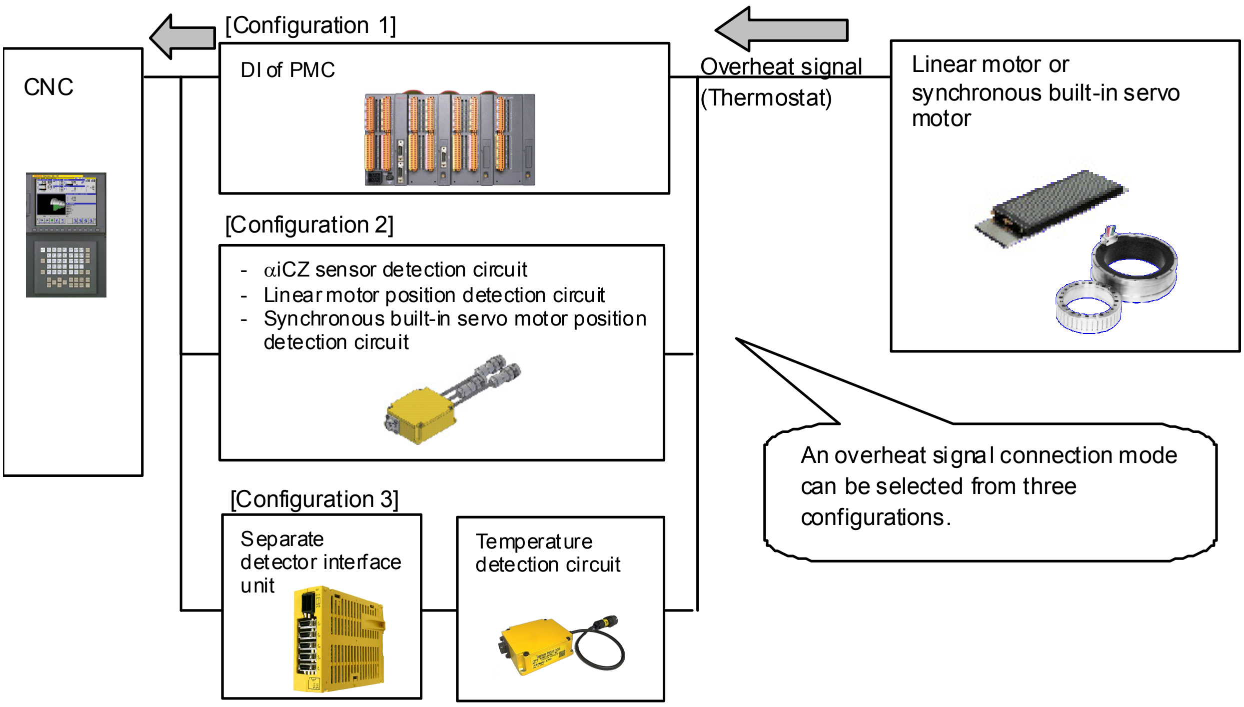


Fig. 3.3 (a) Overheat signal connection configuration

> ⚠ **CAUTION**
> When using a linear motor or synchronous built-in servo motor, be sure to monitor the overheat signal by using any of the methods mentioned above. Otherwise, the motor cannot be properly protected against overheating.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	(*1)
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	(*1) HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(*1) Configuration 1 is supported in J(10) and subsequent editions

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2300	CKLNOH				THRMO			

THRMO(#3) When bit 7 of parameter No. 2300 is 1, an overheat alarm is:

0: Obtained from the DI signal via the PMC

1: Obtained from the α*i*CZ detection circuit or the linear motor or synchronous built-in servo motor position detection circuit, or the temperature detection circuit

* When this parameter has been set, the power must be turned off before operation is continued.

CLKNOH(#7) An overheat alarm for the linear motor or synchronous built-in servo motor position detection circuit is:

1: Obtained from the DI signal via the PMC, the α*i*CZ detection circuit, the position detection circuit, or the temperature detection circuit

* When this parameter has been set, the power must be turned off before operation is continued.

Set these parameters according to the overheat signal connection mode (configuration) as indicated in the table below.

CKLNOH	THRMO	Description
1	0	Detects an overheat alarm with a DI signal via the PMC. (Configuration 1)
1	1	Detects an overheat alarm via the α*i*CZ detection circuit or linear motor or synchronous built-in servo motor position detection circuit. (Configuration 2)
		Detects an overheat alarm via the temperature detection circuit. (Configuration 3)(*1)

(*1) Before an overheat alarm can be detected via the temperature detection circuit (configuration 3), the temperature detection circuit must be set (with a parameter such as No. 2278). (See Subsection 2.1.8.)

NOTE

If bits 3, 7 of No. 2300 are set to 1, 1 (to enable overheat alarm detection with the built-in temperature detection circuit) when an αiCZ sensor of old type (A860-2142-Txxx) not supporting the temperature detection circuit is used, an illegal parameter setting alarm (detail number 3002) is issued.

⚠ CAUTION

1 This function bit is automatically set during automatic loading of the standard parameters. However, if the setting differs from the configuration, set it manually.
2 In the CNC that cannot use interface G326 of the PMC, if this function bit is set to 1, a servo alarm SV0430 (motor overheat) is issued. If this occurs, set the function bit to 0.

(4) Signals (only in configuration 1)

When using configuration 1, connect the overheat signal from the motor to the following G signal with ladder circuitry:

Overheat state signals via the PMC: SVDI61 to SVDI68<Gn326>

	#7	#6	#5	#4	#3	#2	#1	#0
Gn326	SVDI68	SVDI67	SVDI66	SVDI65	SVDI64	SVDI63	SVDI62	SVDI61

[Classification] Input signal

[Function] Thermostat signals are input via the PMC. An independent signal is provided for each axis, and the last digit of each name indicates the number of a controlled axis.

[Status] 0: A signal for issuing an overheat alarm or detecting an overheat is not connected.
1: No overheat alarm is issued.

(5) Connection and usage

<1> Parameter setting
Set parameter No. 2300 according the overheat signal connection mode.
By default, bit 7 (CKLNOH) of No.2300=1 and bit 3 (THRMO) of No.2300=0 are set for a linear motor and synchronous built-in servo motor (to obtain the overheat signal via the PMC). If the setting of a parameter does not match the actual overheat signal connection, the motor overheat alarm SV0430 is issued.

<2> Overheat signal connection
Connect the overheat signal to a proper point according to each configuration. When configuration 1 (connection via the PMC) is used, a ladder program for connecting the overheat signal (external signal) to the G signal needs to be created. (No ladder program is needed for configuration 2 and configuration 3.)

<3> Checking of an overheat alarm on the diagnosis screen
An overheat alarm via the pulse coder can be distinguished from an overheat alarm via the PMC DI signal based on diagnosis data

[Alarm detail indication on the diagnosis screen]

Alarm	Bit (OVL) of diagnosis No.200	Bit 7(ALD) of diagnosis No.201	Bit 4(EXP) of diagnosis No.201
Overheat alarm via Pulsecoder	1	1	0
Overheat alarm via PMC DI signal	1	1	1

4 αiS/αiF/βiS/βiF/LiS/DiS SERIES PARAMETER ADJUSTMENT

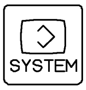
This chapter describes parameter tuning for the FANUC AC SERVO MOTOR αiS, αiF, βiS, βiF, LiS, and DiS series. A servo tuning tool, SERVO GUIDE, is available which lets you perform parameter tuning smoothly. See Chapter 7 for the summary of SERVO GUIDE.

Chapter 4, "αiS/αiF/βiS/βiF/LiS/DiS SERIES PARAMETER ADJUSTMENT", consists of the following sections:

4.1 SERVO TUNING SCREEN AND DIAGNOSIS INFORMATION

4.1.1 Servo Tuning Screen

Display the servo tuning screen, and check the position error, actual current, and actual speed on the screen.
Using the keys on the CNC, enter values according to the procedure explained below.



→ [SYSTEM] → [▷] → [SV-PRM] → [SV-TUN]

If the servo setting/tuning screen does not appear, set the following parameter, then switch the CNC off and on again.

	#7	#6	#5	#4	#3	#2	#1	#0
3111								SVS

SVS (#0) 1: Displays the servo setting/tuning screen.

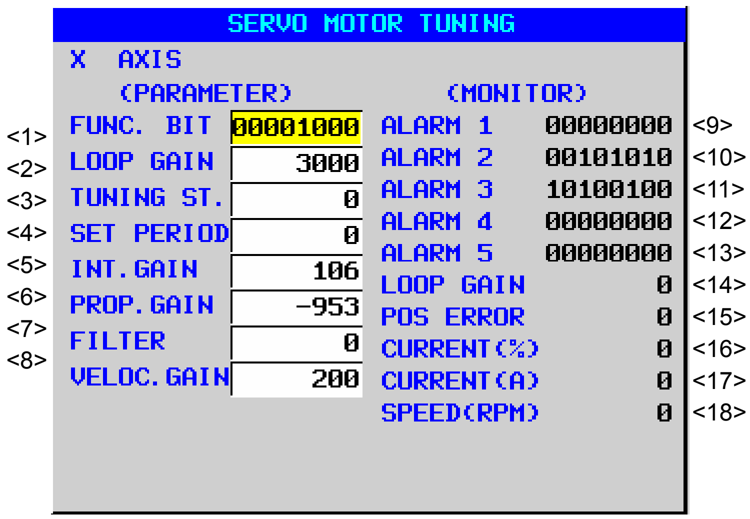
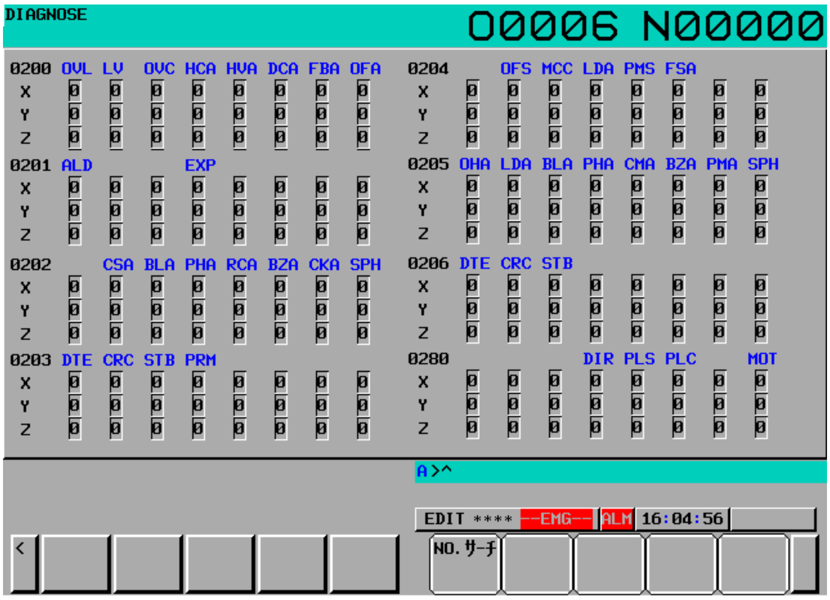


Fig. 4.1.1 (a) Tuning screen

<9> <10> <11> <12>



<13> <19> <20>

Fig. 4.1.1 (b) Diagnosis screen

The items on the servo tuning screen correspond to the following parameter numbers:

Table 4.1.1 Correspondence between the servo tuning screen and diagnosis screen, and parameters

Item	Description
<1> Function bit <2> Loop gain	No. 2003 No. 1825
<3> Tuning start bit <4> Setting period	Not used at present Not used at present
<5> Velocity loop integral gain <6> Velocity loop proportional gain <7> TCMD filter	No. 2043 No. 2044 No. 2067
<8> Velocity loop gain	Related to No. 2021 The relationship with the load inertia ratio (LDINT= No.2021) is as follows: Velocity gain = (1 + LDINT/256) $\times$ 100 [%]
<9> Alarm 1 diagnosis <10> Alarm 2 <11> Alarm 3 <12> Alarm 4 <13> Alarm 5 <19> Alarm 6 <20> Alarm 7	Diagnosis No. 200 Diagnosis No. 201 Diagnosis No. 202 Diagnosis No. 203 Diagnosis No. 204 Diagnosis No. 205 Diagnosis No. 206
<14> Loop gain or actual loop gain	The actual servo loop gain is displayed.
<15> Position error diagnosis	Diagnosis No. 300 Position error = (feedrate) [mm/min] / (least input increment $\times$ 60 $\times$ loop gain $\times$ 0.01) [mm]
<16> Actual current [%] <17> Actual current [Ap] <18> Actual speed [min^{-1}] or [mm/min]	Indicates the percentage [%] of the current value to the continuous rated current. Indicates the current value (peak value). Indicates the actual speed or feedrate.

4.1.2 Diagnosis Information List

The table below provides a list of servo-related data items displayed on the diagnosis screen.

Table 4.1.2 (a) Diagnosis number list

Diagnosis No. (DGN)	Unit of data	Data description	Remarks
200	-	Alarm 1	→ See Section 4.2
201	-	Alarm 2	→ See Section 4.2
202	-	Alarm 3	→ See Section 4.2
203	-	Alarm 4	→ See Section 4.2
204	-	Alarm 5	→ See Section 4.2
205	-	Alarm 7	→ See Section 4.2
206	-	Alarm 1	→ See Section 4.2
280	-	Invalid parameter details (CNC)	→ See Subsection 2.1.9
300	Detection unit	Positional deviation	
308	°C	Servo motor temperature	(Note 1)
309	°C	Pulse coder temperature	
350	-	Servo state flag 1	(Note 2)
351	-	Servo state flag 2	(Note 3)
352	-	Invalid parameter details (SV)	→ See Subsection 2.1.9
353	-	Adjustment data #1	
354	-	Adjustment data #2 Acceleration data	→ See Subsection 4.1.4
355	Number of times	Separately installed in serial Communication alarm neglect counter	
356	Number of times	Built-in pulse coder Feedback extrapolation counter	
357	Number of times	Separately installed in serial Feedback extrapolation counter	
358	-	V-READY OFF information	
359	Number of times	Built-in pulse coder Communication alarm neglect counter	
360	Detection unit	Command pulse accumulation (NC)	
361	Detection unit	Compensation pulse (NC)	
362	Detection unit	Command pulse accumulation (SV)	
363	Detection unit	Feedback accumulation (SV)	
550	Detection unit	Dual position Error on the full-closed side	
551	Detection unit	Dual position Error on the semi-closed side	
552	Detection unit	Dual position Error on the semi-/full-closed side	
553	Detection unit	Dual position Compensation value	
700	-	Servo state flag 3	(Note 4)
750	%	OVC data	Alarm with 100%
752	V	Voltage information	(Note 5)
760	I_{max}[Ap]/6554	R phase current value	I_{max}=Maximum amplifier current
761	I_{max}[Ap]/8027	Effective current value	I_{max}=Maximum amplifier current
762	360[deg]/256	Excitation phase data	

Note 1:

When a linear motor or synchronous built-in servo motor is used and temperature information (thermistor signal) is connected to a temperature detection circuit, αiCZ detection circuit, linear motor position detection circuit, or synchronous built-in servo motor position detection circuit, the temperature of the motor can be displayed on diagnosis No. 308.

⇒ See the following subsection or section:
2.1.8 Setting Parameters When an Acceleration Sensor or Temperature Detection Circuit Is Used
3.3 Detection of an Overheat Alarm by Servo Software when a Linear Motor and a Synchronous Built-in Servo Motor are Used

Note 2:

Diagnosis No. 350 displays the following state signals:

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.350		ALMTMP	ALMACC	A_PHAL	PM1CHK	PM1TMP	PM1ACC	PM1POS

PM1POS(#0) 1: A position detector is connected to the first SDU unit.
PM1ACC(#1) 1: An acceleration sensor is connected to the first SDU unit.
PM1TMP(#2) 1: A temperature detection circuit is connected to the first SDU unit.
PM1CHK(#3) 1: A servo check interface unit is connected to the first SDU unit.
A_PHAL(#4) 1: An error has occurred in the EEPROM of the αi pulse coder. (This is not an alarm.)
ALMACC(#5) 1: An alarm is issued from an acceleration sensor.
ALMTMP(#6) 1: An alarm is issued from a temperature detection circuit.

Note 3:

Diagnosis No. 351 displays the following state signals:

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.351					PM2CHK	PM2TMP	PM2ACC	PM2POS

PM2POS(#0) 1: A position detector is connected to the second SDU unit.
PM2ACC(#1) 1: An acceleration sensor is connected to the second SDU unit.
PM2TMP(#2) 1: A temperature detection circuit is connected to the second SDU unit.
PM2CHK(#3) 1: A servo check interface unit is connected to the second SDU unit.

Note 4:

Diagnosis No. 700 displays the following state signals:

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis No.700	L2048	O2048	1VPP	FSFMB	PSFMB	DCLNK	HRV3OK	HRV3ON

HRV3ON(#0) 1: The high-speed HRV current control mode is ON (HRV3, HRV4).
HRV3OK(#1) 1: The configured hardware enables high-speed HRV current control and PDM to be used.
DCLNK(#2) 1: DC link voltage information can be used.
PSFMB(#3) 1: On the semi-closed side, a high resolution rotary scale (such as RCN727) is connected.
FSFMB(#4) 1: On the full-closed side, a high resolution rotary scale (such as RCN727) is connected.
1VPP(#5) 1: A detector is connected via an analog SDU unit.
O2048(#6) 1: The detector on the full-closed side enables 2048-magnification interpolation setting.
L2048(#7) 1: The detector on the semi-closed side enables 2048-magnification interpolation circuitry. (Linear motor)

Note 5:

To use diagnosis data about voltage information, the following software and hardware are required:

CNC software

Series 30*i*-A : Series G00C, G01C. G02C / 27 and subsequent editions
: Series G004, G014, G024 / 01 and subsequent editions
Series 31*i*-A5 : Series G12C, G13C / 27 and subsequent editions
: Series G124, G134 / 01 and subsequent editions
Series 31*i*-A : Series G103, G113 / 07 and subsequent editions
: Series G104, G114 / 01 and subsequent editions
Series 32*i*-A : Series G203 / 07 and subsequent editions
: Series G204 / 01 and subsequent editions
Series 0*i*-MD : Series D4F1 / 01 and subsequent editions
Series 0*i*-TD : Series D6F1 / 01 and subsequent editions
Series 0*i* Mate-MD: Series D5F1 / 01 and subsequent editions
Series 0*i* Mate-TD: Series D7F1 / 01 and subsequent editions

For the Series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support the use of diagnosis data about voltage information.

Servo software

: Series 90G0 / first edition and subsequent editions
: Series 90E1 / first edition and subsequent editions
: Series 90E0 / O(15) and subsequent editions
: Series 90D0 / O(15) and subsequent editions
: Series 90C5,C8 / first edition and subsequent editions
: Series 90E5,E8 / first edition and subsequent editions

α*i* PS (Power Supply)

: A06B-6140-Hxxx (200-V Power Supply for 30*i*-A)
: A06B-6150-Hxxx (400-V Power Supply for 30*i*-A)

All models of Power Supplies for the Series 30*i*-B support the use of diagnosis data about voltage information.

α*i* SV (Servo Amplifier)

: A06B-6117-Hxxx (200-V Servo Amplifier for 30*i*-A)
: A06B-6127-Hxxx (400-V Servo Amplifier for 30*i*-A)

All models of servo amplifiers for the Series 30*i*-B support the use of diagnosis data about voltage information.

β*i* SV (Servo Amplifier)

: A06B-6130-Hxxx
: A06B-6131-Hxxx
: A06B-6160-Hxxx
: A06B-6161-Hxxx
: A06B-6166-Hxxx

All models of servo amplifiers for the Series 30*i*-B support the use of diagnosis data about voltage information.

β*i* SVSP

: A06B-6164-Hxxx#H580
: A06B-6165-Hxxx#H560
: A06B-6167-Hxxx#H560

All models of servo amplifiers for the Series 30*i*-B support the use of diagnosis data about voltage information.

Note 6:

For the Series 30i-B and Power Motion i-A, the unit of data and valid data range of the voltage information displayed for diagnosis No. 752 are changed.

Diagnosis No.	Description	Value displayed for the FS30*i*-A and 0i-D	Value displayed for the FS30*i*-B	Remarks
No.752	DC link voltage information	Unit of data: Vrms Valid data range: 0 to 452 (200-V amplifier) 0 to 905 (400-V amplifier)	Unit of data: V Valid data range: 0 to 1023	(*1)

(*1) For example, when the power supply voltage is 200 Vrms, the value displayed on the diagnosis screen changes from 200 (FS30*i*-A and 0*i*-D) to 283 (FS30*i*-B).

4.1.3 Actual Current Peak Hold Display

(1) Overview

The servo tuning screen displays an actual current value (Ap) and a ratio (%) to the rated current value. However, if current abruptly changes during acceleration, for example, its value cannot be checked. By setting the parameter indicated below, a peak current value is displayed for about 3 seconds, so that a maximum current value during acceleration can be read.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

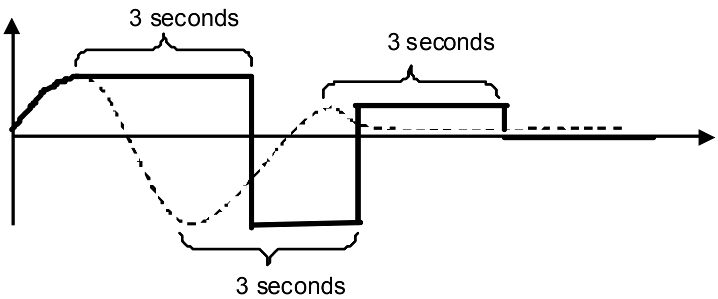
	#7	#6	#5	#4	#3	#2	#1	#0
2201		CPEEKH						

PK2VDN (#6) 0: A current value is displayed as usually done.
1: The display of a peak current value is held.

NOTE

When reading an actual current by using an application that uses SERVO GUIDE or the FOCAS library or an application that uses the PMC window, note that this function displays a waveform different from an actual momentary current waveform.

Actual momentary current: Dashed line
Observed current: Solid line



4.1.4 Acceleration Monitor Function

(1) Overview

Width the acceleration monitor function, acceleration feedback can be observed on diagnosis screen No. 354.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	P(16) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

By setting bit 0 of No. 2290 to 1 after setting an acceleration sensor (Subsection 2.1.8), acceleration feedback can be displayed on diagnosis screen No. 354.
By setting bit 1 of No. 2290 to 1, a peak acceleration rate can be held (for 1 second). By setting bit 2 of No. 2290 to 1, the remaining acceleration data after a stop can be observed.

	#7	#6	#5	#4	#3	#2	#1	#0
2290						ACCMON	ACCHLD	ACCOUT

ACCOUT(#0) To the diagnosis screen (No. 354), acceleration data output is:
0: Not performed.
1: Performed.

ACCHLD(#1) A peak acceleration rate is:
0: Not held.
1: Held (for 1 second).

ACCMON(#2) 0: Acceleration data is output at all times.
1: The remaining acceleration data after a stop is output. (The acceleration data is cleared to 0 during movement and for 16 ms after a stop.)

Diagnosis No.354	Acceleration feedback

[Display unit] mm/s^2

4.2 ACTIONS FOR ALARMS

If a servo alarm is issued, the related alarm number is displayed on the CNC alarm screen. Based on this information, check the cause of the servo alarm and take appropriate action.

(1) Alarms related to the amplifier and motor

Number	Message	Description
SV0010	SV OVERHEAT	Amplifier internal overheat → See Supplementary 1.

Number	Message	Description
SV0011	SV MOTOR OVER CURRENT(SOFT)	The digital servo software detected an abnormal specified value. Possible causes include an unconnected power cable, cable disconnection (open phase), and short-circuit. → See Supplementary 2.
SV0012	SV DRIVE OFF CIRCUIT FAILURE	The two drive off inputs are not in the same status or a drive off circuit error occurred. → See Supplementary 2.
SV0013	SV CPU BUS FAILURE	An error was found in CPU bus data in the amplifier. → See Supplementary 2.
SV0014	SV CPU WATCH DOG	An error occurred in CPU operation in the amplifier. → See Supplementary 2.
SV0015	SV LOW VOLT DRIVER	The driver power supply voltage has dropped in the amplifier. → See Supplementary 2. Possible causes include improper insertion of the control PC board and amplifier failure.
SV0016	SV CURRENT DETECT ERROR	An error was found in motor current detection data in the amplifier. Possible causes include improper insertion of the control PC board and amplifier failure. → See Supplementary 2.
SV0017	SV INTERNAL SERIAL BUS FAILURE	An error occurred in serial bus communication in the amplifier. Possible causes include improper insertion of the control PC board and amplifier failure. → See Supplementary 2.
SV0018	SV ROM DATA FAILURE	An error was found in ROM data in the amplifier. → See Supplementary 2.
SV0019	SV MOTOR OVER CURRENT (GND FAULT)	A ground fault occurred in the motor, power cable, or amplifier. → See Supplementary 2.
SV0020	PS GROUND FAULT	A ground fault occurred in the motor, power cable, or amplifier. → See Supplementary 2.
SV0021	PS OVERCURRENT 2	Overcurrent flowed in the input circuit. → See Supplementary 2.
SV0022	PS OVERCURRENT 3	Overcurrent flowed in the input circuit. → See Supplementary 2.
SV0023	PS OVERCURRENT 4	Overcurrent flowed in the input circuit. → See Supplementary 2.
SV0024	PS SOFT THERMAL	A load higher than the rating was applied. → See Supplementary 2.
SV0025	PS OVER VOLT. DC LINK 2	Overvoltage of the DC link section → See Supplementary 2.
SV0026	PS OVER VOLT. DC LINK 3	Overvoltage of the DC link section → See Supplementary 2.
SV0027	PS OVER VOLT. DC LINK 4	Overvoltage of the DC link section → See Supplementary 2.
SV0028	PC LOW VOLT. DC LINK 2	The DC link voltage has dropped. → See Supplementary 2.
SV0029	PC LOW VOLT. DC LINK 3	The DC link voltage has dropped. → See Supplementary 2.
SV0030	PC LOW VOLT. DC LINK 4	The DC link voltage has dropped. → See Supplementary 2.
SV0031	PS ILLEAGAL PARAMETER	An invalid value is set for a PS control parameter. For details, refer to the relevant servo amplifier descriptions such as B-65412EN.
SV0032	PS CONTROL AXIS ERROR 1	An invalid value is set for parameter No. 2557. Set parameter APS (No.11549#0) to 1 and execute automatic setting.
SV0033	PS CONTROL AXIS ERROR 2	An invalid value is set for parameter No. 2557. Set parameter APS (No.11549#0) to 1 and execute automatic setting.

Number	Message	Description
SV0034	PS HARDWARE ERROR	A PS hardware error was detected. → See Supplementary 2.
SV0035	SV NO FAILURE	No failure occurs in the servo amplifier. → See Supplementary 2.
SV0036	PHASE OPEN	A power line or the like has an open phase. → See Supplementary 2.
SV0037	FAILURE OF SV (OPEN)	An open failure occurred in the output of the servo amplifier. → See Supplementary 2.
SV0038	SV FAILURE OF CURRENT CTL.	A failure occurred in the current detection circuit in the servo amplifier. → See Supplementary 2.
SV0039	FAILURE OF SV (SHORT)	A short-circuit occurred in the output of the servo amplifier. → See Supplementary 2.
SV0040	PS SUB MODULE ERROR 1	Failure of PS SUB MODULE, PS or cable. Replace PS SUB MODULE, PS or cable. → See Supplementary 2.
SV0041	PS SUB MODULE ERROR 2	Failure of PS SUB MODULE, PS or cable. Replace PS SUB MODULE, PS or cable. → See Supplementary 2.
SV0042	PS SUB MODULE ERROR 3	Failure of PS SUB MODULE, PS or cable. Replace PS SUB MODULE, PS or cable. → See Supplementary 2.
SV0043	PS SUB MODULE ERROR 4	Failure of PS SUB MODULE, PS or cable. Replace PS SUB MODULE, PS or cable. → See Supplementary 2.
SV0044	MISMATCHED FUNCTION CODE	CNC, SV, SP or PS software has been update. Turn the power off, then restart.
SV0430	SV MOTOR OVERHEAT	Overheat → See Supplementary 1.
SV0431	PS OVERLOAD	Overheat → See Supplementary 2.
SV0432	PS LOW VOLT. CONTROL	The control power supply voltage has dropped. → See Supplementary 2.
SV0433	PS LOW VOLT. DC LINK	Low DC link voltage → See Supplementary 2.
SV0434	SV LOW VOLT CONTROL	The control power supply voltage has dropped. → See Supplementary 2.
SV0435	SV LOT VOLT. DC LINK	Low DC link voltage → See Supplementary 2.
SV0436	SOFTTHERMAL(OVC)	The digital servo software detected a software thermal (OVC). → See Supplementary 3.
SV0437	PS OVERCURRENT	Overcurrent on input circuit section. → See Supplementary 2.
SV0438	SV ABNORMAL CURRENT	Motor overcurrent → See Supplementary 4.
SV0439	PS OVER VOTL. DC LINK	The DC link voltage is too high. → See Supplementary 2.
SV0440	PS EXCESS-REGENERATION2	Excessive generative discharge → See Supplementary 2.
SV0442	PS PRE-CHARGE FAILURE	The spare charge circuit for the DC link is abnormal. → See Supplementary 2.
SV0443	PS INTERNAL FAN FAILURE	Internal cooling fan failure. → See Supplementary 2.
SV0444	SV INTERNAL FAN FAILURE	Internal cooling fan failure. → See Supplementary 2.

Number	Message	Description
SV0449	SV IPM ALARM	The IPM (Intelligent Power Module) detected an alarm. → See Supplementary 2.
SV0600	SV DC LINK OVER CURRENT	DC link overcurrent. → See Supplementary 2.
SV0601	SV EXTERNAL FAN FAILURE	Radiator cooling fan failure. → See Supplementary 2.
SV0602	SV RADIATOR OVERHEAT	Overheat → See Supplementary 2.
SV0603	INV. IPM ALARM(OH)	The IPM (Intelligent Power Module) detected an overheat alarm. → See Supplementary 2.
SV0604	AMP COMMUNICATION ERROR	The communication between Servo Amplifier (SV) and Common Power Supply (PS) is in error. → See Supplementary 2.
SV0605	PS EXCESS-REGENERATION1	The motor regenerative power is too much. → See Supplementary 2.
SV0606	PS EXTERNAL FAN FAILURE	External radiator cooling fan failure. → See Supplementary 2.
SV0607	PS IMPROPER INPUT POWER	An abnormality was found with the input power supply. → See Supplementary 2.
SV0654	DB RELAY FAILURE	A failure occurs in the dynamic brake relay of the servo amplifier. Replace the amplifier. → See Supplementary 2.

Action 1: Overheat alarms

If an overheat alarm occurs after long-time continuous operation, the alarm can be determined to have been caused by a temperature rise in the motor or amplifier. Stop operation for a while. If the alarm still occurs after the power is kept off for about 10 minutes, the hardware may be defective.
If the alarm occurs intermittently, increase the time constant, or increase the programmed stop time period to suppress temperature rise.
Motor and Pulsecoder temperature information is displayed on the diagnosis screen.

	Diagnosis No.
Motor temperature (°C)	No.308
Pulsecoder temperature (°C)	No.309

Action 2: Hardware alarms

For action to be taken, refer to manuals including the maintenance manual of the relevant servo amplifier.
Maintenance manual of α*i* series: B-65285EN
Maintenance manual of β*i* series: B-65325EN

Action 3: OVC alarms

When an OVC alarm occurs, check that standard values are set for the following parameters. When the parameters are correct, take action to ease the operating condition, including increasing the time constant or programmed stop time period.

Parameter No.	Details
2062	Overload protection coefficient (POVC1)
2063	Overload protection coefficient (POVC2)
2065	Soft thermal coefficient (POVCLMT)
2161	OVC magnification at a stop (OVCSTP)
2162	Overload protection coefficient 2 (POVC21)
2163	Overload protection coefficient 2 (POVC22)
2164	Soft thermal coefficient 2 (POVCLMT2)

FOVC data is displayed on the diagnosis screen. (An OVC alarm occurs when OVC data is set to 100%.)

	Diagnosis No.
OVC data (%)	No.750

Action 4: Overcurrent alarms

This type of alarm is issued when an extremely large current flows through the main circuit.

When an overcurrent alarm is always issued after emergency stop is released or at the time of moderate acc./dec., the cause of the alarm is determined to be an amplifier failure, cable connection error, line disconnection, or a parameter setting error. First, check that standard values are set for the following servo parameters. If these parameter settings are correct, check the amplifier and cable status by referring to the maintenance manual on the servo amplifier.

Parameter No.	Details
2004	HRV setting
2040	Current loop gain (PK1)
2041	Current loop gain (PK2)
2013#1-4	-
2014#1-4	-

If an overcurrent alarm is issued only when an strong acc./dec. is performed, the operating conditions may be too abrupt. Increase the acc./dec. time constant, and see whether the alarm is issued.

⚠ **CAUTION**

1 If an overcurrent alarm is detected, and the LED indication in the amplifier remains set to "–", the overcurrent alarm may have been detected by the servo software. The cause may be one of the following:
  - The contact of the power line is poor, or the power line is disconnected or broken.
  - The AMR conversion coefficient or AMR offset is not set correctly.

2 If the emergency stop state is released without connecting the motor power line in a test such as a test for machine start-up, an overcurrent alarm (software) may be issued. In such a case, the alarm can be avoided temporarily by setting the bit parameter indicated below to 1. However, be sure to return the bit parameter to 0 before starting normal operation after the completion of the test. To ignore the overcurrent alarm (software), set the bit 0 of No2207.

(2) Alarms related to the Pulsecoder and separate serial Pulsecoder

Number	Message	Description
SV0360	ABNORMAL CHECKSUM(INT)	The checksum alarm occurred on the built–in Pulsecoder. →See Supplementary 1.
SV0361	ABNORMAL PHASE DATA(INT)	The phase data abnormal alarm occurred on the built–in Pulsecoder.
SV0362	ABNORMAL REV. DATA(INT)	The revolution count error alarm occurred on the built-in Pulsecoder.
SV0363	ABNORMAL CLOCK(INT)	The clock alarm occurred on the built–in Pulsecoder.
SV0364	SOFT PHASE ALARM(INT)	A digital servo soft detected an abnormality on the built in Pulsecoder. →See Supplementary 2.
SV0365	BROKEN LED(INT)	An LED in the built-in Pulsecoder is abnormal.
SV0366	PULSE MISS(INT)	A pulse error occurred on the built–in Pulsecoder. →See Supplementary 2.
SV0367	COUNT MISS(INT)	A count error occurred on the built–in Pulsecoder. →See Supplementary 2.

Number	Message	Description
SV0368	SERIAL DATA ERROR(INT)	The communications data could not be received from the built–in Pulsecoder. →See Supplementary 3.
SV0369	DATA TRANS. ERROR(INT)	A CRC error or stop bit error occurred in the communications data from the built–in Pulsecoder. →See Supplementary 3.
SV0380	BROKEN LED(EXT)	Separate detector error
SV0381	ABNORMAL PHASE (EXT)	An abnormal alarm in the position data occurred on the separate detector.
SV0382	COUNT MISS(EXT)	A count error occurred on the separate detector. →See Supplementary 2.
SV0383	PULSE MISS(EXT)	A pulse error occurred on the separate detector. →See Supplementary 2.
SV0384	SOFT PHASE ALARM(EXT)	The digital servo software detected abnormal data on the separate detector. →See Supplementary 2.
SV0385	SERIAL DATA ERROR(EXT)	The communications data could not be received from the separate detector. →See Supplementary 3.
SV0386	DATA TRANS. ERROR(EXT)	A CRC error or stop bit error occurred in the communications data from the standalone detector. →See Supplementary 3.
SV0387	ABNORMAL ENCODER(EXT)	An abnormality occurred on a separate detector. For details, contact the manufacturer of the detector.
SV0445	SOFT DISCONNECT ALARM	The digital servo software detected a disconnected Pulsecoder. →See Supplementary 4.
SV0447	HARD DISCONNECT(EXT)	The hardware detected a disconnected separate detector. This alarm may be issued when a separate phase A/B scale is used. Check whether the phase A/B detector is connected properly.
SV0453	SPC SOFT DISCONNECT ALARM	Software disconnection alarm of the α Pulsecoder. Turn off the power to the CNC, then remove and insert the Pulsecoder cable. If this alarm is issued again, replace the Pulsecoder. →See Supplementary 5.
DS0306	APC ALARM: BATTERY VOLTAGE 0	The battery voltage of the absolute position detector has dropped to a level at which data can no longer be held. Or, the power was supplied to the Pulsecoder for the first time. The battery or cable is thought to be defective. Replace the battery with the machine turned on. →See Supplementary 6.
DS0307	APC ALARM: BATTERY LOW 1	The battery voltage of the absolute position detector has dropped to a level at which a replacement is required. Replace the battery with the machine turned on. →See Supplementary 6.
DS0308	APC ALARM: BATTERY LOW2	The battery voltage of the absolute position detector dropped to a level at which a replacement was required in the past. (including during power off) Replace the battery with the machine turned on. →See Supplementary 6.

⚠ CAUTION

For alarms with no action number indicated, the detector may be defective. Replace the detector.

Supplementary 1: Alarm that may occur due to a failure in the Pulsecoder or separate serial detector

The Pulsecoder or separate serial detector may be defective. Replace the detector.

Supplementary 2: Alarms that may occur due to noise

When an alarm occurs intermittently or occurs after emergency stop is released, there is a high possibility that the alarm is caused by noise. Take thorough noise-preventive measures. If the alarm still occurs continuously after the measures are taken, replace the detector.

Supplementary 3: Alarms that may occur due to a serial communication failure

Serial communication is not performed correctly. Check whether cable connection is correct and whether there is a line disconnection. This alarm may also be caused by noise. Take noise-preventive measures. If the alarm always occurs after power is turned on, the Pulsecoder, the control board of the amplifier, or the separate detector interface unit may be defective.

Supplementary 4: Alarm that may occur due to software disconnection

This alarm occurs when the change in the position feedback pulses obtained from the separate detector is relatively small for the change in velocity feedback pulses obtained from the built-in Pulsecoder. This alarm does not occur in a semi-closed system configuration. If this alarm occurs, check whether the separate detector outputs position feedback pulses correctly. When the detector outputs pulses correctly, only the motor rotates in the reverse direction at the start of machine operation because there is a large backlash between the motor position and scale position. In this case, you can increase the alarm level to a value equivalent to the backlash to avoid this alarm during normal operation.

Checking position feedback pulses

<1> Set the types of data on the channel setting screen of SERVO GUIDE.
CH1: ABS (Integral value of position feedback of the detector built into the motor)
CH2: POSF (Integral value of position feedback of the separate detector)

<2> In the Operation and Display dialog box, specify Synchro in Operation, CH1 in Input 1, and CH2 in Input 2.

<3> Acquire data and display the difference between the semi-closed and full-closed modes (Input 2 - Input 1) in the graph window.

<4> Check the graph data.

- If the difference between the semi-closed and full-closed modes becomes larger during reverse rotation, perform servo adjustment to decrease the difference. Alternatively, set a value a little larger than the difference between the semi-closed and full-closed modes for parameter No. 2064 to avoid the alarm.
- If the difference is too large not during reverse rotation, check whether the parameters for the separate detector are set properly.

Related parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2003							**TGAL**	

TGAL(#1) 1: The level for detecting the software disconnection alarm is set by parameter.
When bit 1 of parameter No. 2003 is set to 0, the alarm is detected by 1/32rev.
When bit 1 of parameter No. 2003 is set to 1, the alarm is detected by value set for parameter No. 2064/32 rev.

2064	**Software disconnection alarm level**

Standard setting 4: Alarm occurs when motor turns 1/8 of a turn.
Increase this value.

Supplementary 5: Software disconnection alarm of the α Pulsecoder

This alarm occurs when the absolute position data sent from the built-in Pulsecoder cannot be synchronized with the phase data. Remove the Pulsecoder cable with the NC power switched off and wait for about 10 minutes, then connect the cable again. If this alarm occurs again, replace the Pulsecoder.
When an absolute type linear encoder is used with a linear motor or when a synchronous built-in servo motor is used, this alarm must be ignored because the detector does not have phase data. Set the following bit.

	#7	#6	#5	#4	#3	#2	#1	#0
2013	APTG							

APTG(#7) 1: Ignores α Pulsecoder software disconnection.

Supplementary 6: Battery-related alarms

Check the connection and voltage of the battery. If the voltage drops, replace the battery. After absolute position detection is enabled, when the power to the CNC is turned on for the first time, the alarm may occur. In this case, turn the power to the CNC off then on again.

(3) Illegal servo parameter setting alarm

Number	Message	Description
SV0417	ILL DGTL SERVO PARAMETER	A digital serve parameter setting is incorrect. Investigate the cause of the alarm according to the instructions described in Subsection 2.1.9, "Actions for Illegal Servo Parameter Setting Alarms."

(4) Other alarms

Number	Message	Description
SV0407	EXCESS ERROR	The difference value of the amount of positional deviation for the synchronization axis exceeded the setting value (No.8314). (during synchronization control only)
SV0409	DETECT ABNORMAL TORQUE	An abnormal load was detected on the servo motor, or during Cs axis or spindle positioning. The alarm can be canceled by RESET. This alarm occurs when a load exceeding the alarm level is detected. The alarm may also occur when the estimated disturbance is not adjusted properly. In this case, adjust the estimated disturbance again according to the instructions described in Section 5.9, "UNEXPECTED DISTURBANCE TORQUE DETECTION FUNCTION".
SV0410	EXCESS ERROR (STOP)	The amount of positional deviation during stopping exceeded the parameter No. 1829 setting value. Check the following points: Check whether the motor is not locked and whether the detector is connected properly. If this alarm occurs during a gradual stop, the time constant may be too small or gain adjustments may be made insufficiently. * Setting a large value for parameter No. 1829 may damage the machine. Carefully set the value.

Number	Message	Description
SV0411	EXCESS ERROR (MOVING)	The amount of positional deviation during moving exceeded the parameter No. 1828 setting value. Check the following points: • Whether the motor is not locked. • The detector is connected properly. • The time constant and parameter No. 1828 value are not too small. • Gain adjustments are made thoroughly. * Setting a large value for parameter No. 1828 may damage the machine. Carefully set the value.
SV0413	LSI OVERFLOW	The specified feedrate exceeded the limit. (See Appendix D). Decrease the feedrate.
SV0415	MOTION VALUE OVERFLOW	The specified feedrate exceeded the limit. (See Appendix D). Decrease the feedrate.
SV0420	SYNC TORQUE EXCESS	In feed axis synchronization control, for synchronization, the difference value of torque between a master and slave axes exceeded the parameter No. 2031 setting value. This alarm occurs for a master axis.
SV0421	EXCESS ERROR(SEMI-FULL)	The difference in feedback between the built-in Pulsecoder and separate detector exceeded the value set for parameter No. 2118. See Subsection 2.1.11.1, “Function for monitoring the difference in error between the semi-closed and full-closed modes”.
SV0422	EXCESS VELOCITY IN TORQUE	In torque control, the commanded permissible velocity was exceeded.
SV0423	EXCESS ERROR IN TORQUE	In torque control, the total permissible move value specified as a parameter was exceeded.
SV0441	ABNORMAL CURRENT OFFSET	The digital servo software detected an abnormality in the motor current detection circuit. The current offset (equivalent to the current value in the emergency stop state) of the current detector became abnormally large. If the alarm occurs again after the power is turned on and off, the current detector may be abnormal. Replace the amplifier.
SV0448	UNMATCHED FEEDBACK ALARM	The sign of the feedback signal from the standalone detector is opposite to that from the feedback signal from the built–on Pulsecoder. →See Supplementary 1.
SV0454	ILLEGAL ROTOR POS DETECT	The magnetic pole detection function terminated abnormally. The magnetic pole could not be detected because the motor did not run. See "(6) Action for trouble for pole position detection function" in Subsection 3.2.1.2, "Parameter setting procedure 2 (pole position detection)".
SV0456	LLEGAL CURRENT LOOP	An attempt was made to set the current loop that could not be set. See "Supplementary 2: Control cycle setting" in Subsection 2.1.9, "Actions for Illegal Servo Parameter Setting Alarms".
SV0458	CURRENT LOOP ERROR	The specified current loop differs from the actual current loop. See "Supplementary 2: Control cycle setting" in Subsection 2.1.9, "Actions for Illegal Servo Parameter Setting Alarms".
SV0459	HI HRV SETTING ERROR	For two axes whose servo axis numbers (parameter No. 1023) are consecutively even and odd numbers, HIGH SPEED HRV control is possible for one axis and impossible for the other. See "Supplementary 2: Control cycle setting" in Subsection 2.1.9, "Actions for Illegal Servo Parameter Setting Alarms".

Number	Message	Description
SV0465	READ ID DATA FAILED	A read of the ID information for the amplifier has failed at power-on. The FB cable may be connected to the JX5 pin incorrectly. Check the connection and turn the power off then on again. If this alarm still occurs after that, replace the amplifier.
SV0466	MOTOR/AMP. COMBINATION	The maximum current of an amplifier is different to that of a motor. Probable causes are: • The FSSB setting is incorrect. • Servo parameters have not been initialized. • The parameter No.2165 setting is incorrect
SV0468	HI HRV SETTING ERROR(AMP)	An attempt was made to set up HIGH SPEED HRV control for use when the controlled axis of an amplifier for which HIGH SPEED HRV control could not be used. See "Supplementary 2: Control cycle setting" in Subsection 2.1.9, "Actions for Illegal Servo Parameter Setting Alarms".
SV0646	ABNORMAL ANALOG SIGNAL(EXT)	An error occurred in the analog 1Vp-p output of the separate detector. The cable, separate detector, or separate detector interface unit may be failed.
SV0649	MOTOR OVER SPEED	The permissible motor speed was exceeded.
SV0652	TEMP. ERROR	Communication between the separate detector interface unit and temperature sensor was disconnected. The cable may be disconnected or the temperature sensor may be defective.
SV0653	EXCESS ERROR (SV)	The difference between the estimated position error and actual position error exceeded the value set for parameter No. 2460. See Subsection 2.1.11.2, "Detection of excessive error between the estimated position and actual position (dynamic error monitoring)".

Supplementary 1: Feedback mismatch

This alarm occurs when the move directions for the position detector and velocity detector are opposite to each other. Check the rotation direction of the separate detector. If the direction is opposite to the direction in which the motor turns, take the following action:

- Phase A/B detector: Switch A and XA connection. Alternatively, set the following parameter to 1 to reverse the signal direction for the separate detector.
- Serial detector: Set the following parameter to 1 to reverse the signal direction for the separate detector.

	#7	#6	#5	#4	#3	#2	#1	#0
2018								RVRSE

RVRSE(#0) The signal direction for the separate detector is:

0: Not reversed.

1: Reversed.

When there is a large torsion or backlash between the motor and separate detector, this alarm may occur when an abrupt acceleration/deceleration is performed. In this case, set the following parameter to 1 to change the detection level.

	#7	#6	#5	#4	#3	#2	#1	#0
2201							RNLV	

RNLV(#1) Change of the feedback mismatch alarm detection level

0: To be detected at 600 min^{-1} or more

1: To be detected at 1000 min^{-1} or more

4.3 ADJUSTING PARAMETERS FOR HIGH-SPEED AND HIGH-PRECISION MACHINING

4.3.1 Servo HRV Control Adjustment Procedure

(1) Overview

For higher positioning precision, higher precision in the machined surface and machining profile, shorter machining time, and other improvements in machine tools, the adjustments of the servo control system are required. This subsection explains the servo adjustment procedure using servo HRV control. Servo adjustments can also be made easily by using SERVO GUIDE, which is an integrated tuning tool for servo spindles.

(2) Outline of the adjustment procedure

Before servo control performance can be improved by servo adjustments, it is necessary to understand these procedures and make adjustments step by step accordingly. Servo control is implemented by the structure shown in the block diagram below.
In the block diagram in Fig. 4.3.1 (a), servo HRV current control, which is located closest to the motor, drives the motor according to the command output by velocity control. The performance of this servo HRV current control supports the performance of velocity control. Velocity control controls the motor speed according to the velocity command output by position control. To attain the final target, which is to improve the capability to follow up position commands, a higher position gain must be set. This requires the improvement of velocity control performance. Hence, this requires the improvement of servo HRV current control performance. Therefore, in servo adjustments for improving the performance of servo control, the highest priority is given to the improvement of servo HRV current control, the next highest priority is given to the improvement of velocity control, then the third priority is given to the improvement of position control. Be sure to follow this order.

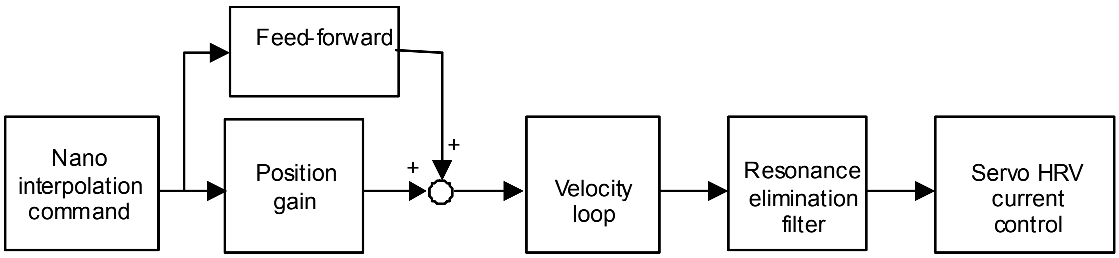
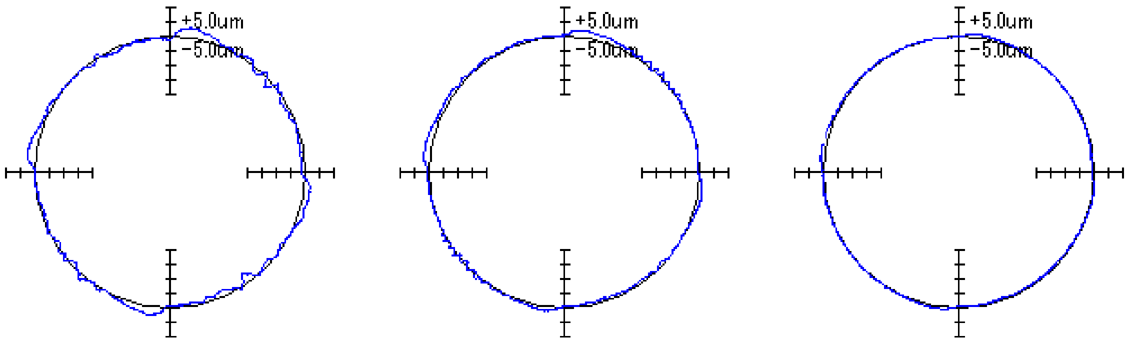


Fig. 4.3.1 (a) Block diagram of a servo control system

The adjustment of servo HRV current control improves the response speed of the current loop, therefore, higher gains can be set for the velocity loop and position loop. Gains increased for each control loop leads not only to the improvement of the command follow-up performance and disturbance suppression performance, but only to the simplification in servo function adjustments such as quadrant protrusion compensation. As a result, servo adjustments can be made more easily.

Fig. 4.3.1 (b) below shows the results of a gain adjustment for each current control cycle with servo HRV control. The figure indicates that the improvement of the response of the current control loop improves the response of velocity control and position control, and therefore quadrant protrusions can be reduced without the backlash acceleration function (described below).



(i) Servo HRV2 control (ii) Servo HRV3 control (iii) Servo HRV4 control

Fig. 4.3.1 (b) Results of a velocity gain adjustment with each servo HRV control type (arc radius: 10 mm, F4000 mm/min, without using the backlash acceleration function)

This manual explains the servo adjustment procedure in the following order:

1 Initialization of parameters related to high-speed and high-precision machining
Before starting the servo adjustment for high-speed and high-precision machining, set minimum required parameters.
2 Servo HRV control setting
Select suitable servo HRV control from servo HRV2, HRV3, and HRV4.
3 Adjustment of high-speed velocity control
Adjust the velocity loop gain and filter by using SERVO GUIDE.
4 Adjustment of acc./dec. in rapid traverse
Adjust the time constant for rapid traverse. In position gain setting made in the next step, the limit is confirmed by checking stability during rapid traverse.
5 Position gain adjustment
Adjust the position gain while observing the TCMD and motor speed in rapid traverse and cutting feed.
6 Adjustment by using an arc
Adjust the feed-forward and backlash acceleration function while measuring an arc figure.
7 Adjustment by using a square figure
Adjust the reduced feedrate and the acceleration for deceleration at a corner while measuring the corner figure.
8 Adjustment by using a square with rounded corners
Adjust the velocity in the arc parts while measuring the contour error in the arc parts.

(3) Details of the adjustment procedure

(3)-1 Initialization of parameters related to high-speed and high-precision machining

Table 4.3.1 (a) lists the parameter values to be set first before servo adjustments are made. Sufficient performance can be obtained just by setting these values. Furthermore, by separately adjusting the settings indicated by gray shading, much higher speed and higher precision can be obtained.

Table 4.3.1 (a) Fundamental parameters

Parameter No.	Standard setting value	Description
2004	0X000011 (Note 1)	Enables HRV2 control
2040	Standard parameter (Note 1)	Current integral gain
2041	Standard parameter (Note 1)	Current proportional gain
2003 #3	1	Enables velocity loop PI function
2017 #7	1 (Note 2)	Enables velocity loop high cycle management function
2006 #4	1	Enables 1-ms velocity feedback acquisition

Parameter No.	Standard setting value	Description
2016 #3	1	Enables variable proportional gain in the stop state
2119	2 (detection unit of 1 μm) 20 (detection unit of 0.1μm)	For variable proportional gain function in the stop state : judgment level for stop state (specified in detection units)
1825	5000	Servo loop gain (Position gain)
2021	128	Load Inertia ratio (Velocity Loop Gain) (Note 3)
2202 #1	1	Cutting/rapid traverse velocity loop gain variable
2107	150	Velocity loop gain override at cutting traverse

NOTE

1 Optimum parameters can be loaded automatically by setting a motor ID number for servo HRV2 control.

2 With some machines, a higher velocity loop gain can be set by using neither the acceleration feedback function nor auxiliary function rather than by using these functions. If it is impossible to set a high velocity loop gain when the velocity loop high cycle management function is used, try to use the acceleration feedback function (See Subsection 5.3.2), and use the function that allows a higher velocity loop gain to be set.

3 There is the following relationship between the load inertia ratio and velocity loop gain (%).
Velocity loop gain (%) = (1 + load inertia ratio / 256) × 100

Table 4.3.1 (b) Feed-forward

Parameter No.	Standard setting value	Description
2005 #1	1	Enables feed-forward
2092	10000	Advanced preview feed-forward coefficient
2069	50	Velocity feed-forward coefficient

Table 4.3.1 (c) Backlash acceleration

Parameter No.	Standard setting value	Description
1851	1 or more	Backlash compensation
2003 #5	1	Enables backlash acceleration
2006 #0	0/1	0 : Semi-close system 1 : Full-close system
2009 #7	1	Backlash acceleration stop
2009 #6	1	Backlash acceleration only at cutting feed (FF)
2223 #7	1	Backlash acceleration only at cutting feed (G01)
2015 #6	0	Two-stage backlash acceleration (Note 1)
2048	100	Backlash acceleration amount
2082	5 (detection unit of 1 μm) 50 (detection unit of 0.1μm)	Backlash acceleration stop timing
2071	20	Backlash acceleration time

NOTE

1 The above table lists the initial values set when the conventional backlash acceleration function is used. Set this parameter additionally if you want to use the two-stage backlash acceleration function or quadrant protrusion tuning with Tuning Navigator.

[Time Constant]
Set the initial value of the time constant of acc./dec. according to the high-speed and high-precision function of the CNC used.

Table 4.3.1 (d) AI contour control I, AI contour control II (30*i* Series, 0*i*-D Series), and AI advanced preview control (0*i*-D Series)

Parameter No.	Standard setting value	Description
1660	700	cc./dec. before interpolation: Acceleration (mm/s^2) → 0.07G
1772	64	Acc./dec. before interpolation: Bell-shaped time constant (ms)
1769	24	Time constant for acc./dec. after interpolation (ms)

(3)-2 Servo HRV control setting

(For 30*i* Series)

In standard setting, servo HRV2 control is set. However, to make high-speed and high-precision adjustments, servo HRV3 is recommended. If sufficient precision cannot be obtained with servo HRV3, consider using servo HRV4. (See Subsec. 5.1.3.)

(For 0*i* -D Series and Power Motion *i*-A)

In standard setting, servo HRV2 control is set. However, if sufficient precision cannot be obtained with servo HRV2, consider using servo HRV3. (See Subsec. 5.1.2.)

(a) Servo HRV2 control

By setting a motor ID number for servo HRV2 control, load the standard parameters.

(b) Servo HRV3 control

After setting servo HRV2 control, set the parameters as listed in Table 4.3.1 (e).

Table 4.3.1 (e) HRV3 parameters

Parameter No.	Recommended value	Description
2013#0	1	Enables HRV3 current control.
2202#1	1	Enables the cutting/rapid velocity loop gain switching function.
2283#0	1	Enables high-speed HRV current control in cutting feed (Note 1)
2334	150	Current gain magnification in HRV3 mode
2335	200	Velocity gain magnification in HRV3 mode

NOTE

1 When bit 0 of parameter No. 2283 is set to 1, no G code is needed. When bit 0 of parameter No. 2283 is set to 0, to use high-speed HRV current control, G codes need to be set. (High-speed HRV current control is enabled between G5.4Q1 and G5.4Q0.)

2 For other than Series 90D0, 90C5, and 90C8, when servo HRV3 control is used, the maximum number of axes per servo card decreases.

(c) Servo HRV4 control

After setting servo HRV2 control, set the parameters as listed in Table 4.3.1 (f).

Table 4.3.1 (f) HRV4 parameters

Parameter No. 30*i* Series	Recommended value	Description
2014#0	1	Enables HRV4 current control.
2300#0	1	Enables the extended HRV function.
2202#1	1	Enables the cutting/rapid velocity loop gain switching function.
2334	150	Current gain magnification in HRV3 mode
2335	200	Velocity gain magnification in HRV3 mode

NOTE

1. Servo HRV4 can be used with Series 90G0(30*i*-B Series) or Series 90D0 (30*i*-A Series).
2. Use of servo HRV4 decreases the maximum number of axes per servo card and limits the maximum torque of the servo motor to 70%. For details, see Subsection 5.1.3, "Servo HRVV4 Control".
3. To use high-speed HRV current control, G codes must be set. (High-speed HRV current control is enabled between G5.4Q1 and G5.4Q0.)

(3)-3 Adjustment of velocity control

After setting servo HRV control, adjust the velocity loop gain and the resonance elimination filter.

To obtain high servo performance, a high velocity loop gain must be set. Some machines, however, vibrate easily at a particular frequency, and setting a high velocity loop gain may cause vibration at that frequency (machine resonance). As a result, it becomes impossible to set a high velocity loop gain.

In such a case, the adjustment of the resonance elimination filter is effective. The resonance elimination filter can lower the gain only in an area around a particular frequency, therefore allowing a high velocity loop gain to be set without the occurrence of machine resonance. The velocity loop gain and the resonance elimination filter can be adjusted more easily by using “Tuning Navigator” of SERVO GUIDE.

(a) Adjusting the velocity loop gain and the resonance elimination filter (when Tuning Navigator is used)

For adjustment of the resonance elimination filter, Tuning Navigator of SERVO GUIDE can be used. On the main bar of SERVO GUIDE, click the [Navigator] button, as shown in Fig. 4.3.1 (c).

[Starting Tuning Navigator]

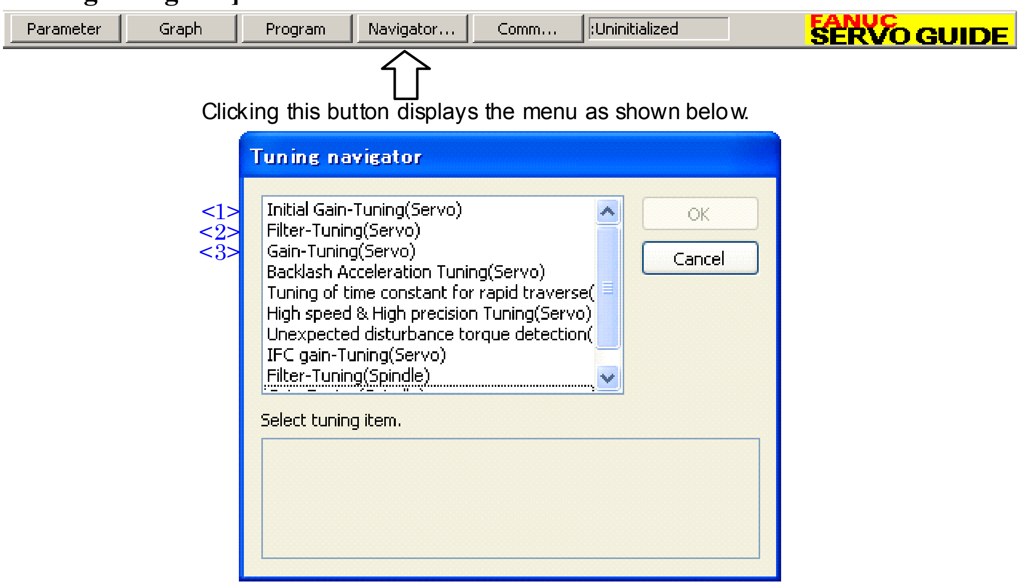


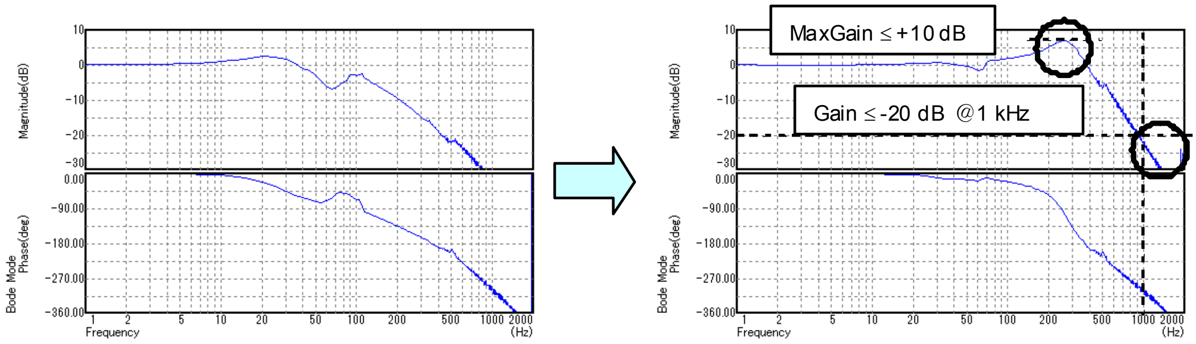
Fig. 4.3.1 (c) Starting Tuning Navigator of SERVO GUIDE

(Procedure for adjusting the velocity loop gain and the resonance elimination filter)

In the adjustment of the velocity loop gain and the resonance elimination filter, use <1> through <3> in the above figure. Make adjustments in order from <1>.

<1> Initial Gain Tuning

First, select Initial Gain Tuning from the dialog box of Tuning Navigator. Initial Gain Tuning determines the velocity loop gain value with a margin for the oscillation limit. By making this adjustment, a higher velocity gain than the initial value is set, so the frequency of machine resonance can be determined clearly (This gain is tentatively determined. The final velocity gain is determined in step <3>, "Gain Tuning".). Tuning Navigator shows a bode-plot as shown in Fig. 4.3.1 (d) and you can check the frequency characteristics of velocity loop. The upper line shows the gain characteristic and the lower line shows the phase characteristic.



(i) Before velocity gain tuning (ii) After velocity gain tuning

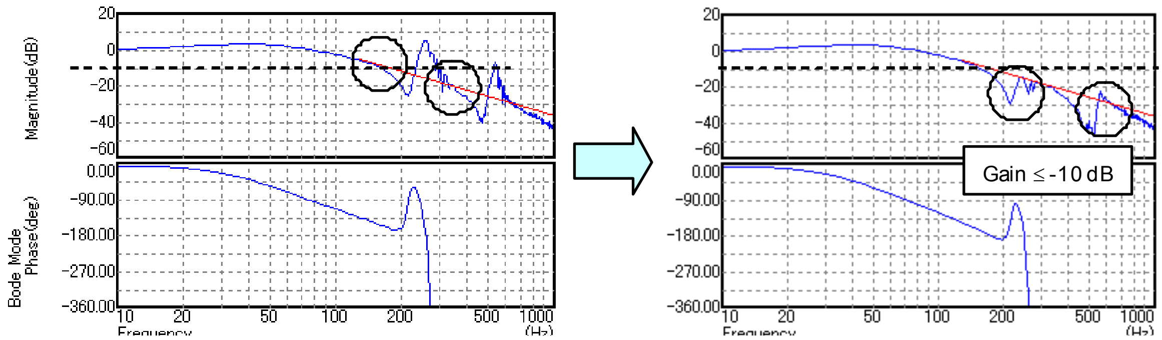
Fig. 4.3.1 (d) Change in frequency characteristics with velocity gain tuning

[Points to be checked for frequency characteristics (bode-plot, gain line in particular)] (For details, refer to books of the control theory.)

- Gain level of resonance frequency has to be suppressed at least under -10dB.
- The peak gain (maximum value) has to be lower than +10 dB.
- Gain level near 1000Hz has to be lower than -20dB.

<2> Filter Tuning

Next, select Filter Tuning from Tuning Navigator to adjust the resonance elimination filter to suppress machine resonance. Fig. 4.3.1 (e) shows an example of automatic filter tuning for a machine with two resonance frequencies (250 Hz and 530 Hz).



(i) Before filter tuning (ii) After filter tuning

Fig. 4.3.1 (e) Change in frequency characteristics with filter tuning

<3> Gain Tuning

By steps <1> and <2>, the influence of machine resonance can be eliminated, so a high velocity loop gain can be set. Finally, select "Gain Tuning". Tuning Navigator decides the final result of gain tuning. Automatic gain and filter tuning using Tuning Navigator is now completed.

(b) Adjusting the velocity loop gain and the resonance elimination filter (when Tuning Navigator is not used)

The following explains the procedure for adjusting the velocity loop gain and resonance elimination filter manually without using the automatic tuning functions of SERVO GUIDE.

A) Adjustment by torque command waveform

1. Perform rapid traverse with a full stroke of the machine, and observe the torque command when the machine is stopped and when the machine moves at high speed. To observe the high-frequency vibration component (high-frequency machine resonance) of TCMD precisely, the sampling cycle period should be 125 μs.

NOTE

When using the cutting/rapid velocity loop gain switching function, perform cutting feed at the maximum cutting feedrate to also check the oscillation limit for the velocity loop gain during cutting feed.

2. As the velocity loop gain is increased gradually, the following oscillation phenomena occur:
   - Vibration occurs in the torque command waveform.
   - Vibration sound is generated from the machine.
   - A large variation in positional deviation is observed when the machine movement stops.
3. Perform frequency analysis (Ctrl-F) for the torque command issued when the above phenomena occur, and measure the vibration frequency.
4. While referencing Table 4.3.1 (g) as a guideline, set a filter using the measured vibration frequency as the attenuation center frequency. For the parameter numbers, see Table 4.3.1 (h). Set the initial values of the center frequency, attenuation bandwidth, and damping. When SERVO GUIDE is available, the resonance elimination filter can be set from the parameter window as shown in Fig. 4.3.1 (f). (In this example, values are set for "HRV Filter 2" and "HRV Filter 3". You can also set values for "HRV Filter 1" and "HRV Filter 2" in order.)

Table 4.3.1 (g) Guideline for setting a resonance elimination filter

Resonance frequency	Attenuation bandwidth	Damping
Lower than 150 Hz	Decrease the velocity loop gain. (Note 1)	
150 to 200 Hz	Decrease the velocity loop gain. (Note 2)	
200 to 400 Hz	60 to 100 Hz	0 to 50 %
Higher than 400 Hz	100 to 200 Hz	0 to 10 %

NOTE

1 The disturbance elimination filter (see Subsection 5.4.4) may be effective.

2 When the resonance elimination filter is used, set a narrow attenuation bandwidth (about 50 Hz or less) and a large damping attenuation factor (about 50% to 80%).

Table 4.3.1 (h) Parameter numbers for setting resonance elimination filters

	Attenuation center frequency [Hz]	Attenuation bandwidth [Hz]	Damping [%]
Resonance elimination filter 2	No.2360	No.2361	No.2362
Resonance elimination filter 3	No.2363	No.2364	No.2365
Resonance elimination filter 4	No.2366	No.2367	No.2368
Resonance elimination filter 1	No.2113	No.2177	No.2359

NOTE

1 When the center frequency becomes 200 Hz or lower, almost the same effect as when the velocity loop gain is decreased is obtained. Since the resonance elimination filter also has the effect in the change of phase, decreasing the velocity loop gain is recommended.

2 The resonance elimination filter becomes more effective as damping becomes closer to 0%. Therefore, when adjusting damping, start with a large value and decrease it gradually.

[Starting the parameter window]

Clicking this button displays the parameter window.

[Parameter window main screen] **[Velocity control + filter]**

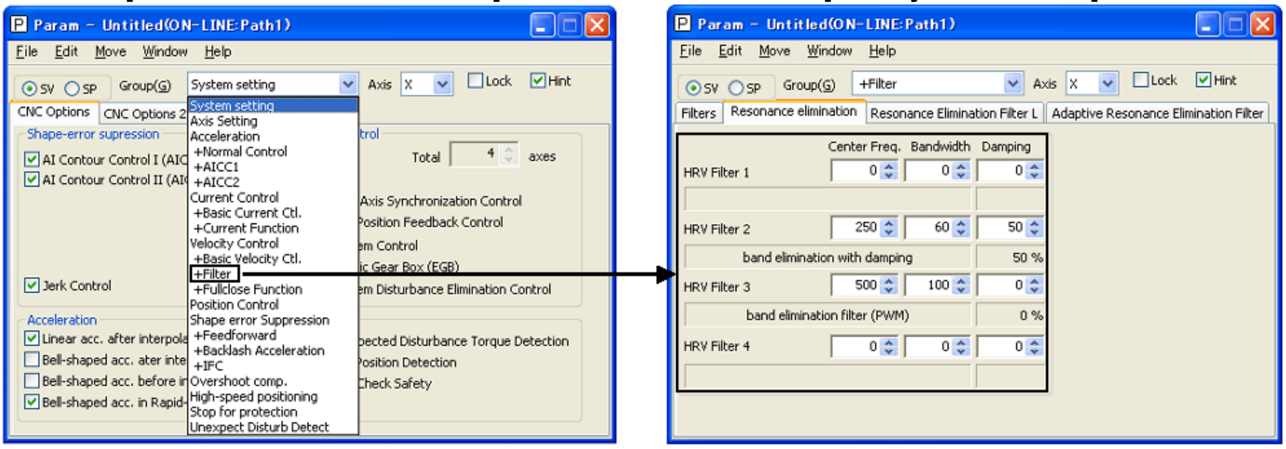


Fig. 4.3.1 (f) Resonance elimination filter setting screen of SERVO GUIDE

5. After setting the resonance elimination filter by specifying tentative initial values in step 4, measure the torque command again. If there is still vibration left at the same frequency as before the application of the filter, decrease the damping setting. If vibration occurs at a frequency other than the set frequency, it may be adversely influenced by the setting of the resonance elimination filter. So, try to increase the setting of damping to about 80% to reduce the influence of the resonance elimination filter on velocity control. If vibration is still observed, stop setting the resonance elimination filter and decrease the velocity loop gain.
6. After determining the attenuation bandwidth and damping, increase the velocity loop gain until vibration phenomena checked in step 2 occur. The final value of the velocity loop gain is 70% to 80% of the velocity loop gain (oscillation limit for the velocity loop gain) set when the vibration phenomena occur.

B) Adjustment using the frequency characteristics

The velocity loop gain can be adjusted also by increasing the velocity loop gain while measuring the frequency characteristics. As the velocity loop gain increases, the gain at a certain frequency swells in the frequency characteristics. The frequency corresponding to the swell is the resonance frequency. This method is to adjust the velocity loop gain by increasing it while the swell in gain is suppressed with the resonance elimination filter.

The velocity loop gain to be set is 70% to 80% of the velocity loop gain observed when the swell can no longer be suppressed by the resonance elimination filter (oscillation limit for the velocity loop gain). It is regarded as the final setting if there is no problem during rapid traverse and cutting feed at the maximum feedrate. If vibration occurs, decrease the velocity loop gain until the vibration stops.

(3)-4 Adjustment of acc./dec. in rapid traverse

The time constant of acc./dec. in rapid traverse is adjusted (Fig. 4.3.1(g)). Make adjustments in rapid traverse with the maximum load applied to the machine. Adjusting the time constant in rapid traverse can reduce the total machining time. No recommended value is specified for the time constant of acc./dec. in rapid traverse. It is important to make appropriate adjustments according to the characteristics of individual machines. While observing the torque command (TCMD) at the time of acc./dec. in rapid traverse to check that the TCMD does not reach the maximum current value, decrease the time constant of acc./dec. in rapid traverse.

[Parameter window main screen] **[Acc./dec. + normal control]**

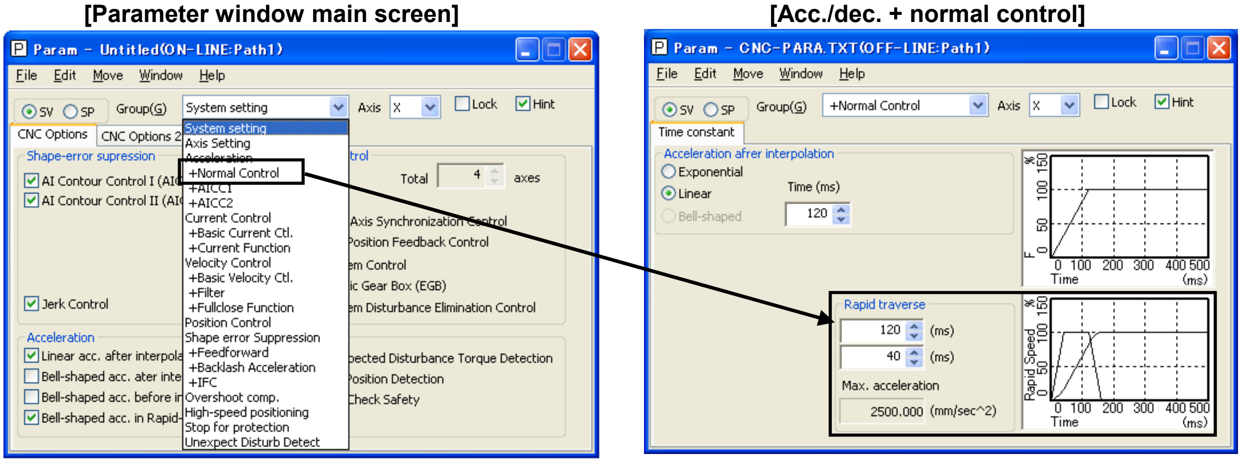
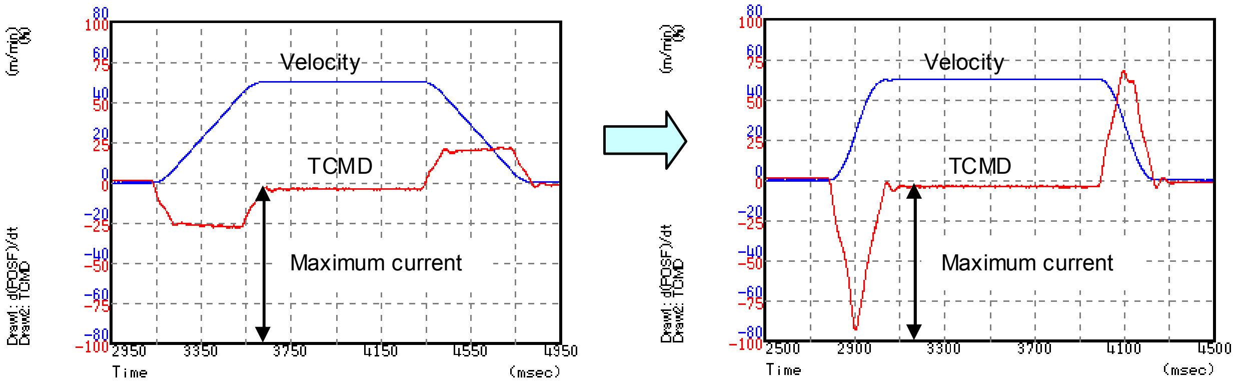


Fig. 4.3.1 (g) Setting screen for the time constant of acc./dec. in rapid traverse of SERVO GUIDE

Fig. 4.3.1 (h) below shows the results of adjustments of the time constant in rapid traverse.



(i) Before the adjustment of the time constant of acc./dec. in rapid traverse **(ii) After the adjustment of the time constant of acc./dec. in rapid traverse**

Fig. 4.3.1 (h) Measurement of acc./dec. in rapid traverse (checking that the torque command does not reach the maximum current value)

(3)-5 Adjustment of the position gain

Observe the velocity and torque command waveform at the time of acc./dec. during rapid traverse and cutting feed at the maximum cutting feedrate as shown in Fig. 4.3.1 (i). The standard setting of the position gain is from 5000 to 10000. When a low frequency vibration (hunting) of about 10 to 30 Hz occurs in the torque command waveform, the corresponding position gain is regarded as the oscillation limit. The position gain to be set is about 80% of the position gain of the oscillation limit.

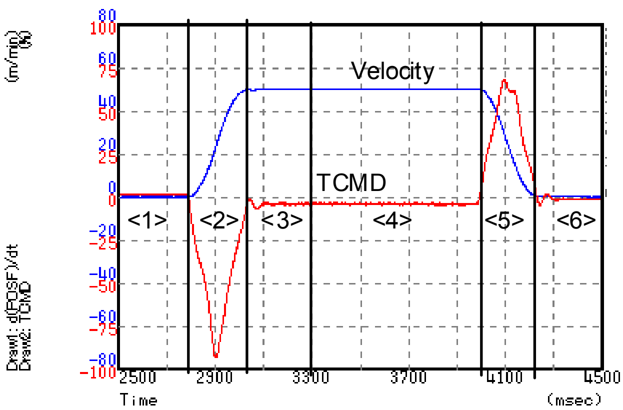


Fig. 4.3.1 (i) Measurement of acc./dec. during rapid traverse for adjustments of the position gain

(Points to be checked for time regions <1> to <6>)

- No vibration is allowed in the stopped state. (Region <1>)
- Neither vibration nor sound must be generated during acceleration and deceleration. If the TCMD level has reached the maximum value, increase rapid traverse acc./dec. time constant T1 (linear part of the time constant). (Regions <2> and <5>)
- Neither vibration nor excessive overshoot must be generated at the end of acceleration and deceleration. If the TCMD level has reached the maximum value, increase rapid traverse acc./dec. time constant T2 (exponent part of the time constant). (Regions <3> and <6>)
- There must be no large variation in feedrate during movement at a constant feedrate. (Region <4>)

> **NOTE**
> For axes for which interpolation is performed, set the same position gain.

[Parameter window main screen] **[Position control]**

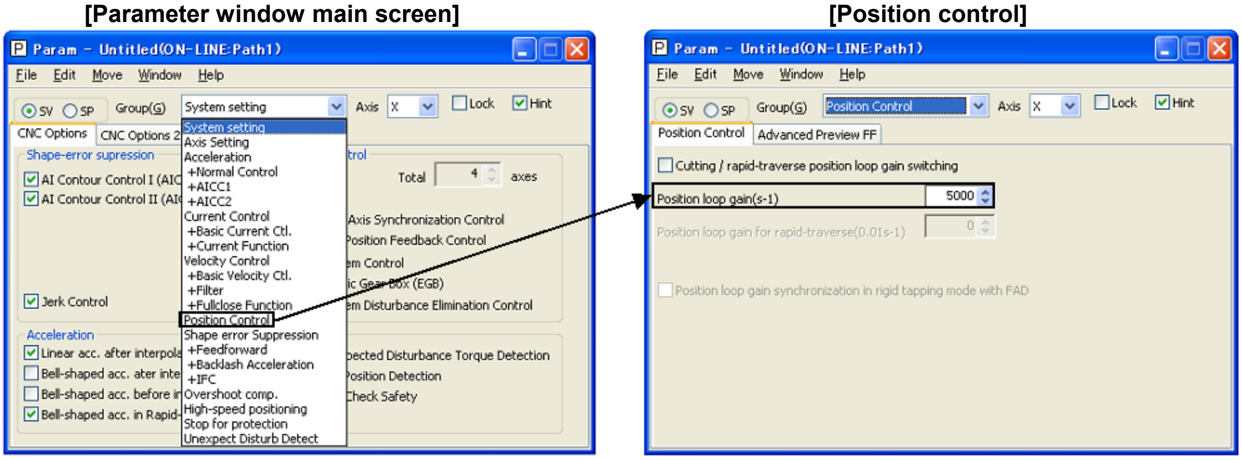


Fig. 4.3.1 (j) Position gain setting screen of SERVO GUIDE

(3)-6 Adjustment by using an arc (adjustment of the feed-forward coefficient and adjustment of the servo function)

(a) Feed-forward function

For higher precision with small servo follow-up delay, the feed-forward function shown in Fig. 4.3.1 (k) is used. When the feed-forward coefficient is set to 100%, the positional deviation can be almost eliminated.

(Feed-forward)
By adding to a velocity command value the velocity compensation value equivalent to the position command issued from the CNC, the contour error due to position loop response delay can be reduced.

(Velocity feed-forward)
The torque compensation amount equivalent to the amount of change in velocity command (acceleration) is added to a specified torque value so that the contour error due to velocity loop response delay can be reduced.

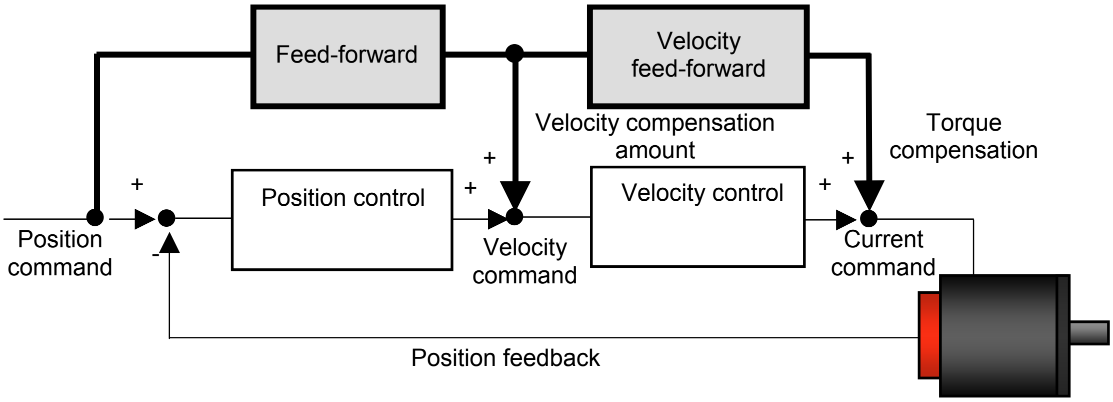
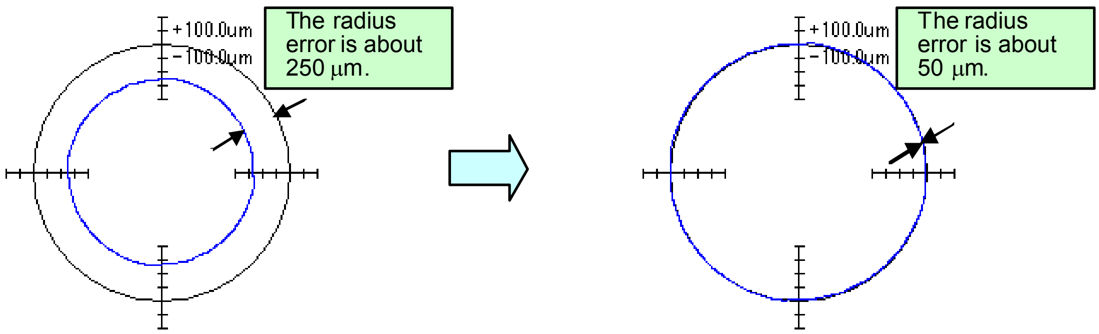


Fig. 4.3.1 (k) Feed-forward control in a servo control system

(b) Adjusting the feed-forward coefficient

Fig. 4.3.1 (ℓ) shows the effect of the feed-forward function. The figure indicates that an arc radius error of 250 μm, which was measured before the use of the feed-forward function, has been reduced to almost 0 after the use of the feed-forward function. The feed-forward coefficient can be adjusted using SERVO GUIDE as shown in Fig. 4.3.1 (m). Note that, however, setting the feed-forward coefficient to more than 10000 (100%) means that the actual machine position advances ahead of commands from the CNC. So, such setting is not permitted. While checking fluctuation of radius by using an arc with about R10/F4000 or R100/F10000 set, make an adjustment so that the actual path matches the commanded path. At this time set the velocity feed-forward coefficient to about 100 % (To fine-tune the amount of arc radius, also adjust the feed-forward timing parameter after adjusting the feed-forward coefficient. For details of the feed-forward function, see Subsection 5.5.3.).



(i) Feed-forward coefficient: 0% (ii) Feed-forward coefficient: 100%

Fig. 4.3.1 (l) Reduction of the contour error with the feed-forward function

[Parameter window main screen] [Contour error suppression + feed-forward]

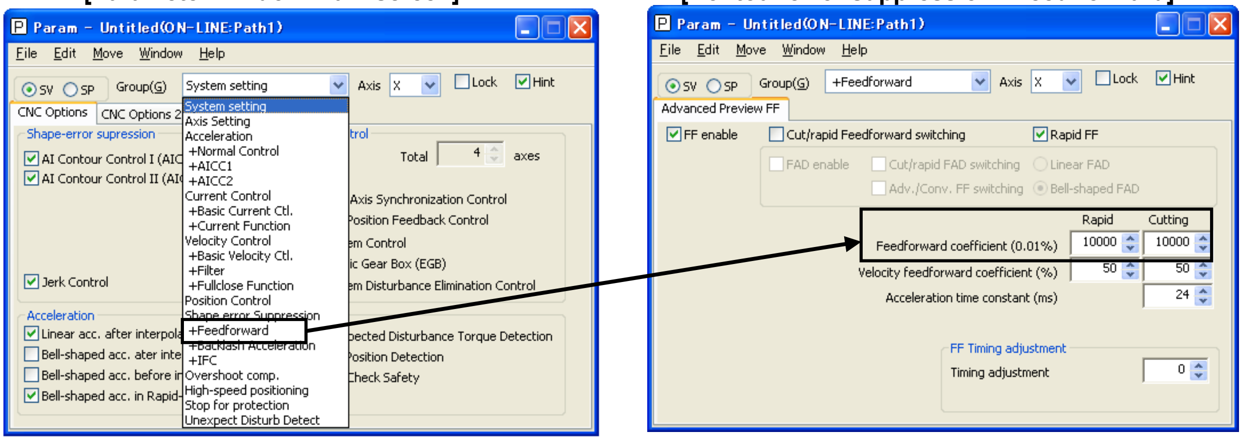
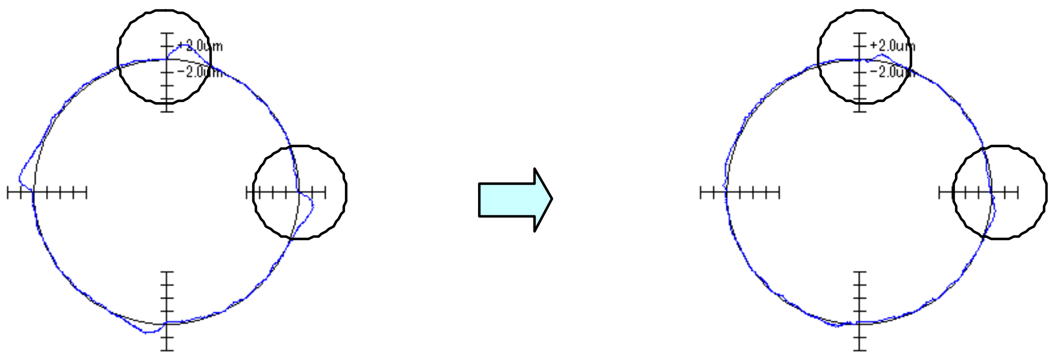


Fig. 4.3.1 (m) Feed-forward function setting screen of SERVO GUIDE

(c) Adjusting backlash acceleration

To reduce quadrant protrusions (errors generated where the axis move direction is reversed), the backlash acceleration function is used. Set the backlash acceleration to the recommended value listed in Table 4.3.1 (c) and change the acceleration in steps of about 10 to 20 while observing the quadrant protrusion size. End the adjustment immediately before undercut occurs. A large quadrant protrusion or undercut may adversely affect cutting results. So, adjust the backlash acceleration to make the quadrant protrusions as small as possible. (For details of the backlash acceleration function, see Subsection 5.5.4. When higher precision is required, use the two-stage backlash acceleration function described in Subsection 5.5.5, "Two-stage Backlash Acceleration Function".)



(i) Backlash acceleration function: Disabled (ii) Backlash acceleration function: Enabled

Fig. 4.3.1 (n) Reduction of the quadrant protrusions with backlash acceleration (when F4000 and R10 are set and the feed-forward function is enabled)

[Parameter window main screen] **[Contour error suppression + backlash acceleration]**

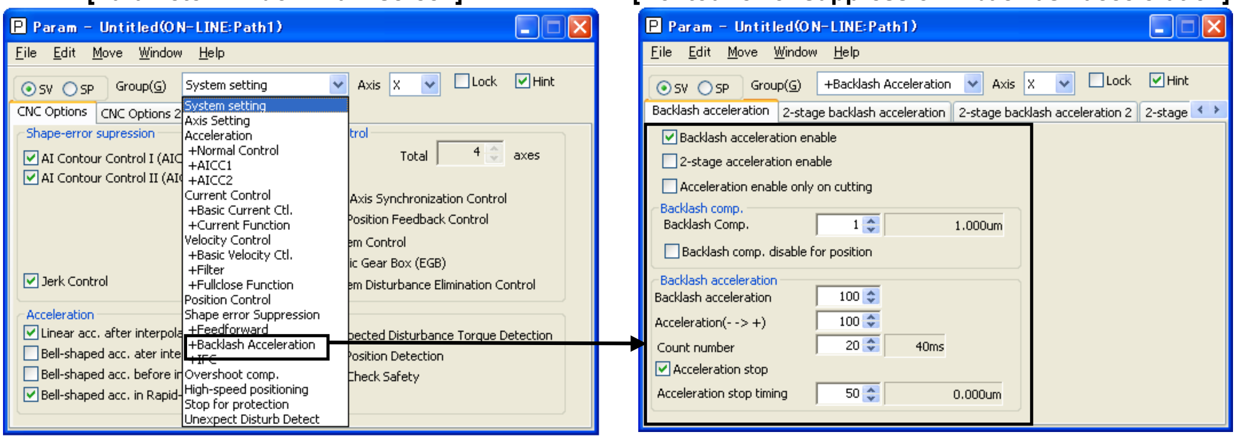


Fig. 4.3.1 (o) Backlash acceleration function setting screen of SERVO GUIDE

(9) Adjustment by using a square figure (adjustment of the high-speed and high-precision function and adjustment of the servo function)

(a) Setting the corner deceleration function

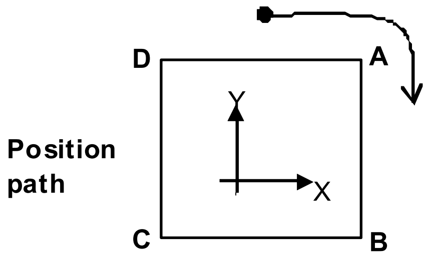


Fig. 4.3.1 (p) Square figure path

When the automatic corner deceleration function is used, an error (overshoot) at the corner (of a square figure) shown in Fig. 4.3.1 (p) can be reduced. Set the acceleration and time constant to the recommended values (Fig. 4.3.1 (q) corresponds to Tables 4.3.1 (d) and 4.3.1 (e)) and set the reduced corner feedrate to 400 mm/min (Fig. 4.3.1 (r)).

[Parameter window main screen] **[Acc./dec. + AI contour control I (when AI contour control I is used)]**

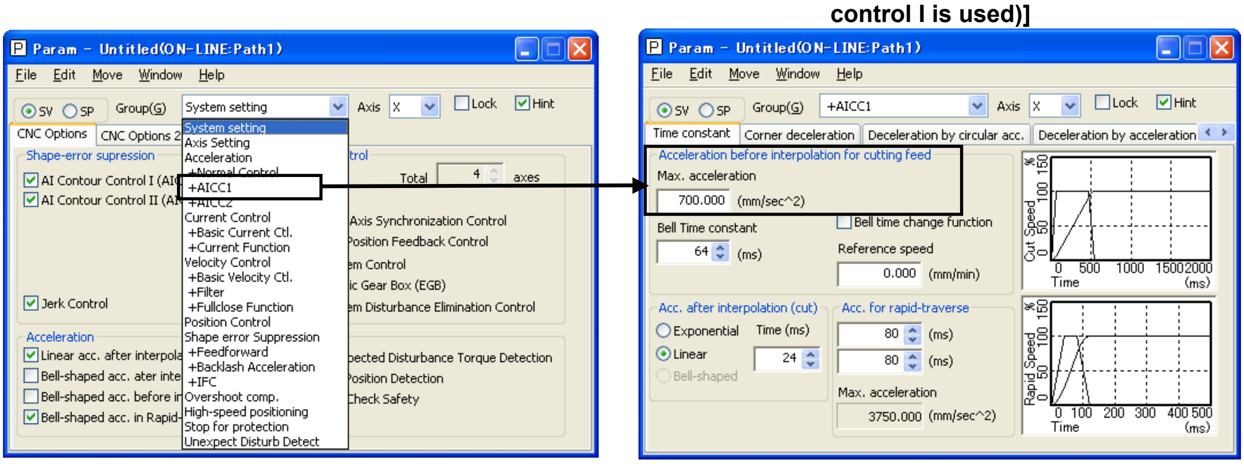


Fig. 4.3.1 (q) Setting screen for acc./dec. before interpolation in cutting feed of SERVO GUIDE

[Parameter window main screen] **[Acc./dec. + AI contour control I (when AI contour control I is used)]**

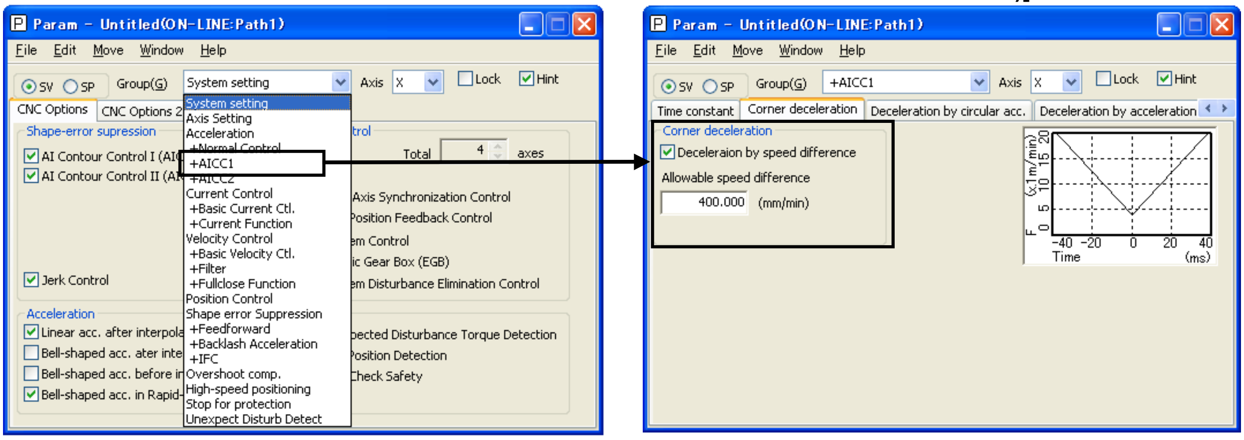
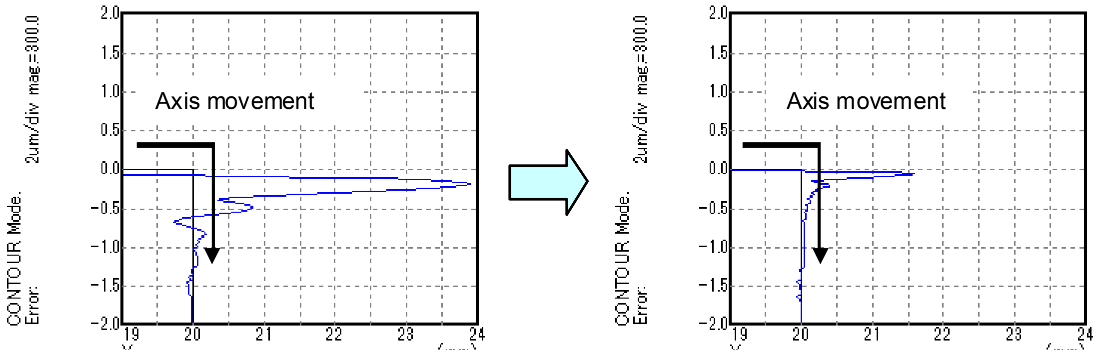


Fig. 4.3.1 (r) Automatic corner deceleration function of SERVO GUIDE

Fig. 4.3.1 (s) shows the effect of the corner deceleration function. Deceleration at a corner reduces the amount of the overshoot.

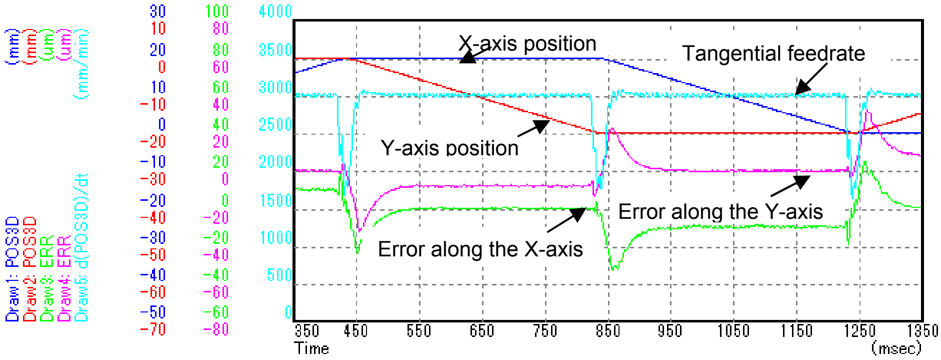


(i) Automatic corner deceleration function: Disabled (ii) Automatic corner deceleration function: Enabled

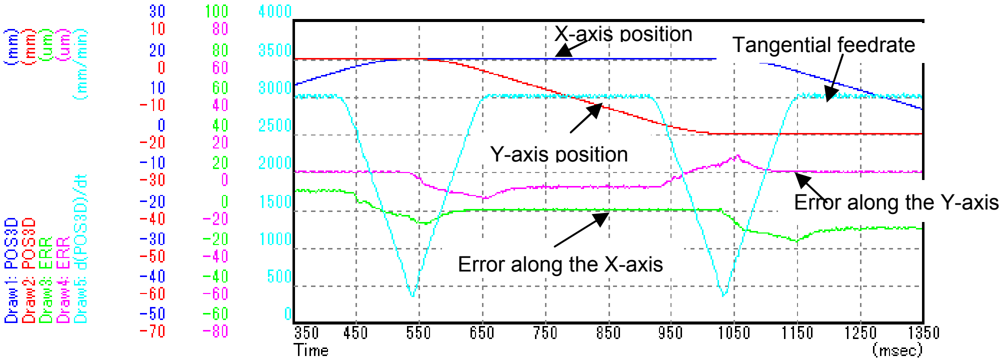
Fig. 4.3.1 (s) Reduction of overshoot with the automatic corner deceleration function

(b) Adjustment for smooth deceleration at a corner

In automatic corner deceleration, the feedrate at which the tool moves along a corner is reduced according to the permissible acceleration set for acc./dec. before interpolation. When the automatic corner deceleration function is used, the tangential feedrate at the corner changes in a sharp V-shaped manner as shown in Fig. 4.3.1 (t) (i). If deceleration at the corner can be made smoother, the contour error at the corner can be decreased. To make deceleration smoother, the following three adjustments are available: (1) decrease the permissible acceleration for acc./dec. before interpolation, (2) increase the time constant of acc./dec. before interpolation, and (3) decrease the permissible feedrate difference at the corner. As shown in Fig. 4.3.1 (t) (ii), reducing the acceleration reduces the shock on the machine, which decreases the contour error. Note that when the time constant is increased, the precision is improved, but the total machining time becomes longer.



(i) Before the adjustment of the acceleration, time constant, and feedrate difference (the tangential feedrate sharply changes to about F2000.)

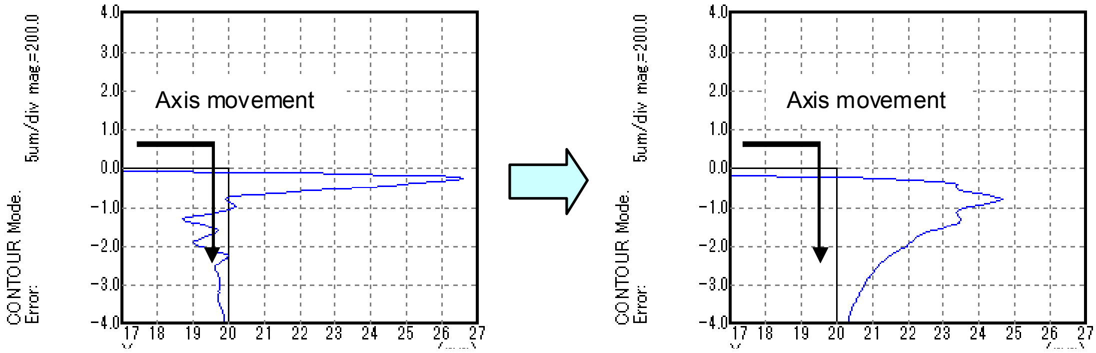


(ii) After the adjustment of the acceleration, time constant, and feedrate difference (the tangential feedrate smoothly changes up to F500.)

Fig. 4.3.1 (t) Reduction of the contour error by adjusting the deceleration at the corner

(c) Adjusting velocity feed-forward

The velocity feed-forward function has the effect of helping the torque command start earlier at the time of acc./dec. This effect is reflected in corner figures. So, adjust the velocity feed-forward coefficient so that corner figures can be improved. When the velocity feed-forward coefficient is too small, vibration occurs in the figure path. Adjusting the velocity feed-forward coefficient can suppress this vibration (Fig. 4.3.1 (u)).



(i) The velocity feed-forward coefficient is small. (ii) The velocity feed-forward coefficient is sufficiently large.

Fig. 4.3.1 (u) Improvement of the vibrating path by adjusting the velocity feed-forward coefficient

[Parameter window main screen] [Contour error suppression + feed-forward]

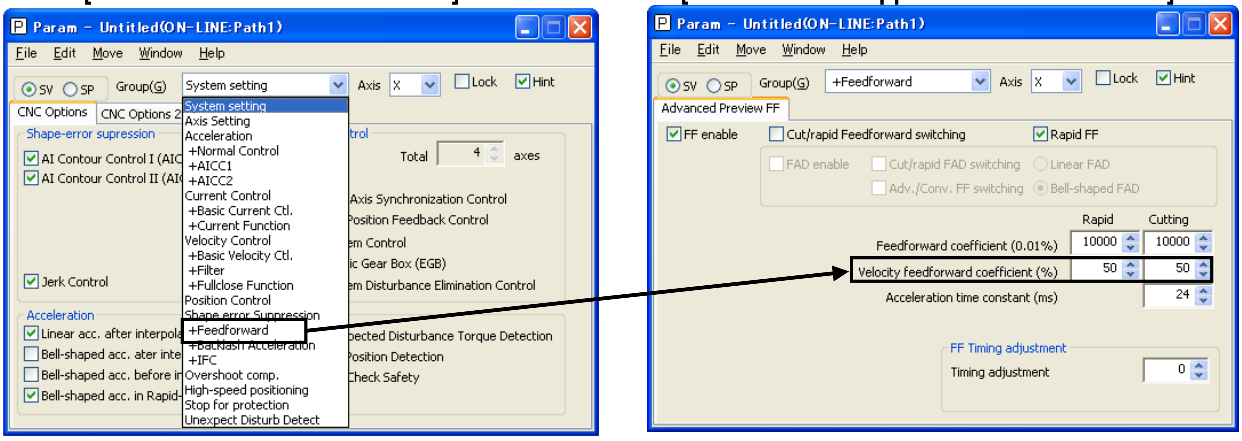


Fig. 4.3.1 (v) Velocity feed-forward function setting screen of SERVO GUIDE

(3)-8 Adjustment by using a square with rounded corners (adjustment of the high-speed and high-precision function and servo function)

When acceleration suddenly changes at an arc part of a square figure with rounded corners as shown in Fig. 4.3.1 (w), positional deviation occurs. To reduce this positional deviation, it is effective to limit the acceleration at the arc part. The acceleration of circular motion is given by (tangential-feedrate)^2/radius-of-circle. For example, when the arc radius is 5 mm and the feedrate in the linear part is F4000 mm/min, to decrease the feedrate in an arc part to F1000 mm/min, set the permissible acceleration to $(1000/60)^2/5 = 55.55$ mm/s^2. For AI contour control, enter this permissible acceleration value as shown in Fig. 4.3.1 (x).

Position path

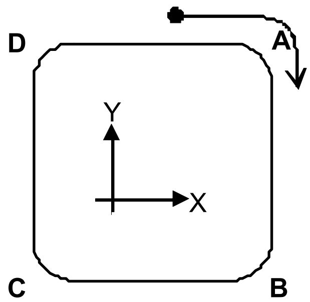


Fig. 4.3.1 (w) Path of a square figure with rounded corners

[Parameter window main screen] [Acc./dec. + AI contour control I (when AI contour control I is used)]

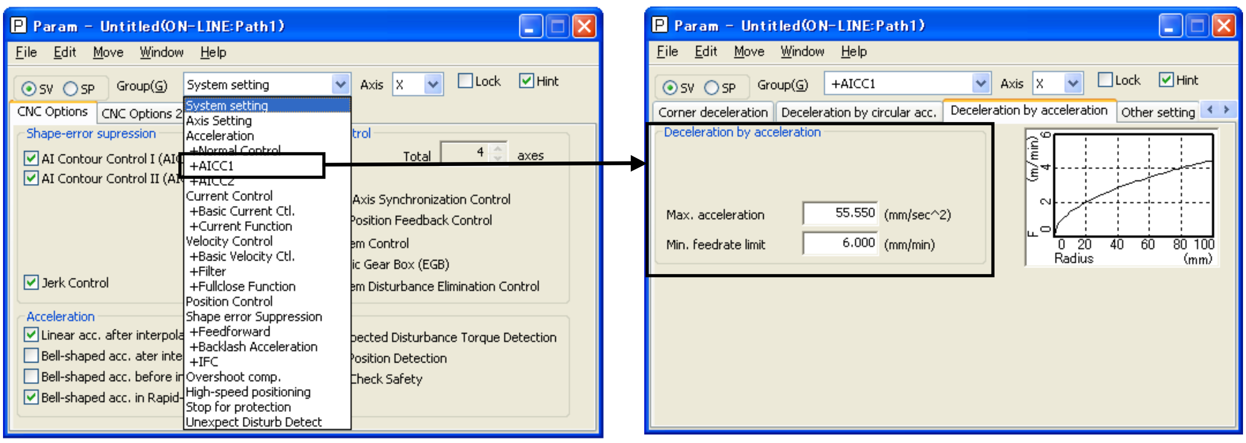
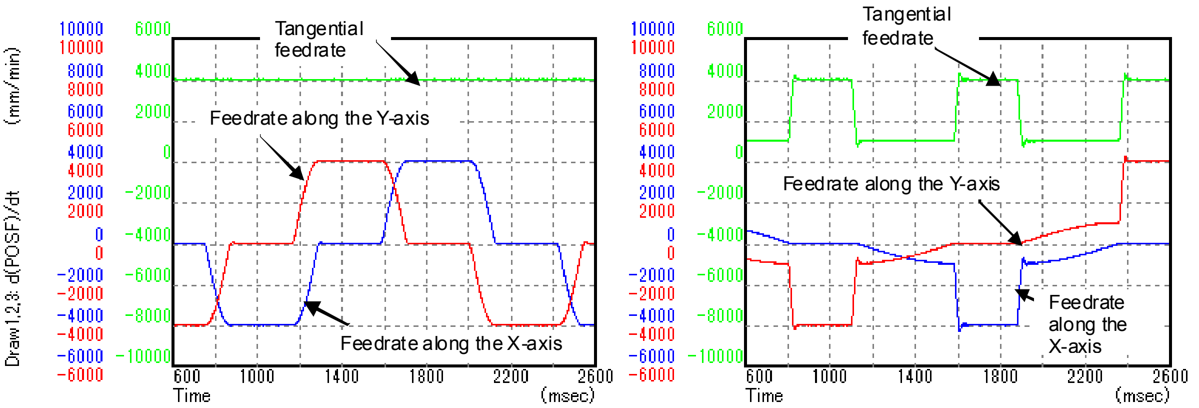


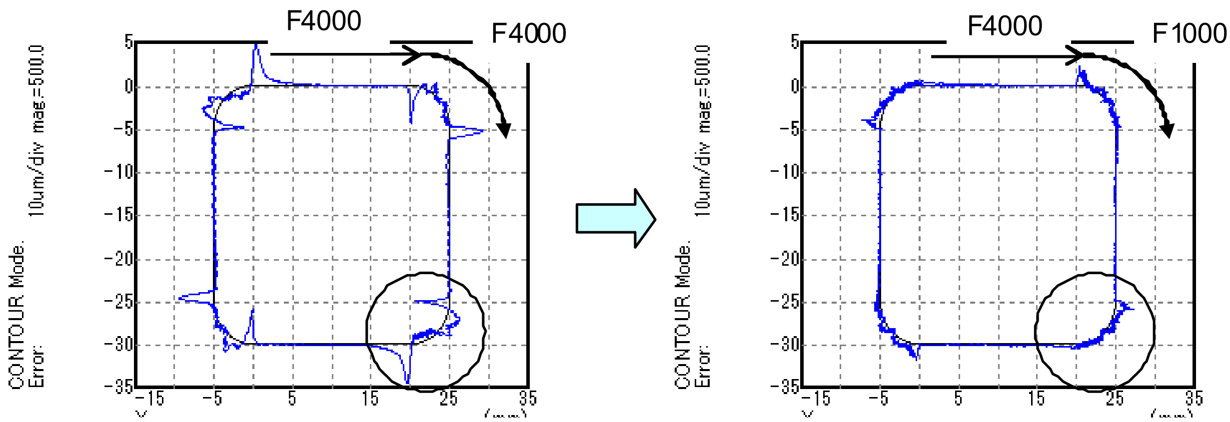
Fig. 4.3.1 (x) Permissible acceleration setting screen of SERVO GUIDE

Fig. 4.3.1 (y) shows the change in feedrate from time to time when it is not reduced at an arc part and when it is reduced. Setting the permissible acceleration reduces the tangential feedrate. The change in feedrate along each axis, that is, acceleration is also reduced. When the permissible acceleration is set to reduce the feedrate at an arc part, the feed precision is improved. Fig. 4.3.1 (z) shows the reduction of the contour error with this feedrate switch function.



(i) The feedrate is not reduced at an arc part. (ii) The feedrate is reduced to F1000 at an arc part.

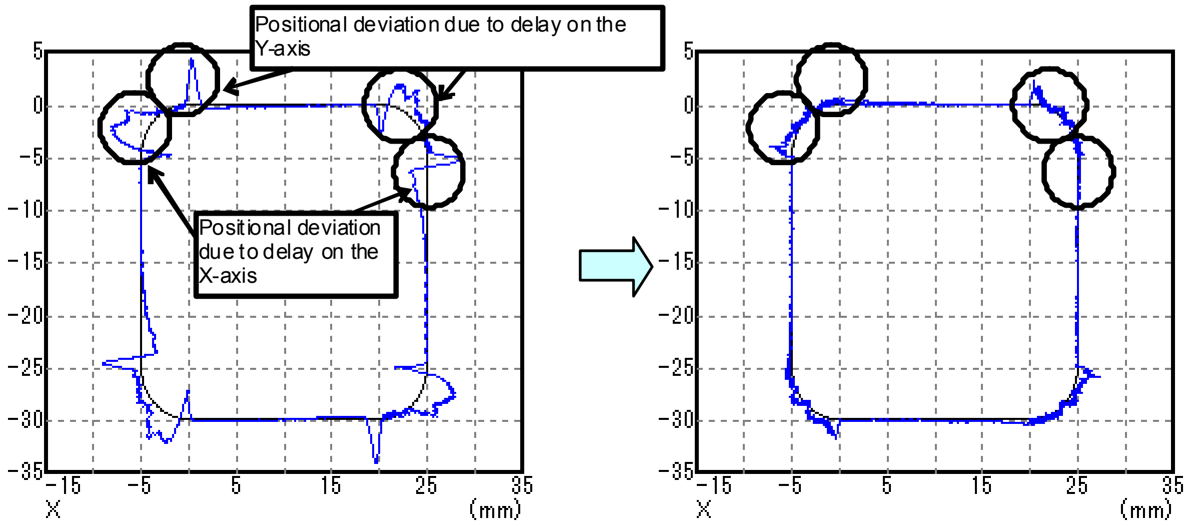
Fig. 4.3.1 (y) Change in feedrate at an arc part by changing the permissible acceleration



(i) The feedrate is not reduced at an arc part. (ii) The feedrate is reduced to F1000 at an arc part.

Fig. 4.3.1 (z) Reduction of the contour error at an arc part by limiting the acceleration

As shown in Fig. 4.3.1 (aa), the positional deviation in an arc part can also be suppressed by adjusting the velocity feed-forward coefficient. Since the positional deviation in an arc part is caused by velocity loop delay at the start and end of the arc, velocity feed-forward, which compensates for delay, is effective in the suppression of the positional deviation in arc parts.



(i) Velocity feed-forward: Disabled (ii) Velocity feed-forward: Enabled

Fig. 4.3.1 (aa) Reduction of the contour error in an arc part with the velocity feed-forward function

4.3.2 High-speed Positioning Adjustment Procedure

(1) Overview

This subsection describes the servo adjustment procedure for high-speed positioning required with a punch press and PC board drilling machine.

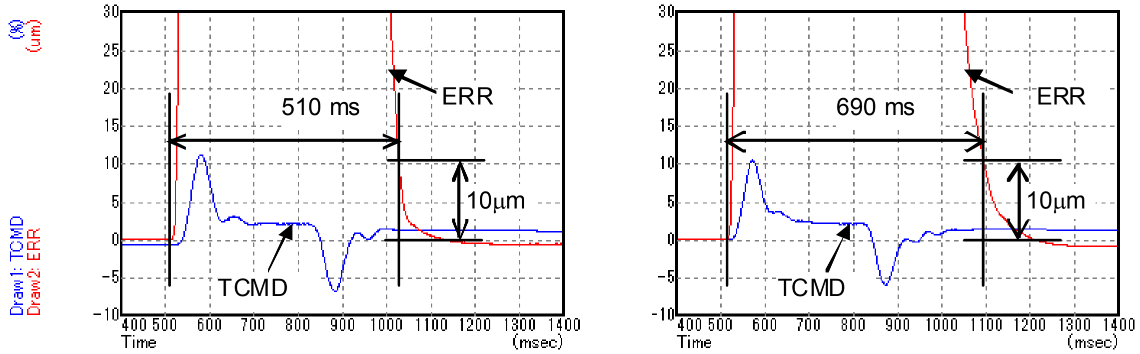
(2) Adjustment procedure

Make a high-speed positioning adjustment while viewing the ERR (servo error amount) and TCMD. Set a measurement range as described below.

- ERR :
  Adjust the measurement range so that the precision required for positioning can be seen. In the example below, a requested precision of 10 μm is assumed.
- TCMD:
  Make an adjustment to view a specified maximum current value. If an adjustment is made to reduce positioning time, TCMD saturation may occur. Make an adjustment so that the TCMD lies within a specified maximum current.

<1> Velocity loop I-P function setting

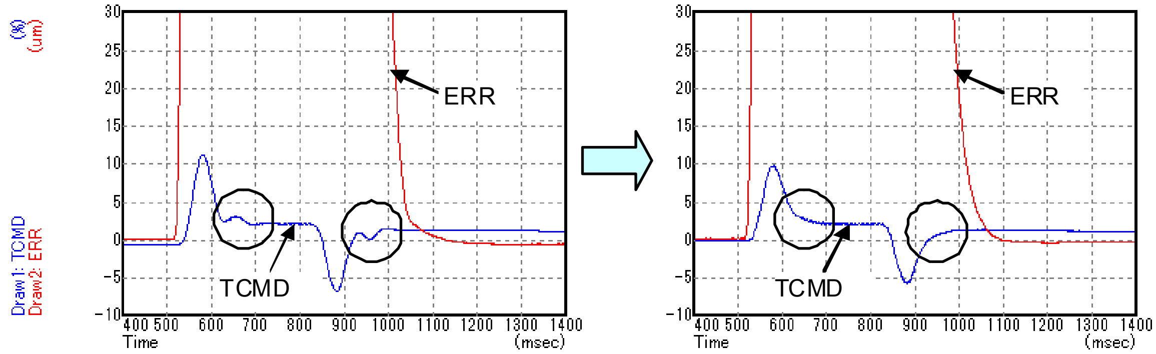
In general, PI function reduces start-up time for a command, but requires a longer setting time, so that PI function is not suitable for high-speed positioning. On the other hand, the I-P function reduces the setting time as compared with the PI function, so the positioning time can be reduced (Fig. 4.3.2 (a)). Use the I-P function for velocity loop control to adjust high-speed positioning.



(i) Velocity loop I-P control (ii) Velocity loop PI control

Fig. 4.3.2 (a) Setting times according to velocity loop control functions (cutting feedrate: F10000 mm/min, required positioning precision: 10 μm)

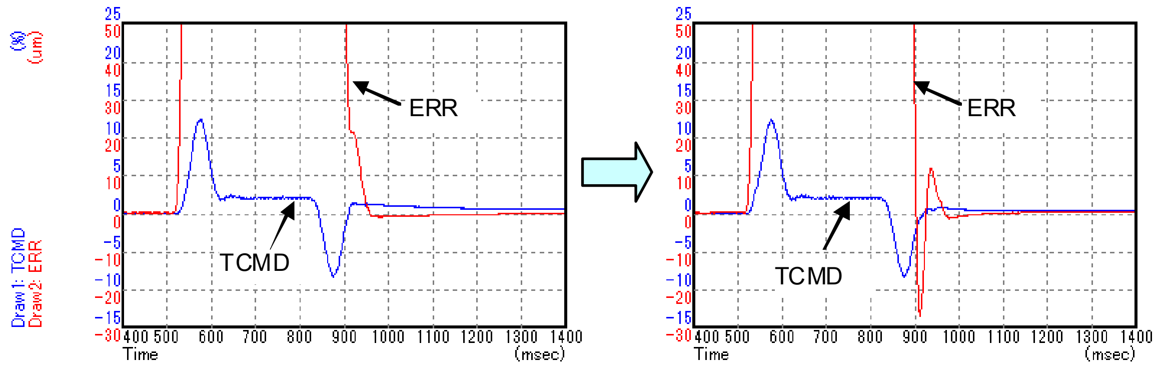
<2> Set a highest possible velocity loop gain while setting the resonance elimination filter when required according to the instructions described in Subsection 4.3.1, "Servo HRV Control Adjustment Procedure". A high velocity loop gain reduces the fluctuation of the torque command waveform as shown in Fig. 4.3.2 (b) and allows stable positioning.



(i) Before velocity loop gain adjustment (ii) After velocity loop gain adjustment

Fig. 4.3.2 (b) Torque command waveform made stable by adjusting the velocity loop gain

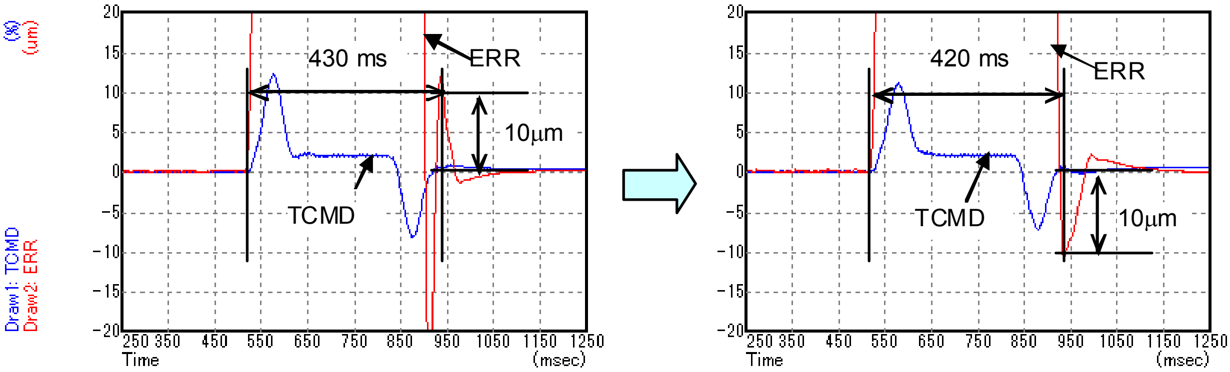
<3> Set a switch speed of 15 min^{-1} (1500 as the CNC parameter value) with the position gain switch function (see Subsection 5.7.1). When this function is enabled, a change in ERR waveform is observed as shown in Fig. 4.3.2 (c).



(i) Position gain switch function: Disabled (ii) Position gain switch function: Enabled

Fig. 4.3.2 (c) Position gain switch function (when the position gain has not been adjusted)

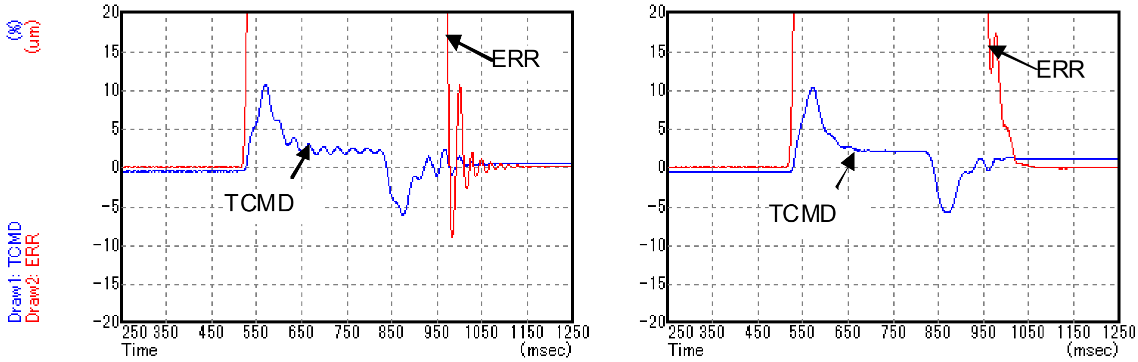
<4> Set a highest possible position gain. While viewing the ERR waveform as shown in Fig. 4.3.2 (d), adjust the position gain so that the overshoot value lies within a requested precision. After setting the position gain, perform rapid traverse for a long distance to check that low-frequency vibration due to an excessively increased position gain does not occur. If the set position gain is too high, vibration after an overshoot exceeds a requested precision. (A small overshoot can be suppressed by the adjustment in step <5> below.) In this example, the positioning time is reduced from 690 ms when the velocity loop PI function is used at first to 420 ms after adjustment (reduction by about 40%).



(i) Excessively high position gain (ii) Adequate position gain

Fig. 4.3.2 (d) Position gain switch function (position gain adjustment)

<5> A fine adjustment can be made for PK1V (velocity loop integral gain) so that neither overshoot nor undershoot occurs as shown in Fig. 4.3.2 (e). If the PK1V setting is too large, a large undershoot occurs.



(i) Excessively large PK1V value (ii) Adequate PK1V value

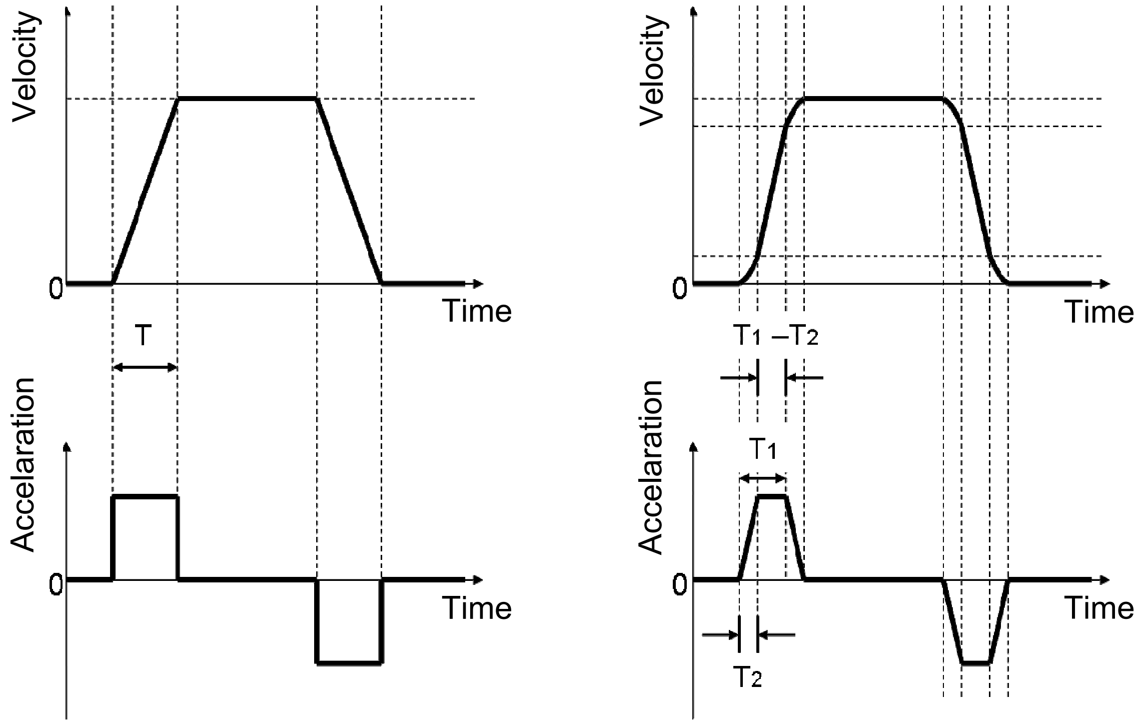
Fig. 4.3.2 (e) PK1V adjustment

4.3.3 Rapid Traverse Positioning Adjustment Procedure

(1) Overview

With the Series 30*i* and 0*i*-D, nano interpolation is applied as standard. By combining nano interpolation with feed-forward, high-speed positioning can be performed in rapid traverse. This subsection describes servo adjustments for rapid traverse positioning.

(2) Reduction of a shock by bell-shaped acc./dec. and reduction of the positioning time by the feed-forward function



(i) Rapid traverse linear acc./dec. (ii) Rapid traverse bell-shaped acc./dec. (T1 ≥ T2)

Fig. 4.3.3 (a) Rapid traverse acc./dec. types and time constants

For high-speed positioning, it is necessary to set a short time required for acc./dec. and high position gain, and enable the feed-forward function. In rapid traverse according to linear acc./dec., however, acceleration change at the start and end of acceleration is large, so large force is produced for a short time, which causes a mechanical shock as shown in Fig. 4.3.3 (a) (i). (When the feed-forward function is disabled, the shock can be reduced to some extent since there is original delay in the servo control system.) In this case, the shock can be reduced by applying bell-shaped acc./dec. for smooth acceleration change as shown in Fig. 4.3.3 (a) (ii). When the problem with a shock can be solved by applying bell-shaped acc./dec., the feed-forward function can be used for eliminating servo system delay to reduce the positioning time. When feed-forward is applied, the positional deviation decreases during movement. Accordingly, positional deviation convergence occurs more rapidly, thus reducing the time required for positioning.

(3) Adjustment procedure

Make a rapid traverse positioning adjustment while viewing the ERR (servo error amount). Adjust the measurement range so that the time required for position deviation convergence within the in-position width can be seen. At the same time, observe the TCMD to check that the TCMD is not saturated. Before proceeding to the adjustment described below, adjust the velocity loop gain according to item (3)-3, "Adjustment of high-speed velocity control" in the Subsec. 4.3.1, "Gain Adjustment Procedure."

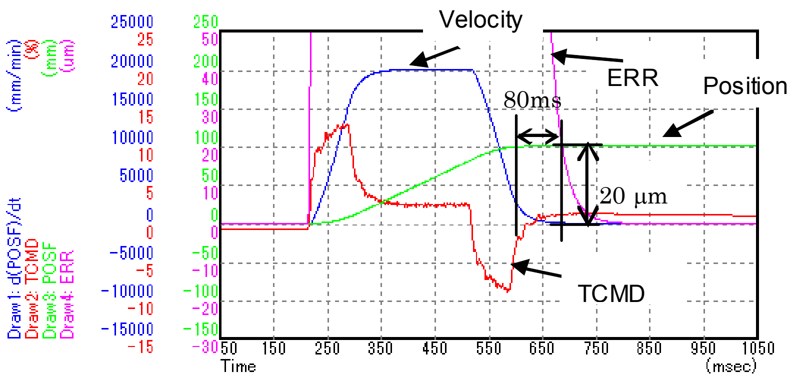


Fig. 4.3.3 (b) Measurement of rapid traverse acc./dec. before adjustment (when the feed-forward function is disabled)

The measurement data of Fig. 4.3.3(b) has been obtained under the condition below. Feed-forward are not used.

- Rapid traverse rate: 20000 mm/min
- Rapid traverse linear time constant: 150 msec
- Position gain: 30 sec⁻
- Travel distance: 100 mm

When the precision requested for rapid traverse positioning is 20 µm, a time of about 80 ms is required from the completion of distribution to positioning. Reducing this time can speed up positioning.

<1> Default parameter setting for feed-forward
Set the parameters according to Table 4.3.3(a). By setting the default parameters, the time required for positioning can be much reduced.

Table 4.3.3 (a) Default parameters for rapid traverse positioning adjustment

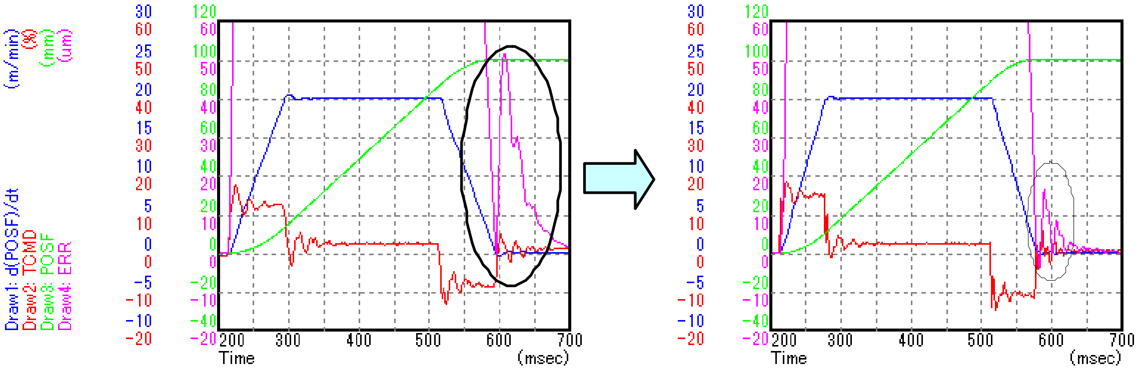
Item	Default parameter	
	Series 30*i*	Setting
Rapid traverse feed-forward enable	No.1800#3	1
Rapid traverse acc./dec. time constant - linear part (ms)	No.1620	-
Rapid traverse acc./dec. time constant - bell-shaped part (ms)	No.1621	-
Enables feed-forward	No.2005#1	1
Feed-forward coefficient	No.2092(*1)	9700
Velocity feed-forward coefficient	No.2069(*1)	100

(*1) When using different values for cutting and rapid traverse, use the cutting feed/rapid traverse switchable fine acc./dec. function according to Section 5.2, "CUTTING FEED/RAPID TRAVERSE SWITCHABLE FUNCTION."

<2> Adjustment of the rapid traverse acc./dec. time constants (for details, see (3)-4 in Subsection 4.3.1)
Adjust rapid traverse acc./dec. time constants T1 and T2 (Fig. 4.3.3 (a)). (No values recommended for the time constants are listed in Table 4.3.3 (a). This is because recommended values vary depending on the characteristics of the machine.) While measuring the ERR and TCMD, if the waveforms are not distorted abnormally and the precision does not change largely, make an adjustment by decreasing the time constants. Carefully adjust them to satisfy the condition T1 ≥ T2. If a large mechanical shock occurs, increasing the time constant for the bell-shaped part, T2, is effective for reducing the shock.

<3> Velocity feed-forward adjustment

When feed-forward is enabled, the positioning time can be reduced, but a swell may occur due to insufficient velocity loop response immediately before machining stops. A swell can be reduced by an increased velocity loop gain, but there is an upper limit on the velocity loop gain. So, adjust the velocity feed-forward coefficient to reduce a swell for positioning time reduction. With the default setting of the velocity feed-forward coefficient, a swell occurs immediately before machining stops (Fig. 4.3.3 (c) (i)). The swell can be reduced by adjusting the velocity feed-forward coefficient (Fig. 4.3.3 (c) (ii)).



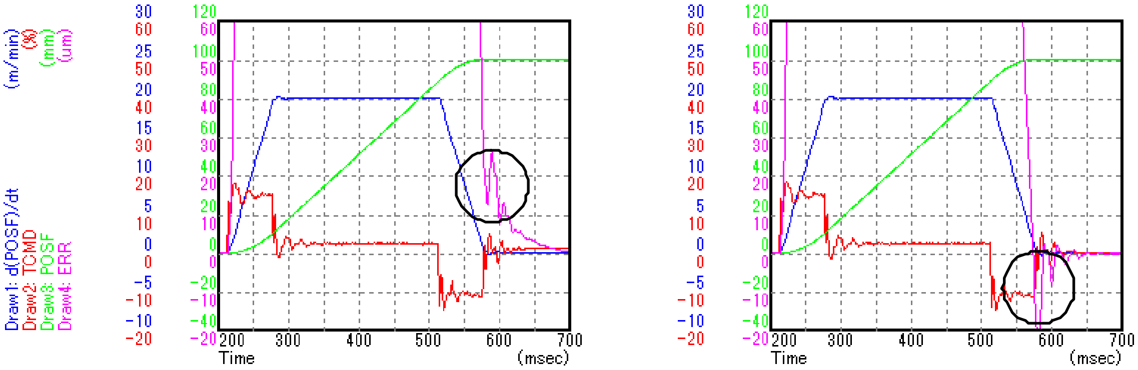
(i) Before the adjustment of the velocity feed-forward coefficient

(ii) After the adjustment of the velocity feed-forward coefficient

Fig. 4.3.3 (c) Reduction of a swell at the stop of machining by adjusting the velocity feed-forward coefficient

<4> Fine adjustment of feed-forward

Reduce the time required for positioning by making a fine adjustment of the feed-forward coefficient. If the feed-forward coefficient is not sufficiently large (Fig. 4.3.3 (d) (i)), make an adjustment by increasing the feed-forward coefficient by about 0.5% at a time. If the feed-forward coefficient is too large (Fig. 4.3.3 (d) (ii)), make an adjustment by decreasing the feed-forward coefficient by about 0.5% at a time.



(i) Position feed-forward coefficient: Too small (Undershoot)

(ii) Position feed-forward coefficient: Too large (Overshoot)

Fig. 4.3.3 (d) Reduction of a swell at the stop of machining by adjusting the position feed-forward coefficient

If an adequate feed-forward coefficient is set, the in-position width is satisfied nearly at the same as distribution command completion, and shortest-time positioning is achieved as shown in Fig. 4.3.3 (e).

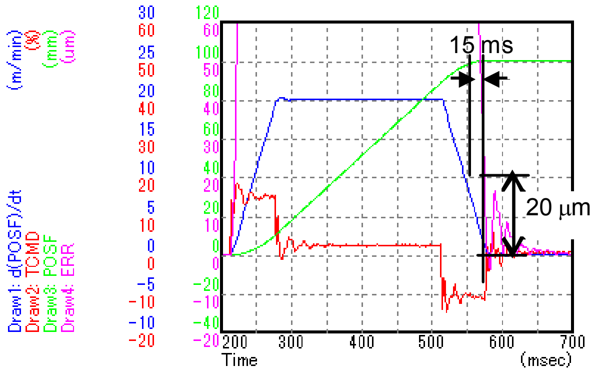


Fig. 4.3.3 (e) When an adequate feed-forward coefficient is set

4.3.4 Vibration in the Stop State

Vibration generated only in the stop state is caused by the decreased load inertia in a backlash. Adjust the auxiliary functions for suppressing stop-time vibration. Vibration may be generated only in the stop state also when the position gain is too large.

<1> Is an auxiliary function set to increase the oscillation limit for the velocity loop gain?
Machine with high rigidity: Velocity loop proportional high-speed processing function (function 1)
Machine with low rigidity: Acceleration feedback function (function 2)

↓

<2> Is an auxiliary function set to suppress vibration in the stop state?
Function for changing the proportional gain in the stop state (50%, 75%, arbitrary) (function 3)

↓

<3> Vibration frequency?

- Several tens of hertz or higher → <4> Decrease the velocity loop gain. When using the cutting feed/rapid traverse velocity loop gain switch function, decrease the velocity loop gain for rapid traverse.
- Low frequency → <5> The position gain may be too large for the velocity loop gain. (Vibration is sometimes generated when the load inertia is too high or when the velocity loop gain is not yet adjusted.)

↓

<6> When the velocity loop gain is not adjusted, follow the description in Subsec. 4.3.1 to set the velocity loop gain to 70% of the oscillation limit.

↓

<7> Decrease the position gain.

(Reference: Parameter numbers)
For details, see Chapter 5, "SERVO FUNCTION DETAILS."

Function 1: Velocity loop proportional high-speed processing function

	#7	#6	#5	#4	#3	#2	#1	#0
2017	PK2V25							

PK2V25(#7) 1: Enables velocity loop high cycle management function

Function 2: Acceleration feedback

2066	Acceleration feedback gain

Function 3: Function for changing the proportional gain in the stop state

	#7	#6	#5	#4	#3	#2	#1	#0
2016					PK2VDN			

PK2VDN(#3) 1: Enables the function for changing the proportional gain in the stop state. In the stop state: 75%

	#7	#6	#5	#4	#3	#2	#1	#0
2207					PK2D50			

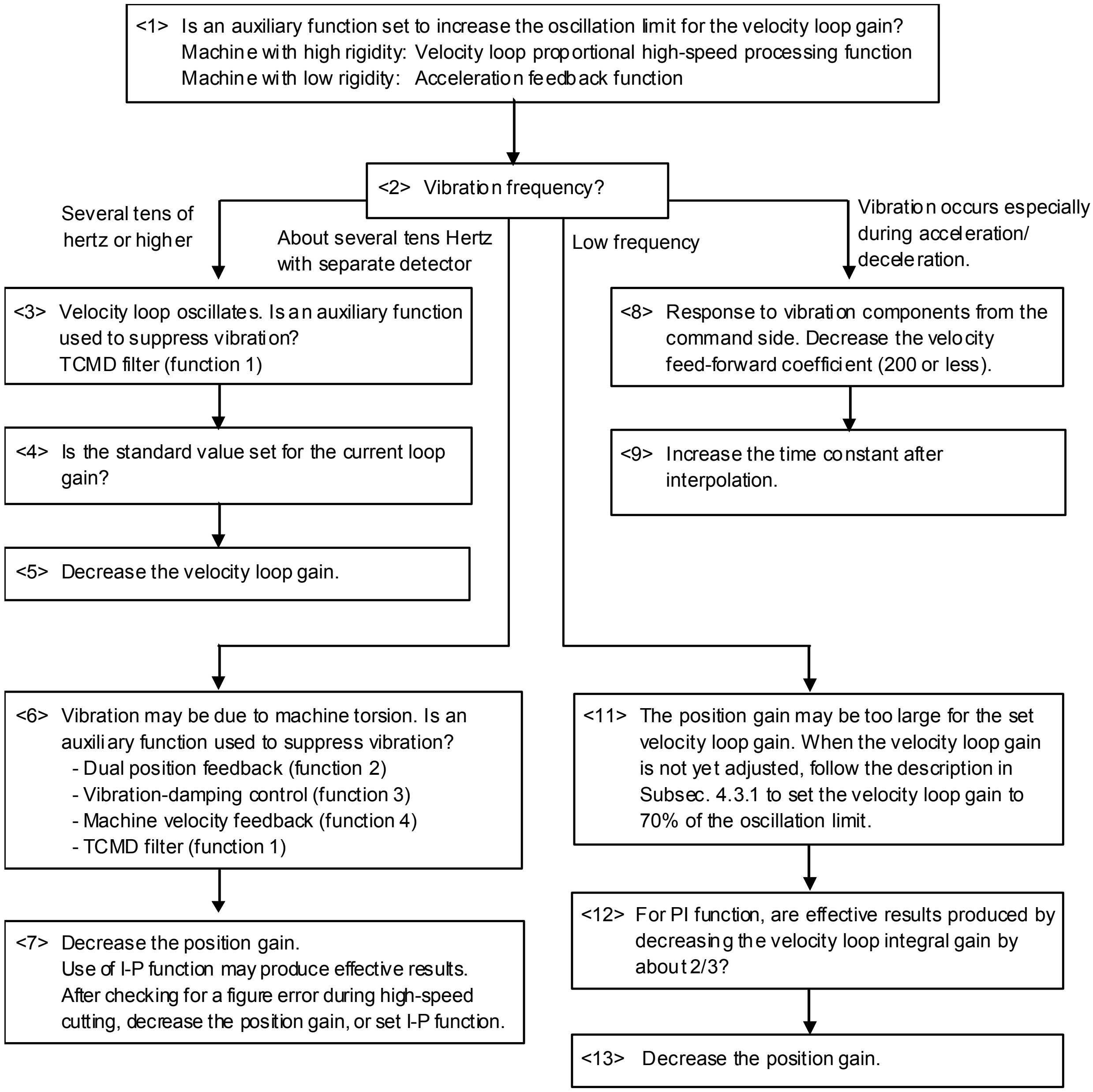
PK2D50(#3) 1: Decreases the proportional gain in the stop state to 50%.

2119	Stop decision level

2324	Function for changing the proportional gain in the stop state: Arbitrary magnification in the stop state (during cutting feed only)

4.3.5 Vibration during Travel

Vibration is generated during travel by various causes. So, a most appropriate method must be selected after observing the vibration status carefully.



(Reference: Parameter numbers)
For details, see Chapter 5, “SERVO FUNCTION DETAILS.”

Function 1: TCMD filter

2067	TCMD filter coefficient

Function 2: Dual position feedback function

	#7	#6	#5	#4	#3	#2	#1	#0
2019	DPFB							

DPFB(#7) 1: Enables dual position feedback.

2078	Dual position feedback: conversion coefficient (numerator)

2079	Dual position feedback: conversion coefficient (denominator)

2080	Dual position feedback: primary delay time constant

Function 3: Vibration-damping control

2033	Vibration-damping control function: number of position feedback pulses

2034	Vibration-damping control function: gain

Function 4: Machine velocity feedback

	#7	#6	#5	#4	#3	#2	#1	#0
2012							MSFE	

MSFE(#1) 1: Enables machine velocity feedback.

2088	Machine velocity feedback gain

4.3.6 Stick Slip

When the time from the detection of a position error until the compensation torque is output is too long, a stick slip occurs during low-speed feed. Improvement in gain is required. However, for a machine with high friction and torsion, a higher gain cannot be set. In such a case, a stick slip phenomenon may occur.

<1> Adjust the position gain and velocity loop gain according to the description in Subsec. 4.3.1.

↓

<2> Set PI function.

↓

<3> To improve torque start, increase the velocity loop integral gain.

↓

<4 Set the incomplete integral coefficient within the range 32700 to 32767. For axes subject to interpolation, this coefficient must not be set.

(Reference: Parameter numbers)
For details, see Chapter 5, "SERVO FUNCTION DETAILS."

2045	Incomplete integral gain

4.3.7 Overshoot

When the machine is operated at high speed or with a detection unit of 0.1 μm or less, the problem of overshoots may arises. Select a most appropriate preventive method depending on the cause of the overshoot.

<1> When the velocity loop gain is not yet adjusted, follow the description in Subsec. 3.3.1 to adjust the gain. Select PI function.

↓

<2> When high-speed and high-precision control is used, adjust automatic corner deceleration. Also, increase settings such as the time constant after interpolation to allow commands for corner and stop operations to be executed as moderately as possible.

↓

<3> When feed-forward is used, try to adjust the velocity feed-forward coefficient.

↓

<4> Where possible, decrease the position gain and feed-forward coefficient.

↓

<5> If the overshoot in question is for about one or two pulses, set overshoot compensation (TYPE-1 or -2). (Function 1)

(Reference: Parameter numbers)
For details, see Chapter 5, "SERVO FUNCTION DETAILS."

Function 1: Overshoot compensation function

	#7	#6	#5	#4	#3	#2	#1	#0
2003		OVSC						

OVSC(#6) 1: Enables the overshoot compensation function.

2077	Overshoot prevention counter

2045	Incomplete integral coefficient

	#7	#6	#5	#4	#3	#2	#1	#0
2202					OVS1			

OVS1(#3) 1: Enables overshoot compensation TYPE-2.

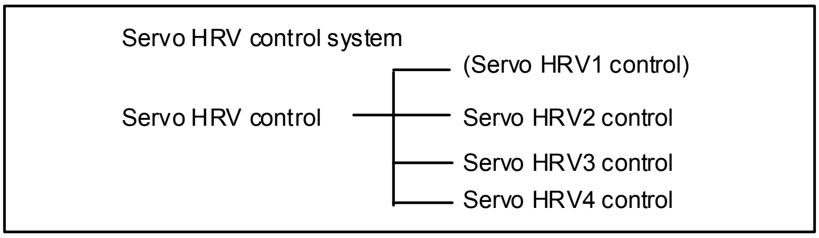
5 SERVO FUNCTION DETAILS

Chapter 5, "SERVO FUNCTION DETAILS", consists of the following sections:

5.1 SERVO HRV CONTROL

(1) Overview

Servo HRV control is a digital servo control system based on high-speed, high-response current control and includes servo HRV1 control, servo HRV2 control, servo HRV3 control, and servo HRV4 control. Use of these control systems allows higher acceleration, higher speed, and higher precision.



(2) Servo HRV control and Series and editions of applicable servo software

	30*i*–B Series	30*i*–A Series		0*i*–D Series
	90G0 and subsequent editions	90D0 and subsequent editions (Note 1, 2)	90E0 and subsequent editions 90E1 and subsequent editions (Note 2)	90C5 and subsequent editions 90E5 and subsequent editions 90C8 and subsequent editions 90E8 and subsequent editions
(Servo HRV1 control)	×	×	×	×
Servo HRV2 control	○	○	○	●
Servo HRV3 control	●	○	●	○
Servo HRV4 control	○	●	×	×

○: Supported (● is recommended)
×: Not supported

NOTE

1 When using servo HRV4 control, use Series 90D0/J(10) and subsequent editions.
2 Series 32*i*-A, Series 32*i*/35*i* –B, and Power Motion *i*-A do not support servo HRV4 control.
3 For 30i-A Series (Series 90D0 and 90E0), apply the same servo HRV control to all axes.
4 In 300*i*-B Series (Series 90G0), the same HRV control needs to be applied for each FSSB line.

(3) Features of servo HRV control

(a) Servo HRV2 control

Servo HRV control is a total control technology implemented by a servo motor, servo amplifier, and control systems as shown in the figure below. Servo HRV2 control has the following features:

(1) HRV filters for eliminating vibration components of the machine system can be used.
The HRV filters include the following filters to cover a wide range of vibration from low frequency vibration to high frequency vibration:
TCMD filter (a filter for eliminating middle frequency vibration)
Resonance elimination filter (a filter for eliminating high frequency vibration)
Disturbance elimination filter (a filter for eliminating low frequency vibration)

(2) Use of a α*i*S/α*i*F/β*i*S/β*i*F series motor and a α*i*/β*i* servo amplifier enables high-speed, high-precision, and smooth feed.

(3) Use of a precise pulse coder improves control performance.

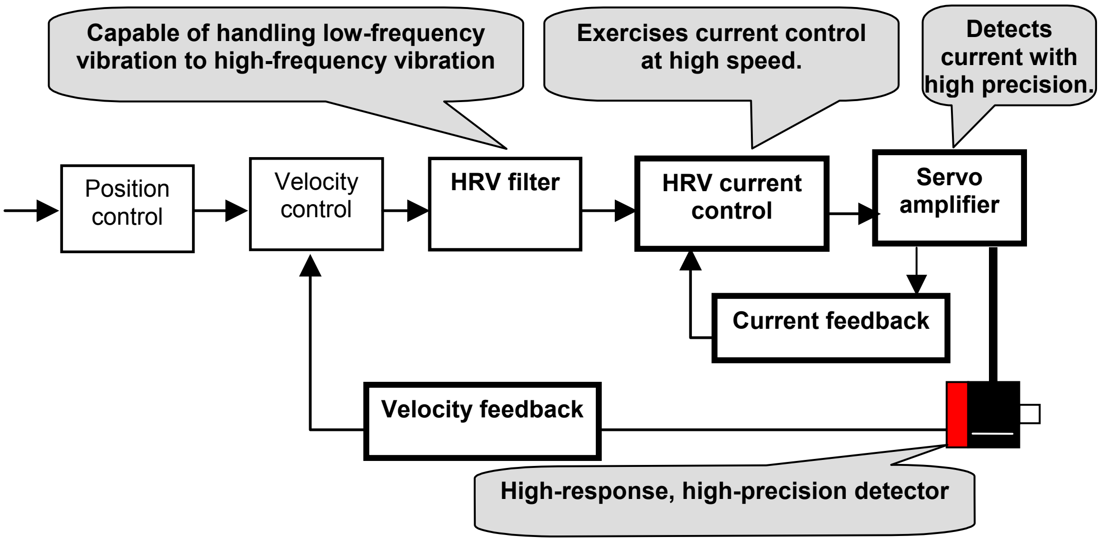


Fig. 5.1 (a) Overview of servo HRV control

(b) Servo HRV3 control

In addition to the features of HRV2 control, servo HRV3 control has the following features:

(1) Improvement of the response of a current loop through high-speed HRV current control
(2) Best suited to machine tools that require high-speed and high-precision.

With 30*i* Series, use of servo HRV3 control is recommended.

(c) Servo HRV4 control

In addition to the features of servo HRV2 and servo HRV3, servo HRV4 control has the following features:

(1) Further improvement of the response of a current loop than servo HRV3 control
(2) Best suited to high-precision processing machines etc.

Series 90G0 or Series 90D0 is required to use servo HRV4 control.

5.1.1 Servo HRV2 Control

(1) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(2) Setting the parameters for servo HRV2 control

<1> Set a motor ID number for HRV2 control.
(For a motor ID number, see (3) of Subsection 2.1.3.)
<2> Set initialization bit 1 to 0 then turn off the power to the CNC then turn on the power again.
<3> The standard parameters for servo HRV2 control are automatically loaded.
<4> Completion of setting

NOTE
For servo parameter initialization, see Subsection 2.1.3.

5.1.2 Servo HRV3 Control

(1) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(2) Setting parameters for servo HRV3 control

<1> See Subsection 5.1.1, and make settings for servo HRV2 control.

<2> Set servo HRV3 current control. (For each axis)

	#7	#6	#5	#4	#3	#2	#1	#0
2013								HR3

HR3(#0) 0: Does not use servo HRV3 control.
1: Uses servo HRV3 control.

> **NOTE**
> Available servo axis numbers (parameter No. 1023) vary with the setting of HRV control. For details, see the following table.

Table 5.1.2 (a) Available servo axis numbers

	30*i*–B Series			30*i*–A Series					0*i*–D Series			
	Series 90G0 No.1023=8n+1			Series 90D0 No.1023=2n+1			Series 90E0 Series 90E1 No.1023=4n+1		Series 90C5 Series 90C8 No.1023=2n+1		Series 90E5 Series 90E8 No.1023=4n+1	
No.1023	HRV2	HRV3	HRV4	HRV2	HRV3	HRV4	HRV2	HRV3	HRV2	HRV3	HRV2	HRV3
8n+1	○	○	○	○	○	○	○	○	○	○	○	○
8n+2	○	○	×	○	○	×	○	○	○	○	○	○
8n+3	○	○	×	○	○	○	○	○	○	○	○	○
8n+4	○	○	×	○	○	×	○	×	○	○	○	×
8n+5	○	×	×	○	○	○	○	○	○	○	○	○
8n+6	○	×	×	○	○	×	○	○	○	○	○	○
8n+7	×	×	×	○	○	○	○	○	○	○	○	○
8n+8	×	×	×	○	○	×	○	×	○	○	○	×

○: Available, ×: Not available

> **NOTE**
> Series 32*i*-A, Series 32*i*/35*i*-B, and Power Motion *i*-A do not support HRV4 control.

<3> Set the cutting/rapid velocity loop gain switching function.

	#7	#6	#5	#4	#3	#2	#1	#0
2202							**VGCCR**	

VGCCR (#1) 0: Does not use the cutting/rapid velocity loop gain switching function.
1: Uses the cutting/rapid velocity loop gain switching function.

<4> Set the current loop gain magnification.

2334	**Current loop gain magnification in high-speed HRV current control mode**

[Unit of data] %
[Valid data range] 100 to 150
[Recommended value] 150
This parameter is valid only for cutting feed in the high-speed HRV current control mode.

<5> Set the velocity loop gain magnification.

2335	**Velocity loop gain magnification in high-speed HRV current control mode**

[Unit of data] %
[Valid data range] 100 to 400 (A value of 0 indicates the default value (100%).)
This parameter is valid only for cutting feed in the high-speed HRV current control mode.

2107	**Velocity loop gain magnification for cutting (cutting/rapid velocity loop gain switching)**

[Unit of data] %
[Valid data range] 100 to 400 (A value of 0 indicates the default value (100%).)
This parameter is valid only for cutting feed when the high-speed HRV current control mode is not set.

<6> Set the high-speed HRV current control mode.
To use servo HRV3 control with 30*i* Series or 0*i*-D Series, set the following bit, which automatically sets the high-speed HRV current control mode during cutting feed:

	#7	#6	#5	#4	#3	#2	#1	#0
2283								**NOG54**

NOG54(#0) The high-speed HRV current control mode (servo HRV3 control) is:
0: Set only when both G5.4Q1 and G01 are specified.
1: Set when G01 is specified (G5.4Q1 is not monitored).

> **NOTE**
> This function cannot be used during servo HRV4 control.

<7> This completes parameter setting. To actually enter the high-speed HRV current control mode, G codes must be programmed. (This is not required if bit 0 (NOG54) of No.2283 is set to 1. See Subsection 5.1.5, "High-Speed HRV Current Control" for details.)

> **NOTE**
> The velocity loop gain is changed as listed below according to whether the high-speed HRV current control mode is set or not.

Table 5.1.2 (b) Velocity loop gain for cutting feed and rapid traverse

High-speed HRV current control mode	Feed	Velocity loop gain [%]
Set (G5.4Q1 - G5.4Q0)	Rapid traverse	(1 + No. 2021 / 256) × 100
	Cutting feed	(1 + No. 2021 / 256) × **No. 2335** (High-speed HRV current control: Velocity loop gain magnification)
Not set	Rapid traverse	(1 + No. 2021 / 256) × 100
	Cutting feed	(1 + No. 2021 / 256) × No. 2107 (Cutting/rapid switching: Velocity loop gain magnification)

(3) Limitation on servo HRV3 control

(a) Servo motor output torque

The servo amplifiers that support 30*i* Series and 0*i*-D Series have high heat resistance, so there is no limitation on them.

(b) Rated current

The rated current during use of HRV3 may be reduced as compared with HRV2. For details, refer to "Environmental conditions - derating" in FANUC SERVO AMPLIFIER α*i*SV SERIES DESCRIPTIONS (B-65282EN).

5.1.3 Servo HRV4 Control

(1) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*-B	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4

(2) Setting parameters for servo HRV4 control

<1> See Subsection 5.1.1, and make settings for servo HRV2 control.

<2> Set servo HRV4 control. (For each axis)

	#7	#6	#5	#4	#3	#2	#1	#0
2014								**HR4**

HR4(#0) 0: Does not use servo HRV4 control.
1: Uses servo HRV4 control.

NOTE

1. When the high-speed HRV current control mode is set by the G5.4Q1 command, servo HRV3 control or servo HRV4 control, whichever set in a parameter, is enabled. Therefore, both the servo HRV3 control enable bit and the servo HRV4 control enable bit cannot be set to 1 at the same time. (If these bits are both set to 1, an alarm indicating invalid current control setting is issued.)
2. Available servo axis numbers (parameter No. 1023) vary with the setting of HRV control. For details, see the table shown in "Setting parameters for servo HRV3 control".
3. If servo HRV4 control is set, servo HRV3 control is performed during rapid traverse or when high-speed HRV current control is disabled.
4. In servo HRV4 control using Series 90G0 (30*i*-B Series) or Series 90D0 (30*i* -A Series), one axis is controlled with one CPU. So, functions (such as tandem vibration-damping control during synchronization control, and torque tandem control) involving two or more axes in servo software processing cannot be used.

<3> Enable the extended HRV function. (For each axis)

	#7	#6	#5	#4	#3	#2	#1	#0
2300								HRVEN

HRVEN(#0) 0: Does not use the extended HRV function.
1: Uses the extended HRV function.

<4> Set the cutting/rapid velocity loop gain switching function.

	#7	#6	#5	#4	#3	#2	#1	#0
2202							VGCCR	

VGCCR (#1) 0: Does not use the cutting/rapid velocity loop gain switching function.
1: Uses the cutting/rapid velocity loop gain switching function.

<5> Set the current loop gain magnification.

2334	Current loop gain magnification in high-speed HRV current control mode

[Unit of data] %
[Valid data range] 100 to 150
[Recommended value] 150
This parameter is valid only for cutting feed in the high-speed HRV current control mode.

<6> Set the velocity loop gain magnification.

2335	Velocity loop gain magnification in high-speed HRV current control mode

[Unit of data] %
[Valid data range] 100 to 400 (A value of 0 indicates the default value (100%).)
This parameter is valid only for cutting feed when the high-speed HRV current control mode is set.

2107	Velocity loop gain magnification (cutting/rapid velocity loop gain switching)

[Unit of data] %
[Valid data range] 100 to 400 (A value of 0 indicates the default value (100%).)
This parameter is valid only for cutting feed when the high-speed HRV current control mode is not set.

<7> This completes parameter setting. To actually enter the high-speed HRV current control mode, G codes must be programmed. (See Subsection 5.1.5, "High-Speed HRV Current Control" for details.)

NOTE
The velocity loop gain is changed as listed below according to whether the high-speed HRV current control mode is set or not.

Table 5.1.3 (a) Velocity loop gain for cutting feed and rapid traverse

High-speed HRV current control mode	Feed	Velocity loop gain [%]
Set (G5.4Q1 - G5.4Q0)	Rapid traverse	(1 + No. 2021 / 256) × 100
	Cutting feed	(1 + No. 2021 / 256) × **No. 2335** (High-speed HRV current control: Velocity loop gain magnification)
Not set	Rapid traverse	(1 + No. 2021 / 256) × 100
	Cutting feed	(1 + No. 2021 / 256) × No. 2107 (Cutting/rapid switching: Velocity loop gain magnification)

(3) Limitation on servo HRV4 control

(a) Servo motor output torque

During cutting operation in high-speed HRV current control, the torque command is automatically limited to 70% of the maximum current value of the servo amplifier. As a result, the torque command is easily saturated. Therefore, when determining the time constant in cutting feed, consider the cutting load and the above limitation. Normally, the high-speed HRV current control mode is used for light cutting for finish machining, so the limitation of the torque command to 70% of the maximum current value of the servo amplifier is not regarded as critical.

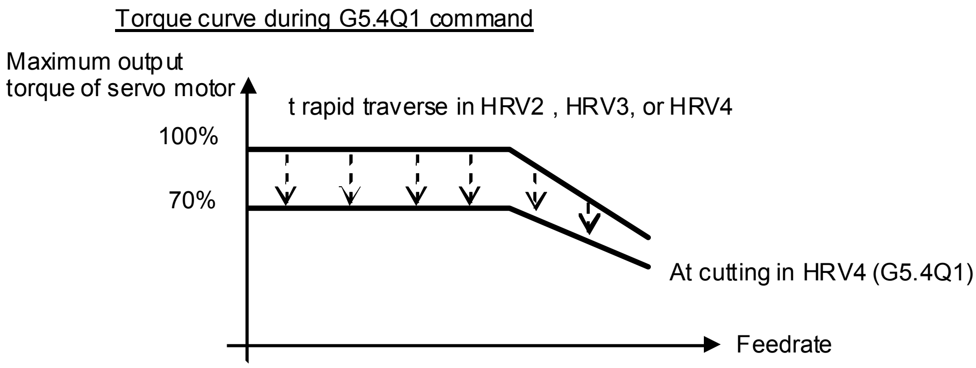


Fig. 5.1.3 (a) Limitation on torque during servo HRV4 control

(b) Rated current

The rated current during use of HRV4 may be reduced as compared with HRV2. For details, refer to "Environmental conditions - derating" in FANUC SERVO AMPLIFIER α*i*SV SERIES DESCRIPTIONS (B-65282EN).

(4) Servo HRV4 control hardware

(a) Servo amplifiers

A servo amplifier supporting servo HRV4 control must be specified.

(b) Detector

To use servo HRV4 control, a detector supporting high-speed communication needs to be used for motor feedback (as a detector on the semi-closed loop side).
The table below indicates examples of detectors that support high-speed communication.

If a setting is made to enable HRV4 when a detector not supporting high-speed communication is connected, "SV0456 INVALID CURRENT CONTROL PERIOD SETTING ALARM" is issued.

Table 5.1.3 (a) Sample configuration of a detector usable with HRV4

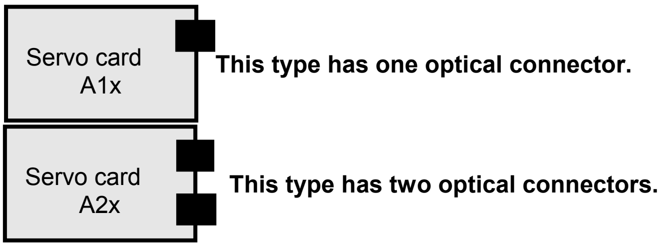
Manufacture	Configuration or model
FANUC	α*i* Pulse coder, β*i* Pulse coder
FANUC	α*i*CZ sensor (512A, 768A, 1024A)
FANUC	Combination of high-resolution serial output circuit H with an incremental scale (1Vpp output) supplied by a vendor other than FANUC
FANUC	Combination of high-resolution serial output circuit C with an incremental scale (1Vpp output) supplied by a vendor other than FANUC
HEIDENHAIN	RCN827F, RCN727F, RCN227F, RCN223F, ECN223F RCN8590F, RCN8390F, RCN5590F, RCN5390F, RCN2590F, RCN2390F LC493F, LC193F LC495F, LC195F
MITUTOYO	AT553, AT555, ST753
Magnescale	RU77, RS97, SR77, SR87
NEWALL	SHG-AF
Renishaw	RESOLUTE
FAGOR	LAF, GAF, SAF, SVAF, HAF-D, SAF-D

* The table above indicates the configurations and models whose support for high-speed communication is confirmed as of October, 2012. For details, contact the detector manufacturers.

5.1.4 Servo Card and Number of Servo Controlled Axes

(1) 30*i*-B Series

The servo card has one or two optical connectors depending on the number of FSSB systems, so the number of connectable amplifiers and separate detector interface units are changed accordingly.



- Maximum number of amplifier axes and separate detector interface units that can be connected to one FSSB optical connector

	Amplifier (α*i*SV+α*i*SP)	Separate detector interface unit
Servo HRV2 control	28 axes	4 台
Servo HRV3 control	13 axes	2 台
Servo HRV4 control	6 axes	1 台

- Maximum number of amplifier axes that can be connected to the servo card

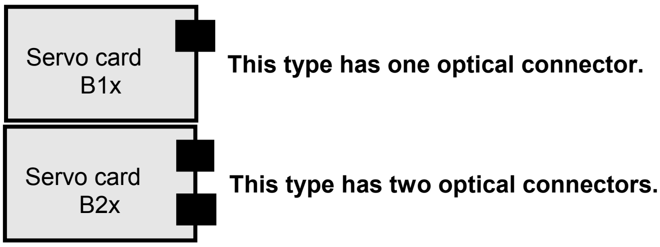
Servo card		Number of FSSB systems	Maximum number of amplifier axes		
Name	Specification		HRV2	HRV3	HRV4
Servo card A11	A02B-0323-H094	1	6 axes	4 axes	1 axes
Servo card A12	A02B-0323-H095	1	12 axes	8 axes	2 axes
Servo card A13	A02B-0323-H096	1	18 axes	12 axes	3 axes
Servo card A24	A02B-0323-H097	2	24 axes	16 axes	4 axes
Servo card A26	A02B-0323-H098	2	32 axes	24 axes	6 axes

* The assumed CNC is 30*i*-B. The maximum number of amplifier axes is limited to the maximum number of controlled axes for each CNC model.

> **NOTE**
> For the maximum number of controlled axes, refer to Section 6.2, " Interface to the Amplifiers" in Series 30*i*-B CONNECTION MANUAL (HARDWARE) (B-64483EN).

(2) 30*i*-A Series

The servo card has one or two optical connectors depending on the number of FSSB systems, so the number of connectable amplifiers and separate detector interface units are changed accordingly.



- Maximum number of amplifier axes and separate detector interface units that can be connected to one FSSB optical connector

	Amplifier	Separate detector interface unit
Servo HRV2 control	16 axes	2 units
Servo HRV3 control	10 axes	2 units
Servo HRV4 control	4 axes	1 unit

- Maximum number of amplifier axes that can be connected to the servo card

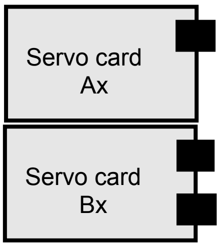
Servo card		Number of FSSB systems	Maximum number of amplifier axes		
Name	Specification		HRV2	HRV3	HRV4
Servo card B11	A02B-0303-H082	1	4 axes	3 axes	1 axes
Servo card B12	A02B-0303-H083	1	8 axes	6 axes	2 axes
Servo card B13	A02B-0303-H084	1	12 axes	9 axes	3 axes
Servo card B24	A02B-0303-H089	2	16 axes	12 axes	4 axes
Servo card B26	A02B-0303-H085	2	24 axes	18 axes	6 axes

* The servo control software for servo HRV2 and HRV3 control is 90E0 and 90E1 Series.
* The servo control software for servo HRV4 control is 90D0 Series.

> **NOTE**
> For the maximum number of controlled axes, refer to Section 7.1, " CONNECTION TO THE SERVO AMPLIFIERS" in Series 30*i*-A CONNECTION MANUAL (HARDWARE) (B-63943EN).

(3) 0*i*-D Series

The servo card has one or two optical connectors depending on the number of FSSB systems, so the number of connectable amplifiers and separate detector interface units are changed accordingly.



This type has one optical connector.

This type has two optical connectors.

- Maximum number of amplifier axes and separate detector interface units that can be connected to one FSSB optical connector

	Amplifier	Separate detector interface unit
Servo HRV2 control	16 axes	2 units
Servo HRV3 control	10 axes	2 units

- Maximum number of amplifier axes that can be connected to the servo card

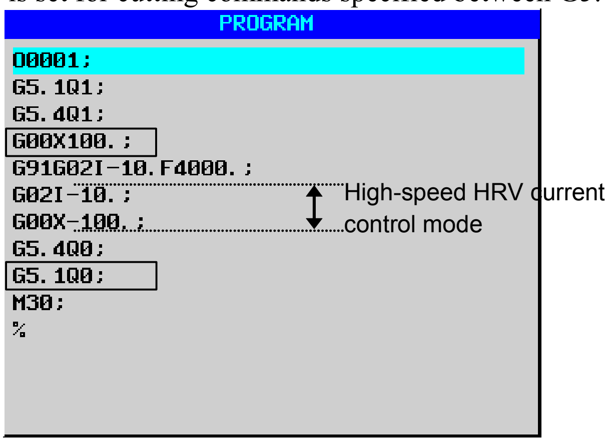
Servo card		Number of FSSB systems	Maximum number of amplifier axes	
Name	Specification		HRV2	HRV3
Servo card A1	A02B-0319-H031	1	2 axes	2 axes
Servo card A2	A02B-0319-H032	1	4 axes	4 axes
Servo card A3	A02B-0319-H033	1	6 axes	6 axes
Servo card A4	A02B-0319-H034	1	8 axes	8 axes
Servo card B2	A02B-0319-H042	2	8 axes	6 axes
Servo card B3	A02B-0319-H043	2	9 axes	9 axes

* The servo control software for servo cards A1 to A4 is 90C5 and 90C8 Series.
* The servo control software for servo cards B2 and B3 is 90E5 and 90E8 Series.

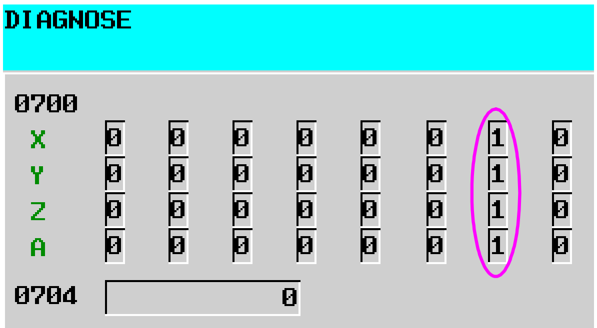
5.1.5 High-Speed HRV Current Control

(1) Starting the high-speed HRV current control mode

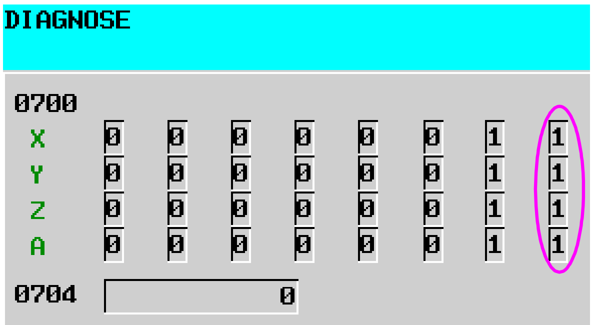
The high-speed HRV current control mode is turned on and off by using a G code (G5.4). The high-speed HRV current control mode is set for cutting commands specified between G5.4Q1 and G5.4Q0.



(2) Checking the high-speed HRV current control mode



Diagnosis No. 700 is used for checking the status of the high-speed HRV current control mode in servo HRV3 control and servo HRV4 control. After setting servo HRV3 or HRV4 control and turning the power off then back on, check that bit 1 (HOK) of diagnosis No. 700 is set. When servo HRV3 or HRV4 control can be used, HOK is set to 1.



When HOK is set to 1, specifying G5.4Q1 sets bit 0 (HON) of diagnosis No.700 to 1 during the cutting feed command. If NOG54 is set to 1, bit 0 is set to 1 during the cutting feed command even if G5.4Q1 is not specified.
When bit 0 (HON) of No.2283 is set to 1, a high-speed current control cycle is set, and the current gain magnification for high-speed HRV current control is applied.

5.2 CUTTING/RAPID SWITCHING FUNCTION

(1) Overview

Increasing the gains of the position loop and velocity loop is effective in the improvement of cutting profiles. However, the maximum feedrate and the acceleration of acc./dec. in rapid traverse are generally higher than those in cutting feed. So, vibration in the velocity loop or hunting in the position loop may occur in rapid traverse even when stable cutting feed can be performed with the same settings. To prevent this problem, the functions below are provided with a function for switching between parameters for cutting feed and parameters for rapid traverse.

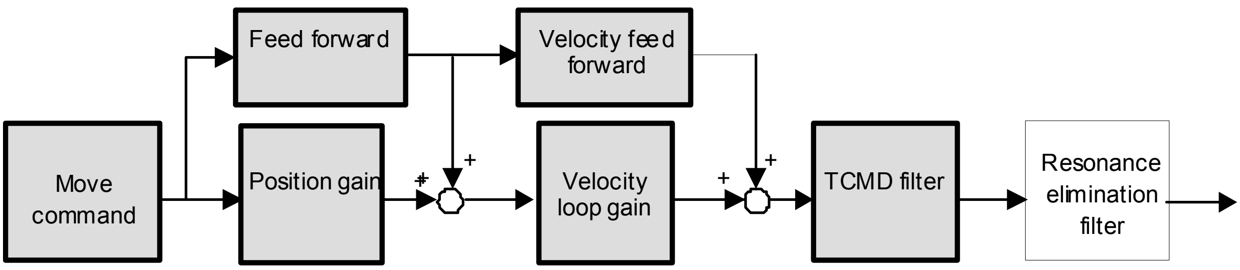


Fig. 5.2 Parameters that can be switched between parameters for cutting feed and for rapid traverse

NOTE
1 The TCMD filter and resonance elimination filter can be used at the same time by parameter setting.
2 The cutting/rapid switching function is not applied to the resonance elimination filter.

(2) Setting procedure

(a) Switching of the velocity loop gain and fine acc./dec.

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

<1> Cutting/rapid velocity loop gain switching function

When TCMD is saturated during acceleration in rapid traverse, oscillation is easily generated in the velocity loop at the end of acceleration in rapid traverse. In some machines, as the feedrate becomes higher, high-frequency oscillation easily occurs. In such cases, switching between the gain for cutting feed and the gain for rapid traverse is effective.

If the cutting/rapid velocity loop gain switching is set, the conventional velocity gain is used in rapid traverse, and the overridden value is used during cutting feed. The override value is usually set to about 150% to 200%. When vibration occurs only in the stop state, use the variable proportional gain function described in Subsection 5.3.3. (The variable proportional gain function described in Subsection 5.3.3 and the velocity loop high cycle management function described in Subsection 5.3.1 can be used together.)

When servo HRV3 control or HRV4 control is used, a separate override value can be specified during high-speed HRV current control. See Subsection 5.1.4, "High-speed HRV Current Control".

	#7	#6	#5	#4	#3	#2	#1	#0
2202							VGCCR	

0: Disables the cutting/rapid velocity loop gain switching function.
1: Enables the cutting/rapid velocity loop gain switching function.

2107	Velocity loop gain magnification for cutting (%)

[Valid data range] 100 to 400 (A value of 0 indicates the default value (100%).)

Cutting/rapid velocity loop gain switching function		Velocity loop gain [%]
No. 2202#1=0 (disabled)	Always	(1 + No. 2021 / 256) × 100
No. 2202#1=1 (enabled)	Rapid traverse	(1 + No. 2021 / 256) × 100
	Cutting feed	(1 + No. 2021 / 256) × **No. 2107**

(b) Feed-forward, TCMD filter, 1/2 PI current control switching

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

<1> Cutting/rapid feed-forward switching function

The position feed-forward coefficient and the velocity feed-forward coefficient can also be changed. To do this, use the cutting/rapid feed-forward switching function.

	#7	#6	#5	#4	#3	#2	#1	#0
2214				FFCHG				

0: Disables the cutting/rapid feed-forward switching function.

1: Enables the cutting/rapid feed-forward switching function.

Cutting/rapid feed-forward switching function		Position FF	Velocity FF
No. 2214#4=0 (disabled)	Always	No. 2092	No. 2069
No. 2214#4=1 (enabled)	Rapid traverse	No. 2092	No. 2069
	Cutting feed	**No. 2144**	**No. 2145**

<2> TCMD filter switching

When high frequency vibration occurs only in rapid traverse, use of the TCMD filter, rather than the resonance elimination filter, is sometimes effective. On the other hand, when the TCMD filter is used unnecessarily in cutting feed, a delay caused by the filter reduces the stability limit of velocity loop gain. In such a case, using the TCMD filter only for rapid traverse is effective.

2067	TCMD filter coefficient

2156	TCMD filter coefficient for rapid traverse

Cutting/rapid feed-forward switching function		TCMD filter
No. 2156=0 (disabled)	Always	No. 2067
No. 2156≠0 (enabled)	Rapid traverse	**No. 2156**
	Cutting feed	No. 2067

<3> Switching of the current loop 1/2 PI control function in cutting feed and rapid traverse

When the cutting/rapid velocity loop gain switching function is enabled, the current loop 1/2 PI control function is turned off at the time of rapid traverse. Only when current loop 1/2 PI control must be used also for rapid traverse while the cutting/rapid velocity gain switching function is enabled, set the bit for always enabling the current loop 1/2 PI control function.

	#7	#6	#5	#4	#3	#2	#1	#0
2203						CRPI		

0: Disables the current loop 1/2 PI control function.

1: Enables the current loop 1/2 PI control function.

	#7	#6	#5	#4	#3	#2	#1	#0
2202							VGCCR	

0: Always enables the current loop 1/2 PI control function.
1: Enables the current loop 1/2 PI control function for cutting only.

NOTE
Since this function bit is the same as that of the cutting/rapid velocity loop gain switching function, enable bit 2 of parameter No. 2202 to always enable the current loop 1/2 PI control function during use of the cutting/rapid velocity loop gain switching function.

- When the cutting/rapid velocity loop gain switching function is used:

	#7	#6	#5	#4	#3	#2	#1	#0
2202						PIAL		

1: Always enables the current loop 1/2 PI control function.

No. 2203#2=1	No. 2202#1	No. 2202#2
Always enables the current loop 1/2 PI control function.	0	0
	1	**1**
Enables the current loop 1/2 PI control function for cutting only.	1	0

NOTE
To disable the current loop 1/2 PI control function, set bit 2 of parameter No. 2203 to 0.

(c) Position loop gain switching

[Series and editions of applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

<1> Cutting/rapid position loop gain function
The position loop gain is set for cutting and rapid traverse separately so that they can be switched.

NOTE

- If mode switching is performed in a state where the in-position check is set to a large value and position error remains, a shock occurs.
- In addition, if the difference between the cutting and rapid traverse position loop gain settings is large, a shock may also occur.

In such a case, reduce the setting of the in-position check. Alternatively, reduce the difference between the position loop gain settings so that a shock becomes a permissible level.

	#7	#6	#5	#4	#3	#2	#1	#0
2213		PGCCR2						

0: Disables the cutting/rapid traverse position loop gain function.
1: Enables the cutting/rapid traverse position loop gain function.

1825	Position loop gain

2178	Position loop gain for rapid traverse

[Valid data range] 0 to 32767
[Unit of data] 0.01/S

Cutting/rapid position loop gain function		Position loop gain parameters
No.2213#6=0 (disabled)	Always	No.1825
No.2213#6=1 (enabled)	Rapid traverse	**No.2178**
	Cutting feed	No.1825

5.3 VIBRATION SUPPRESSION IN THE STOP STATE

5.3.1 Velocity Loop High Cycle Management Function

(1) Overview

This function makes the stability limit of velocity loop gain higher than before by accelerating velocity loop proportional calculation.

The use of this function enables the following:

- Improvement of the command follow-up characteristic of a velocity loop
- Improvement of the servo rigidity

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2017	PK2V25							

PK2V25 (#7) 1: The velocity loop high cycle management function is used.

Configuration of the control system (for PI function)

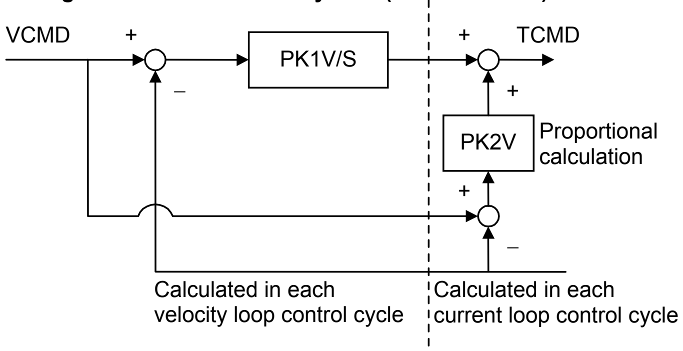


Fig. 5.3.1 (a) Overview of velocity loop high cycle management function

(4) Performance comparison with the acceleration feedback function

	Acceleration feedback function	Velocity loop high cycle management function
Control method	Acceleration feedback is performed at high speed.	Only a velocity loop proportional calculation is made at high speed.
Adjustment method	Set a value of –10 to –20.	Set the function bit.
Effect	This function may prove more effective than the velocity loop high cycle management function, depending on the machine system resonance frequency and intensity.	In general, this function is more effective than the acceleration feedback function in improving the velocity loop gain.

(5) Caution and notes on use

⚠ CAUTION

Depending on the resonance frequency and resonance strength of the machine system, the use of this function may result in machine resonance.
If this occurs, do not use this function.

NOTE

1. When this function is used, the observer function is disabled. To remove high-frequency oscillations, use the resonance elimination filter or torque command filter.
2. The normalization of the machine speed feedback function is disabled. If hunting cannot be eliminated by increasing the velocity loop gain, use the vibration damping control function, which provides a capability similar to the machine speed feedback function.
3. In (torque command) tandem control, velocity loop high cycle management function cannot be used with Series 9096. To use velocity loop high cycle management function with Series 9096, velocity command tandem control must be enabled before the high cycle management function is enabled.
4. When this function is used, some functions are restricted as follows:

Unavailable function	Function with restricted usage
Non-linear control	Machine speed feedback; normalization not performed
Acceleration feedback	Observer used for unexpected disturbance torque detection
N pulses suppression function	

5.3.2 Acceleration Feedback Function

(1) Overview

The acceleration feedback function is used to control velocity loop oscillation by using motor speed feedback signal multiplied by the acceleration feedback gain to compensate the torque command.
This function stabilizes the servo system when vibration of approximately 50 to 150 Hz occurs in a machine in which, for example:

- The motor and machine system are spring-coupled with each other.
- The external inertia is larger than the motor inertia.

Fig 5.3.2 is a velocity loop block diagram that includes acceleration feedback function.

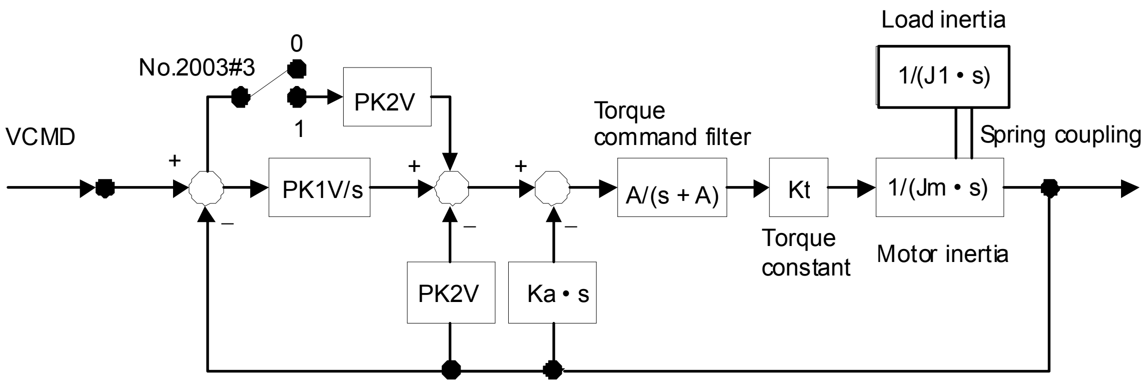


Fig. 5.3.2 (a) Velocity loop block diagram that includes acceleration feedback function

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

Specifying the following parameters as a negative value enables the acceleration feedback function.

2066	Acceleration feedback gain

[Valid data range] -10 to -20

(4) Caution and note

> ⚠ **CAUTION**
> If the acceleration feedback gain is too large, abnormal sound or vibration can occur during acc./dec.
> To solve this problem, reduce the gain.

> **NOTE**
> This function is disabled when the velocity loop high cycle management function (see Subsection 5.3.1) is used.

5.3.3 Variable Proportional Gain Function in the Stop State

(1) Overview

The velocity gain or load inertia ratio is generally increased if a large load inertia is applied to a motor, or to improve the response. An excessively large velocity gain may cause the motor to generate a high-frequency vibration when it stops. This vibration is caused by excessive proportional gain of the velocity loop (PK2V) when the motor is released within the backlash of the machine in the stop state.
This function decreases the velocity loop proportional gain (PK2V) in the stop state only. The function can suppress the vibration in the stop state and also enables the setting of a high velocity gain.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2016					PK2VDN			

PK2VDN (#3) 1: The variable proportional gain function in the stop state is used.

2119	Variable proportional gain function in the stop state : Stop judgment level

[Unit of data] Detection unit
[Recommended value]
2 to 10 (Detection unit: 1 μm)
20 to 100 (Detection unit: 0.1 μm)

In addition to the specification for reducing the proportional gain to 75% of the set value in the stop state, the function for reducing the proportional gain to 50% of the set value and the function for arbitrarily setting the magnification only during cutting feed are provided. When decreasing the velocity loop proportional gain in the stop state to 50%, set the following bit parameter in addition to the function bit for the function for changing the proportional gain in the stop state and the parameter for stop determination level.

	#7	#6	#5	#4	#3	#2	#1	#0
2207					PK2D50			

PK2D50 (#3) When the variable proportional gain function in the stop state enabled (K2VDN = 1):
0: The velocity loop proportional gain in the stop state is 75%.
1: The velocity loop proportional gain in the stop state is 50%.

When an arbitrary magnification is used for a proportional gain in the stop state during cutting feed, set the function bit for stop judgment level of the function for changing the proportional gain in the stop state. In addition, set the following parameter:

2324	**Variable proportional gain function in the stop state : Arbitrary magnification in the stop state (during cutting feed only)**

[Unit of data] %
[Recommended value]
25 to 100

(4) Example of parameter setting

(a) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is not used, and
Bit 3 of No. 2016 = 1
Actual velocity gain in the stop state=(velocity gain setting)×0.75

(b) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is not used,
Bit 3 of No. 2016 = 1 and bit 3 of No. 2207 = 1
Actual velocity gain in the stop state=(velocity gain setting)×0.5

(c) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is not used,
Bit 3 of No. 2016 = 1 and No. 2324 = α
Actual velocity gain in the stop state=(velocity gain setting)×α/100

When the absolute value of an error is lower than the stop judgment level, the function changes the proportional gain of the velocity loop (PK2V) to 75% or 50% of the set value.
If the machine vibrates while in the stop state, enable this function and set a value greater than the absolute value of the error causing the vibration as the stop judgment level. The function cannot stop the vibration of a machine in the stop state when the current velocity loop proportional gain is too high. If this occurs, reduce the velocity loop proportional gain.

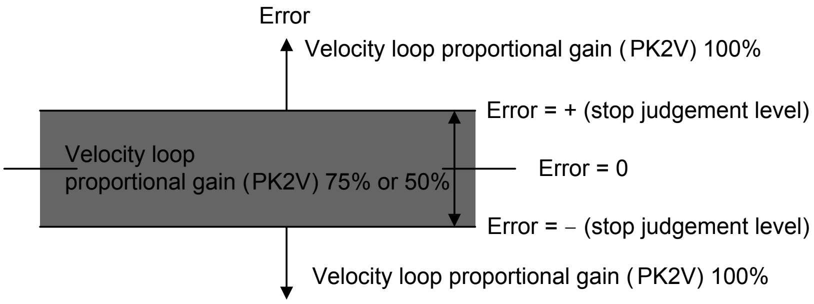


Fig. 5.3.3 (a) Relationship between error and velocity loop proportional gain (PK2V)

[Tip] Example of setting an arbitrary magnification in the stop state

(a) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is used, and
Bit 3 of No. 2016 = 1
- If the mode in the stop state is the cutting mode:
  Actual velocity gain in the stop state = (velocity gain setting for cutting) × 0.75
- If the mode in the stop state is the rapid traverse mode:
  Actual velocity gain in the stop state = (velocity gain setting for rapid traverse) × 0.75

(b) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is used,
Bit 3 of No. 2016 = 1 and bit 3 of No. 2207 = 1
- If the mode in the stop state is the cutting mode:
  Actual velocity gain in the stop state = (velocity gain setting for cutting) × 0.5

- If the mode in the stop state is the rapid traverse mode:
  Actual velocity gain in the stop state = (velocity gain setting for rapid traverse) × 0.5

(c) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is used,
Bit 3 of No. 2016 = 1 and No. 2324 = α

- If the mode in the stop state is the cutting mode:
  Actual velocity gain in the stop state = (velocity gain setting for cutting) × α/100
- If the mode in the stop state is the rapid traverse mode:
  Actual velocity gain in the stop state = (velocity gain setting for rapid traverse) × 0.75

(d) When the cutting feed/rapid traverse switchable velocity loop gain function (see Section. 4.3) is used,
Bit 3 of No. 2016 = 1, bit 3 of No. 2207 = 1, and No. 2324 = α

- If the mode in the stop state is the cutting mode:
  Actual velocity gain in the stop state = (velocity gain setting for cutting) × α/100
- If the mode in the stop state is the rapid traverse mode:
  Actual velocity gain in the stop state = (velocity gain setting for rapid traverse) × 0.5

5.3.4 Current Loop 1/2 PI Control Function

(1) Overview

To improve servo performance in high-speed and high-precision machining, high-speed positioning, ultrahigh-precision positioning, and so forth, a velocity loop gain as high as possible needs to be set stably.
To set a high velocity loop gain stably, the response of the current loop needs to be improved.
The current loop 1/2 PI control function enables the response of the current loop to be improved.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Control method

As shown in Fig. 5.3.4 (a), in the area where a small current flows, a current loop calculation is based on PI control rather than on the conventional I-P control method. When a large current flows, the control method returns to I-P control to suppress a current overshoot.

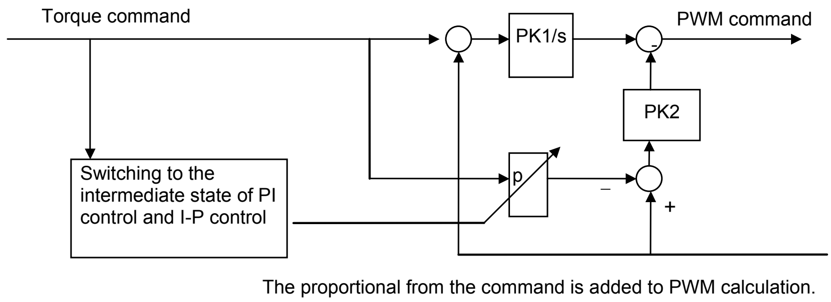


Fig. 5.3.4 (a) Block diagram of current loop 1/2PI control

(4) Setting parameters

<1> Enabling the current loop 1/2 PI control function at all times

	#7	#6	#5	#4	#3	#2	#1	#0
2203						CRPI		

CRPI (#2) 1: To enable the current loop 1/2 PI control function

<2> To enable the function for cutting only, use the following bit in addition to the previous bit:

	#7	#6	#5	#4	#3	#2	#1	#0
2202							VGCCR	

VGCCR (#1) 1: To enable the current loop 1/2 PI control function for cutting only
(This function is used together with the cutting feed/rapid traverse velocity loop gain switch function.)

<3> To enable the function at all times while using bit 1 of parameter No. 2202, use the following bit in addition to the settings of <1> and <2>:

	#7	#6	#5	#4	#3	#2	#1	#0
2202						PIAL		

PIAL (#2) 1: To enable the current loop 1/2 PI control function at all times
(When this function is used together with the cutting feed/rapid traverse velocity loop gain switch function)

> ⚠ **CAUTION**
> If the motor activation sound or vibration in the stop state increases when this parameter is set, do not use this parameter.

(5) Current control PI rate modification

The current control PI rate (p in Fig. 5.3.4(a)) is usually fixed at 1/2, but can be changed freely.

2323	Current control PI rate

[Valid data range] 0 to 4096
[Unit of data] 4096 represents p = 1.0 (complete PI).
When the value 0 is specified, the specification of 2048 (1/2PI), which is equivalent to p = 0.5, is assumed.

> ⚠ **CAUTION**
> If you need to increase the velocity gain, in particular, a value greater than 1/2PI may be set. However, do not use this parameter usually.

5.4 MACHINE RESONANCE ELIMINATION FUNCTION

5.4.1 Selecting a Resonance Elimination Function

The frequency band where the resonance elimination functions produce elimination effects varies from one function to another. Check the resonance frequency in question with SERVO GUIDE or a vibrometer then select a resonance elimination function according to the frequency.
The figure below shows the classified functions and their effective resonance frequency bands.

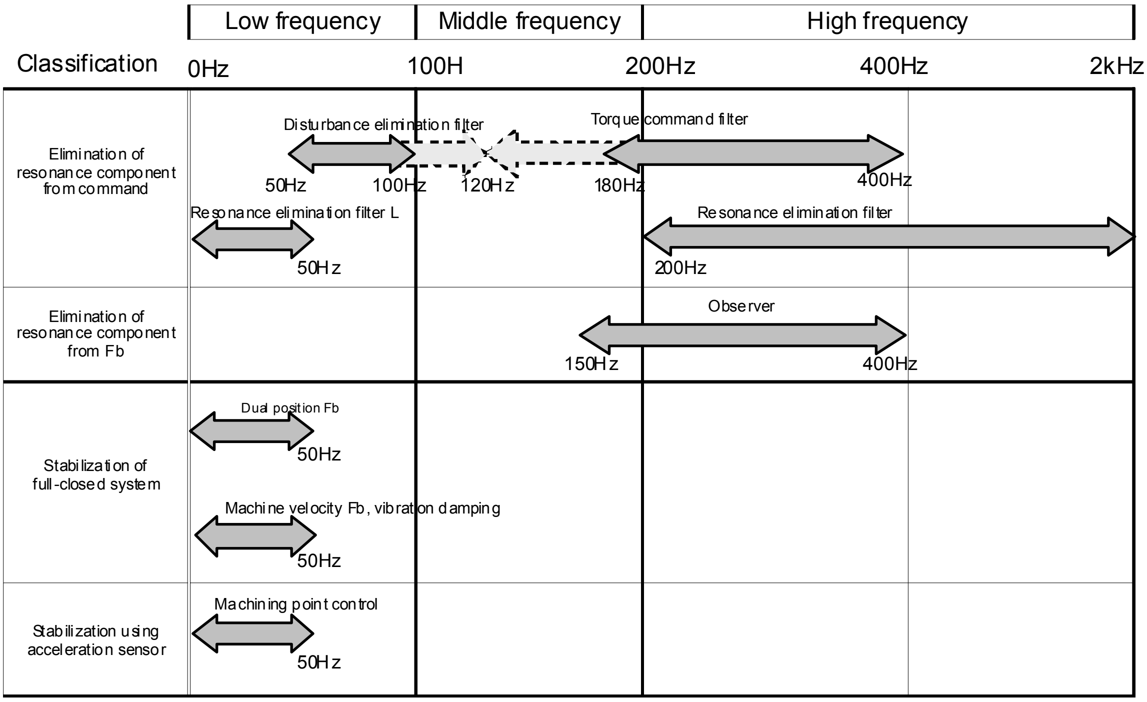


Fig. 5.4.1 (a) Resonance elimination functions and frequency bands

* The figure above shows guideline frequencies.
* For vibration at 100 Hz to 180 Hz, a disturbance elimination filter or torque command filter may be useful. A vibration improvement may be made by applying the current loop 1/2PI function or by fine velocity loop gain tuning.
* The observer function may have an adverse effect such as instability produced at stop time. For resonance elimination at middle to high frequencies, try a torque command filter or resonance filter first. Only when resonance still exists, use the observer function.
* The resonance elimination functions for use at low frequencies have the following features:

Function	Feature
Resonance elimination filter L	Parameter setting is easy, and a large resonance elimination effect can be expected. However, precision degradation (such as overshoot) is unavoidable. So, this function is not suitable for applications that require high precision. By using an exclusion rate, the precision and elimination effect need to be balanced.
Disturbance elimination filter	This function compensates for a torque command, so that precision is less affected. However, the maximum torque may decrease.
Dual position Fb, machine velocity Fb, vibration damping control	These functions are dedicated to a full-closed system and improve vibration (instability) caused by a twist between the motor and scale. The order of effect is: Dual position Fb > Machine velocity Fb = Vibration damping control.
Machining point control	This function has a limited influence on precision and produces a high elimination effect. Depending on the setting of gain, an acceleration loop may oscillate. An acceleration sensor needs to be installed.

5.4.2 Torque Command Filter (Middle-Frequency Resonance Elimination Filter)

(1) Overview

The torque command filter applies a primary low-pass filter to the torque command.

If the machine resonates at one hundred Hz or over, this function eliminates resonance at such high frequencies.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Explanation

Fig. 5.4.2 (a) shows the configuration of a velocity loop including the torque command filter.

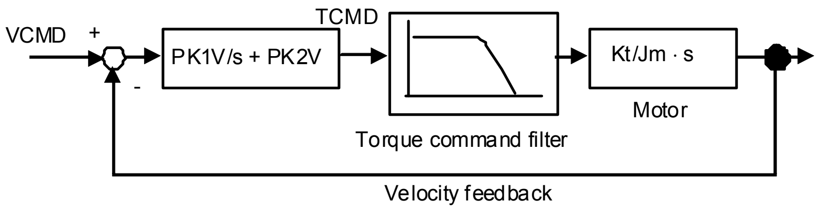


Fig. 5.4.2 (a) Configuration of velocity loop including torque command filter

As shown in Fig. 5.4.2(a), the torque command filter applies a low–pass filter to the torque command. When the machine has a resonance frequency of 100 Hz or higher, the components are included in the velocity feedback in Fig. 5.4.2 (a) and the resonance components may be amplified by the proportional of the velocity loop. However, the resonance is prevented by interrupting the high–frequency component of the torque command using the filter.

(4) Proper use of the observer and torque command filter

The torque command filter is set in the forward direction. Therefore, there are fewer bad influences exerted upon the entire velocity control system than the observer that filters a feedback signal. If the resonance is very strong and it cannot be eliminated, use the observer.
Use the torque command filter first when the mechanical system resonates at high frequency. If the resonance cannot be eliminated, use the observer.

(5) Setting parameters

2067	Torque command filter (FILTER)

[Typical setting] 1166 (200 Hz) to 2327 (90 Hz)
When changing the torque command filter setting, see Table 5.4.2.
As the cut-off frequency, select the parameter value corresponding to a half of the vibration frequency from the table below.

(Example)
In the case of 200-Hz vibration, select a cutoff frequency of 100 Hz for the torque command filter, and set FILTER = 2185.

> ⚠ **CAUTION**
> Do not specify 2400 or a greater value. Such a high value may increase the vibration.

Table 5.4.2 (a) Parameter setting value of torque command filter

Cutoff frequency (Hz)	Setting value of parameter	Cutoff frequency (Hz)	Setting value of parameter
90	2327	170	1408
95	2255	180	1322
100	2185	190	1241
110	2052	200	1166
120	1927	220	1028
130	1810	240	907
140	1700	260	800
150	1596	280	705
160	1499	300	622

(6) Cutting feed/rapid traverse switchable torque command filter

With this function, the torque command filter coefficient can be switched between rapid traverse and cutting feed to improve contouring accuracy during cutting and increase a maximum feedrate and maximum acceleration during rapid traverse at the same time.

2156	Torque command filter coefficient for rapid traverse

[Valid data range] 1166 (200 Hz) to 2327 (90 Hz)

When 0 is set, the cutting feed/rapid traverse switchable torque command filter is disabled. The normal filter coefficient (No. 2067) is used at all times.

When a value other than 0 is set, No. 2156 is used for stop time, rapid traverse, and jog feed, and No. 2067 is used for cutting only.

5.4.3 Resonance Elimination Filter Function (High-Frequency Resonance Elimination Filter)

(1) Overview

A filter function for removing high-speed resonance is added. With this function, high-speed resonance can be removed to set a higher velocity loop gain.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Control block diagram

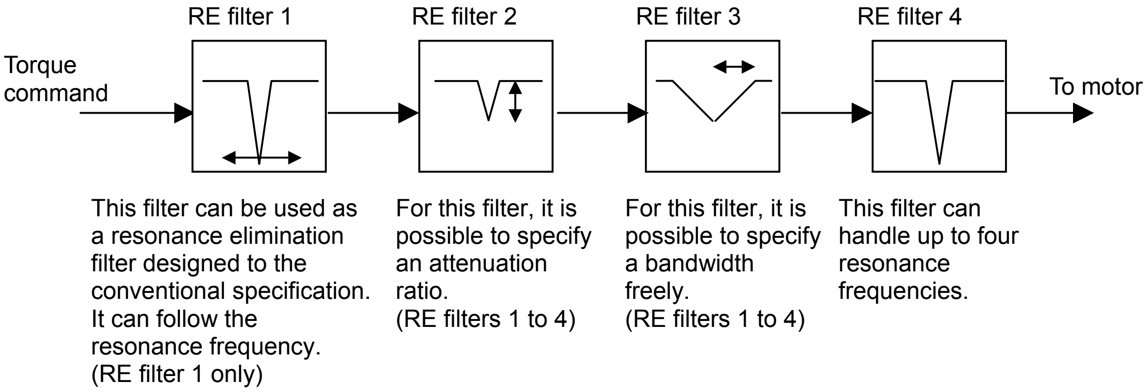


Fig. 5.4.3 (a) Overview of a resonance elimination filter

(4) Setting parameters

> ⚠ **CAUTION**
> 1 If the frequency of a resonance elimination filter is set to a low frequency around 100 Hz, the control system can become unstable, resulting in a large vibration.
> 2 Modify parameters in the emergency stop state.

(5) Setting parameters

<1> Setting for resonance elimination filters 2 to 4

The resonance elimination filter has a function for cutting signals of a particular frequency band. Three parameters are used for this filter. They specify the center frequency of a range to be cut, a bandwidth to be cut, and damping separately.

2360	RE filter 2 : Attenuation center frequency

[Valid data range] 96 to 1000(HRV1 or HRV2), 96 to 2000(HRV3), 96 to 4000(HRV4) (independent of the damping setting)
[Unit of data] Hz

2361	RE filter 2 : Attenuation bandwidth

[Valid data range] 0 to attenuation center frequency (independent of the damping setting)
[Unit of data] Hz

2362	RE filter 2 : Damping

[Valid data range] 0 to 100 (If it is 0, the attenuation ratio is maximized.)
[Unit of data] %

Resonance elimination filters 3 and 4 have the same specification as resonance elimination filter 2.

2363	RE filter 3 : Attenuation center frequency

2364	RE filter 3 : Attenuation bandwidth

2365	RE filter 3 : Damping

2366	RE filter 4 : Attenuation center frequency

2367	RE filter 4 : Attenuation bandwidth

2368	RE filter 4 : Damping

	#7	#6	#5	#4	#3	#2	#1	#0
2221		QNOTCH					LNOTCH	

LNOTCH(#1) 0: Resonance elimination filter 4 is used.
1: Resonance elimination filter L is used.

(90G0/17.0 and subsequent editions)
QNOTCH(#6) Resonance elimination filter 4 has:
0: The standard specification.
1: The extended frequency specification.

Table 5.4.3 (a) Extension of the setting range of the attenuation center frequency of resonance elimination filter 4

	HRV1, HRV2	HRV3	HRV4
Setting range of attenuation center frequency No. 2366 (No.2221#6=0)	96 to 1000	96 to 2000	96 to 4000
Setting range of attenuation center frequency No. 2366 (No.2221#6=1)	96 to 2000	96 to 4000	96 to 4000

⚠ **CAUTION**
1 For resonance elimination filters 2 to 4, there is no specification that supports compatibility with conventional resonance elimination filters. Even if damping = 0, an arbitrary attenuation bandwidth can be specified for them.
2 Resonance elimination filters 2 to 4 are enabled if a nonzero value is set in the attenuation bandwidth or damping parameters for them. If you do not want use these resonance elimination filters, reset all the three parameters (attenuation center frequency, attenuation bandwidth, and damping) to 0.

<2> Setting for resonance elimination filter 1

Only resonance elimination filter 1 has the conventional specification if the damping is 0 and the improved specification if the damping is not 0.

2113	RE filter 1 : Attenuation center frequency

[Valid data range] 250 to 992 (if damping = 0)
96 to 1000(HRV1 or HRV2), 96 to 2000(HRV3), 96 to 4000(HRV4) (if damping ≠ 0)
[Unit of data] Hz

2177	RE filter 1 : Attenuation bandwidth

[Valid data range] 20, 30, 40 (if damping = 0) (0 to attenuation center frequency for 30*i*-B)
0 to attenuation center frequency (if damping ≠ 0)
[Unit of data] Hz

2359	RE filter 1 : Damping

[Valid data range] 0 (If it is 0, the resonance elimination filer has the conventional specification.)
1 to 100 (If it is 1, the attenuation ratio is maximized. For resonance elimination filer 1.)
[Unit of data] %

⚠ **CAUTION**

1 If damping = 0 for resonance elimination filter 1, this filter has the same specification as for conventional resonance elimination filters. So, its attenuation bandwidth can be set only to 20, 30, or 40 Hz (specification compatible with conventional resonance elimination filters). In 30*i*-B Series, even if damping = 0, resonance elimination filter 1 has the improved specification. (The specification compatible with conventional resonance elimination filters is not supported.)

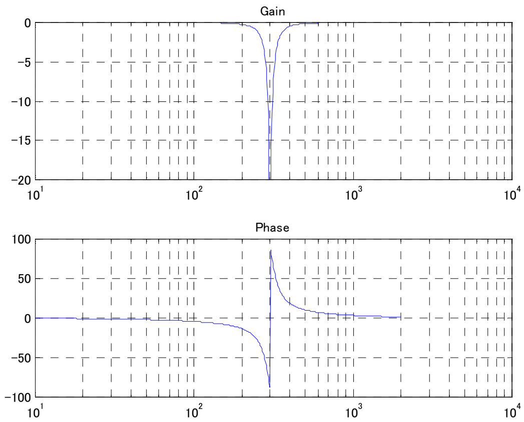
2 Resonance elimination filter 1 is enabled if a nonzero value is set in the attenuation bandwidth or damping parameter for it. If you do not want use the resonance elimination filter, reset all the three parameters (attenuation center frequency, attenuation bandwidth, and damping) to 0.

[Parameters for resonance elimination filters]

	Attenuation center frequency [Hz]	Attenuation bandwidth	Damping
Resonance elimination filter 2	No.2360	No.2361	No.2362
Resonance elimination filter 3	No.2363	No.2364	No.2365
Resonance elimination filter 4	No.2366	No.2367	No.2368
Resonance elimination filter 1	No.2113	No.2177	No.2359

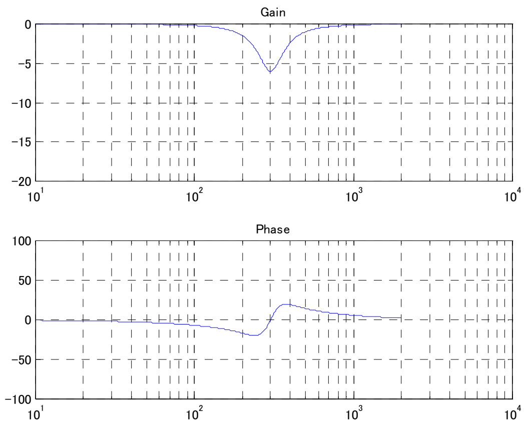
(6) Example of filter characteristics

<1> Conventional resonance elimination filter



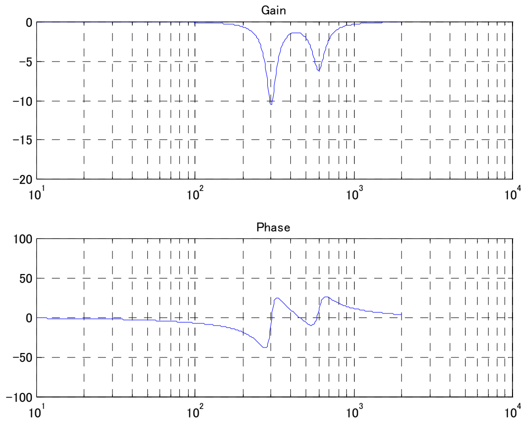
Center frequency = 300 Hz
Bandwidth = 30 Hz
Damping = 0

<2> Improved resonance elimination filter (with damping)



Center frequency = 300 Hz
Bandwidth = 100 Hz
Damping = 50%

<3> Improved resonance elimination filter (with two stages of damping)



(First stage)
Center frequency = 300 Hz
Bandwidth = 50 Hz
Damping = 30%
(Second stage)
Center frequency = 600 Hz
Bandwidth = 100 Hz
Damping = 50%

5.4.4 Disturbance Elimination Filter Function (Low-Frequency Resonance Elimination Filter)

(1) Overview

The disturbance elimination filter function estimates a disturbance by comparing a specified torque with the actual velocity, and feeds forward the estimation to the specified torque to suppress the effect of the disturbance. In particular, this function is useful for a vibration of 50 Hz to 100 Hz.

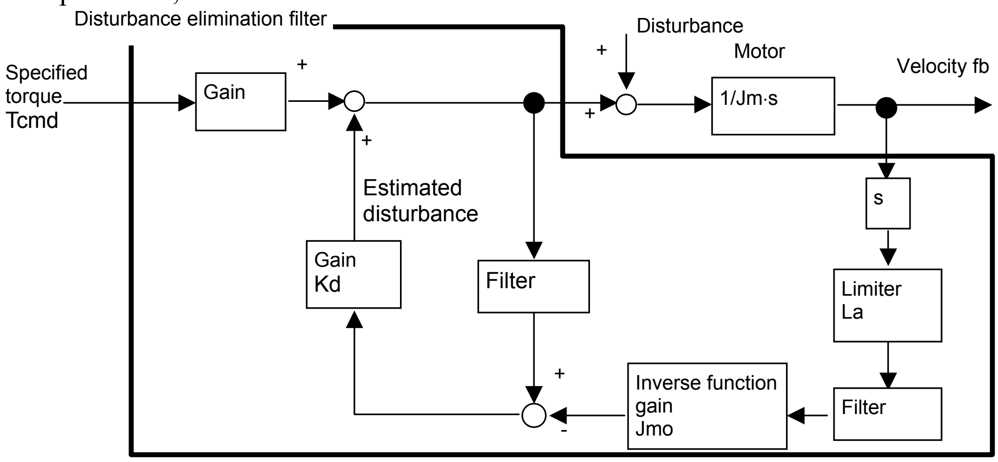


Fig. 5.4.4 (a) Configuration of disturbance elimination filter

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2223								DISOBS

DISOBS (#0) The disturbance elimination filter function is:
0 : Disabled.
1 : Enabled.

2318	Disturbance elimination filter gain (Kd)

[Valid data range] 101 to 500
[Typical setting] 500

> **NOTE**
> If a gain of 0 to 100 is set, the disturbance elimination filter function does not operate.

2319	Inertia ratio (Rj) (%)

[Valid data range] 0 to 32767
[Typical setting] 100
Set an inertia ratio (= machine inertia/motor inertia) in %.
Usually, set 100%.

2320	Inverse function gain (Jmo)

[Valid data range] 100 to 2000
[Initial setting] 100 (Increase the setting step by step.)
Set an inverse function gain as a conversion coefficient for acceleration-to-TCMD conversion. This parameter needs to be adjusted. As a guideline, set a value not greater than the value obtained by the following expressions:
Linear motor (The detection unit of the scale is assumed to be p μm.)

Jmo = 466048×p×Jm/Kt/Imax

Rotary motor

Jmo = 1396264×Jm/Kt/Imax

Jm: Weight [kg] or inertia [kgm^2]
Kt: Torque constant [N/Ap] or [Nm/Ap]
Imax: Maximum amplifier current [Ap]

> **NOTE**
> If an excessively large gain value is set, an abnormal sound and vibration can occur.

2321	Filter time constant (Tp)

- When HRV1, HRV2, or HRV3 is used:

[Valid data range] 0 to 4096
[Typical setting] 3700 (equivalent to T = 10 ms).
* Usually, this value does not need to be changed.
Set a filter time constant for determining an estimated disturbance velocity by using the following expression:
Tp = 4096 × exp (-t/T)
T: Setting time constant [sec], t = 0.001 [sec]

- When HRV4 is used:

[Valid data range] 0 to 4096
[Typical setting] 3994 (equivalent to T = 10 ms).
* Usually, this value does not need to be changed.

Set a filter time constant for determining an estimated disturbance velocity by using the following expression:
Tp = 4096 × exp (-t/T)
T: Setting time constant [sec], t = 0.00025 [sec]

2322	Acceleration feedback limit (La)

[Valid data range] 0 to 7282
[Typical setting] 1000

Set a limiter for a feedback torque calculated from acceleration. This parameter suppresses an excessive motion at the time of adjustment.
The value 7282 represents a maximum amplifier current. When a 160-A amplifier is used, for example, the value 1000 is equivalent to 22 A.

NOTE
In a case where a value close to the torque limit may be used, the torque is limited if the acceleration feedback limit is not increased.

(4) Procedure

(1) Make an adjustment according to the procedure below. First, disable those functions that operate only in the stop state such as the function for changing the proportional gain in the stop state.
For determining the resonance frequency and adjusting the disturbance elimination filter, use frequency characteristics measurement by SERVO GUIDE.

(2) Enable the disturbance elimination filter function, set the disturbance elimination filter gain to 100 (not functioning), then measure the frequency characteristics.
With SERVO GUIDE, observe the response waveform obtained during the above measurement, and set the input amplitude (to about 500) to allow the waveform to be observed and machine sound to be heard. A sinusoidal torque command is used, so that the command does not generate a torque in one direction. The command is to be executed away from the machine stroke limits.

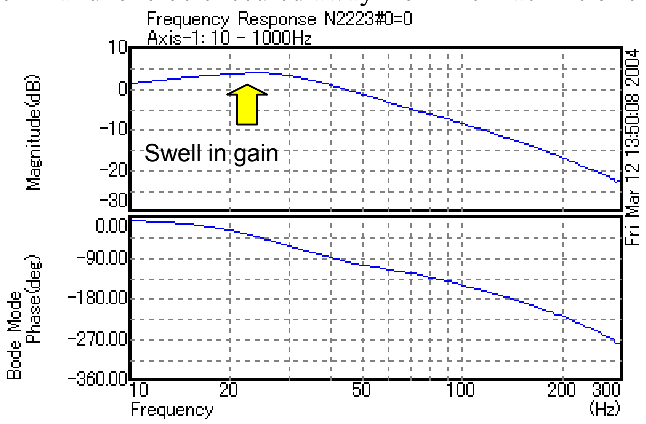


Fig. 5.4.4 (b) Measurement example using SERVO GUIDE (before adjustment)

(3) Set the disturbance elimination filter gain to 500 and check the frequency characteristics with SERVO GUIDE while increasing the gain for inverse model starting with 100 in steps of 100. Adjust the value so that the gain swell part becomes small.

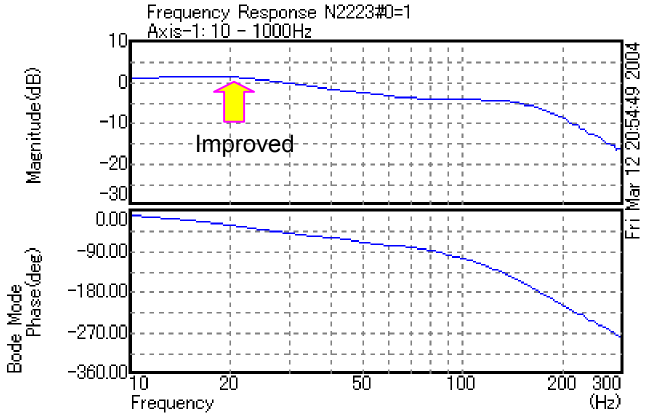


Fig. 5.4.4 (c) Measurement example using SERVO GUIDE (after adjustment)

(4) Note that the velocity loop gain of higher frequencies is increased and even a violent vibration may be caused simply by enabling the disturbance elimination filter function. If a vibration occurs, increase the inverse function gain gradually, and check the vibration of the torque command. If the vibration becomes greater, decrease the inverse function gain. If the vibration can not be reduced by increasing and decreasing the inverse function gain, change the filter time constant by ±50 to eliminate the vibration.

(5) If the frequency of vibration is higher than 100 Hz, use a separate machine resonance prevention function such as the vibration suppression filter and torque command filter.

5.4.5 Resonance Elimination Filter L (Low-Frequency Resonance Elimination Filter)

(1) Overview

The resonance elimination filter L function eliminates low-frequency vibration by applying a filter designed to eliminate low-frequency components to a feed-forward command/velocity command.
This function reduces low-frequency vibration but can degrade contouring accuracy in high-speed feed. Before using this function, check the accuracy.

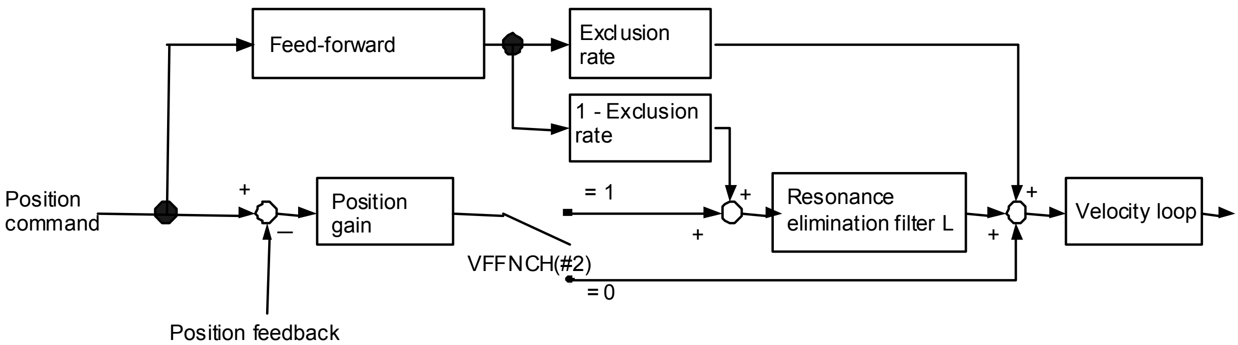


Fig. 5.4.5 (a) Configuration of a position loop including resonance elimination filter L

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	P(16) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

For resonance elimination filter L, the fourth-stage parameter of an ordinary resonance elimination filter for the torque command is used.
So, the two filters cannot be used at the same time.
To use the resonance elimination filter L function, enable the function bit (LNOTCH) below.

	#7	#6	#5	#4	#3	#2	#1	#0
2221						VFFNCH	LNOTCH	

LNOTCH(#1)
- 0: Uses resonance elimination filter 4.
- 1: Uses resonance elimination filter L.

VFFNCH(#2) Resonance elimination filter L is applied to:
- 0: Feed-forward part only of the velocity command (← Default)
- 1: Entire velocity command

NOTE
1 To enhance the elimination effect, set VFFNCH to 1.
2 When this parameter is set, the power must be turned off before operation is continued.

Set the following filter parameters:

2366	Resonance elimination filter L/resonance elimination filter 4 attenuation center frequency

[Valid data range] 5 to 50
[Unit of data] Hz

2367	Resonance elimination filter L/resonance elimination filter 4 attenuation bandwidth

[Valid data range] 3 to 20
[Unit of data] Hz

2368	Resonance elimination filter L/resonance elimination filter 4 damping

[Valid data range] 10 to 100 (A maximum attenuation rate is specified when 0 is set.)
[Unit of data] %

⚠ CAUTION
To stop the use of this function, be sure to set all parameters above to 0 then restart the CNC.

> **NOTE**
> When the value 4 or a smaller number is specified as the attenuation center frequency, an illegal parameter setting alarm (detail number 3663 or 3603) is issued. Set the value 5 or a greater number.

2356	**Resonance elimination filter L/feed-forward filter exclusion rate**

[Valid data range] 0 to 100

[Unit of data] %

When resonance elimination filter L is applied to the feed-forward part, contouring accuracy can degrade. So, this function is used to balance contouring accuracy and the effect of resonance elimination.

When 100% is set, this filter is not applied to the feed-forward part.

When 50% is set, this filter is applied to a half of the feed-forward part.

Exclusion rate 100%	Exclusion rate 50%	Exclusion rate 0%
Contouring accuracy High Elimination effect Low	Observe contouring accuracy and elimination effect for optimum value adjustment.	Contouring accuracy Low Elimination effect High

Example of effect

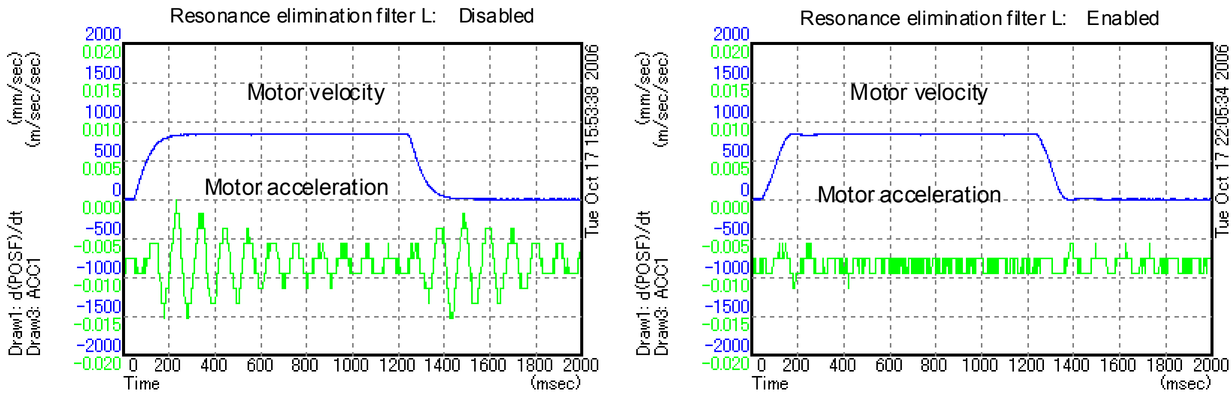


Fig. 5.4.5 (b) Effects of resonance elimination filter L

5.4.6 Observer Function

(1) Overview

The observer is used to eliminate the high-frequency component and to stabilize a velocity loop when a mechanical system resonates at high frequency of several hundred Hertz.

The observer is a status observer that estimates the controlled status variables using the software.

In a digital servo system, the speed and disturbance torque in the control system are defined as status variables. They are also estimated in the observer. An estimated speed consisting of two estimated values is used as feedback. The observer interrupts the high-frequency component of the actual speed when it estimates the speed. High-frequency vibration can thus be eliminated.

(2) Explanation

Fig. 5.4.6 (a) shows a block diagram of the velocity loop including an observer.

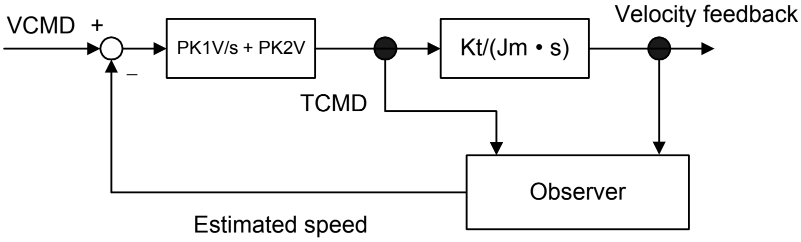


Fig. 5.4.6 (a) Configuration of velocity loop including observer

Fig. 5.4.6 (b) shows a block diagram of the observer.

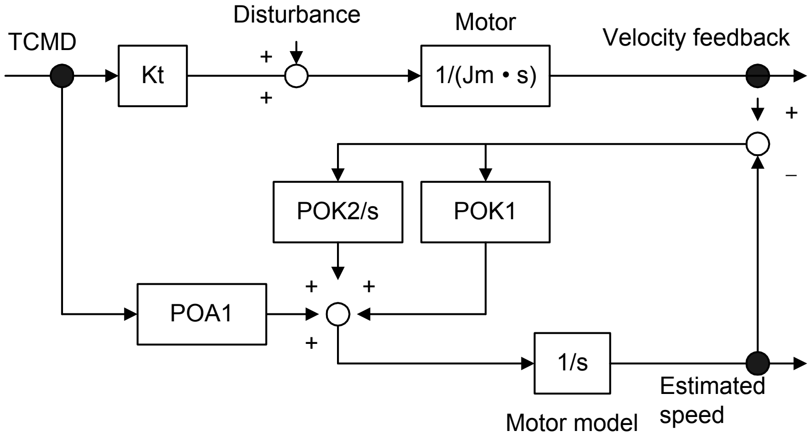


Fig. 5.4.6 (b) Block diagram of the observer

POA1, POK1, and POK2 in Fig. 5.4.6 (b) correspond to digital servo parameters. The observer has an integrator as a motor model. POA1 is a coefficient that converts the torque command into motor acceleration and is the characteristic value of the motor. The motor model is accelerated by this value. The actual motor is also accelerated by the torque and disturbance torque that it generates.

The disturbance torque works on the actual motor. There is a time lag in the current loop. The POA1 value does not completely coincide with the characteristic value of actual motor. This is why the motor's actual velocity differs from the motor speed estimated by an observer. The observer is compensated by this difference. The motor model is compensated proportionally (POK1), and the observer is compensated integrally (POK2/s).

POK1 and POK2 act as a secondary low–pass filter between the actual speed and estimated speed. The cutoff frequency and damping of the filter are determined by the POK1 and POK2 values. The difference between the observer and low-pass filter lies in the existence of a POA1 term. Using POA1, the observer's motor model can output an estimated speed that has a smaller phase delay than the low–pass filter.

When an observer function is validated, the estimated speed in Fig. 5.4.6 (b) is used as velocity feedback to the velocity control loop. A high-frequency component (100 Hz or more) contained in the actual motor speed due to the disturbance torque's influence may be further amplified by the velocity loop, making the entire system vibrate at high frequency. The high frequency contained in the motor's actual speed is eliminated by using the velocity feedback that the observer outputs. High-frequency vibration can be suppressed by feeding back a low frequency with the phase delay suppressed.

In some systems, the use of the observer function can suppress vibration during movement but makes the machine unstable while it is in the stop state. In such cases, use the function for disabling the observer in the stop state, as explained in Art. (7) of this section.

(3) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(4) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2003						OBEN		

OBEN (#2) 1: To enable the observer function

2047	Observer coefficient (POA1)

[Setting value] Keep the standard setting unchanged.

2050	Observer coefficient (POK1)

- When HRV1, HRV2, or HRV3 is used:

[Setting value] Usually, use the standard setting.

- When HRV4 is used:

[Setting value] 956 → To be changed to 264

2051	Observer coefficient (POK2)

- When HRV1, HRV2, or HRV3 is used:

[Setting value] Usually, use the standard setting.

- When HRV4 is used:

[Setting value] 510 → To be changed to 35

(5) Note

As shown in Fig. 5.4.6 (a), the standard parameters are set so that the cutoff frequency of the filter becomes 30 Hz. With this setting, the effect of filtering becomes remarkable at resonance frequencies above the range of 150 Hz to 180 Hz.
To change the cutoff frequency, set parameters POK1 and POK2 to a value listed below, while paying attention to Table 5.4.6 (a):
Generally, the observer function does not work unless its cutoff frequency is held below Fd/5 or Fd/6, where Fd is the frequency component of an external disturbance. However, if this bandwidth is some 20 Hz or lower, the velocity loop gain also drops or becomes unstable, possibly causing a fluctuation or wavelike variation.

Table 5.4.6 (a) Changing the observer cutoff frequency

Cutoff frequency (Hz)	HRV1, HRV2, HRV3		HRV4	
	POK1	POK2	POK1	POK2
10	348	62	90	4
20	666	237	178	16
30	956	510	264	35
40	1220	867	348	62
50	1460	1297	430	96

Cutoff frequency (Hz)	HRV1, HRV2, HRV3		HRV4	
	POK1	POK2	POK1	POK2
60	1677	1788	511	136
70	1874	2332	1874	183

(6) Setting observer parameters when the unexpected disturbance torque detection function is used

The unexpected disturbance torque detection function (see Section 5.9) uses the observer circuit shown in Fig. 5.4.6 (b) to calculate an estimated disturbance. In this case, to improve the speed of calculation, change the settings of observer parameters POA1, POK1, and POK2 by following the explanation given in Section 5.9.

When the observer function and unexpected disturbance torque detection function are used together, however, the defaults for POK1 and POK2 must be used.

(7) Stop time observer disable function

If the observer function is enabled, the machine may fluctuate and become unstable when it stops. Such a fluctuation or unstable operation can be prevented by disabling the observer function only in the stop state.

(8) Setting parameters

<1> Function bit

	#7	#6	#5	#4	#3	#2	#1	#0
2018							MOVOBS	

MOVOBS (#1) The function for disabling the observer in the stop state is:

0: Disabled

1: Enabled ← Set this value.

<2> Level at which the observer is determined as being disabled

2119	Level at which the observer is determined as being disabled

[Unit of data] Detection unit

[Typical setting] 1 to 10

If the absolute value of the position error is less than the level at which the observer is determined as being disabled, the observer function is disabled.

NOTE
This parameter is also used for the stop determination level of the function for changing the proportional gain in the stop state.

(Usage)

Set the function bit and the level at which the observer is determined as being disabled so that it is greater than the peak absolute value of the oscillating position error.

5.4.7 Vibration Damping Control Function

(1) Overview

In a closed-loop system, the Pulsecoder on the motor is used for velocity control and a separate detector is used for position control.

During acceleration/deceleration, the connection between the motor and machine is distorted and causes the speed of the machine to slightly differ from the actual motor speed, making it difficult to properly control the machine (reduce vibration on the machine) in some cases.

The vibration damping control function feeds back the difference between the speeds on the motor and machine (speed transfer error) to the torque command, to reduce vibration on the machine.

This function has the effect of the machine velocity feedback function, but is superior to the machine velocity feedback function in that restrictions as imposed with the machine velocity feedback function are eliminated.

(2) Control method

The following figure shows the block diagram for vibration damping control:

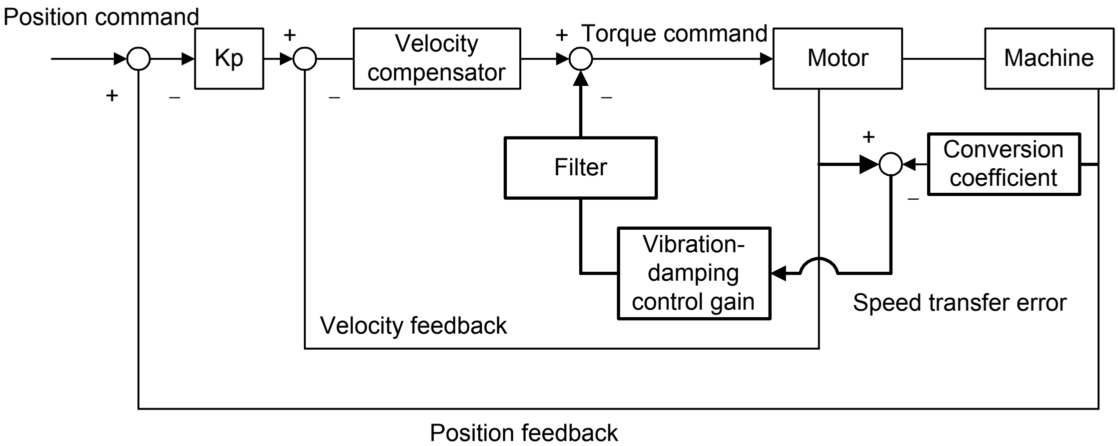


Fig. 5.4.7 (a) Block diagram for vibration damping control

(3) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	015.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(4) Setting parameters

2033	Number of position feedback pulses for vibration damping control conversion coefficient

[Valid data range] -32767 to 32767

When 0 is set, this function is disabled.

If a negative value is specified, it is internally read as 10 times the specified value. (-1000=10000)

When a flexible feed gear (F·FG) is used (In the case of using the A/B phase separate type detector and analog SDU)
Set value = Number of feedback pulses per motor revolution, received from a separate detector/8

(Example 1)

With a 5 mm/rev ball screw, 0.5 μm/pulse separate detector, and a detection unit of 1 μm, F·FG = 1/2

Then,

Set value = 10,000 × 1/8 = 1250

When a flexible feed gear (F·FG) is used (In the case of using the serial separate type detector)
Set value = Number of feedback pulses per motor revolution, received from a separate detector (after feedback pulse)/8

(Example 2)

If a flexible feed gear is used under the conditions described in example 1 above,
Set value = 10,000 × 1/2 × 1/8 = 625

When a flexible feed gear (F·FG) is used (In the case of using the analog SDU)
Set value = (Travel distance per motor revolution [mm]) / (detector signal pitch [mm]) × 512 / 8

(Example 3)

When travel distance per motor revolution=10 [mm], and detector signal pitch=20 [μm]
Set value = 10 / 0.020 × 512 / 8 = 32000

> ⚠ **CAUTION**
> If the above expression is indivisible, set the nearest integer.

> **NOTE**
> For 30*i*-B Series and Power Motion *i*-A, it is not necessary to set parameter No. 2033 because automatic calculation is performed based on the parameter for the number of position pulses.

2034	Vibration-damping control gain

[Valid data range] –32767 to 32767
[Standard setting] About 500

This is the feedback gain for vibration damping control.
Adjust the value in increments of about 100, observing the actual vibration. An excessively large gain will amplify the vibration.
If setting a positive value amplifies the vibration, try setting a negative value.

5.4.8 Dual Position Feedback Function (Optional Function)

(1) Overview

A machine with large backlash may cause vibrations in a closed loop system even if it works steadily in a semi–closed loop system. The dual position feedback function controls the machine so that it operates as steadily as in the semi–close system.
This function is optional function.

(2) Control method

The following block diagram shows the general method of dual position feedback control:

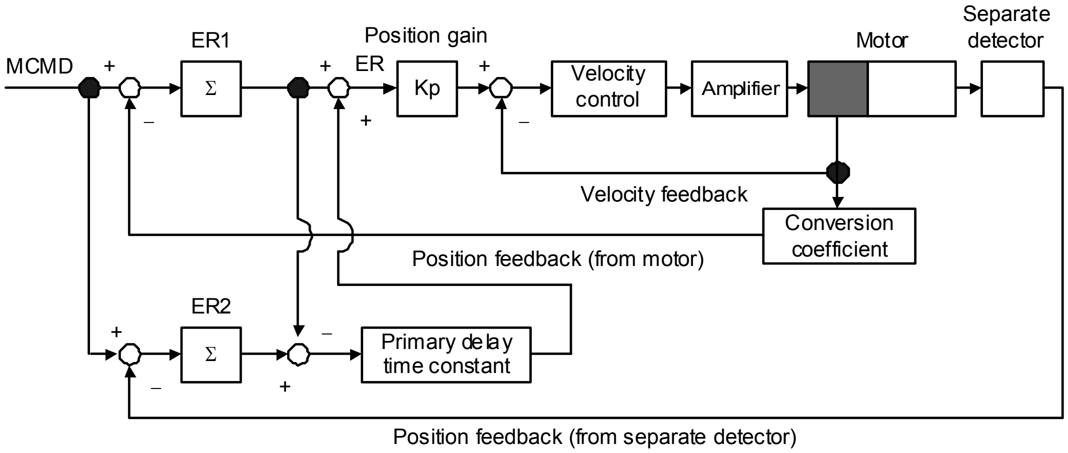


Fig. 5.4.8 (a) Block diagram of dual position feedback control

As shown in Fig. 5.4.8, error counter ER1 in the semi-closed loop system and error counter ER2 in the closed loop system are used. The primary delay transfer function is represented by the following equation:

Primary delay time constant = $(1 + \tau s)^{-1}$

The actual error, ER, depends on the time constant τ, as described below:

(1) When time constant τ is 0 ······ $(1 + \tau s)^{-1} = 1$
ER = ER1 + (ER2 – ER1) = ER2 (error counter of the full-closed loop system)

(2) When time constant τ is ∞ ······ $(1 + \tau s)^{-1} = 0$
ER = ER1 (error counter of the semi-closed loop system)

This shows that control can be changed according to the primary delay time constant. The semi-closed loop system applies control at the transitional stage and the full-closed loop system applies control in positioning.

This method allows vibrations during traveling to be controlled as in the semi-closed loop system.

(3) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(4) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2019	DPFB							

DPFB (#7) 1: To enable dual position feedback

2049	Dual position feedback maximum amplitude

[Setting value] Maximum amplitude (μm)/(minimum detection unit for full-closed mode × 64)
This parameter should normally be set to 0.

[Unit of data] Minimum detection unit for full-closed mode (μm/p) × 64
If setting = 0, compensation is not clamped. If the parameter is specified, and a position error larger than the specified value occurs during semi-closed and full-closed modes, compensation is clamped. So set the parameter with a value two times the sum of the backlash and pitch error compensation amounts.
If it is impossible to find the sum, set the parameter to 0.

2078	Dual position feedback conversion coefficient (numerator)

2079	Dual position feedback conversion coefficient (denominator)

[Setting value] Reduce the following fraction and use the resulting irreducible fraction.

$$\text{Conversion coefficient}\left(\frac{\text{Numerator}}{\text{Denominator}}\right) = \frac{\text{Number of position feedback pulses per motor revolution (Value multiplied by the feed gear)}}{\text{1 million}}$$

(Example)

When the αi Pulsecoder is used with a tool travel of 10 mm/motor revolution (1 μm/pulse)

$$\text{Conversion coefficient } \left(\frac{\text{Numerator}}{\text{Denominator}}\right) = \frac{10 \times 1000}{1,000,000} = \frac{1}{100}$$

2080	Dual position feedback primary delay time constant

[Setting value] Set to a value in a range of 10 to 300 msec or so.

[Unit of data] msec

Normally, set a value of around 100 msec as the initial value. If hunting occurs during acc./dec., increase the value in 50-msec steps. If a stable status is observed, decrease the value in 20-msec steps. When 0 msec is set, the same axis movement as that in full-closed mode is performed. When 32767 msec is set, the same axis movement as that in semi-closed mode is performed.

For a system that requires simultaneous control of two axes, use the same value for both axes.

2081	Dual position feedback zero-point amplitude

[Setting value] Zero width (μm)/minimum detection unit for full-closed mode

[Unit of data] Minimum detection unit (μm/p) for full-closed mode

Positioning is performed so that the difference in the position between full-closed mode and semi-closed mode does not exceed the pulse width that corresponds to the parameter-set value.

First set the parameter to 0. If still there is fluctuation, increase the parameter value.

If this is applied to an axis with a large backlash, a large position error may remain. For details, see Art. (5) in this section.

2118	Dual position feedback: Level on which the difference in error between the semi-closed and full-closed modes becomes too large

[Setting value] Level on which the difference in error is too large (μm)/minimum detection unit (μm/p) for full-closed mode

[Unit of data] Minimum detection unit (μm/p) for full-closed mode

If the difference between the Pulsecoder and the separate detector is greater than or equal to the number of pulses that corresponds to the value specified by the parameter, an alarm is issued.

Set a value two to three times as large as the backlash.

When 0 is set, detection is disabled.

P2080:
Normalmente, impostare come valore iniziale 100 msec.
Se si verifica un grosso errore di inseguimento durante acc. / dec., aumentare il valore a passi di 50 msec.
Se si osserva uno stato stabile, diminuire il valore a passi di 20 msec.

Quando è impostato 0 msec, si ottiene lo stesso comportamento della modalità full-closed
(la posizione viene determinata solo dalla riga esterna).

Quando viene impostato 32767 msec, si ottiene lo stesso comportamento della modalità semi-closed
(la posizione viene determinata solo dall'encoder motore).
ATTENZIONE: impostando valori elevati (15000-20000), è capitato di aver problemi durante le fasi di cambio utensile perchè non viene chiuso il segnale IN-POSITION e la macchina resta in attesa.

Per un sistema con il controllo simultaneo di due assi (gantry), utilizzare lo stesso valore per entrambe gli assi.

NOTE

The function for monitoring the difference in error between the semi-closed and full-closed modes is useful also for monitoring for a problem such as the feedback pulse missing of a separate detector. When only the monitoring of the difference in error between the semi-closed and full-closed modes is to be performed on a machine for which dual position feedback is not required as a stabilization function, the function for monitoring the difference in error between the semi-closed and full-closed modes can be used by not only making an ordinary full-closed loop setting but also setting a conversion coefficient for dual position feedback and the parameter for the monitoring level of the difference in error between the semi-closed and full-closed modes. (No option setting and function bit setting need to be made.) See Subsection 2.1.11.1, "Function for monitoring the difference in error between the semi-closed and full-closed modes" for details.

	#7	#6	#5	#4	#3	#2	#1	#0
2010			HBBL	HBPE				

HBBL (#5) The backlash compensation is added to the error count of:
0: The semi-closed loop. (Standard setting)
1: The closed loop.

HBPE (#4) The pitch error compensation is added to the error count of:
0: The closed loop. (Standard setting)
1: The semi-closed loop.

	#7	#6	#5	#4	#3	#2	#1	#0
2206				HBSF				

HBSF (#4) A backlash compensation and pitch error compensation are:
0: Added after selection according to the conventional parameter No. 2010.
1: Added to the closed loop side and semi-closed loop side at the same time.
When this parameter is set to 1, the settings of No. 2010 are ignored.

* In 30*i*-B Series, when the dual position feedback function is enabled, pitch error compensation amounts are added to both the closed loop side and the semi-closed side regardless of the bit setting. Compensation of backlash acceleration amounts is the same as before.

No.2010#4	No.2206#4	Counter to which pitch error compensation amount is added	
		30*i*-A, 0*i*-D Series	30*i*-B Series
0	0	Closed loop side	Closed loop side and semi-closed loop side
1	0	Semi-cllosed loop side	Closed loop side and semi-closed loop side
0	1	Closed loop side and semi-closed loop side	Closed loop side and semi-closed loop side
1	1	Closed loop side and semi-closed loop side	Closed loop side and semi-closed loop side

> **NOTE**
> If a setting is made to perform the function for monitoring the difference in error between the semi-closed and full-closed modes for an axis placed in a simple full-closed loop, the specification for addition of a backlash compensation and pitch error compensation is the same as in the case of using the dual position feedback function. In this case, it is recommended to make the setting above to "Add a backlash compensation and pitch error compensation to the closed loop side and semi-closed loop side at the same time".

(5) Use with smooth backlash compensation

A smooth backlash compensation value can be added onto the semi-closed side by setting the parameter indicated below to 1 when the dual position feedback function is used together with smooth backlash compensation.

[Applicable servo software]

(30*i*-B Series)
90G0 Series 21.0 and subsequent editions
(30*i*-A Series)
90D0 Series Q(17) and subsequent editions
90E0 Series Q(17) and subsequent editions
90E1 Series 01.0 and subsequent editions
(0*i*-D Series)
90C5,C8 Series A(01) and subsequent editions
90E5,E8 Series A(01) and subsequent editions

[Applicable system software]

Series 30*i*-A	: G00C, G01C, G02C Series 27 and subsequent editions
	: G004, G014, G024 Series 01 and subsequent editions
Series 31*i*-A5	: G12C, G13C Series 27 and subsequent editions
	: G124, G134 Series 01 and subsequent editions
Series 31*i*-A	: G103, G113 Series 12 and subsequent editions
	: G104, G114 Series 01 and subsequent editions
Series 32*i*-A	: G203 Series 12 and subsequent editions
	: G204 Series 01 and subsequent editions
Series 0*i*-MD	: D4F1 Series 01 and subsequent editions
Series 0*i*-TD	: D6F1 Series 01 and subsequent editions
Series 0*i* Mate-MD	: D5F1 Series 01 and subsequent editions
Series 0*i* Mate-TD	: D7F1 Series 01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B, all series and editions support this function.

	#7	#6	#5	#4	#3	#2	#1	#0
11601(FS30*i*)		**SBN**						

SBN (#6) When both of smooth backlash compensation and dual position feedback are enabled, a smooth backlash compensation value is:
1: Used for compensation on the semi-closed side.
0: Dependent on the settings of bit 4 of No. 2206 and bit 5 of No. 2010.

(6) Zero-width setting for a machine with a large backlash or twist

Dual position feedback function (or hybrid function) is used for an axis where a machine backlash of about 1/10 revolution in terms of the motor shaft exists, the machine may stop with a position error remaining, which is greater than the dual position feedback zero-width parameter value. (In some cases, there may be ten or more pulses left.) To solve this problem, make the following settings:

	#7	#6	#5	#4	#3	#2	#1	#0
2202				DUAL0W				

DUAL0W (#4) The zero-width determination is performed with:
0: Semi-full error only.
1: Both of the position error on the full-closed side and semi-full error. ← Set this value.

5.4.9 Machine Speed Feedback Function

(1) Overview

In many full-closed systems, the machine position is detected by a separate detector and positioning was controlled according to the detected positioning information. The speed is controlled by detecting the motor speed with the Pulsecoder on the motor. When distortion or shakiness between the motor and the machine is big, the machine speed differs from the motor speed during acceleration and deceleration. Hence, it is difficult to maintain high position loop gain.
This machine speed feedback function allows adding the speed of the machine itself to the speed control in a fully closed system, making the position loop stable.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Control block diagram

Fig. 5.4.9 (a) is a control block diagram

PK1V: velocity loop integral gain
PK2V: velocity loop proportional gain
α : machine speed feedback gain

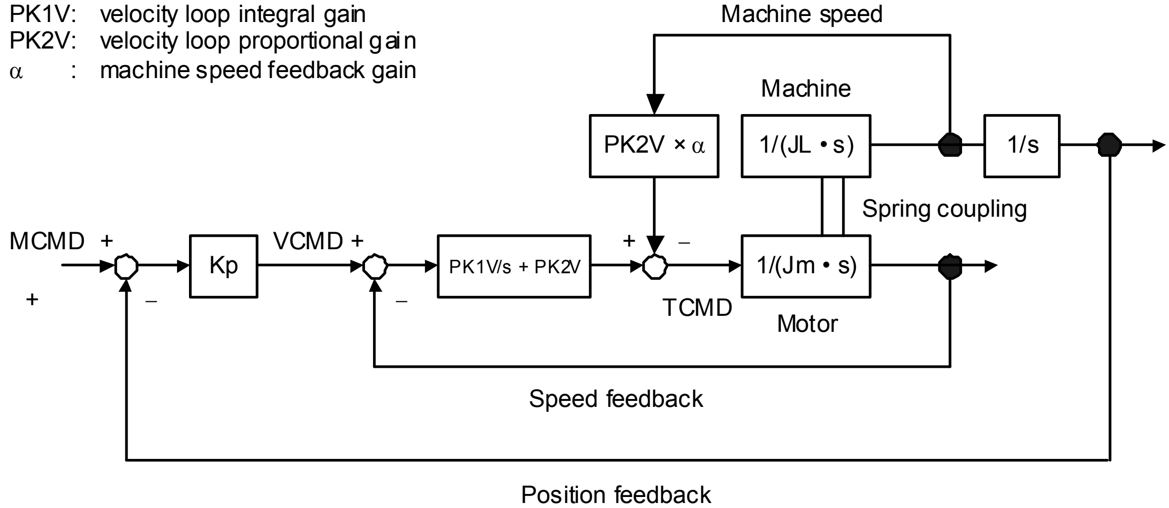


Fig. 5.4.9 (a) Position loop block diagram that includes machine speed feedback function

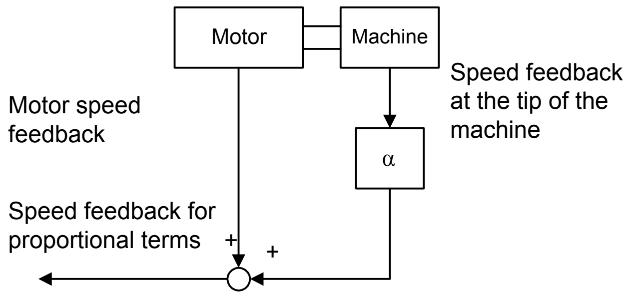
As shown in Fig. 5.4.9 (a), this function corrects the torque command by multiplying the machine speed by machine velocity feedback gain, α, as shown by the bold line. When α = 1, the torque command is corrected equally by the motor speed and the machine speed.

(4) Adding the normalization function

(a) Overview

If an arc is drawn with the machine speed feedback function enabled, the arc may be elongated in the direction parallel to the axis to which the machine speed feedback function is applied. To solve this problem, the machine speed feedback function was improved.

(b) Explanation



The current machine speed feedback configuration is as shown above figure. Assuming that the motor speed feedback is much the same as the speed feedback at the tip of the machine, the speed feedback for the proportional term is (1 + α) times the motor speed feedback. This causes a conflict to the weight of the VCMD.

So, the proportional term speed feedback is divided by (1 + α) to eliminate the conflict.

* The normalization function cannot be used when the velocity loop proportional high-speed processing function is used.

(5) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2012							**MSFE**	

MSFE (#1) 1: To enable the machine speed feedback function

2088	Machine speed feedback gain (MCNFB)

- When a serial output type separate detector is used or when the flexible feed gear (parameters Nos. 2084 and 2085, parameter Nos. 1977 and 1978) is set to 1/1
  (Setting range: 1 to 100 or −1 to −100)
  (Typical setting)

When the normalization function is not used:	MCNFB = 30 to 100
When the normalization function is used:	MCNFB = −30 to −100

- Other than flexible feed gear (No. 2084, 2085, 1977, 1978) = 1/1
  (Setting range: 101 to 10000 or −101 to −10000)
  (Typical setting)

When the normalization function is not used:	MCNFB = 3000 to 10000
When the normalization function is used:	MCNFB = −3000 to −10000

- When 30*i*-B Series is used (valid data range: 1 to 100 (in units of 1%) or 101 to 10000 (in units of 0.01%))
  For 30*i*-B Series, the normalization function is always enabled.
  (Typical setting)

When the increment system is 0.01%:	MCNFB＝3000 to 10000
When the increment system is 1%:	MCNFB＝30 to 100

(6) Note

It the machine has a resonance frequency of 200 to 400 Hz, using this function may result in a resonance being amplified, thus leading to abnormal vibration or sound. If this happens, take either of the following actions to prevent resonance.

- Using an observer (⇒ Subsection 5.4.6)
  (If the machine speed feedback function is used together with the observer function, the motor speed and machine speed are filtered out simultaneously.)
- Using a torque command filter (⇒ Subsection 5.4.2)

5.4.10 Machining Point Control

(1) Overview

The machining point control function suppresses vibration after positioning by attaching an acceleration sensor to the machining point and using acceleration feedback for control.

> **NOTE**
> Machining point control uses an acceleration sensor. For the setting of an acceleration sensor, see Subsection 2.1.7.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	P(16) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4

(3) Setting parameters

(a) Setting machining point control

(Function bit setting)

To use machining point control, enable the following function bit:

	#7	#6	#5	#4	#3	#2	#1	#0
2288	MPCEF							

MPCEF(#7) Machining point control is:

0: Disabled

1: Enabled

(Band-pass filter setting)

When gain is tuned for machining point control, components other than a vibration suppression target frequency may cause vibration to disable a high gain value from being set. To extract a vibration suppression target frequency component only, be sure to set the vibration suppression target frequency component in the following parameter:

2355	Machining point control/center frequency of band-pass filter

[Unit of data] Hz

[Valid data range] 5 to 200

> **NOTE**
> If the value 4 or a smaller number is set, an illegal parameter setting alarm (detail number 3553) is issued. Set the value 5 or a greater number.

(b) Tuning machining point control

Three parameters are available for tuning machining point control. By tuning these parameters, vibration after specified acceleration/deceleration can be suppressed.

- Gain 1
- Timing adjustment parameter
- Gain 2

(Tuning of machining point control gain 1)

Tune machining point control gain 1 so that the acceleration rate (enclosed by the dashed line in the Fig. 5.4.10 (a)) after acceleration/deceleration based on specified acceleration decreases. Tune machining point control gain 1, starting with a small value (about 50).

2266	Machining point control gain 1 (MPCK1)

[Valid data range] 0 to 32767

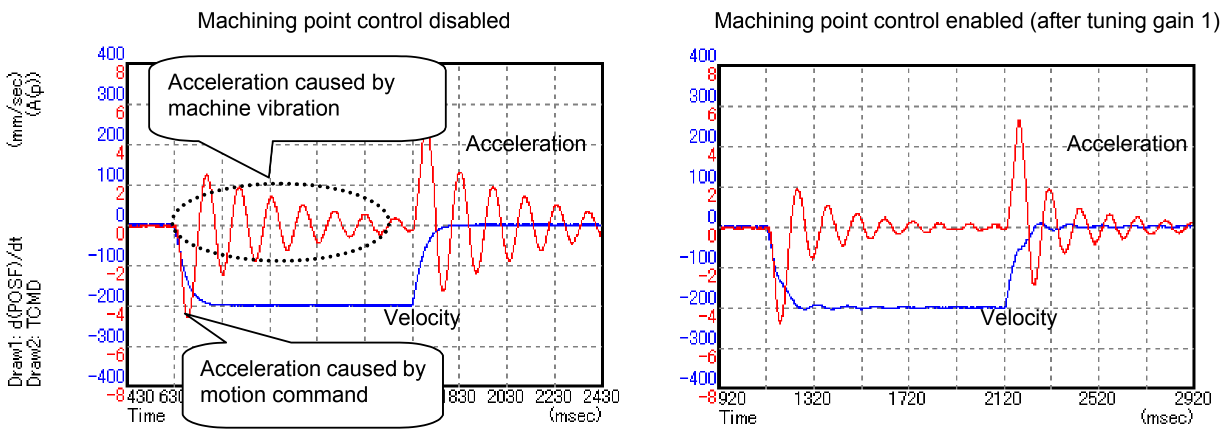


Fig. 5.4.10 (a) Adjustment of machining point control gain 1

(Tuning of the timing adjustment parameter)
Tune the machining point control timing adjustment parameter so that the acceleration rates (enclosed by the dashed lines in the Fig. 5.4.10 (a)) after acceleration/deceleration based on specified acceleration decrease.
This timing adjustment is implemented with a low-pass filter applied to feedback. Set the parameter so that the cut-off frequency of the filter is around the frequency of vibration.

After the setting of the timing adjustment parameter is modified, gain 1 needs to be tuned again. To obtain an optimum vibration suppression effect, tune the timing adjustment parameter and gain 1 repeatedly.

Machining point control enabled
(after tuning of gain 1 and the timing adjustment parameter)

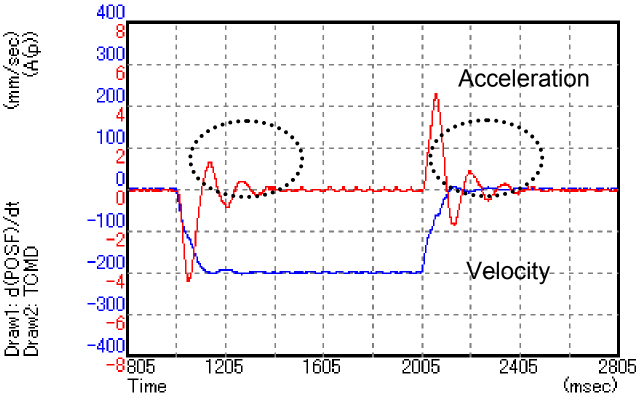


Fig. 5.4.10 (b) Adjustment of machining point control gain 1 and timing adjustment parameter

2096	Machining point control timing adjustment parameter (MPCTIM)

[Valid data range] 0 to 32767
[Typical setting] The setting of the parameter corresponds to the cut-off frequency of the low-pass filter. Set the parameter so that the cut-off frequency is around the frequency of vibration.

Table 5.4.10 (a) Cut-off frequency and Parameter setting value

Cut-off frequency [Hz]	Parameter setting	Cut-off frequency [Hz]	Parameter setting
5	3969	17.5	3669
7.5	3907	20	3612
10	3847	25	3501
12.5	3787	30	3392
15	3728	40	3186

NOTE
When 0 is set in the parameter, the cut-off frequency of the filter is 40 Hz.

(Tuning of machining point control gain 2)
By tuning machining point control gain 2, vibration may be further suppressed.
While checking the effect of vibration suppression, tune machining point control gain 1 and machining point control gain 2 repeatedly. Tune machining point control gain 2, starting with a small value about 10).

2265	Machining point control gain 2 (MPCK2)

[Valid data range] 0 to 32767

5.4.11 Torque Command Filter (Secondary) (High-frequency Resonance Elimination Filter)

(1) Overview

The torque command filter in Subsection 5.4.2 applies a primary low-pass filter to a torque command. On the other hand, the torque command filter (secondary) applies a secondary low-pass filter. The secondary low-pass filter has higher resonance elimination effects than the primary low-pass filter. The secondary low-pass filter is effective particularly when multiple resonance points are present in a high frequency of 1 kHz or more.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

The torque command filter (secondary) uses the same parameters as the resonance elimination filter function in Subsection 5.4.3.

2113, 2360, 2363, 2366	RE filters 1 to 4: Attenuation center frequencies

[Valid data range] 500 to 1000(HRV1,HRV2), 500 to 2000(HRV3), 500 to 4000(HRV4)
[Unit of data] Hz

Set a cutoff frequency. The cutoff frequency needs to be equal to or less than the resonance frequency to be eliminated. For example, when the resonance frequency is 1 kHz, the cutoff frequency needs to be 500 Hz or less.

2177, 2361, 2364, 2367	RE filters 1 to 4: Attenuation bandwidth

Set 0.

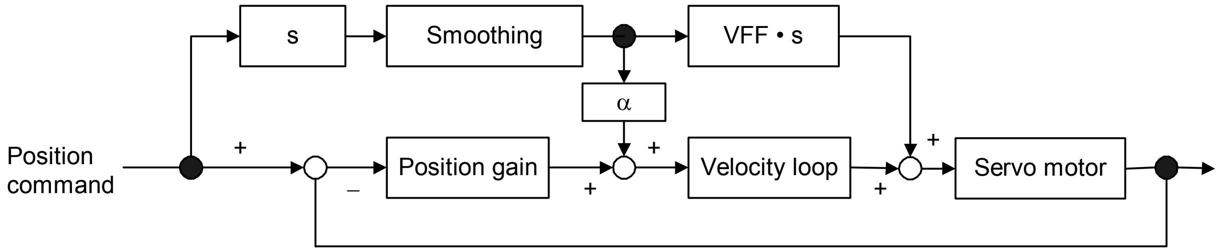
2359, 2362, 2365, 2368	RE filters 1 to 4: Damping

[Standard setting] 70 (Set a positive value.)
[Unit of data] %

5.5 CONTOUR ERROR SUPPRESSION FUNCTION

5.5.1 Feed-forward Function

(1) Principle



α: Feed-forward coefficient (0 to 1)
VFF: Velocity loop feed-forward coefficient

Fig. 5.5.1 (a) Feed-forward control block diagram

Adding feed-forward term α to the above servo system causes the position error to be multiplied by (1 - α).

$$\text{Position error} = \frac{\text{Feedrate (mm/s)}}{\text{Minimum detection unit (mm)} \times \text{position gain}} \times (1 - \alpha)$$

Adding feed-forward term α also causes figure error ΔR1 (mm) due to a radial delay of the servo system during circular cutting to be multiplied by $(1 - \alpha^2)$.

$$\Delta R1\ (\text{mm}) = \frac{\text{Feedrate}^2\ (\text{mm/s})^2}{2 \times \text{position gain}^2 \times \text{radius (mm)}} \times (1 - \alpha^2)$$

(Example) If α = 0.7, ΔR1 is reduced to about 1/2.

Beside ΔR1, figure error ΔR2 (mm) may occur in a position command when an acc./dec. time constant is applied after interpolation for two axes.
Therefore, total radial figure error ΔR during circular cutting is:

$$\Delta R = \Delta R1 + \Delta R2$$

This section describes the conventional feed-forward function.
The shape error in the direction of the radius during circular cutting is as shown in Fig. 5.5.1 (b) below.

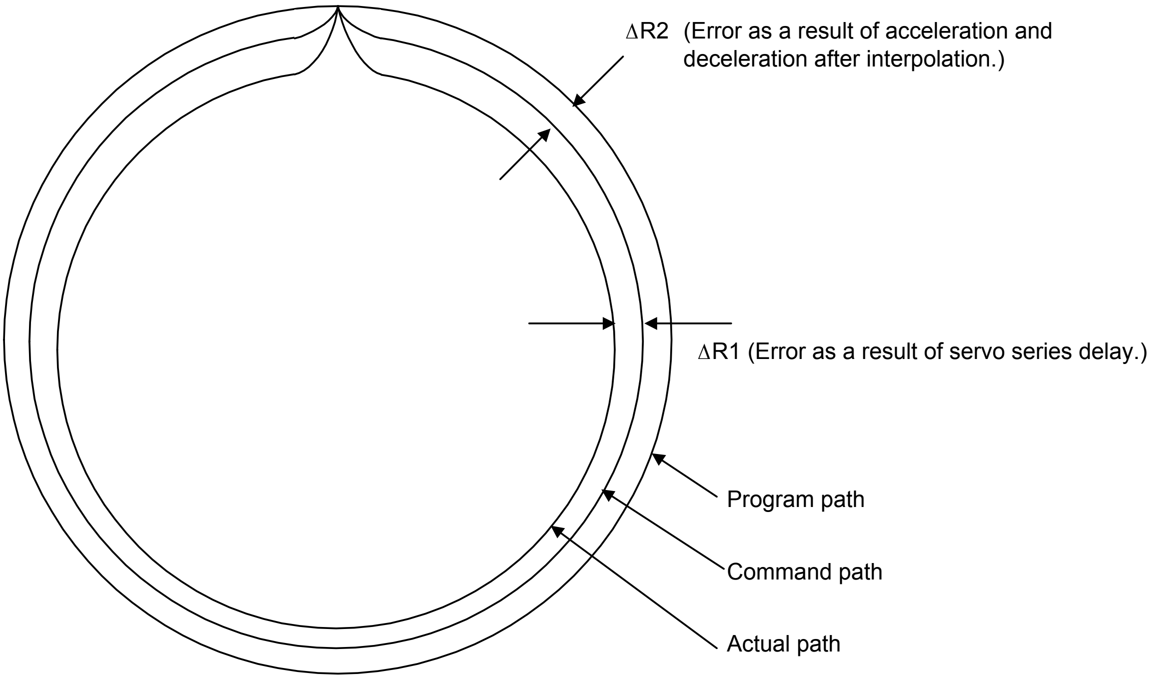


Fig. 5.5.1 (b) Path error during circular cutting

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

<1> Enable PI control and the feed-forward function.

	#7	#6	#5	#4	#3	#2	#1	#0
2003					PIEN			

PIEN (#3) 1: To enable PI control

	#7	#6	#5	#4	#3	#2	#1	#0
2005							FEED	

FEED (#1) 1: To enable the feed-forward function

<2> Specify the feed-forward coefficient.

2092	Advanced preview feed-forward coefficient (ADFF1)

[Typical setting] 9800 to 10000

Advanced preview feed-forward coefficient (in units of 0.01%)
$= \alpha \times 10000 \ (0 \le \alpha \le 1)$

Example) When α = 98.5%, ADFF1 = 9850

<3> Specify the velocity feed-forward coefficient.

2069	Velocity feed-forward coefficient (VFFLT)

VFFLT = 50 (50 to 200)

<4> Run a program to move the axis for cutting feed at maximum feedrate. Under this condition, check whether the VCMD waveform observed on the Servo Guide or the servo check board overshoots and what the shock caused during acceleration /deceleration is like.

⇒ If an overshoot occurs, or the shock is big, increase the acc./dec. time constant, or reduce α.

⇒ If an overshoot does not occur, and the shock is small, reduce the acc./dec. time constant, or increase α.

Linear acc./dec. is more effective than exponential acc./dec.
Using acc./dec. before interpolation can further reduce the figure error.

<5> By setting the parameter below, the feed-forward function can be used for cutting feed as well.

	#7	#6	#5	#4	#3	#2	#1	#0
1800					FFR			

FFR (#3) Specifies whether feed-forward control during rapid traverse is enabled or disabled.
0: Disabled
1: Enabled

By using the feed-forward function during rapid traverse, the positioning time can be reduced. On some machines, however, a shock may occur at the time of acc./dec. In such a case, make adjustments such as increasing the acc./dec. time constant.
Moreover, a feed-forward coefficient can be set separately for each of cutting and rapid traverse. (See Subsection 5.5.2, "Cutting/Rapid Feed-forward Switching Function".)

<6> To use the EGB function, set the following parameter:

	#7	#6	#5	#4	#3	#2	#1	#0
2011							FFAL	

FFAL (#1) Feed-forward control is:
1: Always enabled regardless of the mode.

When the EGB functions are used, conventional feed-forward coefficients are applied.

2068	Feed-forward coefficient (FALPH)

FALPH = α × 100 or α × 10000

When FALPH is smaller than or equal to 100: In units of 1%
When FALPH is greater than 100: In units of 0.01%

[Typical setting] 70 or 7000

5.5.2 Cutting/Rapid Feed-forward Switching Function

(1) Overview

This function enables the use of separate feed-forward coefficients between cutting feed and rapid traverse.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

<1> First, set the parameters below in the same way as for the current feed-forward function.

	#7	#6	#5	#4	#3	#2	#1	#0
2003					PIEN			

PIEN(#3) 1: A switch is made to PI control.

	#7	#6	#5	#4	#3	#2	#1	#0
2005							FEED	

FEED (#1) 1: The feed-forward function is enabled.

<2> Next, set the cutting/rapid feed-forward switching function.

	#7	#6	#5	#4	#3	#2	#1	#0
2214				FFCHG				

FFCHG (#4) 1: The cutting/rapid feed-forward switching function is enabled.

<3> With the setting of the parameters above, the parameters below are enabled in cutting.

2145	Velocity feed-forward coefficient for cutting
2144	Advanced preview feed-forward coefficient for cutting

The parameters below are enabled in rapid traverse.

2069	Velocity feed-forward coefficient for rapid traverse
2092	Advanced preview feed-forward coefficient for rapid traverse

5.5.3 Feed-forward Timing Adjustment Function

(1) Overview

If the feed-forward function is applied with the aim of decreasing contour errors, the same feed-forward coefficient must be used for all axes. Even if a unified feed-forward coefficient is used, however, the axes may not necessarily behave in the same manner because of differences in the mechanical characteristic and velocity loop response among the axes.
The feed-forward timing adjustment function is intended to change the feed-forward timing so as to make the characteristics of each axis at high-speed movement. It does not change the feed-forward coefficient. So it can change the characteristic of a portion where the acceleration is high without affecting the operation for straight portions.
If the radius of an arc subjected to high-speed cutting differs among axes, resulting in a vertical or horizontal oval, this function is useful in improving roundness through fine adjustment.

(2) Control method

When an arc is cut at high speed, delaying the feed-forward timing causes the path to bulge. On the contrary, advancing the feed-forward timing causes the path to shrink. The feed-forward timing adjustment function lets you make fine adjustments on the characteristic of servo axes.

Let the radius, feedrate, and position gain be, respectively, R, V, and Kp. Delaying the feed-forward timing by τ(s) increases the radius of the arc by:
$\Delta R = \tau \times V^2/(Kp \times R)$
To be specific, assume radius R = 10 mm, feedrate V = 4000 mm/min, and position gain Kp = $40s^{-1}$. Shifting the timing by 1 ms corresponds to:
$\Delta R = 11\ \mu m$

(3) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(4) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2415							IAHDON	

IAHDON(#1) The default value of the feed-forward timing adjustment parameter is:
0: Feed-forward timing is adjusted by only No. 2095.
1: Compatible with that of 16*i* Series. (See the table below.)
* By setting No.2415#1(IAHDON)=1 and No. 2095=0, the feed-forward timing becomes compatible with that of 16*i* Series. For 30*i*-B Series, the default value is fixed to the timing compatible with that of 16*i* Series regardless of the setting of this bit.

The feed-forward timing actually applied is represented by the following equation.
Feed-forward timing = Parameter No.2095 + Default value

Table 5.5.3 (a) Default feed-forward timing value

	Default feed-forward timing value			
	No.2415#1=0		No.2415#1=1	
	30*i*-A,0*i*-D Series	30*i*-B Series	30*i*-A,0*i*-D Series	30*i*-B Series
HRV2 control	0	3900	3900	3900
HRV3 control	0	3900	3900	3900
HRV4 control	0	3792 (*1)	3792 (*1)	3792 (*1)

If the same feed-forward timing as before is set when the NC is replaced, set parameter No. 2095 with reference to the following table.

Table 5.5.3 (b) Setting of parameter No. 2095 when the NC model is replaced

NC model		No.2415#1	No.2095
Before replacement	After replacement		
16*i* Series	30*i*-A, 0*i*-D Series	0	No.2095(new setting) = No.2095 + Default value
		1	No.2095(new setting) = No.2095(old setting) - Default value
16*i* Series	30*i*-B Series	0	No.2095(new setting) = No.2095(old setting) - Default value
		1	No.2095(new setting) = No.2095(old setting) - Default value
30*i*-A Series	30*i*-B Series	0	No.2095(new setting) = No.2095(old setting) - Default value
		1	No.2095(new setting) = No.2095(old setting)

(*1) When HRV4 control is used and any of the following functions is used, the default value is -240:

- High-speed processing
- AI contour control II
- High-speed cycle machining

2095	Feed-forward timing adjustment coefficient

Specifying +4096 causes the feed-forward timing to advance by 1 ms.
Specifying -4096 causes the feed-forward timing to delay by 1 ms.
If you want to decrease the radius of an arc at high-speed cutting, increase the coefficient by about 300 at each step.
If you want to increase the radius of an arc at high-speed cutting, decrease the coefficient by about 300 at each step.

5.5.4 Backlash Acceleration Function

(1) Overview

If the influence of backlash and friction is large in the machine, a delay may be produced on reversal of motor, thus resulting in quadrant protrusion on circular cutting.
This is a backlash acceleration function to improve quadrant protrusion.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	Override is supported by J(10) and subsequent editions
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4 Override is supported by J(10) and subsequent editions
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

<1> Set the backlash compensation.

1851	Backlash compensation

In semi-closed mode:
Set the machine backlash. (Minimum value = 1)
In full-closed mode:
Set the minimum value of 1. When the backlash compensation value is not to be reflected in the position, enable the function below additionally.

> **NOTE**
> Be sure to set a positive backlash compensation value.

	#7	#6	#5	#4	#3	#2	#1	#0
2006								FCBL

FCBL (#0) Backlash compensation is not performed for the position in the full-closed mode.
0: Invalid
1: Valid

Generally, for a machine in full-closed mode, backlash compensation is not reflected in positions, so this bit is set. (This parameter is applicable also to a machine with a semi-closed loop.)

<2> Enable the backlash acceleration function.

	#7	#6	#5	#4	#3	#2	#1	#0
2003			BLEN					

BLEN (#5) 1: To enable backlash acceleration

2048	Backlash acceleration amount

[Typical setting] 20 to 600

Offset for the velocity command that is to be added immediately after a reverse.

2071	Period during which backlash acceleration remains effective (in units of 2 msec)

[Typical setting] 20 to 100

The period during which the acceleration amount is added. At the start of adjustment, set 20. When a long quadrant protrusion is found, gradually increase the setting in steps of 10.

<3> When the optimum backlash acceleration amount varies with the machining feedrate, use the acceleration amount override and the limit of the acceleration amount.

2114	Acceleration amount override

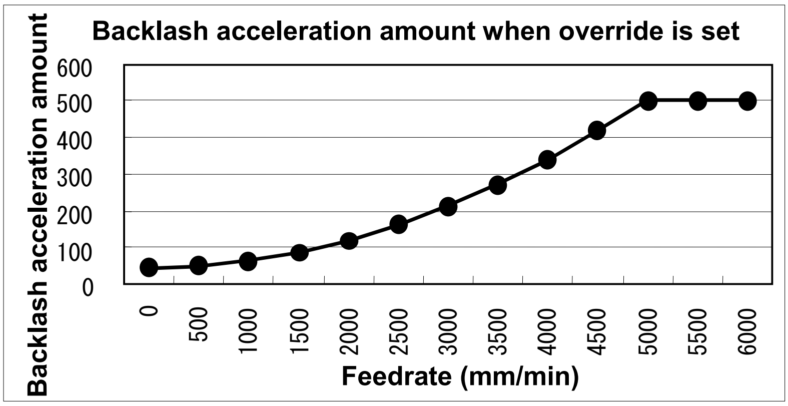
[Valid data range] 0 to 32767

2338	Limit of acceleration amount

[Valid data range] 0 to 32767 (When 0 is set, the acceleration amount is not limited.)

[Example] Example of setting the acceleration amount

Acceleration amount (parameter No. 2048) = 46, acceleration amount override (parameter No. 2114) = 23, limit of acceleration amount (parameter No. 2338) = 500



<4> Setting the direction-based backlash acceleration function

When the optimum acceleration amount differs between a reverse operation in the positive direction and a reverse operation in the negative direction, set the acceleration amount used for the reverse operation from the negative direction to positive direction in the following parameter:

2094	Backlash acceleration amount (for reverse from negative to positive direction)

[Typical setting] 20 to 600

2340	Acceleration amount override (for reverse from negative to positive direction)

[Valid data range] 0 to 32767

2341	Limit of acceleration amount (for reverse from negative to positive direction)

[Valid data range] 0 to 32767 (When 0 is set, the acceleration amount is not limited.)

[Parameters used for direction-based setting]

Direction-based setting	Reverse direction	Backlash acceleration amount	Acceleration amount override	Limit of acceleration amount
None	Common	No. 2048	No. 2114	No. 2338
Present	From + to -			
	From - to +	**No. 2094**	**No. 2340**	**No. 2341**

<5> If a reverse cut occurs, use the backlash acceleration stop function.

	#7	#6	#5	#4	#3	#2	#1	#0
2009	BLST							

BLST (#7) 1: To enable the backlash acceleration stop function

> **NOTE**
> When the backlash acceleration stop function is enabled (with BLST = 1), be sure to set a positive value in the backlash acceleration stop timing parameter described below. (If 0 or a negative value is set, backlash acceleration is not performed.)

2082	Backlash acceleration stop distance

[Typical setting] 2 to 5 (detection unit of 1μm), 20 to 50 (detection unit of 0.1μm)
This parameter is related to the distance until backlash acceleration ends. Determine the parameter value by checking the actual profile.

This completes the general setting procedure for the backlash acceleration function.

> **NOTE**
> When the following conditions are satisfied and the adjusted values in 30*i*-A Series are applied to 30*i*-B Series, the adjusted values on which parameter No. 2028 is based need to be divided by 4.
> - HRV4 control is enabled. (No.2014#0=1)
> - Two-stage backlash acceleration is enabled. (No.2015#6=1)
> - Two-stage backlash acceleration Type-2 is disabled. (No.2271#5=0)
>
> When two-stage backlash acceleration Type-2 is enabled (bit 5 of parameter No. 2271 is 1), the adjusted values on which parameter No. 2089 is based also need to be divided by 4.

(4) Procedure for setting acceleration amount override

There are two methods for setting the acceleration amount override as listed below.

- Setting method 1 (calculation not required)
  <1> With an assumed minimum acceleration, obtain the optimum backlash acceleration amount while observing quadrant protrusions. Set the obtained value as the backlash acceleration amount (setting).
  <2> Set the acceleration to a middle point between the minimum and maximum levels, and while increasing the override value, observe quadrant protrusions to determine the optimum override value.
  <3> Finally, set the maximum acceleration, and observe the arc figure. If an undercut is generated at the switching point of quadrants, set the acceleration amount limit to prevent the acceleration amount from increasing excessively.

- Setting method 2 (strict calculation required)
  Obtain an optimum backlash acceleration amount for two different accelerations (an assumed minimum acceleration and an intermediate acceleration between the minimum and maximum accelerations), and substitute the obtained value in the following equation for the backlash acceleration amount override:

$$\text{Backlash acceleration amount} = \text{Backlash acceleration amount (setting)} \times \left(1 + \frac{\text{Acceleration amount override} \times \text{Acceleration}}{2048}\right)$$

$$\text{Acceleration} = \frac{(\text{Feedrate [mm/min]})^2}{\text{Radius [mm]}} \times \frac{128}{\text{Detection unit [}\mu\text{m]} \times 1000}$$

Find a solution of the simultaneous equations. The results are as follows:

$$\text{Acceleration amount override} = \frac{(\text{Acceleration amount 2}) - (\text{Acceleration amount 1})}{(\text{Acceleration amount 1}) \times (\text{Acceleration 2}) - (\text{Acceleration amount 2}) \times (\text{Acceleration 1})} \times 2048$$

$$\text{Backlash acceleration amount (setting)} = \frac{(\text{Acceleration amount 1}) \times (\text{Acceleration 2}) - (\text{Acceleration amount 2}) \times (\text{Acceleration 1})}{(\text{Acceleration 2}) - (\text{Acceleration 1})}$$

Finally, operate at the maximum acceleration, and adjust the limit of the acceleration amount.

(5) Ignoring the backlash acceleration function at handle feed

To disable the backlash acceleration function at handle feed, set the following:

	#7	#6	#5	#4	#3	#2	#1	#0
2009		BLCU						

BLCU (#6) 1: To enable the backlash acceleration function during cutting feed only

NOTE
If bit 3 of parameter No. 1800 is set to 1, the backlash acceleration function is always enabled, and it cannot be disabled.

The bit shown below can also be used to enable the backlash acceleration function only during cutting. Use of this bit enables and disables the backlash acceleration function even when bit 3 of parameter No. 1800 is set to 1. Backlash acceleration is enabled even at the hole bottom during rigid tapping.

	#7	#6	#5	#4	#3	#2	#1	#0
2223	BLCUT2							

BLCUT2 (#7) 1: To enable the backlash acceleration function during cutting feed only

[Reference]

Adjustment the backlash acceleration

Run a program for an arc, and make an adjustment while checking the arc figure on SERVO GUIDE.

(6) Disabling backlash acceleration after a stop

When using the function for disabling backlash acceleration after a stop, make the setting below. For details, see "(7) Adjustment of backlash acceleration" in Appendix E.

	#7	#6	#5	#4	#3	#2	#1	#0
2283	BLSTP2							

BLSTP2(#7) 1 : Disables backlash acceleration after a stop.

5.5.5 Two-stage Backlash Acceleration Function

(1) Overview

When the machine reverses the direction of feed, two types of delay are likely to occur; one type due to friction in the motor and the other due to friction in the machine.
The two-stage backlash acceleration function compensates for two types of delays separately, thus enabling two-stage compensation.

Two-stage compensation	First stage:	The friction torque is canceled when the motor reverses.
	Second stage:	The friction torque in the machine is canceled.

Furthermore, optimum compensation can be performed at all times for first stage against changing speed and load.
The two-stage backlash acceleration function performs compensation as shown below:

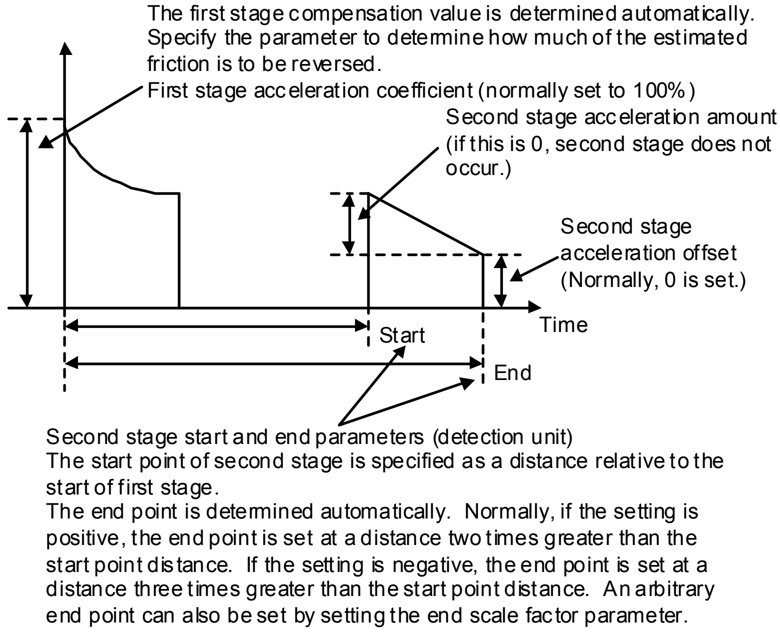


Fig. 5.5.5 (a) Backlash acceleration under control of the two-stage backlash acceleration function

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

<1> With SERVO GUIDE, make settings for measuring the motor speed and estimated disturbance value.
(See Chapter 7, “SERVO TUNING TOOL SERVO GUIDE” for SERVO GUIDE.)
<2> Turn on the power to the NC.
<3> Specify the backlash compensation value.

1851	Backlash compensation value

For semi-closed mode, specify the machine backlash (minimum of 1).
For full-closed mode, specify 1. When the backlash compensation value is not to be reflected in the position, enable the function below additionally.

> **NOTE**
> Be sure to set a positive backlash compensation value.

	#7	#6	#5	#4	#3	#2	#1	#0
2006								FCBL

FCBL (#0) Backlash compensation is not performed for the position in the full-closed mode.
0: Invalid
1: Valid

<4> Adjusting the velocity loop gain
Enable PI control, and increase the velocity loop gain (load inertia ratio) as much as possible.
(For velocity loop gain adjustment, see Subsection 4.3.1.)

* By setting a high velocity loop gain, the response of the motor improves, and quadrant protrusions can be reduced. If the velocity loop gain is changed in the subsequent adjustments, the adjustments become complicate. So, increase the velocity loop gain sufficiently at this stage.

<5> Enable the two-stage backlash acceleration function.

	#7	#6	#5	#4	#3	#2	#1	#0
2003			BLEN					

BLEN (#5) 1: To enable the backlash acceleration function

	#7	#6	#5	#4	#3	#2	#1	#0
2015		BLAT						

BLAT (#6) 1: To enable the two-stage backlash acceleration function

<6> Set the observer-related parameters.
(Related parameters)

2050	Observer gain

- When HRV1, HRV2, or HRV3 control is used:

[Setting value] No change is required.

- When HRV4 control is used:

[Setting value] 956 → To be changed to 264

2051	Observer gain

- When HRV1, HRV2, or HRV3 control is used:

[Setting value] No change is required.

- When HRV4 control is used:

[Setting value] 510 → To be changed to 35

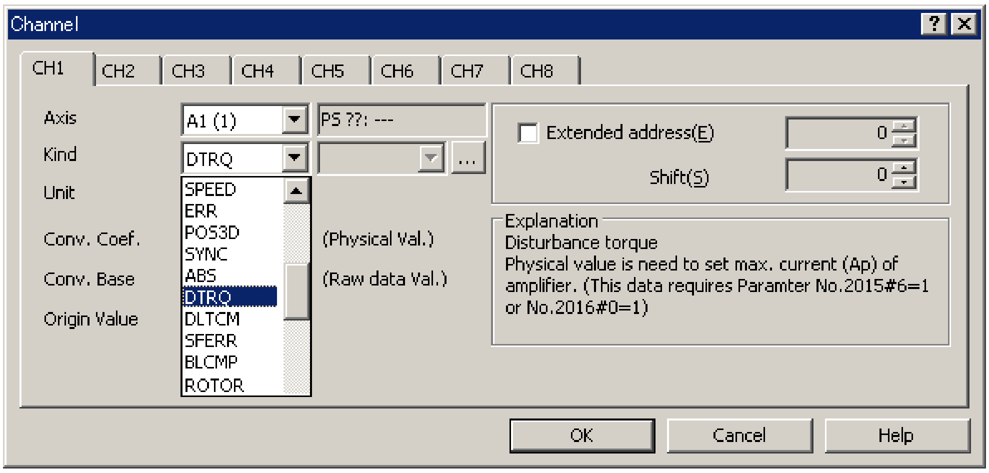
* When setting an observer gain, follow the settings of other functions (observer, unexpected disturbance torque detection). When the two-stage backlash acceleration function is used, the settings need not be changed.

<7> Adjust observer parameter POA1.

The two-stage backlash acceleration function takes the friction torque as an estimated disturbance value by using the observer circuit and determines the first stage acceleration amount. Therefore, observer parameter POA1 must be adjusted to obtain correct acceleration. While observing estimated disturbance value DTRQ, perform acc./dec. to adjust POA1 to the optimum value.

NOTE

The procedure for this adjustment is similar to the procedure for adjusting observer-related parameters in the unexpected disturbance torque detection function (Subsection 5.9.1). Make an adjustment by following steps <5> and <6> in (3), "Parameter adjustment methods", in Subsection 5.9.1 in this parameter manual. When the unexpected disturbance torque detection function is used, and the adjustment has already been made, re-adjustment is not needed.



2047	Observer parameter (POA1)

[Setting value] Adjusted value (Make an adjustment according to steps <5> and <6> in (3) in Subsection 5.9.1.)

2087	Torque offset parameter

[Setting value] Adjusted value (If the center of an estimated disturbance value does not become zero on an axis such as the gravity axis, make an adjustment according to step <6> in (3) in Subsection 5.9.1.)

<8> Adjusting the first stage acceleration

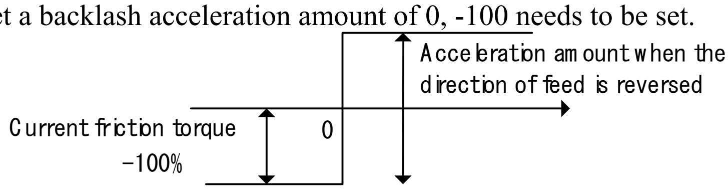
Specify the following parameters.

2048	First stage backlash acceleration amount (%)

[Unit of data] % (The acceleration amount required to reverse the torque equal to the friction torque value is assumed to be 100%.)

[Typical setting] 50 (Normally, optimum values range from 20% to 70%.)

To set a backlash acceleration amount of 0, -100 needs to be set.



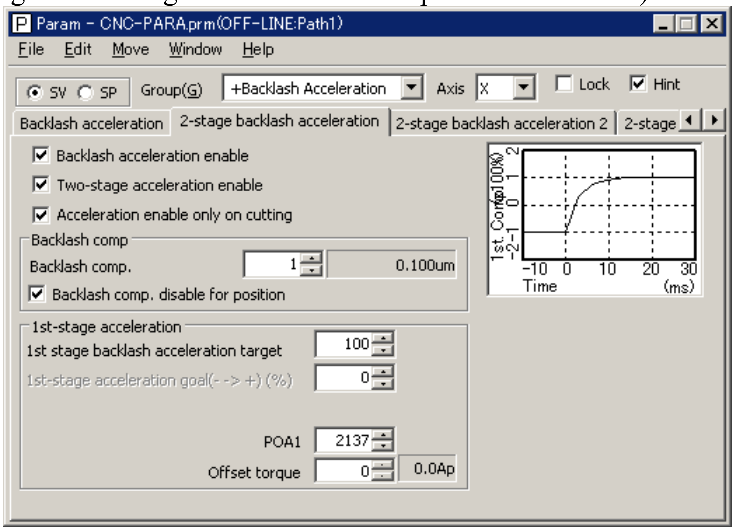
2094	First stage acceleration amount from negative direction to positive direction (%)

[Unit of data] %

Normally, this parameter is set to 0. If the quadrant protrusion varies with the reverse direction of the position command in the machine conditions, set an appropriate value in this parameter.

When this parameter is set, parameter No. 2048 specifies the first stage positive-to-negative backlash acceleration amount.

(Setting the first stage acceleration in the parameter window)



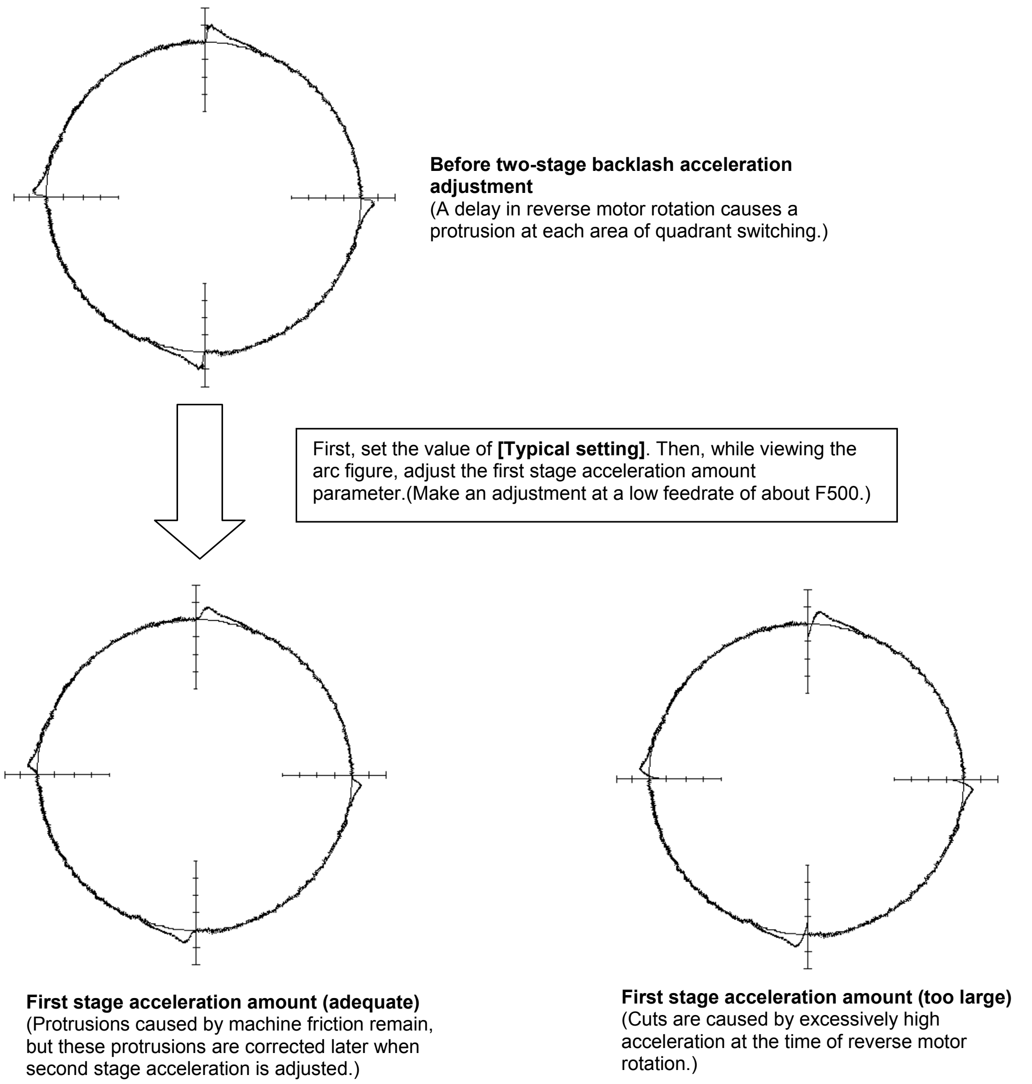


Fig. 5.5.5 (b) Two-stage backlash acceleration (first stage acceleration amount adjustment)

2082	Second stage start position (detection unit)

[Unit of data] Detection unit
[Typical setting] 10 (For a detection unit of 1 μm)
100 (For a detection unit of 0.1 μm)

> **NOTE**
> 1 As the second stage start position, the absolute value of the setting is used.
> 2 When setting = 0, the specification of 100 is internally assumed.

2089	Second stage end scale factor

[Unit of data] In units of 0.1
[Valid data range] 0 to 10279 (multiplication by 0 to 1027.9)
[Typical setting] Normally, this value may be set to 0.
When the second stage end scale factor is set to 0, the second stage acceleration distance is assumed as follows:
If a positive value is set as the second stage start position, a value obtained by multiplying the start position by 2 is assumed.
If a negative value is set as the second stage start position, a value obtained by multiplying the start position by 3 is assumed.

By setting the second stage end scale factor, the second stage acceleration distance may be set to any value.

> **NOTE**
>
> When the following conditions are satisfied and the adjusted values in 30*i*-A Series are applied to 30*i*-B Series, the adjusted values on which parameters Nos. 2082 and 2089 are based need to be divided by 4.
>
> - HRV4 control is enabled. (No.2014#0=1)
> - Two-stage backlash acceleration is enabled. (No.2015#6=1)
> - Two-stage backlash acceleration Type-2 is disabled. (No.2271#5=1)

When two-stage backlash acceleration Type-2 is enabled (bit 5 of parameter No. 2271 is 1), the adjusted values on which parameter No. 2089 is based also need to be divided by 4.

(Setting example)

When the second stage start position is set to 10, and the second stage end scale factor is set to 50 (meaning multiplication by 5), second stage acceleration is performed as shown below.

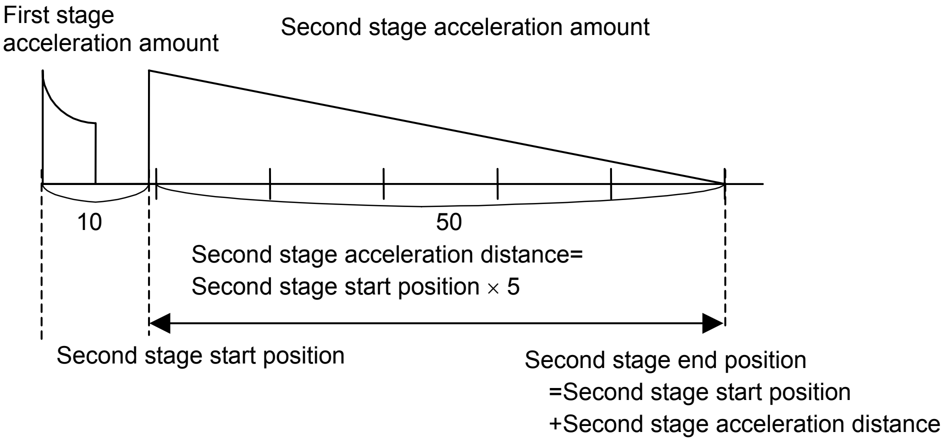
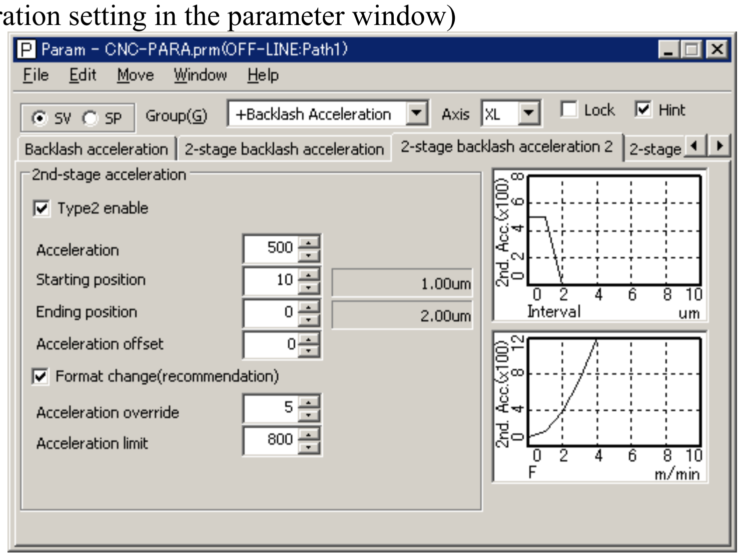
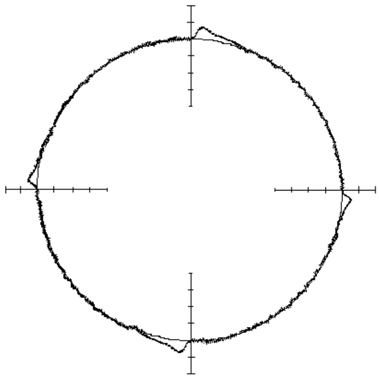


Fig. 5.5.5 (c) Second stage end scale factor

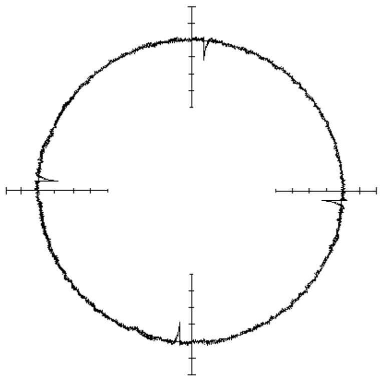
(Second stage acceleration setting in the parameter window)



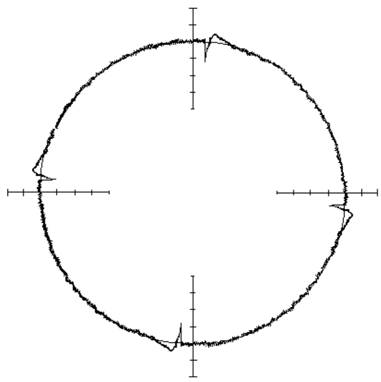


Before start/end parameter adjustment

Set the following:
Start/end parameter = Value of **[Typical setting]**
Second stage acceleration amount = 500
Then, adjust the start/end parameter while viewing the timing of second stage acceleration from the arc figure.



Start/end parameter (adequate)
(A larger second stage acceleration amount is set to view the timing of second stage acceleration, so that cuts occur. This is corrected later.)



Start/end parameter (insufficient)
(The time for second stage acceleration is too short, so that second stage protrusions are not fully eliminated.)

Fig. 5.5.5 (d) Two-stage backlash acceleration (adjustment of start position and end scale factor)

NOTE

Note that the two-stage backlash acceleration cannot be used together with the backlash stop function.

Second stage acceleration is not completed by nature until a distance specified by "Second stage end scale factor" is moved. For example, if only several microns are moved after the direction is reversed, second stage acceleration continues. To prevent such continued acceleration from occurring, set a maximum allowable duration of time with the parameter below.

2146	Two-stage backlash acceleration end timer

[Unit of data] ms
[Typical setting] 50

<9> Second stage acceleration adjustment

The two-stage backlash acceleration function has effect even if only first stage is used. However, a protrusion may linger because of machine friction. In such a case second stage is useful.

Adjust the second stage acceleration so that it falls in a range where no cut occurs.

2039	Second stage acceleration amount for two-stage backlash acceleration

[Typical setting] 100 (Too large a value could cause a cut at low feedrate.)

NOTE
When second stage acceleration is not used, set second stage acceleration amount = 0. The setting of second stage start position = 0 alone cannot disable second stage acceleration.

2167	Second stage offset for two-stage backlash acceleration

Normally, set 0.

Offset for the second stage acceleration amount. See Fig. 5.5.5(a).

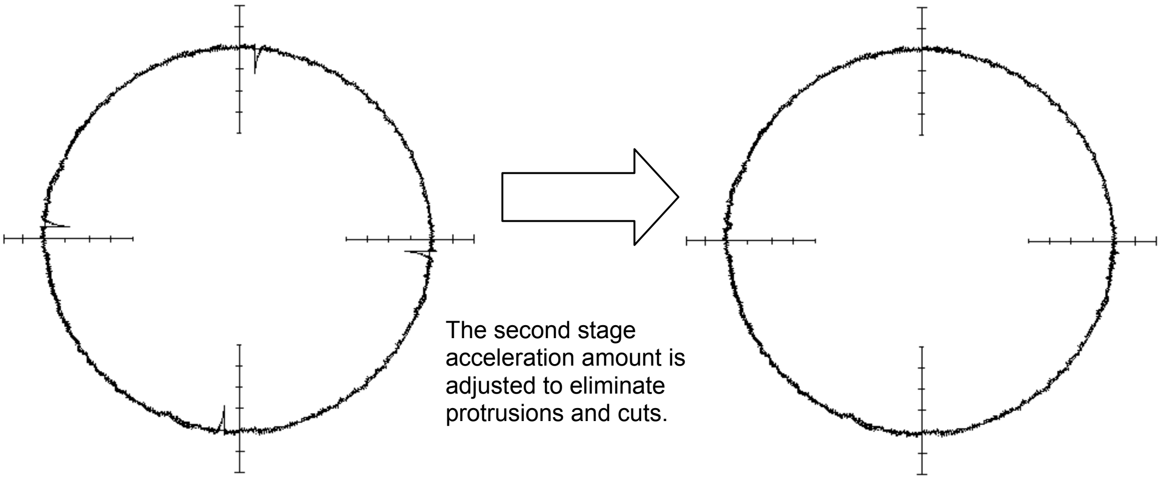


Fig. 5.5.5 (e) Two-stage backlash acceleration (second stage acceleration amount adjustment)

<10>Second stage acceleration override adjustment

Second stage acceleration amounts can be overridden according to the circular acceleration.

When using the second stage acceleration override function, set the following.

	#7	#6	#5	#4	#3	#2	#1	#0
2018						OVR8		

OVR8 (#2) 0: The format of the second stage acceleration override is in reference to 4096.
1: The format of the second stage acceleration override is in reference to 256.

Normally, set it to 1.

2114	Second stage acceleration override

[Valid data range] 0 to 32767

When the second stage acceleration override function is used, the second stage acceleration amount of two-stage backlash acceleration is found from the following formula:

(Second stage acceleration amount)=

$$\text{(Second stage acceleration amount setting)} \times \left\{ 1 + \alpha \times \frac{\text{(Second stage override setting)}}{\text{a}} \right\}$$

If OVR8 = 1, a = 256
If OVR8 = 0, a = 4096

Here, let α be a circular acceleration, R be a radius (mm), F be a circular feedrate (mm/min), and P be a detection unit (mm). Then, α can be expressed as:

$$\alpha = \left\{ \frac{2}{R} \left(F / 60 \times 0.008 \right)^2 \right\} / P$$

So, the second stage override setting and acceleration amount are related as follows:

$$\text{(Second stage override setting)} = \frac{a}{\alpha} \times \left\{ \frac{\text{(Second stage acceleration amount)}}{\text{(Second stage acceleration amount setting)}} - 1 \right\}$$

Example)

When using a second stage acceleration amount override, adjust the backlash second stage acceleration amount for two types of feedrates. Suppose that the adjusted values below are obtained.

No. 2018#2=1

i) In the case of R10, F1000 (detection unit of 1 μm), the optimal second stage acceleration amount is 40.

ii) In the case of R10, F6000 (detection unit of 1 μm), the optimal second stage acceleration amount is 100.

From the results above, the expressions below are obtained.

For i)

$$\alpha = \left\{ \frac{2}{10} \left(1000/60 \times 0.008 \right)^2 \right\} \Big/ 0.001 = 3.56$$

Expressions <1>

$$\text{(Second stage override setting)} = \frac{256}{3.56} \times \left\{ \frac{40}{\text{(Second stage acceleration amount setting)}} - 1 \right\}$$

For ii)

$$\alpha = \left\{ \frac{2}{10} \left(6000/60 \times 0.008 \right)^2 \right\} \Big/ 0.001 = 128$$

Expressions <2>

$$\text{(Second stage override setting)} = \frac{256}{128} \times \left\{ \frac{100}{\text{(Second stage acceleration amount setting)}} - 1 \right\}$$

From expressions <1> and <2>, the following is obtained:

$$\frac{256}{3.56} \times \left\{ \frac{40}{\text{(Second stage acceleration amount setting)}} - 1 \right\}$$
$$= \frac{256}{128} \times \left\{ \frac{100}{\text{(Second stage acceleration amount setting)}} - 1 \right\}$$

Accordingly, (second stage acceleration amount setting) = 38.3 ≒ 38

From expression <2> (or from expression <1>), (second stage override setting) = 3.3 ≒ 3

Set these values in No. 2039 and No. 2114. This completes the setting of a second stage acceleration override.

> **NOTE**
> Second stage override is effective for second stage offset.

<11>Setting a limit to the second stage acceleration amount

Making an optimum override setting for low-speed and high-speed ranges may result in an insufficient acceleration amount in a medium-speed range. To avoid this problem, adjust overriding for low-speed and medium-speed ranges, and set an optimum value for the high-speed range in the following parameter as a limit value.

2338	Limit value for the two-stage backlash second stage acceleration amount

[Valid data range] 0 to 32767 (if this parameter is 0, no limit is placed to the second stage acceleration amount.)

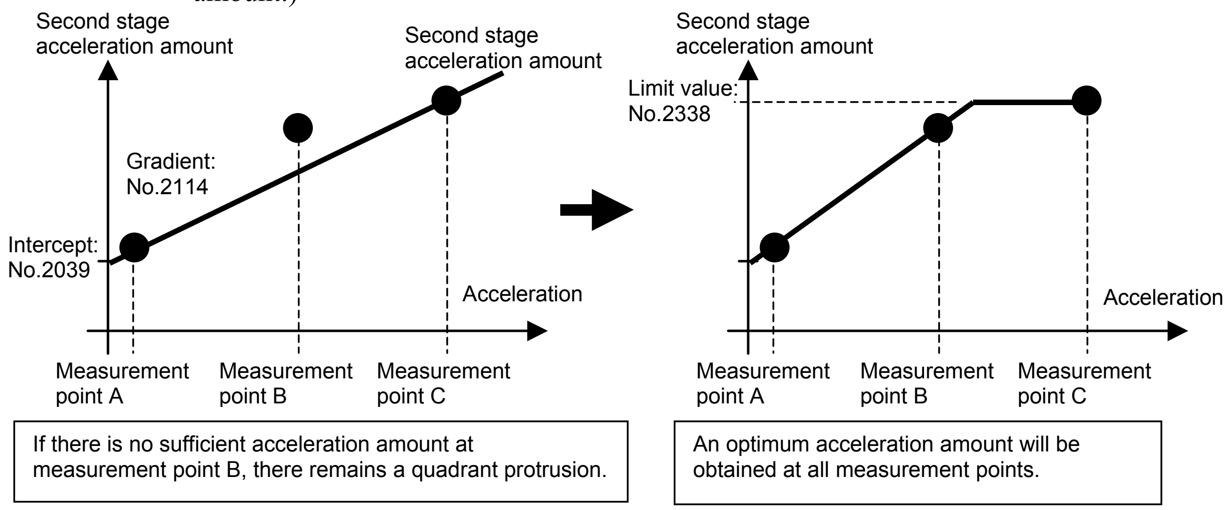


Fig. 5.5.5 (f) Override adjustment for the second stage acceleration amount of two-stage backlash acceleration

<12>Direction-specific setting for second stage acceleration

If the optimum second stage acceleration amount varies depending on the direction in which turn-over occurs, specify the following parameters.

2339	Two-stage backlash second stage acceleration amount override for turn-over from the negative direction to the positive direction

[Recommended value] 100

2340	Second stage acceleration amount override for turn-over from the negative direction to the positive direction

[Valid data range] 0 to 32767

Not used if the two-stage backlash second stage acceleration amount from the negative direction to the positive direction (parameter No. 2339) is 0.

This parameter takes effect when a reverse from the negative direction to the positive direction takes place if the two-stage backlash second stage acceleration amount from the negative direction to the positive direction (parameter No. 2339) is not 0.

It is not overridden if the setting is 0.

2341	Second stage acceleration limit value for turn-over from the negative direction to the positive direction

[Valid data range] 0 to 32767

Not used if the two-stage backlash second stage acceleration amount from the negative direction to the positive direction (parameter No. 2339) is 0. This parameter takes effect when a reverse from the negative direction to the positive direction takes place if the two-stage backlash second stage acceleration amount from the negative direction to the positive direction (parameter No. 2339) is not 0.

If the setting is 0, the second stage acceleration amount is not limited.

[Parameters used for direction-based setting]

<table>
<tr><th>Direction-based setting</th><th>Reverse direction</th><th>Second stage acceleration</th><th>Acceleration amount override</th><th>Acceleration limit value</th></tr>
<tr><td>None</td><td>Common</td><td rowspan="2">No.2039</td><td rowspan="2">No.2114</td><td rowspan="2">No.2338</td></tr>
<tr><td rowspan="2">Present</td><td>From + to -</td></tr>
<tr><td>From - to+</td><td>No.2339</td><td>No.2340</td><td>No.2341</td></tr>
</table>

(4) Neglecting backlash acceleration during feeding by the handle

By enabling the bit below, the backlash acceleration function can be enabled only during cutting feed.

	#7	#6	#5	#4	#3	#2	#1	#0
2009		BLCU						

BLCU (#6) 1: To enable backlash acceleration only during cutting feed

> **NOTE**
> When bit 3 of No. 1800 is set to 1, the backlash acceleration function is enabled at all times, and switching is disabled.

The bit 7 of parameter No. 2223 can also be used to enable the backlash acceleration function only during cutting feed.
By using this bit, switching is enabled even when bit 3 of No. 1800 is set to 1. Backlash acceleration is enabled even at the hole bottom during rigid tapping.

	#7	#6	#5	#4	#3	#2	#1	#0
2223	BLCUT2							

BLCUT2(#7) 1: The backlash acceleration function is enabled only during cutting feed.

(5) Two-stage backlash acceleration function (type 2)

When the two-stage backlash acceleration function is used, quadrant protrusions may be reduced more effectively by starting the second stage acceleration as early as possible. The two-stage backlash acceleration function type 2 enables the second stage acceleration immediately after a reverse operation takes place.

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	E(05) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	E(05) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

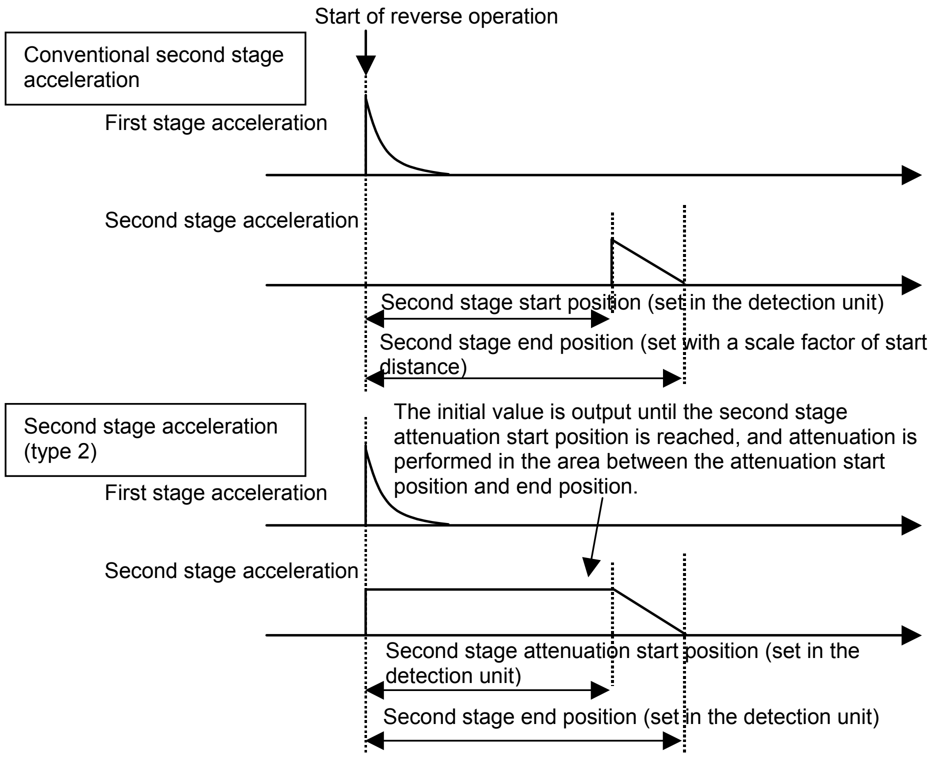


Fig. 5.5.5 (g) Comparison with conventional second stage acceleration

Normally, second stage acceleration is not output until the second stage start distance is reached. The two-stage backlash acceleration type 2 starts outputting the acceleration amount immediately after the reverse operation, and starts attenuation after the start distance.

- Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2271			2NDTMG					

2NDTMG(#5) 0: Does not use the two-stage acceleration type 2.
1: Uses the two-stage acceleration type 2.

2082	Second stage attenuation start position

[Valid data range] 0 to 32767
[Unit of data] Detection unit
[Typical setting] 0 to 10 μm

2089	Second stage end position

[Valid data range] 0 to 32767
[Unit of data] Detection unit
[Typical setting] 20 to 30 μm

> **NOTE**
> For the two-stage backlash acceleration function type 2, the second stage end position is set directly in the detection unit.

5.5.6 Static Friction Compensation Function

(1) Overview

When a machine, originally in the stop state, is activated, the increase in speed may be delayed by there being a large amount of static friction. The backlash acceleration function (see Subsection 5.5.4 and Subsection 5.5.5) performs compensation when the motor rotation is reversed. This function adds compensation data to a velocity command when the motor, originally in the stop state, is requested to rotate in the same direction, thus reducing the activation delay.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Block diagram

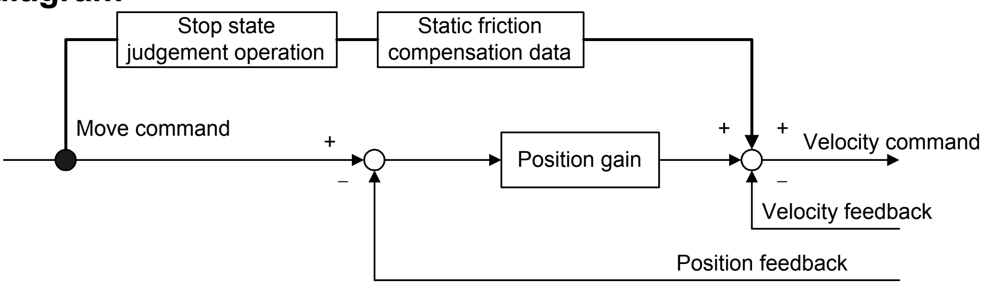


Fig. 5.5.6 (a) Configuration of static friction compensation

(4) Setting parameters

<1> Enable this function.

	#7	#6	#5	#4	#3	#2	#1	#0
2003			BLEN					

BLEN (#5) 1: The backlash acceleration function is enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2005	SFCM							

SFCM (#7) 1: The static friction compensation function is enabled.

<2> Set adjustment parameters.

2071	Time during which the static friction compensation function is enabled (in 2-ms units)

[Valid data range] 0 to 32767
[Recommended value] 10

2072	Static friction compensation

[Valid data range] 0 to 32767
[Recommended value] 100

Offset for the velocity command that is to be added at the start of travel from a stopped state

2073	Stop state judgement parameter

[Valid data range] 1 to 32767
[Method of setting] Stop determination time = (parameter setting) × Ts
Ts = 4ms (Series 30*i*), 8ms (Series 0*i*)
If the machine starts moving after stopping for the time set in this parameter or more, this compensation function is enabled.

NOTE
1 If a small value is set in this parameter, feed at a low feedrate is regarded by mistake as stop state, and compensation may not be performed correctly. In such a case, increase the setting of this parameter.
2 When the static friction compensation function is enabled, be sure to set a nonzero positive value in this parameter.

	#7	#6	#5	#4	#3	#2	#1	#0
2009	BLST							

BLST (#7) 1: The function used to release static friction compensation is enabled.

2097	Parameter for stopping static friction compensation

[Valid data range] 0 to 32767
[Recommended value] 5
Parameter related to the distance the tool travels until the end of the static friction compensation function. Determine the setting by looking at the actual shape.

2347	Static friction compensation (minus direction)

[Valid data range] 0 to 32767
Speed command offset applied when a movement is started from a stop in the minus (-) direction.
When No. 2347≠0, direction-by-direction static friction compensation is enabled. When a movement is made in the minus (-) direction, the value set in parameter No. 2347 is applied as a static friction compensation value. When a movement is made in the plus (+) direction, the value set in parameter No. 2072 is applied.
When No. 2347=0, the value set in parameter No. 2072 is used as a static friction compensation value.

No.2347	Applied static friction compensation		Remarks
	Movement in + direction	Movement in – direction	
0	No.2072	No. 2072	Disables direction-by-direction static friction compensation.
Non-zero value	No.2072	No. 2347	Enables direction-by-direction static friction compensation.

5.5.7 Torsion Preview Control Function

(1) Overview

For relatively large machines having torsion, torsion occurs between the motor and the machine end during acceleration and deceleration. In machines of this type, positional deviation is caused by torsion during acceleration and deceleration.
Torsion preview control compensates the speed command by estimating the amount of torsion from the position command. This reduces the amount of positional deviation during acceleration and deceleration.

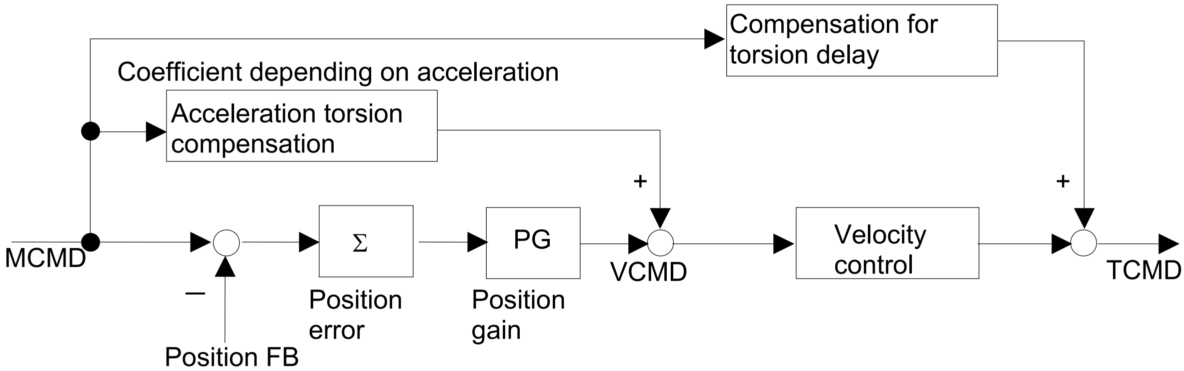


Fig. 5.5.7 (a) Torsion preview control structure

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	M(13) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	M(13) and subsequent editions	HRV4

(3) Notes

- This function works only in the nano interpolation mode.
- Because this function requires the user to observe the machine operation at the time of adjustment, a separate detector is needed.
- Enable the feed-forward function.
- The function is more effective when the time constant of acc./dec. is set so that acceleration changes smoothly. (Example: Bell-shaped acc./dec. before interpolation plus linear-shaped acc./dec. after interpolation)

(4) Setting parameters

<1> Setting feed-forward

Torsion preview control uses feed-forward processing. Therefore, the following parameter must be set:

	#7	#6	#5	#4	#3	#2	#1	#0
2005							FEED	

FEED(#1) The feed-forward function is:
0: Not used.
<u>1: Used.</u>
Set the parameter to use the feed-forward function. Since an error amount is observed to determine the compensation value during the adjustment, set 100% as the feed-forward coefficient for the feed for which torsion preview control is used.

When enabling torsion preview control also in rapid traverse, set FFR to 1

	#7	#6	#5	#4	#3	#2	#1	#0
1800					FFR			

FFR(#3) Feed-forward control during rapid traverse is:
0: Disabled.
1: Enabled.

2092	Advanced preview feed-forward coefficient (ADFF1)

2068	Feed-forward coefficient (FALPH)

2144	Position advanced preview feed-forward coefficient for cutting

<2> Operation measurement and time constant setting

To make adjustments, measure the velocity waveform and error amount.
The waveform may be measured using either the waveform display screen or SERVO GUIDE. When operating the machine at a feedrate of about F10 m/min, check that the following waveform is observed:

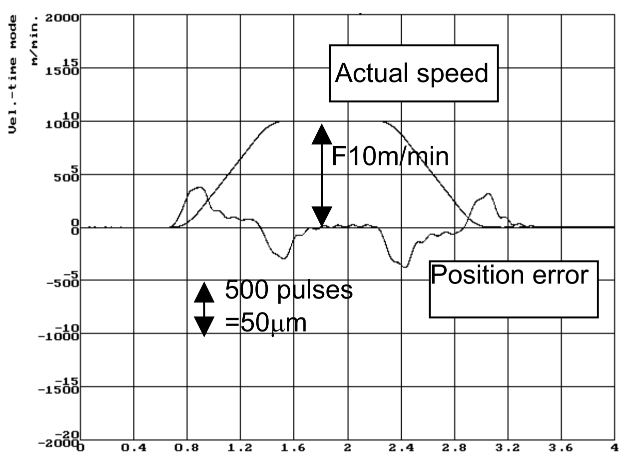


Fig. 5.5.7 (b) Position error and actual speed

Torsion preview control differentiates position commands, so attention should be given to the command mode and time constant setting.
To ensure continuity of position command differential values, the bell-shaped time constant and the time constant of acc./dec. after interpolation must be set as well as the time constant of acc./dec. before interpolation. The adjustment examples presented here assume a large machine with a low resonance frequency of about 10 Hz and set a time constant that prevents the machine from shaking largely at the time of acc./dec.

Time constant of acc./dec. before interpolation: 750 ms taken to reach F12000 mm/min
Acc./dec. before interpolation: bell-shaped time constant: 200ms
Time constant of acc./dec. after interpolation: 100ms

By setting the three time constants as explained above, the acceleration component of position commands form a bell shape, and the compensation value of torsion preview control also becomes smooth. The values of the time constants depend on the vibration status of the machine. So, set the time constants not to allow acc./dec. to cause large vibration.

For position command data resolution and smoothness, nano interpolation is used. When using torsion preview control, be sure to perform operation in a nano interpolation mode such as AI nano contour control or AI nano high precision contour control (when nano interpolation is disabled, torsion preview control is also disabled.)

<3> Setting the acceleration

In torsion preview control, three acceleration areas can be specified, and compensation coefficients can be set separately for these areas.

In a machine having the spring characteristic assumed by torsion preview control, there are almost proportional relationships between the acceleration and the torsion amount and position error. Therefore, setting the acceleration set for the time constant of acc./dec. before interpolation and one acceleration which is about 1/2 to 3/4 of the acceleration is normally sufficient.

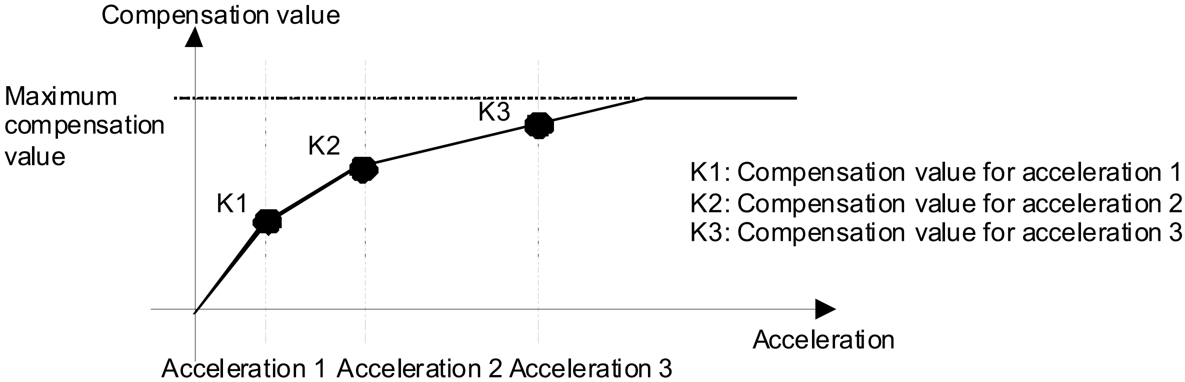


Fig. 5.5.7 (c) Acceleration dependent compensation curve

2383	Torsion preview control: acceleration 1 (LSTAC1)

2384	Torsion preview control: acceleration 2 (LSTAC2)

2385	Torsion preview control: acceleration 3 (LSTAC3)

[Unit of data] D × 1000 [mm/s^2] unit (D: detection unit (mm))
[Valid data range] 0 to 32767

- If the detection unit is 1 µm, the unit is 1 mm/s^2; if the detection unit is 0.1 µm, the unit is 0.1 mm/s^2.
- If the acceleration is set to 0, the setting is ignored.
- Set acceleration values so that acceleration 1 is smaller than acceleration 2, and acceleration 2 is smaller than acceleration 3.
  If acceleration 1 is greater than acceleration 2, the setting of acceleration 2 is ignored.

In this example, set the acceleration for the time constant of acc./dec. before interpolation and another lower acceleration.

- LSTAC2
  Time constant of acc./dec. before interpolation is 750ms taken to reach F12000mm/min

→ Acceleration = 12000/60/0.75 = 266.7mm/s^2
  If the detection unit is 0.1 µm, a value is set in units of 0.1 mm/s^2. Therefore, LSTAC2 = 2667

- LSTAC1
  Acceleration that is 3/4 of LSTAC2, 1000 ms taken to reach F12000 mm/min

→ Acceleration = 12000/60/1 = 200 mm/s^2, therefore, LSTAC1 = 2000

- LSTAC3
  LSTAC3 = 0 because LSTAC3 is not used.

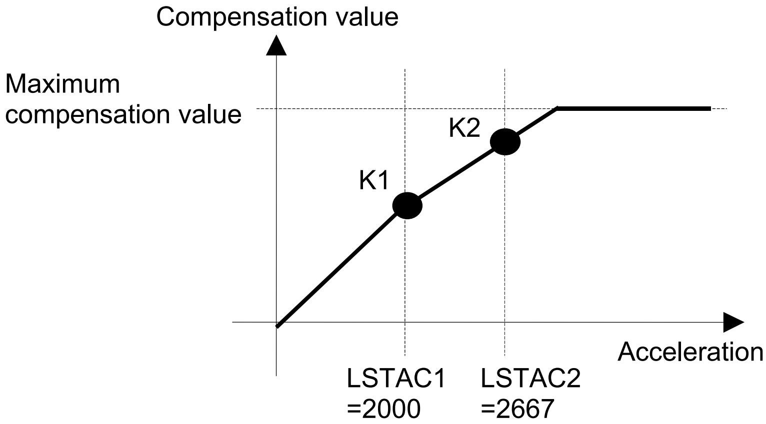


Fig. 5.5.7 (d) Example of compensation curve

<4> Setting the acceleration torsion compensation value

The acceleration torsion compensation value is used to compensate the amount of torsion generated at a constant acceleration. While changing the acceleration setting, measure the position error generated at a constant acceleration.

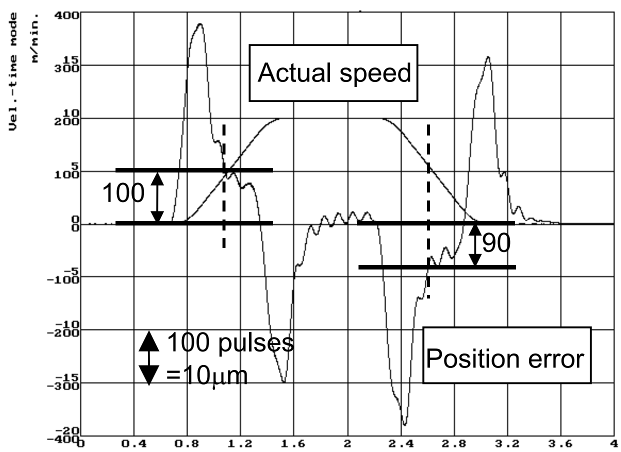


Fig. 5.5.7 (e) Position error at LSTAC2

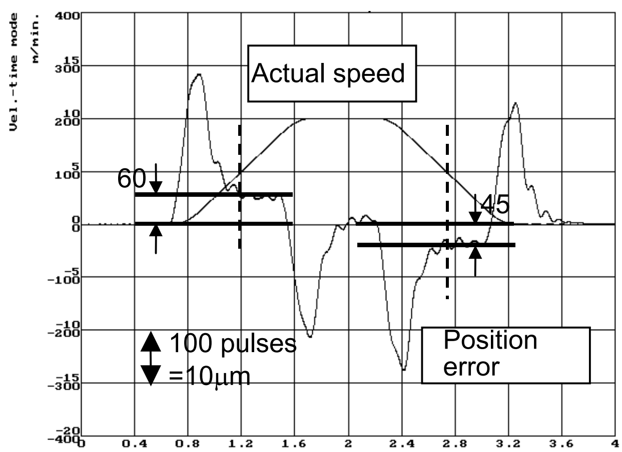


Fig. 5.5.7 (f) Position error at LSTAC1

Set the values measured in Fig. 5.5.7 (e) and Fig. 5.5.7 (f) above in the acceleration torsion compensation values shown below.

(Acceleration torsion compensation value)

2386	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)

[Unit of data] Detection unit
[Valid data range] 0 to 32767
Set the torsion amount generated at acceleration 1 in the detection unit. When 0 is set, compensation is disabled.

2387	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)

[Unit of data] Detection unit
[Valid data range] 0 to 32767
Set the torsion amount generated at acceleration 2 in the detection unit.
When this parameter is set to 0, the K1 setting of acceleration 1 is applied. (See Fig. 5.5.7 (g).)

2388	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)

[Unit of data] Detection unit
[Valid data range] 0 to 32767
Set the torsion amount generated at acceleration 3 in the detection unit.
When this parameter is set to 0, the K2 setting of acceleration 2 is applied. (See Fig. 5.5.7 (h).)
The compensation values are corrected automatically so that the following is satisfied: K1 ≤ K2 ≤ K3. (See Fig. 5.5.7 (i).)

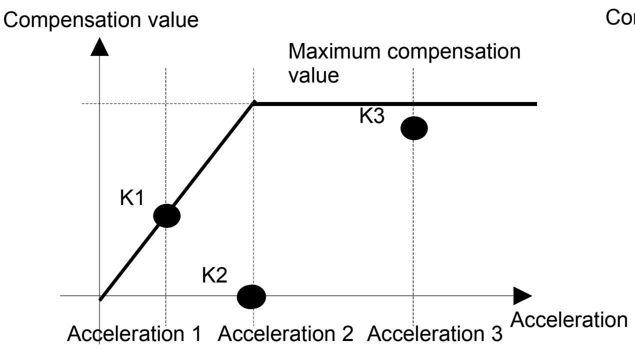


Fig. 5.5.7 (g) Compensation curve when K2 = 0

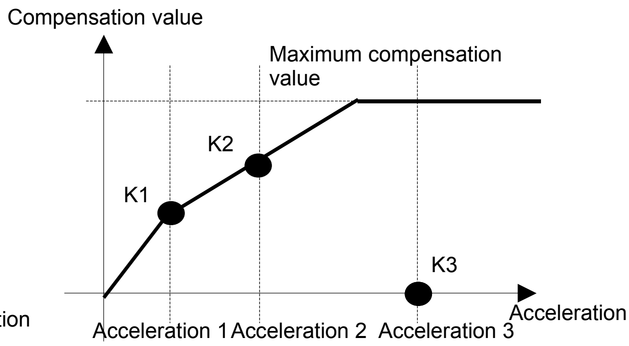


Fig. 5.5.7 (h) Compensation curve when K3 = 0

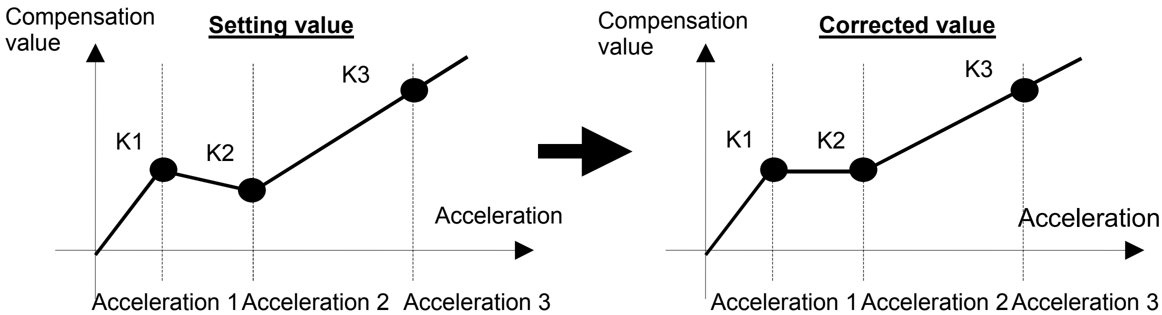


Fig. 5.5.7 (i) Automatic compensation of the compensation curve

(Acceleration torsion compensation value for each direction)

2391	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)

[Unit of data] Detection unit
[Valid data range] 0 to 32767
Set the amount of torsion generated at acceleration 1 (when the acceleration is a negative value) in the detection unit.

2392	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)

[Unit of data] Detection unit

[Valid data range] 0 to 32767

Set the amount of torsion generated at acceleration 2 (when the acceleration is a negative value) in the detection unit.

2393	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)

[Unit of data] Detection unit

[Valid data range] 0 to 32767

Set the amount of torsion generated at acceleration 3 (when the acceleration is a negative value) in the detection unit. If 4 is set, acceleration 2 and the settings up to K2 apply.

> ⚠ **CAUTION**
> When all the three accelerations are not used, set 0 in the parameter of the acceleration not used.

From Fig. 5.5.7 (e) and Fig. 5.5.7 (f), LSTK1 through LSTK3 and LSTK1N through LSTK3N are set as follows:
LSTK1=60, LSTK2=100, LSTK3=0
LSTK1N=45, LSTK2N=90, LSTK3N=0

<5> Setting the maximum compensation value (enabling torsion preview control)

2382	Torsion preview control: Maximum compensation value (LSTCM)

[Unit of data] Detection unit

[Valid data range] 0 to 32767

Set the maximum value of the compensation value to be added to the velocity command in the detection unit. By setting the parameter to a value greater than 0, torsion preview control is enabled. Set a value greater than the maximum position error value measured (a value obtained by multiplication by about 1.2 to 2).

LSTCM=500

The above setting enables this compensation, which reduces the position error generated at the time of acc./dec.

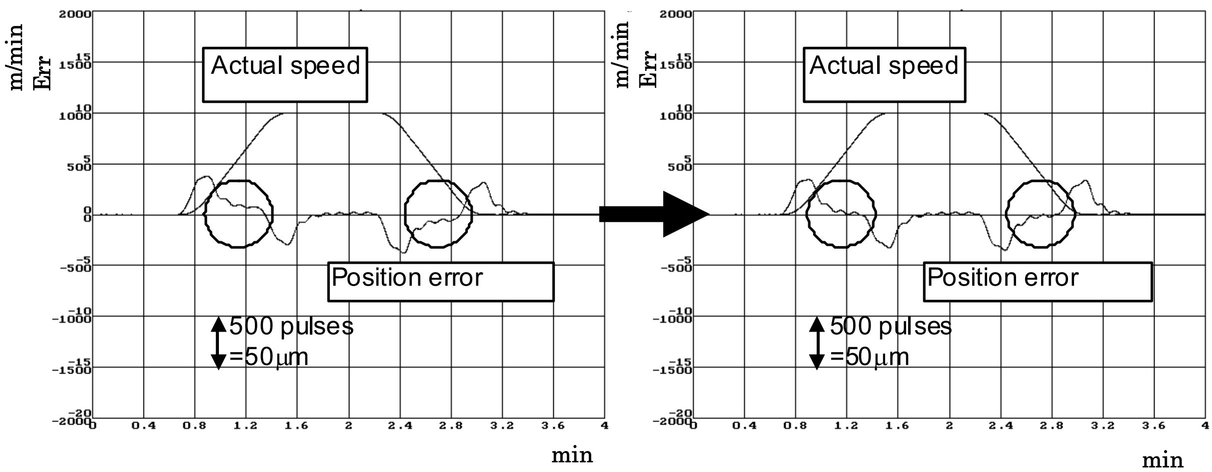


Fig. 5.5.7 (d) Effect of acceleration torsion compensation

<6> Setting the torsion delay compensation value

Just with the acceleration torsion compensation value, the torsion amount generated at the start of acc./dec. due to delay in velocity control cannot be corrected, therefore there is a position error still left.

Adjust the torsion delay compensation value while observing the waveform plotted at the time of acc./dec.

2389	Torsion preview control: Torsion delay compensation value KD (LSTKD)

2396	Torsion preview control: Torsion delay compensation value KDN (LSTKDN)

LSTKDN is used when there is a difference in delay between the start of acceleration and the start of deceleration.

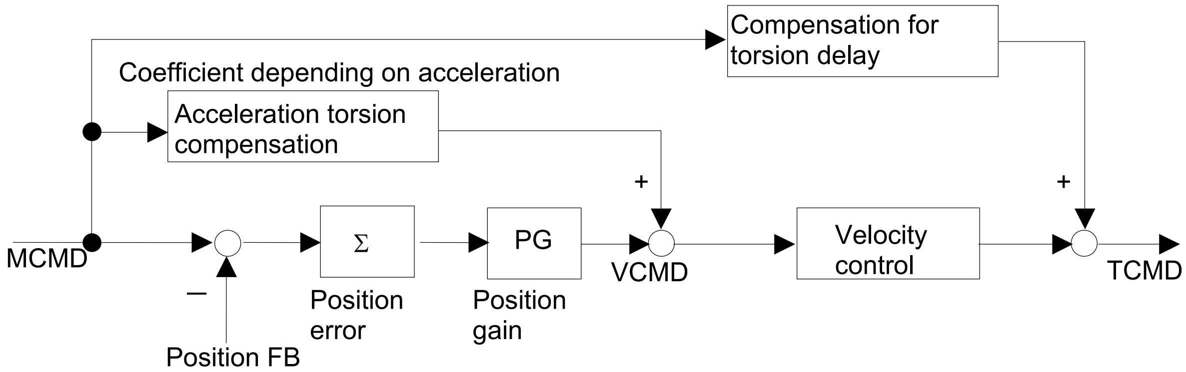


Fig. 5.5.7 (k) Compensation for torsion delay

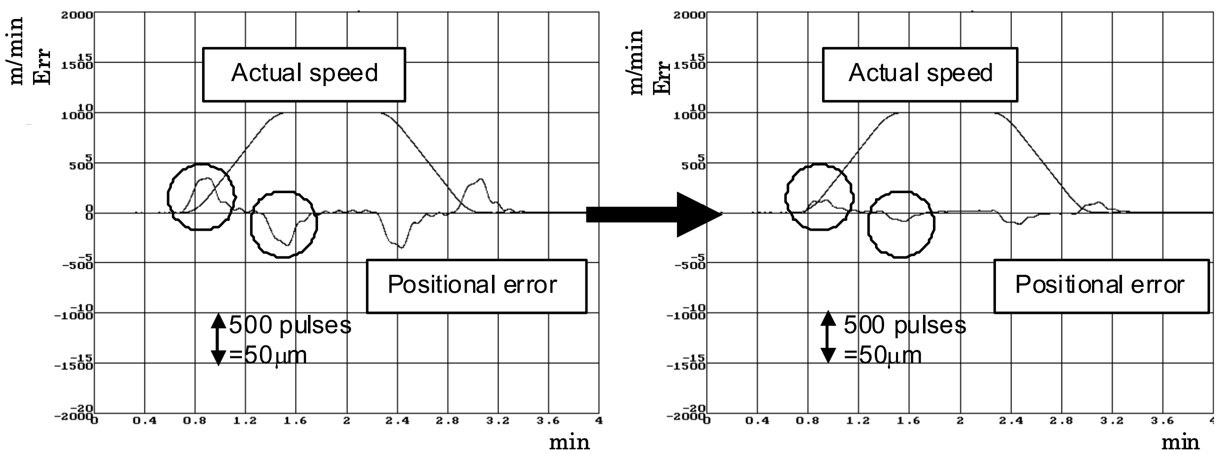


Fig. 5.5.7 (l) Effect of compensation for torsion delay - 1

When the torsion delay compensation value is set to 2000, there is slight position error still left, so a fine adjustment is made. Then, the position error is decreased to 10 μm or less as shown in the figure below.

(Torsion delay compensation value =3000 / 2500)

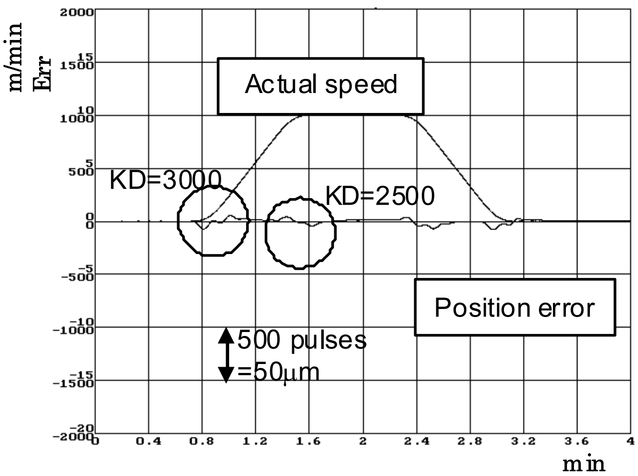


Fig. 5.5.7 (m) Effect of compensation for torsion delay - 2

<7> Setting the torsion torque compensation coefficient

Torsion torque compensation is set when an adequate velocity loop gain cannot be obtained and acceleration torsion compensation does not work efficiently. The delay in velocity control can be compensated by adding the differential of the compensation value to TCMD.

2402	Torsion preview control: Torsion torque compensation coefficient LSTKT

[Unit of data] %
[Valid data range] 0 to 1000

Compensation coefficient used when the compensation value of VCMD is differentiated to compensate TCMD. When 100% is set as the compensation coefficient for TCMD, the acceleration amount of the motor itself is indicated.

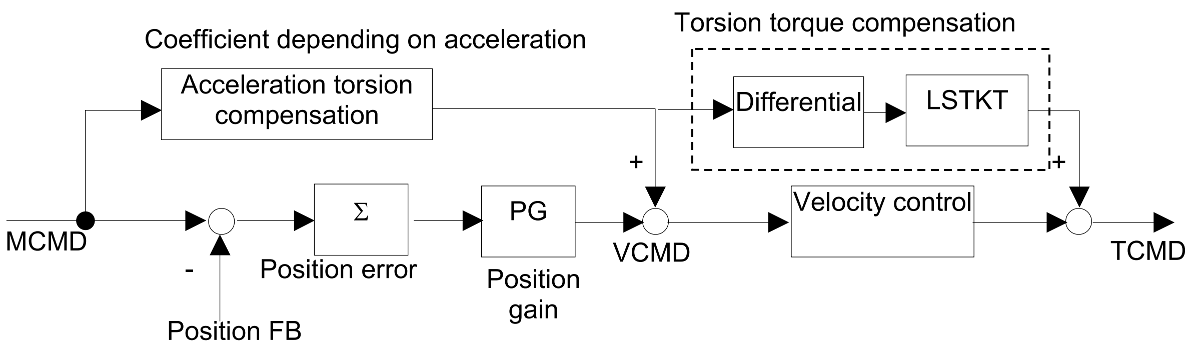


Fig. 5.5.7 (n) Torsion torque compensation

5.5.8 Overshoot Compensation Function

(1) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2003		OVSC						

OVSC (#6) 1: To enable the overshoot compensation function

2045	Velocity loop incomplete integral gain (PK3V)

[Valid data range] 0 to 32767
[Recommended value] 30000

> **NOTE**
> When the overshoot compensation function is not used (OVSC = 0), basically set PK3V to 0.
> If incomplete integration is used when OVSC = 1, the positional deviation does not become 0 in the stop state or the cutting precision degrades.

2077	Overshoot compensation counter (OSCTP)

[Valid data range] 0 to 32767
[Recommended value] 20

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions*	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

* When overshoot compensation Type2 is used in 30*i*-B Series, 90G0/15.0 and subsequent editions are required.

(3) Explanation

(a) Servo system configuration

Fig. 5.5.8 (a) shows the servo system configuration. Fig. 5.5.8 (b) shows the velocity loop configuration.

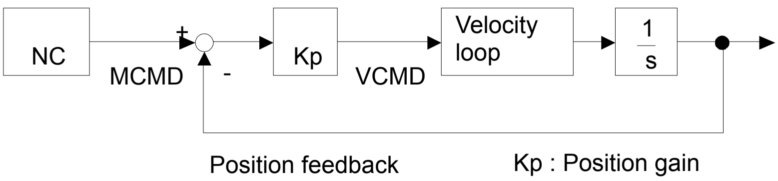


Fig. 5.5.8 (a) Digital servo system configuration

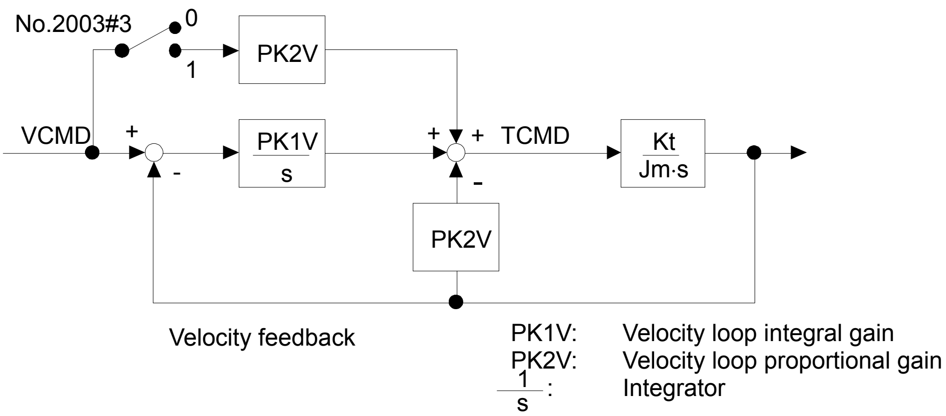


Fig. 5.5.8 (b) Velocity loop configuration

(b) When incomplete integration and overshoot compensation are not used.

First, 1–pulse motion command is issued from NC. Initially, because the Position Feedback and Velocity Feedback are "0", the 1–pulse multiplied position gain Kp value is generated as the velocity command (VCMD).
Because the motor will not move immediately due to internal friction and other factors, the value of the integrator is accumulated according to the VCMD. When the value of this integrator creates a torque command, large enough to overcome the friction in the machine system, the motor will move and VCMD will become "0" as the value of MCMD and the Position Feedback becomes equal.
Furthermore, the Velocity Feedback becomes "1" only when it is moved, and afterwards becomes "0". Therefore the torque command is held fixed at that determined by the integrator.
The above situation is shown in Fig. 5.5.8 (c).

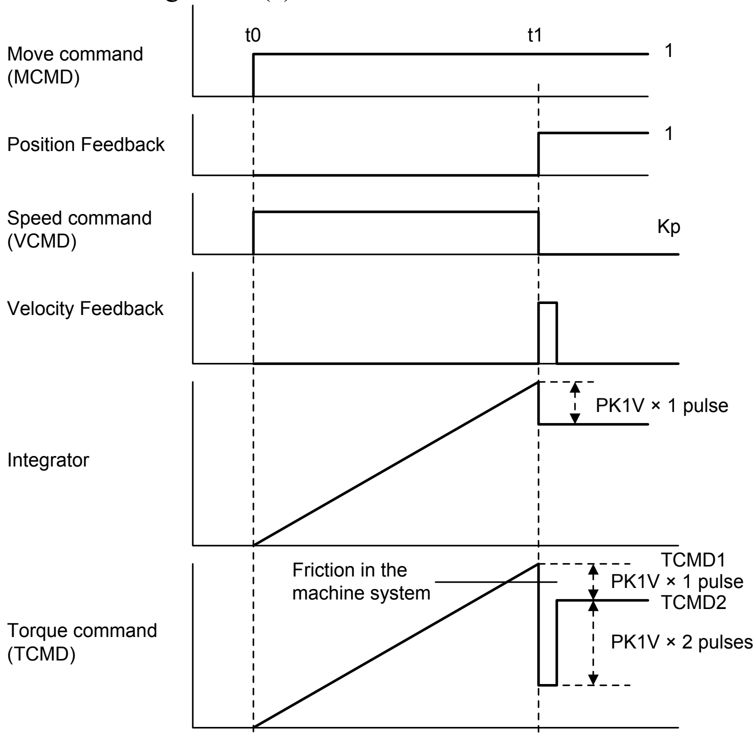


Fig. 5.5.8 (c) Response to 1 pulse movement commands

If Fig. 5.5.8 (c) on the previous page, the torque (TCMD1) when movement has started becomes greater than the machine static friction level. The motor will move 1 pulse, and finally stops at the TCMD2 level. Because the moving frictional power of the machine is smaller than the maximum rest frictional power, if the final torque TCMD2 in Fig. 5.5.8 (c) is smaller than the moving friction level, the motor will stop at the place where it has moved 1 pulse, Fig. 5.5.8 (d). When the TCMD2 is greater than the moving friction level the motor cannot stop and overshoot will occur Fig. 5.5.8 (e).
The overshoot compensation function is a function to prevent the occurrence of this phenomenon.

(c) Response to 1 pulse movement commands

(i) Torque commands for standard settings (when there is no overshoot)

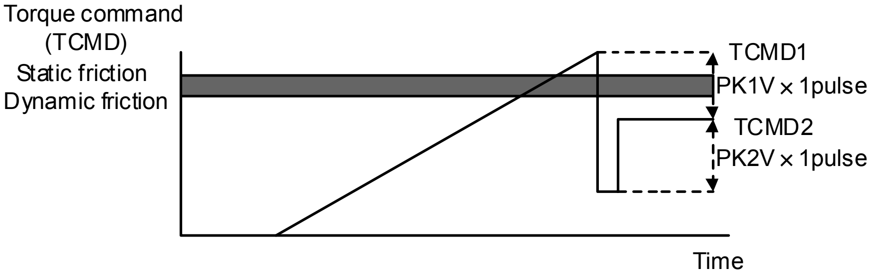


Fig. 5.5.8 (d) Torque commands (when there is no overshoot)

(ii) Torque commands for standard settings (during overshoot)

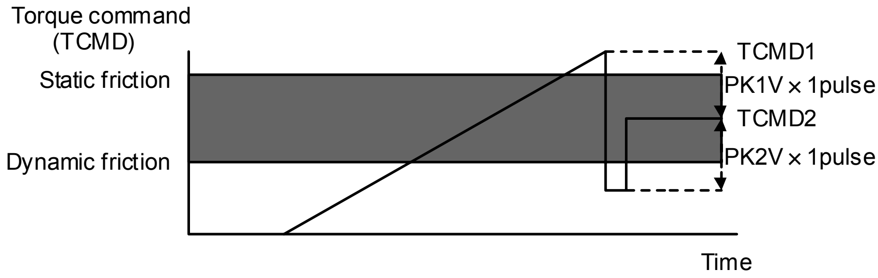


Fig. 5.5.8 (e) Torque commands (during overshoot)

Conditions to prevent further overshoot are as follows.
When
TCMD1 > static friction > dynamic friction > TCMD2…… <1>
and there is a relationship there to
TCMD1 > static friction > TCMD2 > dynamic friction…… <2>
regarding static and dynamic friction like that of (ii), use the overshoot compensation in order to make <2> into <1>.
The torque command status at that time is shown in (iii).

(iii) Torque command when overshoot compensation is used

Function bit OVSC = 1 (Overshoot compensation is valid) Parameter PK3V: around 30000 to 25000 (Incomplete integral coefficient)

(Example)
when PK3V=32000 time constant approx. 42 msec
when PK3V=30000 time constant approx. 11 msec
when PK3V=25000 time constant approx. 4 msec

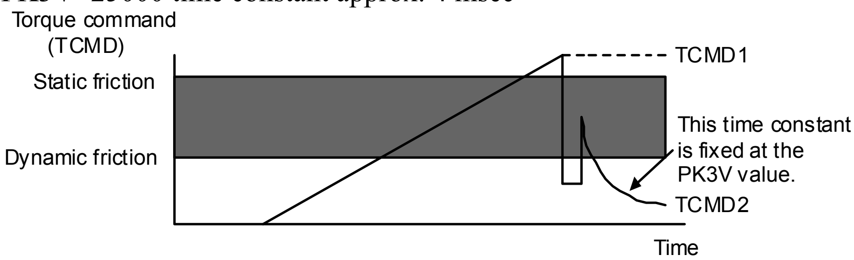


Fig. 5.5.8 (f) Torque command (when overshoot is used)

If this overshoot compensation function is used, it is possible to prevent overshoot so that the relationship between machine static and dynamic friction and TCMD2 satisfies <1>, however the torque TCMD during machine stop is
TCMD2 = 0
the servo rigidity during machine stop is insufficient and it is possible that there will be some unsteadiness at ±1 pulse during machine stop.
There is an additional function to prevent this unsteadiness in the improved type overshoot prevention function and the status of the torque command at that time is shown in (iv).

(iv) Torque command when the improved type overshoot compensation is used

Function bit
OVSC = 1 (Overshoot compensation is valid)
Parameter
PK3V: around 32000 (Incomplete integral coefficient)
OSCTP: around 20 (Number of incomplete integral)

When overshooting with this parameter, try increasing the value of the overshoot protection counter (OSCTP) by 10. Conversely, when there is no overshooting, but unsteadiness occurs easily during machine stop, decrease the overshoot protection counter (OSCTP) value by 10.
When overshoot protection counter (OSCTP) = 0 it is the same as existing overshoot compensation.

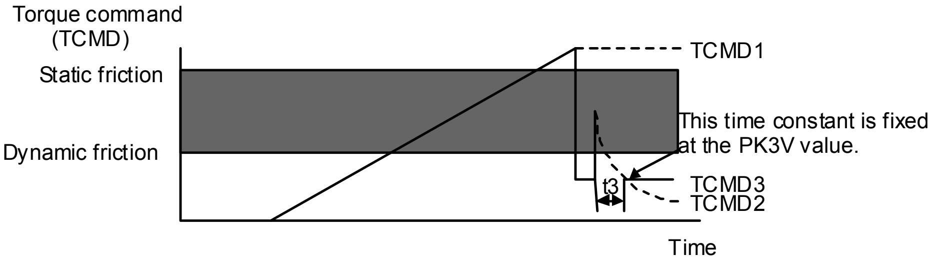


Fig. 5.5.8 (g) Torque command (using improved type overshoot compensation)

If this function is used, the final torque command is TCMD3. If the parameter PK3V (t3) is fixed so that this value becomes less than the dynamic friction level, overshoot is nullified. Because torque command is maintained to some degree during machine stop, it is possible to decrease unsteadiness during machine stop.

(4) Improving overshoot compensation for machines using a 0.1-μm detection unit

(a) Overview

Conventional overshoot compensation performs imperfect integration only when the error is 0.
A machine using a 0.1-μm detection unit, however, has a very short period in which the error is 0, resulting in a very short time for imperfect integration.
The new function judges whether to execute overshoot compensation when the error is within a predetermined range.

(b) Setting parameters

2101	Overshoot compensation enable level

[Valid data range] 0 to 32767
[Unit of data] Detection unit
[Recommended value] 1 (detection unit: 1μm)
10 (detection unit: 0.1 μm)
To set an error range for which overshoot compensation is enabled, set Δ, as indicated below, as the overshoot compensation enable level.

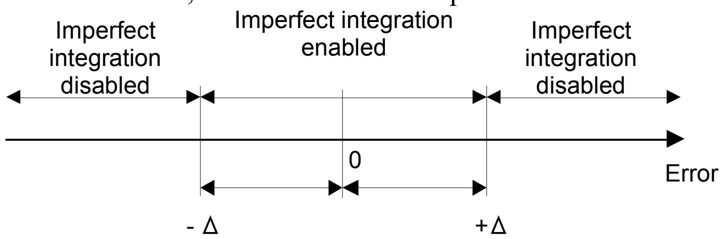


Fig. 5.5.8 (h) Relationship between error and overshoot compensation

(5) Overshoot compensation type 2

(a) Overview

For a machine using, for example, 0.1-μm detection units, the use of the conventional overshoot compensation function may generate minute vibrations when the machine stops, even if the parameter for the number of incomplete integration is set.
This is caused by the repeated occurrence of the following phenomena:

- While the machine is in the stopped state, the position error falls within the compensation valid level, and the integrator is rewritten. Subsequently, the motor is pushed back by a machine element such as a machine spring element, causing the position error to exceed the compensation valid level.
- While the position error is beyond the threshold, a torque command is output to decrease the position error, then it decreases to below the threshold again.

In such a case, set the bit indicated below to suppress the minute vibration.

(b) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2202					OVS1			

OVS1 (#3) 1: Overshoot compensation is enabled only once after the termination of a move command.

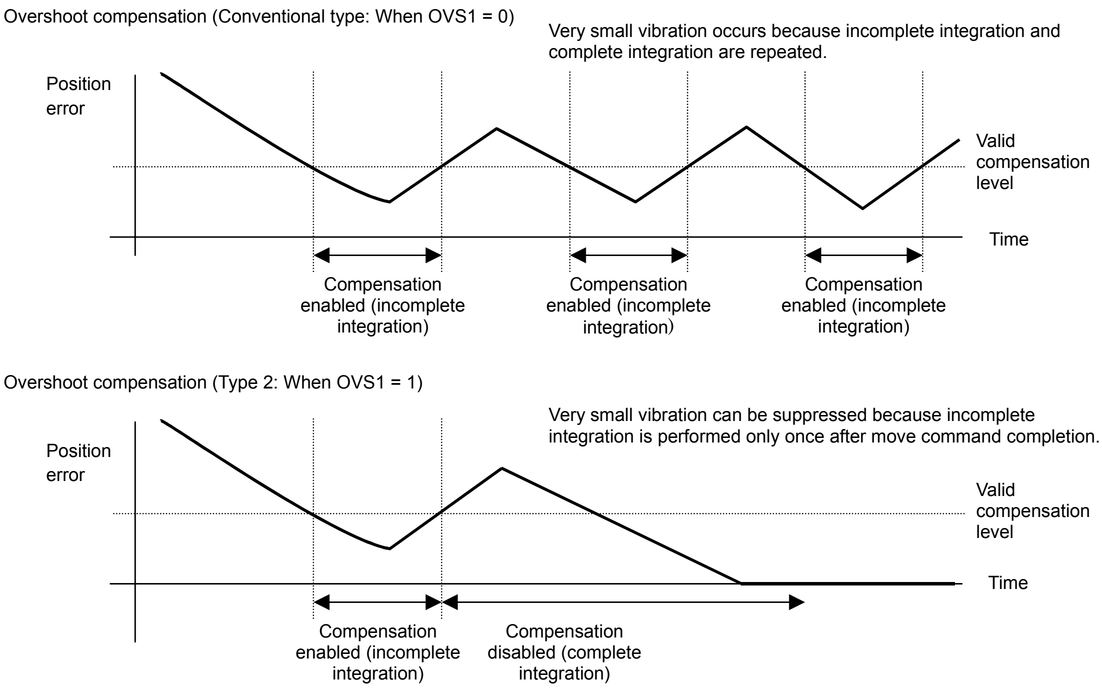


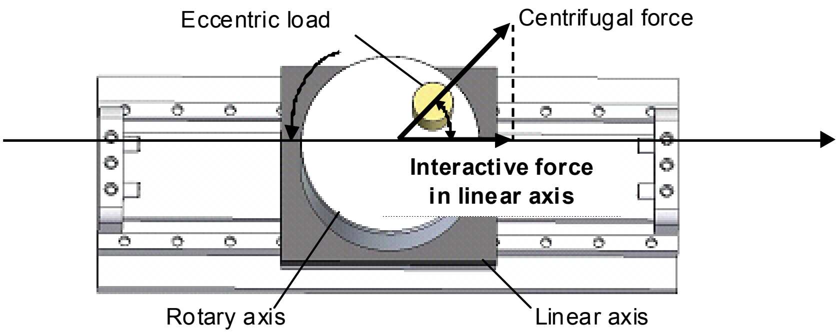
Fig. 5.5.8 (i) Overshoot compensation type 2

5.5.9 Interactive Force Compensation Function

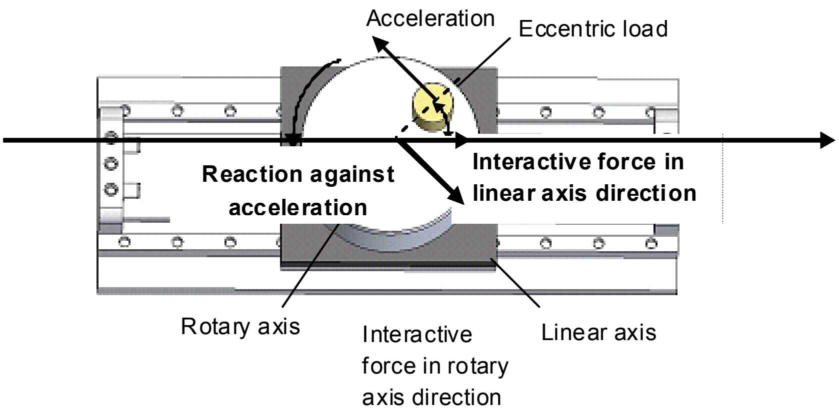
(1) Overview

If a rotary axis with an eccentric load is located on a linear axis, an interactive force such as a centrifugal force or reaction force due to acceleration/deceleration is applied to the linear axis when a motion is made on the rotary axis. Similarly, an interactive force is applied to the rotary axis due to acceleration/deceleration on the linear axis.
The interactive force compensation function is a servo function that achieves more accurate position control by compensating the interactive forces in servo software and canceling their influences. This function is useful for enabling machine tools such as 5-axis machine tools to perform higher-speed and higher-precision machining.

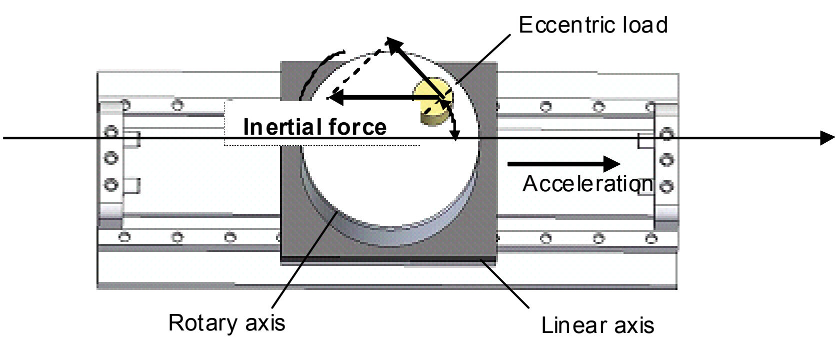
- When a constant-speed rotation is made on a rotary axis



- When acceleration is performed on a rotary axis



- When acceleration is performed on a linear axis



(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	16.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	P(16) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4

To use the interactive force compensation function, the system software below is needed.

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	06 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	06 and subsequent editions
	G204	01 and subsequent editions

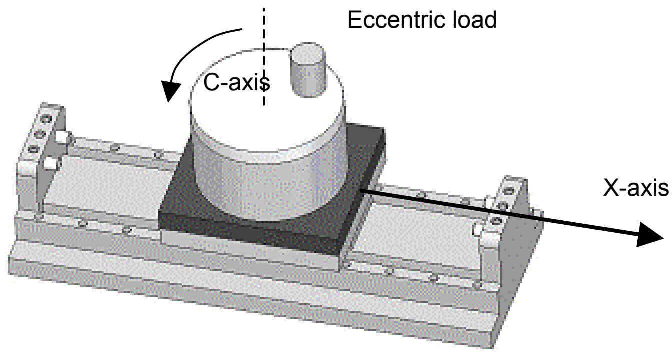
For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

(3) Axis configuration for the interactive force compensation function

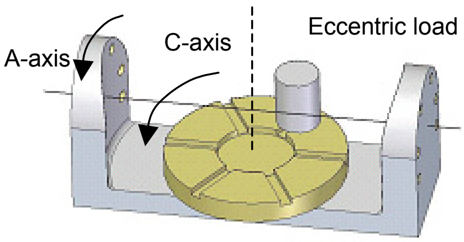
(a) Target axis configuration

The interactive force compensation function basically assumes the two axis configurations described below.

- Configuration 1: Rotary table (C-axis) on a linear axis (X-axis)
  Configuration in which a rotary axis with an eccentric load is located on a linear axis and the center axis of the rotary axis is normal to the linear axis (When the two axes are parallel with each other, no interactive force occurs.)



- Configuration 2: Rotary table (C-axis) on a rotary axis (A-axis)
  Configuration in which the center axis of a rotary axis with an eccentric load is normal to the center axis of a rotary axis on which the rotary axis with an eccentric load is located



(b) Axis naming in interactive force compensation

With the interactive force compensation function, an axis that produces an interactive force when a movement is made on the axis is named a **moving axis**, and an axis affected by such an interactive force (an axis to which interactive force compensation is applied) is named a **compensated axis**.

In configuration 1, for example, suppose that an interactive force acts on the rotary axis due to acceleration operation on the linear axis. In such a case, the linear axis is referred to as the moving axis, and the rotary axis is referred to as the compensated axis.
Conversely, suppose that an interactive force acts on the linear axis due to rotation on the rotary axis. In such a case, the rotary axis is referred to as the moving axis, and the linear axis is referred to as the compensated axis.

(c) Axis configuration

For one compensated axis, up to two moving axes can be specified (interactive force applied from two axes onto one axis can be compensated for simultaneously). Of two specifiable moving axes, the first one is referred to as the first moving axis, and the second one is referred to as the second moving axis.
Bidirectional compensation is applicable between two axes.
An axis to which torque tandem control or synchronous control is applied can be set as a moving axis or compensated axis.
When a servo axis number (No. 1023) is represented in the following format, set servo axis numbers so that n for a moving axis matches n for the corresponding compensated axis.

For series 90D0: Servo axis number = 4n+k
(where, n is an integer, and k = 1 ,2, 3, 4)

No.1023=1,2,3,4	5,6,7,8	9, . . .

The servo axis numbers in one group (enclosed in a dashed frame) can be used to specify a combination of moving axes and a compensated axis.

For series 90E0 or 90E1: Servo axis number = 8n+k
(where n is an integer, and k = 1, 2, 3, 4, 5, 6, 7, 8)

No.1023=1,2,3,4,5,6,7,8	9,10,11,12,13,14,15,16	17, . . .

For series 90G0: Servo axis number = 16n+k
(where n is an integer, and k = 1,2,3,4,5,6,9,10,11,12,13,14)

No.1023=1,2,3,4,5,6, 9,10,11,12,13,14	17,18,19,20,21,22, 25,26,27,28,29,30	33,···

(d) Notes

To use the interactive force compensation function, **feed-forward must be enabled**. While feed-forward is disabled for a moving axis, interactive force is disabled.
When no direct connection is made between a moving axis and compensated axis, the interactive force compensation function cannot be used.

(4) Setting parameters

The function of each parameter is described below.

* For an example of parameter setting, see "(5) Example of parameter setting".
* A compensation value used with the interactive force compensation function is calculated on the compensated axis side. So, parameters for setting a compensation gain, angle data offset value, and so forth are to be set on the compensated axis side.

	#7	#6	#5	#4	#3	#2	#1	#0
2292(FS30*i*)	MOVAXS	MV1IFC	MV1ID2	MV1ID1	MV1ID0	IFC1ON	C1TYP1	C1TYP0

Set with moving axis

MOVAXS(#7) Specifies whether the axis is a moving axis used with the interactive force compensation function. (Power-off parameter)

0: The axis is not a moving axis.
1: The axis is a moving axis.

For an axis used with the interactive force compensation function as a moving axis (axis that affects another axis), set this bit parameter to 1.

Set with compensated axis

MV1IFC(#6) Sets calculation of interactive force from the first moving axis.(Power-off parameter)

0: Disables calculation of interactive force from the first moving axis.
1: Enables calculation of interactive force from the first moving axis.

When this bit parameter is set to 1, interactive force from the first moving axis is calculated. (However, when position feed-forward for the first moving axis is disabled, the calculated value of interactive force is 0.)
This bit parameter specifies interactive force calculation alone. To enable interactive force compensation actually, IFC1ON (bit 2 of No. 2292) needs to be set as well.

Set with compensated axis

MV1ID2,MV1ID1,MV1ID0(#5,4,3) Specifies a servo axis number for the first moving axis.
This bit parameter is specific to 30*i*-A Series. In 30*i*-B Series and Power Motion *i*-A, the servo axis numbers of the first moving axis and second moving axis are specified by parameter No. 2606.
For calculation of interactive force from the first moving axis (bit 6 of No. 2292=1), a servo axis number needs to be specified for the first moving axis. Set these bit parameters to values below according to a desired servo axis number.

MV1ID2	MV1ID1	MV1ID0	Servo axis number for moving axis (Series 90E0,90E1)
0	0	0	8n+1
0	0	1	8n+2
0	1	0	8n+3
0	1	1	8n+4
1	0	0	8n+5
1	0	1	8n+6
1	1	0	8n+7
1	1	1	8n+8

* n = 0, 1, 2, ...

NOTE

When the interactive force compensation function is used, a restriction is imposed on selection of a moving axis and compensated axis. When a servo axis number (No. 1023) is represented in the format below, select a moving axis and compensated axis from those axes that have the same n value.

Series 90D0:

Servo axis number = 4n+k (where, n is an integer, and k = 1, 2, 3, 4)

Series 90E0, 90E1:

Servo axis number = 8n+k (where n is an integer, and k = 1, 2, 3, 4, 5, 6, 7, 8)

Series 90G0:

Servo axis number = 16n+k (where n is an integer, and k = 1, 2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14)

If the n value of a moving axis and the n value of a compensated axis differ from each other, modify the servo axis number setting so that the two n values match.

Set with compensated axis

IFC1ON(#2) Turns on/off the compensation function for interactive force from the first moving axis.

0: Does not compensate for interactive force from the first moving axis.

1: Compensates for interactive force from the first moving axis.

By setting this bit parameter to 1, compensation for interactive force from the first moving axis is enabled. (However, bit 6 (MV1IFC) of No. 2292 must be set to 1.)

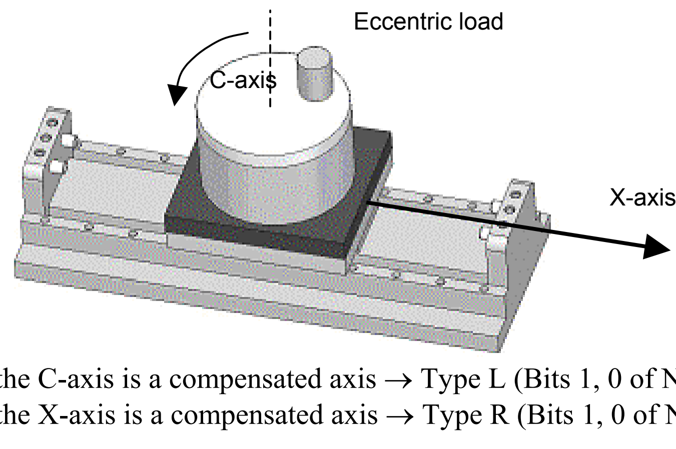
Set with compensated axis

C1TYP1,C1TYP0(#1,0)Sets a compensation type (for the first moving axis).

Set a compensation type according to the axis configuration and axis type to which the interactive force compensation function is applied. An example of axis configuration is provided below.

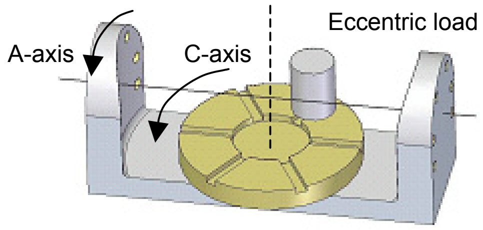
Axis configuration	C1TYP1	C1TYP0	Compensation type
Interactive force from linear axis to rotary axis	0	0	Type L
Interactive force from rotary axis to linear axis	0	1	Type R

- Configuration 1: Rotary axis (C-axis) on a linear axis (X-axis)



When the C-axis is a compensated axis → Type L (Bits 1, 0 of No. 2292=0,0)
When the X-axis is a compensated axis → Type R (Bits 1, 0 of No. 2292=0,1

- Configuration 2: Rotary axis (C-axis) on a rotary axis (A-axis)



When the C-axis is a compensated axis → Type L (Bits 1, 0 of No. 2292=0,0)
When the A-axis is a compensated axis → Type R (Bits 1, 0 of No. 2292=0,1)

	#7	#6	#5	#4	#3	#2	#1	#0
2293(FS30*i*)		MV2IFC	MV2ID2	MV2ID1	MV2ID0	IFC2ON	C2TYP1	C2TYP0

Set with compensated axis

(Power-off parameter)

MV2IFC(#6) Sets calculation of interactive force from the second moving axis.
0: Disables calculation of interactive force from the second moving axis.
1: Enables calculation of interactive force from the second moving axis.

Set with compensated axis

MV2ID2,MV2ID1,MV2ID0(#5,4,3) Specifies a servo axis number for the second moving axis.
This bit parameter is specific to 30*i*-A Series. In 30*i*-B Series and Power Motion *i*-A, the servo axis numbers of the first moving axis and second moving axis are specified by parameter No. 2606.

MV2ID2	MV2ID1	MV2ID0	Servo axis number for moving axis (Series 90E0, 90E1)
0	0	0	8n+1
0	0	1	8n+2
0	1	0	8n+3
0	1	1	8n+4
1	0	0	8n+5
1	0	1	8n+6
1	1	0	8n+7
1	1	1	8n+8

* n = 0, 1, 2, ...

Set with compensated axis

IFC2ON(#2) Turns on/off the compensation function for interactive force from the second moving axis.
0: Does not compensate for interactive force from the second moving axis.
1: Compensates for interactive force from the second moving axis.

Set with compensated axis

C2TYP1,C2TYP0(#1,0)Sets a compensation type (for the second moving axis).

Axis configuration	C2TYP1	C2TYP0	Compensation type
Interactive force from linear axis to rotary axis	0	0	Type L
Interactive force from rotary axis to linear axis	0	1	Type R

Set with compensated axis

This parameter is specific to 30*i*-B Series. In 30*i*-A Series, the servo axis numbers of the first moving axis and second moving axis are specified by bits 3, 4, and 5 of parameter No. 2292 and bits 3, 4, and 5 of parameter No. 2293, respectively.

2606(FS30*i*-B)	Axis number of second moving axis	Axis number of first moving axis

[Unit of data] -
[Valid data range] 1 to 9999
[Setting value] Set the axis number (1 to 99) of the second moving axis 2 × 100 + the axis number (1 to 99) of the first moving axis.

When the interactive force from the first moving axis and second moving axis is calculated (bit 6 of parameter No. 2292 = 1 and bit 6 of parameter No. 2293 = 1), the target moving axes (axes having influences) need to be specified.
Set this parameter according to the axis numbers (parameter No. 1023) of the moving axes.
When the moving axis is a tandem axis, make settings according to the axis number of the master axis.

NOTE
It is not possible to arbitrarily select the moving axis and compensated axis to which the interactive force compensation function is applied. The moving axis and compensated axis need to be selected from among axes having the same value "n" in the axis number (parameter No. 1023) represented in the following form.
Axis number = 16n + k (where, n is an integer, and k = 1 to 6, 9 to 14)
If the value "n" of the moving axis is different from that of the compensated axis, change the settings of axis numbers so that they coincide with each other.

Set with compensated axis

2478(FS30*i*)	Interactive force compensation: Compensation gain (for the first moving axis)

[Unit of data] -
[Valid data range] 0 to 32767
Set a coefficient (gain) for interactive force compensation.
The optimum value varies according to the weight of an eccentric load and the distance from the rotation center. So, set a proper value according to "(6) Setting parameters".

Set with compensated axis

2479(FS30*i*)	Interactive force compensation: Angle data offset (for the first moving axis)

[Unit of data] 360/4096 deg
[Valid data range] 0 to 4096
Set angle data that can be read when an eccentric load is placed at the reference position of the rotary axis. The parameter setting varies, depending on the compensation type as follows:
Compensation type L → An offset relative to the angle data of the compensated axis is set with the compensated axis.
Compensation type R → An offset relative to the angle data of the moving axis is set with the compensated axis.

Set with compensated axis

2480(FS30*i*)	Interactive force compensation: Compensation gain (for the second moving axis)

Set with compensated axis

2481(FS30*i*)	Interactive force compensation: Angle data offset (for the second moving axis)

For a rotary axis, the number of pulses per revolution output from a detector needs to be set.

Set with rotary axis

2455(FS30*i*)	Integer part of the number of pulses per revolution (α)

[Valid data range] 0 to 32767

Set with rotary axis

2456(FS30*i*)	Exponent part of the number of pulses per revolution (β)

[Valid data range] 0 to 12

From the number of feedback pulses per revolution on a rotary axis, find the values of the integers (α and β) that satisfy the expression below then set the found values in the parameters above.

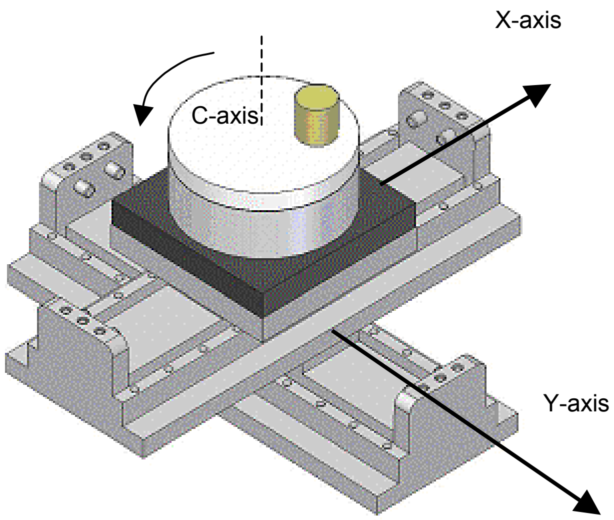
Number of pulses per revolution on a rotary axis = $\alpha \times 2^{\beta}$
(where, $1 \le \alpha \le 32767$, $0 \le \beta \le 12$)
An example of parameter setting is provided below using a detector indicated below for a synchronous built-in servo motor.

Detector	No.2455	No.2456	Remarks
α*i*CZ 512A	8192	7	Manufactured by FANUC
α*i*CZ 768A	12288	7	Manufactured by FANUC
α*i*CZ 1024S	16384	7	Manufactured by FANUC
RCN223F	16384	10	Manufactured by HEIDENHAIN

(5) Example of parameter setting

To use the interactive force compensation function, an axis (moving axis) that produces an interactive force by movement on the axis and an axis (compensated axis) that is affected by the interactive force need to be set, and the relationship between the two axes needs to be set properly according to the machine configuration. This example explains the parameters for axis setting.

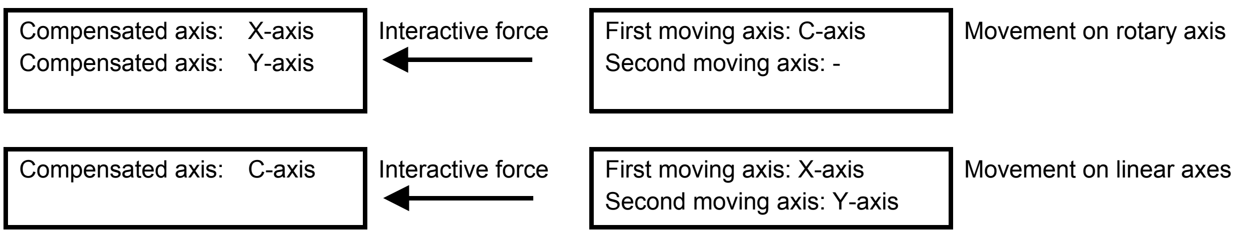
As an example, suppose a machine with the following axis configuration:



- Assume a configuration where the X-axis (linear axis) is placed on the Y-axis (linear axis), the C-axis (rotary axis) is placed on the X-axis, and an eccentric load is mounted on the C-axis.
- Suppose that a synchronous built-in servo motor is used for the C-axis and that the detector α*i*CZ1024A is used.
- Suppose also that the servo axis numbers (No. 1023) and detection units indicated below are used for the axes. (Use of servo software Series 90G0 is assumed.)

Axis	No.1023	Detection unit	Remarks
X-axis	1	1 μm	Linear axis
Y-axis	2	1 μm	Linear axis
C-axis	6	0.001 deg	Rotary axis

- Suppose that the X-axis and Y-axis cross each other at right angles and that no interactive force occurs between the X-axis and Y-axis.
- This example simultaneously compensates for an interactive force that is produced by rotation on the C-axis and acts on the X-axis and Y-axis and also compensates for an interactive force that is produced by acceleration on the X-axis and Y-axis and acts on the C-axis.



(Parameter setting)

No.	Description	Setting			
		X-axis	Y-axis	C-axis	
No.2292#7	Moving axis specification	1 *1	1 *1	1 *1	
No.2455	Integer part of the number of pulses	0	0	16384	*2
No.2456	Exponent part of the number of pulses	0	0	7	*2
No.2292#6	Calculation of interactive force from the first moving axis	1	1	1	*3
No.2606	Servo axis number specification for the first moving axis	6	6	102	*4
No.2292#2	Enabling compensation for interactive force from the first moving axis	1	1	1	
No.2292#1,0	Type of compensation for interactive force from the first moving axis	01	01	00	
No.2478	Compensation gain for interactive force from the first moving axis	Adjusted value	Adjusted value	Adjusted value	
No.2479	Angle data offset for the first moving axis	Adjusted value	Adjusted value	Adjusted value	
No.2293#6	Calculation of interactive force from the second moving axis	0	0	1	*5
No. 2606	Servo axis number specification for the second moving axis	6	6	102	*5
No.2293#2	Enabling compensation for interactive force from the second moving axis	-	-	1	*5
No.2293#1,0	Type of compensation for interactive force from the second moving axis	-	-	00	
No.2480	Compensation gain for interactive force from the second moving axis	-	-	Adjusted value	
No.2481	Angle data offset for the second moving axis	-	-	Adjusted value	

*1) All axes are moving axes. So, set bit 7 of No. 2292 to 1 for all axes.

*2) The X-axis and Y-axis are linear axes. So, set 0 as the number of pulses per revolution. The C-axis is a rotary axis, so the number of pulses per revolution needs to be set. When using α*i*CZ 1024A, set 16384 in No. 2455, and set 7 in No. 2456.

*3) Considering the C-axis as the first moving axis for the X-axis and Y-axis, and the X-axis as the first moving axis for the C-axis, set the first moving axis for the X-axis, Y-axis, and C-axis.

While the servo axis numbers of the first moving axis and the second moving axis are specified by parameter No. 2606 in 30*i*-B Series and Power Motion *i*-A, the servo axis numbers of the first moving axis and the second moving axis are specified by bits 5, 4, and 3 of parameter No. 2292 and bits 5, 4, and 3 of parameter No. 2293, respectively, in 30*i*-A Series.

Example of setting the servo axis numbers of the first moving axis and second moving axis in 30*i*-A Series

Axis	No.2292#5,4,3 Specification of servo axis number of first moving axis	No.2293#5,4,3 Specification of servo axis number of second moving axis
X-axis	101	-
Y-axis	101	-
C-axis	000	001

*4) The linear axes (X-axis and Y-axis) are affected by an interactive force from the rotary axis (C-axis). So, set type R for the X-axis and Y-axis.
The rotary axis (C-axis) is affected by an interactive force from the linear axes (X-axis and Y-axis). So, set type L for the C-axis.

(6) Setting parameters

For interactive force compensation, two parameters, one for angle data offset and the other for compensation gain, need to be adjusted. The method of adjustment is described below.

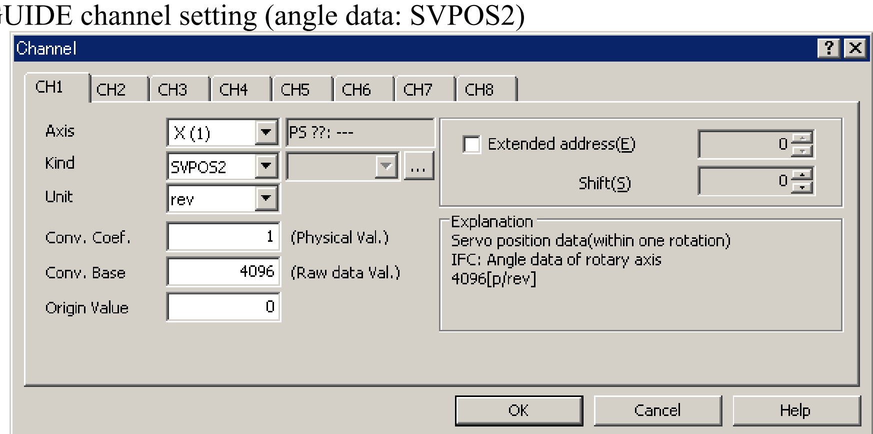
> **NOTE**
> To use the interactive force compensation function, Various parameters need to be set. Before starting parameter adjustment, **Set bit 2 of No. 2292 to 0 and set bit 2 of No. 2293 to 0 (to disable interactive force compensation).** If these bit parameters are set to 0, interactive force compensation is not actually enabled but calculated compensation data can be observed. At the initial stage of adjustment, disable compensation.

(a) Checking the angle data of a rotary axis

When a rotary axis is to be set as a compensated axis or moving axis, the angle data of the rotary axis is required. Check that the number of pulses per revolution (No. 2455 and No. 2456) is set correctly and the angle data is calculated correctly. For all rotary axes that are used for interactive force compensation, check that phase data is output correctly, by using the method described below.

- Check method
  By making a movement on a rotary axis by a certain amount, observe the change in angle data. If the number of pulses per revolution is set correctly, the angle data changes by 4096 when a movement is made on the rotary axis by 360°. Check whether the actual amount of movement matches the change in phase data.
  For example, check that when a movement of 90° is made on a rotary axis, the change in phase data is 1024 (= 4096×90/360).
  If the actual amount of movement does not match the change in phase data, recheck the settings of No. 2455 and No. 2456.

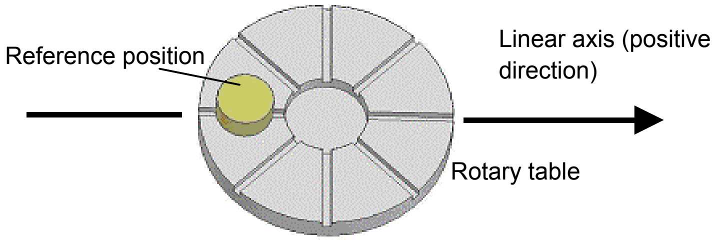
- SERVO GUIDE channel setting (angle data: SVPOS2)



Axis : Select a target rotary axis.
Kind : Select SVPOS2.
Unit : Select rev.
Conv. Coef : Set 1. (Set 360 when change is observed with 360°/rev.)
Conv. Base : Set 4096.
Origin value : Set 0.

(b) Setting angle data (No. 2479 and No. 2481)

Move the eccentric load on a rotary axis to the reference position shown below and observe the value of phase data. Set the observed value in the angle data parameter (No. 2479 or No. 2481).



If the eccentric load cannot be moved to the reference position, find a value by estimation from the angle data at a position to which the eccentric load can be moved.
For example, if a phase data of 2000 is observed when the eccentric load is moved to a position of 90° away from the reference position, the value to be set as angle data is:

$2000-4096\times90/360 = 976$

(If the result of calculation is a negative value, add 4096 to the result to make a value from 0 to 4095.)
If the accurate position of the eccentric load is unknown, set an approximate position with the method above then make a fine adjustment according to "(c) Adjusting compensation gain" below.

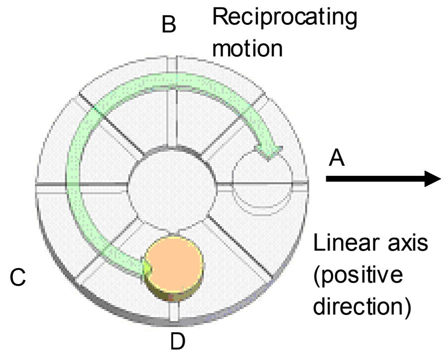
(c) Adjusting compensation gain (No. 2478 and No. 2480)

The method of compensation gain adjustment is described below.
The example described below uses a rotary table as a moving axis and uses a linear axis as a compensated axis in configuration 1, and uses a waveform produced by making reciprocating motions in the arrow directions. It is supposed that each reciprocating motion is made by 270° through the reference position.

NOTE

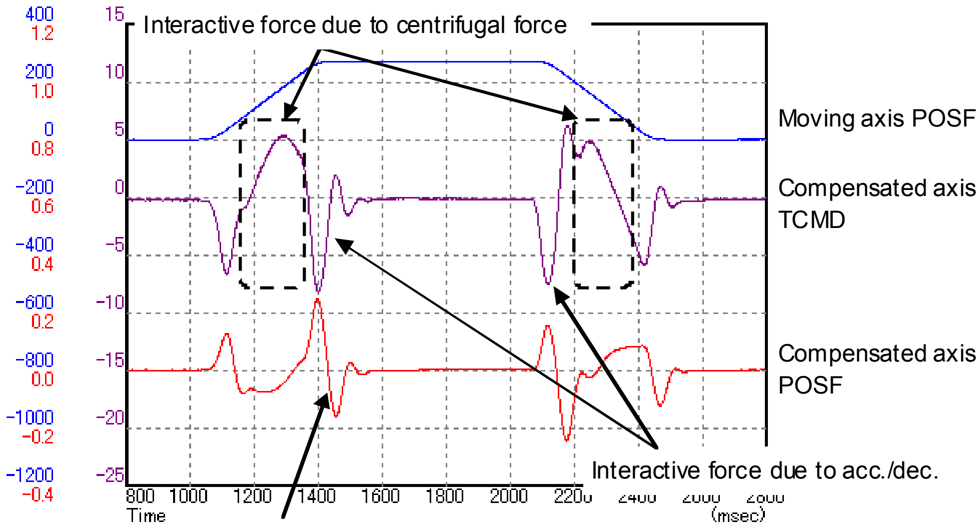
The magnitude of interactive force varies, depending on the position (angle) of an eccentric load on the rotary table. Depending on the position of an eccentric load, no interactive force is produced. So, when making a compensation gain adjustment, make a check by making movements fully across the movable range on the rotary axis.

- If acceleration/deceleration is performed on the linear axis in the following figure, no interactive force is produced on the rotary axis at positions A and C.
- At positions A and C, acceleration/deceleration performed on the rotary axis produces no interactive force on the linear axis. However, interactive force due to centrifugal force is produced.
- At positions B and D, interactive force due to the centrifugal force of the rotary axis is not produced on the linear axis. However, acceleration/deceleration performed on the rotary axis produces interactive force.



<1> Checking the influence of interactive force

While making no movement on the compensated axis to which the interactive force compensation function is applied, make a movement on the moving axis. At this time, observe the waveform of the torque command (TCMD) and position feedback (POSF) on the compensated axis with SERVO GUIDE.



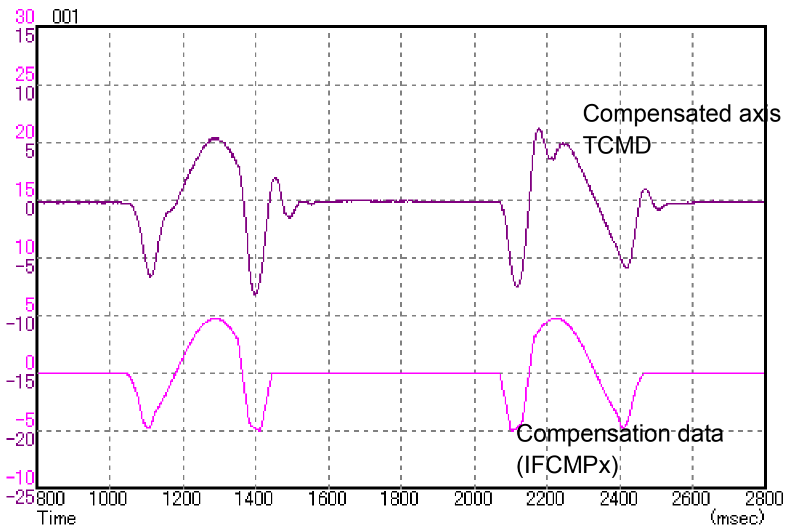
The position on the compensated axis varies, depending on movement on the moving axis.

<2> Checking interactive force compensation data

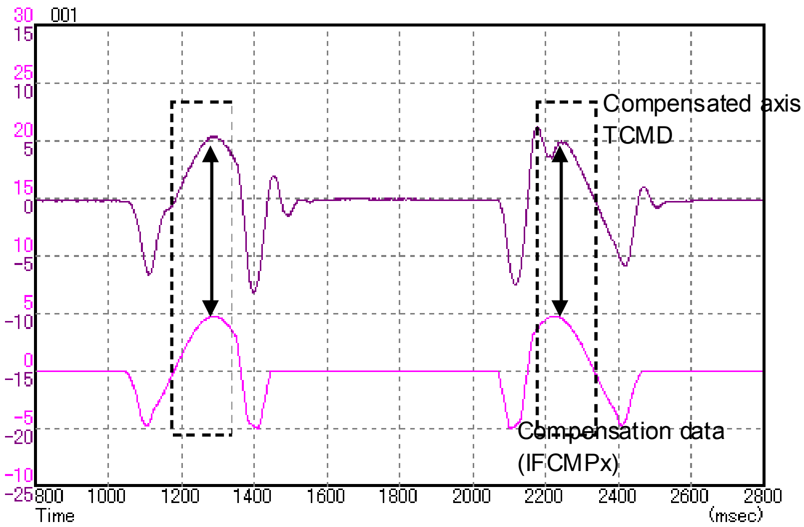
When interactive force compensation is disabled (bit 2 of No. 2292=0, bit 2 of No. 2293=0), adjust the compensation gain (No. 2478, No. 2480).

A torque command change occurring on the compensated axis according to a movement on the moving axis is considered to be a torque produced to cancel the influence of interactive force. Accordingly, the torque command waveform observed at this time is about equal to the interactive force. So, observe the torque command and interactive force compensation data on the compensation axis present when a movement is made on the moving axis (IFCMP1 for the first moving axis/IFCMP2 for the second moving axis), and adjust the compensation gain so that the torque command approximately matches the compensation data.

See the next item for the setting of SERVO GUIDE for observing interactive force compensation data.



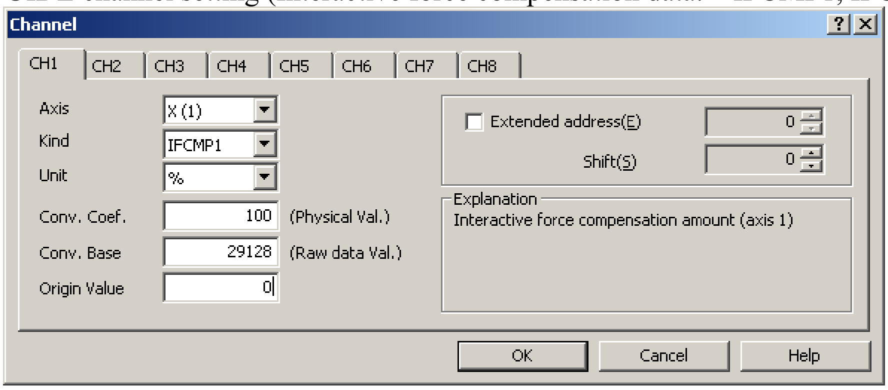
If the accurate position of the eccentric load cannot be identified in angle data adjustment of item (b), gain adjustment alone may not produce a waveform match. Make a fine adjustment of the angle data offset (No. 2479, No. 2481).



The timing of a maximum interactive force due to centrifugal force matches, so the angle data offset is considered to be adjusted correctly.

> **NOTE**
> 1 **<u>Be sure to enable feed-forward.</u>**
> 2 When the motor rotation direction of a compensated axis (No. 2022) is set to -111 (CW direction), the polarity of compensation data is opposite to that of the torque command. So, make an adjustment so that IFCMPx is TCMD inverted upside down.

- SERVO GUIDE channel setting (Interactive force compensation data: IFCMP1, IFCMP2)



Axis	:	Select a target compensated axis.
Kind	:	Select IFCMP1 or IFCMP2.
Unit	:	Select %.
Conv. Coef	:	Set 100.
Conv. Base	:	Set 29128.
Origin value	:	Set 0.

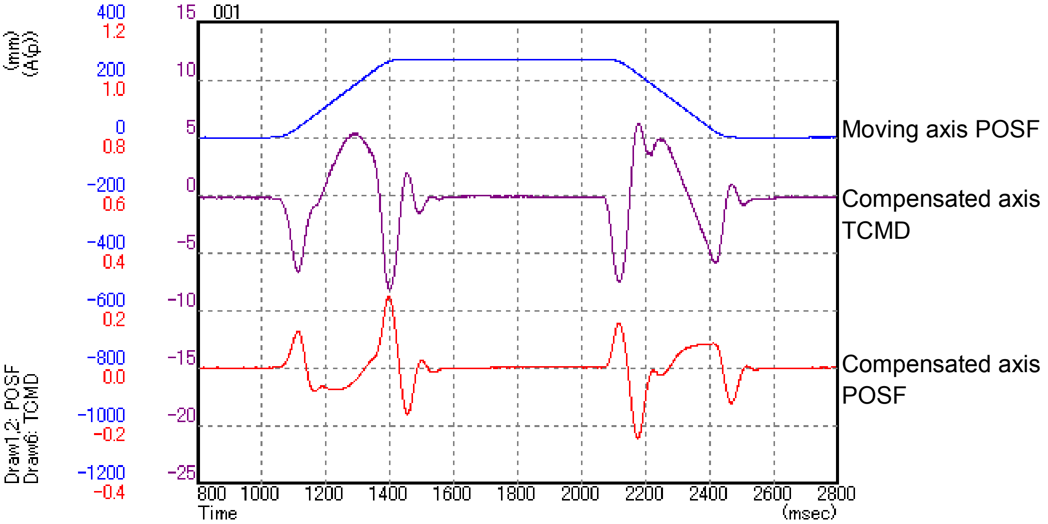
<3> Checking the effect of interactive force compensation

After adjusting the compensation gain parameter, enable the interactive force compensation function (First moving axis: Bit 2 of No. 2292=1, Second moving axis: Bit 2 of No. 2293=1) then observe the waveform of position feedback (POSF) on the compensated axis.

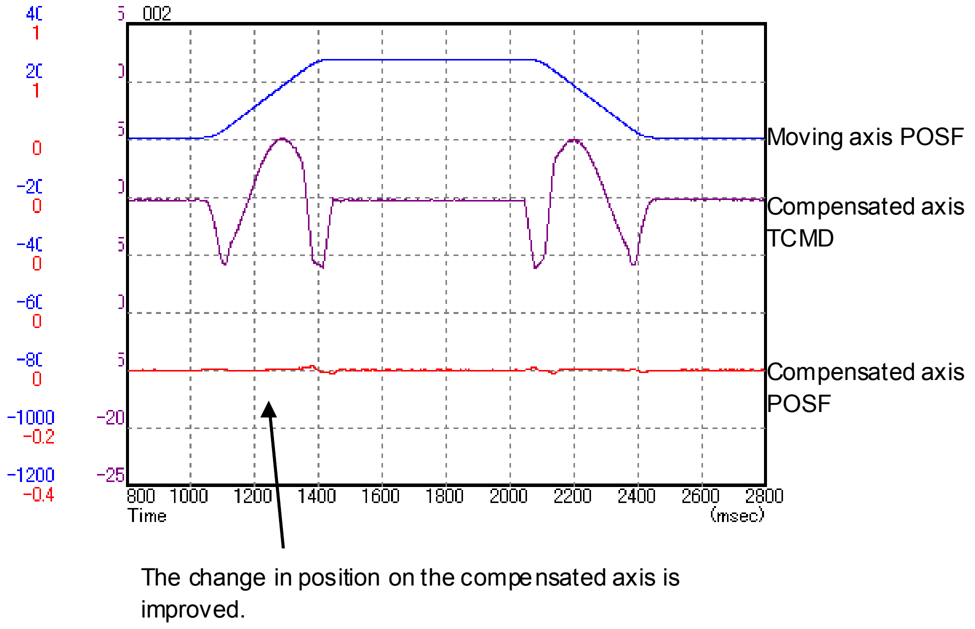
Check that when a movement is made on the moving axis, the change in position feedback is reduced.

Make a fine adjustment of the compensation gain parameter so that the change in position feedback is minimized.

- Without compensation (Bit 2 of No. 2292=0)



- With compensation (Bit 2 of No. 2292=1)



5.6 FUNCTION FOR REDUCING EFFECTS OF VARIATIONS IN MACHINE CHARACTERISTICS

5.6.1 Inertia Estimation Function

(1) Overview

This function estimates the inertia of the machine. Since various workpieces are attached to the rotary axis and linear axis that drive the workpiece, the inertia varies. In such a case, the estimation of the inertia enables the PMC to set the time constant of acc./dec. or the velocity gain that are appropriate for the inertia that varies. Estimation is started by the PMC signal and the results are indicated on the diagnosis screen (No. 764). There are two estimation methods shown below.

Torque application method

This method is applied to a direct driving axis that uses a linear motor or DD motor.

Velocity application method

This method is applied to a ball screw driving axis that uses a rotary motor with an axis or a linear motor or DD motor with a reducer.

(2) Series and editions of applicable servo software

[Applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	- 08.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5 90C8	E(05) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	E(05) and subsequent editions A(01) and subsequent editions	

The following editions support this function, but do not support the velocity application method (bit 3 of parameter No. 2418).

Series 90E0 /30.0 and subsequent editions
Series 90E1 /04.0 and subsequent editions

In addition, the following editions do not support detection sensitivity improvement (bit 2 of parameter No. 2418) and tandem control.

Series 90E0 /28.0 and subsequent editions
Series 90E1 /03.0 and subsequent editions

[Applicable system software]

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	13 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	13 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions

CNC	System software	
	Series	Edition
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

(3) Caution

- This function estimates inertia by adding a small vibration to a motor. Therefore, this function cannot be applied to the motor that is locked.
- Estimation error becomes large in the case of machines with a spring or backlash or tandem control or feed axis synchronous control with low rigidity.
- The disturbance elimination filter does not operate during estimation of inertia.
- Since the estimated precision depends on the machine status, make verification sufficiently.
- If the inertia estimation function is not used (bit 2 of parameter No. 2419 is 0), be sure to set the vibration frequency (parameter No. 2025) and vibration gain (parameter No. 2026) to 0.

(4) Parameter

	#7	#6	#5	#4	#3	#2	#1	#0
2419	INESGH	INESGL	INESFH	INESFL	INESMG	INESFC		

INESFC (#2) The inertia estimation function is:
0: Disabled.
1: Enabled.

INESMG (#3) The weight on diagnosis screen (No. 764) indication is:
0: The standard output value.
1: The standard output value divided by 32.
If error "-3" is indicated on the diagnosis screen (No. 764) upon completion of estimation, an overflow occurred in the estimation results. In this case, enable this bit and perform estimation again.

INESFL (#4) The vibration frequency for inertia estimation is:
0 : The standard frequency. (50Hz)
1 : The low frequency. (25Hz)

INESFH (#5) The vibration frequency for inertia estimation is:
0 : The standard frequency. (50Hz)
1 : The high frequency. (100Hz)

INESGL (#6) The vibration gain for inertia estimation is:
0 : The standard value. (Rated current)
1 : Half the standard value. (Rated current /2)
If an excessive error alarm (SV410) at stop time occurs during estimation of inertia, increase the setting (parameter No. 1829) of the excessive error at stop time or enable this bit and perform estimation again.
If error "-1" is indicated on the diagnosis screen (No. 764) upon completion of estimation, the vibration gain is too large. In this case, also enable this bit and perform estimation again. If the error persists, set the vibration frequency to the low frequency (bit 4 of parameter No. 2419 is 1).

INESGH (#7) The vibration gain for inertia estimation is:
0 : The standard value. (Rated current)
1 : Double the standard value. (Rated current×2)

If error "-2" is indicated on the diagnosis screen (No. 764) upon completion of estimation, enable this bit and perform estimation again. If the error persists, set the vibration frequency to the high frequency (bit 5 of parameter No. 2419 is 1) or divide the detectable minimum deceleration by 32 (bit 2 of parameter No. 2418 is 1).

	#7	#6	#5	#4	#3	#2	#1	#0
2418					INEVCM	INESHS		

INESHS (#2) The detectable minimum acceleration in inertia estimation is:
0: The normal value.
1: The normal value divided by 32 (detection sensitivity improvement).
If error "-2" is indicated on the diagnosis screen upon completion of inertia estimation, enable this bit.

INEVCM (#3) Inertia estimation uses:
0: The torque application method.
1: The velocity application method.
The torque application method is used for a direct driving axis that uses a linear motor or DD motor. The velocity application method is used for a ball screw driving axis that uses a rotary motor with an axis.

The above two bit parameters require the corresponding servo software. See "(2) Series and editions of applicable servo software" above.

Settings against error (Torque application method)

Parameter	No.2419				No.2418
Bit	INESGH #7	INESGL #6	INESFH #5	INESFL #4	INESHS #2
Vibration frequency: Standard (50Hz)	-	-	0	0	-
Low frequency (25Hz): Against error "-1"	-	-	0	1	-
High frequency (100Hz): Against error "-2"	-	-	1	0	-
Vibration gain: Standard	0	0	-	-	-
Half the rated current: Against error "-1"	0	1	-	-	-
Double the rated current: Against error "-2"	1	0	-	-	-
Minimum acceleration divided by 32: Against error "-2"	-	-	-	-	1

Settings against error (Velocity application method)

Parameter	No.2025	No.2026	No.2418
Bit			INESHS #2
Vibration frequency: as a guide	5	-	-
Low frequency: Against error "-1"	3	-	-
High frequency: Against error "-2"	10	-	-
Vibration gain: as a guide	-	5000	-
Low velocity: Against error "-1"	-	2500	-
High velocity: Against error "-2"	-	10000	-
Minimum acceleration divided by 32: Against error "-2"			1

2025	Vibration frequency

[Unit of data] Hz
[Valid data range] 0 to 200
[Standard setting] 5

Set the vibration frequency for the velocity application method. This parameter is not affected by the settings of bits 4 and 5 of parameter No. 2419. This parameter requires the corresponding servo software. See "(2) Series and editions of applicable servo software" above. When the inertia estimation function is not used, be sure to set this parameter to 0.

2026	Vibration gain

[Unit of data] 0.1 min^{-1} (rotary motor), 5 mm/min (linear motor)
[Valid data range] 0 to 30000
[Standard setting] 5000

Set the vibration gain for the velocity application method. This parameter is not affected by the settings of bits 6 and 7 of parameter No. 2419. This parameter requires the corresponding servo software. See "(2) Series and editions of applicable servo software" above. When the inertia estimation function is not used, be sure to set this parameter to 0.

2086	Rated current value

[Unit of data] The maximum current of an amplifier is equivalent to 6554.
[Valid data range] 0 to 6554

The vibration gain used for the torque application method is calculated using this parameter and bits 7 and 6 of parameter No. 2419. This value is set according to the motor specification. If the value is 0, error "-2" is indicated.

2345	Friction compensation

[Unit of data] TCMD unit (The maximum current of an amplifier is equivalent to 7282.)
[Valid data range] 0 to 7282

This compensation eliminates effects of friction. This parameter sets the absolute value of a torque command value (TCMD) during operation at 10min^{-1} (rotary motor) or 10mm/s (linear motor).
If the average current during estimation is less than the value of this parameter, error "-2" is indicated. In this case, increase the vibration gain.

NOTE
In a multi-winding driving motor, tandem control, and feed axis synchronous control, set all the above parameters on the sub-axis to the same values as in the main axis.

(5) PMC signal

The start and end of inertia estimation is controlled by PMC signal Gn390. For two seconds after the start of estimation, the motor vibrates slightly. Completion of the estimation is reported by PMC signal Fn371. At the same time, the estimation results are indicated on the diagnosis screen (No. 764). The estimation results on the diagnosis screen (No. 764) are retained until the next estimation starts. The results can be used by the PMC program.
In a multi-winding driving motor or tandem control, turn on only Gn390 for the main axis and check the obtained results from the main axis. On the other hand, in feed axis synchronous control, turn on Gn390 for the main axis and the sub-axis at the same time to obtain the sum of the results from the axes as the inertia of the machine.

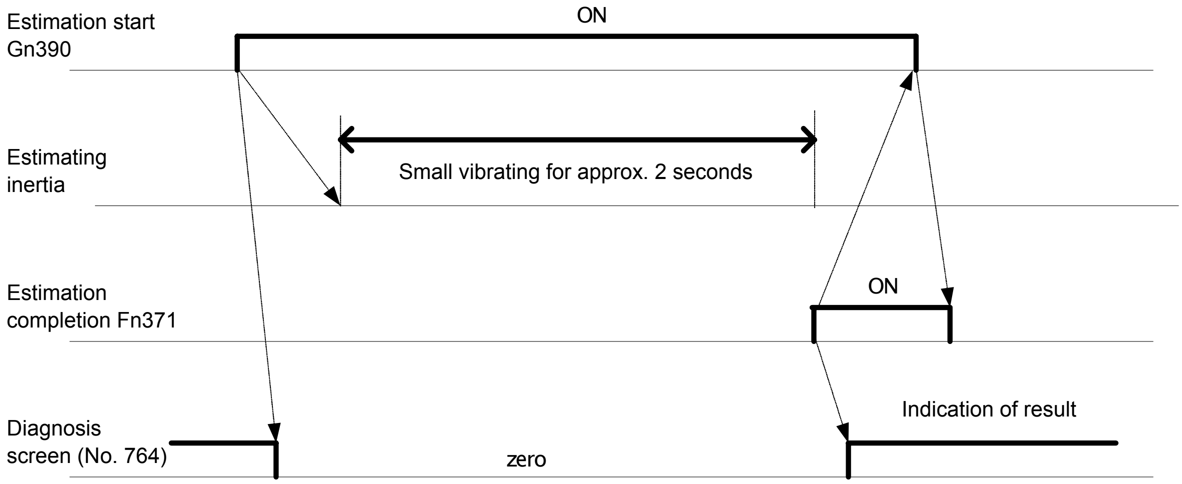
Inertia estimation start DI signal
Gn390.0 to Gn390.7 (axis type)

[Classification] Input signal
[Function] Starts and ends inertia estimation.
[Operation] Enabling or disabling this signal starts or ends inertia estimation, respectively.

Inertia estimation start DO signal
Fn371.0 to Fn371.7 (axis type)

[Classification] Output signal
[Function] Reports the completion of inertia estimation.
[Operation] When inertia estimation is completed, this signal turns on.

Timing chart



Signal address

	#7	#6	#5	#4	#3	#2	#1	#0
Gn390	INIDRQ8	INIDRQ7	INIDRQ6	INIDRQ5	INIDRQ4	INIDRQ3	INIDRQ2	INIDRQ1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn371	INIDFN8	INIDFN7	INIDFN6	INIDFN5	INIDFN4	INIDFN3	INIDFN2	INIDFN1

(6) Indication of the diagnosis screen

The estimation results are indicated on the diagnosis screen (No. 764). The inertia can be calculated by the following equation based on the values.

Rotary motor

$$Jm = \frac{DGN764 \times (Kt/\sqrt{2}) \times \mathrm{Im}ax \times P}{6.4557 \times 10^{12}}$$

Inertia Jm[kgm^2], torque constant Kt[Nm/Arms], amplifier maximum current Imax[Ap]、
NOTE)
For motor constants such as inertia Jm and torque constant Kt, refer to the specification of the motor.

Resolution of built-in detectors P[pulse]

α*i*CZ512A	$P=2^{19}$
α*i*CZ768A	P=786432
α*i* Pulsecoder, α*i*CZ1024A	$P=2^{20}$ (See the following example.)
RCN223, RCN723, RCN727	$P=2^{23}$
Binary encoder or non-binary encoder + High-resolution detection circuit	P=(Number λ of sine waves per rotation of detector)×512

NOTE) For the full-closed system, the resolution of the built-in detector needs to be used as P.

Example)

In αiS8/4000, if Kt = 0.72 [Nm/Arms], Imax = 80 [Ap], P = 2^{20} [pulse], and the estimation result DGN764 = 176, then inertia Jm = 0.00116 [kgm^2].

Linear motor

$$M = \frac{DGN764 \times (Kf/\sqrt{2}) \times \mathrm{Im}ax}{8.2196 \times 10^6 \times A}$$

Weight of object to be moved M[kg], thrust constant Kf[N/Arms], amplifier maximum current Imax[Ap]、resolution of detector A[μ m]

Linear incremental detector + High-resolution detection circuit	A= Signal pitch [μm]/512 (See the following example.)
Linear absolute detector	A= Resolution [μm]

Example)

In LiS600A1/4, if Kf=41.1[N/Arms], Imax=40[Ap], A=20[um]/512, and the estimation result DGN764=1358, then weight of object to be moved M=4.9[kg].

The value of inertia to be estimated by this function should satisfy the following expression.

Rotary motor

$$2^5 \le \frac{Jm \times 6.4557 \times 10^{12}}{(Kt/\sqrt{2}) \times \mathrm{Im}ax \times P} \le 2^{20}$$

If the stall current is assumed to be Is [Arms]:

$$\frac{0.81 \times Kt \times Is \times P}{\pi \times 10^6 \times 2^{14}} \le Jm \le \frac{0.81 \times Kt \times Is \times P \times 2^2}{\pi^2 \times 10^8}$$

When the detection sensitivity improvement (bit 2 of parameter No. 2418) is enabled:

$$\frac{Kt \times Is \times P}{\pi^2 \times 10^6 \times 2^{13}} \le Jm \le \frac{Kt \times Is \times P \times 2^7}{\pi^2 \times 10^7}$$

Linear motor

$$2^5 \le \frac{M \times 8.2196 \times 10^6 \times A}{(Kf/\sqrt{2}) \times \mathrm{Im}ax} \le 2^{20}$$

If the continuous current is assumed to be Ic [Arms]:

$$\frac{0.81 \times Kf \times Ic}{A \times 2^{14}} \le M \le \frac{0.81 \times Kf \times Ic}{25\pi \times A}$$

When the detection sensitivity improvement (bit 2 of parameter No. 2418) is enabled:

$$\frac{Kf \times Ic}{\pi \times A \times 2^{13}} \le M \le \frac{Kf \times Ic \times 2^7}{\pi \times A \times 10}$$

NOTE) For stall current Is and continuous current Ic, refer to the specifications of the motor.

Error indication and measures

- If an error is indicated, first check whether the conditions of the above expression are satisfied. When the conditions are satisfied, take the following actions.

- If the acceleration is too large to calculate a correct inertia, error "-1" is displayed on diagnosis screen No. 764. In this case, halve the vibration gain (bit 6 of parameter No. 2419 = 1 or parameter No. 2026 = set value/2) and perform estimation again. If the error persists, set the vibration frequency to a low frequency (bit 4 of parameter No. 2419 = 1 or parameter No. 2025 = set value/2).
- If the acceleration is too small to calculate a correct inertia, error "-2" is displayed on diagnosis screen No. 764. In this case, double the standard value of the vibration gain (bit 7 of parameter No. 2419 = 1 or parameter No. 2026 = set value × 2) and perform estimation again. If the error persists, set the vibration frequency to a high frequency (bit 5 of parameter No. 2419 = 1 or parameter No. 2025 = set value× 2) or divide the minimum detectable acceleration by 32 (bit 2 of parameter No. 2418 = 1).
- If an overflow occurs in the calculation results, error "-3" is displayed on diagnosis screen No. 764. In this case, divide the standard value of the indication of the diagnosis screen by 32 (bit 3 of parameter 2419 = 1) and perform estimation again.

(7) How to use

The following describes the preparation and method for applying the inertia estimation function.

1) Creation of a PMC ladder
   Create a PMC ladder with reference to (5) above to start the inertia estimation function. In a multi-winding driving motor or tandem control, input only the inertia estimation start DI signal of the main axis. On the other hand, in feed axis synchronous control, input the inertia estimation start DI signals of the main axis and sub-axis at the same time.
2) Measurement of friction
   Measure the friction. Set parameter No. 2345 to the absolute value of the torque command value (TCMD) during operation at 10 min^{-1} (rotary motor) or 10 mm/s (linear motor). In measurement with the servo guide, if the data type is TCMD and both the conversion coefficient and conversion reference are 1, the displayed value can be read as is. In a machine with small friction, the setting is not necessarily required.
3) Confirmation of inertia estimation results
   Estimate the inertia when the largest workpiece and smallest workpiece whose actual inertia values are known are attached. Confirm that the estimation result indicated on the diagnosis screen matches the actual inertia. If an error (-1, -2, or -3) is indicated on the diagnosis screen upon completion of estimation, see "(6) Error indication and measures" above.
4) Method for changing the acc./dec. time constant and the velocity gain
   Attach a workpiece whose inertia value is known and adjust the acc./dec. time constant and the velocity gain. Then, estimate the inertia and record the estimation result on the diagnosis screen as the initial value. When workpieces with different inertias are attached, estimate the inertia, compare the estimation result with the initial value, and change the acc./dec. time constant and the velocity gain based on the ratio between them. However, since the velocity gain is not necessarily proportional to the change rate of the inertia, give detailed consideration in advance.

5.6.2 Adaptive Resonance Elimination Filter

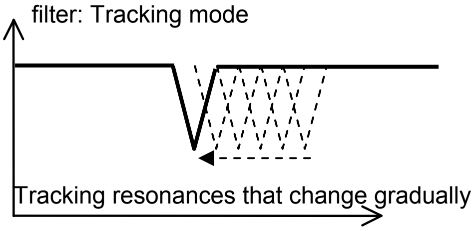
(1) Overview

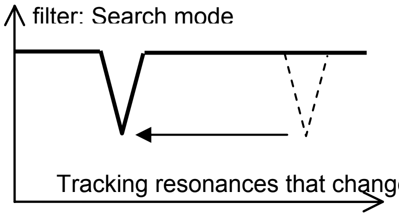
An adaptive resonance elimination filter detects changes in the resonance frequency as described below and change the filter characteristics based on the changes.

- Changes in the resonance frequency depending on the machine position
- Changes in the resonance frequency depending on individual differences of machines
- Changes in the resonance frequency across the ages
- Changes in the resonance frequency depending on the rigidity of a workpiece

1) Follow-up mode and search mode
   The follow-up mode is used for follow-up in a narrow bandwidth and the search mode is used for follow-up in a wide bandwidth.

The follow-up mode is applied when the resonance frequency gradually changes according to the machine position.
The search mode is applied when the resonance frequency greatly changes such as when the workpiece is attached or detached.





2) Application method
In the follow-up mode, follow-up is performed generally during axis feed operation. PMC signal G322 enables follow-up even in a stop state.
In the search mode, PMC signal G324 starts or stops follow-up regardless of whether axis feed operation is in progress or the stop state is entered.

3) Automatic update of parameters
The center frequency of a resonance elimination filter in the follow-up result is lost when the NC power is turned off. The center frequency can be recorded in the parameter (No. 2113) by enabling (bit 1 of parameter No. 2290 = 1) the automatic update of parameters.
Changes in the center frequency during follow-up can be checked at any time on diagnosis screen No. 763.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	S(19) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	S(19) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

The automatic update of parameters requires the following NC software.

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	13 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	13 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

(3) Note

- This function is valid only for resonance elimination filter 1 (parameters Nos. 2113, 2177, and 2359).
- This function is enabled after releasing an emergency stop.
- To measure frequency characteristics with SERVO GUIDE (including the tuning navigator), turn off the adaptive resonance elimination filter.

(4) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2270					ACREF			

ACREF(#3) The adaptive resonance elimination filter is:
0 : Disabled.
1 : Enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2290			FRFPWE	FRFDES	FRFATE			

FRFATE(#3) Execution condition 1 in the follow-up mode of the adaptive resonance elimination filter:
0 : During axis feed operation (handle, rapid traverse, cutting feed)
1 : Only during rapid traverse (other than stop/cutting feed)

FRFDES(#4) Execution condition 2 in the follow-up mode of the adaptive resonance elimination filter:
0 : Executed depending on FRFATE (#3) and PMC signal G322.
1 : Executed depending on only PMC signal G322.

No.2290#4	No.2290#3	Execution condition of follow-up mode
0	0	Executed when G322.x = 1 or during axis feed.
0	1	Executed when G322.x = 1 or during rapid traverse.
1	-	Executed only when G322.x = 1.

NOTE
To use only the search mode without using the follow-up mode, set bit 4 (FRFDES) to 1 and G322.x to 0.

FRFPWE(#5) Parameter No. 2113 of the center frequency of the adaptive resonance elimination filter is:
0 : Not updated automatically.
1 : Updated automatically.
The follow-up result is lost when the power is turned off. If this bit is set to be enabled, the follow-up result is stored in parameter No. 2113 of the center frequency.
In the follow-up mode, the center frequency is rewritten in the stop state when a change in the resonance frequency is detected. In the search mode, when a change in the resonance frequency is detected, the completion signal of the PMC signal F370 is turned on. In addition, when the search mode is stopped by PMC signal G324, the center frequency is rewritten.

	#7	#6	#5	#4	#3	#2	#1	#0
2291						FRFEBW		

FRFEBW(#2) In the HRV3 and HRV4 control, the maximum follow-up frequency of the adaptive resonance elimination filter is:
0 : Standard frequency 1.3 kHz.
1 : Extended frequency 2.0 kHz.
* The maximum frequency of HRV control is 1.0 kHz and cannot be extended.

* For an extended frequency, the maximum of the detection time in the search mode is changed from 2 seconds to 3 seconds.
* This setting can be used by the servo software 90G0/15 and subsequent editions

2113	Resonance elimination filter 1: Center frequency

[Unit of data] Hz

[Valid data range] 100 to 1 kHz (HRV2), 100 Hz to 2 kHz (HRV3), 100 Hz to 4 kHz (HRV4)

The follow-up range is 100 Hz to 990 Hz (HRV2) and 100 Hz to 1270 Hz (HRV3 and HRV4). When the adaptive resonance elimination filter is enabled (No.2270#3 = 1), the center frequency needs fall within this range. The adaptive resonance elimination filter follows up the resonance frequency with the bandwidth set in the follow-up range (parameter No. 2351), centered on the set frequency. If this parameter is rewritten, the follow-up result is lost and this parameter is reset to the set value.

2177	Resonance elimination filter 1: Bandwidth

[Unit of data] Hz

[Valid data range] 10 to Center frequency

The bandwidth can be set to a value in a range from 10 Hz to the center frequency (parameter No. 2113).

2359	Resonance elimination filter 1: Attenuation ratio

[Unit of data] %

[Valid data range] 0 to 100%

2350	Adaptive resonance elimination filter: Allowable acceleration

[Unit of data] Amount of distribution pulse change per 8 ms

[Valid data range] 0 to 10

[Standard setting] 0 (A value of 0 means an internal value of 2.)

Set the allowable acceleration of a command in the follow-up mode. If the specified acceleration is large, TCMD vibration may occur. Follow-up is not performed unless the command becomes the allowable acceleration or less in order to prevent follow-up error from occurring in this case.

2351	Adaptive resonance elimination filter: Follow-up range

[Unit of data] Hz

[Valid data range] 40 to 500 (A setting of 39 or less means an internal value of 40.)

[Standard setting] 0 (A value of 0 means an internal value of 40.)

Set the follow-up range of the center frequency in the follow-up mode. If this parameter is set to 0, follow-up is performed in the range of ±40 Hz centered on the value of parameter No. 2113. The follow-up range is 100 Hz to 1.0 kHz (HRV2) and 100 Hz to 1.3 kHz (HRV3 and HRV4). However, when the maximum frequency is extended (bit 2 of parameter No. 2291 is 1) in 90G0/15 or subsequent editions, the follow-up range is 100 Hz to 2.0 kHz (HRV3 and HRV4).

2352	Adaptive resonance elimination filter: Detection level

[Unit of data] A value of 7282 in TCMD units corresponds to the maximum amplifier current.

[Valid data range] 0 to 7282

[Typical setting] 0 (A value of 0 means an internal value of 16.)

NOTE

If the detection level is too small, accurate detection may be prevented by noise. Before application, check if appropriate follow-up is performed using an actual machine.

2353	Adaptive resonance elimination filter: Setting waiting time

[Unit of data] TCMD unit
[Valid data range] 0 to 32767
[Typical setting] 0 (A value of 0 means an internal value of 25.)
Set the setting time in the follow-up mode. If the acc./dec. time constant is small, TCMD vibration may occur upon completion of a move command. It is necessary to set the time until follow-up starts after the move command becomes the allowable acceleration or less so as not to receive the vibration. If TCMD vibration by acceleration/deceleration is large, the setting needs to be larger.

2459	Adaptive resonance elimination filter: Search range

[Unit of data] Hz
[Valid data range] 40 to 890Hz (A setting of 39 or less means an internal value of 40.)
[Standard setting] 0 (A value of 0 means an internal value of 890.)
Set the search range of the resonance frequency in the search mode.
A search is made in the range indicated by the center frequency ± the search range. A setting of 0 means a search range of ±890 Hz. The searchable range is 100 Hz to 1.0 kHz (HRV2) and 100 Hz to 1.3 kHz (HRV3 and HRV4). However, when the maximum frequency is extended (bit 2 of parameter No. 2291 is 1) in 90G0/15 or subsequent editions, the searchable range is 100 Hz to 2.0 kHz (HRV3 and HRV4).

(5) PMC signal

Follow-up mode and search mode

Follow-up mode:

Follows up the resonance frequency that moves in the range indicated by the center frequency (parameter No. 2113) ± the follow-up range (parameter No. 2351). The follow-up mode is used when the width of variations in the resonance frequency is small (within ±40 Hz) and the velocity of variations is high. (The detection time is approximately 0.4 seconds.)

Search mode:

Follows up the resonance frequency in the range indicated by the center frequency (parameter No. 2113) ± the search range (parameter No. 2459). The search mode is used when the resonance frequency varies greatly due to, for example, attachment or detachment of the workpiece. (The detection time is approximately 2 to 3 seconds.)

Follow-up start DI signal of the adaptive resonance elimination filter Gn322.0 to Gn322.7 (axis type)

[Classification] Input signal
[Function] Starts and stops the follow-up mode.
[Operation] Although the follow-up mode is used during axis feed, follow-up is performed even in the stop state if this signal is enabled.

Search start DI signal of the adaptive resonance elimination filter Gn324.0 to Fn324.7 (axis type)

[Classification] Input signal
[Function] Starts and stops the search mode.
[Operation] Follow-up in the search mode is performed if this signal is enabled.

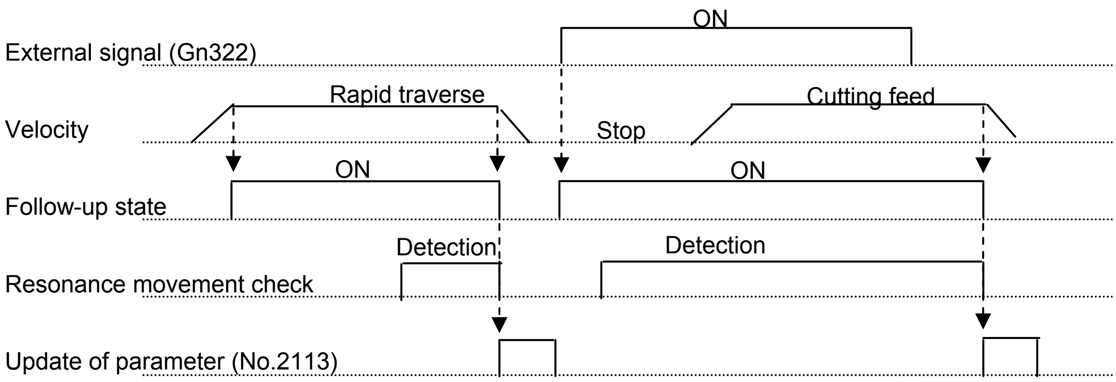
Search completion DO signal of the adaptive resonance elimination filter Fn370.0 to Fn370.7 (axis type)

[Classification] Output signal
[Function] Reports the completion of the search mode.
[Operation] This signal is turned on when the resonance frequency is detected in the search mode.

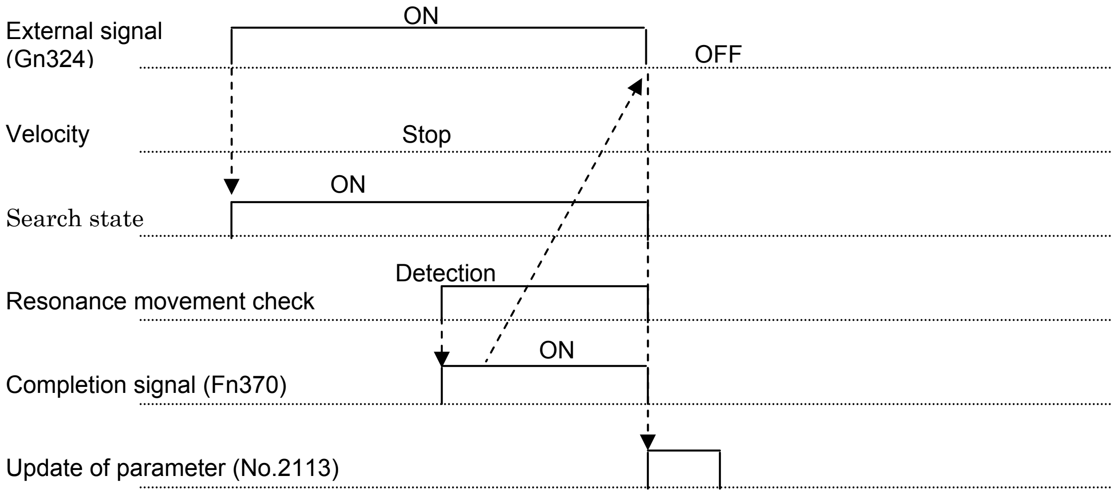
> **NOTE**
> The timing at which Gn322 or Gn324 is turned off depends on the mechanical and machining conditions. However, Gn322 or Gn324 needs to be turned off basically when detection completion signal Fn370 is turned on or before actual machining is performed.

Timing chart

Follow-up mode (No.2270#3=1,No.2290#5=1,#4=0,#3=1)



Search mode (No.2270#3=1,No.2290#5=1,#4=0,#3=0)



Signal address

	#7	#6	#5	#4	#3	#2	#1	#0
Gn322	FRFRQS8	FRFRQS7	FRFRQS6	FRFRQS5	FRFRQS4	FRFRQS3	FRFRQS2	FRFRQS1

	#7	#6	#5	#4	#3	#2	#1	#0
Gn324	FRFSMD8	FRFSMD7	FRFSMD6	FRFSMD5	FRFSMD4	FRFSMD3	FRFSMD2	FRFSMD1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn370	FRFDET8	FRFDET7	FRFDET6	FRFDET5	FRFDET4	FRFDET3	FRFDET2	FRFDET1

5.7 HIGH-SPEED POSITIONING FUNCTION

High-speed positioning is used in the following cases:

<1> To perform point-to-point movement quickly, where the composite track of two or more simultaneous axes can be ignored such as, for example, in a punch press

<2> To speed up positioning in rapid traverse while errors in the shape during cutting must be minimized (reduction of cycle time)

In case <1>, the position gain switching function and the low-speed integral function are effective (⇒ See Subsection 4.3.2, "High-Speed Positioning Adjustment Procedure"). In case <2>, rapid traverse feed-forward is effective.

This section explains these functions.

5.7.1 Position Gain Switching Function

(1) General

An increase in the position gain is an effective means of reducing the positioning time when the machine is about to stop.
An excessively high position gain decreases the tracking ability of the velocity loop, making the position loop unstable. This results in hunting or overshoot. A position gain adjusted in high-speed response mode produces a margin in the position gain when the machine is about to stop.
Increase the position gain in low-speed mode so that both the characteristics in high-speed response mode and a short positioning time are achieved.

> **NOTE**
> When this function is used, the error amount in constant-speed feed and the actual position gain indication on the CNC do not match the logical values.

(2) Series and edition of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

<1> This parameter specifies whether to enable the position gain switching function as follows:

	#7	#6	#5	#4	#3	#2	#1	#0
2015								PGTW

PGTW (#0) The position gain switching function is used.
0: Invalid
1: Valid

<2> This parameter specifies whether to set the velocity at which position gain switching is to occur, as follows:

2028	Limit speed for enabling position gain switching

The position gain is doubled with a speed lower than or equal to the speed specified above.

[Unit of data] Rotary motor: 0.01 min^{-1}
Linear motor: 0.01 mm/min

[Valid data range] 0 to 32767

[Typical setting] 1500 to 5000

> **REFERENCE**
> Using the high-speed positioning velocity increment system magnification function (→ (5) in Subsection 5.7.1) can increase the effective velocity to ten times.

Fig. 5.7.1 (a) shows the relationships between the position error and velocity command.

(4) When the feed-forward function is used at the same time (position gain switching function type 2)

When using the position gain switching function together with the feed-forward function, make the setting below.

(a) Overview

When the conventional position gain switching function is used in conjunction with the feed-forward function, it can cause an overshoot at a relative low feed-forward coefficient, sometimes resulting in a difficulty in adjustment, because also the feed-forward term-based effect is doubled. Position gain switch function type 2 has been improved to make position gain switching independently of the feed-forward function.

(b) Setting parameters

In addition to the parameter of the position gain switching function described earlier, set the following parameter.

	#7	#6	#5	#4	#3	#2	#1	#0
2204			PGTWN2					

PGTWN2 (#5) Specifies whether to double the feed-forward-based effect at position gain switching as follows:

0: To double
1: Not to double

> **NOTE**
> This function is invalid when the VCMD interface is in use.
> (When the VCMD interface is in use, set PGTWN2 = 0.)

(5) High-speed positioning velocity increment system magnification function

(a) Overview

This function increases the velocity increment system for the effective velocity parameter of the high-speed positioning functions (position gain switch and low-speed integral functions) to ten times.

(b) Setting parameters

Using the following parameter can change the increment system for the effective velocity.

	#7	#6	#5	#4	#3	#2	#1	#0
2204							HSTP10	

HSTP10 (#1) Specifies the effective velocity increment system for the high-speed positioning functions (position gain switch and low-speed integral functions) as follows:
0: 0.01 min^{-1} (rotary motor), 0.01 mm/min (linear motor)
1: 0.1 min^{-1} (rotary motor), 0.1 mm/min (linear motor)

> **NOTE**
> The value set in this function applies to the increment system of both the "position gain switching function" and "low-speed integral function."

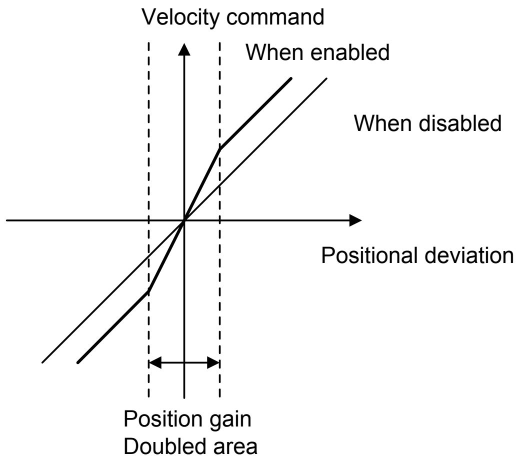


Fig. 5.7.1 (a) Position gain switching

5.7.2 Low-speed Integral Function

(1) Overview

To ensure that the motor responds quickly, a small time constant must be set so that a command enabling quick startup is issued.
If the time constant is too small, vibration or hunting occurs because of the delayed response of the velocity loop integrator, preventing further reduction of the time constant.
With the low-speed integral function, velocity loop integrator calculation is performed in low-speed mode only. This function ensures quick response and high stability while maintaining the positioning characteristics in the low-speed and stop states.

(2) Series and edition of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

<1> Specify whether to enable the low-speed integral function.

	#7	#6	#5	#4	#3	#2	#1	#0
2015							SSG1	

SSG1 The low-speed integral function is used.
0: Invalid
1: Valid

<2> Specify whether to enable integration at acc./dec. time.

2029	Limit speed for disabling low-speed integral at acceleration

The integral gain is invalidated during acceleration at a speed higher than or equal to the specified speed.

[Unit of data] Rotary motor: 0.01 min^{-1}
Linear motor: 0.01 mm/min
[Valid data range] 0 to 32767
[Typical setting] 1000

2030	Limit speed for enabling low-speed integral at deceleration

The integral gain is validated during deceleration at a speed lower than or equal to the specified speed.

[Unit of data] Rotary motor: 0.01 min^{-1}
Linear motor: 0.01 mm/min
[Valid data range] 0 to 32767
[Typical setting] 1500

> **REFERENCE**
> Using the high-speed positioning velocity increment system magnification function (→ (5) in Subsection 5.7.1) can increase the effective velocity to ten times.

This function can specify whether to enable the velocity loop integration term for two velocity values, the first for acceleration and the second for deceleration. It works as shown in Fig. 5.7.2 (a).

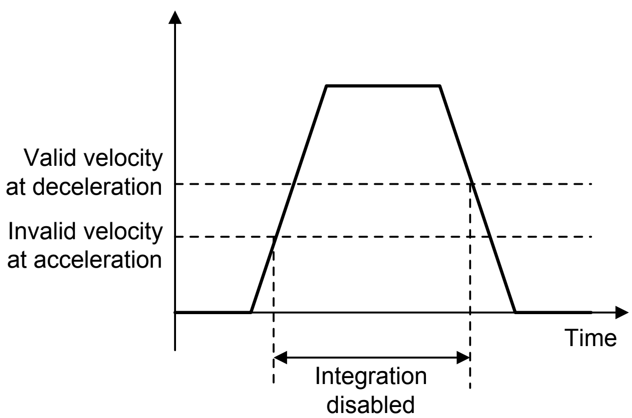


Fig. 5.7.2 (a) Integration invalid range at low-speed integral

5.8 CONTROL STOP FUNCTIONS

5.8.1 Brake Control Function

(1) Overview

This function prevents the tool from dropping vertically when a servo alarm or emergency stop occurs. The function prevents the motor from being immediately deactivated, instead keeping the motor activated for the period specified in the corresponding parameter, until the mechanical brake is fully applied.

(2) Hardware configuration

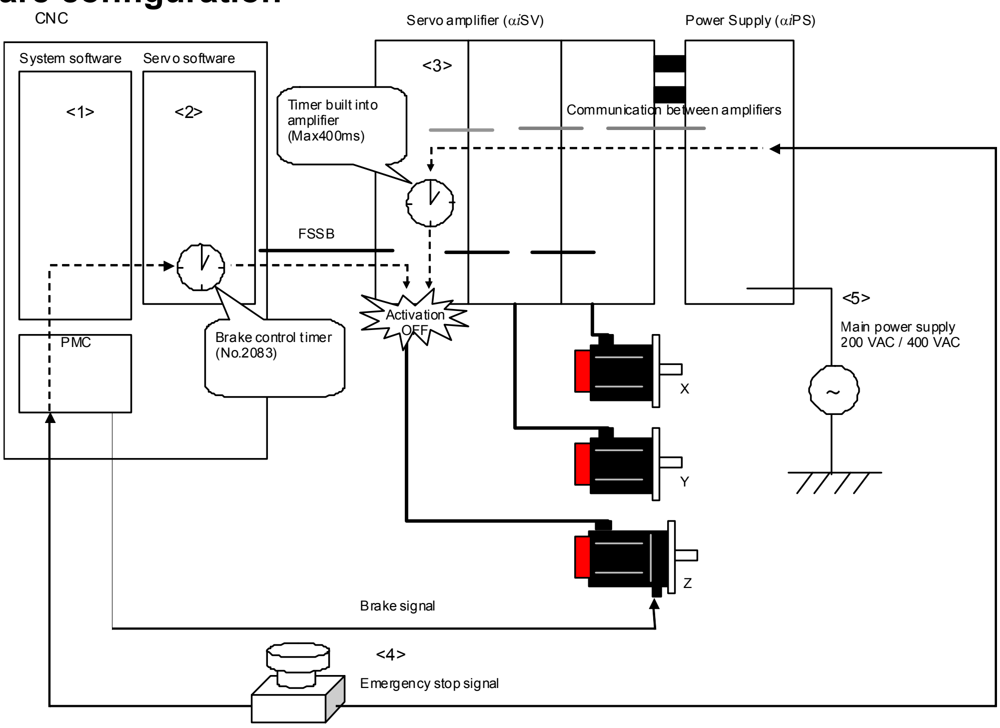


Fig. 5.8.1 (a) Example of configuration

The numbers of the following descriptions correspond to those in the figure:

<1> Applicable system software
Any system soft can be used.

<2> Applicable servo software
Any system soft can be used.

<3> Servo amplifier

- For the servo amplifiers for the 30*i*-B including 2-axis and 3-axis amplifiers, the brake control function can be set for each axis.
- For other than the servo amplifiers for the 30*i*-B, the use of a 1-axis servo amplifier is recommended since the brake control function cannot be set for each axis when you want to use the function for a 2-axis or 3-axis amplifier.

For an axis to which the brake control function is not applied, any servo amplifier can be used.

> **NOTE**
> 1 If you want to use the brake control function with a 2-axis or 3-axis amplifier other than that for the 30*i*-B, specify the brake control parameters for all axes on the multiaxis amplifier including the target axis. In this case, however, if an alarm is issued for any of the axes connected to the 2-axis or 3-axis amplifier, the brake control function does not operate effectively.
> 2 For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

<4> Emergency stop signal

With the α*i* series, a timer for the emergency stop signal is built into the α*i*SV. While motor activation is kept by brake control, the timer in the α*i*SV is used to extend the activation time that lasts until the emergency stop signal operates. Motor deactivation can be delayed by the α*i*SV for 50 ms, 100 ms, 200 ms, and 400 ms. To delay motor deactivation by brake control for 400 or more, insert a timer in the contact signal of the emergency stop signal and +24V, and delay the emergency stop signal to be input to the α*i*PS, as traditionally done. (For α*i*SV timer setting, see Item (3) "Setting parameters" below.)

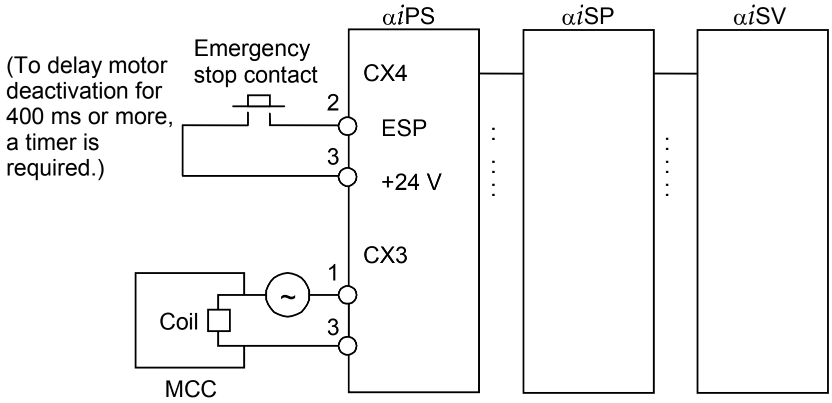


Fig. 5.8.1 (b) α*i* series amplifier

<5> 200/400 VAC

If the 200 VAC or 400 VAC supply to the servo amplifier is cut, the brake control function cannot operate.

To cause the brake control function to work effectively even at a power break, apply the power brake machine protection function.

(3) Setting parameters

<1> Brake control function enable/disable bit

	#7	#6	#5	#4	#3	#2	#1	#0
2005		**BRKC**						

BRKC (#6) Brake control function is:
0: Disabled.
1: Enabled.

<2> Activation delay

2083	**Brake control timer**

[Increment system] msec
[Valid data range] 0 to 16000

(Example)

To specify an activation delay of 200 ms, set the brake control timer usually with 200 (appropriately). Also set the timer connected to the emergency stop contact with the same value as set in the parameter.

<3> Setting the emergency stop timer built into the α*i*SV

	#7	#6	#5	#4	#3	#2	#1	#0
2210		ESPTM1	ESPTM0					

ESPTM0 (#5), ESPTM1 (#6)

Set a period of time from the input of the emergency stop signal into the αiPS until emergency stop operation is actually performed in the servo amplifier (α*i* SV).

ESPTM1	ESPTM0	Delay time
0	0	50 ms (default)
0	1	100ms
1	0	200ms
1	1	400ms

When using brake control, set a time longer than the setting of the brake control timer (No. 2083).

NOTE

For those axes that are connected to a 2-axis or 3-axis amplifier other than that for the 30*i*-B, the parameters above need to be set in the same way.

(4) Detailed operation

Suppose that there is a machine having horizontal and vertical axes of motion. If a servo alarm(NOTE 1) occurs on an axis, the READY signal is turned off for the amplifiers for all axes. If the emergency stop button is pressed, the READY signal is also turned off for the amplifiers for all axes. When the READY signal is turned off for an amplifier, the force to support the tool is lost, so the mechanical brake functions to prevent the tool from dropping vertically.

Since it takes time until the mechanical brake actually function and force is generated, the tool may drop vertically, causing the workpiece or tool to be damaged.

The brake control function delays the timing to turn the READY signal for the amplifiers off to prevent the tool from dropping by making the servo motor support the tool until the mechanical brake functions.

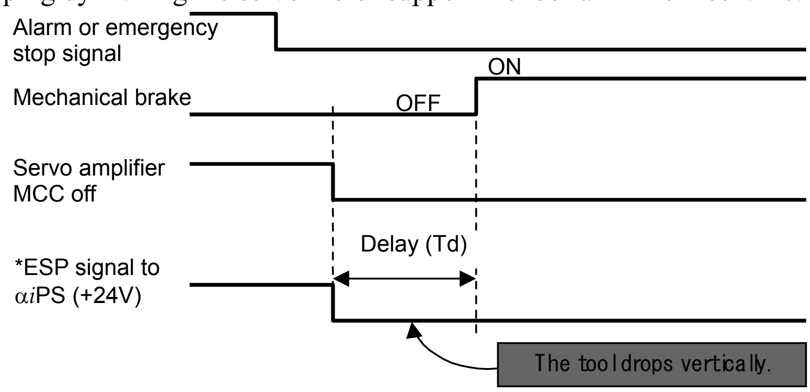


Fig. 5.8.1 (c) When the brake control function is not used

(*) With the αi servo amplifier, the operation (Section A) of the *ESP signal in the αiSV can be delayed for up to 400 ms by setting the parameter for the emergency stop timer built into the amplifier. So, when the brake control timer is set to less than 400 ms, no external timer is required for the *ESP signal to be input to the αiPS.

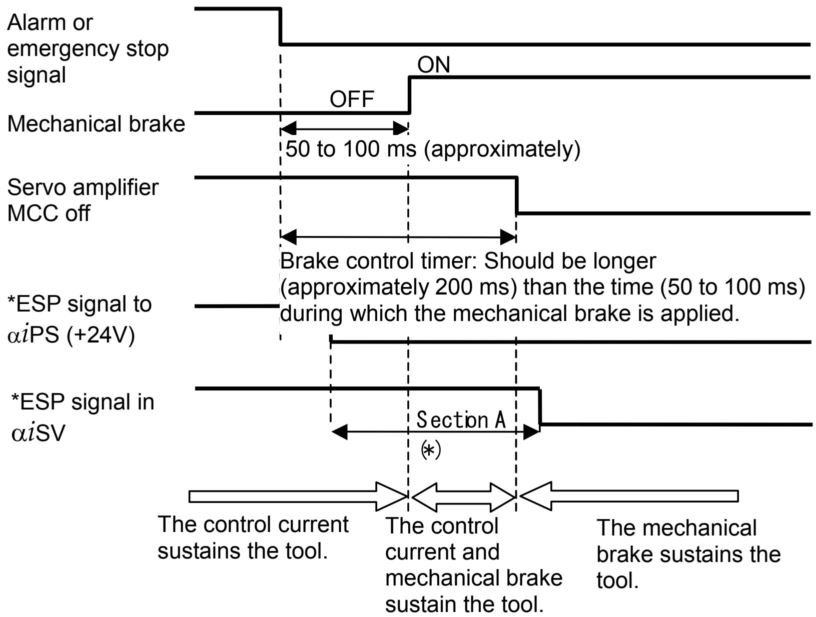


Fig. 5.8.1 (d) When the brake control function is used

NOTE

1 The servo alarm mentioned in the above description refers to a servo alarm detected by the software (OVC alarm, motor overheat alarm, software disconnection alarm, etc.), an alarm detected by the servo amplifier, or a servo alarm detected by the CNC (excessive error).
If a servo alarm occurs on the axis using this function, no brake control is performed on the axis (except for a motor overheat alarm).

2 For brake control, use the SA signal (F0.6, which is common to all axes).

5.8.2 Torque Limit Setting Function during Brake Control

(1) Overview

This function can be used to limit the torque during brake control. The function is useful when you do not want to apply a high torque to the machine or want to set a low torque limit.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2273	DBTLIM							

DBTLIM (#7) The torque limit setting function during brake control is:
0: Disabled.
1: Enabled.

2375	Torque limit magnification during brake control

[Unit of data] % (The maximum torque is assumed to be 100%.)
[Valid data range] 30 to 100 (Default: 70%)

> ⚠ **CAUTION**
> If a too small value is specified for the torque limit, the stop distance becomes longer, which may cause the tool to collide with the machine or workpiece. Carefully specify the parameter value.

> **NOTE**
> 1 When a value of 0 or less is specified for the torque limit magnification during brake control, 70% is applied. When a value of 100 or greater is specified, 100% (maximum torque) is applied.
> 2 This function cannot be used together with the quick stop function at emergency stop.

The following functions are also provided to reduce the motor stop distance and prevent the tool to collide with the machine or workpiece if a disconnection, overheat, or OVC alarm occurs in the separate detector or at emergency stop.

5.8.3 Quick Stop Type 1 at Emergency Stop

(1) Overview

This function reduces the stop distance by resetting the velocity command for a servo motor to 0 at a position where an emergency stop signal is detected for the servo motor. To further reduce the stop distance required for the motor to stop, use quick stop type 2 at emergency stop described in Subsec. 5.8.4.

> **NOTE**
> For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2017								DBST

DBST (#0) Specifies whether to enable quick stop type 1 at emergency stop as follows:
0: To disable
1: To enable

To use the quick stop at emergency stop, enable the brake control function to all axes, which use the quick stop function.

(Brake control function)

	#7	#6	#5	#4	#3	#2	#1	#0
2005		BRKC						

BRKC (#6) Specifies whether to enable brake control function as follows:
0: To disable
1: To enable

> **NOTE**
> When only the brake control function is set, a gradual stop occurs with the torque limit set by the torque limit setting function during brake control.
> When the quick stop at emergency stop is enabled, a gradual stop occurs with the torque limit set to 100%, so that the stop distance is reduced.

2083	Brake control timer

[Unit of data] ms
[Setting value] 50 to 100

(4) Timing diagram

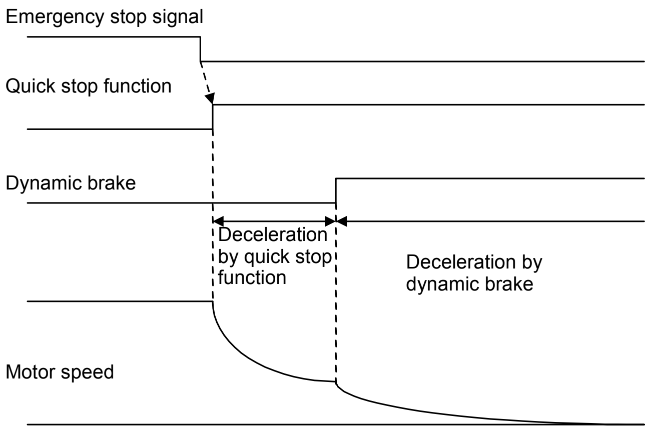


Fig. 5.8.3 (a) Timing diagram of quick stop function

(5) Connection of amplifier

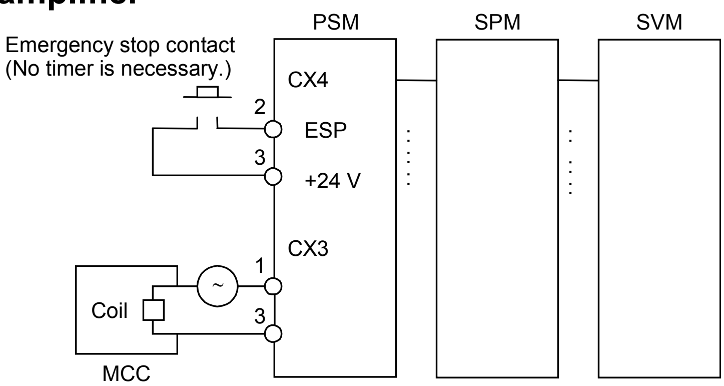


Fig. 5.8.3 (b) αi series amplifier

5.8.4 Quick Stop Type 2 at Emergency Stop

(1) Overview

This function returns a servo motor to a position where an emergency stop signal is detected for the servo motor and stops the motor, thereby assuring a shorter stop distance than with quick stop type 1 at emergency stop.

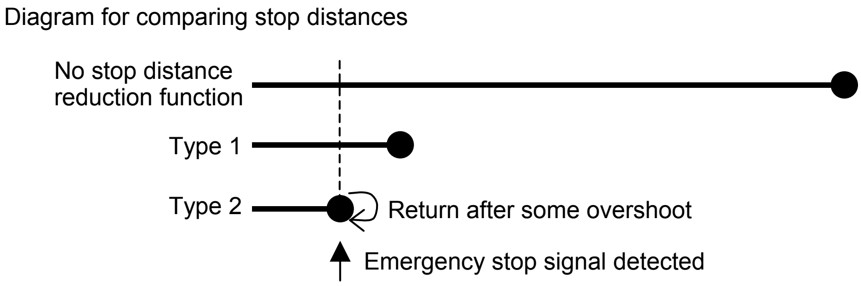


Fig. 5.8.4 (a) Diagram for comparing stop distances

> **NOTE**
> For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2204	DBS2							

DBS2 (#7) Specifies whether to enable quick stop type 2 at emergency stop as follows:
0: To disable
1: To enable

NOTE
1 Like type 1, type 2 requires that the brake control parameter be set.
2 The method of connecting the amplifier for type 2 is the same as for type 1.
3 If both type 1 and type 2 function bits are set, type 2 function is assumed.

5.8.5 Lifting Function Against Gravity at Emergency Stop

NOTE
For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

5.8.5.1 Lifting function against gravity at emergency stop

(1) Overview

This function is intended to lift and stop the vertical axis (Z-axis) of a vertical machining center when the machine comes to an emergency stop or power failure.
(For details of how the tool is prevented from dropping vertically at a power failure, refer to the description about the "power failure detection function" in the relevant servo amplifier descriptions.)

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

Because this function uses quick stop at emergency stop type 2, the following function bit must be set to 1 (enable). (Quick stop type 1 at emergency stop (bit 0 of No. 2017 is not needed.)

	#7	#6	#5	#4	#3	#2	#1	#0
2204	DBS2							

DBS2 (#7) Specifies whether to enable quick stop type 2 at emergency stop as follows:
0: To disable
1: To enable

2373	Distance to lift

This parameter is for determining a distance to lift at an emergency stop. The larger the value, the larger becomes the distance to lift.

[Unit of data] Detection unit or 1μm (→See Subsec. 5.8.5.3.)
[Valid data range] -32767 to 32767
[Typical setting] Detection unit 1μm : Approximately 500
Detection unit 0.1μm : Approximately 5000

NOTE
1 If the brake is in use, it starts working while the vertical axis is being lifted. So the distance through which the axis is actually lifted differs from the setting.
2 Whether the parameter values is positive or negative matches whether the machine coordinate value is positive or negative.
3 Using this function causes the load to stop after moving it to one side of the machine. So, it should be used for the vertical axis (Z-axis) of a vertical machining center in which an axis retracts in a fixed single direction at an emergency stop.

2374	Lifting time

This parameter determines the lifting time as measured from the time of an emergency stop. The distortion easing function is executed after the lifting time has elapsed. This function is intended to decrease the amount of machine elastic strain that can increase when a vertical axis is lifted when the machine is about to apply the brake. Executing this function can reduce the shock that may occur when the axis drops because the servo amplifier stops energizing. The initial value of the function is a quarter of the distance to lift.
(See the following figure.)

[Unit of data] ms
[Valid data range] Specify an integer multiple of 4 (Series 30*i*) or of 8 (Series 0*i*-D) between 8 and 32767.

[Typical setting] Approximately 16 or 24 ms

> **NOTE**
> 1 To use the lifting function against gravity at emergency stop, specify 4 ms or longer (Series 30*i*) or 8 ms or longer (Series 0*i*-D) as the lifting time.
> 2 If the distortion easing function is not used, specify the time longer than or equal to the one set in the brake control timer as the lifting time.

- Velocity command

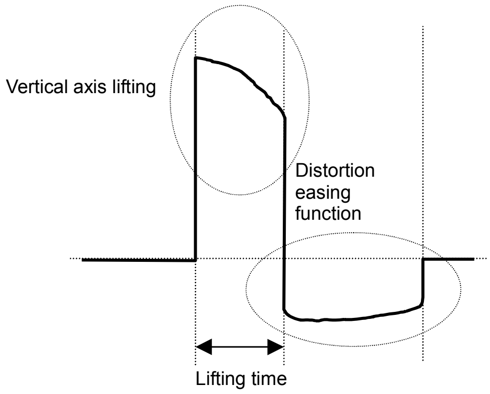


Fig. 5.8.5.1 (a) Velocity command

- Motor position waveform

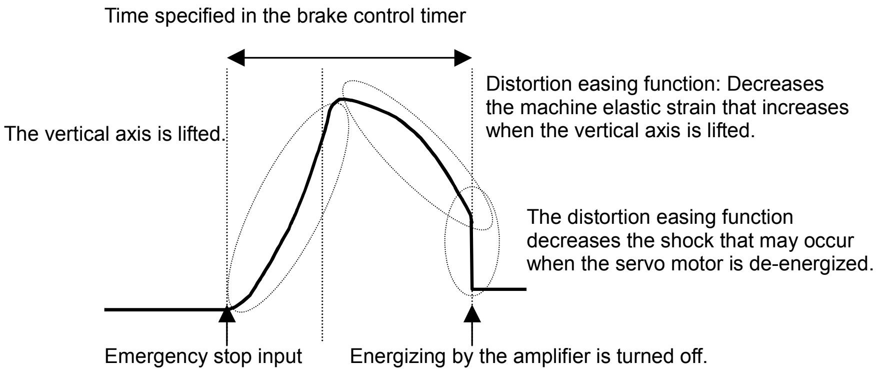


Fig. 5.8.5.1 (b) Motor position waveform

Using this function requires specifying the following brake control parameters.

Brake control function bit

	#7	#6	#5	#4	#3	#2	#1	#0
2005		BRKC						

BRKC(#6) The brake control function is:
0 : Disabled.
1 : Enabled.

Energizing delay time

2083	Brake control timer

[Unit of data] ms
[Typical setting] 50 to 100 ms

> **NOTE**
> If the vertical axis (Z-axis) is connected to a multiaxis amplifier other than a servo amplifier for the 30*i*-B, it is necessary to enable the brake control function for all the axes connected to the amplifier.

Set the time from the instant when an emergency stop signal is input to α*i*PS to the instant when the emergency stop function works in the servo amplifier.

	#7	#6	#5	#4	#3	#2	#1	#0
2210		**ESPTM1**	**ESPTM0**					

ESPTM1	ESPTM0	Delay time
0	0	50ms (default value)
0	1	100ms
1	0	200ms
1	1	400ms

It is necessary to specify the time longer than or equal to the brake control timer value.
If the brake control timer value is 100 ms, for example, specify ESPTM1 (bit 6) and ESPTM2 (bit 5) to be, respectively, 0 and 1 (100 ms).

> **NOTE**
> For a multiaxis amplifier other than a servo amplifier for the 30*i*-B, the largest of the values specified for the axes is assumed to be the delay time.

(4) Example of using the parameter

The following example shows the effect of using the lifting function against gravity at emergency stop for the vertical axis (Z-axis). In this example, the distance to lift is 500, and the lifting time is 16 ms. The vertical axis of the graph is graduated 2 μm/div.

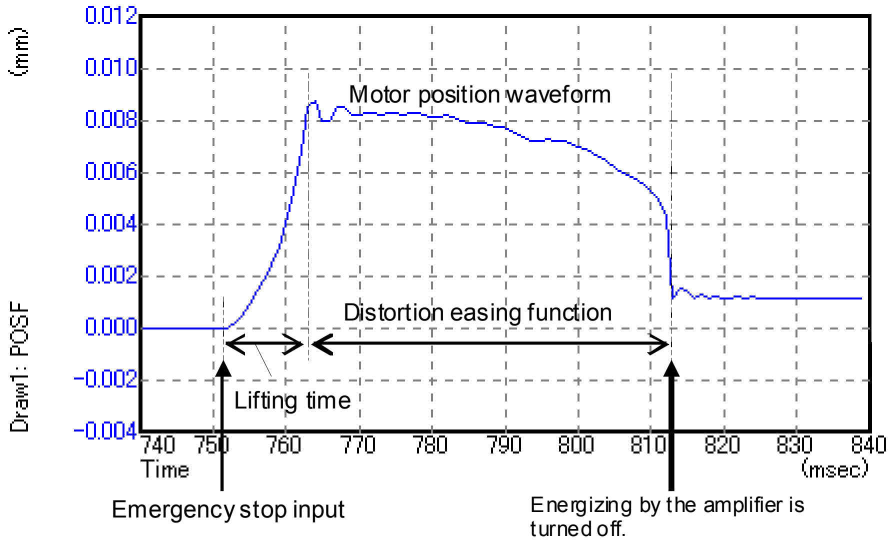


Fig. 5.8.5.1 (c) Motor position waveform

As seen from the graph, the motor is lifted through a large distance after an emergency stop signal is input. The graph also shows that the distortion easing function decreased the machine elastic strain and kept the motor from falling when the amplifier stopped energizing. Also as seen from the graph, the position where the motor finally rested is higher than the position where the motor was before the emergency stop signal was input.

NOTE
1 In this example, positive coordinates of the machine coordinate system correspond to the direction in which the axis is lifted.
2 Variation occurs in the position where the Z-axis stops depending on the direction in which the Z-axis is moving before an emergency stop. When tuning the parameter, it is necessary to take, into account, both the position where the motor rests before the axis is moved up and the position where the motor rests after the axis is moved down.

5.8.5.2 Function based on the DI signal for switching the distance to lift

(1) Overview

With the lifting function against gravity at emergency stop, switching between two types of parameters for specifying a distance to lift is enabled based on the DI signal of the PMC. By setting either parameter to 0, lift operation can be temporarily disabled.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	P(16) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Switching signal

Signal for switching the distance to lift for the lifting function against gravity at emergency stop

	#7	#6	#5	#4	#3	#2	#1	#0
Gn323	SWDBS8	SWDBS7	SWDBS6	SWDBS5	SWDBS4	SWDBS3	SWDBS2	SWDBS1

[Classification] Input signal

[Function] This signal is used to switch the distance to lift when the lifting function against gravity at emergency stop is enabled. A number suffixed at the end of the signal represents the number of each controlled axis.

(Details of operation)

- When this signal (SWDBSx) is set to 0, the distance to lift for the lifting function against gravity at emergency stop follows the value set in No. 2373.
- When this signal (SWDBSx) is set to 1, the distance to lift for the lifting function against gravity at emergency stop follows the value set in No. 2173.

- The distance to lift depends on the state of this signal (SWDBSx) present when the emergency stop command is input. (If this signal is changed during lift operation after the emergency stop command is input, the change does not become effective until the lift operation is completed and the excitation is turned off.)
- Among the parameters related to the lifting function against gravity at emergency stop, the parameters other than those related to the distance to lift are common, regardless of the state of this signal (SWDBSx).

(4) Setting parameters

Set the parameters below in addition to the parameters for the lifting function against gravity at emergency stop.

2373	Distance to lift (when SWDBSx=0)

This parameter is for determining a distance to lift at an emergency stop. The larger the value, the larger becomes the distance to lift.

[Unit of data] Detection unit or 1μm (→See Subsec. 5.8.5.3.)
[Valid data range] -32767 to 32767
[Typical setting] Detection unit 1μm : Approximately 500 or -500
Detection unit 0.1μm : Approximately 5000 or -5000

This parameter is effective only when the signal (SWDBSx) for switching the distance to lift for the lifting function against gravity at emergency stop is set to 0.
To disable lift operation when (SWDBSx) = 0, set 0 in this parameter.

2173	Distance to lift (when SWDBSx=1)

This parameter is for determining a distance to lift at an emergency stop. The larger the value, the larger becomes the distance to lift.

[Unit of data] Detection unit or 1μm (→See Subsec. 5.8.5.3.)
[Valid data range] -32767 to 32767
[Typical setting] Detection unit 1μm : Approximately 500 or -500
Detection unit 0.1μm : Approximately 5000 or -5000

This parameter is effective only when the signal (SWDBSx) for switching the distance to lift for the lifting function against gravity at emergency stop is set to 1.

NOTE

1. When a brake is used, brake application starts during lift operation, so that the set value does not match the actual lift distance.
2. The parameter polarity matches the polarity of the machine coordinate system.
3. Use this function only when lift operation does not cause a mechanical interference.

5.8.5.3 Method of setting a distance to lift in μm

(1) Overview

When the servo software below is used with the lifting function against gravity at emergency stop, the parameter for specifying a distance to lift can be set in [μm], independently of the detection unit. With this function, a large distance to lift can be used when a small detection unit is used.

(2) Series and editions of applicable servo software

[Applicable servo software]

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	P(16) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

[Applicable system software]

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	06 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	06 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2298	DUNIT							

DUNIT(#7) When the lifting function against gravity at emergency stop is used, the function that enables the parameter for specifying a distance to lift to be set in μm, independently of the detection unit, is

0: Not used

1: Used

- When this function is enabled, the parameter (No. 2373 or No. 2173) for specifying a distance to lift for the lifting function against gravity at emergency stop can be set in μm, independently of the detection unit.
- When this parameter has been set, the power must be turned off before operation is continued.
- If this function is used with a CNC that does not support the function for sending the detection unit to servo software, an illegal parameter setting alarm (detail number 2982) is issued.

5.8.6 Quick Stop Function for Hardware Disconnection of Separate Detector

(1) Overview

This function reduces the stop distance by resetting the velocity command for a servo motor to 0 when the separate detector for the servo motor encounters a hardware disconnection condition. It also causes the other axes to stop sooner than they would when a usual alarm occurs.

> **NOTE**
> For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2205				HDIS	HD2O			

HD2O (#5) The quick stop function for hardware disconnection of separate detector is:
0: Not applied to axes under synchronous control.
1: Applied to axes under synchronous control.

HDIS (#4) Specifies whether to enable quick stop function for hardware disconnection of separate detector as follows:
0: To disable
1: To enable
* For the Series 30i-B and Power Motion *i*-A, when bit 4 of parameter No. 2205 or bit 5 of parameter No. 2282 is set, the quick stop function for separate detector alarms is enabled.

Setting	Alarms for which to apply the quick stop function	
	FS30*i*-A,0*i*-D	FS30*i*-B, Power Motion *i*-A
No.2205#4=1	Hardware disconnection of the phase A/B detector	Hardware disconnection of the phase A/B detector or separate serial detector alarm
No.2282#5=1	Separate serial detector alarm	

2083	Brake control timer

[Unit of data] ms
[Setting value] 100

NOTE

1 When applying this function to axes under feed axis synchronization control, follow the steps below:
   1) Change the servo axis setting (No. 1023) of the two axes under feed axis synchronization to set an odd-numbered axis as the master axis and an even-numbered axis ((master axis number) + 1) as the slave axis.
   2) Set HD2O (bit 3) to 1 for both axes under synchronous control.

2 This function is implemented using part of the "unexpected disturbance torque detection function" option. So, using it requires that option.

3 Usually, when a separate detector disconnection alarm occurs for an axis, not only this axis but also the others are brought to an emergency stop. If an unexpected disturbance torque detection group function is set up, however, only the axes in the same group as the axis for which an alarm condition has occurred are brought to an emergency stop.

4 If the value (No. 1880) specified as an interval between the detection of an unexpected disturbance torque and the occurrence of an emergency stop is small, it may impossible to keep the sufficient stop time. The value should be at least greater than or equal to the one specified in the brake control timer parameter (there is no problem with a setting value of 0, because it means 200 ms).

5.8.7 Quick Stop Function for Separate Serial Detector Alarms

(1) Overview

This function reduces the stop distance by setting the velocity command for the servo motor to 0 when the separate serial detector is placed in an alarm state indicated below. With this function, motion on the axes other than the axis with which any of the alarms below is issued is also stopped quicker than in the case of an ordinary alarm.

Alarm number	Description
SV0380	BROKEN LED (EXT)
SV0381	ABNORMAL PHASE (EXT)
SV0382	COUNT MISS (EXT)
SV0383	PULSE MISS (EXT)
SV0384	SOFT PHASE ALARM (EXT)
SV0385	SERIAL DATA ERROR (EXT)
SV0386	DATA TRANS. ERROR (EXT)
SV0387	ABNORMAL ENCODER (EXT)

NOTE

For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	L(12) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	L(12) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2282			FSAQS					

FSAQS(#5) The quick stop function for separate serial detector alarms is:
0: Disabled
1: Enabled
* For the Series 30*i*-B and Power Motion *i*-A, when bit 4 of parameter No. 2205 or bit 5 of parameter No. 2282 is set, the quick stop function for separate detector alarms is enabled.

Setting	Alarms for which to apply the quick stop function	
	FS30*i*-A,0*i*-D	FS30*i*-B, Power Motion *i*-A
No.2205#4=1	Hardware disconnection of the phase A/B detector	Hardware disconnection of the phase A/B detector or separate serial detector alarm
No.2282#5=1	Separate serial detector alarm	

	#7	#6	#5	#4	#3	#2	#1	#0
2205					HD2O			

HD2O(#3) When a separate serial detector alarm is issued, two-axis simultaneous stop is:
0: Disabled
1: Enabled
* This parameter can be used with either the quick stop function for hardware disconnection of separate detector (bit 4 of No. 2205=1) or the quick stop function for separate serial detector alarms (bit 5 of No. 2282=1).

5.8.8 Quick Stop Function at OVL and OVC Alarm

(1) Overview

This function reduces the stop distance for a servo motor when an OVL (motor overheat or amplifier overheat) or OVC alarm condition is detected for the servo motor. It also causes the other axes to stop sooner than they would when a usual alarm occurs.

NOTE
For the Series 30*i*-A and 0*i*-D, if you want to use the brake control function, quick stop function, or lifting function against gravity at emergency stop with a multiaxis amplifier for which a dummy axis is set, be sure to connect a dummy connector.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2212	OVQK							

OVQK (#7) Specifies whether to enable quick stop function at the OVC and OVL alarm as follows:
0: To disable
1: To enable

NOTE
The operation of this function is performed by using part of the unexpected disturbance torque detection function. Therefore, to use this function, the option for the “unexpected disturbance torque detection function” is required.

2083	Brake control timer

[Unit of data] ms
[Setting value] 100

5.9 UNEXPECTED DISTURBANCE TORQUE DETECTION FUNCTION (OPTIONAL FUNCTION)

5.9.1 Unexpected Disturbance Torque Detection Function

(1) Overview

When a tool collides with the machine or workpiece, or when a tool is faulty or damaged, a load torque greater than that experienced during normal feed is imposed.
This function monitors the load torque to the motor at servo high-speed sampling intervals. If it detects an abnormal torque, it brings the axis to an emergency stop by issuing an alarm, or reverses the motor by an appropriate amount.
In addition, the function enables the PMC to be used to switch the speed at warning occurrence or load fluctuation.

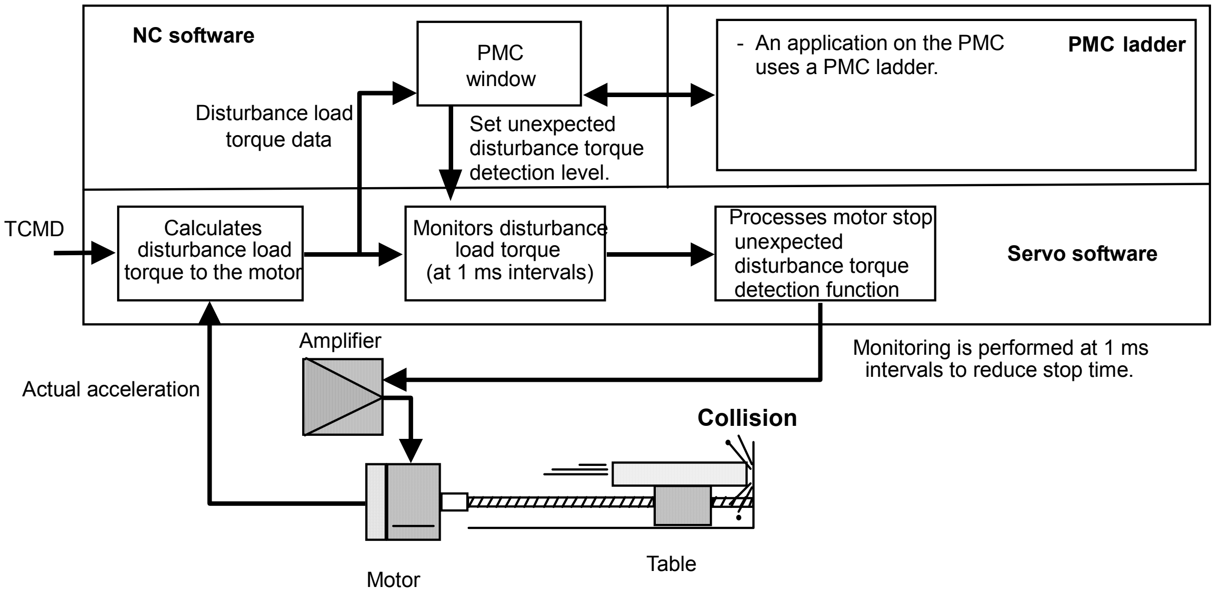


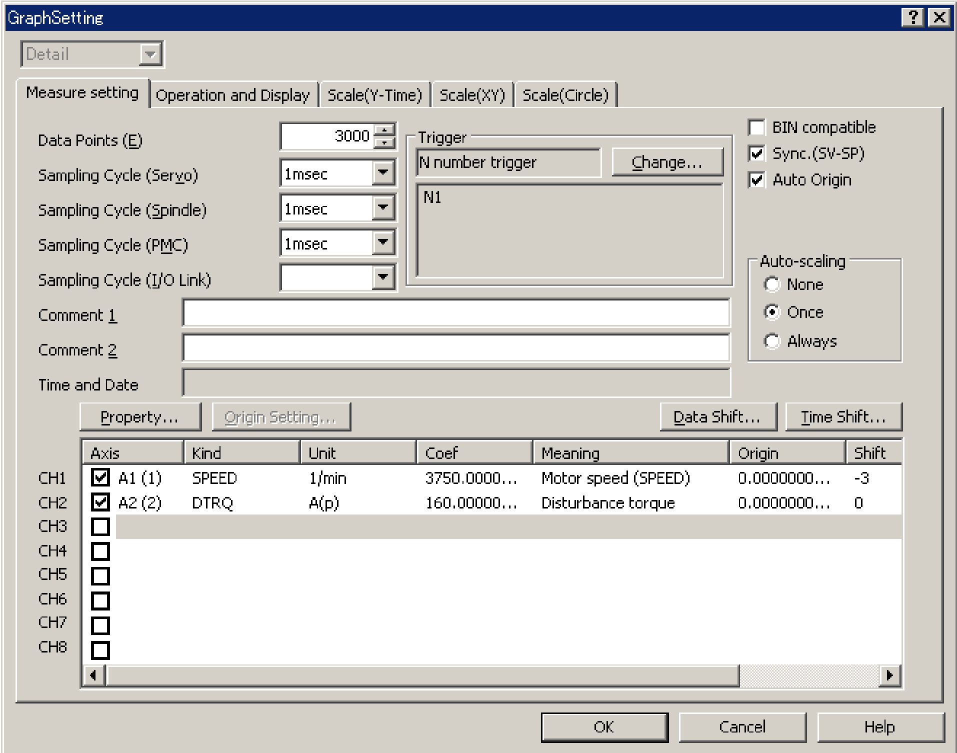
Fig. 5.9.1 (a) Overview of unexpected disturbance torque detection

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Parameter adjustment methods

<1> Use SERVO GUIDE to observe the motor speed (SPEED) and estimated disturbance torque (DTRQ).
(Example of channel settings on SERVO GUIDE)



(See Chapter 7, " SERVO TUNING TOOL SERVO GUIDE " for detailed descriptions about how to use the SERVO GUIDE.)

<2> Switch on the CNC.
<3> Enable the unexpected disturbance torque detection function

	#7	#6	#5	#4	#3	#2	#1	#0
2016								**ABNT**

ABNT (#0) Specifies whether to enable the unexpected disturbance torque detection function as follows:
0: To disable
1: To enable

Moreover, **be sure to set 1** also the following parameters.

	#7	#6	#5	#4	#3	#2	#1	#0
2200						**IQOB**		

IQOB (#2) Specifies whether to eliminate influence of control voltage saturation when estimating disturbance, as follows:
0: Not to take influence of control voltage saturation when estimating disturbance into consideration
1: To eliminate influence of control voltage saturation when estimating disturbance

<4> Set up the parameters related to the observer.

2050	**Observer gain**

- When HRV1, HRV2, or HRV3 control is used:

[Standard setting value] 956 → To be changed to 3559.

- When HRV4 control is used:

[Standard setting value] 264 → To be changed to 1420

2051	Observer gain

- When HRV1, HRV2, or HRV3 control is used:

[Standard setting value] 510 → To be changed to 3329.

- When HRV4 control is used:

[Standard setting value] 35 → To be changed to 332

> **NOTE**
> When using this function together with the observer, do not modify the standard setting of the parameter above.
> Observer:
> Bit 2 of No.2003

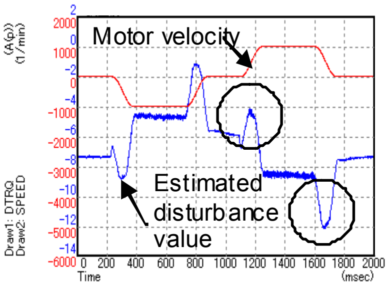
<5> Make adjustments on the **POA1** observer parameter.

2047	Observer parameter (POA1)

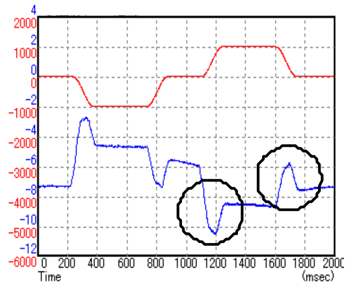
Turn the servo motor to perform linear back and forth operation at a speed equal to about 50% of the rapid traverse rate, and observe the motor speed (SPEED) and the estimated disturbance value (DTRQ). The waveform observed before the adjustment should show one of the following features:

> **NOTE**
> When a negative value is set for POA1, it is assumed to be |POA1| × 10.

Example of measurement: 1000min^{-1} (when using a rotary motor)

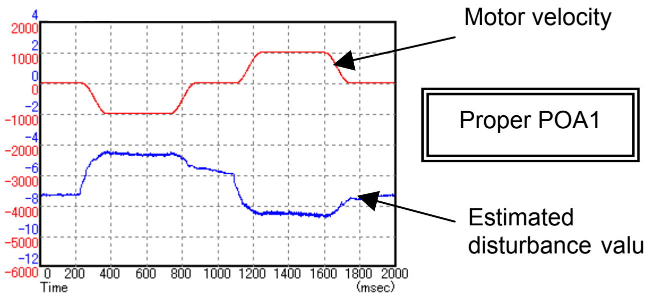


Insufficient POA1 value
Overshoot or undershoot on the estimated disturbance value



Excessive POA1 value
Overshoot or undershoot on the estimated disturbance value (in the direction opposite to the overshoot or undershoot caused by an insufficient POA1 value)

Adjust the value of the observer parameter (POA1) so that neither an overshoot nor an undershoot will not be observed on the estimated disturbance value at acc./dec. After adjustment, the waveforms shown below should be obtained.
(A clear waveform as shown below may not be obtained in some machines. In such machines, find the POA1 parameter value that can minimize the overshoot and undershoot while watching the estimated disturbance waveform at acc./dec.)



NOTE

The POA1 parameter is related to the load inertia ratio parameter ("velocity gain" on the servo screen) through the inside of the software. When the load inertia ratio parameter is changed, the POA1 parameter must also be changed. So, first determine the load inertia ratio (velocity gain) when adjusting the servo.
If you must change the load inertia ratio (velocity gain) after the POA1 parameter is determined, re-set the POA1 parameter using the following expression.
(New POA1 value) =
(Previous POA1 value) ×
(Load inertia ratio value set after adjustment+256) /
(Load inertia ratio value set before adjustment+256)
Load inertia ratio: No. 2021
The velocity gain magnification (in cutting or high-speed HRV current control) does not affect the setting of POA1.

(Details)

The observer estimates a disturbance torque by subtracting the torque required for acc./dec. from the entire torque. The torque required for acc./dec. is calculated using a motor model. The POA1 parameter corresponds to the inertia of the motor model. If the parameter value differs from the actual value, it is impossible to estimate a correct disturbance torque. To detect an unexpected disturbance torque correctly, therefore, you must adjust the value of this parameter.
An estimated disturbance value when a usual condition is supposed to be related only to frictional torque (for the horizontal axis), and proportional to the velocity. Therefore, a program, like the one used for adjustment, that merely repeats simple acc./dec. is supposed to generate a trapezoidal estimated disturbance torque waveform like a velocity waveform.

<6> For the vertical axis, adjust the torque offset. (This is unnecessary for the horizontal axis.)
For the vertical axis, the estimated disturbance value is not centered at level 0. Torque offset adjustment is done to center the estimated disturbance value at level 0.

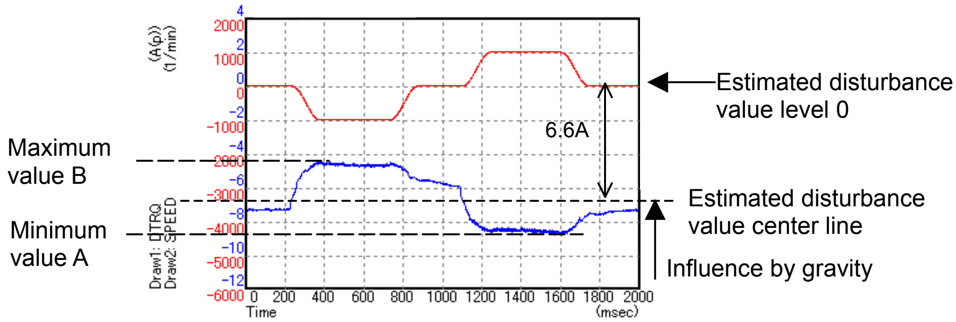
2087	Torque offset parameter

[Unit of data] TCMD unit (7282 with the maximum current value of the amplifier)
[Valid data range] -7282 to 7282

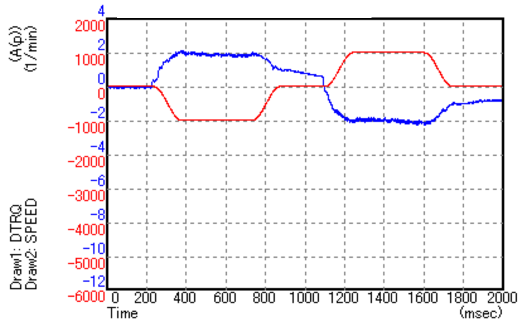
(Example of torque offset setting)

Estimated disturbance values for constant-velocity movements in the + direction and - direction are read. In the figure below, minimum value A (signed) is read in a movement in the + direction, and maximum value B (signed) is read in a movement in the - direction. A torque offset parameter setting is given using the following expressions:

$$\text{Torque offset} = \frac{A\,[Ap] + B\,[Ap]}{\text{Maximum amplifier current value [Ap]}} \times 3641$$



If you read the minimum value A and maximum value as –8.6 [Ap] and –4.5 [Ap] in the above chart (the amplifier used is rated at 80 [Ap] maximum), the torque offset parameter = -[(-8.6)+(-4.5)]/80×3641 = 596. The following chart applies when the parameter is set with 596.



When the torque offset parameter is set, **be sure to set** the following parameter **to 1**.

	#7	#6	#5	#4	#3	#2	#1	#0
2215							**TCPCLR**	

TCPCLR(#1) The function for setting a value for canceling the torque offset at an emergency stop in the velocity loop integrator is:
0: Disabled
1: Enabled

NOTE
When using the torque offset canceling function (bit 1 of parameter No. 2215), do not use the function for adding a preload with a time constant (bit 4 of parameter No. 2417).

<7> Compensate for dynamic friction.

(i) Method of canceling a dynamic friction in proportion to velocity

Measure an estimated disturbance value at a constant velocity. Then, by assuming this measured value as a dynamic friction, set the proportional coefficient for a velocity and dynamic friction compensation value.

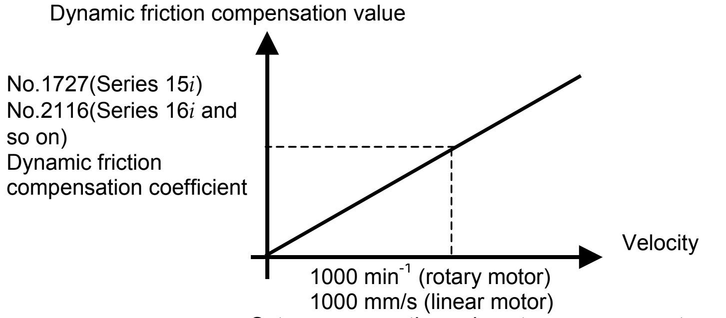
2116	**Dynamic friction compensation coefficient**

[Unit of data] See the equation below.
[Valid data range] -264 to 264
[Measurement velocity] Rotary motor: 1000 min^{-1}, Linear motor: 1000 mm/s

Measure an estimated disturbance value at a measurement velocity, then set the results of calculations made according to the table below.

$$\text{Dynamic friction compensation coefficient} = \frac{\text{Estimated disturbance value [Ap]}}{\text{Maximum amplifier current value [Ap]}} \times 440$$

> **NOTE**
> If the measurement velocity is too high, lower the measurement velocity, and measure the estimated disturbance value. By proportional calculation, obtain the estimated disturbance value at the above measurement velocity.

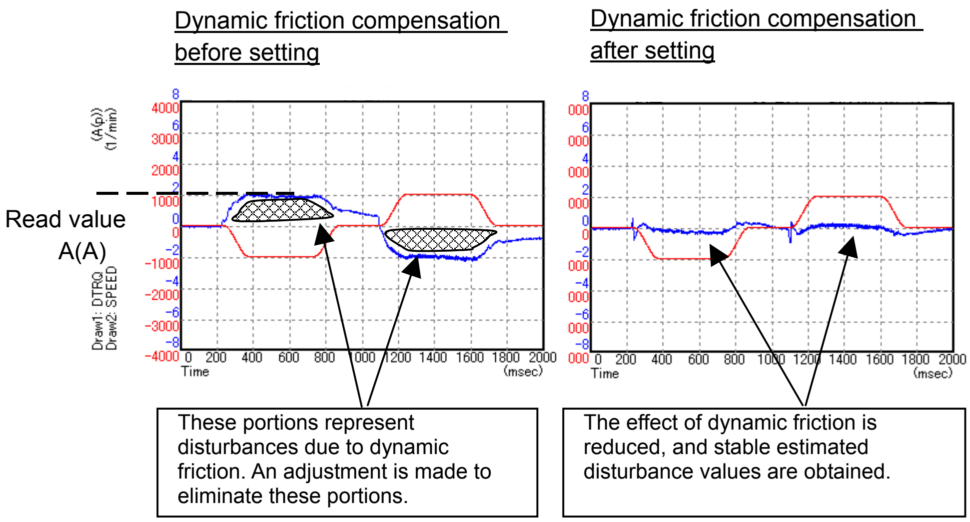


Set a compensation value at a measurement velocity, and correct the value proportional to the velocity as a dynamic friction.

(Example of setting for a rotary motor)

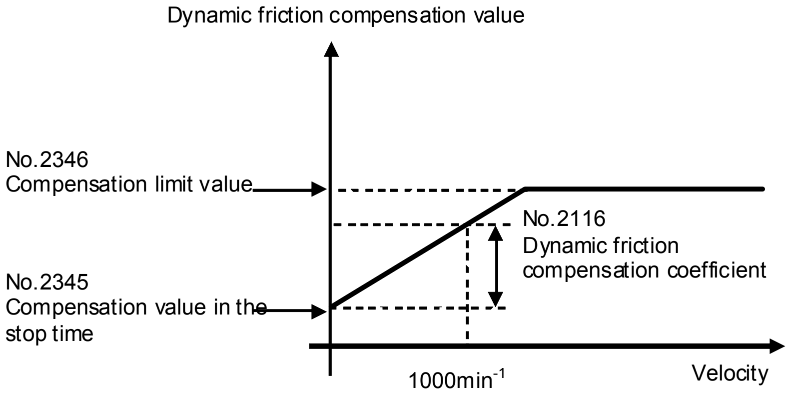
- Suppose that the estimated disturbance value at 1000 min^{-1} is 1 [Ap] (the maximum amplifier current value is 40 [Ap]).

  Dynamic friction compensation coefficient = 1/40 × 440 = 11



(ii) Method of setting a dynamic friction as "portion proportional to velocity + constant portion" and imposing a limit

If the compensation value for stop time to low-velocity movement is insufficient in adjustment of (i), set a dynamic friction compensation value in the stop state. If the compensation value for high-speed movement is excessive, a limit is imposed on the compensation value.



Set a compensation value in the stop time and a compensation limit value in addition to a compensation value at 1000 min^{-1}.

2345	Dynamic friction compensation value in the stop state

[Unit of data] TCMD unit (7282 when the estimated disturbance value is equivalent to the maximum current value of the amplifier)

[Valid data range] 0 to 7282

[Measurement velocity] 10 min^{-1} (rotary motor), 10 mm/s (linear motor)

The absolute value of a setting is used.

2346	Dynamic friction compensation limit value

[Unit of data] TCMD unit (7282 when the estimated disturbance value is equivalent to the maximum current value of the amplifier)

[Valid data range] 0 to 7282

[Measurement velocity] Maximum feedrate

The absolute value of a setting is used.

(Method of setting)

First, measure an estimated disturbance value when a movement is made at a maximum feedrate on the axis, then set the results of calculations made according to the table below in "dynamic friction compensation limit value".

$$\text{Dynamic friction compensation limit value} = \frac{|\text{Estimated disturbance value [Ap]}|}{\text{Maximum amplifier current value [Ap]}} \times 7282$$

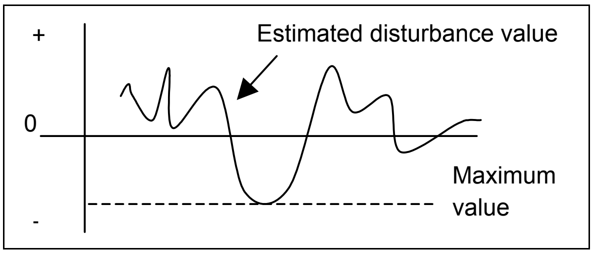
Next, measure an estimated disturbance value when a movement is made on the axis at the measurement velocity (10 min^{-1} or 10 mm/s) for "dynamic friction compensation value in the stop state", then set the results of calculations made according the table below in "dynamic friction compensation value in the stop state".

$$\text{Dynamic friction compensation value in the stop state} = \frac{|\text{Estimated disturbance value [Ap]}|}{\text{Maximum amplifier current value [Ap]}} \times 7282$$

Finally, measure an estimated disturbance value when a movement is made on the axis at the measurement velocity (1000 min^{-1} or 1000 mm/s) for "dynamic friction compensation coefficient", then set the results of calculations made according the table below in "dynamic friction compensation coefficient".

$$\text{Dynamic friction compensation coefficient} = \frac{|\text{Estimated disturbance value [Ap]}|}{\text{Maximum amplifier current value [Ap]}} \times 440$$

<8> Set an unexpected disturbance torque detection alarm level.
Perform several different operations (sample machining program, simultaneous all-axis rapid traverse acc./dec., etc.), and observe estimated disturbance values, and measure the absolute maximum value.
Then, set up an alarm level.



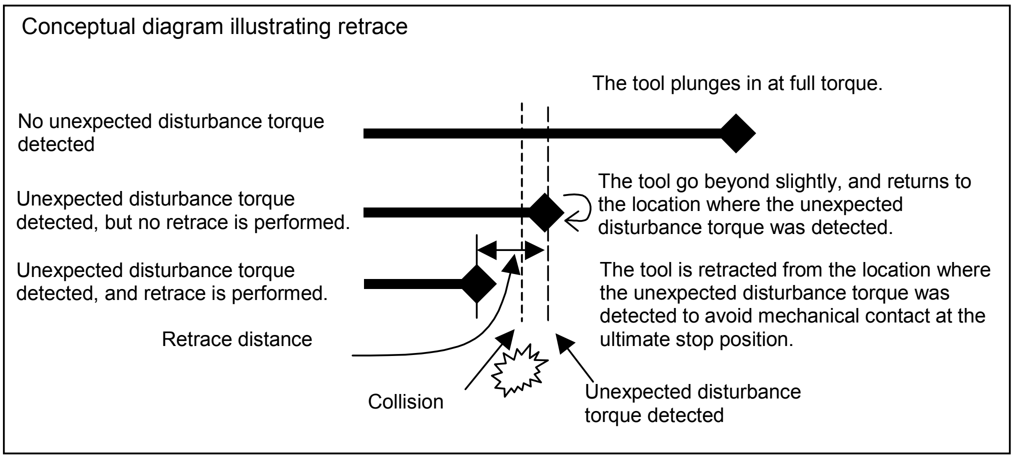
2104	Unexpected disturbance torque detection alarm level

Alarm level conversion uses the following expression.

$$\text{Unexpected disturbance torque detection alarm level} = \frac{|\text{Estimated disturbance value [Ap]}|}{\text{Maximum amplifier current value [Ap]}} \times 7282 + 500 \text{ to } 1000 \text{ approximately}$$

> **NOTE**
> 1 Add some margin (usually about 500 to 1000) to the alarm level to be set.
> 2 If the "unexpected disturbance torque detection alarm level" parameter is 32767, no unexpected disturbance torque alarm detection is performed.

<9> Set a distance to be retraced at unexpected disturbance torque detection.
If the retrace amount parameter is 0, the motor stops at the point where an unexpected disturbance torque was detected. To retract the tool from the location of collision quickly, set the retrace distance parameter.



2103	Retrace distance

[Unit of data] Detection unit
[Setting value] Approximately 3 mm

> **NOTE**
> When the tool is moving faster or slower than the velocity listed below, the tool will not go back even if this parameter is set. It stops at the location where an unexpected disturbance torque was detected.
> Let the value set in the retrace distance parameter be A:
> Minimum retract velocity =
> A × detection unit (μm) × 60/512 [mm/min]
> Example)
> When detection unit = 1 μm, and retract amount setting = 3000, the minimum velocity at which the tool is retracted is:
> Minimum retract velocity =
> 3000 × 1 × 60/512 = 352 [mm/min]

[2-axis simultaneous retract function at detection of an unexpected disturbance torque]

Usually, retraction at detection of an unexpected disturbance torque is performed only on the axis with which the unexpected disturbance torque is detected. However, when an unexpected disturbance torque is detected on one position tandem axis, retraction can be performed on the other position tandem axis as well by setting the parameter below.

(Setting parameters)

To use the unexpected disturbance torque detection function, set the following bit to 1 for both the master and slave axes.

	#7	#6	#5	#4	#3	#2	#1	#0
2271						RETR2		

RETR2(#2) With the unexpected disturbance torque detection function, 2-axis simultaneous retraction is:

0: Not performed

1: Performed

In the parameter for the distance to retract, specify the same value for both the master and slave axes. If an unexpected disturbance torque is detected on one of the axes, both axes are retracted.

> **NOTE**
> 1 This function can be applied only when position tandem control is used on the same DSP. Do not use this function for any axis that has not been set for position tandem.
> 2 If different values are specified for the master and slave axes, an invalid parameter alarm is issued. (The detail No. of the alarm is 1033.)

<10>Run the machine with the alarm level set up.

If the unexpected disturbance torque detection function works incorrectly, increase the alarm level.

<11>Now adjustment is completed.

5.9.2 Cutting/Rapid Unexpected Disturbance Torque Detection Switching Function

(1) Overview

An alarm threshold for unexpected disturbance torque detection is set separately for cutting and rapid traverse.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Setting parameters

A threshold can be set separately for cutting and rapid traverse by setting the following bit when the unexpected disturbance torque detection function is used:

	#7	#6	#5	#4	#3	#2	#1	#0
2200					ABG0			

ABG0(#3) The cutting feed/rapid unexpected disturbance torque detection switching function is:
0: Disabled.
1: Enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2215	ABT2							

ABT2(#7) Cutting feed/rapid unexpected disturbance torque detection switching function type-2 is:
0: Disabled.
1: Enabled.

> **NOTE**
> Set the two bits above. (Servo software was revised in type-2 to be able to switch even if you set bit 3 of No.1800 to 1, feed-forward always enable.)

Alarm thresholds for unexpected disturbance torque detection are set in the following parameters:

2104	Unexpected disturbance torque detection threshold for cutting (This parameter is used both in not switching mode and in switching mode.)

[Valid data range] 1 to 7282

2142	Unexpected disturbance torque detection threshold for rapid traverse

[Valid data range] 1 to 7282

> **NOTE**
> 1 When the alarm level for cutting is 0 or 32767, unexpected disturbance torque detection is not performed during cutting.

> **NOTE**
> 2 When the alarm level for rapid traverse is 0 or 32767, unexpected disturbance torque detection is not performed during rapid traverse. When both parameters are 32767, unexpected disturbance torque detection is not performed at any time.

5.9.3 Unexpected Disturbance Torque Detection Switching Function Depending on Acc.

(1) Overview

This function separately sets a threshold level for unexpected disturbance torque alarms detected in an acceleration/deceleration zone where the estimated disturbance value tends to fluctuate. This function can protect against erroneous detection of an unexpected disturbance torque alarm in an acceleration/deceleration zone.

1. In a zone where acceleration/deceleration is performed (zone where extensive acceleration is applied), a higher alarm level can be set.
2. The influence of acceleration after positioning can be avoided by setting a timer when returning to the original alarm level after alarm level switching.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	P(16) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Notes

- When using this function, set the post-acceleration timer (No. 2358).
- This function can be used together with the cutting/rapid unexpected disturbance torque detection switching function.

(4) Setting parameters

(Related parameters)

2342	Acceleration threshold in unexpected disturbance torque detection

[Unit of data] Detection unit

[Setting value] Let α [mm/s^2] be an acceleration rate and let P [mm/pulse] be a detection unit. Then, the value to be set in the parameter can be found from the following expression:

$$\text{Setting} = \frac{\alpha \times 16}{P \times 10^6}$$

[Valid data range] 0 to 32767

When 0 is set in this parameter, acceleration-based alarm level switching is disabled.

2343	Alarm level for high acceleration in unexpected disturbance torque detection

[Unit of data] TCMD (7282 with the maximum current value of the amplifier)

[Valid data range] 0 to 32767

When the absolute value of a specified acceleration rate is equal to or greater than the setting of No. 2342, the setting of No. 2343 is applied as an unexpected disturbance torque detection alarm level.
When 0 is set in this parameter, acceleration-based alarm level switching is disabled.

2358	Post-acceleration timer in unexpected disturbance torque detection

[Unit of data] ms
[Valid data range] 0 to 32767
This parameter maintains a changed alarm level for a timer-set period even after the specified acceleration rate is reduced below a certain level.

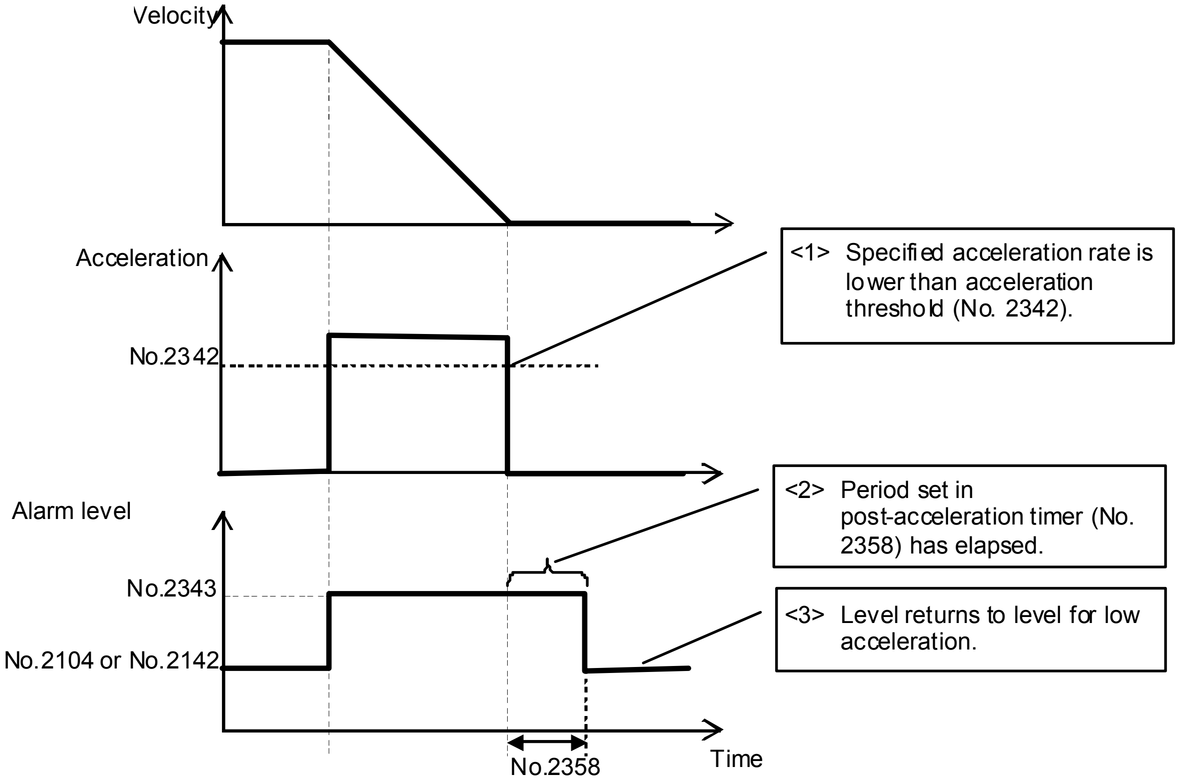


Fig. 5.9.3 (a) Acceleration-based alarm level switching

5.10 MULTIPLE-MOTOR DRIVING (TANDEM DRIVING)

(1) Overview

If a single motor is not capable of producing sufficient torque to drive a large table or if you want to reduce the backlash between gears, multiple motors can be used to produce movement along one axis.
Also, as a special case, a large servo motor (motor with plural windings) may be driven by multiple amplifiers.
For multiple-motor driving, the following three tandem control methods are available according to the control method for the slave or sub axis (position control, velocity control, or torque control). (In this section, to make a distinction between feed axis synchronization control and torque tandem control, the terms master and slave axes are used for the former, while main and sub axes are used for the latter.)

- Position tandem control
  Feed axis synchronization control (feed axis synchronization control option (J843) for the Series 30i) is necessary. When even and odd numbers are specified for servo axis arrangement (parameter No. 1023) in this order, in particular, the control applied is called "position tandem control". In this status, the master and slave axes are enabled to perform various types of operation in a coordinated way. For example, the tandem disturbance elimination control option (S660), which suppresses interference between two axes, is available.
  In general, position tandem control is used for multiple-motor driving.
  NOTE)
  With the 30*i*-B or later, the feed axis synchronization control option includes the tandem control option (J733).

  Position tandem control is also available for driving linear motors connected in series, motors with two windings (α*i*S300/2000, α*i*S500/2000, and α*i*S1000/2000HV), and motors with four windings (α*i*S1000/3000HV, α*i*S2000/2000HV, and α*i*S3000/2000HV).
  In addition, position tandem control is available for performing tandem control for motors with plural windings.
  NOTE)
  With the 30*i*-B or later, a motor with plural windings can be driven without the feed axis synchronization control option.

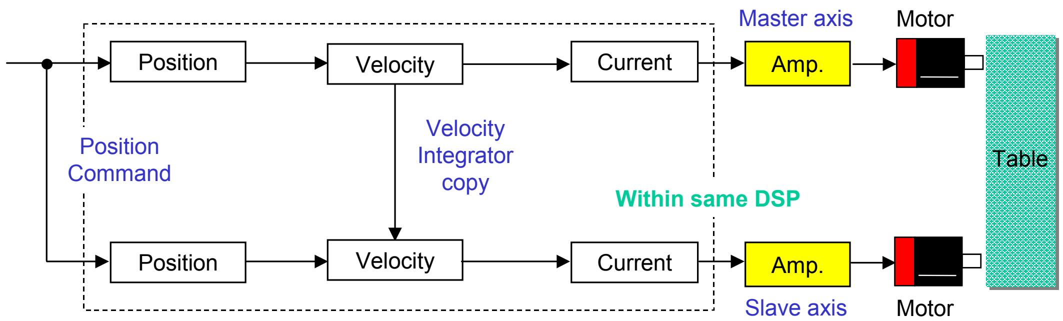


Fig. 5.10 (a) Block diagram of position tandem control

- Torque tandem control
  The tandem control option is necessary. (For the Series 30i-B, the feed axis synchronization control option is necessary.)
  Conventional torque tandem control can be replaced with position tandem control + velocity loop integrator copy function using feed axis synchronization control. The position tandem control + velocity loop integrator copy function can control the position and velocity, so can control the sub-motor more stably as compared with torque tandem control.

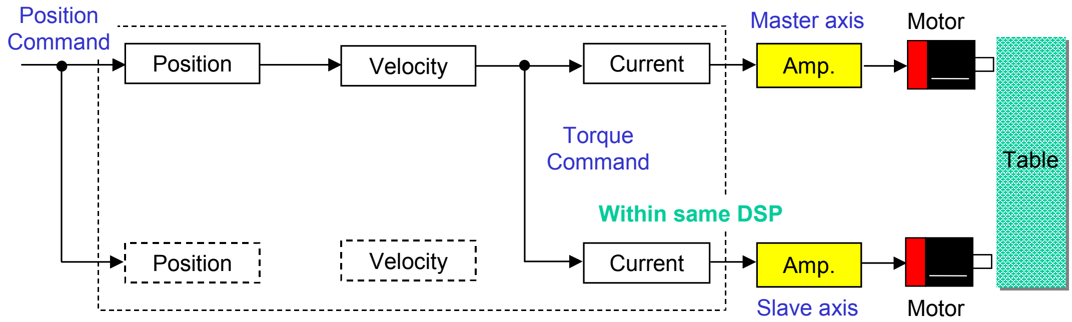


Fig. 5.10 (b) Block diagram of torque tandem control

- <u>Velocity tandem control</u>
  The tandem control option is necessary. (For the Series 30i-B, the feed axis synchronization control option is necessary.)
  The velocity tandem control + velocity loop integrator copy function can control the velocity, so can control the motors more stably as compared with torque tandem control. Velocity tandem control can be replaced with position tandem control + velocity loop integrator copy function to control the sub-motor more stably than velocity tandem control.

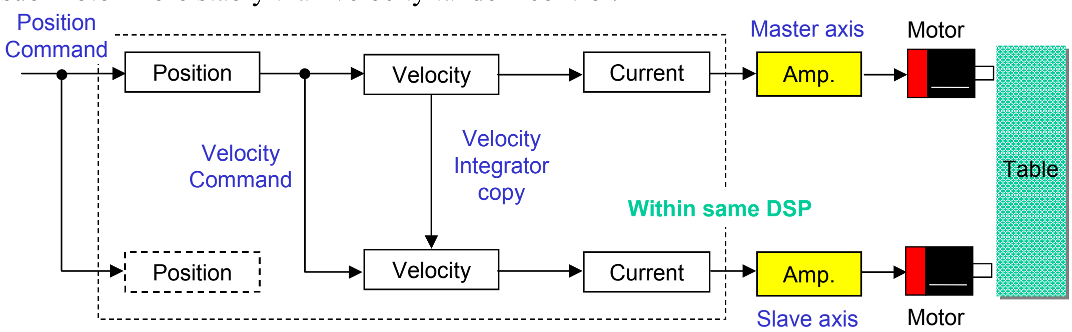


Fig. 5.10 (c) Block diagram of velocity tandem control

The three types of tandem control described above are generally used for two axes. By using the "multiaxis tandem function", these types of tandem control can also be used for four and eight axes. For details, see Subsection 5.10.2, "Multiaxis Tandem".

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

NOTE
This function cannot be used together with the servo HRV4 control.

(3) Servo software functions and their corresponding tandem control methods

Function name	Position tandem	Torque tandem	Velocity tandem	Remarks
Feed Axis Synchronization Control (Simple synchronous control)	○	-	-	Option
Velocity loop integrator copy function	○	-	○	Suppresses interference between axes. Can be turned off and on using Gn321.
Preload function	○	○	○	Suppresses the backlash. With a time constant.
Servo alarm two-axis monitor function	○	○	○	Prevents damage to the machine.
Tandem disturbance elimination control function	○	-	○	Option
Synchronous axes automatic compensation function	○	-	-	
Torque difference alarm function	○	-	-	Prevents damage to the machine.
Full-closed loop feedback sharing function (sub-axis)	○	-	○	One scale
Driving a motor with four windings	○ Note 2	-	-	Set automatically.
Driving a motor with two windings	○ Note 2	-	-	Set manually.
Tandem control	-	○	○	Option
Damping compensation function	-	○	-	
Tandem speed difference alarm	-	○	-	Prevents damage to the machine.
Velocity feedback average function	-	○	○	
Motor feedback sharing function	○	○ Note 1	-	Motor with two windings

NOTE

1. With the 30*i*-A or earlier, drive the motor using torque tandem control + motor feedback sharing function.
2. With the 30*i*-B, this method is available without the feed axis synchronization control option.

(4) Using the velocity loop integrator copy function and preload function together

The motor for each axis produces almost the same torque as that produced when positioning is performed for the single axis, so double the torque can be obtained with two motors. (Load sharing mode).
If interference between axes is caused by driving multiple axes, the velocity loop integrator copy function is useful.

If you want to suppress the backlash between gears of the reducer or the like for each axis, enable the integrator copy function and use the preload function together. By adding a preload torque to the master and slave motors in opposite directions to produce tension, the backlash between gears can be reduced. (Anti-backlash mode)

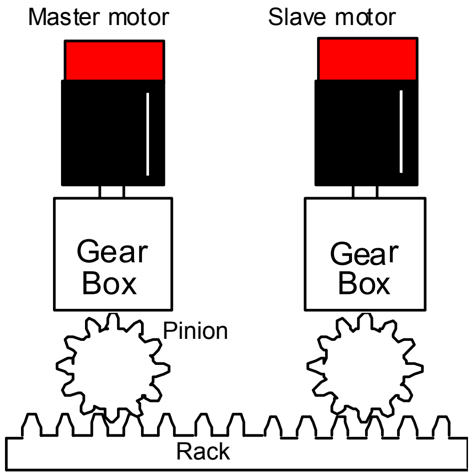


Fig. 5.10 (d) Example of driving multiple axes (1)

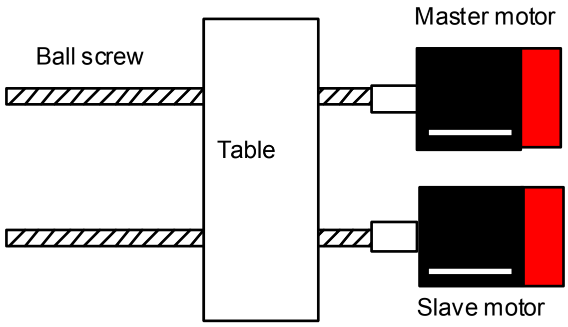


Fig. 5.10 (e) Example of driving multiple axes (1)

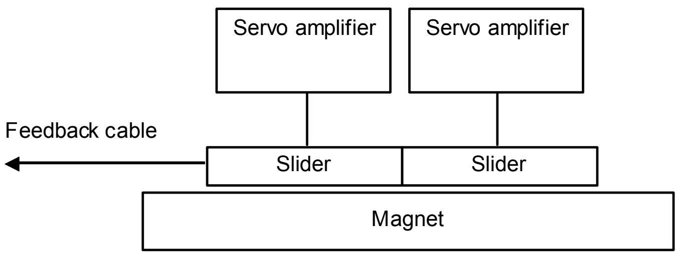


Fig. 5.10 (f) Example of tandem control (linear motors connected in series)

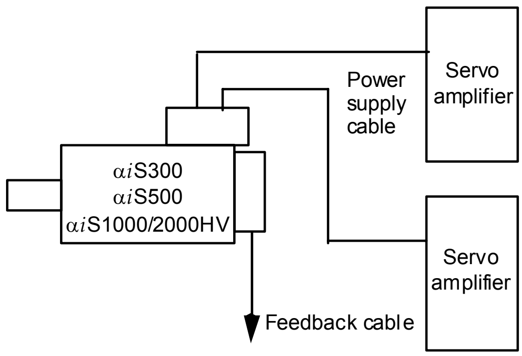


Fig. 5.10 (g) Example of tandem control (motors with two windings)

(5) Using a motor with plural windings and EGB (electric gear box)

To implement the EGB, usually, it is necessary to receive the position feedback signal of the master axis from the entry at the separate detector side of the dummy axis (even-numbered axis) to drive the slave axis (odd-numbered axis). For a motor with two or four windings, however, it is necessary to receive the position feedback signal from the separate detector side of the even-numbered axis, not the dummy axis, since there is an even-numbered axis.

For the EGB (FSSB method), the position feedback signal can also be received from the even-numbered axis side in the same way.

When position tandem control or torque tandem control is used for two-motor driving, the EGB cannot be used together.

Example of parameter setting (motor with four windings)

Axis No.	Arrange-ment No.1023	Motor with four windings No.2211#7	Separate detector No.1815#1	EGB No.2011#0	Remarks
1	1 (L)	1	x *1	1	1st axis of the motor with four windings
2	2 (M)	1	1	1	2nd axis of the motor with four windings (received from the master axis)
3	3 (J)	1	0	0	3rd axis of the motor with four windings
4	4 (K)	1	0	0	4th axis of the motor with four windings

Example of parameter setting (motor with four windings): FSSB method

Axis No.	Arrange - ment No.1023	Motor with four windings No.2211#7	Separate detector No.1815#1	FSSB method No.2429#2	EGB No.2011#0	Remarks
1	1 (L)	1	x *1	0	1	1st axis of the motor with four windings
2	2 (M)	1	1	1 *2	1	2nd axis of the motor with four windings (received from the master axis)
3	3 (J)	1	0	0	0	3rd axis of the motor with four windings
4	4 (K)	1	0	0	0	4th axis of the motor with four windings

Example of parameter setting (motor with two windings)

Axis No.	Arrange- ment No.1023	Motor with two windings No.2211#6	Separate detector No.1815#1	EGB No.2011#0	Remarks
1	1 (L) *3	1	x *1	1	1st axis of the motor with two windings
2	2 (M) *3	1	1	1	2nd axis of the motor with two windings and separate detector (received from the master axis)

Example of parameter setting (motor with two windings): FSSB method

Axis No.	Arrange- ment No.1023	Motor with two windings No.2211#6	Separate detector No.1815#1	FSSB method No.2429#2	EGB No.2011#0	Remarks
1	1 (L) *3	1	x *1	0	1	1st axis of the motor with two windings
2	2 (M) *3	1	0	1 *2	1	2nd axis of the motor with two windings (received from the master axis)

NOTE)

For details of setting the EGB ratio (parameters Nos. 7782, 7783, and 2372) and others, refer to the "PARAMETER MANUAL (FUNCTION)".

*1) Set the parameter for specifying whether to use a separate detector for the master axis of a motor with four or two windings as required.

*2) With the 30*i*-B or later, the EGB using the FSSB method is available. It is necessary to set parameter No. 4549, bit 0 of parameter No. 24203, and parameter No. 24204.

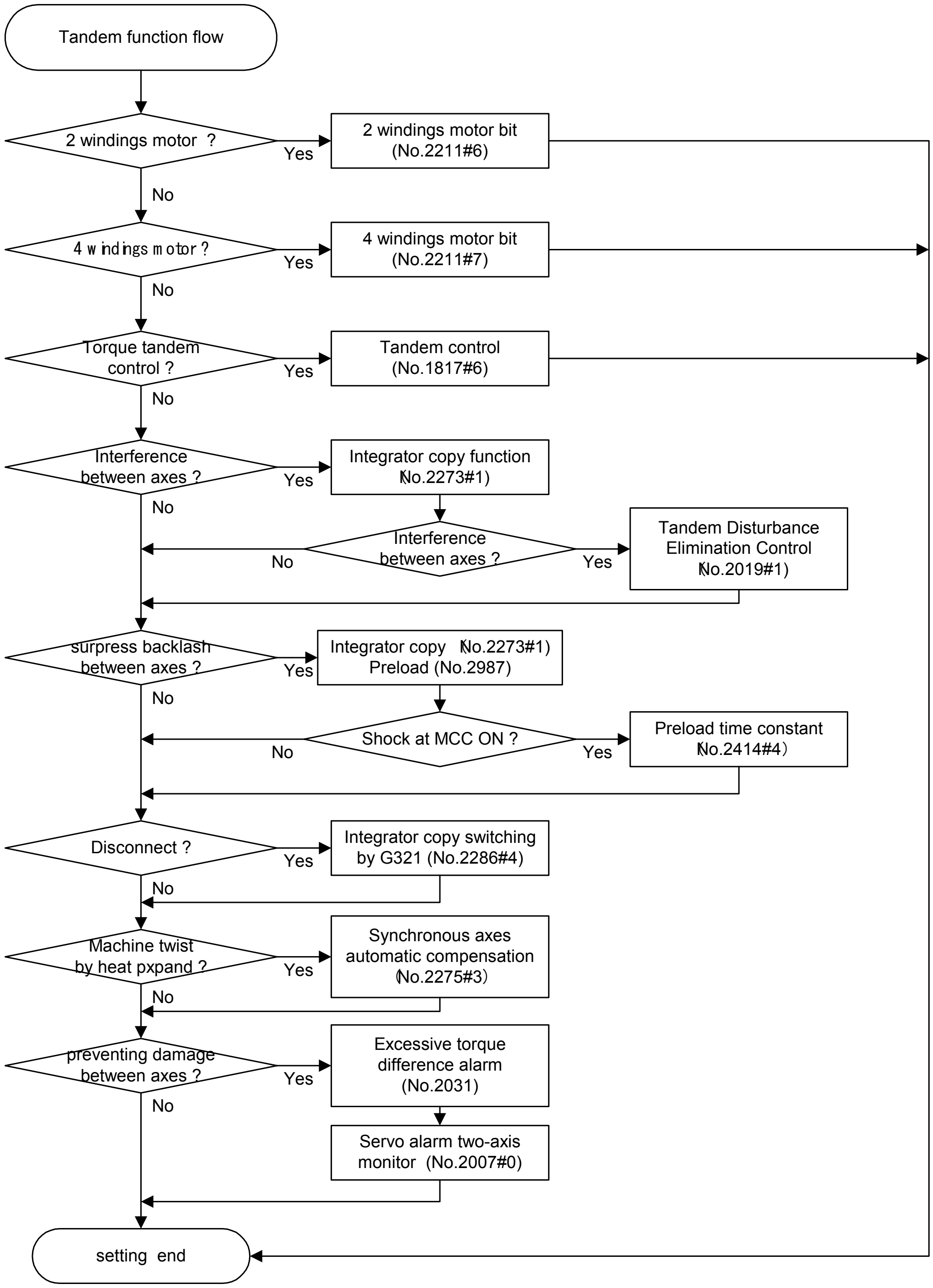
*3) For a motor with two windings, combinations of (8n+1, 8n+2), (8n+3, 8n+4), and (8n+5, 8n+6) are allowed.

(NOTE) The following table lists the series and editions of applicable servo software.

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	13.0 and subsequent editions	FSSB method
Series 30*i*/31*i*/32*i*-A	90E0 90E1	- 03.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5	-	
	90C8	-	
	90E5	-	
	90E8	-	

(6) Function selection flow for multiple motor driving

The following figure shows a function selection flow for multiple motor driving.



5.10.1 Position Tandem

5.10.1.1 Velocity Loop Integrator Copy Function

(1) Overview

If the velocity loop integrator gets unbalanced between the master and slave during feed axis synchronization control or velocity tandem control, the axes may get twisted, leading to an OVC alarm.
In this case, this function copies the velocity loop integrator from the master axis to the slave axis, thereby preventing integrator imbalance between the master and slave.
When the preload function is used together, the backlash can be suppressed by adding a preload torque in opposite directions, in the same way as when the preload function is used in a conventional torque tandem configuration.

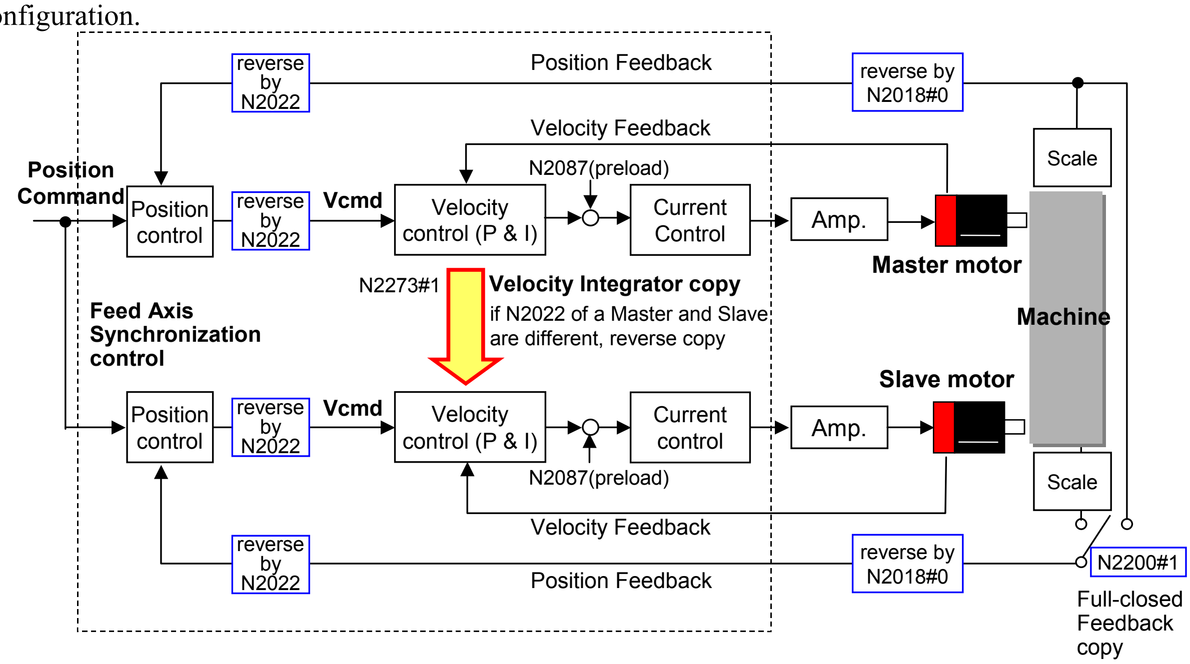


Fig. 5.10.1.1 (a) Block diagram of the velocity loop integrator copy function

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

- Dynamic switching between whether to enable or disable the integrator copy function
  (Series 30*i*/31*i*/32*i*/35*i*-B, Power Motion *i*-A)
  Series 90G0 03.0 and subsequent editions
  (Series 30*i*/31*i*/32*i*-A)
  Series 90E0 Y(25.0) and subsequent editions
  Series 90E1 01.0 and subsequent editions

Velocity loop integrator può essere utilizzata contemporaneamente al precarico, è un errore del manuale Fanuc, vedi mail 04.11.2013

(3) Setting parameters

	#7	#6	#5	#4	#3	#2	#1	#0
2273							WSVCP	

(Set this parameter for the master and slave axes.)

WSVCP(#1) 1: The velocity loop integrator of the master axis is copied to the slave axis.

> ⚠ **CAUTION**
> 1 When using this function, ensure that an odd-numbered axis is assigned to the master axis and an even-numbered servo axis ((master axis) + 1) is assigned to the slave axis in servo axis arrangement (parameter No. 1023).
> 2 This function bit is available when feed axis synchronization control or velocity tandem control is used.
> 3 This function can~~not~~ be used together with the preload function.
> 4 It is impossible to specify functions related to the velocity loop integrator (such as the incomplete integral or low-speed integral function) separately for the master axis and slave axis.
> 5 This function cannot be used together with servo HRV4 control.

(4) Dynamic switching between whether to enable or disable the integrator copy function

If you want to enable the integrator copy function only when two axes are coupled mechanically, you can use external signal Gn321 (coupling signal) to turn the velocity loop integrator copy function off and on. You may not want to operate the velocity loop integrator copy function. For example, for axes along which the workpiece is chucked from both sides, when the workpiece is not chucked, you can set external signal Gn321 to 1 to turn the integrator copy function off.

	#7	#6	#5	#4	#3	#2	#1	#0
2286				WCCNCK				

(Set this parameter for the slave axis.)

WCCNCK(#4) 1: When external signal Gn321 is set to 0, the velocity loop integrator is copied to the slave axis.

0: The velocity loop integrator is always copied to the slave axis regardless of whether external signal Gn321 is set to 0 or 1.

	#7	#6	#5	#4	#3	#2	#1	#0
Gn321	SVDI18	SVDI17	SVDI16	SVDI15	SVDI14	SVDI13	SVDI12	SVDI11

(Input this signal for the master and slave axes.)

SVDI1x 1: Uncoupled state

0: Coupled state

The bit position represents the relevant NC axis number. For example, bit 0 represents the first NC axis.

5.10.1.2 Preload function

(1) Overview

This function can apply torques of opposite directions to the master axis (master motor) and slave axis (slave motor) by applying an offset (preload) torque to the torque command to maintain tension at all times. This function can reduce the backlash between the master and slave axes, caused by the tandem connection of two motors through gears. However, this function does not reduce the backlash between the ball screw and table, which is a feature of the machine system.

For example, set preload +Pre for the master axis and preload -Pre for the slave axis. Then, torques are produced as shown in Fig. 5.10.1.2 (a) below.

If a torque is required during acc./dec., a torque of the same direction is produced with the two motors. (Load sharing mode)
If no torque is required, for example, during stop state, preload torques produce tension between the two axes. (Anti-backlash mode)
The average driving torque for the master and slave motors when this function is used is the value obtained by averaging the driving torques of each motor, which is represented with a dotted line in Fig. 5.10.1.2 (b) below.

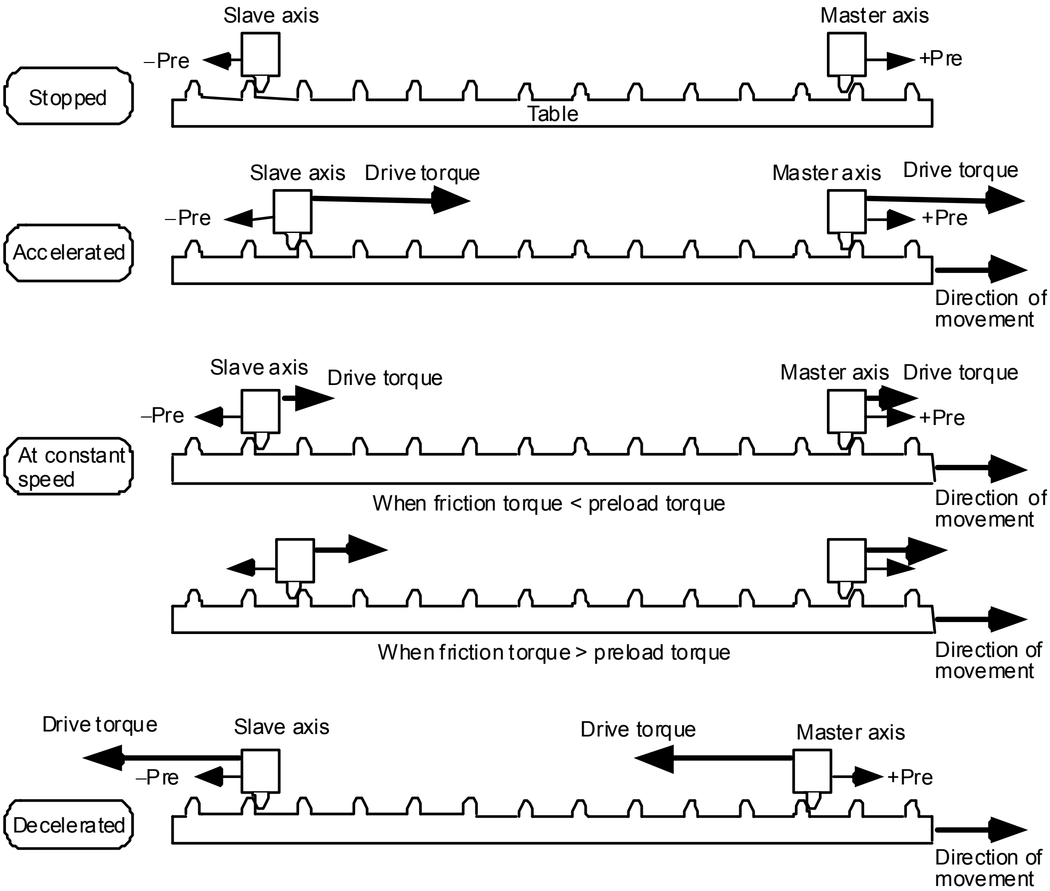


Fig. 5.10.1.2 (a) Changes of torque during movement

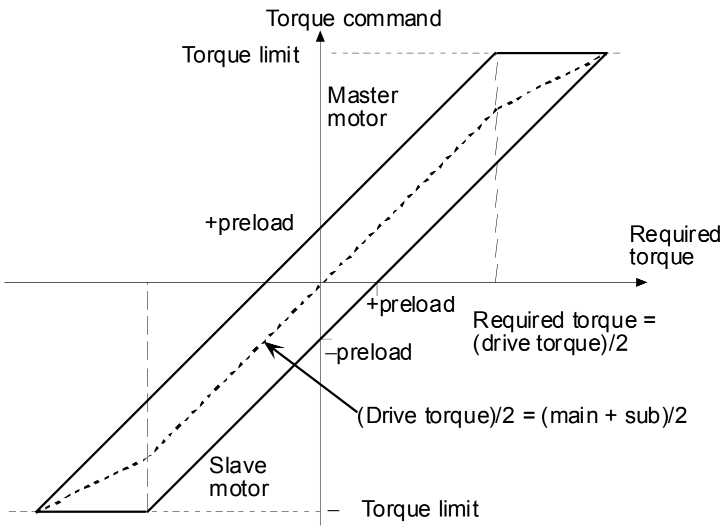


Fig. 5.10.1.2 (b) Relationships between the average driving torque and torque command for each motor

2087	Preload value (PRLOAD)

[Unit of data] TCMD unit (The value 7282 represents the maximum amplifier current.)
Set this parameter for the master and slave axes.

> ⚠ **CAUTION**
> Set a value that is as small as possible but greater than the static friction torque. A set preload torque is applied to each motor at all times. So, set a value that does not exceed the rated torque of each motor. As a guideline, specify a value equal to one-third of the rated torque.
> As shown in Fig. 5.10.1.1 (a) in Subsec. 5.10.1.1, a preload torque is added in any case. So, set the preload torque directions as follows:
> - When the rotation directions of the master axis and slave axis are the same: Different signs
> - When the rotation directions of the master axis and slave axis are different: Same sign

Example of setting)

For the α*i*S8/4000 (Servo amplifier α*i* SV 80)
When a preload torque of 5 Nm is to be added, the torque constant is 0.72 Nm/Arms according to the descriptions of the servo motor. So, the peak value is 0.509 Nm/Ap. So, the peak value is 0.368 N·m/Ap. The torque is converted to a current value as follows:
5/0.509 ＝ 9.82 Ap.
The amplifier limit is 80 Ap, so that the value to be set is:
9.82/80 × 7282 = 894
So, set 894 for the master axis, and -894 for the slave axis (when the directions of rotation of the two motors are the same).
When movement of the table is stopped, check whether the system is in tension. If not, increase this value gradually.

> ⚠ **WARNING**
> For torque tandem control, when two motors are not connected, always set a preload value of 0.
> The sub-axis motor may rotate at extremely high speed, which is very dangerous. (→ See Subsec. 5.10.4.4 "Tandem speed difference alarm function.")

(2) Preload function with a time constant

With the conventional preload function, since a torque offset is always added to the torque command, a stepwise torque is produced at the moment of activation, which may cause a shock.
When this function is enabled, a torque offset can be applied exponentially. A time constant is determined based on the position gain. For example, when the position loop gain is Pg = 30 [s^{-1}], the preload function starts with a time constant of 33.3 ms. In addition, a function bit can be set to increase the time constant by four times.
The time constant is also applied when activation is turned off or when the parameter value is changed.

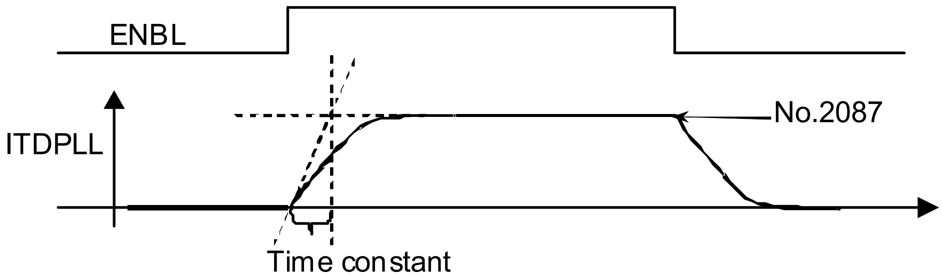


Fig. 5.10.1.2 (c) Preload value with a time constant

(2-1) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	Y(25) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5 90C8	- -	
	90E5 90E8	- -	

(2-2) Parameter

	#7	#6	#5	#4	#3	#2	#1	#0
2417				TIMCAL		TIMPR2		

TIMCAL(#4) Preload time constant calculation is:
1: Performed.
0: Not performed. (Conventional specification)

> **NOTE**
> When using the torque offset canceling function (bit 1 of parameter No. 2215) for the unexpected disturbance torque detection function, do not use this function.

TIMPR2(#2) The exponential time constant of the preload function is:
1: Four times of the reciprocal number of the position loop gain.
0: Reciprocal number of the position loop gain.

5.10.1.3 Functions for preventing damage between two axes

(1) Overview

In a position tandem or torque tandem configuration, motors are mechanically coupled. To prevent mechanical damage, the following functions are available:

<1> Function which monitors the torque between the master and slave axes and prevents a large torque from being applied (excessive torque difference alarm)

<2> Function which turns the activation for the other axis off immediately when an error occurs in one of the axes (servo alarm two-axis monitor function)

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	A(01) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Details

(a) Excessive torque difference alarm

2031	Excessive torque difference alarm threshold

[Unit of data] TCMD unit (The value 7282 represents the maximum amplifier current.) (Set this parameter for the master axis.)

[Valid data range] 0 to 32767 (When a value of 0 is set, this alarm is not detected.)

(b) Servo alarm two-axis monitor function

If an alarm occurs in either of two axis motors used to operate a machine in concert as in position tandem control or torque tandem control, it is necessary to stop the other axis motor immediately so as to prevent the machine from being twisted. This function monitors two axes controlled by the same DSP simultaneously for servo alarms. If an alarm occurs in either of the two axes, the function can promptly turn the activation for the other axis.
This function is not confined to tandem axes. When consecutive (odd and even) servo axis numbers are assigned, the function can be applied and available for feed axis synchronization control and others.

	#7	#6	#5	#4	#3	#2	#1	#0
2007							IGNVRO	ESP2AX

(Set this parameter for the master axis (to which an odd number is assigned by parameter No. 1023.)

ESP2AX (#0) 1: The servo alarm two-axis monitor function is enabled.

(Set this parameter for the master axis (to which an odd number is assigned by parameter No. 1023.)

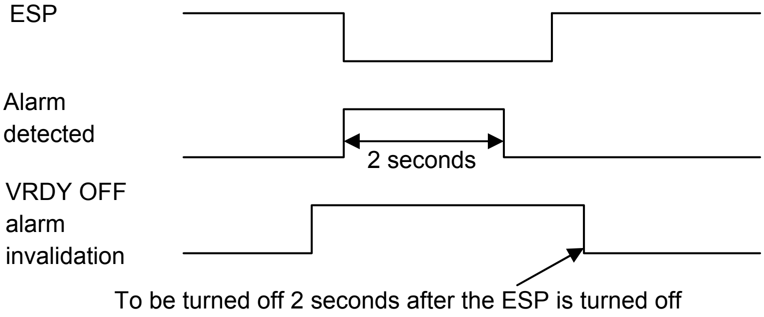
IGNVRO (#1) 1: An alarm condition is released 2 seconds after the servo alarm two-axis monitor function holds the alarm condition.

Some systems have a configuration in which the ESP line of the PS is cut off with an interlocked machine door, independently of the emergency stop button, for safety purposes. In these systems, the amplifier is turned off with an emergency stop not in effect, and therefore, a "V ready off alarm" occurs. This alarm is evaded by using the "VRDY OFF alarm invalidation signal".
Conventionally, it was impossible to use "PS cut-off based on the VRDY OFF alarm invalidation signal" along with the "servo alarm two-axis monitor function", however. This is because the "servo alarm two-axis monitor function" holds an alarm condition in the servo software and will not activate a motor when the ESP line is connected after that.

To avoid this problem, a function has been added which clears information about an alarm condition in the servo software 2 seconds after the alarm is detected. This function enables the simultaneous use of the "servo alarm two-axis monitor function" and " PS cut-off based on the VRDY OFF alarm invalidation signal".

NOTE

It is necessary to release the VRDY OFF alarm invalidation signal 2 seconds after the PS ESP signal is turned off.



5.10.1.4 Tandem Disturbance Elimination Control (Optional Function)

(1) Overview

This function suppresses vibration caused by interference between the master axis and slave axis in position tandem (feed axis synchronization) control.

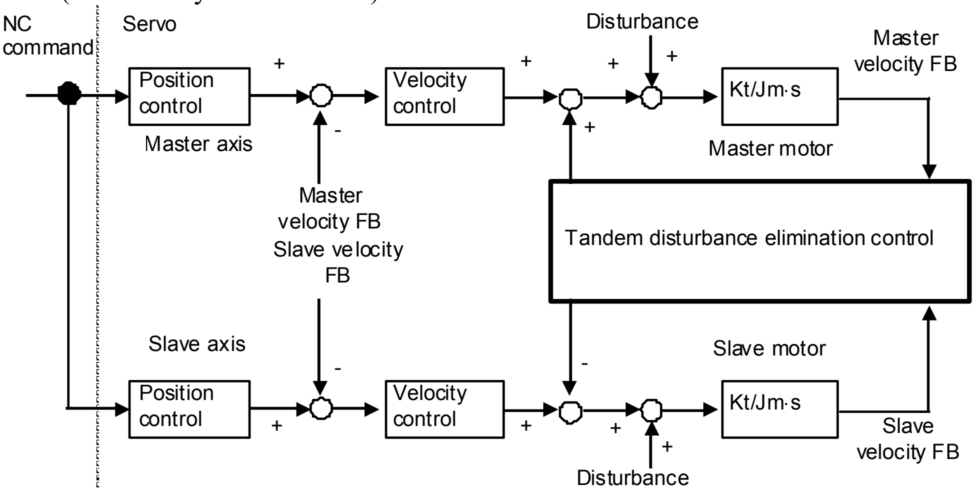


Fig. 5.10.1.4 (a) Block diagram of tandem disturbance elimination control

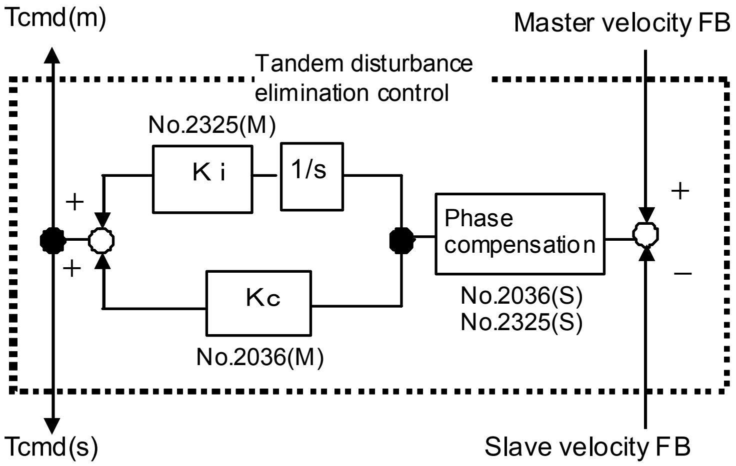
(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Cautions

1. This function is optional. (To enable the position tandem function, feed axis synchronization control is additionally needed.)
2. This function can be used only for two-axis feed axis synchronization control. It cannot be used for more than two axes.
3. In servo axis arrangement (No.1023), the main axis must be an odd-numbered axis, and the sub-axis must be a subsequent even-numbered axis.
4. This function cannot be used together with servo HRV4 control.

(4) Setting parameters



	#7	#6	#5	#4	#3	#2	#1	#0
2019							**TANDMP**	

(Set this parameter for the master axis only.)

TANDMP (#1) Tandem disturbance elimination control is:
0: Not used.
1: Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2008						**VFBAVE**		

(Set this parameter for the master axis only.)

VFBAVE (#2) The velocity feedback average function is:
0: Not used.
1: Used.

Usually, set this parameter to 0.

The velocity feedback average function has an effect equivalent to that of tandem disturbance elimination control for machines that have a certain rigidity. In general, this function is not used together with tandem disturbance elimination control. When using this function together with tandem disturbance elimination control, set integral gain Ki and proportional gain Kc to 0.

2036	**Proportional gain Kc**

(Set this parameter for the master axis only.)

[Valid data range] 0 to 32767 (0<Kc<0.5)

[Typical setting] 0

This parameter is not used generally, but is used for machines with a large friction. This parameter has the same function as damping compensation gain Kc of the tandem control function. (See Subsec. 5.10.4.1.)

2036	Phase compensation coefficient α

(Set this parameter for the slave axis only.)

[Valid data range] 51 to 512 (0.1< α <1)

[Typical setting] 0 (512 internally)

This parameter has the same function as damping compensation of the tandem control function. When 512 is specified, the advance amount is 0 degree. (See Subsec. 5.10.4.1.)

2325	Integral gain Ki

(Set this parameter for the master axis only.)

[Valid data range] 0 to 4000

This parameter compensates for a machine spring element. Set a large value when the rigidity is high. Set a small value for a motor with a greater torque constant.

2325	Phase compensation coefficient 2T/t

(Set this parameter for the slave axis only.)

[Valid data range] 0 to 32767

[Typical setting] 0 (40 internally)

This parameter is used with coefficient α to compensate the compensation delay. When the resonance frequency is 100 Hz or more, set α = 100 and 2T/t = 6.

2333	Incomplete integral time constant

(Set this parameter for the master axis only.)

[Valid data range] 0 to 32767

[Typical setting] 0 (30877 internally)

As integral gain Ki increases, vibration in the low frequency area (10 Hz or less) may occur. In such a case, set the incomplete integral time constant to decrease the time constant. Set a parameter value listed below.

Table 5.10.1.4 (a) Setting in the incomplete integral time constant parameter (when HRV1, HRV2, HRV3 is used)

Time constant (sec)	Parameter setting
0.1	30887
0.05	29307
0.02	25810

(5) Dynamic switching between whether to enable or disable the tandem disturbance elimination control function

If you want to enable the tandem disturbance elimination control function only when two axes are coupled mechanically, you can use external signal Gn321 (uncoupling flag) to turn the tandem disturbance elimination control function and velocity feedback average function off and on.

You may not want to operate the tandem disturbance elimination control function and velocity feedback average function. For example, for axes along which the workpiece is chucked from both sides, when the workpiece is not chucked, you can set external signal Gn321 to 1 to turn the tandem disturbance elimination control function and velocity feedback average function off.

	#7	#6	#5	#4	#3	#2	#1	#0
2007						SUBDEP		

(Set this parameter for the master axis.)

SUBDEP (#2) The slave axis separation function is:

0: Not used. (The tandem disturbance elimination control function is always enabled regardless of whether G321 is set to 0 or 1.)

1: Used. (When G321 is set to 1, the tandem disturbance elimination control function is turned off.)

	#7	#6	#5	#4	#3	#2	#1	#0
Gn321	SVDI18	SVDI17	SVDI16	SVDI15	SVDI14	SVDI13	SVDI12	SVDI11

(Input this signal for the master and slave axes.)

SVDI1x 1: Uncoupled state

0: Coupled state

The bit position represents the relevant NC axis number. For example, bit 0 represents the first NC axis.

NOTE

The following series and editions of servo software support dynamic switching between whether to enable or disable the tandem disturbance elimination control function:

(30*i*-B Series, Power Motion *i*-A)

Series 90G0/09.0 and subsequent editions

(30*i*-A Series)

Series 90E0/J(10) and subsequent editions,

Series 90E1/01.0 and subsequent editions

Series 90D0/J(10) and subsequent editions

(0*i*-D Series)

Series 90C5/01.0 and subsequent editions,

Series 90E5/01.0 and subsequent editions

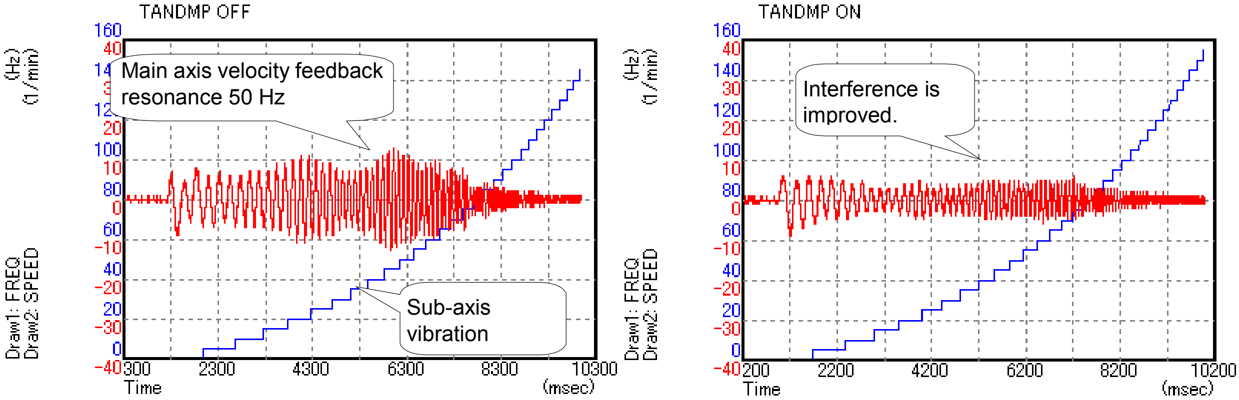
Series 90C8/01.0 and subsequent editions,

Series 90E8/01.0 and subsequent editions

(6) Adjustment method

- Check the torque commands for the master axis and slave axis and velocity feedback vibration by using a Servo Guide. (See Item (7).)
- If the vibration phase is shifted by 180 degrees, the cause of resonance is assumed to be inter-axis interference.
- Enable tandem disturbance elimination control, and adjust integral gain Ki.
- Increase the value of integral gain Ki gradually from 0, and observe vibration. Ki has an optimal value. When the value of Ki is increased excessively, vibration becomes stronger.
- When the velocity loop gain is changed, the frequency of vibration changes. So, adjust Ki to minimize vibration.
- If the frequency of vibration exceeds 100 Hz, the effect of tandem disturbance elimination control decreases. In such a case, set phase compensation coefficients α and 2T/t or increase the current loop gain with the current 1/2 PI control function.

Effect of tandem disturbance elimination control



* Velocity feedback and vibration frequency when the slave axis is vibrated

(7) Method for checking the resonance frequency

With this check, use the disturbance input function for the slave axis, measure the velocity feedback for the master axis, check for interference between the axes, and check and adjust the effect of tandem disturbance elimination control.

The following explains how to use the disturbance input function and how to make settings for data measurement.

(a) Setting parameters related to disturbance input

Parameters related to the disturbance input function are set for the slave axis.

(About the disturbance input function)
The disturbance input function applies vibration to an axis by inputting a sine wave disturbance to the torque command. In the adjustment of tandem disturbance elimination control, this function is used for the slave axis to observe the interference status between the axes when vibration is applied to the slave axis.

For the slave axis, set parameters related to the disturbance input function.

	#7	#6	#5	#4	#3	#2	#1	#0
2270	DSTIN	DSTTAN	DSTWAV					

DSTIN(#7) Disturbance input
0: Stop
1: Start (Disturbance input starts on the rising edge from 0 to 1.)

DSTTAN(#6) Set 0.

DSTWAV(#5) Set 0.

2326	Disturbance input gain

[Setting value] 500

(*) Set the amplitude of the applied vibration (torque). (Value 7282 is equivalent to the maximum current of the amplifier.)
First, set about 500 to apply vibration to the machine so that light sound is generated. If it is difficult to observe the vibration status, increase the parameter value gradually.

2327	Disturbance input function: Start frequency (Hz)

[Setting value] 0

(*) If 0 is set, the default (10 Hz) is assumed to be the vibration start frequency.

2328	Disturbance input end frequency

[Setting value] 0

(*) If 0 is set, the default (200 Hz) is assumed to be the vibration end frequency.

2329	Number of disturbance input measurement points

[Setting value] 0

(*) If 0 is set, the default (3) is assumed as the number of disturbance input measurement points.

[Cautions]
1 Disable the functions that operate only in the stop state, such as the variable proportional gain function in the stop state and the overshoot compensation function.
2 When characteristics at the time of cutting are measured, cutting/rapid switching functions should be treated carefully.
3 Decrease the position gain to about 1000.

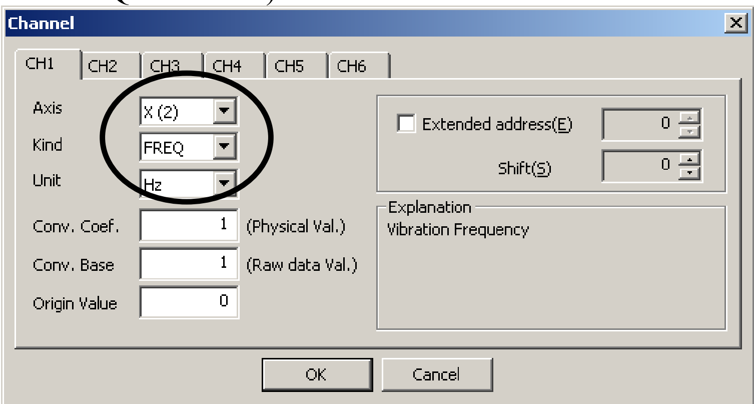
(b) Channel setting with SERVO GUIDE

With SERVO GUIDE, make settings for data acquisition.
Two types of data including disturbance frequency data (the slave axis) and velocity feedback data (the master axis) are acquired at the same time.

From the graph window menu of SERVO GUIDE, select [Setting] then [Channel].

Channel 1: Disturbance frequency

- Specify the slave axis as the axis, and set the data type to "FREQ". (The other items are automatically set when FREQ is selected.)



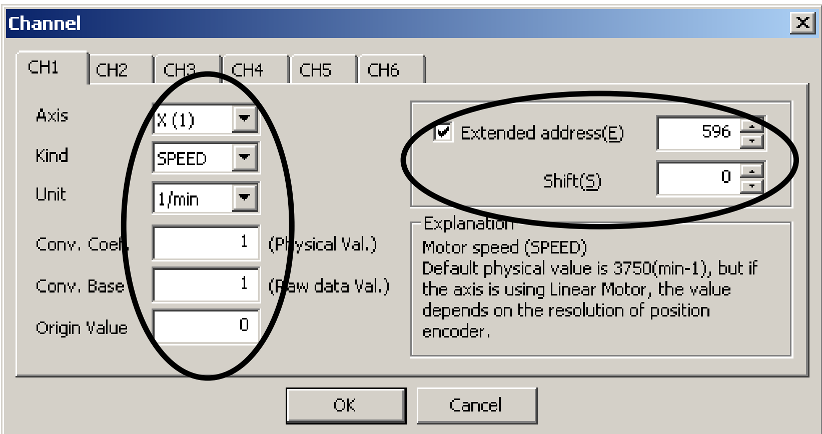
Channel 2: Master axis velocity feedback

- Specify the master axis as the axis, and set the data type to "SPEED".
- Set the conversion coefficient to 1, and set the conversion base data to 1.
- Check the check box of the extended address, and set an address as listed in the table below. (The setting varies depending on the value set in parameter No. 1023.)

Set the shift amount to 0 for Series 90Dx, 90Ex, and 90Cx or to -5 for Series 90Gx.

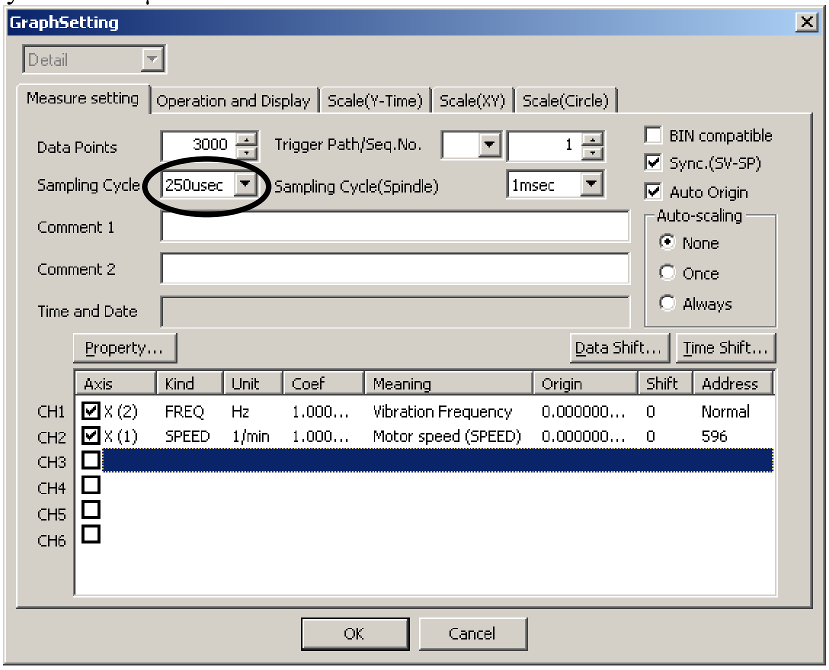
No.1023 (n:0,1,2,..)	4n+1	4n+2	4n+3	4n+4
Series 90D0,C5,C8	596	724	-	-
Series 90E0,E1,E5,E8	596	724	6740	6868

No.1023 (n:0,1,2,..)	8n+1	8n+2	8n+3	8n+4	8n+5	8n+6
Series 90G0	5888	9984	14080	18176	22272	26368



(c) Setting for sampling

Set the sampling cycle to 250 μs.



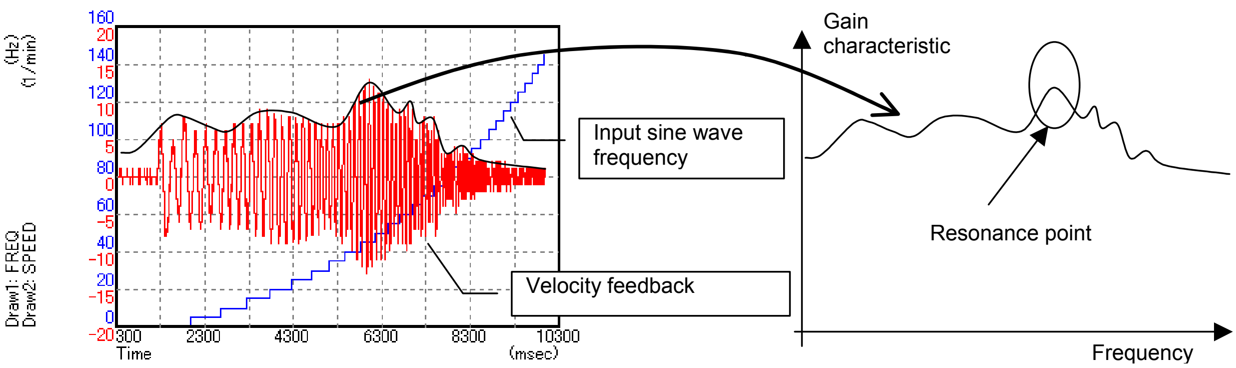
(d) Usage

When the rising edge of the disturbance input bit (**DSTIN**) is detected, application of vibration is started. Vibration is automatically stopped after a sine sweep is performed from the start frequency to the end frequency. The operation is stopped by a reset or an emergency stop. After the emergency stop is released, disturbance input is resumed starting with the start frequency by setting the function bit off then on again.

[Example of setting]

No.2326 = 500 → Gain = 500
No.2327 = 0 → Start frequency = 10Hz
No.2328 = 0 → End frequency = 200Hz
No.2329 = 0 → Number of measurement points = 3

By using SERVO GUIDE, obtain data, and display the frequency (ch1) and velocity feedback (ch2) in the XY-YT mode.



As shown in the above waveform, the envelope of the velocity feedback indicates the gain characteristic at each frequency, and a swell portion in the waveform shows a resonance point.

Adjust the tandem disturbance elimination control parameters so that the degree of the gain swell at the resonance point is reduced.

5.10.1.5 Synchronous axes automatic compensation

(1) Overview

With synchronized axes having a long stroke, a machine twist may occur due to the absolute precision of the scale and thermal expansion of the machine. In such a case, the master motor and slave motor of the synchronized axes pull each other, and if a large current flows for the pull, an overheat problem or OVC alarm is raised.

The fundamental cause of this is a measurement position error. Pitch error compensation can compensate for the scale error but cannot compensate for thermal expansion due to change in temperature.

The synchronous axes automatic compensation function is useful for such cases. The function monitors a torque error between the master and slave and corrects the position on the slave side slowly to reduce the torque error.

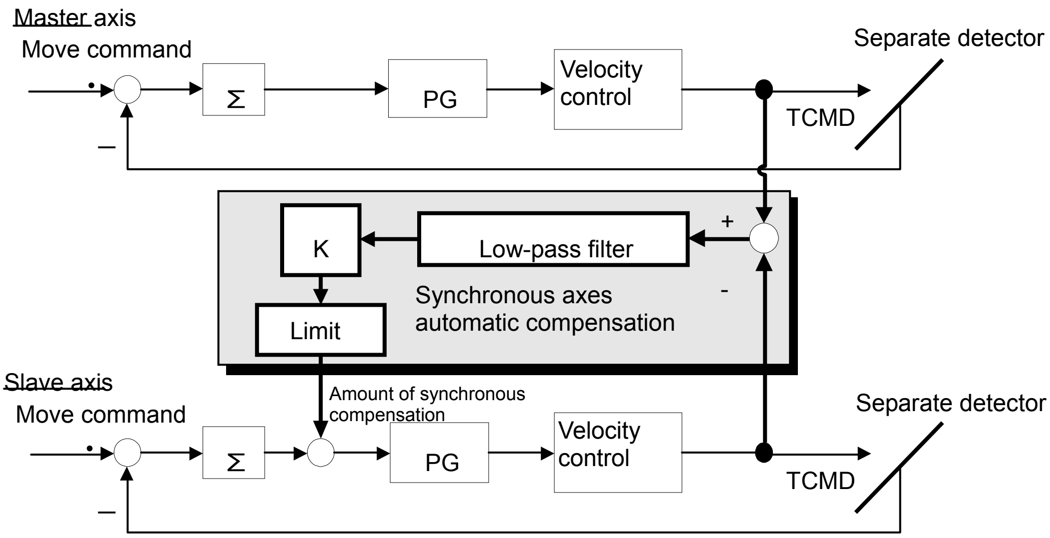


Fig. 5.10.1.5 (a) Configuration of the synchronous axes automatic compensation function

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	N(14) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	N(14) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

- Supporting the coupling signal and preset function
  (Series 30*i*/31*i*/32*i*-A)
  Series 90E0/30.0 and subsequent editions
  Series 90E1/05.0 and subsequent editions
  * Series 0*i*-D does not support them.
- Supporting the compensation amount hold function
  (Series 30*i*/31*i*/32*i*-A)
  Series 90E0/U(21) and subsequent editions

Series 90E1/01.0 and subsequent editions
* Series 0*i*-D does not support them.

> **NOTE**
> This function cannot be used together with servo HRV4 control.

(3) Setting parameters

- The following parameters are all set for the slave axis (the axis for which an even number is set in parameter No. 1023) only.

	#7	#6	#5	#4	#3	#2	#1	#0
2275					ASYN			

ASYN (#3) Synchronous axes automatic compensation function is:
0: Disabled.
1: Enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2221	ASYCS							

(Power-off parameter)

ASYCS(#7) The use of the coupling signal for the synchronous axes automatic compensation function is:
0: Disabled.
1: Enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2289								SYNDI

SYNDI(#0) The function for holding the compensation amount in synchronous axes automatic compensation is:
0: Not used.
1: Used.

The function for holding the compensation amount in synchronous axes automatic compensation temporarily stops the update of the compensation amount according to DI signal Gn325. When Gn325 is set to 1, this function stops the update of the compensation amount.

2121	Synchronous axes automatic compensation: Preset

[Unit of data] Detection unit
[Valid data range] 0 to 5000
* Use this parameter to input the initial compensation amount.
* If an excessive large value is input, the machine may move by a large extent at power-on. Set a smaller value.
* If the power is turned off while the synchronous axes automatic compensation function is being used, the compensation amount is reset to 0. After power-on, the servo software reads the value of parameter No. 2121, which sets the value as the compensation amount of the synchronous axes automatic compensation function. The setting is valid only when bit 7 of parameter No. 2221 is set to 1.
* Before the value of parameter No. 2121 is rewritten from the PMC, make sure that movement along all axes stops.

2403	Synchronous axes automatic compensation coefficient (K)

[Unit of data] Detection unit / TCMD unit × 4096 (TCMD unit: 7282 with the maximum current value of the amplifier)
[Valid data range] -32767 to 32767

From the relationship between the current value generated in the stopped state when this function is disabled and the position error between the synchronized axes, determine the coefficient (K) according to the following expression:

K = position error/current value (in TCMD) × 4096 .... <1>

When the current value is measured on the servo tuning screen, the current value is indicated in amperes or as the percentage to the rated current value. So, use expression <2> or <3> for calculation.

K = position error/{current value (%) × Ir × 7282/6554} × 4096 .... <2>

Ir: Rated current in parameter No. 2086

K = position error/{current value (A)/Amax × 7282} × 4096 .... <3>

Amax: Maximum current value of the amplifier

Measure the current value when the problem of a pull is being observed at the release of emergency stop. The position error between the synchronized axes is obtained from the difference in position error between the master axis and slave axis at the time of emergency stop. Normally, the position error of the master axis at the time of emergency stop is 0, so you need to check the position error of the slave axis only.

Example)

Suppose that the position error of the slave at the time of emergency stop is 200, the current value at the release of emergency stop is 60% (the percentage to the rating), and 1437 is set in parameter No. 2086 (rated current value):

Settings = 200 / { 1437 × 60/100 × 7282/6554 } × 4096 = 855

2404	Synchronous axes automatic compensation: Maximum compensation

[Unit of data] Detection unit
[Valid data range] 0 to 5000

Set the maximum compensation amount in synchronous axes automatic compensation.

2405	Synchronous axes automatic compensation: Filter time constant

[Unit of data] sec
[Valid data range] 0 to 10
[Typical setting] 0 (When a value of 0 is set, 1 second is assumed.)

Set the time constant for reflecting the twist in position compensation. As a larger time constant is set, compensation to release the twist is performed more slowly.

NOTE

1. This function reduces the difference in torque between the master and slave axes by adding compensation pulses to the slave axis. In the steady state, position error equivalent to the compensation amount is accumulated in the slave axis.
2. This function cannot be used together with the dual position feedback function.
3. Set parameters on the even-numbered axis side.
4. When assigning (No.1023) servo axes to the synchronous master and slave axes, ensure that an odd-numbered axis is assigned to the master axis, and an even-numbered axis ((master axis) + 1) is assigned to the slave axis.

Set the following parameter for the odd-numbered axis side (the master axis) only:

2404	Synchronous axes automatic compensation: Dead-band width

[Unit of data] % unit 100% is equivalent to the rated current.
[Valid data range] 0 to 800

If the difference in torque between the master axis and slave axis is within the dead-band width, the synchronous axes automatic compensation amount becomes 0.

(4) Signal

- SVDI1n : Coupling signal

	#7	#6	#5	#4	#3	#2	#1	#0
Gn321	SVDI18	SVDI17	SVDI16	SVDI15	SVDI14	SVDI13	SVDI12	SVDI11

[Classification] Input signal

[Function] This signal is used to disable the functions acting between synchronous axes when the mechanical coupling of the synchronous axes normally driven in the coupled state is temporarily released.
This signal is available also for the tandem disturbance elimination control, velocity feedback average function, and velocity loop integrator copy function.

[Operation] 0 : Coupled state (The functions for synchronization control are turned on.)
1 : Uncoupled state (The functions for synchronization control are turned off.)

- SVDI5n : Signal for holding the compensation amount in synchronous axes automatic compensation

	#7	#6	#5	#4	#3	#2	#1	#0
Gn325	SVDI58	SVDI57	SVDI56	SVDI55	SVDI54	SVDI53	SVDI52	SVDI51

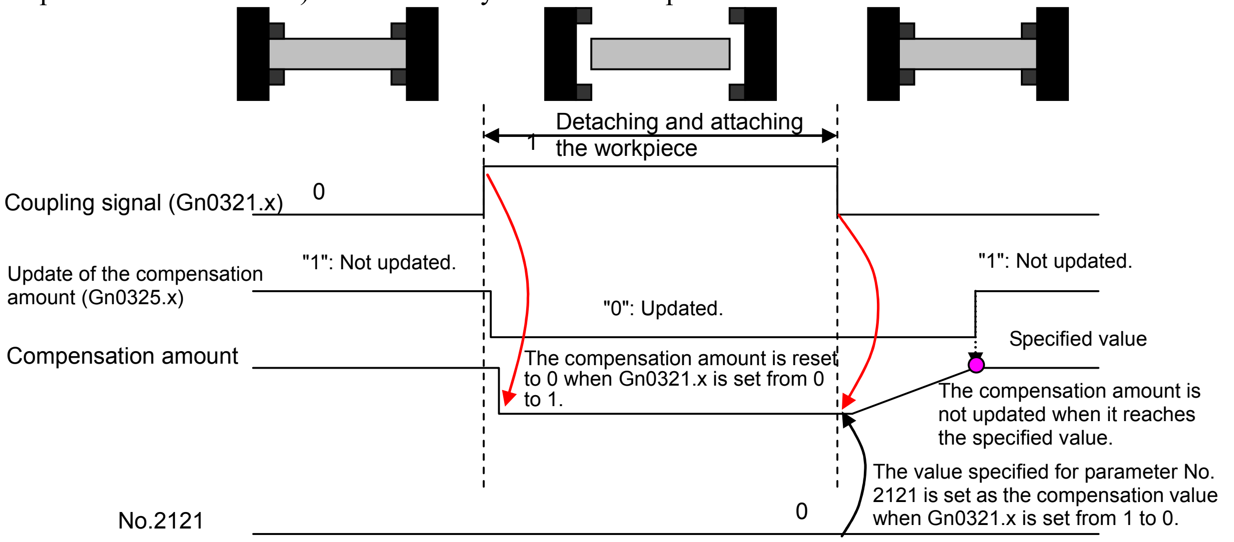
[Classification] Input signal

[Function] This signal is used to request the stop of the update of the synchronization compensation amount.

[Operation] When the function for holding the synchronization compensation amount (bit 0 of parameter No. 2289) is used, setting this signal to "1" stops the update of the synchronization compensation amount.

(4-1)Timing chart

Operation performed when the workpiece is attached and detached (resetting the synchronization compensation amount to 0) * Enabled only when bit 7 of parameter No. 2221 is set to 1.



(5) Application example

The figure below shows how synchronous axes automatic compensation works effectively.
When the master axis and slave axis, which are synchronized axes coupled mechanically, indicate different positions as position B, the master axis and slave axes pull each other, and their TCMD waveforms increase in the opposite directions.
Use of this function allows the position of the slave axis to move slowly to such a position that is balanced with the master axis position, so the problem that the axes pull each other does not occu

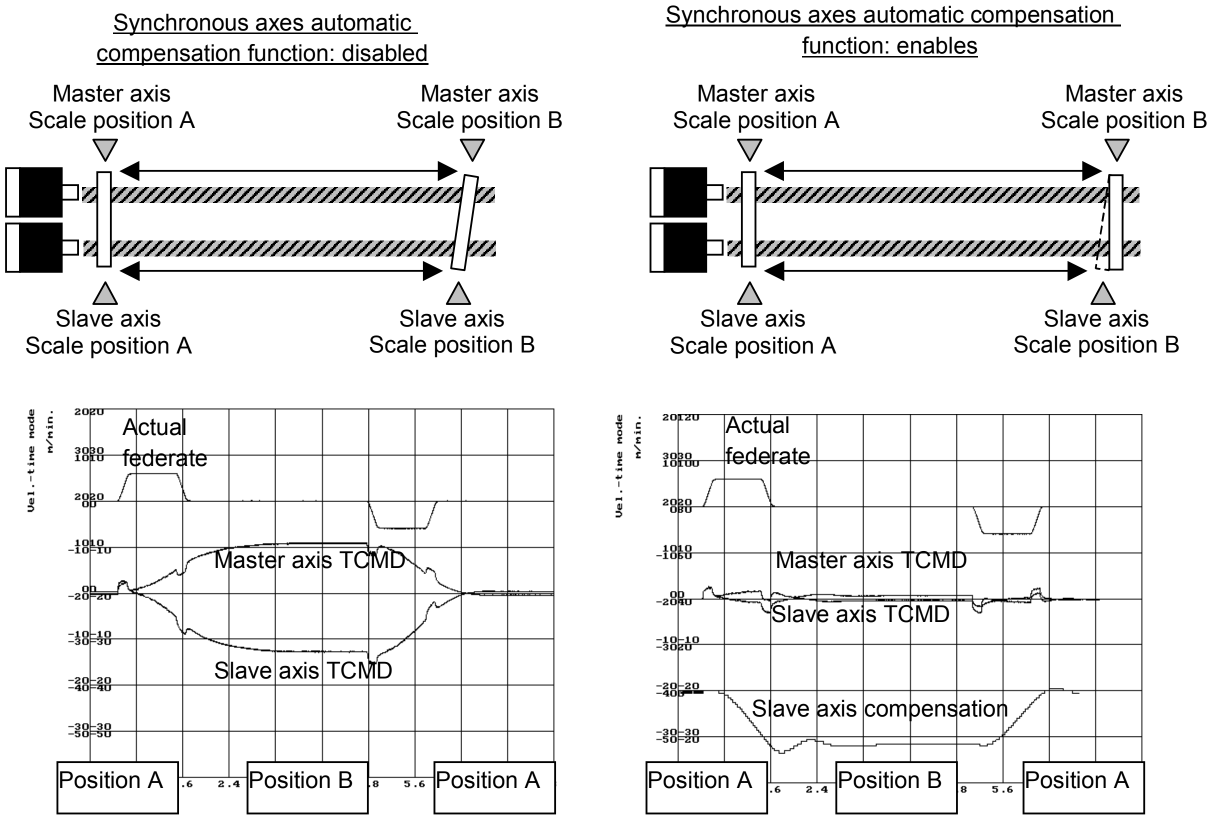

Synchronous axes automatic compensation function: disabled
Master axis Scale position A
Master axis Scale position B
Slave axis Scale position A
Slave axis Scale position B
Actual federate
Master axis TCMD
Slave axis TCMD
Position A
Position B
Position A
Synchronous axes automatic compensation function: enables
Master axis Scale position A
Master axis Scale position B
Slave axis Scale position A
Slave axis Scale position B
Actual federate
Master axis TCMD
Slave axis TCMD
Slave axis compensation
Position A
Position B
Position A

Fig. 5.10.1.5 (b)

5.10.1.6 Functions for sharing a separate detector

If a feedback cable cannot be divided into two as in the case of a serial cable, the following methods are available for sharing one separate position feedback by the main axis and sub-axis.

30*i*-A Series, 0*i*-D Series	(1) Method for using the full-closed feedback sharing function
30*i*-B Series	(2) Method for setting the FSSB

(1) Method for using the full-closed feedback sharing function

	#7	#6	#5	#4	#3	#2	#1	#0
2200							**FULLCP**	

(To be set for the slave axis only)

FULLCP(#1) 1: A separate position feedback is shared by the master and slave axes.

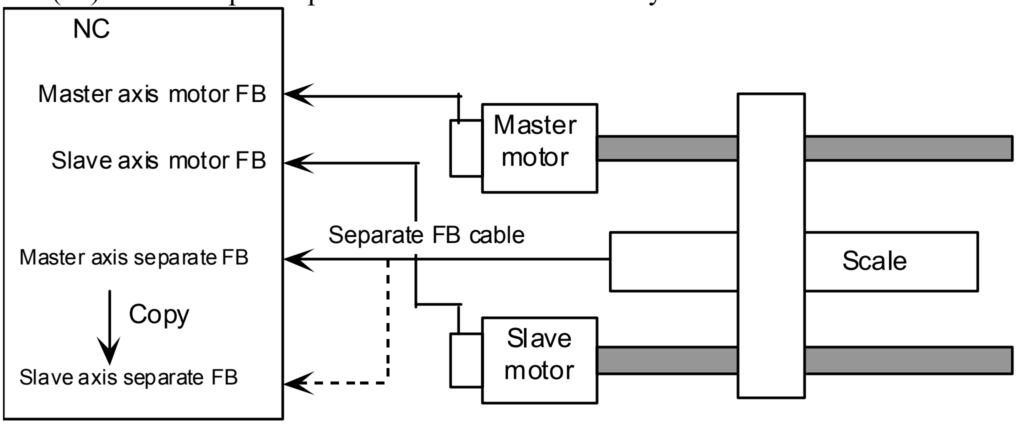


Fig. 5.10.1.6 (a) Full-closed feedback sharing function

<Setting method>

<1> Set bit 1 of parameter No. 2200 to 1 for the slave axis.

<2> Set bit 1 of parameter No. 1815 to 1 and make FSSB setting related to the separate detector for both the master and slave axes. Set the number of the connector to which the separate detector is actually connected for the master axis and the number of an unused connector to which no detector is connected for the slave axis.

(2) Method for setting the FSSB

	#7	#6	#5	#4	#3	#2	#1	#0
14476			**SSC**					

SSC (#5) One connector on the separate detector interface unit is:
0: Not shared between multiple axes.
1: Shared between multiple axes.

	#7	#6	#5	#4	#3	#2	#1	#0
1902								**FMD**

FMD The FSSB setting is made in:
1: Manual setting mode (manual setting 2 mode)
0: Automatic setting mode

24096 (FS30*i*-B)	**Connector number for the first separate detector interface unit (1 to 8)**

24097 (FS30*i*-B)	**Connector number for the second separate detector interface unit (1 to 8)**

24098 (FS30*i*-B)	**Connector number for the third separate detector interface unit (1 to 8)**

24099 (FS30*i*-B)	**Connector number for the fourth separate detector interface unit (1 to 8)**

24104 (FS30*i*-B) to 24111 (FS30*i*-B)	**ATR value corresponding to connector number i on the first separate detector interface unit (No.1023 + 1000)**

24112 (FS30*i*-B) to 24119 (FS30*i*-B)	**ATR value corresponding to connector number i on the second separate detector interface unit (No.1023 + 1000)**

24120 (FS30*i*-B) to 24127 (FS30*i*-B)	**ATR value corresponding to connector number i on the third separate detector interface unit (No.1023 + 1000)**

24128 (FS30*i*-B) to 24135 (FS30*i*-B)	**ATR value corresponding to connector number i on the fourth separate detector interface unit (No.1023 + 1000)**

<Setting method>

<1> Set bit 0 of parameter No. 1902 to 1 and bit 5 of parameter No. 14476 to 1.

<2> Set the same connector numbers for the axes sharing the separate detector. (No.24096, No.24097, No.24098, No.24099)

<3> Set the value of (value of parameter No. 1023 for the axis referencing the connector + 1000) for the ATR value corresponding to the separate detector interface connector number (parameters Nos. 24104 to 24135).

Only one axis can be set for the parameter at a time. So, when multiple axes reference a connector, set the parameter as many times as the number of reference axes. For details, see the example of setting.

<Example of setting>

[Configuration]

SDU (First unit)

First connector - Separate detector

Second connector - Blank

Third connector - Blank

Fourth connector - Blank

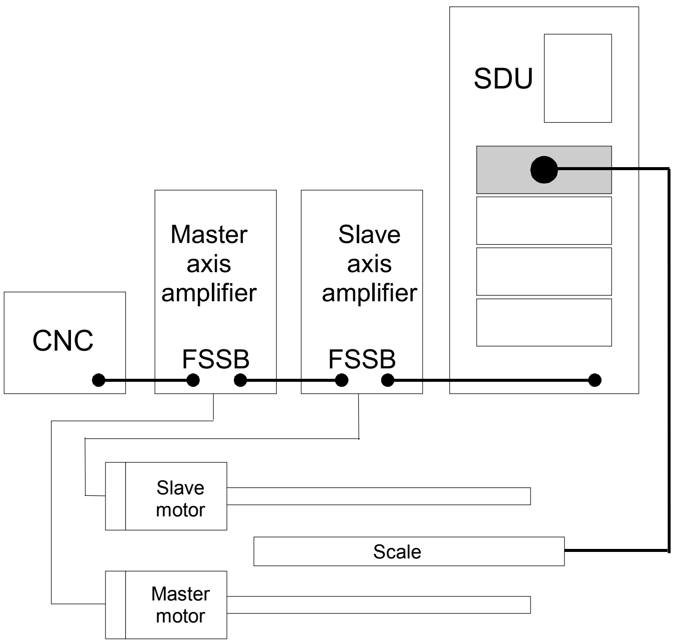


Fig. 5.10.1.6 (b) Example of SDU connection

[Setting]

No.1902#0=1, No.14476#5=1

Set 1 for parameter No. 24096 for each axis referencing the separate detector.

Set the value set for parameter No. 1023 for the first axis referencing the separate detector + 1000 for parameter No. 24104.

Set the value set for parameter No. 1023 for the second axis referencing the separate detector + 1000 for parameter No. 24105.
Parameters Nos. 24106 and after =1000

5.10.1.7 Examples of position tandem setting

This subsection gives examples of parameter setting.

(1) Full-closed loop system using a 1-μm increment system, a scale detection unit of 0.5 μm/P, a linear scale resolution of 0.1 μm/P, a distance to move per motor revolution of the ball screw of 10 mm, 100000 P per motor revolution for scale feedback, and an αi A1000 Pulsecoder (when the full-closed feedback sharing function is enabled)

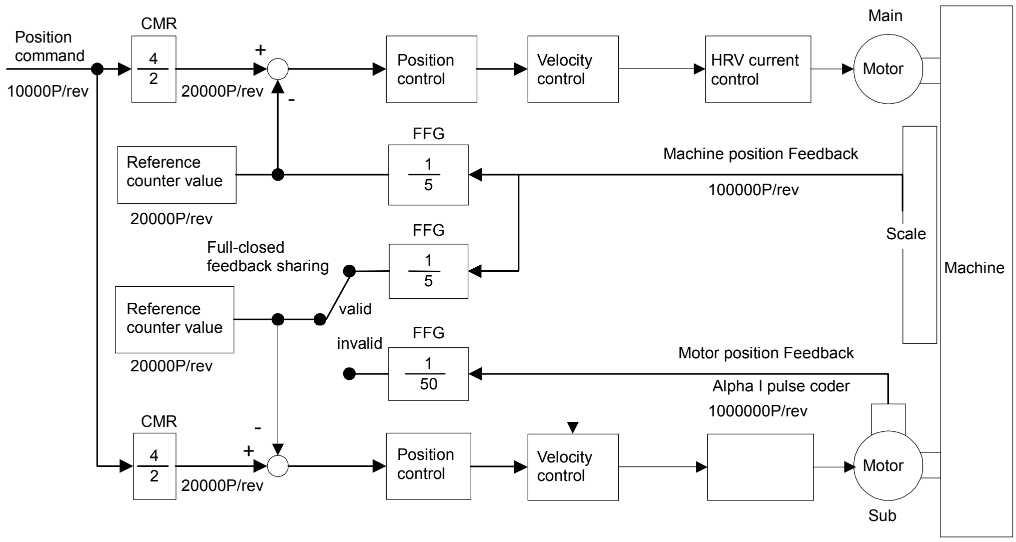


Fig. 5.10.1.7 (a) Example of position tandem setting <1>

		Main	Sub
• Full-closed	No.1815#1	1	0
• Full-closed loop feedback sharing function	No.2200#1	0	1
• CMR	No.1820	4	4
• Reference counter capacity	No.1821	20000	20000
• High-resolution Pulsecoder	No.2000#0	0	0
• Number of velocity pulse	No.2023	8192	8192
• Number of position pulse	No.2024	25000	25000
• Position pulse conversion coefficient	No.2185	4	4
• Flexible feed gear	No.2084	1	1
• Flexible feed gear	No.2085	5	5

(2) Full-closed loop system using a 1-μm increment system, a scale detection unit of 0.5 μm/P, a linear scale detection unit of 0.1 μm/P, a distance to move per motor revolution of the ball screw of 10 mm, 100000 P per motor revolution for scale feedback, an αi A1000 Pulsecoder, an αiSV80 servo amplifier, a torque constant of 0.72Nm/Arms, and a preload torque of 5 Nm (when the full-closed feedback sharing function, velocity loop integrator copy function, and preload function are enabled) For details of the calculation of the preload value, see Subsection 5.10.1.2, "Preload function".

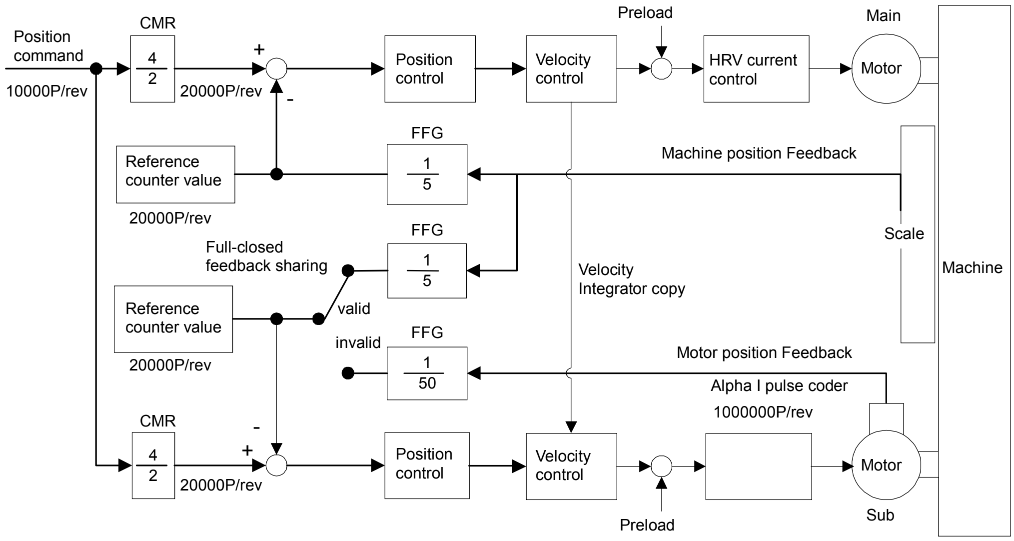


Fig. 5.10.1.7 (b) Example of position tandem setting <2>

.

		Main	Sub
• Full-closed	No.1815#1	1	0
• Full-closed loop feedback sharing function	No.2200#1	0	1
• Velocity loop integrator copy function	No.2273#1	1	1
• CMR	No.1820	4	4
• Reference counter capacity	No.1821	20000	20000
• High-resolution Pulsecoder	No.2000#0	0	0
• Number of velocity pulse	No.2023	8192	8192
• Number of position pulse	No.2024	25000	25000
• Position pulse conversion coefficient	No.2185	4	4
• Flexible feed gear	No.2084	1	1
• Flexible feed gear	No.2085	5	5
• Preload value	No.2087	894	-894

5.10.2 Multiaxis Tandem

(1) Overview

The following methods are available for controlling one axis with two motors: feed axis synchronization control (position tandem control) and torque tandem control. Feed axis synchronization control gives the same command to the master axis and multiple slave axes to control the position. The positions of the master and slave axes are controlled separately. On the other hand, in torque tandem control, the position is controlled only for the main axis*1. Only the torque is controlled for the sub *1 axes.
When two or more motors are used for controlling an axis, the multiaxis tandem function is used together with feed axis synchronization control and torque tandem control as shown in the examples below.

*1) When feed axis synchronization control and torque tandem control are used together, to make a distinction between them, the terms master and slave axes are used for the former, while main and sub axes are used for the latter.

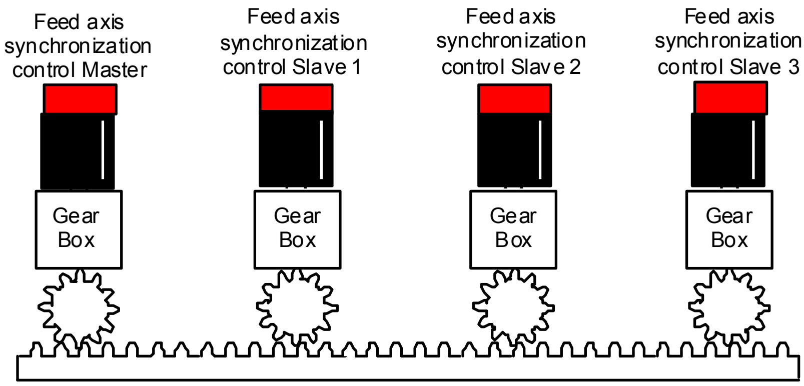


Fig. 5.10.2 (a) Example of four-axis control (feed axis synchronization control for four axes)

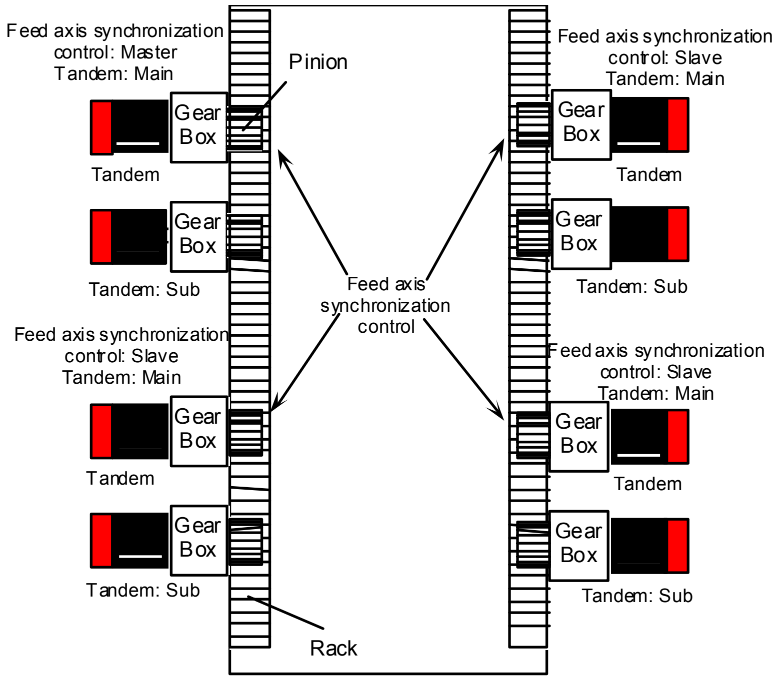


Fig. 5.10.2 (b) Example of eight-axis control (tandem control for four axes and synchronization control for four axes)

The multiaxis tandem function can also be used together with feed axis synchronization control with large motors driven by two amplifiers (two-winding motors: α*i*S300/2000, α*i*S500/2000, and α*i*S1000/2000HV) and those driven by four amplifiers (four-winding motors: α*i*S2000/2000HV and α*i*S3000/2000HV).

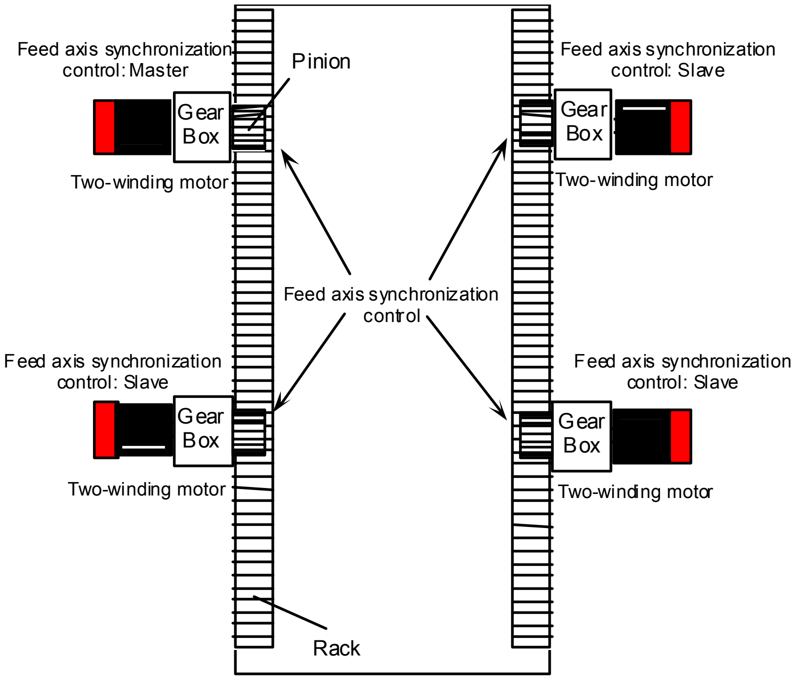


Fig. 5.10.2 (c) Example of using eight NC axes (four motors with two windings and feed axis synchronization control for four axes)

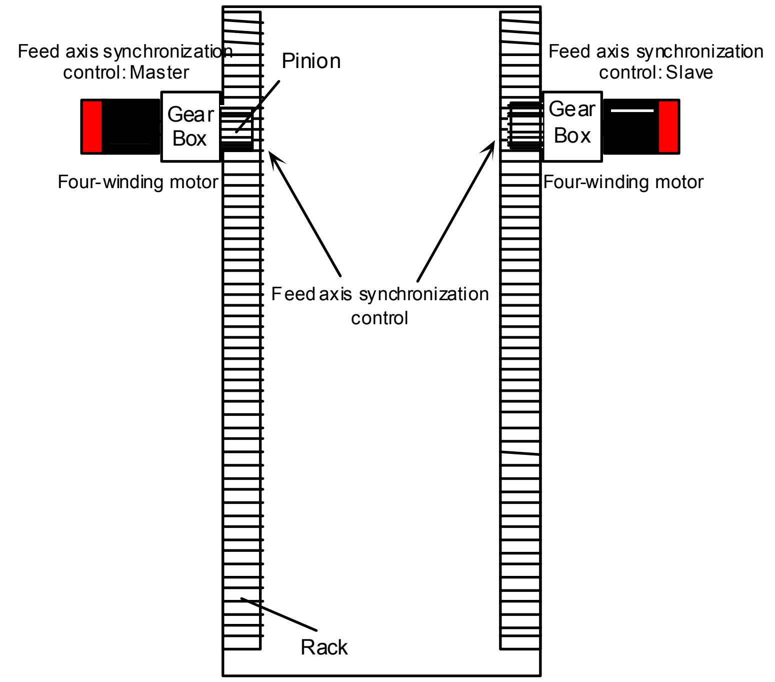


Fig. 5.10.2 (d) Example of using eight NC axes (two motors with four windings and feed axis synchronization control for two axes)

The multiaxis tandem function enables the velocity loop integrator of the master axis to be copied to two or more slave axes.

When two motors are driven in synchronization, if the rigidity between synchronous axes is high, interference occurs due to a slight difference in the stop position, which may generate torque offset. (An OVC alarm may occur at worst.) To avoid this problem, the velocity loop integrator of the master axis can be copied to the velocity loop integrator of the slave axis to suppress interference between the axes.
A similar problem might occur when a four-axis motor is driven in synchronization or when two pairs of two axes in tandem control are driven in synchronization. To avoid this problem, a function has been added which copies the velocity loop integrator of one of the four axes to the velocity loop integrators of the other axes. (This function is an extension of the conventional velocity loop integrator copy function for two axes that is available for up to four axes.)

Form <1>

One of four axes under feed axis synchronization control is set as the master axis and the integrator of the master axis is copied to the other three axes. (See Fig. 5.10.2 (a))

Form <2>

The integrator is copied between main axes in tandem control for four pairs of tandem control axes. (See Fig. 5.10.2 (b))

Form <3>

There are four motors with two windings. One of the motors with two windings occupies two axes. The torque is copied between the axes. The motor with two windings is used for feed axis synchronization control for the four motors and the integrator is copied between the axes. (See Fig. 5.10.2 (c))

Form <4>

There are two motors with four windings. One of the motors with four windings occupies four axes. The torque is copied among the axes. The motor with four windings is used for feed axis synchronization control for the two motors and the integrator is copied between the axes. (See Fig. 5.10.2 (d))

The same applies when four linear motors are used instead of a motor with four windings.

The multiaxis tandem function can be used together with the simultaneous monitor function to monitor three or more axes simultaneously and stops movement along all axes immediately if a servo alarm occurs or at emergency stop. With this function, the conventional quick stop function and lifting function against gravity can be made available for tandem control for three or more axes.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	U(21) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5 90C8	- -	
	90E5 90E8	- -	

NOTE

This function cannot be used together with HRV4 control.

(3) Setting parameters

* In this manual, servo axes are called the axis names respectively according to the setting of parameter No. 1023 for convenience.

	30*i*-A	30*i*-B
No.1023	=4n+1 : 1 axis	=8n+1 : 1 axis
	=4n+2 : 2 axes	=8n+2 : 2 axes
	=4n+3 : 3 axes	=8n+3 : 3 axes
	=4n+4 : 4 axes	=8n+4 : 4 axes
		=8n+5 : 5 axes
		=8n+6 : 6 axes

<1> Setting for using the integrator copy function for four axes

	#7	#6	#5	#4	#3	#2	#1	#0
2223		SLTMAS	SLTAN					

(Set this parameter for all of the master and slave axes.) (Power-off parameter)

SLTAN (#5) 1: The multiaxis tandem function is enabled.

* When this parameter is changed, it is necessary to turn the power to the CNC off.

* When this parameter is set to 1, the simultaneous monitor function and integrator copy function are enabled for three or more axes.
Axis 1 is used as the master of the integrator copy function.
If you want to use the conventional integrator copy function for two axes, set this bit to 0.

It is necessary to set SLTAN = 1 for all axes in the configuration when:

- The integrator copy function is used for three or more axes.

(Power-off parameter)

SLTMAS (#6) 0: Slave axis of multiaxis tandem

1: Master axis of multiaxis tandem

* When this parameter is changed, it is necessary to turn the power to the CNC off.

* Set this parameter to 1 only for the master axis. Only axis 1 on each DSP can be set as the master axis. If an axis other than axis 1 is set as the master axis, an invalid parameter alarm occurs.

	#7	#6	#5	#4	#3	#2	#1	#0
2273							WSVCP	

WSCCP (#1) 1: The velocity loop integrator of the master axis is copied to the slave axes.
(Set 1 for the axes sharing the velocity loop integrator.)

* This parameter can be used together with SLTAN to enable the velocity loop integrator copy function for three or more axes.

* Set this parameter to 1 only for the axes sharing the integrator. (The configuration does not contain the sub axis of torque tandem.)

* When SLTAN is set to 0, the velocity loop integrator copy function for two axes is used.

	#7	#6	#5	#4	#3	#2	#1	#0
2211	PLW4	PLW2						

(Set this parameter for all of the main and sub axes.) (Power-off parameter)

PLW4 (#7) 1: A motor with four windings is enabled.

* When this parameter is changed, it is necessary to turn the power to the CNC off.

* When this parameter is set to 1, the following functions are enabled:

- Torque copy for four axes
- Position feedback sharing for four axes

* To use this parameter, the tandem control option is necessary. With the Series 30i-B or later, this parameter can be used without the feed axis synchronization control option (tandem control option).

(Set this parameter for the main and sub axes.) (Power-off parameter)

PLW2 (#6) 1: A motor with two windings is enabled.

* When this parameter is changed, it is necessary to turn the power to the CNC off.

* When this parameter is set to 1, the following functions are enabled:

- Torque copy for two axes
- Position feedback sharing for two axes

* To use this parameter, the tandem control option is necessary. With the Series 30i-B or later, this parameter can be used without the feed axis synchronization control option (tandem control option).

For details of parameter setting for a motor with plural windings, see Subsection 2.2.2, "Parameter Setting for the Four-Winding and Two-Winding Modes".

<2> Setting for using velocity tandem

	#7	#6	#5	#4	#3	#2	#1	#0
2008			VCMDTM				TANDEM	

(Set this parameter for the master axis.)

VCMDTM(#5) 1: Velocity tandem control is enabled.

* Use this parameter for an axis for which tandem control (option) is enabled.

* Feed axis synchronization control is recommended rather than this function.

<3> Setting for using the servo alarm monitor function for four axes

	#7	#6	#5	#4	#3	#2	#1	#0
2007								ESP2AX

ESP2AX (#0) 1: The servo alarm multiaxis monitor function is enabled.

* When SLTAN is set to 0, the servo alarm two-axis monitor function is used.

* When this parameter is used together with SLTAN, the servo alarm four-axis monitor function is enabled.

<4> Setting for applying a preload for more than two axes

	#7	#6	#5	#4	#3	#2	#1	#0
2417				TIMCAL		TIMPR2		

TIMCAL (#4) Preload time constant calculation is:

0 : Not performed. That is, the time constant is 0. (Conventional specification)

1 : Performed.

* This function reduces a mechanical shock because a preload multiplied by a time constant is applied at the activation of the motor. For the time constant, see the description of TIMPR2 below.

TIMPR2 (#2) The exponential time constant of the preload function is:

0 : Reciprocal number of the position gain (1/s).

1 : Four times of the reciprocal number of the position gain (1/s).

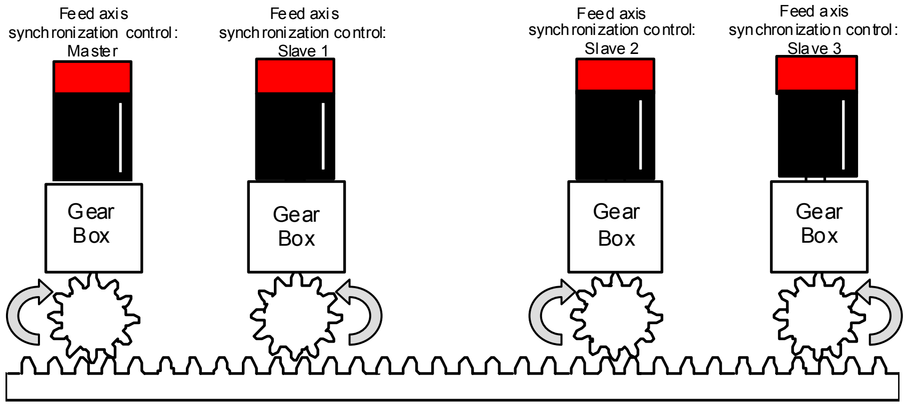
2087	Preload value (PRLOAD)

A torque offset can be added to the master and slave tandem axes in opposite directions to reduce the backlash between axes.

If you want to a preload value for more than two axes, set preload values so that the total value is 0.

For details of the preload function, see Subsection 5.10.1.2 "Preload function".

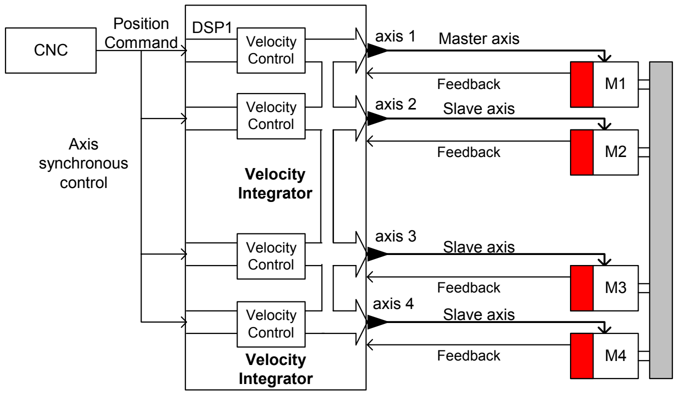
[Example of setting 1] Four axes are used. Tension is produced between two axes, and between pairs of two axes.



Axis No.	Arrange-ment No.1023	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Preload No.2087	Remarks
1	1	1	1	1	+600	Master of feed axis synchronization
2	2	1	0	1	-300	Slave of axis 1
3	3	1	0	1	+300	Slave of axis 1
4	4	1	0	1	-600	Slave of axis 1

(4) Example of parameter setting

(4-1) Driving four axes with feed axis synchronization control and using the integrator copy function for the four axes (Form <1>)

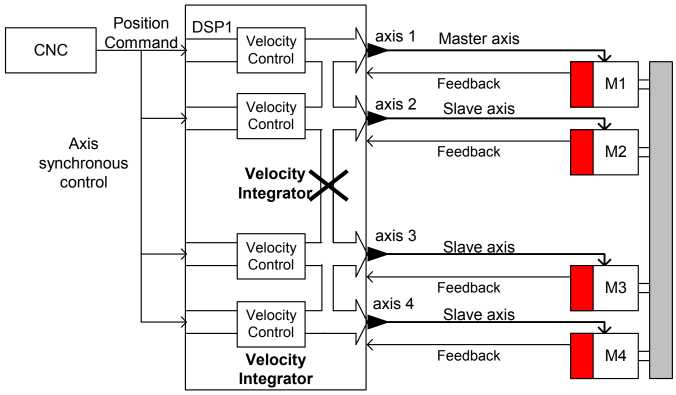


Axis No.	Arrange-ment No.1023	Tandem No.1817#6	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Multiaxis monitor No.2007#0	Remarks
1	1	0	1	1	1	1	Master of feed axis synchronization
2	2	0	1	0	1	1	Slave of axis 1
3	3	0	1	0	1	1	Slave of axis 1
4	4	0	1	0	1	1	Slave of axis 1

*1) Set feed axis synchronization control for axes 1 to 4.

*2) To use the alarm multiaxis monitor function for axes 1 to 4, set bit 5 of parameter No. 2223 (multiaxis tandem) to 1 and bit 0 of parameter No. 2007 (multiaxis monitor) to 1.

(4-2) Driving four axes with feed axis synchronization control and copying the integrator between axes 1 and 2 and that between axes 3 and 4 (Form <1>)



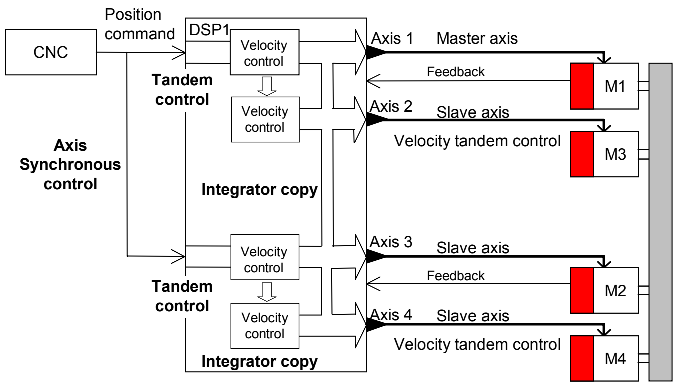
Axis No.	Arrange-ment No.1023	Tandem No.1817#6	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Multiaxis monitor No.2007#0	Remarks
1	1	0	1	1	1	1	Master of feed axis synchronization
2	2	0	0	0	1	1	Slave of axis 1
3	3	0	1	0	0*2	1	Slave of axis 1
4	4	0	0	0	1	1	Slave of axis 1

*1) Set feed axis synchronization control for axes 1 to 4.

*2) Set bit 1 of parameter No. 2273 to 0 for axis 3 (3) so that the integrator of axis 1 is not copied to axis 3.

*3) To use the alarm multiaxis monitor function for axes 1 to 4, set bit 0 of parameter No. 2007 (multiaxis monitor) to 1 and bit 5 of parameter No. 2223 (multiaxis tandem) to 1 for axes 1 and 3.

(4-3) Driving two axes with feed axis synchronization control, setting tandem control (velocity tandem) for the two axes under feed axis synchronization control, and copying the integrator between the axes under feed axis synchronization control (Form <2>)

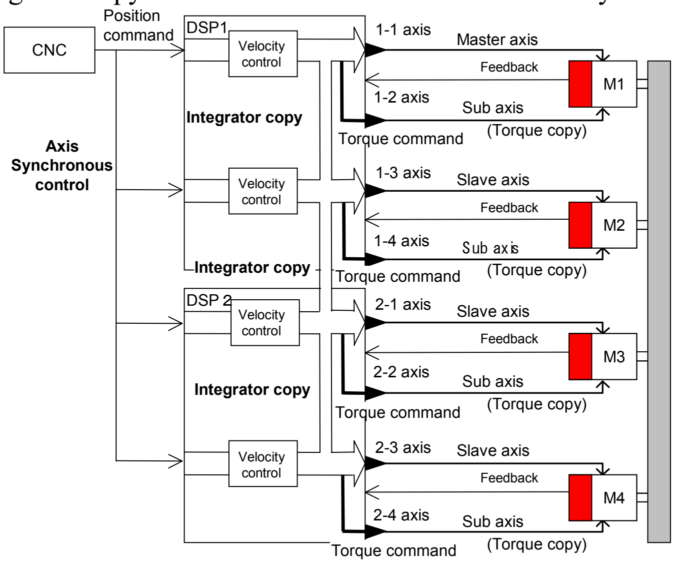


Axis No.	Arrange-ment No.1023	Tandem No.1817#6	Velocity tandem No.2008#5	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Remarks
1	1	1	1	1	1	1	Master of feed axis synchronization (Main of tandem pair 1)
2	3	1	1	1	0	1	Slave of axis 1 (Main of tandem pair 2)
3	2	1	0	1	0	1	Sub of tandem pair 1
4	4	1	0	1	0	1	Sub of tandem pair 2

*1) Tandem control (velocity tandem) is set for axes 1 and 3, and axes 2 and 4.

*2) Set feed axis synchronization control for axes 1 and 2.

(4-4) Driving four motors with two windings, setting four-axis feed axis synchronization control, and using the integrator copy function for the axes under feed axis synchronization control (Form <3>)



Axis No.	Arrange-ment No.1023	Tandem No.1817#6	Position FB copy No.2018#7	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Remarks
1	1 (1-1)	1	0	1	1	1	Master of feed axis synchronization (Main of tandem pair 1)
2	3 (1-3)	1	0	1	0	1	Slave of axis 1 (Main of tandem pair 2)
3	5 (2-1) *4	1	0	1	0	1	Slave of axis 1 (Main of tandem pair 3)
4	7 (2-3) *4	1	0	1	0	1	Slave of axis 1 (Main of tandem pair 4)
5	2 (1-2)	1	1	1	0	0	Sub of tandem pair 1
6	4 (1-4)	1	1	1	0	0	Sub of tandem pair 2
7	6 (2-2) *4	1	1	1	0	0	Sub of tandem pair 3
8	8 (2-4) *4	1	1	1	0	0	Sub of tandem pair 4

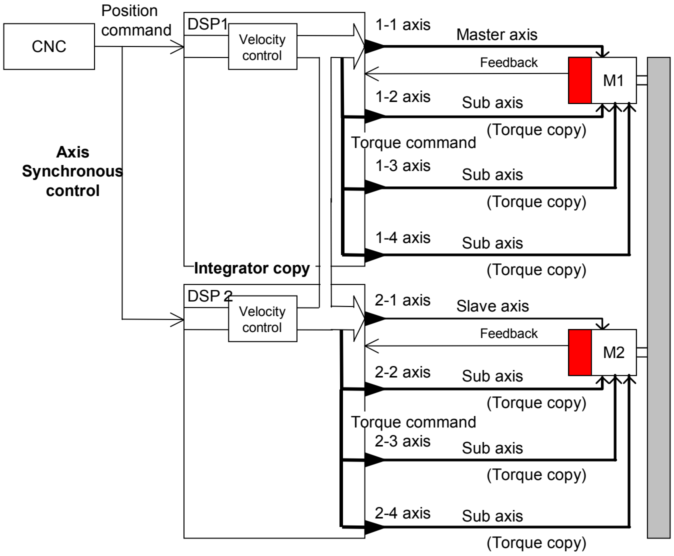
*1) Set feed axis synchronization control for axes 1 to 4.
*2) The integrator of axis 1 is copied to axes 2 to 4.
*3) Tandem control is set for axes 1 and 5, axes 2 and 6, axes 3 and 7, and axes 4 and 8.
*4) With the Series 30*i*-B, values 9 to 16 must be set for parameter No. 1023 for the second DSP. Therefore, set 9 (2-1) for axis 3, 11 (2-3) for axis 4, 10 (2-2) for axis 7, and 12 (2-4) for axis 8.

Example of setting with the 30*i*-B)

Axis No.	Arrange-ment No.1023	Motor with two windings No.2211#6	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Remarks
1	1 (1-1)	1	1	1	1	Master of feed axis synchronization (Main of tandem pair 1)
2	3 (1-3)	1	1	0	1	Slave of axis 1 (Main of tandem pair 2)
3	9 (2-1)	1	1	0	1	Slave of axis 1 (Main of tandem pair 3)
4	11 (2-3)	1	1	0	1	Slave of axis 1 (Main of tandem pair 4)
5	2 (1-2)	1	1	0	0	Sub of tandem pair 1
6	4 (1-4)	1	1	0	0	Sub of tandem pair 2
7	10 (2-2)	1	1	0	0	Sub of tandem pair 3
8	12 (2-4)	1	1	0	0	Sub of tandem pair 4

*1) Set feed axis synchronization control for axes 1 to 4.
*2) The integrator of axis 1 is copied to axes 2 to 4.
*3) Each motor with two windings corresponds to axes 1 and 5, axes 2 and 6, axes 3 and 7, or axes 4 and 8.

(4-5) Driving two motor with four windings, setting two-axis feed axis synchronization control, and using the integrator copy function for the axes under feed axis synchronization control (Form <4>)



Axis No.	Arrange-ment No.1023	Second axis name No.1025 *4	Tandem No.1817#6	Motor with four windings 2211#7	Multiaxis tandem No.2223#5	Multiaxis tandem: Master No.2223#6	Integrator copy No.2273#1	Remarks
1	1 (1-1)	49 (_1)	0	1	1	1	1	Master of synchronization
2	5 (2-1) *5	50 (_2)	0	1	1	0	1	Slave of synchronization
3	2 (1-2)	51 (_3)	0	1	1	0	0	Sub of axis 1
4	3 (1-3)	52 (_4)	0	1	1	0	0	Sub of axis 1
5	4 (1-4)	53 (_5)	0	1	1	0	0	Sub of axis 1
6	6 (2-2) *5	54 (_6)	0	1	1	0	0	Sub of axis 2
7	7 (2-3) *5	55 (_7)	0	1	1	0	0	Sub of axis 2
8	8 (2-4) *5	56 (_8)	0	1	1	0	0	Sub of axis 2

*1) Set feed axis synchronization control for axes 1 and 2.
*2) The integrator of axis 1 is copied to axis 2.
*3) The four-winding motor function is used to copy the position feedback and torque command from axis 1 to axes 3 to 5 and from axis 2 to axes 6 to 8.
For each sub-axis, the position feedback sharing function (bit 7 of parameter No. 2018) is not required.
*4) In this case, use axis names different from those assigned to axes 1 and 2 for axes other than axes 1 and 2, master and slave axes of synchronization (axes 3 to 8) If the same axis name is used, the actual feedrate becomes lower than the specified speed.
- Set the bit 0 of parameter No. 1000 (extended axis name function) to 1 so that the setting for parameter No. 1025 for axes 3 to 8 is not the same as that for parameter No. 1025 for axes 1 and 2.

*5) With the Series 30*i*-B, values 9 to 16 must be set for parameter No. 1023 for the second DSP. Therefore, set 9 (2-1) for axis 2, 10 (2-2) for axis 6, 11 (2-3) for axis 7, and 12 (2-4) for axis 8.

5.10.3 Turning Functions On and Off Using a PMC Signal

(1) Overview

PMC signal G321 (coupling flag) can be used to turn the following functions on and off dynamically:

- Integrator copy function ⇒ See the Item (4) of Subsection 5.10.1.1.
- Tandem disturbance elimination control function ⇒ See the Item (5) of Subsection 5.10.1.4.
- Synchronous axes automatic compensation ⇒ See the Item (4) of Subsection 5.10.1.5.
- Velocity feedback average function ⇒ See the Item (4) of Subsection 5.10.4.2.

(2) Signal

- SVDI1n : Coupling signal

	#7	#6	#5	#4	#3	#2	#1	#0
Gn321	SVDI18	SVDI17	SVDI16	SVDI15	SVDI14	SVDI13	SVDI12	SVDI11

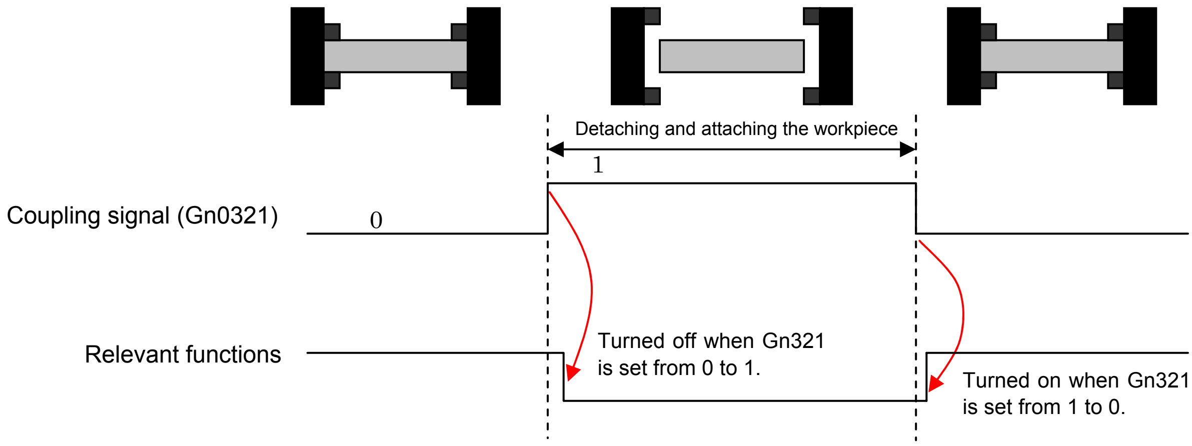
[Classification] Input signal

[Function] This signal is used to disable the functions acting between synchronous axes when the mechanical coupling of the synchronous axes normally driven in the coupled state is temporarily released.
This signal is available for the velocity loop integrator copy function, tandem disturbance elimination control, synchronous axes automatic compensation function, and velocity feedback average function.

[Operation] 0 : Coupled state (The functions are turned on.)
1 : Uncoupled state (The functions are turned off.)

(3) Example of using this signal

<1> The relevant functions are turned off when the workpiece is attached and detached.
* Depends on the relevant function bit.



5.10.4 Torque Tandem Control (Optional Function)

(1) Overview

This function can copy the torque command for the main axis to the sub-axis to drive the motors for both axes with the same torque command. Therefore, double the torque can be obtained as compared when one axis is driven by a single motor.
(Load sharing mode)
In torque tandem control, however, only the main motor is responsible for positioning. The sub-motor only produces a torque.
By applying a preload torque to produce tension between the main motor and sub-motor, the backlash between gears can be reduced.

(Anti-backlash mode)
Tandem control can also be used together with the motor feedback sharing function to drive linear motors connected in series and motors with plural windings (α*i*S300/2000, α*i*S500/2000, α*i*S1000/2000HV, α*i*S1000/3000HV, α*i*S2000/2000HV, and α*i*S3000/2000HV).

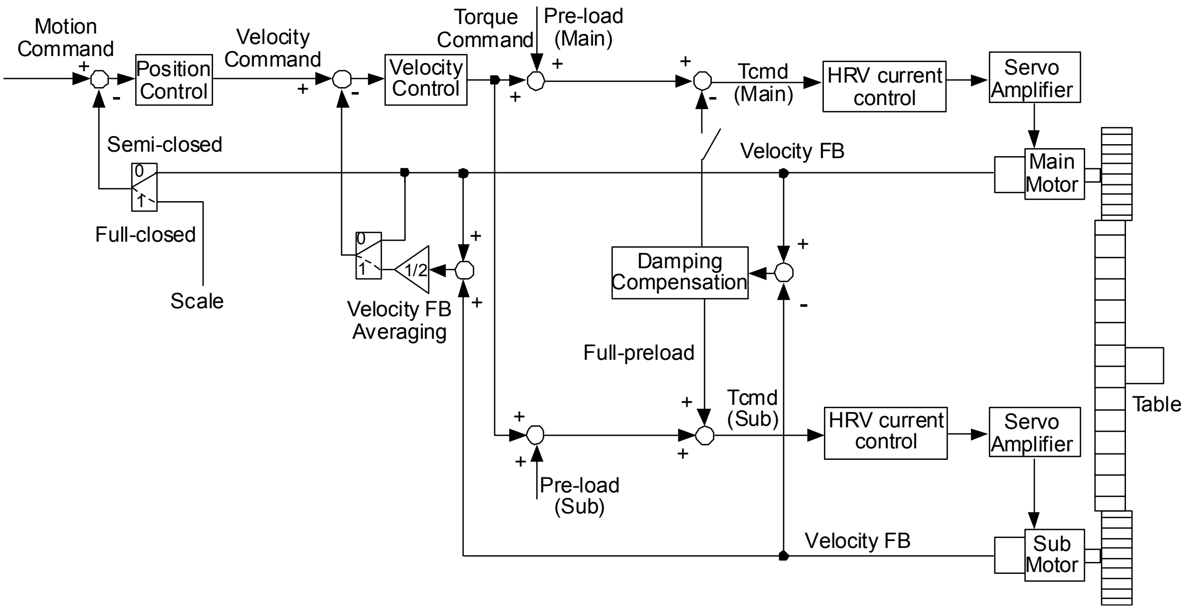


Fig. 5.10.4 (a) Block diagram of torque tandem control (usual case)

> ⚠ **WARNING**
> When torque tandem control is used, position control and velocity control are not exercised on the sub-motor side. Use care.
> When two motors are not connected with each other, applying a force to the main motor side is very dangerous, because the sub-motor may make an extremely high-speed rotation.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

> **NOTE**
> This function cannot be used together with servo HRV4 control.

(3) Start-up procedure

To start tandem control, follow the procedure below.

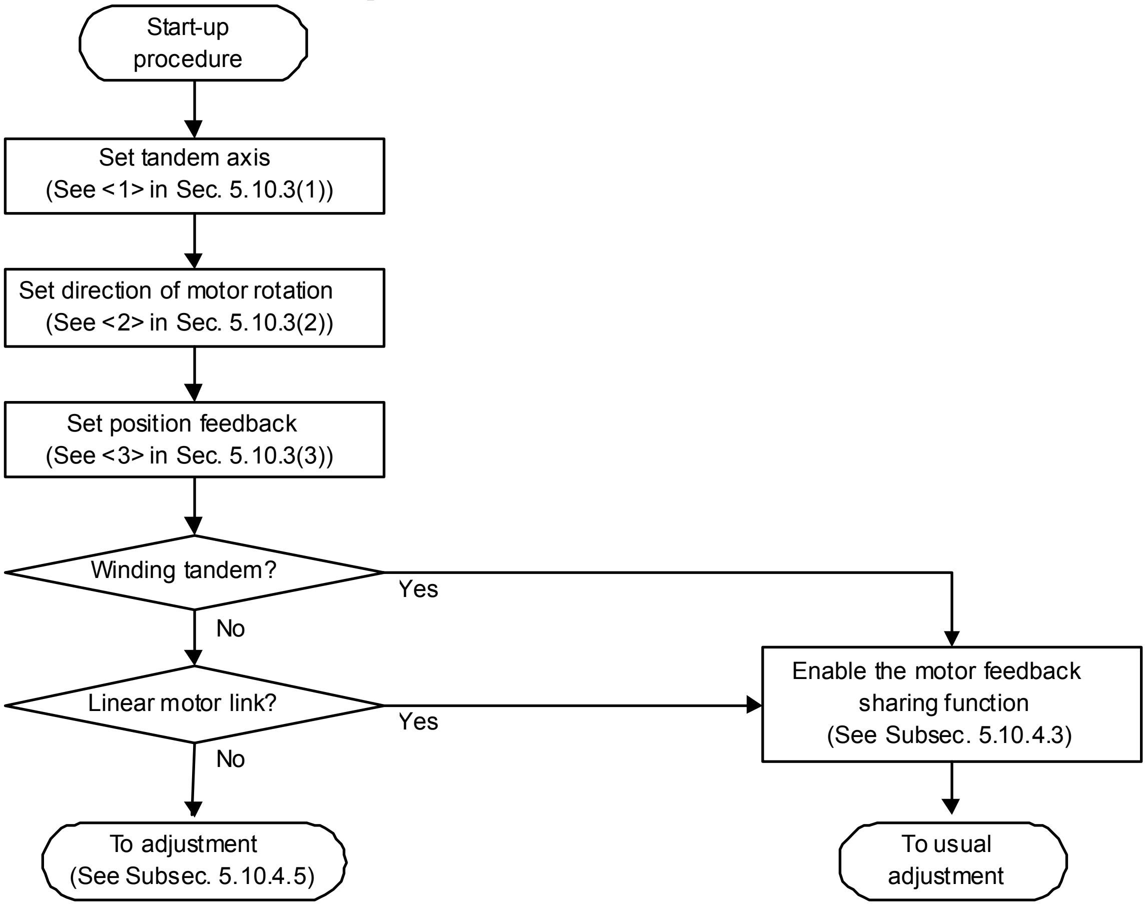


Fig. 5.10.4 (b) Start-up procedure flowchart

<1> Tandem axis setting

Tandem control is an optional function. (When the NC is not the Series 30*i*-B, the "tandem control" option is necessary. With the Series 30*i*-B, the "feed axis synchronization control" option is necessary.)

Refer to the Parameter Manual of CNC for details.

	#7	#6	#5	#4	#3	#2	#1	#0
1817		TANDEM						

TANDEM (#6) 1: Enables tandem control. (Set this parameter for the main- and sub-axes.)

1023	Servo axis arrangement

This parameter specifies servo axis arrangement.
Set an odd number for the main axis and set an even number ((main axis) + 1) for the sub-axis.
If 3 is set for a main axis, for example, set 4 for the sub-axis.

Example of tandem axis setting
(★ indicates a tandem axis.)
Number of controlled axes = 6

	Axis No.	Axis name	Servo axis arrangement No.1023	Tandem No.1817#6	Position display No.3115#0	Remarks
★	1	X	1	1	0	CNC axis (main axis)
★	2	Y	3	1	0	CNC axis (main axis)
	3	Z	5	0	0	CNC axis
★	4	A	2	1	1	Tandem control sub-axis (sub-X-axis)
★	5	B	4	1	1	Tandem control sub-axis (sub-Y-axis)
	6	C	6	0	0	PMC axis

<2> Direction of motor rotation

2022	Direction of motor rotation (DIRCT)

Main axis: With a forward direction specified, 111 specifies that the main axis motor rotates counterclockwise as viewed from the motor shaft side, while -111 specifies the opposite direction.

Sub-axis: To cause the sub-axis motor to rotate in the same direction as for the main axis, specify the same value for both the sub-axis and the main axis because of their mechanical structure. To cause the sub-axis motor to reverse, specify a value whose sign is opposite to that for the normal direction. For winding tandem, be sure to specify the values with the same sign.

<3> Position feedback setting

Specify position feedback for both main axis and sub-axis. (See Subsec. 5.10.4.5 for a concrete example.)

* Assume position feedback shown in Fig. 5.10.4.5 (a) not only for the main axis but also for the sub-axis.

- Semi-closed or full-closed loop setting No.1815#1
- CMR setting No.1820
- Setting the reference counter capacity No.1821
- Setting the high-resolution Pulsecoder No.2000#0
- Setting the number of velocity pulses No.2023
- Setting the number of position pulses No.2024
- Flexible feed gear (numerator) setting No.2084
- Flexible feed gear (denominator) setting No.2085

(4) Descriptions of servo parameters for adjustment

The load inertia ratio to be specified for axes subjected to tandem control differs from that for ordinary axes.

2021	Load inertia ratio (LDINT)

[Standard setting] (Load inertia/motor inertia) × 256

(NOTE) In typical tandem control, the total load inertia of the machine is borne by two motors. So, calculate the load inertia for the above formula as follows:
(Load inertia) = (Total load inertia of machine)/2

Example of setting The example shown in Fig. 5.10 (a) is used. Assume that the inertia of each section applied to the motor shaft as follows:

- Inertias of the reducers of the main- and sub-axes: J_{1m}, J_{1s}
- Inertias of the pinions of the main- and sub-axes: J_{2m}, J_{2s}
- Inertia of the rack: J_3

(Total load inertia of the machine) = $J_{1m} + J_{2m} + J_3 + J_{1s} + J_{2s}$

When the total load inertia of the machine is double that of the motor inertia, for example, set the following:

When typical tandem control is used:
(Load inertia ratio) = (2/2) × 256 = 256
The result obtained from the above formula may cause oscillation due to the mechanical structure. In such a case, set a smaller value.

- Notes on stable tandem control operation
  To ensure stable tandem control operation, the machine must be capable of performing back-feed. "Back-feed" means the feasibility that the axis can be driven not only from the motor side, but also from the machine side. In this description, when the sub-axis can be moved from the main axis and the main axis can be moved from the sub-axis through the connected transmission feature, it is assumed that the axis can also be driven from the machine and back-feed is enabled. If back-feed is disabled, operation becomes unstable and it is necessary to adjust the machine.
  The user can check whether the back-feed capability is enabled. To make this check in the case of the example shown in Figs. 5.10 (a) and (b), turn the main motor with the power line for the sub-motor disconnected, and check that the main motor can be turned with one-third or less of the rated torque of the motor (See (2) in Subsec. 5.10.4.5). If the sub-motor cannot be turned due to a mechanical cause, the axis cannot be moved from the machine. In this case, a higher torque than necessary is produced on the main motor.

5.10.4.1 Damping compensation function

To enable more stable tandem control, a torque offset can be applied to the sub-axis, or to both the main- and sub-axes to eliminate a difference in speed, if any, between the main- and sub-axes.
This function is particularly useful for controlling the vibration (with a frequency of several Hz to 30 or 40 Hz) that may occur in a machine system with low spring rigidity.

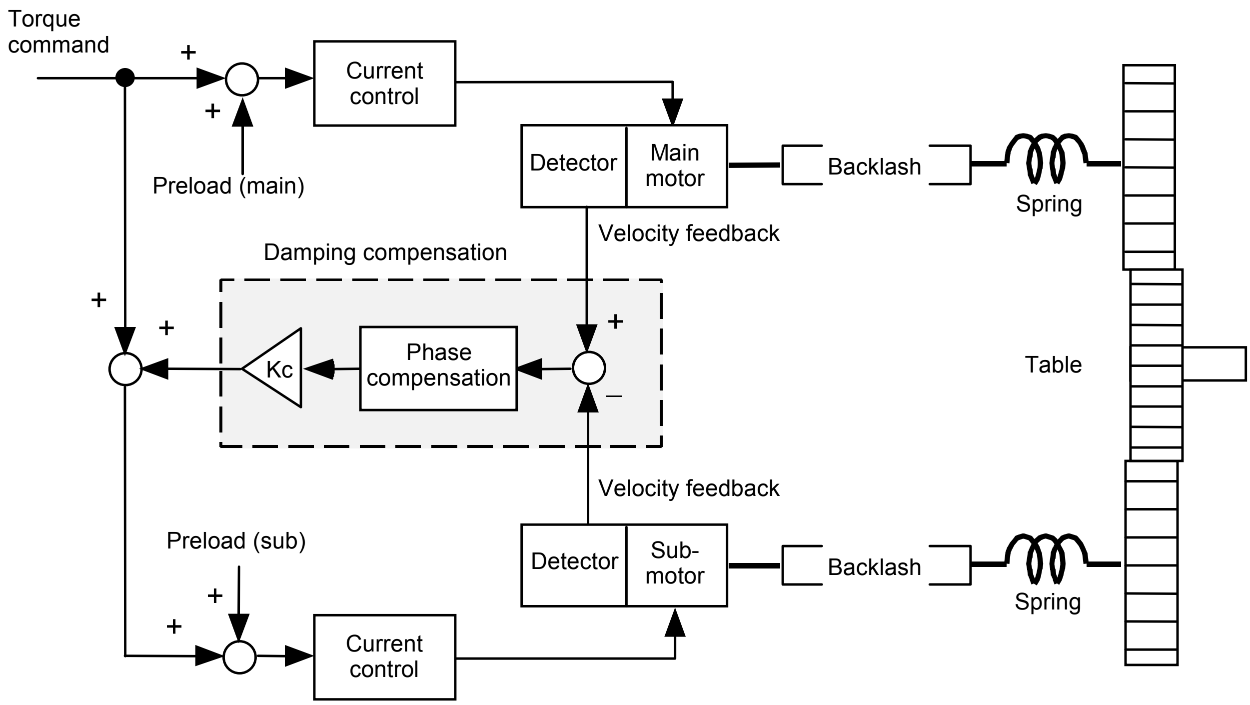


Fig. 5.10.4.1 (a) Damping compensation function

	#7	#6	#5	#4	#3	#2	#1	#0
2008	LAXDMP							

(Set this parameter for the main axis only.)

LAXDMP (#7) 0: Enables the damping compensation function for the sub-axis only.
1: Enables the damping compensation function for the main- and sub-axes.
Usually, set this bit to 0.

2036	Damping compensation gain Kc (ABPGL)

(Set this parameter for the main axis only.)

[Valid data range] 0 to 16384

[Setting method] $Kc \times 32768$ ($0 \leq Kc < 0.5$)

A function bit is not supported for the damping compensation function; the damping compensation function is enabled at all times. When 0 is set in this parameter, the damping compensation function is ineffective.

2036	Damping compensation phase coefficient α (ABPHL)

(Set this parameter for the sub-axis only.)

[Valid data range] 51 to 512

[Setting method] $\alpha \times 512$ ($0.1 \leq \alpha \leq 1.0$)

When 0 is set in this parameter, this setting is internally handled as 512 ($\alpha = 1$), When $\alpha = 1$, phase compensation is not performed. Instead, the set value is output to Kc as is.

(Example of adjustment)

The speeds of the motors are checked using the Servo Guide (when the motors rotate in the same direction).

This function may be useful when the oscillation frequencies (several Hz to 30 or 40 Hz) are the same, and the phases are opposite as shown below.

NOTE

1. When the directions of rotation of the main motor and sub-motor are different, the phase relationship is reversed.
2. When the phase difference is not 180°, the phase coefficient α must be adjusted. Start with 512, then decrease the value gradually.

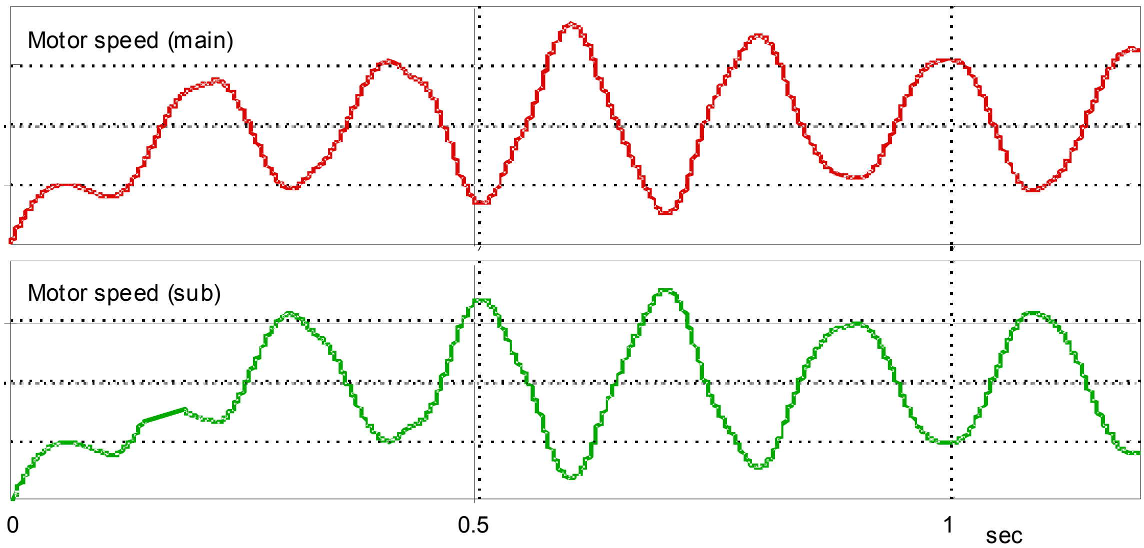


Fig. 5.10.4.1 (b) Motor speed vibration

- Adjustment procedure for damping compensation

1. When the dual-position feedback function is used, set a time constant (parameter No. 2080) of 200 and adjust the setting to ensure stable axis movement.
2. Set 0 or 512 as phase coefficient α.
   [Sub-axis No. 2036]

If 512 is set, the value may have to be reduced when the vibration phase difference between the motors is other than 180°.

3 Set a damping gain of 3277.
[Main axis No. 2036]
To reduce the vibration, this value must be increased or decreased.
Be careful not to increase this value excessively. Otherwise, high-frequency vibration will occur.
When adjusting this parameter, apply the maximum axis load.

4 Repeat steps 2 through 4 until smooth movement is achieved.

> **NOTE**
> To observe the motor speeds along the main axis and sub-axis using SERVO GUIDE, select ABS (absolute position detected by the detector built into the motor) on the Channel dialog and Diff1(VT) on the Operation and Display page, and display a graph. When POSF (position feedback) is selected, the motor position is assumed in the semi-closed mode and the machine position is assumed in the full-closed mode.

5.10.4.2 Velocity feedback average function

As can be seen from the tandem control block diagram shown in Fig. 5.10.4.6 in Subsec. 5.10.4.6, velocity control is not applied to the sub-axis motor. For this reason, the sub-axis may vibrate and become unstable due to a backlash such as, for example, in the gears, in a machine with a large backlash. In such a case, the machine can be made stable by applying velocity control to the sub-axis as well. This function is referred to as the velocity feedback average function.
PMC signal Gn321 can be set to 1 to turn the velocity feedback average function off during NC program operation. For details, see Subsection 5.10.3, "Turning Functions On and Off Using a PMC Signal".

	#7	#6	#5	#4	#3	#2	#1	#0
2008						VFBAVE		

(Set this parameter for the main axis only.)

VFBAVE (#2) 1: Enables the velocity feedback average function. Usually, set this bit to 1.

	#7	#6	#5	#4	#3	#2	#1	#0
2297				VAVNEG				

(Set this parameter for the main axis only.)

VAVNEG(#4) 1: The velocity feedback average function is disabled for high cycle proportional elements.

5.10.4.3 Motor feedback sharing function

To achieve improved thrust, two linear motors may be connected in series.
When linear motors are connected in series, one position feedback signal, which is originally available for the main axis, is to be shared by the sub-axis as well. In this case, the motor feedback sharing function can be used
This function can also be used when a motor with plural windings (α*i*S300/2000, α*i*S500/2000, α*i*S1000/2000HV, α*i*S1000/3000HV, α*i*S2000/2000HV, or α*i*S3000/2000HV) is used.

> **NOTE**
> When using this function in a full-closed loop system, the main axis shares its separate detector feedback loop with the sub-axis.

	#7	#6	#5	#4	#3	#2	#1	#0
2018	PFBCPY							

(Set this parameter for the sub-axis only.)

PFBCPY (#7) 1: The motor feedback signal for the main axis is shared with the sub-axis motor.

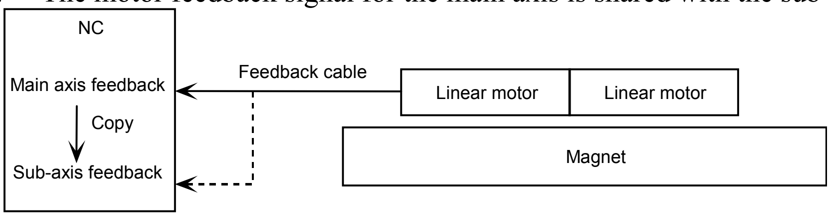


Fig. 5.10.4.3 (a) Motor feedback sharing function

	#7	#6	#5	#4	#3	#2	#1	#0
2285		TRQCPY						

(Set this parameter for the sub-axis only.)

TRQCPY(#6) 1: The current command for the main axis is used as the current command for the sub-axis.

> **NOTE**
> For a rigid connection for which the position feedback sharing function is used as shown in the figure above, the current command for the main axis is used as the current command for the sub-axis.

5.10.4.4 Tandem speed difference alarm function

(1) Overview

Torque tandem control is a method of control for driving a rigidly connected machine by using two motors. The speed of the sub-axis side is not controlled. This means that if the mechanical connection is canceled and a force is applied to the main axis side, the sub-axis can rotate at an unnecessarily high speed. This function monitors the speed difference between the main axis and sub-axis, and when the parameter-set threshold is exceeded, "SV0641 SPEED DIFFERENCE ALARM" is detected.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	L(12) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	L(12) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

The following table lists the series and editions of system software that support the message display of "SV0641 SPEED DIFFERENCE ALARM". Note that if NC software that does not support the message display of alarm SV0641 is used, the message "SV0448 UNMATCHED FEEDBACK ALARM" is displayed when this alarm is issued.

CNC	System software	
	Series	**Edition**
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	04 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	04 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	G4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	G5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function.

(3) Setting parameters

Set new parameters only with the sub-axis of tandem control.

	#7	#6	#5	#4	#3	#2	#1	#0
2007				**VLDALM**				

VLDALM (#4) The tandem speed difference alarm function is:

0: Used. (The tandem speed difference alarm function is enabled by default.)

1: Not used.

2357	Maximum permitted tandem speed difference

[Valid data range] 0 to 2000

[Unit of data] min^{-1} (10 mm/min when a linear motor is used)

When 0 is set in this parameter, the threshold for the tandem speed difference alarm function is set to 1000 by default.

5.10.4.5 Example of torque tandem setting

(1) Examples of parameter setting

This section gives examples of parameter setting.

(a) Semi-closed loop system using a command unit of 1/1000 deg, a detection unit of 1/1000 deg, a rotary axis with a gear reduction ratio of 1/984, and an α*i* A1000 Pulsecoder

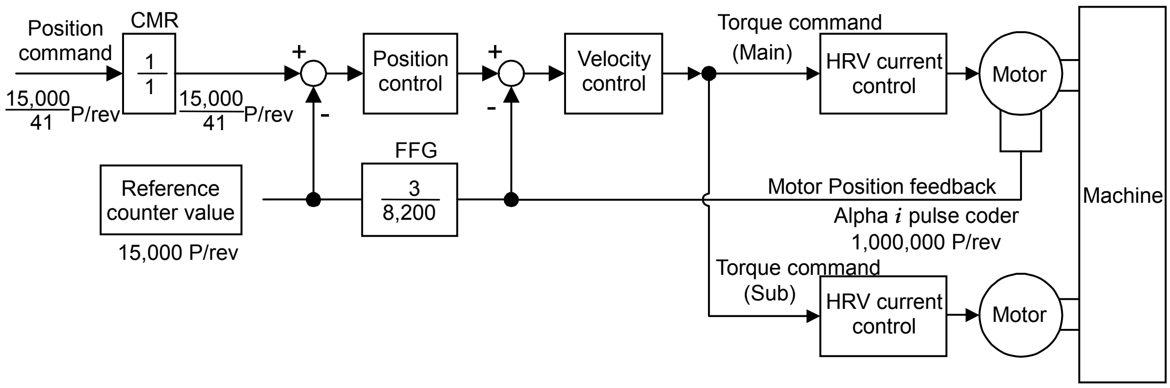


Fig. 5.10.4.5 (a) Example of torque tandem setting <1>

		Main	Sub
• Tandem axis	No.1817#6	1	1
• Semi-closed loop	No.1815#1	0	0
• CMR	No.1820	2	2
• Reference counter capacity	No.1821	15000	15000
• Reference counter capacity (denominator)	No.2179	41	41
• High-resolution Pulsecoder	No.2000#0	0	0
• Number of velocity pulses	No.2023	8192	8192
• Number of position pulses	No.2024	12500	12500
• Flexible feed gear	No.2084	3	3
• Flexible feed gear	No.2085	8200	8200

(NOTE) $\frac{360000/984}{1000000} = \frac{36}{98400} = \frac{3}{8200}$ $\qquad \frac{360000}{984} = \frac{15000}{41}$

(b) Semi-closed loop system using a command unit of 0.1 μm, a detection unit of 0.1 μm, 10 mm stroke per motor revolution, and an α*i*S300 motor (winding tandem)

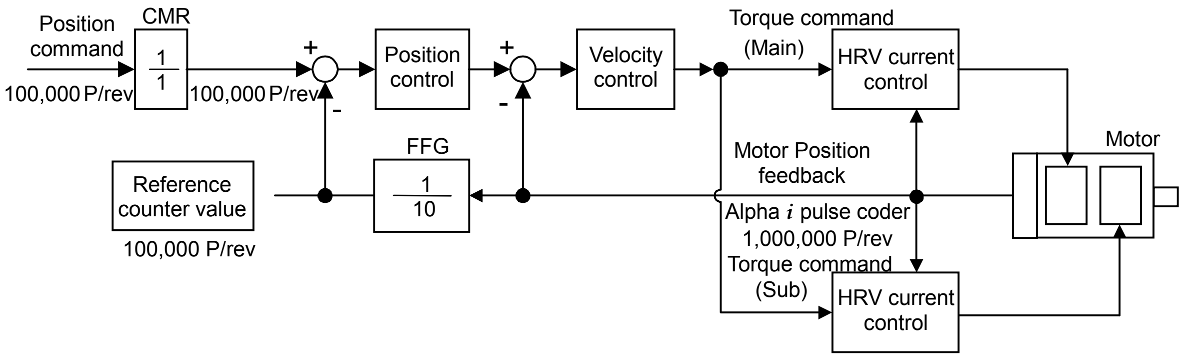


Fig. 5.10.4.5 (b) Example of torque tandem setting <2>

		Main	Sub
• Tandem axis	No.1817#6	1	1
• CMR	No.1820	2	2
• Reference counter capacity	No.1821	100000	100000
• High-resolution Pulsecoder	No.2000#0	0	0
• Motor feedback sharing function	No.2018#7	0	1
• Number of velocity detection pulses	No.2023	8190	8190
• Number of position detection pulses	No.2024	12500	12500
• Flexible feed gear	No.2084	1	1
• Flexible feed gear	No.2085	10	10

(2) Back-feed confirmation method

"Back-feed" means the feasibility that the axis can be driven not only from motor side but also from machine table side. In this description, when the sub-axis can be moved from the main axis and the main axis can be moved from the sub-axis through the connected transmission feature, it is assumed that the axis can also be driven from the machine and back-feed is enabled.

(a) Check whether back-feed is possible when the machine is connected and the power line is removed. If back-feed is impossible, unstable control will result, and machine adjustment such as a gear box adjustment will be necessary.

<1> Making a check manually

First, turn the shaft of the main motor manually to check that the sub-motor turns. Next, turn the shaft of the sub-motor manually to check that the main motor turns. If these checks are successful, back-feed is possible.

<2> Making a check using NC commands
After checking (b) and (c) below, remove the sub-motor power line. Then, enter a plus (+) command or minus (-) command to rotate the main motor. Check that the main motor can be turned with one-third or less of its rated static torque. When this check is successful, back-feed is possible.

When inertia is low and the motor shaft can be turned manually, whether back-feed is possible can be determined using method <1>. If inertia is large or the machine has a complex configuration, whether back-feed is possible cannot be determined by turning the shaft manually. In this case, use method <2>.

(b) With the machine connected, activate the motors. At this time, release the emergency stop state after reducing the torque limit by a factor of about 10.
Check the motor current on the servo adjustment screen. If the current increases gradually, the directions of rotation of the main- and sub-motors may not be set correctly.

(c) Check the operation by entering a plus (+) command and minus (-) command.
If the error persists due to friction load, increase the torque limit.

(d) If the operation is normal, return the torque limit to its original value, and then set a preload value.

(3) Adjustment items

If vibration occurs:

- Check the position feedback setting (<3> in Subsec. 5.10.4 (3)).
- With SERVO GUIDE, check TCMD, ABS(VT display), and POSF(VT display). (With the check board, check the Vcmd, Tcmd, and SPEED signals.)

(a) A higher gear reduction ratio tends to produce more backlash, such that unstable operation will result from the sub-axis running between backlashes.
→ Enable the velocity feedback average function.
(Bit 2 of No.2008 = 1)

(b) The main axis and sub-axis vibrate at the same frequency (several Hz to 30 or 40 Hz) as a result of the spring rigidity being low.
(The twist rigidity is proportional to the second power of the gear reduction ratio, so that the frequency is probably a lower resonant frequency.)
→ Enable damping compensation.
(See the adjustment procedure described in Subsec. 5.10.4.1.) (Bit 2 of No.2008 = 1)

(c) The operation of a full-closed-loop system is unstable.
→ Check the position feedback setting (<3> in Subsec. 5.10.4.) If the parameters are set correctly, place the system in semi-closed loop mode, then adjust the system to achieve stable operation.
Then, return the system to full-closed loop mode. If the operation is still unstable, apply a function such as the dual position feedback function.

(d) In the stop state, no tension is established between the main axis and sub-axis.
→ Set a preload value of 0, and check the torque in the stop state.
Then, set a preload value greater than the stop-state torque.
(No.2087)

(e) Position-dependent vibration occurs.
→ Change the feedrate to determine whether the vibration frequency is constant or proportional to the feedrate.
If the vibration frequency is proportional to the feedrate, position-dependent vibration is occurring. Check position-related items such as the number of gear teeth.

5.10.4.6 Block Diagrams

(1) Tandem control

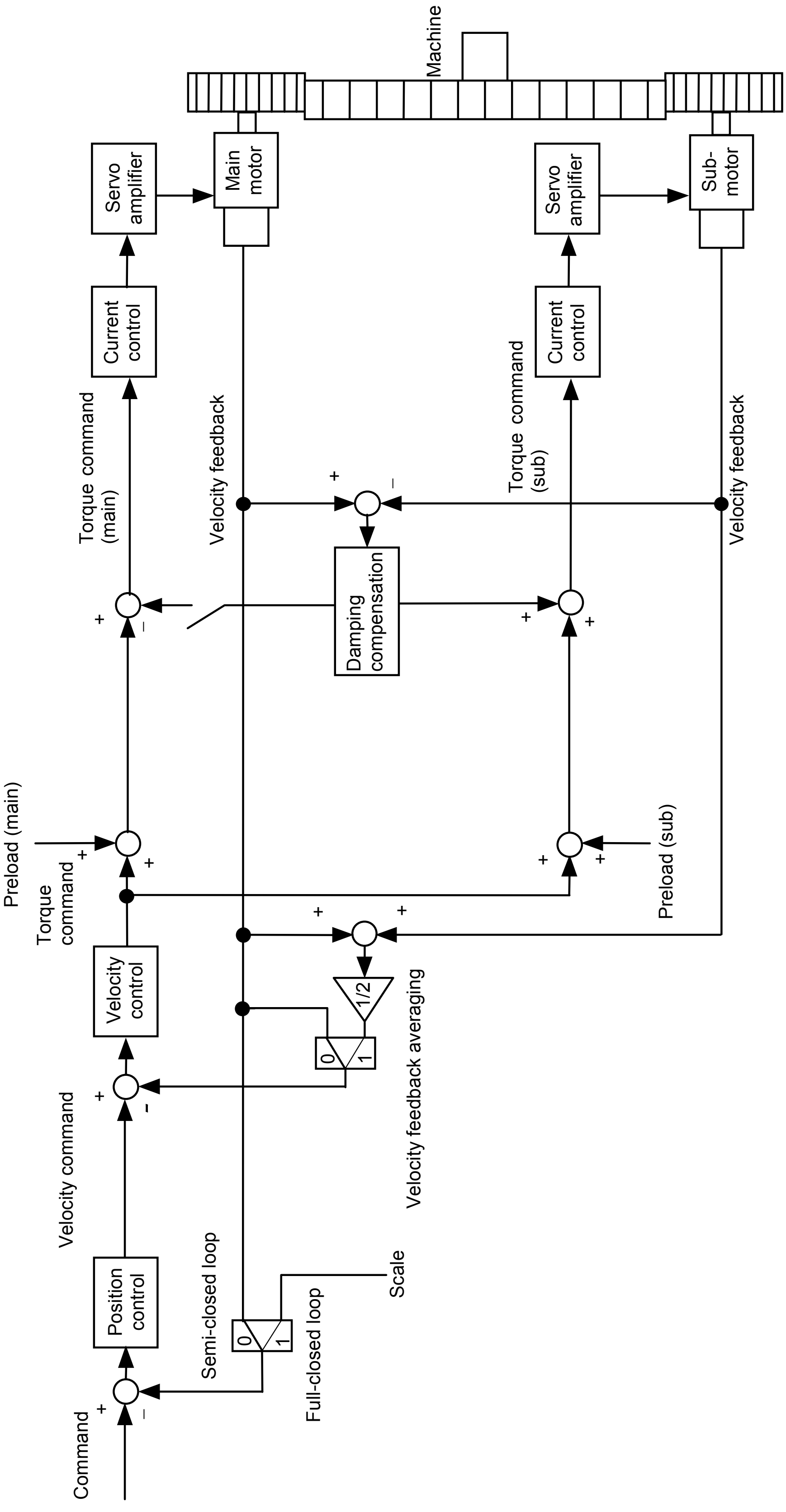


Fig. 5.10.4.6 Tandem control (typical)

5.10.5 Velocity Tandem Control

The tandem control option is necessary.
With torque tandem control, the position and velocity of the slave side tend to be unstable because they are not controlled. In this case, the velocity tandem control + velocity loop integrator control function can be used to make them stable. They can be controlled stably as compared with tandem control. The preload function can also be used together.
The use of the position tandem control + velocity loop integrator copy function together with the feed axis synchronization control is recommended. Position tandem control can control the position of the slave side to allow driving with higher precision as compared with velocity tandem control.

	#7	#6	#5	#4	#3	#2	#1	#0
2008			VCMDTM				TANDEM	

(Set this parameter for the master axis.)

VCMDTM(#5) 1: Velocity command (Vcmd) tandem control is enabled.
* Use this parameter for an axis for which tandem control (option) is enabled.

	#7	#6	#5	#4	#3	#2	#1	#0
2273							WSVCP	

(Set this parameter to 1 for axes sharing a velocity loop integrator.)

WSVCP (#1) 1: The velocity loop integrator for the master axis is copied to the slave axis.

2087	Preload value (PRLOAD)

Set this parameter for both the master and slave axes.

5.11 TORQUE CONTROL FUNCTION

(1) Overview

In PMC axis control, control according to the torque command can be used. The servo motor produces a torque as specified by the NC. Note that the user can switch between position control and torque control.

(2) Control types

Two types of torque control are supported: type 1 and type 2. Generally, use type 2. The two types are explained below.

(i) Torque control type 1
The motor produces a torque according to a torque command specified by the PMC. A servo alarm SV0422, “EXCESS VELOCITY IN TORQUE” is issued if the speed of the motor exceeds the maximum feed rate specified by the PMC.
A block diagram of torque control type 1 is shown below.

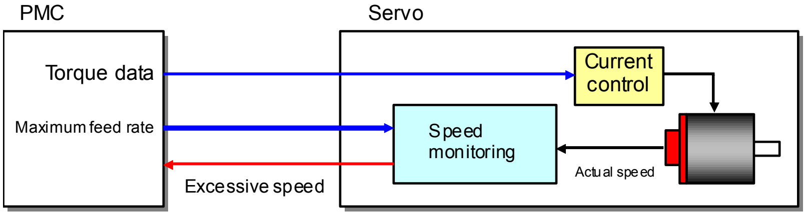


Fig. 5.11 (a) Torque control type 1

(ii) Torque control type 2
The motor produces a torque according to a torque command specified by the PMC.
When the motor is loaded, it produces a torque according to a torque command. When it is not loaded, it rotates at a constant speed (maximum feed rate).

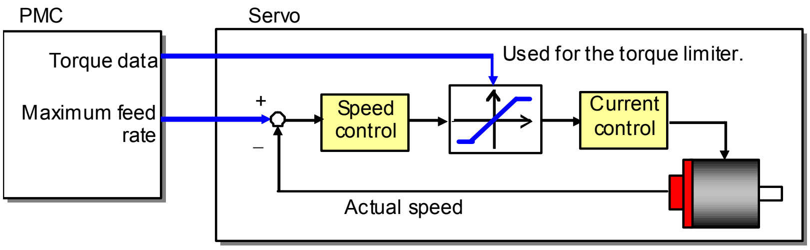


Fig. 5.11 (b) Torque control type 2

* Basically, torque control type 2 performs speed control to cause the limiter to operate on a command from the speed controller according to a torque command specified by the PMC. This causes the motor to produce a torque that matches the torque command when it is loaded and to rotate at a constant speed (maximum feed rate) when it is not loaded.

(3) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(4) Setting parameters

This manual describes servo-related parameters only.

NOTE
For details about the setting of the torque control function for each CNC, refer to "PMC Axis Control" in the respective CNC Connection Manual (Function).

	#7	#6	#5	#4	#3	#2	#1	#0
2007	FRCAXS							

FRCAXS (#7) Torque control is:
0: Not used
1: Used ← To be set

	#7	#6	#5	#4	#3	#2	#1	#0
2203				FRCAX2				

FRCAX2 (#4) Torque control type 2 is:
0: Not used (Torque control type 1 is used.)
1: Used ← To be set (Usually, use type 2.)

	#7	#6	#5	#4	#3	#2	#1	#0
2003					PIEN			

PIEN (#3) The velocity control method to be used is:
0: I-P control
1: PI control ← To be set

2105	Torque constant

This parameter is used to specify a motor-specific torque constant. The units are as follows:

0.00001 N·m/(torque command) for a rotary motor
0.001 N·m/(torque command) for a linear motor

NOTE
1 When the initial parameter setting function (Sec. 2.1) is used, a motor-specific value is set automatically.
2 When torque control is set, the following functions are disabled:
- Velocity loop high cycle management function
- Acceleration feedback function
3 To use torque control type 2, disable the variable proportional gain function in the stop state.
4 Multiaxis tandem and torque control cannot be used simultaneously.

5.12 USING A SERVO MOTOR FOR SPINDLE CONTROL

(1) Overview

The spindle control function by a servo motor can be used to perform spindle speed functions including the spindle speed command and rigid tapping with a servo motor. This section explains the speed arrival signal, and zero-speed detecting signal, and load meter display when a servo motor is used as a spindle.
For details of the spindle speed functions by a servo motor, refer to the "Connection Manual (Function)" for the relevant CNC (Series 30*i*/31*i*/32*i*-A: B-63943EN-1, Series 30*i*/31*i*/32*i*-B: B-64483EN-1, Series 35*i*-B: B-64523EN-1, Series 0*i*-D: B-64303EN-1).

5.12.1 Speed Arrival Signal and Zero-Speed Detecting Signal

(1) Overview

The speed arrival signal (SVSAR) and zero-speed detecting signal (SVSST) are available in the same way as for spindle control.
This function is enabled when the spindle control function by a servo motor is used. For details of the spindle speed functions by a servo motor, refer to the "Connection Manual (Function)" for the relevant CNC (Series 30*i*/31*i*/32*i*-A: B-63943EN-1, Series 30*i*/31*i*/32*i*-B: B-64483EN-1, Series 35*i*-B: B-64523EN-1, Series 0*i*-D: B-64303EN-1).

(2) Series and editions of applicable servo software

- Supporting the speed arrival signal and zero-speed detecting signal

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	T(20) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	T(20) and subsequent editions	HRV4
Series 0*i*-D	90C5	-	
	90C8	D(04) and subsequent editions	
	90E5	-	
	90E8	D(04) and subsequent editions	

- Supporting the speed arrival signal in low speed mode

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	20.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	33.0 and subsequent editions	
	90E1	08.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5	-	
	90C8	D(04) and subsequent editions	
	90E5	-	
	90E8	D(04) and subsequent editions	

To use the speed arrival signal (SVSAR) and zero-speed detecting signal (SVSST), the following series and edition of system software are necessary.

CNC	System software	
	Series	Edition
Power Motion *i*-A	88H0	-
Series 30*i*-A	G00C,G01C,G02C	30 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	30 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	30 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	30 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	25 and subsequent editions
Series 0*i*-TD	D6F1	25 and subsequent editions
Series 0*i* Mate-MD	-	-
Series 0*i* Mate-TD	D7F1	25 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B, all series and editions support this function.

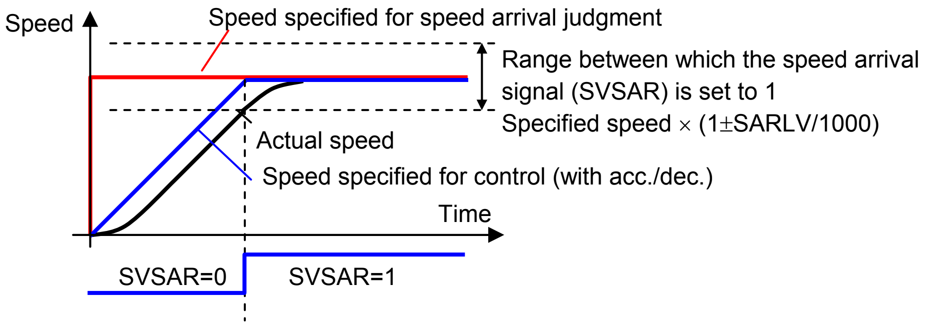
(4) Setting parameters

- Detection of the speed arrival signal

2482	Detection level of speed arrival (SARTLV)

[Valid data range] 0 to 1000
[Unit of data] 0.1%
[Standard setting] 0 (Set value 0 means 15% internally.)

The detection level of speed arrival means the ratio to the specified speed. When the difference between the specified speed and actual speed becomes lower than (specified speed × detection level of speed arrival (parameter No. 2482)), it is assumed that the specified speed is reached and the speed arrival signal SVSARn is set to 1.



- Support of the speed arrival signal in low speed mode
  An offset speed can be set so that the detection level of speed arrival becomes too low in low speed mode. This allows the stable detection of the speed arrival signal. A hysteresis speed can also be set to prevent the fluctuation of the speed arrival signal.

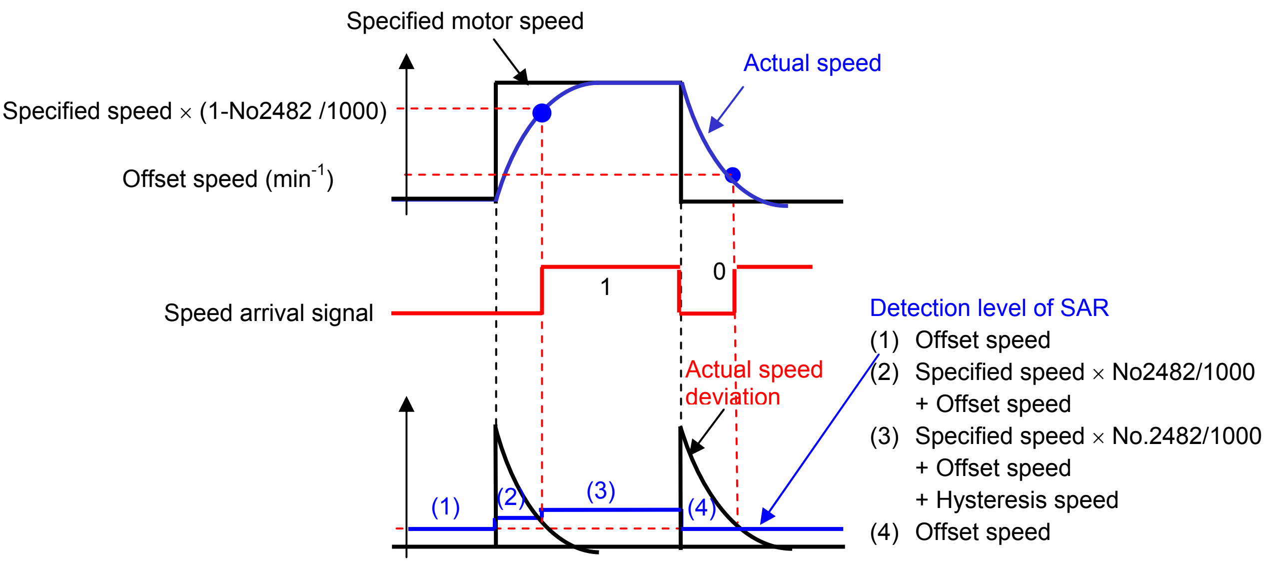
	#7	#6	#5	#4	#3	#2	#1	#0
2422(FS30*i*)							SVSAR1	SVSAR2

SVSAR1 Coefficient for the detection level of speed arrival 1
SVSAR2 Coefficient for the detection level of speed arrival 2

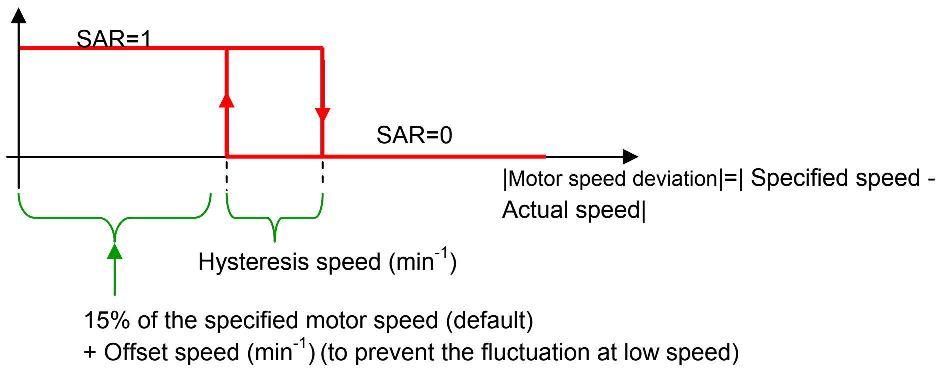
Relationships between the offset speed and hysteresis speed

SVSAR1	SVSAR2	Offset speed	Hysteresis speed	Remarks
0	0	50min^{-1}	20min^{-1}	Recommended (αi, βi motor)
0	1	10min^{-1}	5min^{-1}	
1	0	5min^{-1}	2min^{-1}	Recommended (D*i*S motor)
1	1	2min^{-1}	1min^{-1}	

■ **Operation of the speed arrival signal (details)**



A hysteresis speed is set to prevent the fluctuation of the spindle arrival signal.



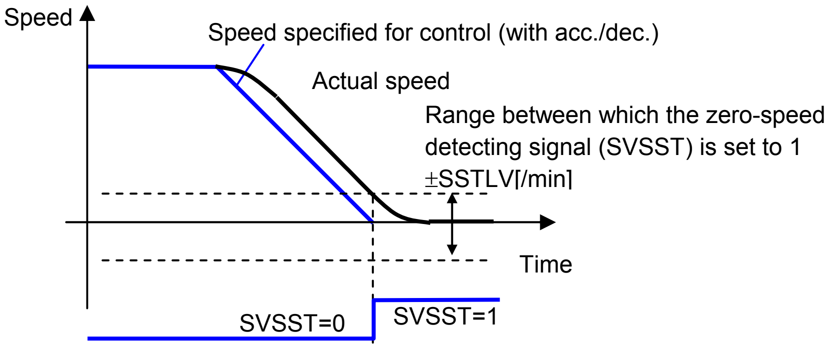
- Detection of the zero-speed detecting signal

2483	Detection level of speed zero (SSTLV)

[Valid data range] 0 to 10000

[Unit of data] min^{-1}
[Standard setting] 0 (Set value 0 means 45 min^{-1} internally.)

The detection level of speed zero means the speed (min^{-1}) at which the motor is determined to stop. When the actual speed becomes lower than the detection level of speed zero, it is assumed that the motor stops and the zero-speed detecting signal SVSSTn is set to 1.



(5) Signal

Speed arrival signal SVSAR1 to SVSAR8<Fn377>

[Classification] Output signal

[Function] This signal notifies that the actual speed of the servo motor reaches the range specified in advance for the speed specified in spindle control by the servo motor.

[Output cond.]
- This signal is set to "1" when the specified speed is reached.
- This signal is set to "0" when the specified speed is not reached.

Zero-speed detecting signal SVSST1 to SVSST8<Fn376>

[Classification] Output signal

[Function] This signal notifies that the speed of the servo motor in spindle control by a servo motor becomes lower than or equal to the detection level of speed zero.

[Output cond.]
- This signal is set to "1" when the actual speed becomes lower than or equal to the detection level of speed zero.
- This signal is set to "0" when the actual speed is higher than the detection level of speed zero.

Signal address

	#7	#6	#5	#4	#3	#2	#1	#0
Fn376	SVSST8	SVSST7	SVSST6	SVSST5	SVSST4	SVSST3	SVSST2	SVSST1

	#7	#6	#5	#4	#3	#2	#1	#0
Fn377	SVSAR8	SVSAR7	SVSAR6	SVSAR5	SVSAR4	SVSAR3	SVSAR2	SVSAR1

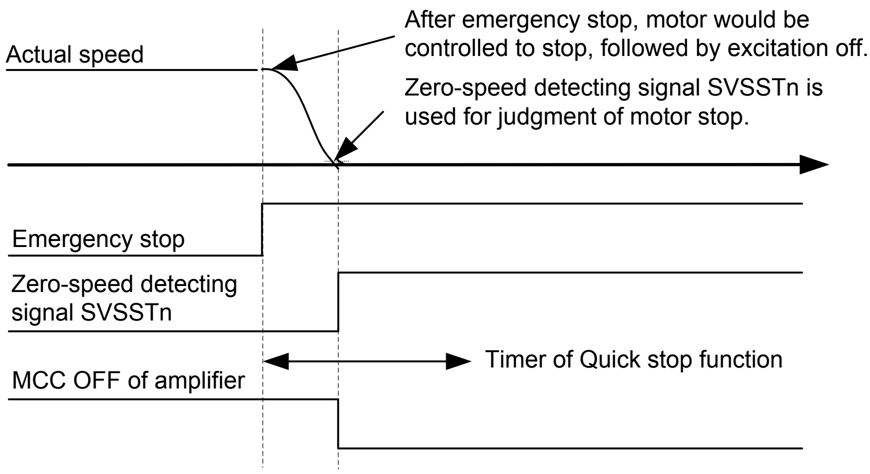
* In the emergency stop state, speed arrival signal SVSARn is set to 0. This signal is set to 0 when the servo software recognizes emergency stop. When an emergency stop is applied during rotation or the DB stops after an alarm occurs, SVSARn is set to 0 even in the speed arrival state.
* When the servo off signal is input, speed arrival signal SVSARn is also set to 0.
* Zero-speed detecting signal SVSSTn is a status signal, which is always monitored. So, the signal status changes according to the actual motor speed. (Emergency stop, alarm, servo-off, and other conditions do not affect this signal.)
* If an alarm occurs in the detector built into the motor, such as when the feedback cable is broken, however, feedback data becomes unpredictable, and the output of the signal may be invalid.

> ⚠ **CAUTION**
> These two signals cannot be used as a function (safety function) for protecting operators from danger due to machine operation.

5.12.2 Control Stop Judgment in the Quick Stop Function at Emergency Stop

(1) Overview

When a large servo motor is used for a spindle, it may take at least several seconds until the motor stops even by deceleration with the maximum torque since inertia is large. If you want to apply the quick stop function at emergency stop for such an axis, it is necessary to set at least several seconds for the timer for the emergency stop signal to secure the time required for control stop. Since it is difficult to estimate the time precisely, however, excitation may be cut off before the completion of control stop. To prevent this problem, a longer time is set for the timer and excitation is cut off when the motor is determined to be in the stopped state according to the zero-speed detecting signal (SVSSTn) to stop the motor surely.



(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	Y(25) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	Y(25) and subsequent editions	HRV4
Series 0*i*-D	90C5	-	
	90C8	-	
	90E5	-	
	90E8	-	

To use the zero-speed detecting signal (SVSST), the following series and edition of system software are necessary.

CNC	System software	
	Series	Edition
Power Motion *i*-A	88H0	-
Series 30*i*-A	G00C,G01C,G02C	30 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	30 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	30 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	30 and subsequent editions
	G204	01 and subsequent editions
Series 0*i*-MD	D4F1	25 and subsequent editions
Series 0*i*-TD	D6F1	25 and subsequent editions
Series 0*i* Mate-MD	-	-
Series 0*i* Mate-TD	D7F1	25 and subsequent editions

For the series 30*i*/31*i*/32*i*/35*i*-B, all series and editions support this function.

(3) Parameter

To enable this function, set SSTMCC to 1.

	#7	#6	#5	#4	#3	#2	#1	#0
2422(FS30*i*)				SSTMCC				

SSTMCC(#4) When the quick stop function at emergency stop is enabled and the zero-speed detecting signal (SVSSTn) is set to 1, the excitation of the amplifier is:
0: Not cut off.
1: Cut off.

2483(FS30*i*)	Detection level of speed zero (SSTLV)

[Valid data range] 0 to 10000
[Unit of data] min^{-1}
[Standard setting] 0 (Set value 0 means 45 min^{-1} internally.)
The detection level of speed zero means the speed (min^{-1}) at which the motor is determined to stop. When the actual speed becomes lower than the detection level of speed zero, it is assumed that the motor stops and the zero-speed detecting signal SVSSTn is set to 1.

To set at least several seconds for the timer for the emergency stop signal for the quick stop function at emergency stop, it is necessary to set a longer period not only for the brake control timer, but also for the emergency stop signal of the α*i*PS. For the emergency stop timer of the α*i*PS, up to 400 ms can be set. To set a longer value, prepare an external timer.
(For details, see Section 5.8, "CONTROL STOP FUNCTIONS".)

2083(FS30*i*)	Brake control timer

[Unit of data] ms
[Valid data range] 0 to 32000ms

	#7	#6	#5	#4	#3	#2	#1	#0
2210(FS30*i*)		ESPTM1	ESPTM0					

Emergency stop timer built into the amplifier

ESPTM1	ESPTM0	Delay time
0	0	50ms (Default value)
0	1	100ms
1	0	200ms
1	1	400ms

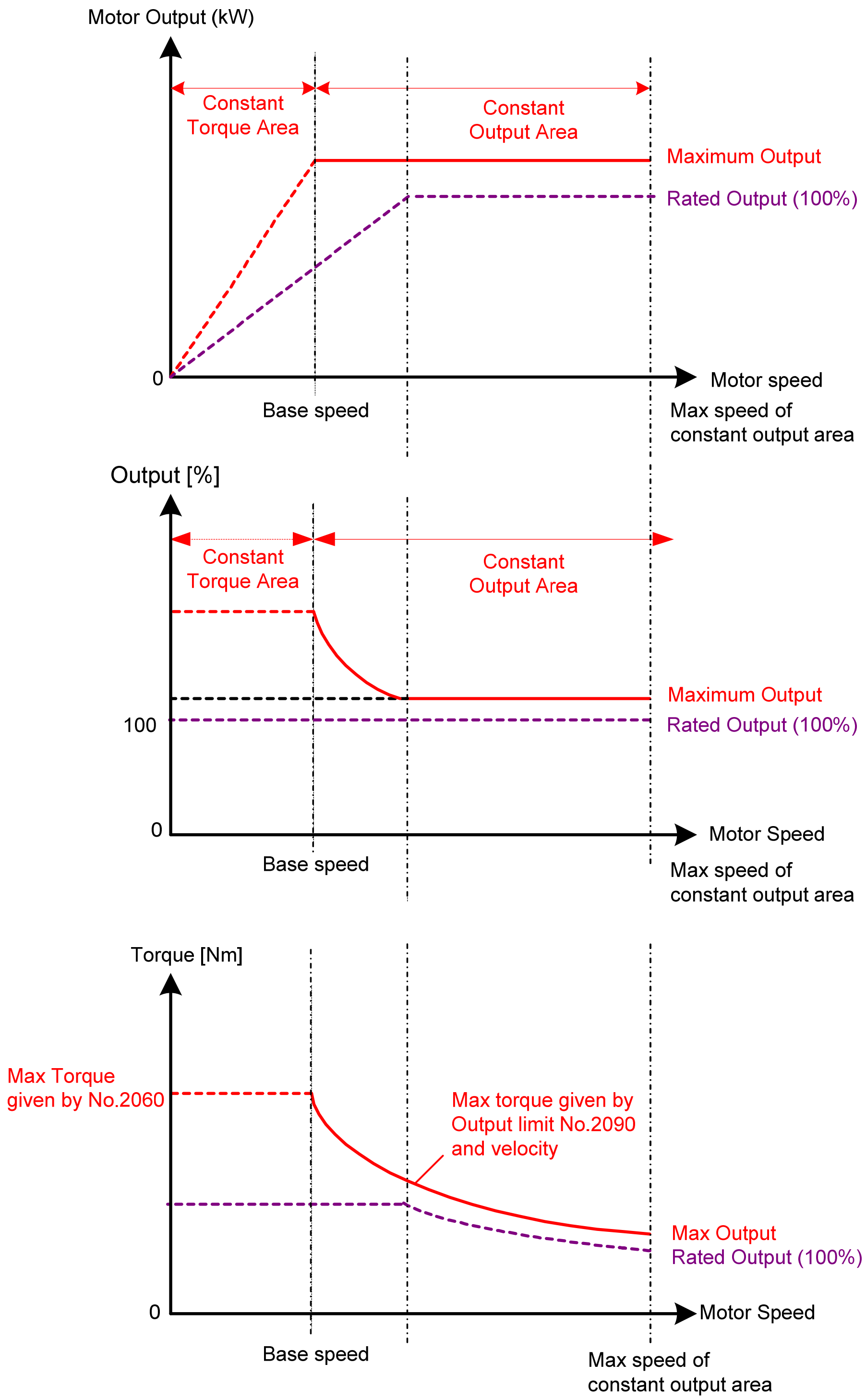
5.12.3 Load Meter Display

(1) Overview

In the same way as when a spindle motor is used, the motor output can be displayed in POWER (%) in the servo tuning screen of the NC, using the rated current as the reference value (100%) in the constant motor torque area or the actual torque to the continuous rated output as the reference value (100%) in the constant output area.

This function is set with the motor standard parameter values. You do not need to change the values. According to whether torque characteristic switching (bit 5 of parameter No. 2014) is enabled or disabled, however, the display on the servo tuning screen is changed from CURRENT (%) to POWER (%), regardless of whether the spindle control function by a servo motor is enabled or disabled. When bit 5 of parameter No. 2014 is set to disable the function, CURRENT (%) is displayed, for which the rated current is used as the reference value (100%) as conventional.

For details of the load meter display of servo motor, refer to the " Operator's Manual (Common to Lathe System/Machining Center System)" for the relevant CNC (Series 30*i*/31*i*/32*i*-A: B-63944EN, Series 30*i*/31*i*/32*i*-B: B-64484EN, Series 35*i*-B: B-64524EN, Series 0*i*-D: B-64304EN).


Motor Output (kW)
Constant
Torque Area
Constant
Output Area
Maximum Output
Rated Output (100%)
0
Motor speed
Base speed
Max speed of
constant output area
Output [%]
Constant
Torque Area
Constant
Output Area
Maximum Output
Rated Output (100%)
100
0
Motor Speed
Base speed
Max speed of
constant output area
Torque [Nm]
Max Torque
given by No.2060
Max torque given by
Output limit No.2090
and velocity
Max Output
Rated Output (100%)
0
Motor Speed
Base speed
Max speed of
constant output area

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	09.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	-	
	90E1	04.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	-	HRV4
Series 0*i*-D	90C5	D(04) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	D(04) and subsequent editions	
	90E8	A(01) and subsequent editions	

5.13 COMPENSATION FOR REVERSE OPERATION IN HIGH-SPEED FSSB RIGID TAPPING

(1) Overview

When the high-speed FSSB rigid tapping function is used, synchronization error may be generated due to delay of reverse operation of the servo motor at the start of tapping and at the hole bottom. Compensation for reverse operation in high-speed FSSB rigid tapping can be used to decrease synchronization error at the start of tapping and at the hole bottom.

* For setting of the high-speed FSSB rigid tapping, refer to the "Connection Manual (Function)" for the CNC (B-64483EN-1).

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	12.0 and subsequent editions	

(3) Setting parameters

To use compensation for reverse operation in high-speed FSSB rigid tapping, set the following parameters.

	#7	#6	#5	#4	#3	#2	#1	#0
2423					RGDFRC	RGDBLA		

RGDBLA (#2) Compensation for reverse operation and at the start of high-speed FSSB rigid tapping is:
0: Disabled.
1: Enabled.

RGDFRC (#3) Compensation for reverse operation and at the start of high-speed FSSB rigid tapping is enabled:
0: Only for reverse operation.
1: For reverse operation and at the start of tapping.

2613	Compensation amount for reverse operation in high-speed FSSB rigid tapping

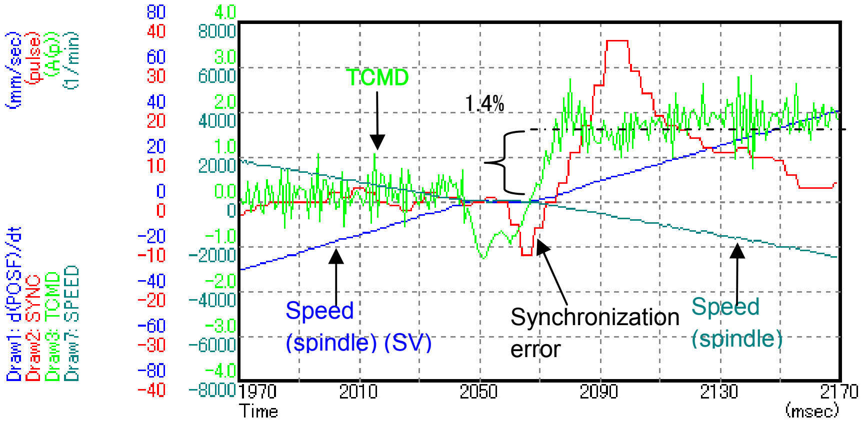
[Unit of data] 0.01% (Set value 10000 is equivalent to the maximum current of the amplifier.)
Set the compensation amount for reverse operation in the high-speed FSSB rigid tapping mode.

(4) Caution

* When compensation for reverse operation and at the start is enabled (bit 2 of parameter No. 2423 is set to 1), the backlash acceleration function and static friction compensation are disabled.

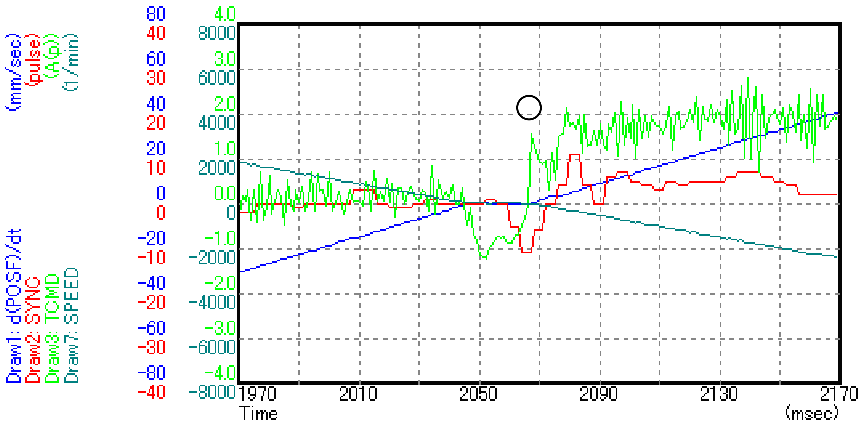
(5) Standard compensation amount

Observe the TCMD (torque command) waveform during reverse operation (at the hole bottom) and use the difference between TCMD immediately before reverse operation and TCMD immediately after reverse operation as the standard compensation amount.



Compensation for reverse operation: OFF

TCMD (after reverse operation - immediately before reverse operation) = 1.4%



Compensation for reverse operation: ON

Set 140 for parameter No. 2613.

TCMD rises at reverse operation (section indicated with ○) earlier and synchronization error is decreased.

5.14 FUNCTION FOR OBTAINING CURRENT OFFSETS AT EMERGENCY STOP

(1) Overview

The current offset is a current feedback offset value arising from the analog offset voltage of the current detector. If the current offset is measured incorrectly, motor current feedback can be adversely affected, resulting in very small motor rotation fluctuations (four components per motor revolution).
A current offset measurement is made when the power is turned on.
This function performs a current offset measurement not only at power-on time but also in each emergency stop state.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

Set the following parameter to obtain current offsets at emergency stop again.

	#7	#6	#5	#4	#3	#2	#1	#0
2201								CROFS

CROFS (#0) Function for obtaining current offsets at emergency stop is:
0: Disabled.
1: Enabled.

6 LEARNING CONTROL FUNCTIONS (OPTIONAL FUNCTION)

(1) Overview

Learning control is used to minimize the effect of follow-up delay and disturbance for cyclic commands and disturbance. This control allows control deviation to be automatically reduced by repeating the same movement. The compensation data (learning data) for reducing control deviation is generated in the volatile memory for learning (learning memory). The learning data generated in the learning memory can be transferred from the servo to CNC memory or external memory (learning data transfer) to save and reuse the data. In this case, learning operation for reducing control deviation becomes unnecessary and it is possible to realize high-precision machining from the beginning.
Learning control is used for cam and crank-pin grinding machines, gear cutting machines, and other machines that require high speed and high precision. The following learning control functions are also available: learning control for rigid tapping, learning control available only for parts with the same shape, and others. (See the table below.)

To use learning control, it is necessary to select the following options according to the application.

"High precision learning control A (preview repetitive control) and high precision learning control B (learning control)" are options applicable to repetitive commands (G05) using high-speed cycle machining and high-speed binary program operation. To use these options with a 30i-A series CNC, a servo card with large-capacity memory is required. Multiple learning data items corresponding to each workpiece can be saved in the learning memory and these learning data items generated in the learning memory can be transferred to the CNC memory and an external memory. These options are applied to cam and crank-pin grinding, and others. For machining in which the value specified in the repetitive command gradually changes, such as piston lathing, high precision learning control. A can be applied to follow the change in the value in the command.

"High precision learning control C (compact learning control)" is an option applicable to a repetitive command written in normal NC statements. For high precision learning control C, not the time, but the position or angle is used as the cycle used as the base of learning, so learning control can be implemented with small-capacity learning memory. Even with a 30i-A series CNC, a standard servo card can be used. However, it is impossible to save multiple learning data items or transfer learning data. This option is applied to Arc. Complement (oscillation cutting) used with a grinding machine and gear cutting.

"Learning control for parts cutting A (learning control for parts cutting)" is an option applied specifically for parts cutting for machining a large amount of parts with the same shape. "Learning control for parts cutting B (learning control for rigid tapping)" is an option applied specifically for rigid tapping.

	Main application	CNC	Option	Servo card
General	Cam grinding Crank-pin grinding Piston lathing Lens cutting	30*i*-B / 31*i*-B	High precision learning control A	Standard servo card (A11,A12,A13,A24,A26)
			High precision learning control B	
		30*i*-A / 31*i*-A	Preview repetitive control	Servo card specifically for learning control (L24)
			Learning control	
	Gear cutting Jig grinding Oscillation cutting	30*i*-B / 31*i*-B	High precision learning control C	Standard servo card
		30*i*-A / 31*i*-A	Compact learning control	Standard servo card (B11,B12,B13,B24,B26)
Limitation	Parts cutting	30*i*-B / 31*i*-B / 32*i*-B	Learning control for parts cutting A	Standard servo card
		30*i*-A / 31*i*-A / 32*i*-A	Learning control for parts cutting	Servo card specifically for learning control(L24)
	Rigid tapping	30*i*-B / 31*i*-B / 32*i*-B	Learning control for parts cutting B	Standard servo card
		30*i*-A / 31*i*-A / 32*i*-A	Learning control for rigid tapping	Standard servo card

(2) Series of applicable servo software

The following table lists series of servo software applicable to learning control (series for learning control) and standard series of servo software (standard series).

Standard series		Series for learning control		Remarks
Series of servo software	**CNC**	**Series of servo software**	**CNC**	
90D0	30*i*-A / 31*i*-A	90D3	30*i*-A / 31*i*-A	HRV2 to HRV4 (Note) supported (2 axes / 1DSP)
		90E7		
90E0, 90E1	30*i*-A / 31*i*-A / 32*i*-A	90E3	30*i*-A / 31*i*-A / 32*i*-A	HRV2 to HRV3 supported
90G0	30*i*-B / 31*i*-B / 32*i*-B / 35*i*-B	90G3	30*i*-B / 31*i*-B / 32*i*-B	HRV2 to HRV4 supported

NOTE

When angle based learning control is used with HRV4, refer to "90G3 Series LEARNING CONTROL OPERATOR'S MANUAL (ANGLE BASED LEARNING CONTROL)" (A-63639E-204).

⚠ CAUTION

When selecting any of the following options, carefully check the series and editions of applicable servo software:

- Compact learning control(30*i*-A)
  Series 90E3/05 and subsequent editions
- Learning control for rigid tapping(30*i*-A)
  Series 90D3/03 and subsequent editions
- High precision learning control A(30*i*-B)
  Series 90G3/02 and subsequent editions

(3) Number of controlled axes

The maximum number of controlled axes in a CNC system depends on the used servo card type and HRV control type. In addition, when learning control is used, the number of available controlled axes may be decreased according to the number of learning controlled axes. The following table lists the number of available controlled axes when learning control is used.

> **NOTE**
> With a Series 30*i*-B or later CNC, learning control is also available for an axis on an additional-axis board. When servo card A26 and an additional-axis board are used together, learning control is available for up to ten axes.

Option		CNC	Number of controlled axes
High precision learning control A	(J706)	30*i*-B / 31*i*-B	(Maximum number of controlled axes) - (number of learning controlled axes)
High precision learning control B	(J705)		
Preview repetitive control	(J706)	30*i*-A / 31*i*-A	
Learning control	(J705)		
High precision learning control C	(R692)	30*i*-B / 31*i*-B	(Maximum number of controlled axes) - (number of learning controlled axes)
Compact learning control	(R692)	30*i*-A / 31*i*-A	
Learning control for parts cutting A	(R510)	30*i*-B / 31*i*-B / 32*i*-B	Maximum number of controlled axes (independent of the number of learning controlled axes)
Learning control for parts cutting	(R510)	30*i*-A / 31*i*-A / 32*i*-A	
Learning control for parts cutting B	(R539)	30*i*-B / 31*i*-B / 32*i*-B	Maximum number of controlled axes (independent of the number of learning controlled axes)
Learning control for rigid tapping	(R539)	30*i*-A / 31*i*-A / 32*i*-A	

Example 1)

Suppose that the 31*i*-A is used, the learning control option is enabled, and servo software of series 90E3, servo card L24, and HRV3 control are used together. In this case, the maximum number of controlled axes is 12. When four of these controlled axes are used for learning control, the number of available controlled axes is 12 - 4 = 8 axes.

Example 2)

Suppose that the 30*i*-B is used, the learning control option is enabled, and servo software of series 90G3, servo card A26, and HRV3 control are used together. In this case, the maximum number of controlled axes is 24. When six of these controlled axes are used for learning control, the number of available controlled axes is 24 - 6 = 18 axes.

(4) Order specification

1) Options and hardware
   03xx (middle four digits) of the specification differs depending on the CNC.

Option	CNC	CPU card	Servo card
High precision learning control A (A02B-032x-J706)	30*i*-B / 31*i*-B	B2 (A02B-0323-H010)	Standard servo card (A11,A12,A13,A24,A26)
High precision learning control B (A02B-032x-J705)			
High precision learning control C (A02B-032x- R692)	30*i*-B / 31*i*-B	All types	Standard servo card
Learning control for parts cutting A (A02B-032x-R510)	30*i*-B / 31*i*-B / 32*i*-B	B2 (A02B-0323-H010) A2 (A02B-0323-H013) C2 (A02B-0323-H016)	Standard servo card
Learning control for parts cutting B (A02B-032x-R539)	30*i*-B / 31*i*-B / 32*i*-B	B2 (A02B-0323-H010) A2 (A02B-0323-H013) C2 (A02B-0323-H016)	Standard servo card

Option	CNC	CPU card	Servo card
Preview repetitive control (A02B-030x-J706)	30*i*-A / 31*i*-A	D3 (A02B-0303-H010)	Servo card specifically for learning control (L24)
Learning control (A02B-032x-J705)			
Compact learning control (A02B-030x- R692)	30*i*-A / 31*i*-A	All types	Standard servo card (B11,B12,B13,B24,B26)
Learning control for parts cutting (A02B-030x-R510)	30*i*-A / 31*i*-A / 32*i*-A	A6 (A02B-0303-H013) C6 (A02B-0308-H016) D3 (A02B-0303-H010)	Servo card specifically for learning control (L24)
Learning control for rigid tapping (A02B-030x-R539)	30*i*-A / 31*i*-A / 32*i*-A	A6 (A02B-0303-H013) C6 (A02B-0308-H016) D3 (A02B-0303-H010)	Standard servo card

2) Software options

When the high precision learning control A (preview repetitive control) or high precision learning control B (learning control) option is selected, either of the following options related to high-speed cycle machining is required:

- High-speed cycle machining A02B-03xx-J832
- High-speed binary program operation A02B-03xx-R516

When high-speed cycle machining or high-speed binary program operation above is used, select the following related options as required:

- High-speed cycle machining skip function A02B-03xx-S662
- High-speed cycle machining retract function A02B-03xx-J663
- High-speed cycle cutting additional variables A/B A02B-03xx-J745/J746
- High-speed cycle cutting additional variables C/D A02B-03xx-S640/R513
- High-speed binary program operation retract function A02B-03xx-S658
- Superimposed control for high-speed cycle machining A02B-03xx-R554
- Superimposed Control A02B-03xx-S818
  (Required to use superimposed control for high-speed cycle machining)
- High-speed cycle machining operation information output function A02B-03xx-R609
- Spindle control switching function for High-speed cycle machining A02B-03xx-R608

For cam or crank-pin grinding using multiple profiles, the following option is required:

- Learning memory expanded function A02B-03xx-J976

NOTE

To use this option, the high precision learning control A (preview repetitive control) or high precision learning control B (learning control) option is required.

For oscillation cutting used with, for example, a jig grinder, the following option is required:

- High precision oscillation function A02B-03xx-R662

NOTE

03xx (middle four digits) of the specification is determined as follows:
30*i*-A: 0303, 31*i*-A5: 0306, 31*i*-A: 0307, 32*i*-A: 0308
30*i*-B: 0323, 31*i*-B5: 0326, 31*i*-B: 0327, 32*i*-B: 0328

(5) Axis allocation

Learning control is applied only to the first axis of each DSP. Reference the table below and set parameter No. 1023.

CNC	Series of servo software	No.1023
30*i*-B / 31*i*-B / 32*i*-B	90G3	1, 9, 17, 25, 33, 41 49, 57, 65, 73 （additional axis）
30*i*-A / 31*i*-A / 32*i*-A	90D3	1, 3, 5, 7, …
	90E7	1, 5, 9, 13, …
	90E3	1, 5, 9, 13, …

(6) Related documents

To use learning control, various settings and operations are required. For details of them, refer to the following documents:

- High precision learning control A (Preview repetitive control) / High precision learning control B (Learning control)
  "FANUC AC SERVO SOFTWARE 90G3 Series LEARNING CONTROL Operator's Manual (Time based Learning control)" (A-63639E-200)
  "FANUC AC SERVO SOFTWARE 90G3 Series LEARNING CONTROL Operator's Manual (Angle Based Learning Control)" (A-63639E-204)
  "FANUC AC SERVO SOFTWARE 90D3/90E3 Series LEARNING FUNCTION Operator's Manual (Time based Learning control)" (A-63639E-108)

- High precision learning control C (Compact learning control)
  "FANUC AC SERVO SOFTWARE 90G3 Series LEARNING CONTROL Operator's Manual (Angle Based Learning Control)" (A-63639E-204)
  "FANUC AC SERVO SOFTWARE 90E3 Series COMPACT LEARNING CONTROL Operator's Manual" (A-63639E-188)

- Learning control for parts cutting A (Learning control for parts cutting)
  "FANUC AC SERVO SOFTWARE 90G3 Series Learning control for Parts cutting A Operator's Manual" (A-63639E-201)
  "FANUC AC SERVO SOFTWARE 90D3/90E3 Series Learning control for Parts cutting Operator's Manual" (A-63639E-115)

- Learning control for parts cutting B (Learning control for rigid tapping)
  "FANUC AC SERVO SOFTWARE 90G3 Series Learning control for Parts cutting B Operator's Manual" (A-63639E-202)
  "FANUC AC SERVO SOFTWARE 90D3/90E3 Series Learning Control for Rigid Tap Operator's Manual" (A-63639E-131)

Reference)

Spindle learning control (option) A02B-03xx-S635
"Spindle learning control" is applied to spindle motor control. This is used with, for example, gear cutting using an electric gear box (EGB).
When the high precision learning control A (preview repetitive control) or high precision learning control B (learning control) option is enabled, the spindle learning control option is not required.

- <u>Spindle learning control</u>
  "FANUC AC SPINDLE MOTOR αi series Spindle learning control DESCRIPTIONS" (A-63639E-132)

7 SERVO TUNING TOOL SERVO GUIDE

(1) Overview

Servo tuning tool "SERVO GUIDE" is an integrated tuning tool for servo and spindle axes that runs on a PC. This tool can be connected to the CNC to observe operation of servo and spindle axes with waveforms. The automatic tuning feature called "Tuning Navigator" extensively supports you to enable serve tuning with simple operations.

[Order specification of the package for new purchase]
A08B-9010-J900 (Supplied on one CD-ROM disk)

[Order specification of the package for upgrade]
A08B-9010-J901 (Supplied on one CD-ROM disk)
To install SERVO GUIDE supplied on the CD for upgrade, a previous version of SERVO GUIDE must have been installed on your PC.

[Order specification of the package for 3-D View Function]
A08B-9010-J904 (Supplied on one CD-ROM disk and one hardware key)

NOTE
3-D View Function (option) comes with a CD for upgrade (A08B-9010-J901).

(2) Operating environment

■ **Applicable SERVO GUIDE editions**

CNC	SERVO GUIDE Edition	Remarks
Series 30*i*/31*i*/32*i*/35*i*-B	7.30 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	3.00 and subsequent editions	
Series 0*i*-D	6.00 and subsequent editions	
Power Motion *i*-A	8.00 and subsequent editions	

■ Necessary hardware and software configuration
Operating this software requires the hardware and software configuration below.

Necessary hardware and software configuration

Item	Description
Computer	IBM PC/AT COMPATIBLE, or CNC display unit with PC functions (PANEL *i*)
OS	Microsoft Windows 2000/XP/Vista(32bit), Windows 7(32bit, 64bit) (Note 1, 2) Supported language: Japanese, English, Chinese versions (Simplified, Traditional)
CPU	Windows 7 : Pentium III 1GHz or higher recommended Windows Vista : Pentium III 1GHz or higher recommended Windows XP : Pentium III 500MHz or higher recommended Windows 2000 : Pentium 200MHz or higher recommended
Memory	Windows 7 : 512MBytes or more (1GB or more recommended) Windows Vista : 512MBytes or more (1GB or more recommended) Windows XP : 256MBytes or more (512MB or more recommended) Windows 2000 : 128MBytes or more (256MB or more recommended)
Hard-disk space	50MBytes or more (Note 3) (100MBytes on installing)

Item	Description
Display resolution	SVGA (800*600) or higher (Note 4) (XGA (1024*768) or higher is recommended) (Note 5)
Others	Port of Ethernet (LAN) (in case of Ethernet connection) A pointing device such as a mouse is required. For browsing online help, Internet Explore 4.01 or later is required.

* Microsoft and Windows are trademarks of Microsoft Corporation in the United States.
* Other company and products name are either registered trademark or trademarks of each company.

NOTE
When opening multiple screens, allocate memory as large as possible.

(Note 1) Windows 95/98/Me/NT4.0 are not supported.
(Note 2) If 3-D View Function (option) is to be used, OpenGL1.4 or later is required. A USB port is required to attach an OpenGL-compliant graphic card and a hardware key.
(Note 3) In addition, the space for storing measurement data is required.
(Note 4) Although SVGA also can be used, when two or more windows are opened simultaneously, it becomes hard to see by window overlap.
(Note 5) If 3-D View Function (option) is to be used, 2-D and 3-D graphs cannot be viewed simultaneously unless XGA or higher is used.

Apart from the above, the hardware configuration below may be required.

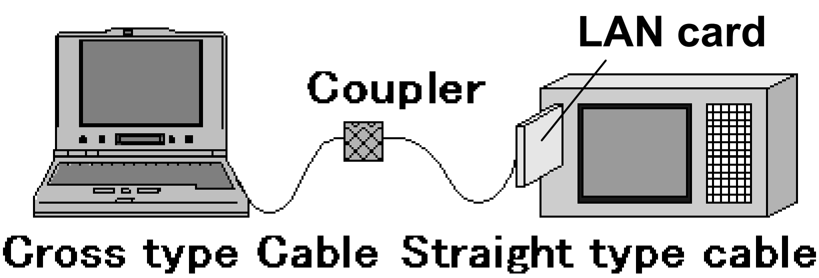
Other hardware configuration

Item	Description
PCMCIA LAN card	Used for an Ethernet connection. (Note 1, 2) Use the FANUC-designated one (A02B-0281-K710).
Coupler	Used for an Ethernet connection. (Note 1) It is commercially available, and can be obtained from a PC shop, etc.
Ethernet cable (cross)	Used for an Ethernet connection. (Note 1) It is commercially available, and can be obtained from a PC shop, etc.
Ethernet cable (straight)	Used for an Ethernet connection. (Note 1) It is commercially available, and can be obtained from a PC shop, etc.
Hub	Used for an Ethernet connection. (Note 1) It is commercially available, and can be obtained from a PC shop, etc.
HSSB board	Required for an HSSB connection. (Note 1) Use a FANUC-made HSSB board. If Panel *i* is used, Panel *i* is provided with an HSSB function.
Printer	Required to print acquired waveforms.

(Note 1)

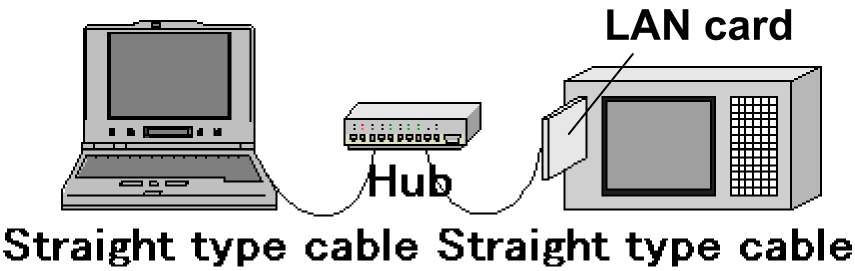
[Ethernet connection (if not using a hub)]

The FANUC-supplied PCMCIA-LAN card comes with a dedicated connector on the card side and a 1.5-m straight cable with an RJ45 male connector on the PC side. The PC and the CNC are connected directly as shown below.



(The cross type cable and coupler are commercially available from ordinary stores dealing in personal computers.)

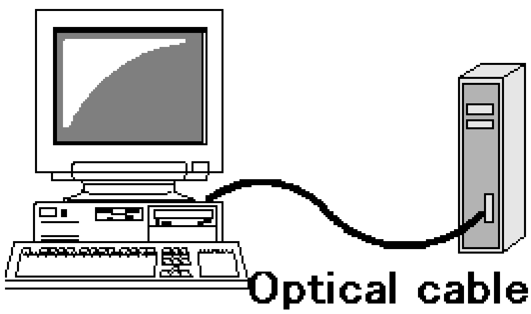
[Ethernet connection (if using a hub)]
When the PC and the CNC are connected via a hub, they are connected as shown in the figure below. In this case, the coupler becomes unnecessary, but a straight type cable must be prepared.



* If using the built-in Ethernet port, do not use a PCMCIA-LAN card but the RJ45 female connector on the CNC.

[HSSB connection]
When HSSB is used, the CNC and the PC are connected using an optical cable as shown in the figure below. So, no special connection must be added to use SERVO GUIDE.

* Also when a CNC display unit with a PC function is used, no special connection is required.



■ Related software series / edition list
The operation of SERVO GUIDE is guaranteed with the combinations below.

(a) System software

CNC models and series / edition of system software

CNC	System software	
	Series	Edition
Series 30*i*-B	G301,G311,G321,G331	01 or later
Series 31*i*-B5	G421,G431	01 or later
Series 31*i*-B	G401,G411	01 or later
Series 32*i*-B	G501,G511	01 or later
Series 35*i* -B	G601,G611	01 or later

CNC	System software	
	Series	Edition
Series 30*i*-A	G004,G014,G024	01 or later
	G003,G013,G023	01 or later
	G002,G012,G022	01 or later
	G00C,G01C,G02C	01 or later
	G00A,G01A,G02A	01 or later
	G001,G011,G021	23 or later
Series 31*i*-A5	G124,G134	01 or later
	G123,G133	01 or later
	G121,G131	01 or later
	G12C,G13C	01 or later
Series 31*i*-A	G104,G114	01 or later
	G103,G113	01 or later
	G101,G111	01 or later
Series 32*i*-A	G201,G203,G204	01 or later
Series 0*i*-MD	D4F1	01 or later
Series 0*i*-TD	D6F1	01 or later
Series 0*i* Mate-MD	D5F1	01 or later
Series 0*i* Mate-TD	D7F1	01 or later
Power Motion *i*-A	88H0	01 or later

* For system software series/editions supporting I/O Link β*i*, refer to the function correspondence table in an appendix in "FANUC SERVO GUIDE OPERATOR'S MANUAL (B-65404EN)" or online help.

(b) FOCAS1/2-related software

CNC models and series / edition of FOCAS1/2-related software

FOCAS1/2-related software	CNC models	Specification	Series / Edition
Control software for embedded Ethernet function	Series 30*i*/31*i*/32*i*/35*i*-B. Power Motion *i*-A	A02B-0323-J571#658M	658M/01 or later
	Series 30*i*/31*i*/32*i*-A	A02B-0303-J571#656E	656E/06 or later
	Series 0*i*-D	A02B-0319-J571#656E	658E/01 or later 658E/02 or later (support stand-alone type)
Software for Ethernet communication management	Series 30*i*/31*i*/32*i*-A	A02B-0303-J572#656F	656F/07 or later
	Series 0*i*-D	A02B-0319-J572#658F	658F/01 or later
Software for 15" LCD control (if using a 15" LCD)	Series 30*i*/31*i*/32*i*-A	A02B-0207-J595#60VB	60VB/1.3 or later
			60VB/1.7 or later (supports I/O Link β*i*)
		A02B-0207-J903#60VF	60VF1.0 or later (supports I/O Link β*i*)
Windows CE.NET customized OS	Series 30*i*/31*i*/32*i*-A (When personal computer function option with WindowsCE is used)	A02B-0207-J594	1.2 or later
Windows CE.NET FOCAS2/HSSB library		A02B-0207-J808	1.5 or later
			1.7 or later (supports I/O Link β*i*)
		A02B-0207-J875	1.0 or later
Windows CE.NET standard application/ library		A02B-0207-J809	1.2 or later

* For software series/editions related to FOCAS1/2 supporting I/O Link β*i*, refer to the function correspondence table in an appendix in "FANUC SERVO GUIDE OPERATOR'S MANUAL (B-65404EN)" or online help on SERVO GUIDE.

(c) Servo software

CNC models and series / edition of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	C(03) and subsequent editions 01.0	
Series 30*i*/31*i*-A	90D0	C(03) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

* For system software series/editions supporting each function of Tuning Navigator, refer to the function correspondence table in an appendix in "FANUC SERVO GUIDE OPERATOR'S MANUAL (B-65404EN)" or Help page.

(3) Outline of software specifications

Servo tuning tool, “SERVO GUIDE” consists of four software functions including three types of window, which are the Parameter Window, the Graph Window, and the Program Window, and a tuning support wizard called Tuning Navigator.
The following outlines the specifications of these software functions.

(a) Parameter Window

- Parameters on the CNC are read and can be changed on the personal computer.
- Servo and spindle parameters are classified and displayed for each function.
- Automatic acceleration/deceleration functions for high speed and high-precision are supported
- CNC parameters can be changed on the personal computer.

Details of function groups that can be set in the Parameter Window

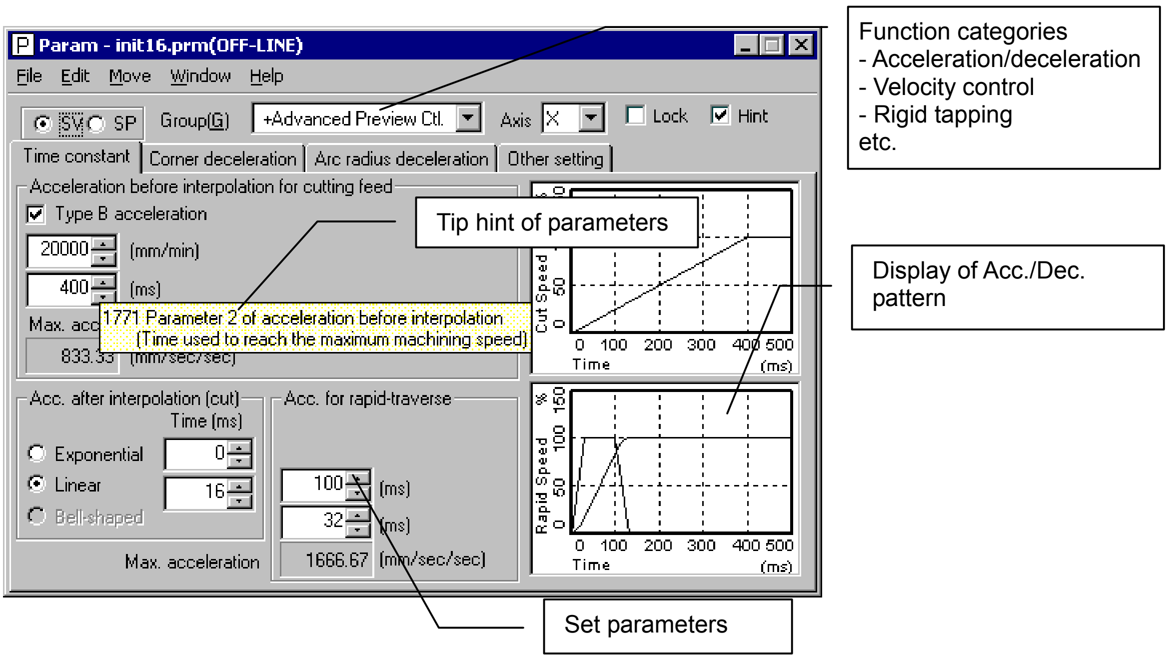
[Servo]

Group	Description
System setting	CNC options related to servo systems are extracted and displayed.
Servo axis setting	Use of separate detector, rotary motor/linear motor/synchronous built-in servo motor (DD motor), CMR, flexible feed gear, setting of AMR, and setting of acceleration sensor, etc.
Acceleration/ deceleration	Time constant of Acc./Dec. before interpolation and time constant of Acc./Dec. after interpolation, speed difference in automatic corner deceleration, setting for arc radius-based feed rate clamp, setting for acceleration-based deceleration, Jerk control (Normal control, advanced preview control, AI advanced preview control, AI contour control, AI nano contour control, high precision contour control, AI high precision contour control, AI nano high precision contour control, AI contour control I and II)
Current control	HRV, HRV2, HRV3, and HRV4 control, and setting of current gain
Velocity control	Velocity loop gain setting, setting of the function of vibration suppression in the stop state, setting of filters for eliminating machine resonance, vibration damping control, setting of dual position feedback, and setting of the full-closed loop function, etc.
Position control	Position gain
Contour error suppression	Feed-forward, backlash acceleration, interactive force compensation, and fine Acc./Dec. (16*i* series only)
Improvement in overshoot	Setting of overshoot compensation function

Group	Description
High-speed positioning function	Setting of position gain switching function, etc.
Stop	Setting of brake control, quick stop., and lifting function against gravity, etc.
Unexpected disturbance torque detection	Adjustment of estimated disturbance value, alarm detection level
Linear motor	Setting of feedback, setting of AMR, and setting of smoothing compensation
DD motor	Setting of feedback, setting of AMR, and setting of smoothing compensation
Tandem control axes	Setting of tandem control axes
Pole position detection	Setting of pole position detection functions

[Spindle]

Group	Description
System setting	CNC options related to spindle systems are extracted and displayed.
Spindle system configuration	Motor end sensor (main and sub) setting, spindle end sensor (main and sub) setting, gear ratio (main and sub)
Normal mode velocity control	Velocity loop gain setting, and setting of filters (main and sub) for eliminating vibration, resonance elimination filter
Orientation	Stop position setting, velocity control setting (main and sub), position control setting (main and sub), acceleration setting (optimum orientation, high-speed orientation), resonance elimination filters
Rigid tapping	Command setting, velocity control setting (main and sub), position control setting, fine Acc./Dec. (16*i* series only)
Cs contour control	Command setting, velocity control setting, position control setting, fine Acc./Dec. (16*i* series only), resonance elimination filters
Spindle synchronous control	Velocity control setting, position control setting, resonance elimination filters
Synchronous spindle	Pole position detection, setting of AMR, current pattern, alarm detection level



Parameter Window (example)

(b) Graph Window

- Data measurement display function
  - Horizontal axis time mode
    Normal mode, first order differential mode, second order differential mode, third order differential mode (YT mode)
    Feed smoothness measurement mode (DXDY mode)

Tangent speed display mode (XTVT mode)
Synchronous error measurement mode (Synchro mode)

- XY mode (Polar coordinates conversion and angular axis conversion also available)
- Arc path error zoom mode (Circle mode)
- Contour path error zoom mode (Contour mode)
- Frequency spectrum analysis mode (Fourier mode)
- Velocity loop and position loop frequency response mode (Bode mode)

For servo and spindle axes, data measurement is possible. (Data of both servo and spindle axes can also be measured at the same time.)

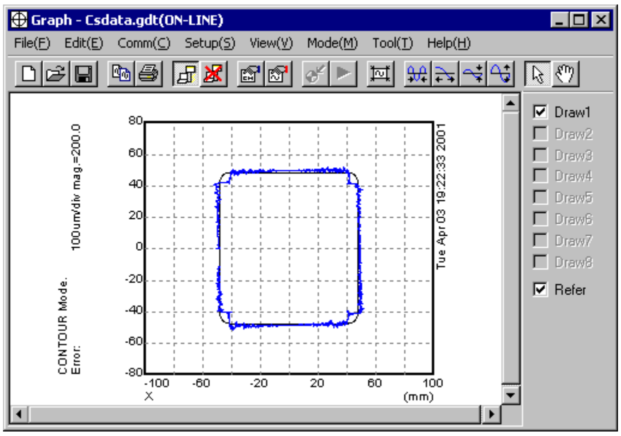
	Maximum number of channels that can be measured simultaneously
Total	8 channels
Per two servo axes	4 channels (*)
Per spindle	4 channels (*)
PMC	Up to 16 PMC signals can be measured simultaneously on one channel. (*)
I/O Link β*i*	2 channels (*)

* Up to four channels can be measured for servo axes that have successive numbers set in parameter No. 1023, 2n-1,2n (n: Non-negative integer).
* Up to four channels can be measured for an α*i* spindle axis connected to the FSSB. (Up to two channels can be measured for a conventional spindle axis.)
* With the Series 0*i*-D, up to eight PMC signals can be measured simultaneously.
* Only one I/O Link β*i* axis can be measured at a time.
* Different I/O Link β*i* axes cannot be measured simultaneously.
* An I/O Link β*i* axis and another CNC axes cannot be measured simultaneously.

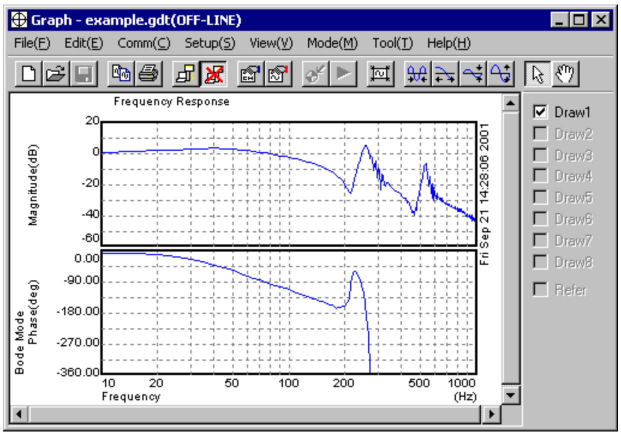
Display data can be printed out.

* Bit map data can be read via the clip board.

The highest-speed sampling period equals the current control period or 62.5 μs, whichever longer. (Servo axis only)



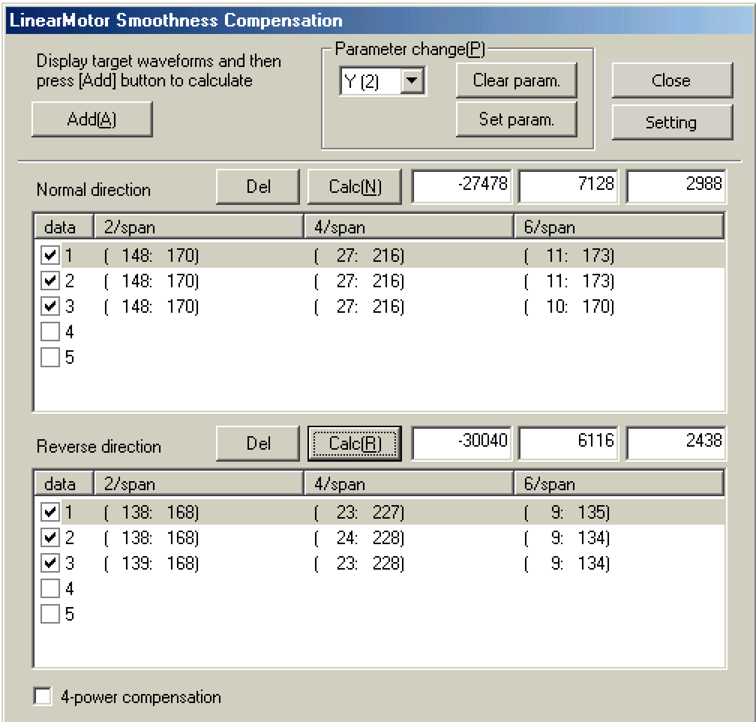
Example of contour error measurement in Cs contour axis control



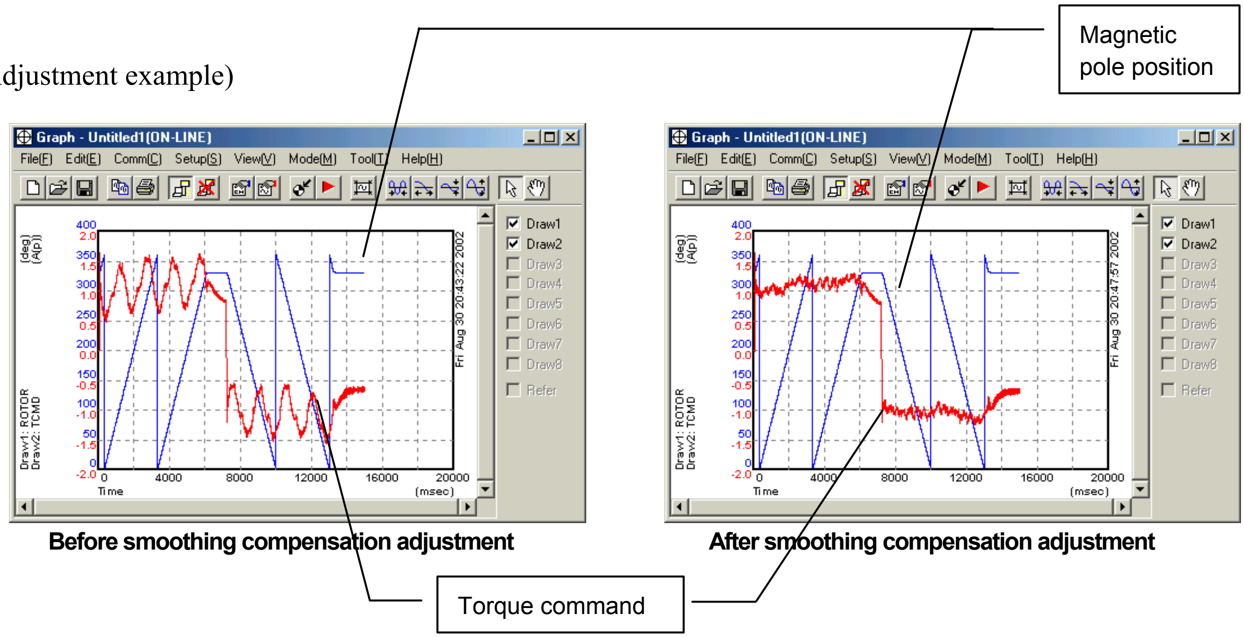
Example of velocity loop frequency response

- Smoothness compensation setting support functions
  With this function, parameters of the smoothing compensation function, which improves the smoothness of linear motor or synchronous built-in servo motor feed, can be determined easily.

(Screen example)



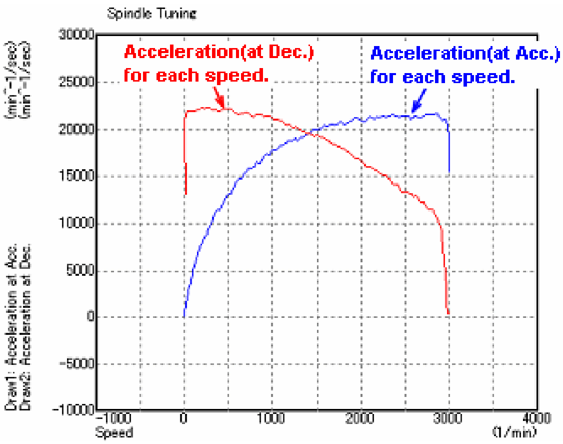
(Adjustment example)



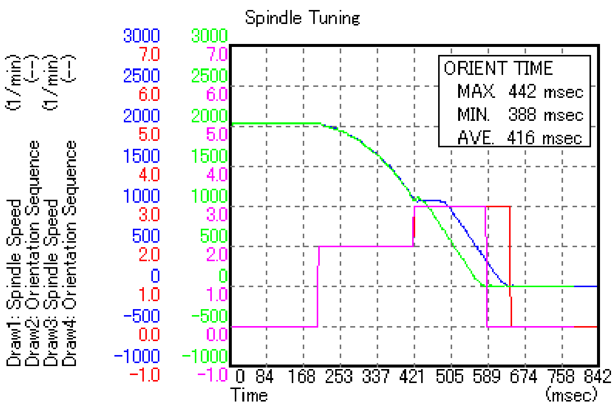
Before smoothing compensation adjustment **After smoothing compensation adjustment**

- Spindle Tuning functions
  These functions support the automatic acquisition of data during the acceleration/deceleration of the spindle, data during orientation, and data for frequency response.

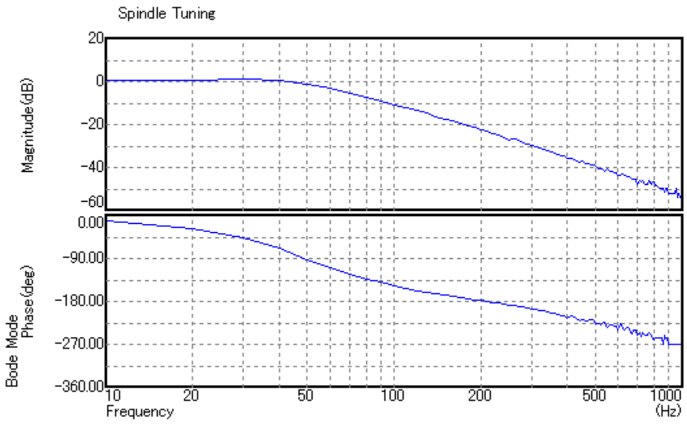
(Acquired data examples)



Measurement of acceleration/deceleration performance (Speed - Acceleration characteristics)

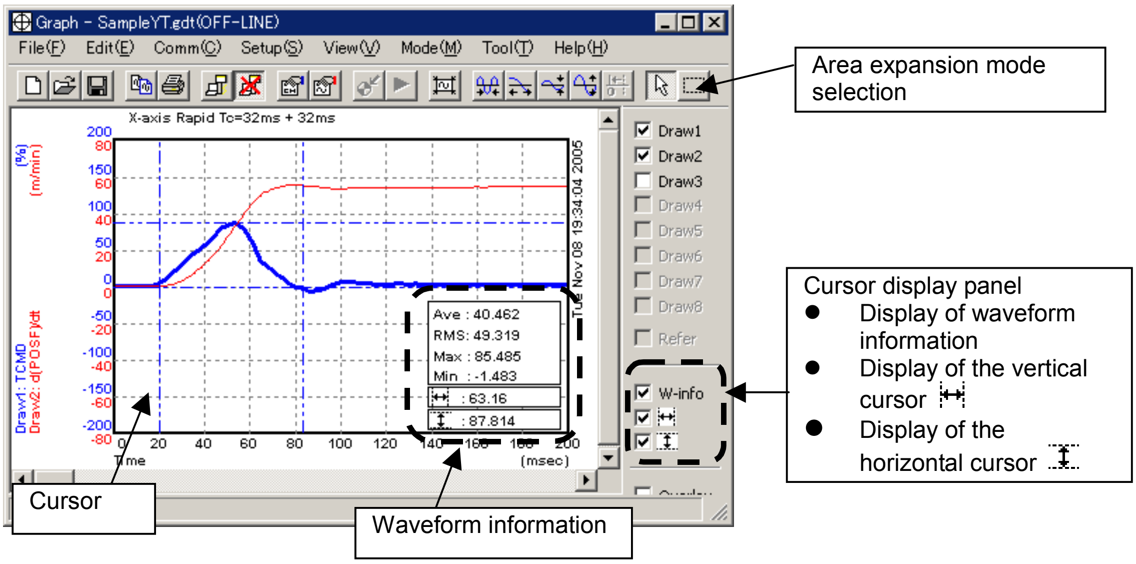


Measurement of orientation (Orientation time)



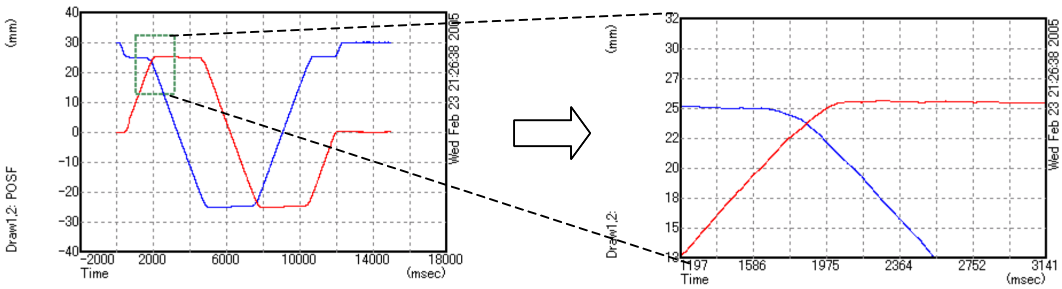
Frequency response measurement

- Cursor function



By using the horizontal and vertical cursors, a waveform measurement can be made.
The type of possible measurement depends on the display mode as described below:

- YT mode:Inter-cursor differential measurement (time measurement)
  Measurements of a maximum value (Max), minimum value (Min), average (Ave), and root-mean-square (RMS) value in an inter-cursor area
- XY mode: Inter-cursor differential measurement
- Fourier mode: Frequency, magnitude, phase
- Bode mode: Frequency, gain, phase
- Area expansion function
  In the area expansion mode, a rectangular area can be selected by dragging the left mouse button within the graph display area. By left-clicking in the selected area, the selected area can be enlarged.



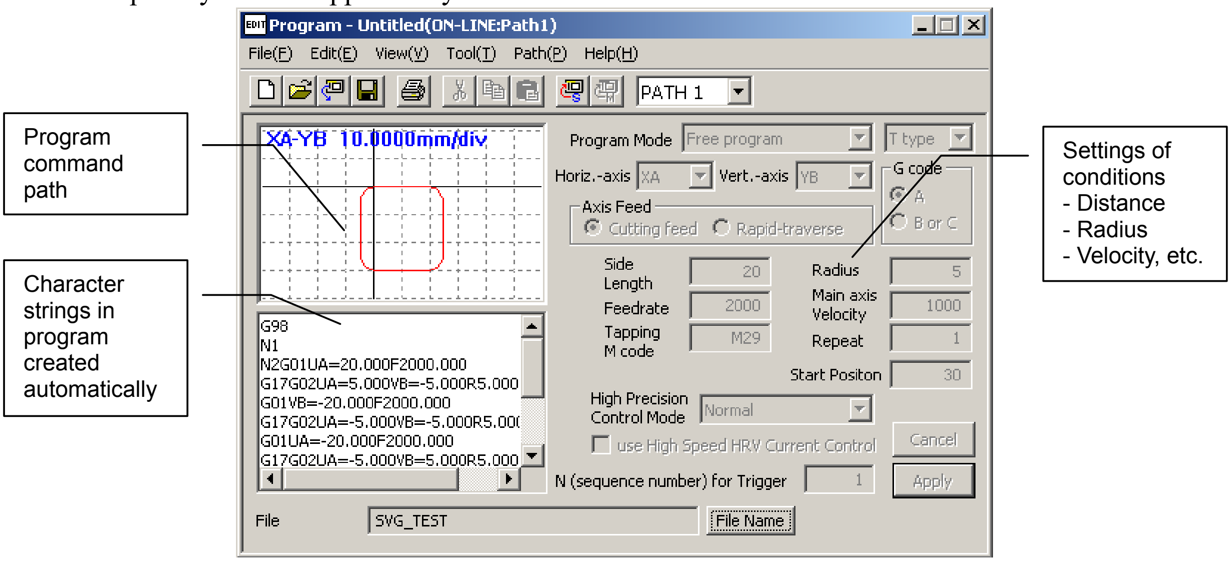
Left-click in a selected rectangular area.

(c) Program Window

- Test program creation support function
  - Linear acceleration/deceleration for one axis
  - Circle
  - Square
  - Square with rounded corners
  - Rigid tapping
  - Cs contour

- Display of test program path
- Sending a test program to CNC memory and executing it
  (The operator needs to press the start button.)
- Selecting a program in CNC memory and executing it
  (The operator needs to press the start button.)
- Printing of a created program

* The multipath system is supported by Version 3.00 or later.



Program Window (example)

(d) Tuning Navigator

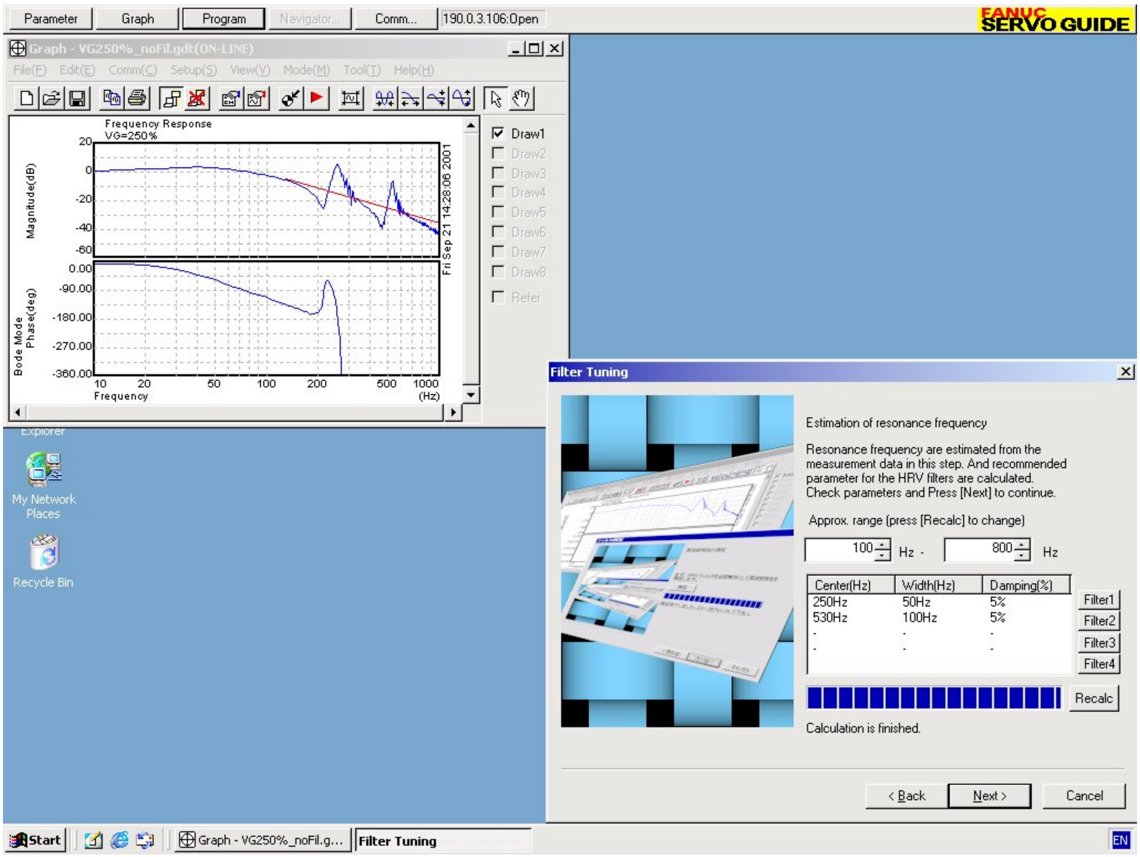
- Automatic tuning functions (servo tuning support functions)
  - Automatic tuning of velocity loop gain and filters
  - Support of high-speed and high-precision function setting
  - Tuning for time constant at rapid traverse
  - Tuning for Automatic Backlash Acceleration function
  - Tuning support of unexpected disturbance torque detection function
  - Tuning support of interactive force compensation function
  - Automatic tuning of spindle filters

NOTE

Some functions cannot be used depending on the version of SERVO GUIDE and the series and editions of the CNC and servo software.

[Automatic tuning of velocity loop gain and filters]

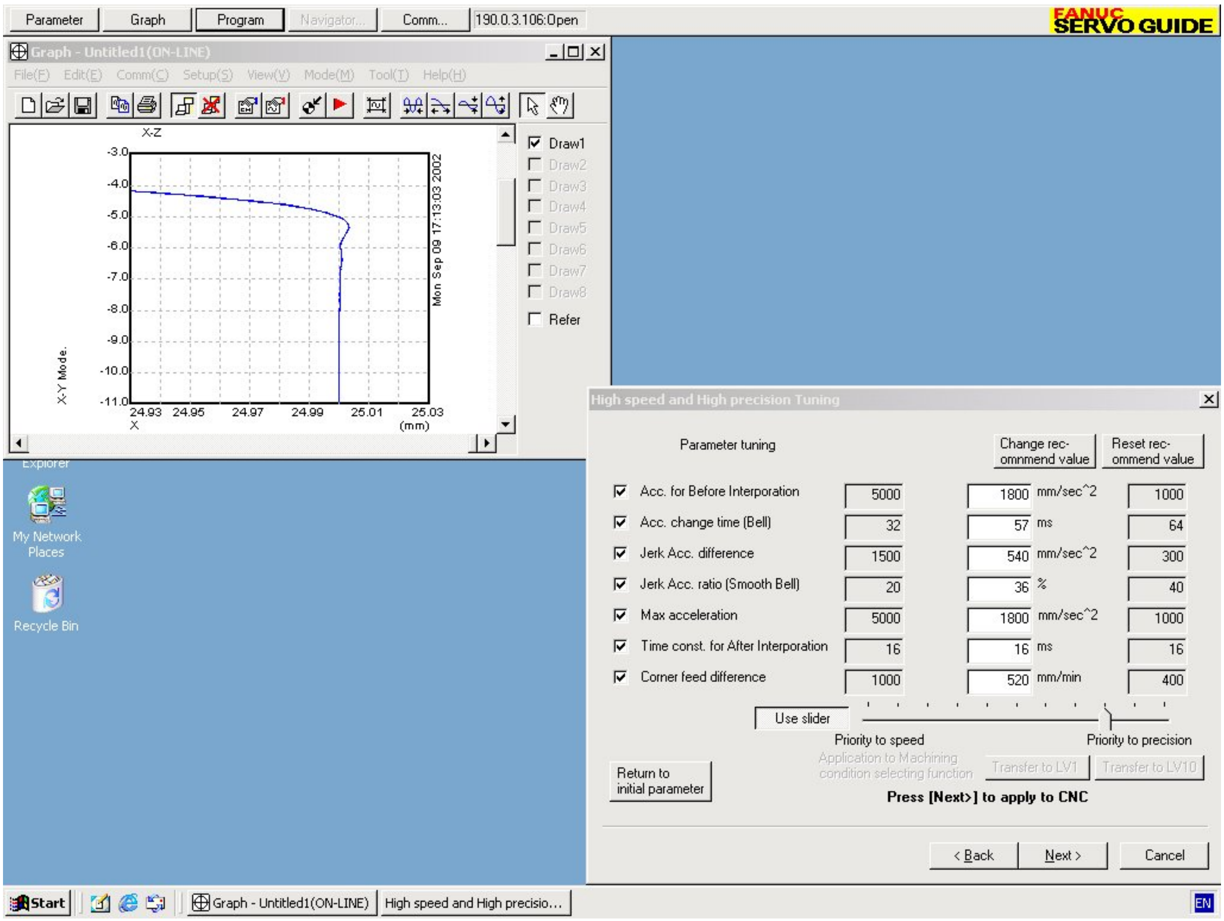
By measuring the frequency response of velocity control loop with moving axis, and the parameters of the velocity loop gain and resonance elimination filters are determined automatically. It is also possible to fine-tune the indicated parameter values and check the effect of the fine-tuning.



Filter adjustment (example)

[Support of high-speed and high-precision function setting]

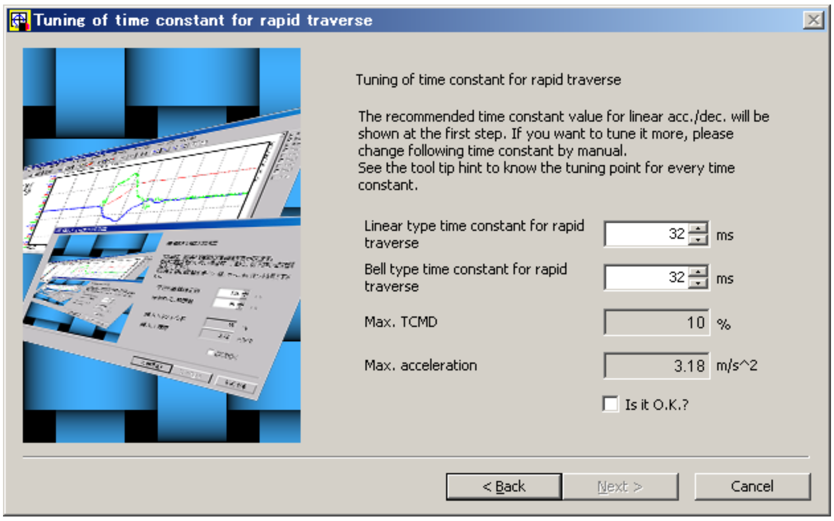
In a program of a square with rounded corners, the high-speed and high-precision function parameters are tuned while overshoots are checked. There are tuning parameters for the high-speed and high-precision function. FANUC provides recommended parameter sets (for speed priority and precision priority), and an intermediate value between recommended parameter values can be selected easily just by using a slider.



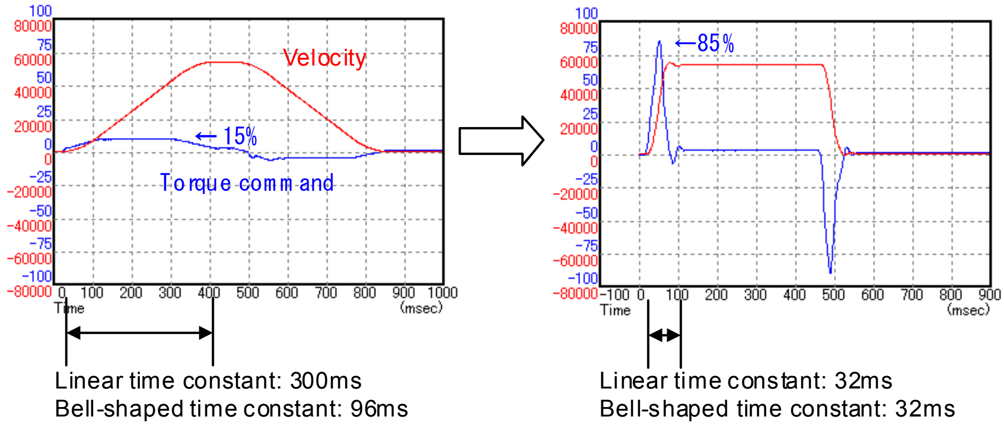
Tuning of the high-speed and high-precision function (example)

[Tuning for time constant at rapid traverse] (Version 4.00 or later)

By measuring the velocity and torque while moving the axis at rapid traverse, the rapid traverse time constant is determined automatically. With this function, a rapid traverse time constant can be determined quickly and easily.



Example of tuning



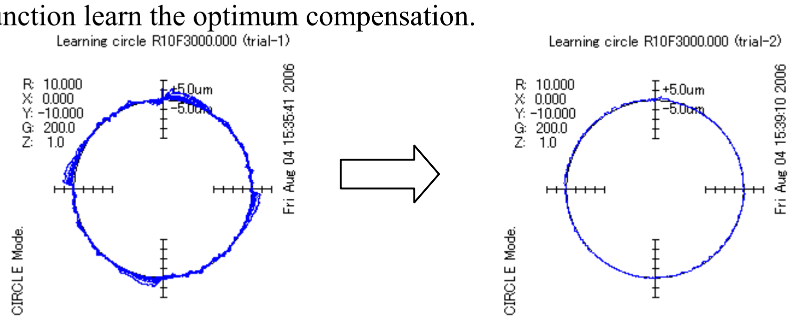
[Tuning for Automatic Backlash Acceleration function] (Version 4.00 or later)

By making several circular motions, this function automatically determines the parameters for the quadrant protrusion compensation function for Tuning Navigator. With this function, quadrant protrusion tuning on an arc can be performed quickly and easily.

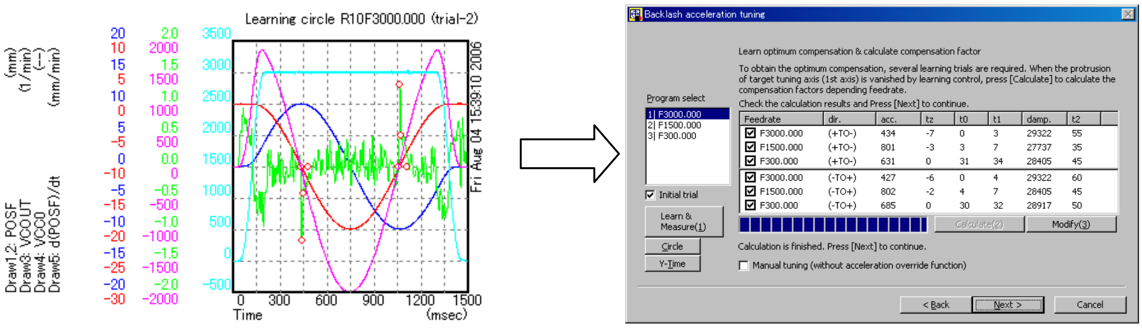
For details, see Appendix M, "QUADRANT PROTRUSION TUNING USING SERVO GUIDE".

Example of tuning

<1> Make circular motions until the quadrant protrusion becomes sufficiently small to let the function learn the optimum compensation.

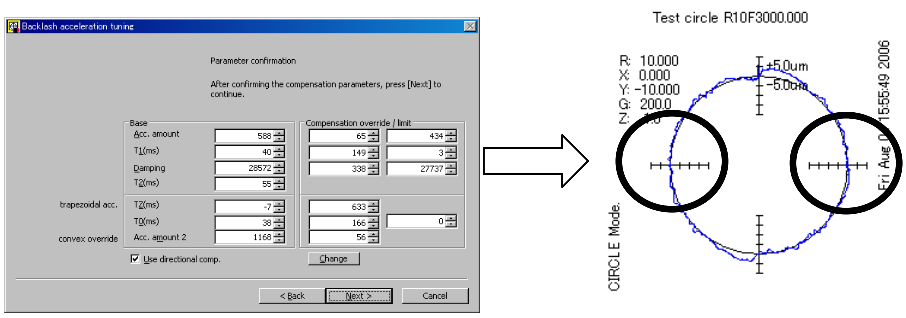


<2> Let the function calculate the compensation based on the result of learning.



<3> Perform steps <1> and <2> at three different feedrates.

<4> Make a circular motion based on the finally determined parameters and check the effect after the application of these parameters.
(Apply the compensation parameters to the horizontal axis.)

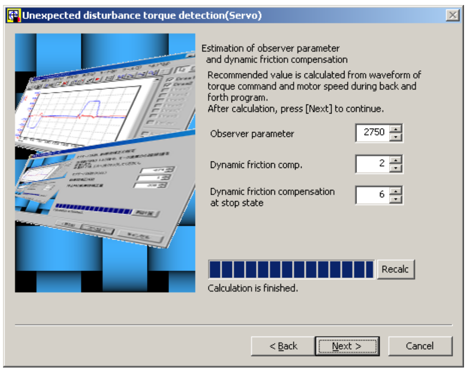


[Tuning support of unexpected disturbance torque detection function] (Version 6.20 or later)

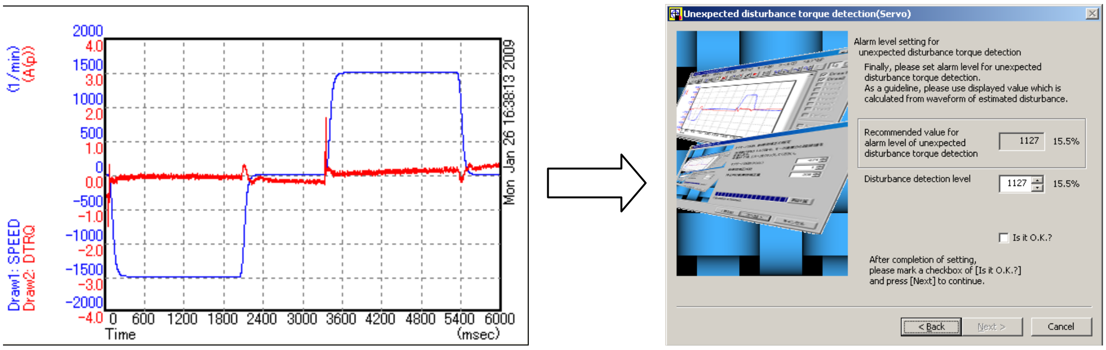
The unexpected disturbance torque detection function monitors the load torque applied to the motor, and if detecting an unexpected disturbance torque, it issues an alarm, and brings the axis to an emergency stop. Tuning Navigator can automatically determine the parameters of the unexpected disturbance torque detection function by estimating the disturbance during back-and-forth acceleration/deceleration operation.

Example of tuning

<1> Let the function automatically calculate the recommended values of the observer gain (POA1), dynamic friction compensation coefficient, and dynamic friction compensation in the stopped state.



<2> Perform back-and-forth acceleration/deceleration operation based on the recommended values and let the function automatically calculate the unexpected disturbance torque detection alarm level.

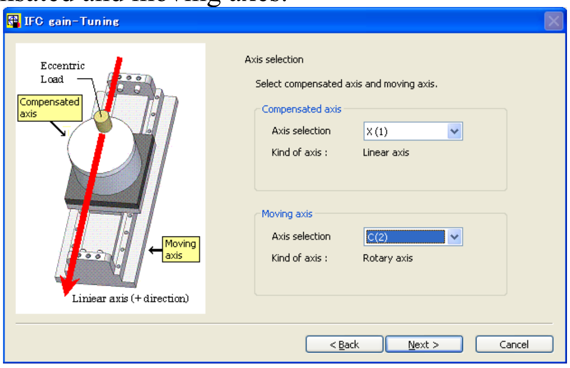


[Tuning support of interactive force compensation function] (Version 6.20 or later)

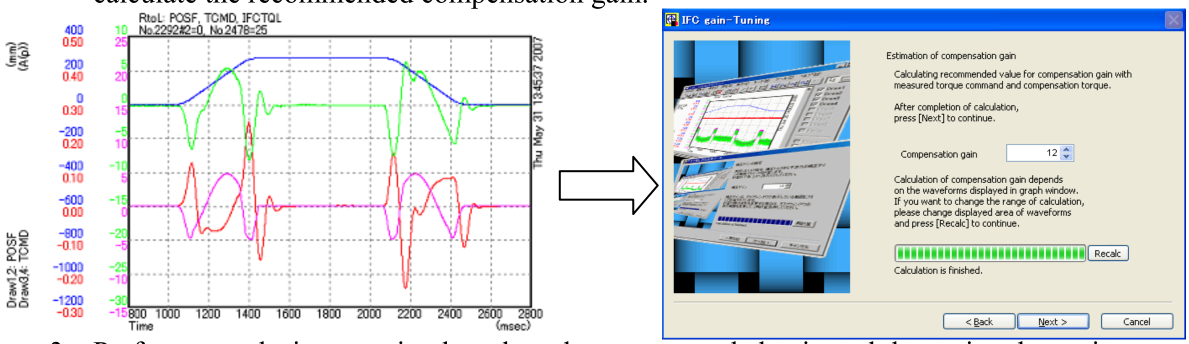
The interactive force compensation function suppresses the effect of the interactive force generated when the rotary axis with eccentric load is moved. Tuning Navigator can automatically determine the parameters of the interactive force compensation function by performing round trip operation on the moving axis and estimating the interactive force acting between the two axes, the compensated and moving axes.

Example of tuning

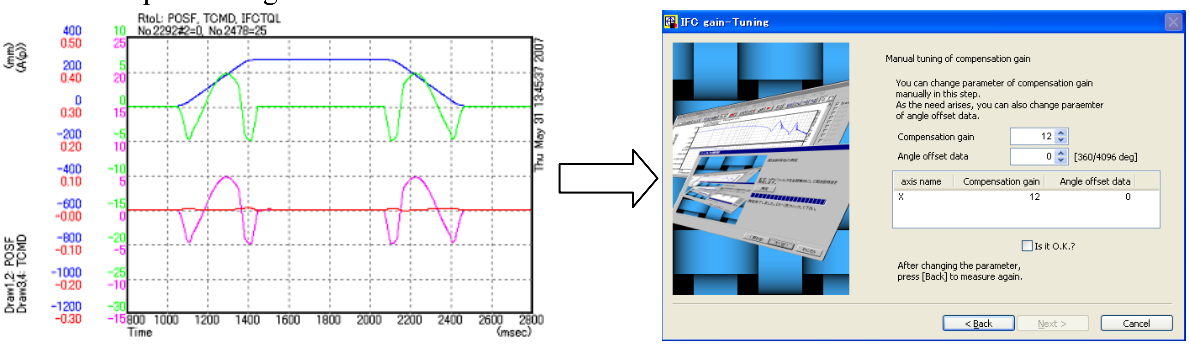
<1> Select compensated and moving axes.



<2> Perform round trip operation on the moving axis and let the function automatically calculate the recommended compensation gain.

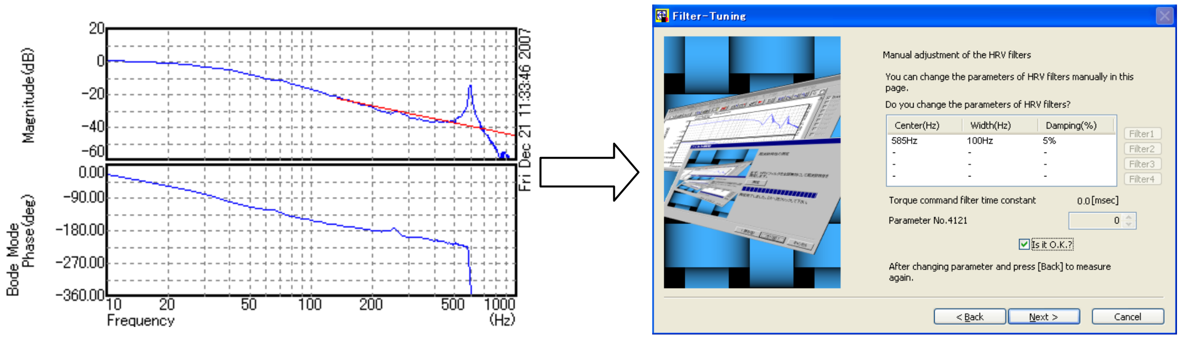


<3> Perform round trip operation based on the recommended gain and determine the optimum compensation gain.



[Automatic tuning of spindle filters] (Version 6.00 or later)

This function calculates an ideal frequency response with no resonance based on the frequency characteristics of the velocity loop violated in the velocity control mode, find the resonation point in comparison with this ideal response, and automatically calculates an optimum filter value.



(4) Outline of the tuning procedure

<1> Set required parameters in the Parameter Window.
<2> Create, send, and execute test programs in the Program Window.
<3> Measure data in the Graph Window.
<4> Repeat steps <1> to <3> while checking graph data to make optimum tunings.

For details of using SERVO GUIDE, refer to "FANUC SERVO GUIDE OPERATOR'S MANUAL (B-65404EN)" or online help after installing the software.

8 DETAILS OF PARAMETERS

This chapter gives details of servo parameters.
For parameters for which no specification method is described, do not change the values automatically set up during servo parameter initialization.

★: Do not change.

	#7	#6	#5	#4	#3	#2	#1	#0
1815			APCX				OPTX	

OPTX (#1) A separate detector is:
0 : Not used.
1 : Used.

Reference item	Subsection 2.1.3

APCX (#5) An absolute detector is:
0 : Not used.
1 : Used.

Reference item	Subsection 2.1.3

	#7	#6	#5	#4	#3	#2	#1	#0
1817		TANDEM						

TANDEM (#6) Tandem control (optional function) is:
0 : Disabled.
1 : Enabled.
Specify this parameter for both main axis and sub-axis

Reference item	Subsections 2.2.3 and 5.10.4

	#7	#6	#5	#4	#3	#2	#1	#0
2000				PGEX	PRMC		DGPR	PLC0

PLC0 (#0) Specifies whether to multiply the number of velocity and position pulses by ten internally as follows:
0 : Not to multiply by ten.
1 : To multiply by ten.

Reference item	Subsection 2.1.3

DGPR (#1) When power is switched on, the motor-specific standard servo parameter is:
0 : Specified.
1 : Not specified.

Reference item	Subsection 2.1.3

PRMC (#3) ★: Do not change.
PGEX (#4) The position gain range is:
0 : Not expanded.
1 : Expanded by 8 times.

	#7	#6	#5	#4	#3	#2	#1	#0
2001	0	AMR6	AMR5	AMR4	AMR3	AMR2	AMR1	AMR0

AMR0 to 6 (#0 to 6)
Specify the AMR value according to the Pulsecoder model for the motor.

AMR							
6	5	4	3	2	1	0	
0	0	0	1	0	0	0	16-pole servo motors α*i*S2000/2000HV, α*i*S3000/2000HV
0	0	0	0	0	0	0	Other than 16-pole servo motor (8-pole servo motors)

Reference item	Subsections 2.2.4, 3.1.1, and 3.2.1.1

	#7	#6	#5	#4	#3	#2	#1	#0
2002					PFSE			

PFSE (#3) A separate detector is:
0 : Not used.
1 : Used.
In the 30*i* Series and 0i-D Series *i*, setting bit 1 (OPT) of parameter No. 1815 to 1 automatically specifies this parameter.

	#7	#6	#5	#4	#3	#2	#1	#0
2003	VOFS	OVSC	BLEN	NPSP	PIEN	OBEN	TGAL	

TGAL (#1) The software disconnection alarm detection level is:
0 : Standard setting (detected by 1/32rev).
1 : Set by a parameter (detected by the value set for parameter No. 2064/32rev).

OBEN (#2) The velocity control observer function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.4.6

PIEN (#3) The velocity control method to be used is:
0 : I-P
1 : PI

NPSP (#4) The N pulse suppression function is:
0 : Not used.
1 : Used.

BLEN (#5) The backlash acceleration function is:
0 : Not used.
1 : Used.

Reference item	Subsections 5.5.4 and 5.5.5

OVSC (#6) The overshoot compensation function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.5.8

VOFS (#7) The VCMD offset function is:
0 : Not used.
1 : Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2004					TRW1	TRW0	TIB0	TIA0

TIA0 (#0), TIB0 (#1), TRW0 (#2), TRW1 (#3)
The setting of these bits varies according to the HRV control method.

TRW1	TRW0	TIB0	TIA0	
0	1	1	0	For HRV1 control
0	0	1	1	For HRV2, HRV3, HRV4 control

	#7	#6	#5	#4	#3	#2	#1	#0
2005	SFCM	BRKC					FEED	

FEED (#1) The feed-forward function is:
0 : Not used.
1 : Used.

Reference item	Subsections 5.5.1 and 5.5.2

BRKC (#6) The brake control function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.8.1

SFCM (#7) The static friction compensation function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.5.6

	#7	#6	#5	#4	#3	#2	#1	#0
2006				ACCF		PKVE		FCBL

FCBL (#0) During full-closed feedback, backlash compensation is:
0 : Applied to the position.
1 : Not applied to the position.

Reference item	Subsections 5.5.4 and 5.5.5

PKVE (#2) Speed-dependent current loop gain variable function is:
0 : Not used.
1 : Used. ★: Do not change.

ACCF (#4) Specifies the amount of velocity feedback data to be used as follows:
0 : Velocity feedback for the latest 2 ms.
1 : Velocity feedback for the latest 1 ms.

	#7	#6	#5	#4	#3	#2	#1	#0
2007	FRCAXS			VLDALM		SUBDEP	IGNVRO	ESP2AX

ESP2AX (#0) The servo alarm 2-axis simultaneous monitor function is:
0 : Not used.
1 : Used.

Reference item	Subsections 5.10.1.3 and 5.10.2

IGNVRO (#1) An alarm condition is:
0 : Not released 2 seconds after the servo alarm 2-axes simultaneous monitor holds the alarm condition.
1 : Released 2 seconds after the servo alarm 2-axes simultaneous monitor holds the alarm condition.

Reference item	Subsection 5.10.1.3

SUBDEP (#2) The slave axis separation function (set for the master axis) is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.1.4

VLDALM (#4) The tandem speed difference alarm function is:
0 : Used.
1 : Not used.

Reference item	Subsection 5.10.4.4

FRCAXS (#7) The torque control function is:
0 : Not used.
1 : Used.

Reference item	Section 5.11

	#7	#6	#5	#4	#3	#2	#1	#0
2008	LAXDMP	PFBSWC	VCMDTM	SPPCHG	SPPRLD	VFBAVE	TNDM	

TNDM (#1) This bit is automatically set to 1 when bit 6 (tandem axis) of parameter No. 1817 is set to 1.
This bit cannot be set directly.

VFBAVE (#2) 1 : Enables the velocity feedback average function.
(Usually, set this bit to 1. Set this parameter for the main axis only.)

Reference item	Subsections 5.10.1.4 and 5.10.4.2

SPPRLD (#3) 1 : Enables the full preload function. (Set this parameter for the main axis only.)

SPPCHG (#4) The motor output torque polarities are as follows:
0 : Outputs only the positive polarity to the main axis, and outputs only the negative polarity to the sub-axis.
1 : Outputs only the negative polarity to the main axis, and outputs only the positive polarity to the sub-axis.
(Set this parameter for the main axis only.)

VCMDTM (#5) 1 : Enables velocity command tandem control.
(Set this parameter for the main axis only.)

Reference item	Subsection 5.10.2

PFBSWC (#6) 1 : Switches position feedback according to the direction of a torque command.
(Set this parameter for the main axis only.)

LAXDMP (#7) 0 : Enables damping compensation for the sub-axis only.
1 : Enables damping compensation with both the main axis and sub-axis.
Usually, set this bit to 1. (Set this parameter for the main axis only.)

Reference item	Subsection 5.10.4.1

	#7	#6	#5	#4	#3	#2	#1	#0
2009	BLST	BLCU		ANALOG				DMY

DMY (#0) The serial feedback dummy function is:
0 : Not used.
1 : Used.

Reference item	Appendix H.1

ANALOG (#4) Analog servo interface function is:
0 : Not used.
1 : Used.

Reference item	Appendix A

BLCU(#6) The function that validates the backlash acceleration function only at cutting is:
0 : Invalidated.
1 : Validated.

Reference item	Subsections 5.5.4 and 5.5.5

BLST (#7) The backlash acceleration stop function is:
0 : Not used.
1 : Used.

Reference item	Subsections 5.5.4 and 5.5.6

	#7	#6	#5	#4	#3	#2	#1	#0
2010	POLE		HBBL	HBPE	BLTE	LINEAR		

LINEAR (#2) Linear motor control is:
0 : Not exercised.
1 : Exercised.
This bit is set automatically when the parameters of the linear motor are initialized. Check that this bit is set before the linear motor is driven.
When using a set of a non-binary detector and synchronous built-in servo motor position detection circuit, set LINEAR to 1.

Reference item	Subsections 3.1.1 and 3.2.2

BLTE (#3) The function to multiply the backlash acceleration amount by 10 is:
0 : Invalidated.
1 : Validated.

HBPE (#4) When the dual position feedback function is used, a pitch error compensation is added to the error counter of:
0 : Full-closed loop. ← Standard setting
1 : Semi-closed loop.
* For the 30*i*-B Series, when the dual position feedback function is enabled, a pitch error compensation is added to the error counters of both the full- and semi-closed loop systems regardless of whether this bit is set to 0 or 1. A backlash compensation amount is added as usual, however.

Reference item	Subsection 5.4.8

HBBL (#5) When the dual position feedback function is used, a backlash compensation amount is added to the error counter of:
0 : Semi-closed loop. ← Standard setting
1 : Full-closed loop.

Reference item	Subsection 5.4.8

POLE (#7) The punch/laser switching function is:
0 : Not used.
1 : Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2011	TMPABS		RCCL				FFAL	EGB

EGB (#0) The EGB function is:
0 : Not used.
1 : Used.

FFAL (#1) Feed-forward control always is:
1 : Enabled in all modes.

Reference item	Subsection 5.5.1

RCCL (#5) The actual current torque limit variable function is:
0 : Not used.
1 : Used. ★: Do not change.

TMPABS (#7) Temporary absolute coordination setting function is:
0 : Not used.
1 : Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2012	STNG		VCM2	VCM1			MSFE	

MSFE (#1) The machine speed feedback function is:
0 : Not used.
1 : Used.

Reference item	Subsections 4.3.5 and 5.4.9

VCM1 (#4) The VCMD waveform signal conversion on the check board is switched.
VCM2 (#5) Switches the VCMD waveform conversion value according to the following list:
For rotary type motor

VCM2	VCM1	Number of velocity commandrevolution/5V
0	0	0.9155 min^{-1}
0	1	14 min^{-1}
1	0	234 min^{-1}
1	1	3750 min^{-1}

For linear motor (P in the table below represents a scale signal pitch[μm].)

VCM2	VCM1	Number of velocity commandrevolution/5V
0	0	0.00375 × P m/min
0	1	0.06 × P m/min
1	0	0.96 × P m/min
1	1	15.36 × P m/min

Reference item	Appendix F

STNG (#7) In velocity command mode, a software disconnection alarm is:
0 : Detected.
1 : Ignored.

	#7	#6	#5	#4	#3	#2	#1	#0
2013	APTG							HR3

HR3 (#0) HRV3 current control is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.1.2

APTG (#7) The α Pulsecoder software disconnection monitor is:
0 : Not ignored.
1 : Ignored .

Reference item	Section 4.2

	#7	#6	#5	#4	#3	#2	#1	#0
2014			SPF					HR4

HR4 (#0) HRV4 current control is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.1.3

SPF (#5) The servo motor torque characteristic is used for:
0 : Feed axis control.
1 : Spindle control.
* When spindle control is selected, the current value (%) in the servo tuning screen is displayed in the load meter mode.

	#7	#6	#5	#4	#3	#2	#1	#0
2015	BZNG	BLAT	TDOUT				SSG1	PGTW

PGTW (#0) The position gain switching function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.7.1

SSG1 (#1) The low-speed integral function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.7.2

TDOU (#5) Switches the check board output data as follows:
0 : TCMD is output.
1 : Estimated load torque is output.

Reference item	Appendix F

BLAT (#6) The two-stage backlash acceleration function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.5.5

BZNG (#7) When a separate detector is used, the battery alarm for the built-in Pulsecoder is:
0 : Not ignored.
1 : Ignored.

	#7	#6	#5	#4	#3	#2	#1	#0
2016					PK2VDN			ABNT

ABNT (#0) The unexpected disturbance torque detection function (option) is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.9.1

PK2VDN (#3) The variable proportional gain function in the stop state is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.3.3

	#7	#6	#5	#4	#3	#2	#1	#0
2017	PK2V25		RISCFF	HTNG	COMSRC			DBST

DBST (#0) The quick stop type 1 at emergency stop is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.8.3

COMSRC(#3) The detector on the semi-closed side is:
0 : Automatically identified.
1 : α*i*/β*i* Pulsecoder at all times.

Reference item	Subsection 2.1.10

HTNG (#4) In velocity command mode, the hardware disconnection alarm of a separate detector is:
0 : Detected.
1 : Ignored.

RISCFF (#5) 0 : When RISC is used, the feed-forward response characteristics remain as is.
1 : When RISC is used, the feed-forward response characteristics are improved.

Reference item	Appendix G.2

PK2V25 (#7) Velocity loop high cycle management function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.3.1

	#7	#6	#5	#4	#3	#2	#1	#0
2018	PFBCPY					OVR8	MOVOBS	RVRSE

RVRSE (#0) The signal direction for the separate detector is:
0 : Not reversed.
1 : Reversed.

Reference item	Subsection 2.1.3 and Section 4.2

MOVOBS (#1) The disable function for observer in the stop state is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.4.6

OVR8 (#2) The stage-2 acceleration amount override format is on the basis of:
0 : 4096.
1 : 256.

Reference item	Subsection 5.5.5

PFBCPY (#7) 1 : The motor feedback signal for the main axis is shared by the sub-axis.
(Set this parameter for the sub-axis only.)

Reference item	Subsections 2.2.3 and 5.10.4.3

	#7	#6	#5	#4	#3	#2	#1	#0
2019	DPFB						TANDMP	

TANDMP (#1) The tandem disturbance elimination control function (option) is:
0 : Not used.
1 : Used.

Reference item	Subsections 5.10.1.4 and 5.10.4.3

DPFB (#7) The dual position feedback function (option) is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.4.8

	#7	#6	#5	#4	#3	#2	#1	#0
2200		P2EX	RISCMC		ABG0	IQOB	FULLCP	OVSP

OVSP (#0) A feedback mismatch alarm is:
0 : Detected.
1 : Not detected.

FULLCP (#2) 1 : A separate position feedback is shared by the master and slave axes.
(Set this parameter for the sub-axis only.)

Reference item	Subsection 5.10.1.6

IQOB (#2) 1 : Eliminates the effect of voltage saturation on unexpected disturbance torque detection.

Reference item	Subsection 5.9.1

ABG0 (#3) 1 : When an unexpected disturbance torque is detected, a threshold is set separately for cutting and rapid traverse.

Reference item	Subsection 5.9.2

RISCMC (#5) When a RISC processor is used:
0 : The response to a positioning command is the same as before.
1 : The response to a positioning command is improved.

Reference item	Appendix G.2

P2EX (#6) The velocity loop proportional gain (PK2V) format is:
0 : Standard format.
1 : Converted format.

Reference item	2.1.9 補足, 5, 3.1.1(7)項

	#7	#6	#5	#4	#3	#2	#1	#0
2201		CPEE					RNLV	CROFS

CROFS (#0) The function for obtaining current offsets upon an emergency stop is:
0 : Not used.
1 : Used.

Reference item	Section 5.14

RNLV (#1) Specifies the detection level for the feedback mismatch alarm as follows:
0 : 600 min^{-1}
1 : 1000 min^{-1}

CPEE (#6) The actual current display peak hold function is:
0 : Not used.
1 : Used.

Reference item	Subsection 4.1.3

	#7	#6	#5	#4	#3	#2	#1	#0
2202				DUAL0W	OVS1	PIAL	VGCCR	

VGCCR (#1) The cutting/rapid velocity loop gain switching function is:
0 : Not used.
1 : Used.

Reference item	Section 5.2 and Subsection 5.3.4

PIAL (#2) When rapid traverse is selected by the cutting/rapid velocity loop gain switching function, the 1/2 PI control function is:
0 : Automatically disabled.
1 : Always enabled.

Reference item	Subsection 5.3.4

OVS1 (#3) 1 : Overshoot compensation is valid only once after the termination of a move command.

Reference item	Subsection 5.5.8

DUAL0W (#4) For zero-width judgment:
0 : Semi-full error only is used.
1 : Both of a position error and semi-full error are used.

Reference item	Subsection 5.4.8

	#7	#6	#5	#4	#3	#2	#1	#0
2203			TCMD4X	FRCAX2	VFFINE	CRPI		

CRPI (#2) The current loop 1/2 PI control function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.3.4

VFFINE (#3) The precision of the velocity feed-forward coefficient is:
0 : As usual.
1 : Improved by a factor of 16.
With the improvement of the precision, an overflow may occur with one-sixteenth the current setting. If an overflow occurs, return the setting to 0.

FRCAX2 (#4) Torque control type 2 is:
0 : Not exercised.
1 : Exercised.

Reference item	Section 5.11

TCMD4X (#5) The check board output voltage of the TCMD signal is:
0 : As usual (default).
1 : Multiplied by 4.

Reference item	Appendix F

	#7	#6	#5	#4	#3	#2	#1	#0
2204	DBS2		PGTWN2				HSTP10	

HSTP10 (#1) The valid speed increment system for the high-speed positioning function is:
0 : $0.01mm^{-1}$ (rotary motor), 0.01mm/min (linear motor).
1 : $0.1mm^{-1}$ (rotary motor), 0.1mm/min (linear motor).

Reference item	Subsection 5.7.1

PGTWN2 (#5) Position gain switching type 2 is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.7.1

DBS2 (#7) Quick stop type 2 at emergency stop is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.8.4

	#7	#6	#5	#4	#3	#2	#1	#0
2205				HDIS	HD2O	FULDMY		

FULDMY (#2) The dummy separate detector function is:
0 : Not used.
1 : Used.

Reference item	Appendix H.1

HD2O (#3) The quick stop function for hardware disconnection of separate detector is:
0 : Not applied to axes under synchronous control.
1 : Applied to axes under synchronous control.

Reference item	Subsections 5.8.6 and 5.8.7

HDIS (#4) The quick stop function for hardware disconnection of separate detector is:
0 : Disabled.

1 : Enabled.

* For the 30*i*-B Series and Power Motion *i*-A, when bit 4 of parameter No. 2205 or bit 5 of parameter No. 2282 is set, the quick stop function for separate detector alarms is enabled.

<table>
<tr><th rowspan="2">Setting</th><th colspan="2">Alarms for which to apply the quick stop function</th></tr>
<tr><th>FS30i-A,0i-D</th><th>FS30i-B, Power Motion i-A</th></tr>
<tr><td>No.2205#4=1</td><td>Hardware disconnection of the phase A/B detector</td><td rowspan="2">Hardware disconnection of the phase A/B detector or
separate serial detector alarm</td></tr>
<tr><td>No.2282#5=1</td><td>Separate serial detector alarm</td></tr>
</table>

Reference item	Subsection 5.8.6

	#7	#6	#5	#4	#3	#2	#1	#0
2206				HBSF				

HBSF (#4) The backlash compensation amount and pitch error compensation amount are added:

0 : Selectively according to the conventional parameter No. 2010.

1 : Simultaneously for the full-closed and semi-closed sides.

If this parameter is set to 1 (enabled), the settings bits 5 and 4 of parameter No. 2010 are ignored.

* For the 30*i*-B Series, when the dual position feedback function is enabled, a pitch error compensation is added to the error counters of both the full- and semi-closed loop systems regardless of whether this bit is set to 0 or 1. A backlash compensation amount is added as usual, however.

Reference item	Subsection 5.4.8

	#7	#6	#5	#4	#3	#2	#1	#0
2207					PK2D50			NEGSHC

NEGSHC (#0) Overcurrent alarm (software) is:

0 : Not ignored.

1 : Ignored .

> ⚠ **CAUTION**
> If the emergency stop state is released without connecting the power line in a test such as a test for machine start-up, the overcurrent alarm detected by the servo software may be issued. In such a case, the alarm can be avoided temporarily by setting this bit parameter to 1. However, be sure to return the bit parameter to 0 before starting up in the normal operation state after completion of a test.

Reference item	Section 4.2

PK2D50 (#3) Specifies a variable proportional gain function in the stop state as follows:

0 : 75% down.

1 : 50% down.

Reference item	Subsection 5.3.3

	#7	#6	#5	#4	#3	#2	#1	#0
2208	TQMNT							

TQMNT (#7) Fine torque sensing data is:

0 : Estimated disturbance value.

1 : TCMD.

For details of fine torque sensing data, refer to the description of the window function in a PMC programming manual (including B-64513EN).

	#7	#6	#5	#4	#3	#2	#1	#0
2209				HCNGL				

HCNGL (#4)
0 : The overcurrent alarm avoidance function based on amplifier hardware is disabled.
1 : The overcurrent alarm avoidance function based on amplifier hardware is enabled.

> **NOTE**
> 1 If an abnormal level of current that causes the overcurrent alarm to be issued is detected momentarily, processing is performed to suppress the level of current without issuing the alarm.
> 2 Even if this function is used, the overcurrent alarm is issued:
> - When a complete short circuit occurs, or
> - When the processing above for suppressing the level of current is continuously performed.

	#7	#6	#5	#4	#3	#2	#1	#0
2210		ESPTM1	ESPTM0			PK12S2		

PK12S2 (#2) The current gain internally 4 times function is:
0 : Not used.
1 : Used.

ESPTM0(#5) Set the timer built into the αi amplifier to delay emergency stop.
ESPTM1(#6)

ESPTM1	ESPTM0	Delay time
0	0	50ms (default)
0	1	100ms
1	0	200ms
1	1	400ms

Reference item	Section 5.8

	#7	#6	#5	#4	#3	#2	#1	#0
2211	PLW4	PLW2					PHCP	

PHCP (#1) The phase lag compensation during deceleration is:
0 : Not used.
1 : Used.

PLW2 (#6) A motor with two windings is:
0 : Not used.
1 : Used.

PLW4 (#7) A motor with four windings is:
0 : Not used.
1 : Used.

Reference item	Subsections 2.2.2 and 5.10.2

	#7	#6	#5	#4	#3	#2	#1	#0
2212	OVQK							

OVQK (#7) When a quick stop function at the OVC and OVL alarm is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.8.8

	#7	#6	#5	#4	#3	#2	#1	#0
2213	OCM				PK1VDN			

PK1VDN (#3) The variable integral gain function in the stop state is:
0 : Disabled.
1 : Enabled.
The variable integral gain function in the stop state is used when decreasing not only the proportional gain, but also the integral gain can suppress the vibration in the stopped state more efficiently.

OCM (#7) Pole position detection function (optional) is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 3.2.1.2

	#7	#6	#5	#4	#3	#2	#1	#0
2214				FFCHG				

FFCHG (#4) The cutting/rapid feed-forward switching function is:
0 : Not used.
1 : Used.

Reference item	Section 5.2 and Subsection 5.5.2

	#7	#6	#5	#4	#3	#2	#1	#0
2215	ABT2						TCPCLR	PK1D50

PK1D50 (# 0) The magnification in the stopped state for the variable integral gain function in the stop state is:
0 : 75%
1 : 50%

TCPCLR (#1) A function of setting the velocity loop integrator with a value for canceling a torque offset at an emergency stop is:
0 : Disabled.
1 : Enabled.

Reference item	Subsections 5.9.1 and 5.10.1.2

ABT2 (#7) Cutting/rapid unexpected disturbance torque detection function type 2 is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 5.9.2

	#7	#6	#5	#4	#3	#2	#1	#0
2220			P16					DECAMR

DECAMR (#0) A non-binary detector is:
0 : Not used.
1 : Used.

Reference item	Subsection 3.2.1.1

P16 (#5) 16-pole servo motor is:
0 : Not used.
1 : Used.

Reference item	Subsection 2.2.4

	#7	#6	#5	#4	#3	#2	#1	#0
2221	ASYCS	QNOTCH	AMREX			VFFNCH	LNOTCH	

LNOTCH(#1)

0 : Uses resonance elimination filter 4.
1 : Uses resonance elimination filter L.

Reference item	Subsections 5.4.3 and 5.4.5

VFFNCH (#2) Resonance elimination filter L is applied to:
0 : Feed-forward part only of the velocity command
1 : Entire velocity command

Reference item	Subsection 5.4.5

AMREX(#5) AMR conversion coefficient 1 (parameter No. 2112) is set to:
0 : Usually set value.
1 : One-sixteenth the usually set value.

QNOTCH(#6) The specification of resonance elimination filter 4 is:
0 : Standard specification.
1 : Frequency extended specification.

Extended valid data range of the attenuation center frequency of resonance elimination filter 4

	HRV1, HRV2	HRV3	HRV4
Valid data range of the attenuation center frequency (parameter No. 2366) (Bit 6 of parameter No. 2221 = 0)	96 to 1000	96 to 2000	96 to 4000
Valid data range of the attenuation center frequency (parameter No. 2366) (Bit 6 of parameter No. 2221 = 1)	96 to 2000	96 to 4000	96 to 4000

Reference item	Subsection 5.4.3

ASYCS(#7) The connection signal for the synchronous axes automatic compensation function is:
0 : Disabled.
1 : Enabled.
(Power-off parameter)

Reference item	Subsection 5.10.1.5

	#7	#6	#5	#4	#3	#2	#1	#0
2223	BLCUT2	SLTMAS	SLTTAN					DISOBS

DISOBS (#0) The disturbance elimination filter function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.4.4

SLTAN (#5) Multi-axis tandem is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.2

SLTMAS (#6) In a multiaxis tandem system, this axis is used as:
0 : Slave axis.
1 : Master axis.

Reference item	Subsection 5.10.2

BLCUT2 (#7) The backlash acceleration function is:
0 : Enabled for both cutting feed and rapid traverse.
1 : Enabled only for cutting feed.

Reference item	Subsections 5.5.4 and 5.5.5

	#7	#6	#5	#4	#3	#2	#1	#0
2225						**TSA05**	**TCMD05**	

TCMD05 (#1) The check board output voltage of the TCMD signal is:
0 : As usual (default).
1 : Halved.

Reference item	Appendix F

TSA05 (#2) The check board output voltage of the SPEED signal is:
0 : As usual (default).
1 : Halved (7500 min^{-1}/5 V).

Reference item	Appendix F

	#7	#6	#5	#4	#3	#2	#1	#0
2228					**ELSAL**			

ELSAL (#3) In pole detection, the motor saliency is:
0 : Lq>Ld
1 : Lq<Ld

	#7	#6	#5	#4	#3	#2	#1	#0
2229				**FORME**	**WATRA**			**ABSEN**

ABSEN (#0) In pole detection, the AMR offset is:
0 : Not used.
1 : Used.

Reference item	Subsection 3.2.1.2

WATRA (#3) After pole detection, an abnormal operation is:
0 : Monitored.
1 : Not monitored.

Reference item	Subsection 3.2.1.2

FORME(#4) The operation mode for pole detection is:
0 : Automatic selection mode.
1 : Minute operation mode.

Reference item	Subsection 3.2.1.2

	#7	#6	#5	#4	#3	#2	#1	#0
2270	**DSTIN**	**DSTTAN**	**DSTWAV**		**ACREF**			**AMR60**

AMR60 (#0) The valid setting range of the AMR offset is from:
0 : -45 degrees to +45 degrees.
1 : -60 degrees to +60 degrees.

Reference item	Subsection 3.1.1

ACREF (#0) The adaptive resonance elimination filter is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 3.1.1

DSTWAV(#5) The input waveform of disturbance input is:
0 : Sine wave. (Usually, select the sine wave.) .
1 : Square wave.

Reference item	Subsection 5.10.1.4

DSTTAN(#6) Disturbance is:
0 : Input for one axis only.
1 : Input for both the L and M axes (To be set only for the L axis side of synchronous axes or tandem axes).

Reference item	Subsection 5.10.1.4

DSTIN (#7) The disturbance input function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.1.4

	#7	#6	#5	#4	#3	#2	#1	#0
2271			2NDTMG			RETR2		

RETR2 (#2) When an unexpected disturbance torque is detected, the simultaneous two-axis retract function is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.9.1

2NDTMG (#5) Two-stage acceleration type 2 of two-stage backlash acceleration is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.5.5

	#7	#6	#5	#4	#3	#2	#1	#0
2273	DBTLIM	EGBFFG	EGBEX	POA1NG			WSVCPY	

WSVCPY (#1) When the Feed axis synchronization control is used, the loop integrator of the master axis :
0 : Can not be copied to the slave axis.
1 : Can be copied to the slave axis.
~~(Specify only the slave axis.)~~

THIS NOTE IS WRONG, THE RIGHT SENTECE IS:
"Set this parameter for the master and slave axes"
SEE PAG. 329

Reference item	Section 5.10

POA1NG (#4) In the calculation of the observer coefficient (POA1), the load inertia ratio (LDINT) is:
0 : Considered.
1 : Not considered.

EGBEX (#5) The EGB automatic phase matching function is:
0 : In the normal mode (deceleration not performed between the master and detector).
1 : In the extended mode (deceleration performed between the master and detector).

EGBFFG(#6) FFG is:
0 : Not considered in the EGB ratio.
1 : Considered in the EGB ratio.

DBTLIM (#7) The torque limit setting function during brake control is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 5.8.2

	#7	#6	#5	#4	#3	#2	#1	#0
2274		DD2048						HP2048

HP2048 (#0) A 2048-time interpolation circuit (position detection circuit H or C) is:
0 : Not used.
1 : Used.

DD2048(#0) For a D*i*S motor, the HP2048 bit is:
0 : Disabled.
1 : Enabled.

(Interpolation magnification to be assumed for setting parameters)

No.2274#6 (DD2048)	No.2274#0 (HP2048)	Interpolation magnification when a position detection circuit is used	
		D*i*S motor	L*i*S motor
0	0	×2048	×2048
0	1		×512
1	1	×512	

Reference item	Subsections 2.1.5, 3.1.1, and 3.2.1

	#7	#6	#5	#4	#3	#2	#1	#0
2275					ASYN		RCNCLR	800PLS

800PLS (#0) When the RCN723 or RCN223 is used, the reference counter setting is made in reference to:
0 : 1/8 turns of the detector.
1 : 1 turn of the detector.

Reference item	Subsection 2.1.5

RCNCLR (#1) The speed data is:
0 : Not cleared.
1 : Cleared. (To use the RCN223 or RCN723, set it to 1.)

Reference item	Subsection 2.1.5
Related parameter	No.2394

ASYN (#3) Synchronous axes automatic compensation function is
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.1.5

	#7	#6	#5	#4	#3	#2	#1	#0
2277	ACC1ON	ACC2ON	ACC3ON	ACCNEG				

ACCNEG (#4) The sign of acceleration feedback is:
0 : Not inverted.
1 : Inverted.

Reference item	Subsection 2.1.8

ACC3ON (#5) Acceleration feedback in the third direction is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 2.1.8

ACC2ON (#6) Acceleration feedback in the second direction is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 2.1.8

ACC1ON (#7) Acceleration feedback in the first direction is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 2.1.8

	#7	#6	#5	#4	#3	#2	#1	#0
2278				PM2ACC	PM2SCB	PM1SCB	PM2TP	PM1TP

PM1TP (#0) With the first or third separate detector interface unit, a temperature detection circuit is:
0 : Not used.
1 : Used.

Reference item	Subsection 2.1.8

PM2TP (#1) With the second or fourth separate detector interface unit, a temperature detection circuit is:
0 : Not used.
1 : Used.

Reference item	Subsection 2.1.8

PM1SCB (#2) The first or third servo check interface unit is:
0 : Not used.
1 : Used.

Reference item	Appendix F

PM2SCB (#3) The second or fourth servo check interface unit is:
0 : Not used.
1 : Used.

Reference item	Appendix F

PM2ACC (#4) Acceleration sensor data is:
0 : Read from the first or third separate detector interface unit counted from the CNC, or no acceleration sensor is used.
1 : Read from the second or fourth separate detector interface unit counted from the CNC.

Reference item	Subsection 2.1.8

	#7	#6	#5	#4	#3	#2	#1	#0
2279								DMCON

DMCON (#0) In emergency stop cancellation with the dummy function enabled:
0 : The ready signal is not output.
1 : The ready signal is output.

Reference item	Appendix H.2

	#7	#6	#5	#4	#3	#2	#1	#0
2281						RDPRR	RDPMU2	RDPMU1

RDPMU1(#0) Internal unit for power consumption monitoring
RDPMU2(#1) Internal unit for power consumption monitoring

Maximum motor output	RDPMU2	RDPMU1
300kW to	0	0
30kW to 300kW	0	1
3kW to 30kW	1	0
to 3kW	1	1

RDPRR(#2) The type of regeneration used for a servo amplifier for power consumption monitoring is:
0 : Electric power regeneration
1 : Resistance regeneration

	#7	#6	#5	#4	#3	#2	#1	#0
2282			FSAQS					

FSAQS (#0) The quick stop function for separate serial detector alarms is:
0 : Disabled.
1 : Enabled.
* For the 30*i*-B Series and Power Motion *i*-A, when bit 4 of parameter No. 2205 or bit 5 of parameter No. 2282 is set, the quick stop function for separate detector alarms is enabled.

Setting	Alarms for which to apply the quick stop function	
	FS30*i*-A,0*i*-D	FS30*i*-B, Power Motion *i*-A
No.2205#4=1	Hardware disconnection of the phase A/B detector	Hardware disconnection of the phase A/B detector or separate serial detector alarm
No.2282#5=1	Separate serial detector alarm	

Reference item	Subsection 5.8.7

	#7	#6	#5	#4	#3	#2	#1	#0
2283	BLSTP2							NOG54

NOG54(#0) High-speed HRV current control mode (servo HRV3 control) is:
0 : Used only when both G5.4Q1 and G01 are specified.
1 : Used when G01 is specified. (G5.4Q1 is not monitored.)

NOTE
This function can be used when servo HRV3 control is used.
This function cannot be used when servo HRV4 control is used.

Reference item	Subsection 5.1.3

BLSTP2 (#7) The function for disabling backlash acceleration after a stop is:
0 : Not used.
1 : Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2285		TRQCPY						

TRQCPY(#6) As the current command for the sub-axis, the current command for the main axis is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.4.3

	#7	#6	#5	#4	#3	#2	#1	#0
2286				WCCNCK				

WCCNCK(#4) 0 : When external signal Gn321 is set to 0, the velocity loop integrator is copied to the slave axis.
1 : The velocity loop integrator is always copied to the slave axis regardless of whether external signal Gn321 is set to 0 or 1.
(Specify only the slave axis.)

Reference item	Subsection 5.10.1.1

	#7	#6	#5	#4	#3	#2	#1	#0
2288	MPCEF							

MPCEF (#7) Machining point control is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 5.4.10

	#7	#6	#5	#4	#3	#2	#1	#0
2289								SYNDI

SYNDI(#0) The function for holding the compensation amount in synchronous axes automatic compensation is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.10.1.5

	#7	#6	#5	#4	#3	#2	#1	#0
2290			FRFPWE	FRFDES	FRFATE	ACCMON	ACCHLD	ACCOUT

ACCOUT(#0) To the diagnosis screen (No. 354), acceleration data output is:
0 : Not performed.
1 : Performed.

Reference item	Subsection 4.1.4

ACCHLD(#1) A peak acceleration rate is:
0 : Not held.
1 : Held (for 1 second).

Reference item	Subsection 4.1.4

ACCMON(#2) Machining point control outputs:
0 : Acceleration data at all times
1 : Remaining acceleration data after a stop (The acceleration data is cleared to 0 during movement and for 16 ms after a stop.)

Reference item	Subsection 4.1.4

FRFATE(#3) Execution condition 1 of the adaptive resonance elimination filter in the follow-up mode
FRFATE(#4) Execution condition 2 of the adaptive resonance elimination filter in the follow-up mode

No.2290#4	No.2290#3	Execution condition in the follow-up mode
0	0	Executed when G322.x = 1 or during axis movement.
0	1	Executed when G322.x = 1 or during rapid traverse.
1	-	Executed only when G322.x = 1.

Reference item	Subsection 5.6.2

FRFPWE(#5) The parameter for the center frequency of the adaptive resonance elimination filter (No. 2113) is:
0 : Not automatically updated.
1 : Automatically updated.

Reference item	Subsection 5.6.2

	#7	#6	#5	#4	#3	#2	#1	#0
2291						FRFEBW		

FRFEBW(#2) The maximum frequency that can be followed by the adaptive resonance elimination filter in HRV3 or HRV4 control is:
0 : 1.3 kHz (standard).
1 : 2.0 kHz (extended).

Reference item	Subsection 5.6.2

	#7	#6	#5	#4	#3	#2	#1	#0
2292	MOVAXS	MV1IFC	MV1ID2	MV1ID1	MV1ID0	IFC1ON	C1TYP1	C1TYP0

C1TYP0,1(#0,1) Sets a compensation type (for the first moving axis).

Reference item	Subsection 5.5.9

IFC1ON(#2) Turns on/off the compensation function for interactive force from the first moving axis.
0 : Does not compensate for interactive force from the first moving axis.
1 : Compensates for interactive force from the first moving axis.

Reference item	Subsection 5.5.9

MV1ID0 to 2(#3,4,5)
Specifies a servo axis number for the first moving axis.

NOTE
For the 30*i*-B Series and Power Motion *i*-A, use parameter No. 2606 to specify servo axis numbers for the first and second moving axes.

Reference item	Subsection 5.5.9

MV1IFC(#6) Sets calculation of interactive force from the first moving axis.
0 : Disables calculation of interactive force from the first moving axis.
1 : Enables calculation of interactive force from the first moving axis.

Reference item	Subsection 5.5.9

MOVAXS(#7) Specifies whether the axis is a moving axis used with the interactive force compensation function.
0 : The axis is not a moving axis.
1 : The axis is a moving axis.

Reference item	Subsection 5.5.9

	#7	#6	#5	#4	#3	#2	#1	#0
2293		MV2IFC	MV2ID2	MV2ID1	MV2ID0	IFC2ON	C2TYP1	C2TYP0

C2TYP0,1(#0,1) Sets a compensation type (for the second moving axis).

Reference item	Subsection 5.5.9

IFC2ON(#2) Turns on/off the compensation function for interactive force from the second moving axis.
0 : Does not compensate for interactive force from the second moving axis.
1 : Compensates for interactive force from the second moving axis.

Reference item	Subsection 5.5.9

MV2ID0 to 2(#3,4,5)
Specifies a servo axis number for the second moving axis.

NOTE
For the 30*i*-B Series and Power Motion *i*-A, use parameter No. 2606 to specify servo axis numbers for the first and second moving axes.

Reference item	Subsection 5.5.9

MV2IFC(#6) Sets calculation of interactive force from the second moving axis.

0 : Disables calculation of interactive force from the second moving axis.
1 : Enables calculation of interactive force from the second moving axis.

Reference item	Subsection 5.5.9

	#7	#6	#5	#4	#3	#2	#1	#0
2294				PK2VDR				

PK2VDR(#4) The arbitrary magnification in the stop state is applied:
0 : Only during cutting feed.
1 : Also in rapid traverse.
The arbitrary magnification in the stop state for the variable proportional gain function in the stop state is also applied in rapid traverse.

NOTE
This parameter is available with series 90G0 edition 03.0 or later (30*i*-B Series, Power Motion *i*-A).

	#7	#6	#5	#4	#3	#2	#1	#0
2297				VAVNEG				

VAVNEG(#4) For high cycle proportional elements, the velocity feedback average function is:
0 : Enabled.
1 : Disabled.
(Set this parameter for the main axis only.)

Reference item	Subsection 5.10.4.2

	#7	#6	#5	#4	#3	#2	#1	#0
2298	DUNIT							

DUNIT(#7) When the lifting function against gravity at emergency stop is used, the function that enables the parameter for specifying a distance to lift to be set in 1 μm, independently of the detection unit, is:
0 : Not used.
1 : Used.

Reference item	Subsection 5.8.5.3

	#7	#6	#5	#4	#3	#2	#1	#0
2299			IGNRFA					

IGNRFA(#5) The detection of an invalid parameter set for the denominator of the reference counter capacity is:
0 : Performed.
1 : Not performed.

NOTE
If an invalid parameter alarm (detail No. 1793) may be issued according to the status, setting IGNRFA = 1 may cause a system alarm. In this case, set IGNRFA to 0.

	#7	#6	#5	#4	#3	#2	#1	#0
2300	CKLNOH				THRMO	DD		HRVEN

HRVEN(#0) The extended HRV function is:
0 : Not used.
1 : Used.

NOTE
Set this function when using servo HRV4 control.

Reference item	Subsection 5.1.3

DD (#2) Synchronous built-in servo motor control is:
0 : Disabled.
1 : Enabled.
This bit is automatically set when the synchronous built-in servo motor parameters are initialized. However, before driving a synchronous built-in servo motor, check that this bit is set to 1.

Reference item	Subsection 3.2.1.1

THRMO (#3) When bit 7 of No. 2300 is set to 1, the overheat alarm of a motor is:
0 : Obtained from a DI signal via the PMC.
1 : Obtained from the α*i*CZ detection circuit, linear motor position detection circuit, or temperature detection circuit.

Reference item	Section 3.3

CKLNOH (#7) The overheat alarm of a motor is:
0 : Obtained from the pulse coder (for an α*i*/β*i* motor).
1 : Obtained from a DI signal via the PMC, or from the α*i*CZ detection circuit, linear motor position detection circuit, or temperature detection circuit.

Reference item	Section 3.3

	#7	#6	#5	#4	#3	#2	#1	#0
2301	TQCT10							

TQCT10 (#7) The torque control setting range extension function is:
0 : Disabled. (The setting of the torque constant parameter is used without modification.)
1 : Enabled. (The setting of the torque constant parameter is increased by a factor of 10 for use in the NC.)

	#7	#6	#5	#4	#3	#2	#1	#0
2414	*			NEGPTD	LCSYN	BUFRST		CMPLC

(#0) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#1) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#2) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#3) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#4) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#5) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
(#6) For tuning the relevant parameter for quadrant protrusion compensation for Tuning Navigator
* These parameters are used by Tuning Navigator during tuning. After tuning, they are set to 0.

	#7	#6	#5	#4	#3	#2	#1	#0
2415	*	*	LBLACC	*	*	*	IAHDON	

IAHDON(#1) The default value of the feed-forward timing adjustment parameter is:
0 : 0.
1 : Compatible with that of the 16*i* Series.
* By setting IAHDON to 1 and parameter No. 2095 to 0, the feed-forward timing becomes compatible with that of the 16*i* Series. For the 30*i*-B Series, the feed-forward timing is fixed to that compatible with the Series 16i regardless of whether bit 1 of parameter No. 2415 is set to 0 or 1. (No.2415#1=1)

Reference item	Subsection 5.5.3

(#2) Attenuation type setting for quadrant protrusion compensation for Tuning Navigator (Normally 0: Exponential)
(#3) Acceleration amount override setting for quadrant protrusion compensation for Tuning Navigator (Normally 1)
(#4) Filter setting for quadrant protrusion compensation for Tuning Navigator (Normally 0)
LBLACC (#5) Quadrant protrusion compensation for Tuning Navigator is:
0 : Disabled.
1 : Enabled.
(#6) Acceleration amount override setting for quadrant protrusion compensation for Tuning Navigator (Normally 1)
(#7) Acceleration amount override setting for quadrant protrusion compensation for Tuning Navigator (1 or 0)

Reference item	Appendix M

	#7	#6	#5	#4	#3	#2	#1	#0
2417	*	*		TIMCAL		TIMPR2		

TIMCAL(#4) Preload time constant calculation is:
0 : Not performed. (Conventional specification)
1 : Performed.

TIMPR2(#2) The exponential time constant of the preload function is:
0 : Reciprocal number of the position loop gain.
1 : Four times of the reciprocal number of the position loop gain.

Reference item	Subsection 5.10.1.2

	#7	#6	#5	#4	#3	#2	#1	#0
2418					INEVCM	INESHS		

INESHS(#2) The minimum detectable acceleration for inertia estimation is set to be:
0 : Normal.
1 : 1/32.
INEVCM(#3) Oscillation for inertia estimation is input by:
0 : Torque command.
1 : Velocity command.

Reference item	Subsection 5.6.1

	#7	#6	#5	#4	#3	#2	#1	#0
2419	INESGH	INESGL	INESFH	INESFL	INESMG	INESFC	DYNTQL	DYNERR

DYNERR(#0) The detection of excessive error between the estimated position and actual position is:
0 : Disabled.
1 : Enabled.
DYNTQL(#1) The detection of excessive error between the estimated position and actual position in the torque limit mode is:
0 : Disabled.
1 : Enabled.

Reference item	Subsection 2.1.11.2

INESFC(#2) The inertia estimation function is:
0 : Disabled.
1 : Enabled.

INESMG(#3) The weight of the diagnosis screen display (No. 764) of the estimated inertia value is:
0 : Standard.
1 : 1/32 of standard.

INESFL(#4) Oscillation frequency for inertia estimation
INESFH(#5) Oscillation frequency for inertia estimation

Amount of the oscillation current command	INESFH	INESFL
Standard frequency (50Hz)	0	0
Low frequency (25Hz)	0	1
High frequency (100Hz)	1	0

INESGL(#6) Amount of the oscillation current command for inertia estimation
INESGH(#7) Amount of the oscillation current command for inertia estimation

Amount of the oscillation current command	INESGH	INESGL
Rated current	0	0
1/2 of the rated current	0	1
Double the rated current	1	0

Reference item	Subsection 5.6.1

	#7	#6	#5	#4	#3	#2	#1	#0
2420	SFUMSET	ATPKVF		DUDYN				

DUDYN(#4) When the dual position feedback function is enabled, the detection of excessive error between the estimated position and actual position is:
0 : Disabled.
1 : Enabled.
* For the 30*i*-B Series, this function bit is not used because the dual position feedback function can be used together by default.

Reference item	Subsection 2.1.11.2

ATPKVF(#6) In the PARAMETER SETTING SUPPORT screen (0*i*-D Series), the servo gain has:
0 : Not been tuned.
1 : Been tuned.

SFUMSET (# 7) The unit of data for the level on which the difference in error between the semi-closed and full-closed modes becomes too large (parameter No. 2118) is:
0 : Detection unit.
1 : 1 μm.
* Use this parameter when the detection unit is too small to set a necessary value within the valid data range for parameter No. 2118.

Reference item	Subsection 2.1.11.1

	#7	#6	#5	#4	#3	#2	#1	#0
2422	SFUMSET			SSTMCC			SVSAR1	SVSAR2

SVSAR2(#0) Coefficient for the detection level of speed arrival 2
SVSAR1(#1) Coefficient for the detection level of speed arrival 2

SVSAR1	SVSAR2	Offset speed	Hysteresis speed	Remarks
0	0	50/min	20/min	Recommended (α*i*, β*i* motor)
0	1	10/min	5/min	
1	0	5/min	2/min	Recommended (D*i*S motor)
1	1	2/min	1/min	

Reference item	Subsection 5.12.1

SSTMCC(#4) When the quick stop function at emergency stop is enabled and the zero-speed detecting signal (SVSSTn) is set to 1, the excitation of the amplifier is:
0 : Not cut off.
1 : Cut off.

Reference item	Subsection 5.12.2

	#7	#6	#5	#4	#3	#2	#1	#0
2423					RGDFRC	RGDBLA	DBCOFF	

DBCOFF(#1) Dead-band compensation for the amplifier is:
0 : Always enabled.
1 : Disabled in the stopped state.
When this parameter is used, the system determines the stopped state when both the conditions below are satisfied, and set dead-band compensation to 0:
- The move command from the CNC is 0.
- The absolute value of the position error becomes lower than or equal to the setting of parameter No. 2193.

NOTE
This parameter is used with Series 90G0/08.0 and subsequent editions (30*i*-B Series, Power Motion *i*-A) or Series 90E1/08.0 and subsequent editions (30*i*-A Series).

RGDBLA(#2) Compensation for reverse operation and at the start of FSSB high-speed rigid tapping is:
0 : Disabled.
1 : Enabled.
RGDFRC(#3) Compensation for reverse operation and at the start of FSSB high-speed rigid tapping is enabled:
0 : Only for reverse operation.
1 : For reverse operation and at the start of rigid tapping.

Reference item	Section 5.13

	#7	#6	#5	#4	#3	#2	#1	#0
2429						FSBSYN	FSBTAP	SVZENB

SVZENB(#0) Leakage detection for the servo amplifier is:
0 : Disabled.
1 : Enabled.
FSBTAP(#1) FSSB high-speed rigid tapping is:
0 : Disabled.
1 : Enabled.
FSBSYN(#2) Servo control for the EGB (FSSB method) is:
0 : Disabled.
1 : Enabled.

> **NOTE**
> 1 To use the EGB (FSSB method), set 1.
> 2 For an axis (EGB dummy axis) for which bit 2 (FSBSYN) of parameter No. 2429 is set to 1, the following functions cannot be used together:
> - FSSB high-speed rigid tapping (bit 1 of No.2429)
> - Servo-spindle synchronization control (bit 4 of No.2016)
> - Servo HRV4 control (bit 0 of No.2014)
>
> 3 When this parameter is set, the power must be turned off before operation is continued.

Reference item	A-94657E

	#7	#6	#5	#4	#3	#2	#1	#0
2436							STO	

STO (#1) The safety torque-off function by the servo amplifier is:
0 : Disabled.
1 : Enabled.
* This parameter is valid for servo amplifiers for the 30i-B Series.

	#7	#6	#5	#4	#3	#2	#1	#0
2437				AILIN				

AILIN(#4) By using LC195F or LC495F, the minimum resolution of the scale is:
0 : Not extended.
1 : Extended.

Reference item	Subsection 2.1.5

	#7	#6	#5	#4	#3	#2	#1	#0
2565								SFEROFF

SEROFF(#0) In a full-closed configuration in which an analog SDU is used, the function for monitoring the difference in error between the semi-closed and full-closed modes is:
0 : Enabled.
1 : Disabled.

Reference item	Subsection 2.1.11.1

	#7	#6	#5	#4	#3	#2	#1	#0
3111								SVS

SVS(＃0) 1 : The SERVO SETTING screen is displayed.

Reference item	Subsections 2.1.3 and 4.1.1

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
1821	Reference counter capacity	→ 2.1.3
1825	Position loop gain (position gain)	→ 4.1.1
1851	Backlash compensation value	→ 5.5.4, 5.5.5
2020	Motor ID No. Motor ID number that can be specified	→ 2.1.3 Initial setting

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2021	Load inertia ratio (LDINT) $\frac{\text{Load inertia}}{\text{Rotor inertia}} \times 256$ Increase velocity loop gain parameters PK1V and PK2V by (1 + LDINT/256) times	Adjust for individual machines separately.
2022 2023 2024	Rotation direction of the motor Number of velocity pulse Number of position pulse	→ 2.1.3 Initial setting
2025 2026	Inertial estimation: Oscillation frequency Inertial estimation: Oscillation gain	→ 5.6.1
2028	Velocity enabling position gain switching	→ 5.7.1
2029 2030	Acceleration-time velocity enabling integral function for low speed Deceleration-time velocity enabling integral function for low speed	→ 5.7.2
2031	Excessive torque difference alarm threshold	→ 5.10.1.3
2033 2034	Number of position feedback pulses Vibration damping control gain	→ 5.4.7
2036	Tandem control/damping compensation gain (main axis) Tandem control/damping compensation phase coefficient (sub-axis)	→ 5.10.1.4, 5.10.4.1
2039	Two-stage backlash acceleration function : stage 2 acceleration amount	→ 5.5.5
2040 2041 2042	Current loop gain (PK1) Current loop gain (PK2) Current loop gain (PK3)	★ Motor-specific
2043 2044	Velocity loop integral gain (PK1V) Velocity loop proportional gain (PK2V)	☆ Motor-specific Adjust for individual machines separately.
2045	Velocity loop incomplete integral gain (PK3V)	☆ Motor-specific → 4.3.7
2046	Velocity loop gain (PK4V)	★ Motor-specific
2047	Observer parameter (POA1) This parameter is adjusted when the unexpected disturbance torque detection and two-stage backlash functions are used. NOTE: If the velocity gain (load inertia ratio) is changed, this parameter must be re-adjusted. When a negative value is set for POA1, it is assumed to be |POA1| × 10.	☆ Motor-specific → 4.3.7, 5.9.1
2048	Backlash acceleration amount	☆ → 5.5.4, 5.5.5
2049	Maximum dual position feedback amplitude	☆ → 5.4.8
2050 2051	Observer gain (POK1) Observer gain (POK2) When only the unexpected disturbance torque detection function is used, these parameters must be changed.	☆ Motor-specific → 5.4.6
2052	Excess speed alarm detection speed	★
2053 2054 2055	Current dead-band compensation (PPMAX) Current dead-band compensation (PDDP) The standard setting for αi motors is 1894. Current dead-band compensation (PHYST)	★ Motor-specific
2056 2057 2058	Variable current loop gain during deceleration (EMFCMP) Phase D current at high-speed (PVPA) Phase D current limit (PALPH)	★ Motor-specific
2060	Torque limit The value 7282 represents the maximum current value of the amplifier. The default represents the maximum current of the motor.	★ Motor-specific

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2061 2062 2063	Back electromotive force compensation (EMFCMP) First OVC alarm parameter (POVC1) First OVC alarm parameter (POVC2)	★ Motor-specific
2064	Software disconnection alarm level	★ Motor-specific → 3.2
2065	First OVC alarm parameter (POVCLMT)	★ Motor-specific
2066	Acceleration feedback gain	☆ → 4.3.4
2067	Torque command filter	☆ → 4.3.5, 5.2, 5.4.2
2068 2069	Feed-forward coefficient Velocity feed-forward coefficient	☆ → 5.5.1, 5.5.7
2070	Backlash acceleration timing	☆
2071	Time during which backlash acceleration is effective, Static friction compensation count	☆ → 5.5.4
2072 2073	Static friction compensation amount Stop state judgment parameter	☆ → 5.5.6
2074	Variable current loop gain depending on current	★ Motor-specific
2075	Not in use at present.	☆
2076	Not in use at present.	☆
2077	Overshoot compensation counter	☆ → 4.3.7
2078 2079 2080 2081	Dual position feedback: Conversion coefficient (numerator) Dual position feedback: Conversion coefficient (denominator) Dual position feedback: Constant of first-order lag Dual position feedback: Zero zone	☆ → 5.4.8
2082	Backlash acceleration stop amount	☆ → 5.5.4
2083	Brake control timer (msec)	☆ → 5.8.1
2084 2085	Flexible feed gear (numerator) Flexible feed gear (denominator)	→ 2.1.2 Initial setting
2086	Rated current parameter	★ Motor-specific
2087	Torque offset Tandem control/Preload value	☆ → 5.5.5, 5.9.1, ☆ → 5.10.1.2
2088	Machine speed feedback gain	☆ → 4.3.5, 5.4.9
2089	Two-stage backlash acceleration function : stage-2 end magnification	☆ → 5.5.5
2091	Nonlinear control parameter	☆
2092	Advanced preview feed-forward coefficient	☆ → 5.5.1
2094	Backlash acceleration amount in the negative direction	☆ → 5.5.4
2095	Feed-forward timing adjustment coefficient	☆ → 5.5.3
2096	Machining point control: Timing adjustment parameter (MPCTIM)	→ 5.4.10
2097	Static friction compensation stop parameter	☆ → 5.5.6
2098	Current phase lead compensation coefficient	★ Motor-specific
2099	N pulses suppression function	
2101	Overshoot compensation valid level	☆ → 5.5.8
2102	Final clamp value for the actual-current limit	★ Motor-specific
2103	Track back amount applied when an unexpected disturbance torque is detected	☆ → 5.9.1
2104	Unexpected disturbance torque detection alarm level (cutting when switching is used)	☆ → 5.9.1
2105	Torque constant	☆ → 5.11
2107	Velocity loop gain magnification for cutting	☆ → 5.2
2110	Magnetic saturation compensation	★ Motor-specific
2111	Torque limit at deceleration	★ Motor-specific
2112	Linear motor AMR conversion coefficient 1	☆→ 3.2.1.1
2113	Resonance elimination filter 1: attenuation center frequency	☆→ 5.4.3,5.6.2

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2114	Backlash acceleration function : acceleration amount override Two-stage backlash acceleration function : stage 2 acceleration amount override	→ 5.5.4 → 5.5.5
2115	For internal data output: Usually to be kept at 0.	
2116	Unexpected disturbance torque detection : dynamic friction cancel	→ 5.9.1
2118	Dual position feedback Semi-closed/full-closed error overestimation level	→ 5.4.8
2119	Variable proportional gain function in the stop state : Stop level	→ 5.3.3, 5.4.6
2121	Synchronous axes automatic compensation: Preset	5.10.1.5
2122	Not used	
2126	Tandem control/position feedback switching time constant	
2127	Non-interference control coefficient (NINTCT)	★ Motor-specific
2128	Coefficient for magnetic flux weaken compensation (MFWKCE)	★ Motor-specific
2129	Coefficient for magnetic flux weaken compensation (MFWKBL)	★ Motor-specific
2130 2131 2132	Smoothing compensation performed twice per pole pair Smoothing compensation performed four times per pole pair Smoothing compensation performed six times per pole pair	☆ → 3.1.2
2133	Coefficient for phase lag compensation during deceleration (PHDLY1)	★ Motor-specific
2134	Coefficient for phase lag compensation during deceleration (PHDLY2)	★ Motor-specific
2137	Two-stage backlash acceleration function : stage 1 acceleration amount override	
2138 2139	Linear motor AMR conversion coefficient 2 Linear motor AMR offset	→ 3.2.1.1
2142	Unexpected disturbance torque detection alarm level in rapid traverse	→ 5.9.2
2144 2145	Position feed-forward coefficient for cutting Velocity feed-forward coefficient for cutting	→ 5.2, 5.5.2, 5.5.7
2146	Two-stage backlash acceleration end timer	→ 5.5.5
2148	Deceleration decision level (HRV control) Usually to be kept at 0.	Usually adjustment is not needed.
2151 2152 2153	For internal data output: Usually, be sure to set 0. For internal data output: Usually, be sure to set 0. For internal data output: Usually, be sure to set 0.	
2154	Static friction compensation function : decision level for movement restart after stop.	→
2156	Torque command filter (at rapid traverse)	→ 5.2, 5.4.2
2161	OVC magnification at a stop (OVCSTP)	★ Motor-specific
2162 2163 2164	Second OVC alarm parameter (POVC21) Second OVC alarm parameter (POVC22) Second OVC alarm parameter (POVCLMT2)	★ Motor-specific
2165	Maximum amplifier current	★ Motor-specific
2167	Two-stage backlash acceleration function : stage 2 acceleration amount offset	→ 5.5.5
2173	Distance to lift for the lifting function against gravity at emergency stop	→ 5.8.5.2
2177	Resonance elimination filter 1: attenuation bandwidth	→ 5.4.3, 5.6.2
2179	Reference counter size (denominator)	→ 2.1.3
2182	Current A for pole detection (DTCCRT_A)	→ 3.2.1.2
2183	Variable integral gain function in the stop state: Stop level	
2185	Position pulses conversion coefficient	→ 2.1, 2.1.9, 2.1.3 Initial setting
2193	Stop level (Dead-band compensation: Disabled in the stopped state)	

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2198 2199	Current B for pole detection (DTCCRT_B) Current C for pole detection (DTCCRT_C)	
2263	Detection unit setting	→ 2.1.9
2265 2266	Machining point control: gain 2 (MPCK2) Machining point control: gain 1 (MPCK1)	→ 5.4.10
2268	Allowable travel distance magnification/stop speed decision value (MFMPMD)	→ 3.2.1.2
2315	Servo check interface unit output signal setting	→ Appendix F
2318 2319 2320 2321 2322	Disturbance elimination filter : gain Disturbance elimination filter : inertia ratio Disturbance elimination filter : inverse function gain Disturbance elimination filter : time constant Disturbance elimination filter : acceleration feedback limit	→ 5.4.4
2323	Variable current PI rate	→ 5.3.4
2324	Variable proportional gain function in the stop state : arbitrary magnification at a stop (for cutting only)	→ 4.3.4, 5.3.3
2325	Tandem disturbance elimination control function/integral gain (main axis) Tandem disturbance elimination control function/phase coefficient (sub-axis)	→ 5.10.1.4
2326 2327 2328 2329	Disturbance input : gain Disturbance input : start frequency Disturbance input : end frequency Number of disturbance input measurement points	→5.10.1.4
2333	Tandem disturbance elimination control function /incomplete integral time constant (main axis)	→ 5.10.1.4
2334 2335	In high-speed HRV current control mode: Current loop gain magnification In high-speed HRV current control mode: Velocity loop gain magnification	→ 5.1.2, 5.1.3, C.2
2338	Backlash acceleration function : acceleration amount limit value Two-stage backlash acceleration function : stage-2 acceleration amount limit value	→ 5.5.4 → 5.5.5
2339	Two-stage backlash acceleration function : stage-2 acceleration amount (negative direction)	→ 5.5.5
2340	Backlash acceleration function : acceleration amount override (negative direction) Backlash acceleration function : Acceleration amount override (negative direction)	→ 5.5.4 → 5.5.5
2341	Two-stage backlash acceleration function : stage-2 acceleration amount limit value (negative direction) Two-stage backlash acceleration function : stage-2 acceleration amount limit value (negative direction)	→ 5.5.4 → 5.5.5
2342 2343	Unexpected disturbance torque detection: Acceleration threshold Unexpected disturbance torque detection: Alarm level for high acceleration	→ 5.9.3
2344	Variable integral gain function in the stop state: Arbitrary magnification in the stop state	
2345 2346	Disturbance estimation function : dynamic friction compensation value in the stop state Disturbance estimation function : dynamic friction compensation limit value	→ 5.9.1
2350	Adaptive resonance elimination filter: Allowable acceleration	→ 5.6.2
2351	Adaptive resonance elimination filter: Follow-up bandwidth	→ 5.6.2
2352	Adaptive resonance elimination filter: Detective level	→ 5.6.2
2353	Adaptive resonance elimination filter: Wait time for setting	→ 5.6.2
2355	Machining point control: Center frequency of band-pass filter	→ 5.4.10
2357	Tandem speed difference alarm threshold	→ 5.10.4.4
2356	Resonance elimination filter L: Feed-forward filter exclusion rate	→ 5.4.5
2358	Unexpected disturbance torque detection: Post-acceleration timer	→ 5.9.3

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2359	Resonance elimination filter 1 : damping	→.4.3, 5.4.11, 5.6.2
2360 2361 2362	Resonance elimination filter 2 : attenuation center frequency Resonance elimination filter 2 : attenuation bandwidth Resonance elimination filter 2 : damping	→ 5.4.3, 5.4.11
2363 2364 2365	Resonance elimination filter 3 : attenuation center frequency Resonance elimination filter 3 : attenuation bandwidth Resonance elimination filter 3 : damping	→ 5.4.3, 5.4.11
2366 2367 2368	Resonance elimination filter 4 / Resonance elimination filter L : attenuation center frequency Resonance elimination filter 4 / Resonance elimination filter L : attenuation bandwidth Resonance elimination filter 4 / Resonance elimination filter L : damping	→ 5.4.3, 5.4.5, 5.4.11
2369 2370 2371	Smoothing compensation performed twice per pole pair (negative direction) Smoothing compensation performed four times per pole pair (negative direction) Smoothing compensation performed six times per pole pair (negative direction)	→ 3.1.2
2372	Serial EGB exponent setting * For the 30*i*-B, no exponent setting is required.	
2373 2374	Lifting function against gravity at emergency stop : Distance to lift Lifting function against gravity at emergency stop : Lifting time	→ 5.8.5.1, 5.8.5.2
2377 2378	Smoothing compensation performed 1.5 times per pole pair Smoothing compensation performed 1.5 times per pole pair (negative direction)	→ 3.2.2
2380 2381	Smoothing compensation performed three times per pole pair Smoothing compensation performed three times per pole pair (negative direction)	→ 3.2.2
2382	Torsion preview control: maximum compensation value (LSTCM)	→ 5.5.7
2383 2384 2385	Torsion preview control: acceleration 1 (LSTAC1) Torsion preview control: acceleration 2 (LSTAC2) Torsion preview control: acceleration 3 (LSTAC3)	→ 5.5.7
2386 2387 2388	Torsion preview control: acceleration torsion compensation value K1 (LSTK1) Torsion preview control: acceleration torsion compensation value K2 (LSTK2) Torsion preview control: acceleration torsion compensation value K3 (LSTK3)	→ 5.5.7
2389	Torsion preview control: torsion delay compensation value KD (LSTKD)	→ 5.5.7
2391 2392 2393	Torsion preview control: acceleration torsion compensation value K1N (LSTK1N) Torsion preview control: acceleration torsion compensation value K2N (LSTK2N) Torsion preview control: acceleration torsion compensation value K3N (LSTK3N)	→ 5.5.7
2394	Number of data mask digits	→ 2.1.5, 3.2.1.1
2396	Torsion preview control: Torsion delay compensation value KDN (LSTKDN)	→ 5.5.7
2402	Torsion preview control: torsion torque compensation coefficient (LSTKT)	→ 5.5.7
2403	Synchronous axes automatic compensation function : coefficient (K)	→5.10.1.5
2404	Synchronous axes automatic compensation function : maximum compensation (sub axis) Synchronous axes automatic compensation function : dead-band width (main axis)	→ 5.10.1.5
2405	Synchronous axes automatic compensation function : filter coefficient	→ 5.10.1.5

☆: Parameters set up automatically at initialization
★: Parameters that can be kept at the automatically set values

Parameter number	Details	
2446 to 2453	Parameters for tuning for quadrant protrusion compensation for Tuning Navigator	→ Appendix M
2455 2456	Integer part of the number of pulses per revolution Exponent part of the number of pulses per revolution	→ 5.5.9
2458	Detection of excessive error between the estimated position and actual position: Detection level	→ 2.1.11.2
2459	Adaptive resonance elimination filter: Search bandwidth	→ 5.6.2
2463 2468 2469	Power consumption monitoring: Loss coefficient C (Power Supply) Power consumption monitoring: Coil resistance Power consumption monitoring: Loss coefficient A (Servo Amplifier)	→ Appendix J
2470 to 2475	Parameters for tuning for quadrant protrusion compensation for Tuning Navigator	→ Appendix M
2478 2479 2480 2481	Interactive Force Compensation: Compensation gain (for the first moving axis) Interactive Force Compensation: Angle data offset (for the first moving axis) Interactive Force Compensation: Compensation gain (for the second moving axis) Interactive Force Compensation: Angle data offset (for the second moving axis)	→ 5.5.9
2482 2483	Detection level of speed arrival Detection level of speed zero	→ 5.12.1
2486 to 2489	Parameters for tuning for quadrant protrusion compensation for Tuning Navigator	
2490	Power consumption monitoring: Loss coefficient B (Servo Amplifier)	→ Appendix J
2491	Power consumption monitoring: Loss coefficient D (Power Supply)	→ Appendix J
2494 to 2505	Parameters for tuning for quadrant protrusion compensation for Tuning Navigator	→ Appendix M
2506 to 2509	Parameters for tuning for quadrant protrusion compensation for Tuning Navigator	→ Appendix M
2606	Interactive force compensation function: First moving axis number, second moving axis number	→ 5.5.9
2613	Compensation amount for reverse operation in FSSB high-speed rigid tapping	→ 5.13

9 PARAMETER LIST

Chapter 9, "PARAMETER LIST", consists of the following sections:

* With the Series 30*i*–B or Power Motion *i*-A, to use a 400-V driving motor, servo software of 90G0/06.0 or later is required.

When *1 to *6 is added in "Remarks" for a motor, a servo amplifier and power supply having specification numbers listed below, and/or servo software of the listed series and edition or later are required.

(*1)

Servo amplifier, Power supply

Series		Specification numbers		Remarks
		200V	400V	
α*i* series	α*i* SV	A06B-6117-Hxxx A06B-6240-Hxxx	A06B-6127-Hxxx A06B-6290-Hxxx	
	α*i* PS	A06B-6140-Hxxx A06B-6200-Hxxx	A06B-6150-Hxxx A06B-6250-Hxxx	
β*i* series	β*i* SV	A06B-6130-Hxxx A06B-6160-Hxxx	A06B-6131-Hxxx A06B-6161-Hxxx	
	β*i* SV(2 axes)	A06B-6136-Hxxx A06B-6166-Hxxx	--- ---	
	β*i* SVSP	A06B-6164-Hxxx	---	
	β*i* SVSPc	A06B-6167-Hxxx	---	

Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	Q(17) 01.0	
Series 30*i*/31*i*-A	90D0	Q(17)	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	01.0 01.0	
	90E5 90E8	01.0 01.0	

(*2)

Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	01.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	N(14) 01.0	
Series 30*i*/31*i*-A	90D0	N(14)	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	01.0 01.0	
	90E5 90E8	01.0 01.0	

(*3)
Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	10.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	28.0 04.0	
Series 30*i*/31*i*-A	90D0	–	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	– –	
	90E5 90E8	– –	

(*4)
Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	09.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	30.0 04.0	
Series 30*i*/31*i*-A	90D0	–	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	04.0 01.0	
	90E5 90E8	04.0 01.0	

(*5)
Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	01.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	N(14) 01.0	
Series 30*i*/31*i*-A	90D0	N(14)	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	01.0 01.0	
	90E5 90E8	01.0 01.0	

(*6)
Series and editions of servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	19.0	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	– –	
Series 30*i*/31*i*-A	90D0	–	HRV4
Series 0*i*-D Series 0*i* Mate-D	90C5 90C8	– –	
	90E5 90E8	– –	

9.1 STANDARD PARAMETERS FOR THE α*i* SERIES SERVO MOTORS

Series 90G0 (for Series 30*i*/31*i*/32*i*/35*i*-B, Power Motion *i*-A)
Series 90E0 and 90E1 (for Series 30*i*/31*i*/32*i*-A)
Series 90D0 (for Series 30*i*/31*i*-A)
Series 90C5 and 90C8 (for Series 0*i*-D)
Series 90E5 and 90E8 (for Series 0*i*-D)

9.1.1 αiS Series

αiS series (1/3)

	Motor model	α iS2 5000	α iS2 6000	α iS4 5000	α iS4 6000	α iS8 4000	α iS8 6000	α iS12 4000	α iS12 6000	α iS22 4000	α iS22 6000	α iS30 4000
	Motor specification	0212	0218	0215	0210	0235	0232	0238	0230	0265	0262	0268
	Motor ID No.	262	284	265	466	285	290	288	462	315	452	318
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	530	552	420	395	550	460	570	471	581	605	799
2041	CUR GAIN P	-2543	-2288	-1748	-1606	-3449	-1760	-3358	-2249	-3844	-2393	-4447
2042	CUR GAIN 3	-1251	-1252	-1276	-1277	-1307	-1305	-1319	-1321	-1337	-1335	-1317
2043	VEL GAIN I	39	48	64	76	33	53	52	43	69	102	82
2044	VEL GAIN P	-350	-429	-574	-678	-294	-478	-466	-387	-616	-914	-733
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	10853	-884	-661	5601	-1289	-794	-815	-980	6163	4150	5175
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	7000	7500	7000	7500	5600	7500	5600	7500	5600	7500	5400
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	-10250	-13062	-8974	-13326	-7685	-16398	-5898	-12808	-7687	-12039	-6412
2058	D-PHASE CUR	-2000	-1000	-3641	-2500	-2000	-1000	-3000	-1800	-2000	-2000	-2300
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32528	32415	32289	32310	32609	32520	32534	32688	32515	32515	32515
2063	OVC K2	3005	4413	5994	5728	1993	3101	2923	998	3166	3166	3166
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	8936	13146	17889	17091	5920	9224	8692	2960	9418	9418	9418
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	20480	12288	16384	0	8192	0	12288	4096	4096	4096
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1540	1868	2824	2585	1253	2075	1518	1181	1627	1977	1836
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	117	96	127	104	562	346	696	837	1216	819	1470
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	32	1555	8	3092	519	1284	521	528	519	1288	775
2111	TQLIM IN DEC.	8995	11550	10295	8208	7268	10255	6174	10260	6224	12830	6450
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	1137	1137	646	660	2106	801	1592	1146	2041	1000	1871
2128	MFWKCE	1000	3000	1667	3000	4000	1000	2000	667	2500	1000	4000
2129	MFWKBL	3851	4112	3847	4365	2580	5388	2575	3850	2580	3854	2574
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	7690	7690	7690	7690	5150	10250	6174	7690	5150	7690	5150
2134	PHDLY2	12840	7740	12840	12830	8990	12830	8990	8990	8990	8990	8990
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	128	128	128
2162	OVC2 K1	32766	32766	32762	32763	32767	32765	32766	32764	32766	32765	32765
2163	OVC2 K2	20	30	77	58	13	38	19	45	28	44	37
2164	OVC2 LIMIT	3776	5554	12702	9912	2501	6857	3672	1721	5177	7743	6687
2165	MAX CURRENT	25	25	25	25	85	85	85	165	165	165	165
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

αiS series (2/3)

	Motor model	αiS40 4000	αiS50 2000	αiS50 3000	αiS50 3000 Fan	αiS60 2000	αiS60 3000 Fan	αiS100 2500	αiS100 2500 Fan	αiS200 2500	αiS200 2500 Fan	αiS300 2000
	Motor specification	0272	0042	0275	0275	0044	0278	0285	0285	0288	0288	0292
	Motor ID No.	322	468	324	325	470	328	335	330	338	334	342
PRM NO	SERVO PRM.											Amp*2
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	712	1539	547	547	1358	1191	1020	1020	1834	1834	1659
2041	CUR GAIN P	-4138	-7321	-3423	-3423	-6767	-6320	-7093	-7093	-7805	-7805	-8045
2042	CUR GAIN 3	-1341	-1344	-1345	-1345	-1344	-1347	-1359	-1359	-1360	-1360	-1354
2043	VEL GAIN I	92	90	69	69	103	69	91	91	115	115	114
2044	VEL GAIN P	-827	-802	-622	-622	-925	-617	-819	-819	-1026	-1026	-1025
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	4589	4731	6099	6099	4103	6152	4632	4632	3699	3699	3709
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	4800	2800	4200	4200	2700	4000	3500	3500	3100	3100	2800
2053	DB-CMP PPMAX	21	31979	31979	31979	31979	31979	21	21	21	21	21
2054	DB-CMP PDDP	1894	3	3	3	3	3	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	-5645	-3867	-5638	-5638	-3097	-4619	-4368	-4368	-3090	-3090	-3081
2058	D-PHASE CUR	-3000	-3393	-1000	-1000	-2995	-2000	-1359	-1359	-2700	-2700	-700
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32515	32515	32558	32348	32515	32388	32310	32309	32309	32309	32391
2063	OVC K2	3166	3166	2627	5245	3166	4744	5728	5734	5734	5734	4714
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	9418	9418	7810	15639	9418	14138	15662	27346	27346	27346	23263
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	4096	8192	4096	4096	0	8192	20480	20480	12288	12288	12288
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	2073	1856	1439	2037	2018	1937	1960	2848	2712	3013	2386
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	1701	2569	3312	3312	2942	4411	4589	4589	5973	5973	10871
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	776	1032	519	519	1544	519	776	776	1290	1290	1296
2111	TQLIM IN DEC.	5682	4954	6174	6174	3151	5220	3787	3787	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	1853	2825	2046	2046	5498	2852	3520	3520	3518	3518	3817
2128	MFWKCE	4000	4601	6500	6500	4004	5000	6500	6500	4000	4000	7000
2129	MFWKBL	2063	1296	2063	2063	1302	1300	1297	1297	1298	1298	1301
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	5150	2570	5150	5150	4146	5150	2570	2570	3092	3092	2574
2134	PHDLY2	8988	12814	8990	8990	12821	8990	8970	8970	12826	12826	12814
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	128	128	0	0	128	0	106	140	140	140	140
2162	OVC2 K1	32765	32764	32754	32739	32761	32742	32750	32745	32745	32745	32738
2163	OVC2 K2	38	51	174	365	81	327	223	292	292	292	375
2164	OVC2 LIMIT	6846	6831	3300	6608	8124	5973	6581	13952	13952	13952	13952
2165	MAX CURRENT	165	165	365	365	165	365	365	365	365	365	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

αiS series (3/3)

	Motor model	αiS500 2000
	Motor specification	0295
	Motor ID No.	345
PRM NO	SERVO PRM.	Amp*2
2003		00001000
2004		00000011
2005		00000000
2006		00000000
2007		00000000
2008		00000000
2009		00000000
2010		00000000
2011		00000000
2012		00000000
2013		00000000
2014		00000000
2210		00000000
2211		00001010
2300		00000000
2301		00000000
2040	CUR GAIN I	2660
2041	CUR GAIN P	-10235
2042	CUR GAIN 3	-1355
2043	VEL GAIN I	134
2044	VEL GAIN P	-1199
2045	VEL GAIN 3	0
2046	VEL GAIN 4	-8235
2047	OBSERVER POA1	3164
2048	BLACC CMP	0
2049	DPFMX	0
2050	OBSERVER POK1	956
2051	OBSERVER POK2	510
2052	OVER SPEED	2400
2053	DB-CMP PPMAX	21
2054	DB-CMP PDDP	1894
2055	DB-CMP PHYST	319
2056	EMFCMP	0
2057	D-PHASE CUR	-2068
2058	D-PHASE CUR	-2600
2059	PPBAS	0
2060	TCMD LIMIT	7282
2061	EMFLMT	0
2062	OVC K1	32309
2063	OVC K2	5734
2064	TGALMLV	4
2065	OVC LIMIT	27346
2066	ACC FB GAIN	0
2067	TCMD FILTER	0
2068-2073		0
2074	AALPH	12288
2077-2083		0
2086	RATED CURRENT	2980
2087-2089		0
2090	ROBSTL	0
2091-2098		0
2099	ONEPSL	400
2100	INPA1	0
2101	INPA2	0
2102	DBLIM	0
2103	ABVOF	0
2104	ABTSH	0
2105	TORQUE CONST.	15096
2106-2109		0
2110	MGSTCM	1296
2111	TQLIM IN DEC.	0
2112	AMRDML	0
2113	HRV FILT	0
2127	NINTCT	4175
2128	MFWKCE	4000
2129	MFWKBL	1041
2130-2132	SMOOTH CMP	0
2133	PHDLY1	2069
2134	PHDLY2	8981
2159	DGCSMM	0
2160	TRQCUP	0
2161	OVC STP	140
2162	OVC2 K1	32745
2163	OVC2 K2	292
2164	OVC2 LIMIT	13952
2165	MAX CURRENT	365
2302	TQLIM AT STOP	0
2304	ACCBSLM	0
2305	ACDCEBD	0
2310	DCIDBS	0
2316	LIMLIM	0

Remarks	

9.1.2 αiS Series HV

αiS series HV (1/4)

	Motor model	α iS2 5000HV	α iS2 6000HV	α iS4 5000HV	α iS4 6000HV	α iS8 4000HV	α iS8 6000HV	α iS12 4000HV	α iS12 6000HV	α iS22 4000HV	α iS22 6000HV	α iS30 4000HV
	Motor specification	0213	0219	0216	0214	0236	0233	0239	0237	0266	0263	0269
	Motor ID No.	263	287	266	467	286	292	289	463	316	453	319
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	400	497	425	432	694	381	783	471	709	605	816
2041	CUR GAIN P	-2312	-2371	-1641	-1673	-3858	-1749	-4294	-2249	-4008	-2393	-4681
2042	CUR GAIN 3	-1251	-1249	-1266	-1266	-1318	-1305	-1333	-1321	-1345	-1335	-1348
2043	VEL GAIN I	39	48	64	77	34	53	52	43	76	102	82
2044	VEL GAIN P	-351	-429	-574	-688	-306	-478	-470	-387	-685	-914	-738
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-1081	-884	-661	5516	-1240	-794	-808	-980	5538	4150	5143
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	7000	7500	7000	7500	5600	7500	5600	7500	5600	7500	5400
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	-10252	-13062	-10262	-13326	-7685	-16398	-5898	-12808	-7683	-12039	-6412
2058	D-PHASE CUR	-1600	-1200	-3300	-2500	-2000	-1000	-3000	-1800	-1000	-2000	-2300
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32532	32416	32289	32288	32596	32548	32530	32688	32501	32501	32501
2063	OVC K2	2953	4405	5994	5995	2153	2755	2976	998	3332	3332	3332
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	8782	13123	17889	17893	6396	8192	8848	2960	9912	9912	9912
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	16384	20480	8192	16384	8192	8192	8192	12288	8192	4096	4096
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1526	1866	2824	2586	1302	2075	1532	1181	1810	1977	1847
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	117	96	127	104	541	346	690	837	1093	819	1460
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	40	1555	40	3092	519	1284	521	528	513	1288	775
2111	TQLIM IN DEC.	10260	11550	10260	8208	7268	10255	6159	10260	6194	12830	6430
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	4548	2302	1293	1368	5103	1600	4904	2292	4264	2000	5117
2128	MFWKCE	1250	2200	3000	3000	4500	1400	2000	667	2000	1000	3000
2129	MFWKBL	3847	4112	5122	4365	2580	5390	2575	3850	3092	3854	2574
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	7690	7690	7685	7690	5150	10260	6174	7690	5150	7690	5150
2134	PHDLY2	12850	7740	12850	12830	8990	12835	8990	8990	8990	8990	8990
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	32766	32766	32762	32763	32767	32765	32766	32764	32766	32765	32766
2163	OVC2 K2	20	30	77	63	14	38	20	45	28	34	30
2164	OVC2 LIMIT	3711	5544	12702	10651	2702	6857	3738	1721	5218	6222	5432
2165	MAX CURRENT	10	10	10	10	45	45	45	85	85	85	85
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

α*i*S series HV (2/4)

	Motor model	α iS40 4000HV	α iS50 2000HV	α iS50 3000HV	α iS50 3000HV Fan	α iS60 2000HV	α iS60 3000HV Fan	α iS100 2500HV	α iS100 2500HV Fan	α iS200 2500HV	α iS200 2500HV Fan	α iS300 2000HV
	Motor specification	0273	0043	0276	0276	0045	0279	0286	0286	0289	0289	0293
	Motor ID No.	323	469	327	326	471	329	336	331	339	337	343
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	01000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00100000	00100000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00001010	00001010	00001010	00001010	00000000	00000000	00001010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	860	1539	705	705	1358	1131	1790	1790	2080	2080	1327
2041	CUR GAIN P	-4938	-7321	-4855	-4855	-6767	-5966	-5915	-5915	-8139	-8139	-7279
2042	CUR GAIN 3	-1350	-1344	-1348	-1348	-1344	-1345	-1359	-1359	-1359	-1359	-1356
2043	VEL GAIN I	93	90	70	70	103	69	91	91	115	115	114
2044	VEL GAIN P	-831	-802	-628	-628	-925	-617	-819	-819	-1026	-1026	-1025
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	4569	4731	6039	6039	4103	6152	4636	4636	3699	3699	3703
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	4800	2800	4200	4200	2700	4000	3500	3500	3100	3100	2800
2053	DB-CMP PPMAX	21	31979	31979	31979	31979	31979	21	21	21	21	21
2054	DB-CMP PDDP	1894	3	3	3	3	3	1894	1894	1894	1894	3787
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	-5648	-3867	-5638	-5638	-3097	-4620	-3846	-3846	-3088	-3088	-3846
2058	D-PHASE CUR	-3000	-3393	-1000	-1000	-2995	-2000	-900	-900	-3000	-3000	-900
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32501	32501	32554	32371	32501	32388	32474	32309	32309	32309	32391
2063	OVC K2	3332	3332	2680	4967	3332	4745	3672	5734	5734	5734	4714
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	9912	9912	7968	14807	9912	14140	15982	27346	27346	27346	23263
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	4096	8192	0	0	0	4096	12288	12288	12288	12288	12288
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	2083	1856	1454	2057	2018	1937	2033	2848	2712	3013	2483
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	10000	10000	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	1693	2569	3279	3279	2942	4411	4423	4423	5973	5973	10871
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	769	1032	519	519	1544	519	1291	1291	1291	1291	1296
2111	TQLIM IN DEC.	5682	4954	6174	6174	3151	5220	0	0	3428	3428	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	5230	5651	4861	4861	5498	5393	6952	6952	6729	6729	7634
2128	MFWKCE	4000	4601	2500	2500	4004	3000	2000	2000	4000	4000	5000
2129	MFWKBL	2063	1296	2068	2068	1302	1300	1549	1549	1551	1551	1298
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	5150	2570	5150	5150	4146	5150	0	0	2575	2575	2574
2134	PHDLY2	8988	12814	8990	8990	12821	8990	0	0	8984	8984	12814
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	140	140	140	140	140
2162	OVC2 K1	32765	32764	32754	32738	32764	32742	32759	32745	32745	32745	32738
2163	OVC2 K2	38	48	178	373	51	327	112	292	292	292	375
2164	OVC2 LIMIT	6908	6829	3366	6736	7077	5974	6752	13952	13952	13952	13952
2165	MAX CURRENT	85	85	185	185	85	185	185	185	185	185	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

αiS series HV (3/4)

	Motor model	αiS300 3000HV	αiS500 2000HV	αiS500 3000HV	αiS1000 2000HV	αiS1000 2000HV	αiS1000 3000HV	αiS1000 3000HV	αiS2000 2000HV	αiS2000 2000HV	αiS2000 2000HV spindle	αiS3000 2000HV
	Motor specification	0290	0296	0297	0298	0098	0099	0099	0091	0091	0091	0092
	Motor ID No.	344	346	347	348	458	350	465	454	459	476	455
PRM NO	SERVO PRM.				Amp*2	Amp*2	Amp*4(PDM)	Amp*4	Amp*4(PDM)	Amp*4	Amp*4	Amp*4(PDM)
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	01000011	00000011	01000011	01000011	00000011	00000011	01000011	01000011	01000011	01000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00001000	00000000	00001000	00000000	00001000	00001000	00001000	00000000	00000000	00001000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00100000	00100000	00100000	00100000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000001	00000000	00000001	00000000	00000000	00000001
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00100000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00011010	00001010	00011010	00001010	00011010	00011010	10011010	00011110	10011110	10011110	00011010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	10000000	10000000	11000000	11000000	11000000	11000000
2040	CUR GAIN I	821	2255	1344	840	1260	960	960	643	643	643	772
2041	CUR GAIN P	-5450	-10049	-7296	-5329	-8010	-6554	-6554	-3600	-3600	-3600	-3819
2042	CUR GAIN 3	-1355	-1356	-1357	-1361	-1362	-1362	-1362	-1358	-1358	-1358	-1357
2043	VEL GAIN I	91	134	111	234	263	191	191	502	502	502	652
2044	VEL GAIN P	-819	-1199	-996	-2096	-2357	-1708	-1708	-4500	-4500	-4500	-5836
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	4633	3164	3811	1811	1610	2221	2221	843	843	843	650
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	3900	2400	4200	2600	2600	3800	3800	2400	2400	2400	2800
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	3787	1894	3787	3787	1894	1894	3787	3787	3787	3787
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	-5646	-2070	-3856	-2320	-2320	-4620	-4620	-3363	-3363	-3363	-2088
2058	D-PHASE CUR	-1800	-2700	-2900	-2500	-2500	-2500	-2500	-3200	-3200	-3200	-5000
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	5097	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32380	32309	32380	32309	32309	32488	32488	32309	32309	32309	32322
2063	OVC K2	4850	5734	4850	5734	5734	3503	3503	5734	5734	5734	5579
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	12155	27346	12155	27346	27346	18280	18280	27346	27346	27346	26742
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	12288	12288	12288	12288	12288	12288	12288	12288	12288	12288	12288
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	2000	2980	2482	2834	2960	2599	2599	2893	2893	2893	3187
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	2800	2800	2800	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	2000	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	13494	15096	18125	28573	27963	3807	3807	5957	5957	5957	8472
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	523	1293	521	1296	785	1040	1040	784	784	784	267
2111	TQLIM IN DEC.	2960	0	2953	3172	2300	3242	3242	2022	2022	2720	2218
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	7720	8341	8021	8637	11851	9876	9876	3449	3449	3449	3029
2128	MFWKCE	4300	4500	2500	6000	4500	4500	4500	3000	3000	3000	2700
2129	MFWKBL	1556	788	1041	1047	1038	1556	1556	1291	1291	1291	777
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	3100	2324	3093	2580	2570	2580	2580	2060	2060	2060	2068
2134	PHDLY2	6422	8984	6418	8985	12810	6418	6418	12820	12820	12820	6410
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	140	140	140	140	140	140	140	140	140	140	140
2162	OVC2 K1	32700	32745	32700	32745	32745	32721	32721	32745	32745	32745	32756
2163	OVC2 K2	853	292	853	292	292	589	589	292	292	292	151
2164	OVC2 LIMIT	10644	13952	10644	13952	13952	13952	13952	13952	13952	13952	13944
2165	MAX CURRENT	0	365	0	365	365	0	365	0	365	365	0
2302	TQLIM AT STOP	20	0	20	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	2720	2720	2720	0
2305	ACDCEBD	29	0	32	0	22	29	29	4112	4112	4112	22
2310	DCIDBS	1700	0	1400	0	1112	1648	1648	1236	1236	1236	1112
2316	LIMLIM	5394	0	5394	0	0	0	0	0	0	0	0

Remarks											
	*1,*2,*3		*1,*2,*3		*1,*2,*3	*1,*2,*3	*1,*2,*3	*1,*2	*1,*2	*1,*2,*3,*4	*1,*2

*1 Supporting servo software, amplifier, and power supply are required.
*2,*3,*4 Supporting servo software is required.

αiS series HV (4/4)

	Motor model	αiS3000 2000HV
	Motor specification	0092
	Motor ID No.	460
PRM NO	SERVO PRM.	Amp*4
2003		00001000
2004		01000011
2005		00000000
2006		00000000
2007		00100000
2008		00000000
2009		00000000
2010		00000000
2011		00000000
2012		00000000
2013		00000000
2014		00000000
2210		00000000
2211		10011010
2300		00000000
2301		11000000
2040	CUR GAIN I	772
2041	CUR GAIN P	-3819
2042	CUR GAIN 3	-1357
2043	VEL GAIN I	652
2044	VEL GAIN P	-5836
2045	VEL GAIN 3	0
2046	VEL GAIN 4	-8235
2047	OBSERVER POA1	650
2048	BLACC CMP	0
2049	DPFMX	0
2050	OBSERVER POK1	956
2051	OBSERVER POK2	510
2052	OVER SPEED	2800
2053	DB-CMP PPMAX	21
2054	DB-CMP PDDP	3787
2055	DB-CMP PHYST	319
2056	EMFCMP	0
2057	D-PHASE CUR	-2088
2058	D-PHASE CUR	-5000
2059	PPBAS	0
2060	TCMD LIMIT	7282
2061	EMFLMT	0
2062	OVC K1	32322
2063	OVC K2	5579
2064	TGALMLV	4
2065	OVC LIMIT	26742
2066	ACC FB GAIN	0
2067	TCMD FILTER	0
2068-2073		0
2074	AALPH	12288
2077-2083		0
2086	RATED CURRENT	3187
2087-2089		0
2090	ROBSTL	0
2091-2098		0
2099	ONEPSL	400
2100	INPA1	0
2101	INPA2	0
2102	DBLIM	0
2103	ABVOF	0
2104	ABTSH	0
2105	TORQUE CONST.	8472
2106-2109		0
2110	MGSTCM	267
2111	TQLIM IN DEC.	2218
2112	AMRDML	0
2113	HRV FILT	0
2127	NINTCT	3029
2128	MFWKCE	2700
2129	MFWKBL	777
2130-2132	SMOOTH CMP	0
2133	PHDLY1	2068
2134	PHDLY2	6410
2159	DGCSMM	0
2160	TRQCUP	0
2161	OVC STP	140
2162	OVC2 K1	32756
2163	OVC2 K2	151
2164	OVC2 LIMIT	13949
2165	MAX CURRENT	365
2302	TQLIM AT STOP	0
2304	ACCBSLM	0
2305	ACDCEBD	22
2310	DCIDBS	1112
2316	LIMLIM	0

Remarks	*1,*2
*1	Supporting servo software, amplifier, and power supply are required.
*2	Supporting servo software is required.

9.1.3 α*i*F Series

α*i*F series

	Motor model	αiF1 5000	αiF2 5000	αiF4 5000	αiF8 3000	αiF8 4000	αiF12 4000	αiF22 3000	αiF22 4000	αiF30 4000	αiF40 3000	αiF40 3000 Fan
	Motor specification	0202	0205	0223	0227	0228	0243	0247	0248	0253	0257	0257
	Motor ID No.	252	255	273	277	492	293	297	494	303	307	308
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00100000	00100000	00000000	00100000	00100000	00000000	00000000	00100000	00100000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00000010	00000000	00001010	00000000	00000000	00001010	00001010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	620	760	993	787	526	1701	1750	1214	768	1500	1500
2041	CUR GAIN P	-3034	-3743	-4260	-4184	-3270	-6391	-6000	-5208	-4492	-8224	-8224
2042	CUR GAIN 3	-1256	-1283	-1311	-1325	-1322	-1315	-1345	-1343	-1347	-1348	-1348
2043	VEL GAIN I	66	76	106	113	90	192	198	170	230	191	191
2044	VEL GAIN P	-594	-680	-953	-1009	-807	-1721	-1775	-1523	-2057	-1712	-1712
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	6384	5578	3980	3760	4704	2204	2137	2492	1845	2216	2216
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	7000	7000	6000	4200	5600	4800	3600	4800	4800	4200	4200
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	-5130	-10	-6430	0	0	0	0	0	-20500	0	0
2057	D-PHASE CUR	0	-12298	-10510	-6420	-10007	-8199	-5136	-7696	-7697	-2570	-2570
2058	D-PHASE CUR	0	-1275	-2575	-2000	-1593	-747	-2800	-2574	-2512	-2000	-2000
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	8010	8010	7282	7282	7282	7282	7282	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32613	32497	32446	32383	32522	32520	32520	32487	32515	32515	32431
2063	OVC K2	1933	3390	4029	4807	3078	3101	3101	3517	3166	3166	4212
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	5739	10085	11998	14327	9154	9224	9224	9418	9418	9418	12545
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	12288	8192	8192	12288	8192	12288	8192	4096	0	0
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1234	1636	1784	1950	1588	2085	2131	1827	2306	1957	2593
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	15000	15000	0	15000	15000	0	0	12000	12000
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	72	109	201	369	461	517	929	1083	1170	1839	1839
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	32	32	1553	776	1300	32	1291	1547	1815	1291	1291
2111	TQLIM IN DEC.	10260	10280	7712	3870	6500	5191	0	5495	0	5220	5140
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	1188	1276	1443	2103	1631	2388	3272	2226	1688	3041	3041
2128	MFWKCE	1667	2000	1401	3500	3139	2000	4500	5518	2500	6000	2000
2129	MFWKBL	3858	3862	3335	1815	3089	2568	1301	2326	2829	1560	1553
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	7690	7693	7712	0	5141	7701	0	5141	5140	2590	3085
2134	PHDLY2	12840	12840	8892	0	8981	5141	0	8981	8995	8990	8990
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	128	128	128	128
2162	OVC2 K1	32767	32766	32766	32765	32765	32765	32765	32762	32764	32764	32717
2163	OVC2 K2	13	23	27	33	40	38	40	75	48	46	637
2164	OVC2 LIMIT	2425	4261	5069	6053	5746	6924	7229	7898	8124	8124	10815
2165	MAX CURRENT	25	25	45	45	85	85	85	165	165	165	165
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	1817	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											
							*1				

*1 Supporting servo software, amplifier, and power supply are required.

9.1.4 αiF Series HV

αiF series HV

	Motor model	αiF4 5000HV	αiF8 3000HV	αiF8 4000HV	αiF12 4000HV	αiF22 3000HV	αiF22 4000HV	αiF30 4000HV	αiF40 3000HV	αiF40 3000HV Fan		
	Motor specification	0225	0229	0220	0245	0249	0240	0255	0259	0259		
	Motor ID No.	275	279	493	295	299	495	304	309	479		
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000		
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011		
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2011		00000000	00000000	00000000	00100000	00100000	00000000	00100000	00000000	00000000		
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2211		00001010	00001010	00001010	00000000	00000000	00001010	00001010	00011010	00011010		
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2040	CUR GAIN I	570	1222	526	1200	1919	1214	785	1441	1441		
2041	CUR GAIN P	-3578	-5890	-3270	-6059	-9132	-5208	-4179	-7513	-7513		
2042	CUR GAIN 3	-1309	-1322	-1322	-1339	-1346	-1343	-1347	-1350	-1350		
2043	VEL GAIN I	113	113	90	193	197	170	225	188	188		
2044	VEL GAIN P	-1009	-1008	-807	-1727	-1765	-1523	-2016	-1684	-1684		
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0		
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235		
2047	OBSERVER POA1	3762	3764	4704	2197	2150	2492	-1882	2253	2253		
2048	BLACC CMP	0	0	0	0	0	0	0	0	0		
2049	DPFMX	0	0	0	0	0	0	0	0	0		
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956		
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510		
2052	OVER SPEED	6000	3900	5600	4800	3600	4800	4800	3600	3600		
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21		
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894		
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319		
2056	EMFCMP	0	0	0	0	0	0	0	0	0		
2057	D-PHASE CUR	-11788	-6159	-10007	-8203	-5136	-7696	-7697	-5137	-5137		
2058	D-PHASE CUR	-1734	-1261	-1593	-1178	-2824	-2574	-2512	-2027	-2027		
2059	PPBAS	0	0	0	0	0	0	0	0	0		
2060	TCMD LIMIT	7282	8010	7282	7282	7282	7282	7282	7282	7282		
2061	EMFLMT	0	0	0	0	0	0	0	0	0		
2062	OVC K1	32433	32433	32522	32548	32548	32487	32501	32501	32501		
2063	OVC K2	4184	4184	3078	2755	2755	3517	3332	3332	3332		
2064	TGALMLV	4	4	4	4	4	4	4	4	4		
2065	OVC LIMIT	12461	12461	9154	8192	8192	9418	9912	9912	9912		
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0		
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0		
2068-2073		0	0	0	0	0	0	0	0	0		
2074	AALPH	12288	12288	12288	12288	8192	8192	12288	8192	8192		
2077-2083		0	0	0	0	0	0	0	0	0		
2086	RATED CURRENT	1888	1948	1588	2092	2118	1827	2259	1876	2607		
2087-2089		0	0	0	0	0	0	0	0	0		
2090	ROBSTL	0	0	0	0	0	0	0	0	0		
2091-2098		0	0	0	0	0	0	0	0	0		
2099	ONEPSL	400	400	400	400	400	400	400	400	400		
2100	INPA1	0	0	0	0	0	0	0	0	0		
2101	INPA2	0	0	0	0	0	0	0	0	0		
2102	DBLIM	0	0	0	15000	15000	0	0	0	0		
2103	ABVOF	0	0	0	0	0	0	0	0	0		
2104	ABTSH	0	0	0	0	0	0	0	0	0		
2105	TORQUE CONST.	190	369	461	516	934	1083	2215	1869	1869		
2106-2109		0	0	0	0	0	0	0	0	0		
2110	MGSTCM	1553	782	1300	774	787	1547	1815	1044	1044		
2111	TQLIM IN DEC.	10300	0	6500	5191	0	5495	0	4241	4241		
2112	AMRDML	0	0	0	0	0	0	0	0	0		
2113	HRV FILT	0	0	0	0	0	0	0	0	0		
2127	NINTCT	2573	4191	1631	4787	6547	2226	3354	6538	6538		
2128	MFWKCE	1001	6000	3139	4000	6000	5518	3000	6147	6147		
2129	MFWKBL	2568	1810	3089	2320	1808	2326	2833	1809	1809		
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0		
2133	PHDLY1	8220	5150	5141	7701	0	5141	5150	3594	3594		
2134	PHDLY2	8990	8990	8981	5141	0	8981	8990	6414	6414		
2159	DGCSMM	0	0	0	0	0	0	0	0	0		
2160	TRQCUP	0	0	0	0	0	0	0	0	0		
2161	OVC STP	0	0	0	0	0	0	0	0	0		
2162	OVC2 K1	32766	32765	32765	32765	32765	32762	32763	32762	32763		
2163	OVC2 K2	31	33	40	39	40	75	58	78	58		
2164	OVC2 LIMIT	5676	6042	5746	6969	7142	7898	9912	8288	9912		
2165	MAX CURRENT	25	25	45	45	45	85	85	85	85		
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0		
2304	ACCBSLM	0	0	0	0	0	0	0	0	0		
2305	ACDCEBD	0	0	0	0	0	0	0	36	36		
2310	DCIDBS	0	0	0	0	0	0	0	0	0		
2316	LIMLIM	0	0	0	0	0	0	0	0	0		

Remarks								*2	*2		
*2	Supporting servo software is required.										

9.1.5 α*Ci* Series

α*Ci* series

	Motor model	αC4 3000i	αC8 2000i	αC12 2000i	αC22 2000i	αC30 1500i
	Motor specification	0221	0226	0241	0246	0251
	Motor ID No.	271	276	291	296	301
PRM NO	SERVO PRM.					
2003		00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00100000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000000
2211		00001010	00001010	00000010	00001010	00001010
2300		00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	1240	1276	1875	2320	2238
2041	CUR GAIN P	-6415	-6288	-9137	-10593	-13330
2042	CUR GAIN 3	-1309	-1326	-1339	-1347	-1347
2043	VEL GAIN I	115	150	280	271	166
2044	VEL GAIN P	-1034	-1342	-2504	-2426	-1486
2045	VEL GAIN 3	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	3670	2827	1516	1565	2553
2048	BLACC CMP	0	0	0	0	0
2049	DPFMX	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510
2052	OVER SPEED	4200	2800	2800	2400	2100
2053	DB-CMP PPMAX	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0
2057	D-PHASE CUR	-5915	-3854	-1804	-2597	-1545
2058	D-PHASE CUR	-1500	-1236	-2500	-1942	-1300
2059	PPBAS	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	8010	7282
2061	EMFLMT	0	0	0	0	0
2062	OVC K1	32406	32289	32289	32114	32520
2063	OVC K2	4529	5994	5994	8171	3101
2064	TGALMLV	4	4	4	4	4
2065	OVC LIMIT	13493	17889	17889	24454	9224
2066	ACC FB GAIN	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0
2068-2073		0	0	0	0	0
2074	AALPH	12288	8192	8192	4096	8192
2077-2083		0	0	0	0	0
2086	RATED CURRENT	1892	2593	3020	2911	1655
2087-2089		0	0	0	0	0
2090	ROBSTL	0	0	0	0	0
2091-2098		0	0	0	0	0
2099	ONEPSL	400	400	400	400	400
2100	INPA1	0	0	0	0	0
2101	INPA2	0	0	0	0	0
2102	DBLIM	0	0	15000	0	0
2103	ABVOF	0	0	0	0	0
2104	ABTSH	0	0	0	0	0
2105	TORQUE CONST.	190	277	350	680	1630
2106-2109		0	0	0	0	0
2110	MGSTCM	1289	1552	0	1548	2059
2111	TQLIM IN DEC.	3900	3880	2168	2600	2148
2112	AMRDML	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0
2127	NINTCT	2544	2380	4150	3695	6680
2128	MFWKCE	5000	4500	12000	4000	14000
2129	MFWKBL	1812	1550	1044	1046	539
2130-2132	SMOOTH CMP	0	0	0	0	0
2133	PHDLY1	3855	3860	5150	2070	1054
2134	PHDLY2	8995	8990	8990	9000	9000
2159	DGCSMM	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0
2161	OVC STP	0	0	0	0	0
2162	OVC2 K1	32766	32763	32761	32761	32766
2163	OVC2 K2	31	63	91	83	23
2164	OVC2 LIMIT	5701	10709	14518	13493	4361
2165	MAX CURRENT	25	25	25	45	85
2302	TQLIM AT STOP	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0

Remarks					

9.2 STANDARD PARAMETERS FOR THE β*i* SERIES SERVO MOTORS

Series 90G0 (for Series 30*i*/31*i*/32*i*/35*i*-B, Power Motion *i*-A)
Series 90E0 and 90E1 (for Series 30*i*/31*i*/32*i*-A)
Series 90D0 (for Series 30*i*/31*i*-A)
Series 90C5 and 90C8 (for Series 0*i*-D)
Series 90E5 and 90E8 (for Series 0*i*-D)

9.2.1 βiS Series

βiS series (1/3)

	Motor model	β iS0.2 5000	β iS0.3 5000	β iS0.4 5000	β iS0.5 6000	β iS1 6000	β iS2 4000	β iS2 4000 40A	β iS2 4000 FS0i	β iS2 4000 FS0i,40A	β iS4 4000	β iS4 4000 40A
	Motor specification	0111	0112	0114	0115	0116	0061-Bxx3	0061-Bxx3	0061-Bxx6	0061-Bxx6	0063-Bxx3	0063-Bxx3
	Motor ID No.	260	261	280	281	282	253	254	306	310	256	257
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000100	00010000	00000100	00010000	00000000	00001110
2014		00000000	00000000	00000000	00000000	00000000	00000100	00010000	00000100	00010000	00000000	00001110
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00000010	00000010	00000010	00001010	00001010	00001110	00001110	00001110	00001110	00001110	00001110
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	123	210	100	138	312	360	720	360	720	400	800
2041	CUR GAIN P	-510	-970	-430	-673	-1360	-1920	-3840	-1920	-3840	-1920	-3840
2042	CUR GAIN 3	-1069	-1146	-2463	-1205	-1203	-1237	-1237	-1237	-1237	-1253	-1253
2043	VEL GAIN I	4	4	7	7	6	78	39	78	39	112	56
2044	VEL GAIN P	-36	-33	-61	-59	-53	-698	-349	-698	-349	-1008	-504
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-10638	-11550	-6249	-6462	-7176	-1089	-2178	-1089	-2178	-753	-1506
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	7000	7000	7000	7500	7500	5600	5600	5600	5600	5600	5600
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	-12850	-12850	-12850	0	0	0	0	0	0
2057	D-PHASE CUR	0	0	0	0	-15114	-10250	-10245	-10250	-10245	-7694	-7687
2058	D-PHASE CUR	0	0	0	0	-1200	-1000	-500	-1000	-500	-2800	-1400
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	5826	7282	7282	6554	3277	6554	3277	7282	3641
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32725	32725	32640	32674	32695	32531	32531	32652	32739	32289	32289
2063	OVC K2	533	533	1603	1178	915	2963	2963	1455	364	5988	5988
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	3163	3163	4759	3497	2714	8811	2203	4317	1079	17873	4468
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	20480	20480	20480	20480	16384	0	16384	0	20480	0
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1929	1929	1605	1376	1212	1529	764	1529	764	2178	1089
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	7	14	22	42	89	119	238	119	238	146	292
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	1	1	30	25	1556	1048	815	1048	815	780	532
2111	TQLIM IN DEC.	7710	7700	10290	10290	10290	11600	11600	11600	11600	7790	7790
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	379	852	400	504	881	1172	1172	1172	1172	796	796
2128	MFWKCE	0	3000	0	0	1500	2500	5000	2500	5000	3000	6000
2129	MFWKBL	0	3880	0	0	5135	3358	3358	3358	3358	3392	3392
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	7700	7695	7690	7690	15400	7192	7192	7192	7192	8992	8992
2134	PHDLY2	12825	12840	12820	12820	12840	8990	8990	8990	8990	12864	9024
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	120	120	0	0
2162	OVC2 K1	0	0	32766	32767	32767	32766	32766	32757	32765	32765	32765
2163	OVC2 K2	0	0	22	16	12	20	20	140	34	42	42
2164	OVC2 LIMIT	0	0	4104	3015	2340	3723	931	2665	666	7551	1888
2165	MAX CURRENT	4	4	25	25	25	25	45	25	45	25	45
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks										

β*i*S series (2/3)

	Motor model	β iS4 4000 FS0i	β iS4 4000 FS0i,40A	β iS8 3000	β iS8 3000 40A	β iS8 3000 FS0i	β iS8 3000 FS0i,40A	β iS12 2000	β iS12 2000 40A	β iS12 2000 FS0i	β iS12 2000 FS0i,40A	β iS12 3000
	Motor specification	0063-Bxx6	0063-Bxx6	0075-Bxx3	0075-Bxx3	0075-Bxx6	0075-Bxx6	0077-Bxx3	0077-Bxx3	0077-Bxx6	0077-Bxx6	0078
	Motor ID No.	311	312	258	259	283	294	269	268	298	300	272
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000
2014		00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2211		00001110	00001110	00001110	00001110	00001110	00001110	00001110	00001110	00001110	00001110	00001110
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	400	800	650	1160	650	1160	547	1094	547	1094	402
2041	CUR GAIN P	-1920	-3840	-3831	-5600	-3831	-5600	-3289	-6578	-3289	-6578	-2217
2042	CUR GAIN 3	-1253	-1253	-1299	-1299	-1299	-1299	-1305	-1305	-1305	-1305	-1304
2043	VEL GAIN I	112	56	164	82	164	82	230	115	230	115	170
2044	VEL GAIN P	-1008	-504	-1476	-738	-1476	-738	-2054	-1027	-2054	-1027	-1530
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-753	-1506	5143	-1029	5143	-1029	3695	7390	3695	7390	4960
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	5600	5600	4200	4200	4200	4200	2800	2800	2800	2800	4200
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	-2570	0	-2570	0	0	0	0	0	0
2057	D-PHASE CUR	-7694	-7687	-5140	-5131	-5140	-5131	-3884	-3862	-3884	-3862	-5140
2058	D-PHASE CUR	-2800	-1400	-3200	-1600	-3200	-1600	-4350	-2175	-4350	-2175	-3500
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	3641	7282	3641	7282	3641	7282	3641	7282	3641	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32532	32709	32289	32289	32381	32671	32284	32646	32323	32646	32205
2063	OVC K2	2945	738	5994	5994	4835	1214	6045	1525	5566	1525	7041
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	8758	2189	17889	4472	14410	3603	18045	4511	16603	4511	21044
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	0	16384	0	16384	0	8192	0	8192	0	16384
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	2178	1089	2780	1390	2780	1390	3126	1563	3126	1563	2363
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	146	292	226	452	226	452	315	630	315	630	418
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	780	532	1807	1045	1807	1045	1	1282	1	1282	1814
2111	TQLIM IN DEC.	7790	7790	7930	7930	7930	7930	3940	3940	3940	3940	7930
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	796	796	1442	1442	1442	1442	1350	1350	1350	1350	1194
2128	MFWKCE	3000	6000	3500	7000	3500	7000	4000	8000	4000	8000	3000
2129	MFWKBL	3392	3392	1298	1298	1298	1298	280	280	280	280	2056
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	8992	8992	3858	3858	3858	3858	3614	3614	3614	3614	5138
2134	PHDLY2	12864	9024	8990	8990	8990	8990	8980	4372	8980	4372	8990
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	120	120	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	32745	32762	32762	32762	32764	32767	32760	32766	32763	32767	32764
2163	OVC2 K2	294	70	74	74	51	12	99	21	60	15	51
2164	OVC2 LIMIT	5407	1352	12305	3076	8896	2224	15559	3890	10250	2785	8891
2165	MAX CURRENT	25	45	25	45	25	45	25	45	25	45	45
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

βiS series (3/3)

	Motor model	β iS12 3000 80A	β iS22 1500 FS0i	β iS22 1500 FS0i,40A	β iS22 2000	β iS22 2000 80A	β iS22 3000	β iS30 2000	β iS40 2000			
	Motor specification	0078	0084-Bxx6	0084-Bxx6	0085	0085	0082	0087	0089			
	Motor ID No.	477	302	305	274	478	313	472	474			
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000			
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011			
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2013		00001110	00000000	00001110	00000000	00001110	00001000	00000010	00000010			
2014		00001110	00000000	00001110	00000000	00001110	00001000	00000010	00000010			
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2211		00001110	00001110	00001110	00001110	00001110	00001110	00001010	00001010			
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2040	CUR GAIN I	804	2171	4342	1184	2368	1157	1650	1624			
2041	CUR GAIN P	-4434	-8178	-16356	-6800	-13600	-5102	-6565	-7197			
2042	CUR GAIN 3	-1304	-1329	-1329	-1331	-1331	-1332	-2681	-1341			
2043	VEL GAIN I	85	280	140	242	121	198	214	208			
2044	VEL GAIN P	-765	-2507	-1254	-2172	-1086	-1766	-1912	-1870			
2045	VEL GAIN 3	0	0	0	0	0	0	0	0			
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235			
2047	OBSERVER POA1	9920	3027	6054	3496	6992	4297	3971	4057			
2048	BLACC CMP	0	0	0	0	0	0	0	0			
2049	DPFMX	0	0	0	0	0	0	0	0			
2050	OBSERVER POK1	956	956	956	956	956	956	956	956			
2051	OBSERVER POK2	510	510	510	510	510	510	510	510			
2052	OVER SPEED	4200	1800	1800	2800	2800	4200	2800	2600			
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21			
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894			
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319			
2056	EMFCMP	0	0	0	-5130	-5130	0	0	0			
2057	D-PHASE CUR	-5130	-2110	-2079	-3612	-3598	-6174	-4647	-3375			
2058	D-PHASE CUR	-1750	-4691	-2342	-3000	-1500	-2843	-3115	-3862			
2059	PPBAS	0	0	0	0	0	0	0	0			
2060	TCMD LIMIT	3641	7282	3641	7282	3641	5462	6554	6554			
2061	EMFLMT	0	0	0	0	0	0	0	0			
2062	OVC K1	31932	32319	32655	32106	31744	32520	32413	32413			
2063	OVC K2	10454	5617	1411	8275	12801	3097	4431	4431			
2064	TGALMLV	4	4	4	4	4	4	4	4			
2065	OVC LIMIT	5230	16756	4189	24770	6422	9212	13201	13201			
2066	ACC FB GAIN	0	0	0	0	0	0	0	0			
2067	TCMD FILTER	0	0	0	0	0	0	0	0			
2068-2073		0	0	0	0	0	0	0	0			
2074	AALPH	0	8192	0	16384	0	12288	8192	8192			
2077-2083		0	0	0	0	0	0	0	0			
2086	RATED CURRENT	1181	3012	1506	2618	1309	2121	2154	2154			
2087-2089		0	0	0	0	0	0	0	0			
2090	ROBSTL	0	0	0	0	0	0	0	0			
2091-2098		0	0	0	0	0	0	0	0			
2099	ONEPSL	400	400	400	400	400	400	400	400			
2100	INPA1	0	0	0	0	0	0	0	0			
2101	INPA2	0	0	0	0	0	0	0	0			
2102	DBLIM	0	0	0	0	0	0	0	0			
2103	ABVOF	0	0	0	0	0	0	0	0			
2104	ABTSH	0	0	0	0	0	0	0	0			
2105	TORQUE CONST.	836	597	1194	692	1384	848	1127	1503			
2106-2109		0	0	0	0	0	0	0	0			
2110	MGSTCM	812	1025	514	0	1280	1289	1546	263			
2111	TQLIM IN DEC.	7930	2248	2248	2866	2866	7268	4255	3065			
2112	AMRDML	0	0	0	0	0	0	0	0			
2113	HRV FILT	0	0	0	0	0	0	0	0			
2127	NINTCT	1194	3290	3290	2459	2459	1967	2095	2712			
2128	MFWKCE	6000	5500	11000	5000	10000	6000	3066	3354			
2129	MFWKBL	2056	1032	1032	562	562	2315	1548	1038			
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0			
2133	PHDLY1	5138	2580	2580	3350	3350	5647	4110	2567			
2134	PHDLY2	4382	8990	4382	8979	4371	12820	12814	8967			
2159	DGCSMM	0	0	0	0	0	0	0	0			
2160	TRQCUP	0	0	0	0	0	0	0	0			
2161	OVC STP	0	0	0	0	0	0	0	0			
2162	OVC2 K1	32766	32763	32767	32763	32766	32765	32765	32765			
2163	OVC2 K2	31	60	14	64	31	40	34	36			
2164	OVC2 LIMIT	2752	10345	2586	10913	3379	7166	7387	7713			
2165	MAX CURRENT	85	25	45	45	85	85	85	85			
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0			
2304	ACCBSLM	0	0	0	0	0	0	0	0			
2305	ACDCEBD	0	0	0	0	0	0	0	0			
2310	DCIDBS	0	0	0	0	0	0	0	0			
2316	LIMLIM	0	0	0	0	0	0	0	0			

Remarks										

9.2.2 βiS Series HV

βiS series HV

	Motor model	β iS2 4000HV	β iS4 4000HV	β iS8 3000HV	β iS12 3000HV	β iS22 2000HV	β iS22 3000HV	β iS30 2000HV	β iS40 2000HV			
	Motor specification	0062	0064	0076	0079	0086	0083	0088	0090			
	Motor ID No.	251	264	267	270	278	314	473	475			
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000			
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011			
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2013		00000100	00000000	00000000	00000000	00000000	00001000	00000010	00000010			
2014		00000100	00000000	00000000	00000000	00000000	00001000	00000010	00000010			
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2211		00001110	00001110	00001110	00001110	00001110	00001110	00001010	00001010			
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2040	CUR GAIN I	348	331	605	427	1446	1146	1650	1624			
2041	CUR GAIN P	-1676	-1560	-3028	-2301	-5822	-5267	-6565	-7197			
2042	CUR GAIN 3	-1232	-1246	-1300	-1302	-1332	-1332	-2681	-1341			
2043	VEL GAIN I	78	112	166	170	244	192	214	208			
2044	VEL GAIN P	-700	-1010	-1482	-1524	-2182	-1722	-1912	-1870			
2045	VEL GAIN 3	0	0	0	0	0	0	0	0			
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235			
2047	OBSERVER POA1	-1085	-751	5118	4978	3478	4406	3971	4057			
2048	BLACC CMP	0	0	0	0	0	0	0	0			
2049	DPFMX	0	0	0	0	0	0	0	0			
2050	OBSERVER POK1	956	956	956	956	956	956	956	956			
2051	OBSERVER POK2	510	510	510	510	510	510	510	510			
2052	OVER SPEED	5600	5600	4200	4200	2700	4200	2800	2600			
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21			
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894			
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319			
2056	EMFCMP	0	0	0	0	0	0	0	0			
2057	D-PHASE CUR	-10250	-7694	-5140	-5140	-3612	-6174	-4647	-3375			
2058	D-PHASE CUR	-1000	-2800	-3200	-3500	-3000	-2843	-3115	-3862			
2059	PPBAS	0	0	0	0	0	0	0	0			
2060	TCMD LIMIT	6554	7282	7282	7282	7282	5462	6554	6554			
2061	EMFLMT	0	0	0	0	0	0	0	0			
2062	OVC K1	32538	32299	32301	32435	32433	32548	32413	32413			
2063	OVC K2	2879	5865	5842	4164	4185	2755	4431	4431			
2064	TGALMLV	4	4	4	4	4	4	4	4			
2065	OVC LIMIT	8560	17504	17435	12399	12462	8192	13201	13201			
2066	ACC FB GAIN	0	0	0	0	0	0	0	0			
2067	TCMD FILTER	0	0	0	0	0	0	0	0			
2068-2073		0	0	0	0	0	0	0	0			
2074	AALPH	20480	20480	20480	20480	8192	8192	8192	8192			
2077-2083		0	0	0	0	0	0	0	0			
2086	RATED CURRENT	1507	2155	2793	2356	2611	2069	2154	2154			
2087-2089		0	0	0	0	0	0	0	0			
2090	ROBSTL	0	0	0	0	0	0	0	0			
2091-2098		0	0	0	0	0	0	0	0			
2099	ONEPSL	400	400	400	400	400	400	400	400			
2100	INPA1	0	0	0	0	0	0	0	0			
2101	INPA2	0	0	0	0	0	0	0	0			
2102	DBLIM	0	0	0	0	0	0	0	0			
2103	ABVOF	0	0	0	0	0	0	0	0			
2104	ABTSH	0	0	0	0	0	0	0	0			
2105	TORQUE CONST.	119	146	225	420	689	869	1127	1503			
2106-2109		0	0	0	0	0	0	0	0			
2110	MGSTCM	1048	780	1807	1814	0	1289	1546	263			
2111	TQLIM IN DEC.	11600	7790	7930	7930	2866	7268	4255	3065			
2112	AMRDML	0	0	0	0	0	0	0	0			
2113	HRV FILT	0	0	0	0	0	0	0	0			
2127	NINTCT	2345	1592	2885	2388	5149	3894	2095	2712			
2128	MFWKCE	1000	500	1000	3000	3000	6000	3066	3354			
2129	MFWKBL	3358	3339	1298	2056	562	2315	1548	1038			
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0			
2133	PHDLY1	7192	8972	3848	5138	3352	5647	4110	2567			
2134	PHDLY2	8990	12816	8990	6430	8989	12820	12814	8967			
2159	DGCSMM	0	0	0	0	0	0	0	0			
2160	TRQCUP	0	0	0	0	0	0	0	0			
2161	OVC STP	0	0	0	0	0	0	0	0			
2162	OVC2 K1	32766	32765	32762	32764	32763	32765	32765	32765			
2163	OVC2 K2	19	41	75	50	64	38	34	36			
2164	OVC2 LIMIT	3617	7395	12424	8836	10854	6815	7387	7713			
2165	MAX CURRENT	10	10	10	25	25	45	45	45			
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0			
2304	ACCBSLM	0	0	0	0	0	0	0	0			
2305	ACDCEBD	0	0	0	0	0	0	0	0			
2310	DCIDBS	0	0	0	0	0	0	0	0			
2316	LIMLIM	0	0	0	0	0	0	0	0			

Remarks										

9.2.3 β*i*Sc Series

β*i*Sc series

	Motor model	β iSc2 4000	β iSc2 4000 40A	β iSc4 4000	β iSc4 4000 40A	β iSc8 3000	β iSc8 3000 40A	β iSc12 2000	β iSc12 2000 40A			
	Motor specification	0061-Bxx7	0061-Bxx7	0063-Bxx7	0063-Bxx7	0075-Bxx7	0075-Bxx7	0077-Bxx7	0077-Bxx7			
	Motor ID No.	306	310	311	312	283	294	298	300			
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000			
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011			
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2013		00000100	00010000	00000000	00001110	00000000	00001110	00000000	00001110			
2014		00000100	00010000	00000000	00001110	00000000	00001110	00000000	00001110			
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2211		00001110	00001110	00001110	00001110	00001110	00001110	00001110	00001110			
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000			
2040	CUR GAIN I	360	720	400	800	650	1160	547	1094			
2041	CUR GAIN P	-1920	-3840	-1920	-3840	-3831	-5600	-3289	-6578			
2042	CUR GAIN 3	-1237	-1237	-1253	-1253	-1299	-1299	-1305	-1305			
2043	VEL GAIN I	78	39	112	56	164	82	230	115			
2044	VEL GAIN P	-698	-349	-1008	-504	-1476	-738	-2054	-1027			
2045	VEL GAIN 3	0	0	0	0	0	0	0	0			
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235			
2047	OBSERVER POA1	-1089	-2178	-753	-1506	5143	-1029	3695	7390			
2048	BLACC CMP	0	0	0	0	0	0	0	0			
2049	DPFMX	0	0	0	0	0	0	0	0			
2050	OBSERVER POK1	956	956	956	956	956	956	956	956			
2051	OBSERVER POK2	510	510	510	510	510	510	510	510			
2052	OVER SPEED	5600	5600	5600	5600	4200	4200	2800	2800			
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21			
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894			
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319			
2056	EMFCMP	0	0	0	0	-2570	0	0	0			
2057	D-PHASE CUR	-10250	-10245	-7694	-7687	-5140	-5131	-3884	-3862			
2058	D-PHASE CUR	-1000	-500	-2800	-1400	-3200	-1600	-4350	-2175			
2059	PPBAS	0	0	0	0	0	0	0	0			
2060	TCMD LIMIT	6554	3277	7282	3641	7282	3641	7282	3641			
2061	EMFLMT	0	0	0	0	0	0	0	0			
2062	OVC K1	32652	32739	32532	32709	32381	32671	32323	32646			
2063	OVC K2	1455	364	2945	738	4835	1214	5566	1525			
2064	TGALMLV	4	4	4	4	4	4	4	4			
2065	OVC LIMIT	4317	1079	8758	2189	14410	3603	16603	4511			
2066	ACC FB GAIN	0	0	0	0	0	0	0	0			
2067	TCMD FILTER	0	0	0	0	0	0	0	0			
2068-2073		0	0	0	0	0	0	0	0			
2074	AALPH	16384	0	20480	0	16384	0	8192	0			
2077-2083		0	0	0	0	0	0	0	0			
2086	RATED CURRENT	1529	764	2178	1089	2780	1390	3126	1563			
2087-2089		0	0	0	0	0	0	0	0			
2090	ROBSTL	0	0	0	0	0	0	0	0			
2091-2098		0	0	0	0	0	0	0	0			
2099	ONEPSL	400	400	400	400	400	400	400	400			
2100	INPA1	0	0	0	0	0	0	0	0			
2101	INPA2	0	0	0	0	0	0	0	0			
2102	DBLIM	0	0	0	0	0	0	0	0			
2103	ABVOF	0	0	0	0	0	0	0	0			
2104	ABTSH	0	0	0	0	0	0	0	0			
2105	TORQUE CONST.	119	238	146	292	226	452	315	630			
2106-2109		0	0	0	0	0	0	0	0			
2110	MGSTCM	1048	815	780	532	1807	1045	1	1282			
2111	TQLIM IN DEC.	11600	11600	7790	7790	7930	7930	3940	3940			
2112	AMRDML	0	0	0	0	0	0	0	0			
2113	HRV FILT	0	0	0	0	0	0	0	0			
2127	NINTCT	1172	1172	796	796	1442	1442	1350	1350			
2128	MFWKCE	2500	5000	3000	6000	3500	7000	4000	8000			
2129	MFWKBL	3358	3358	3392	3392	1298	1298	280	280			
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0			
2133	PHDLY1	7192	7192	8992	8992	3858	3858	3614	3614			
2134	PHDLY2	8990	8990	12864	9024	8990	8990	8980	4372			
2159	DGCSMM	0	0	0	0	0	0	0	0			
2160	TRQCUP	0	0	0	0	0	0	0	0			
2161	OVC STP	120	120	120	120	0	0	0	0			
2162	OVC2 K1	32757	32765	32745	32762	32764	32767	32763	32767			
2163	OVC2 K2	140	34	294	70	51	12	60	15			
2164	OVC2 LIMIT	2665	666	5407	1352	8896	2224	10250	2785			
2165	MAX CURRENT	25	45	25	45	25	45	25	45			
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0			
2304	ACCBSLM	0	0	0	0	0	0	0	0			
2305	ACDCEBD	0	0	0	0	0	0	0	0			
2310	DCIDBS	0	0	0	0	0	0	0	0			
2316	LIMLIM	0	0	0	0	0	0	0	0			

Remarks										

9.2.4 β*i*F Series

β*i*F series

	Motor model	β iF4 3000	β iF4 /3000 40A	β iF8 /2000	β iF8 /2000 40A	β iF12 /2000	β iF12 /2000 40A	β iF22 /2000	β iF22 /2000 80A	β iF30 /1500		
	Motor specification	0051	0051	0052	0052	0053	0053	0054	0054	0055		
	Motor ID No.	483	484	485	486	487	488	489	490	491		
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000		
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011		
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2011		00000000	00000000	00000000	00000000	00100000	00100000	00000000	00000000	00000000		
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2013		00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000		
2014		00000000	00001110	00000000	00001110	00000000	00001110	00000000	00001110	00000000		
2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2211		00001010	00001010	00001010	00001010	00000010	00000010	00001010	00001010	00001010		
2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000		
2040	CUR GAIN I	1240	2480	1276	2552	1875	3750	2320	4640	2238		
2041	CUR GAIN P	-6415	-12830	-6288	-12576	-9137	-18274	-10593	-21186	-13330		
2042	CUR GAIN 3	-1309	-1309	-1326	-1326	-1339	-1339	-1347	-1347	-1347		
2043	VEL GAIN I	231	115	300	150	559	280	542	271	332		
2044	VEL GAIN P	-2068	-1034	-2685	-1342	-5008	-2504	-4851	-2426	-2973		
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0		
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235		
2047	OBSERVER POA1	3670	7339	2827	5654	1516	3031	1565	3129	2553		
2048	BLACC CMP	0	0	0	0	0	0	0	0	0		
2049	DPFMX	0	0	0	0	0	0	0	0	0		
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956		
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510		
2052	OVER SPEED	4200	4200	2800	2800	2800	2800	2400	2400	2100		
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21		
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894		
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319		
2056	EMFCMP	0	0	0	0	0	0	0	0	0		
2057	D-PHASE CUR	-5915	-5901	-3854	-3847	-1804	-1798	-2597	-2578	-1545		
2058	D-PHASE CUR	-1500	-750	-1236	-618	-2500	-1250	-1942	-971	-1300		
2059	PPBAS	0	0	0	0	0	0	0	0	0		
2060	TCMD LIMIT	7282	3641	7282	3641	7282	3641	7282	3641	7282		
2061	EMFLMT	0	0	0	0	0	0	0	0	0		
2062	OVC K1	32546	32537	32297	32297	31979	31986	32105	32105	32589		
2063	OVC K2	2781	2888	5890	5890	9861	9769	8282	8282	2239		
2064	TGALMLV	4	4	4	4	4	4	4	4	4		
2065	OVC LIMIT	7442	1860	14063	3516	20702	5175	18179	4545	5986		
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0		
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0		
2068-2073		0	0	0	0	0	0	0	0	0		
2074	AALPH	12288	0	8192	0	8192	0	4096	0	8192		
2077-2083		0	0	0	0	0	0	0	0			
2086	RATED CURRENT	1655	827	2269	1134	2825	1412	2646	1323	1490		
2087-2089		0	0	0	0	0	0	0	0	0		
2090	ROBSTL	0	0	0	0	0	0	0	0	0		
2091-2098		0	0	0	0	0	0	0	0	0		
2099	ONEPSL	400	400	400	400	400	400	400	400	400		
2100	INPA1	0	0	0	0	0	0	0	0	0		
2101	INPA2	0	0	0	0	0	0	0	0	0		
2102	DBLIM	0	0	0	0	15000	7500	0	0	0		
2103	ABVOF	0	0	0	0	0	0	0	0	0		
2104	ABTSH	0	0	0	0	0	0	0	0	0		
2105	TORQUE CONST.	190	380	277	554	350	700	680	1360	1630		
2106-2109		0	0	0	0	0	0	0	0			
2110	MGSTCM	1289	530	1552	800	0	1280	1548	792	2059		
2111	TQLIM IN DEC.	3900	3900	3880	3880	2168	2168	2600	2600	2148		
2112	AMRDML	0	0	0	0	0	0	0	0	0		
2113	HRV FILT	0	0	0	0	0	0	0	0	0		
2127	NINTCT	2544	2544	2380	2380	4150	4150	3695	3695	6680		
2128	MFWKCE	5000	10000	4500	9000	12000	24000	4000	8000	14000		
2129	MFWKBL	1812	1812	1550	1550	1044	1044	1046	1046	539		
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0		
2133	PHDLY1	3855	3855	3860	3860	5150	5150	2070	2070	1054		
2134	PHDLY2	8995	4387	8990	4382	8990	4382	9000	4392	9000		
2159	DGCSMM	0	0	0	0	0	0	0	0	0		
2160	TRQCUP	0	0	0	0	0	0	0	0	0		
2161	OVC STP	0	0	0	0	0	0	0	0	0		
2162	OVC2 K1	32755	32755	32756	32756	32756	32756	32756	32756	32755		
2163	OVC2 K2	157	158	153	151	151	150	148	147	157		
2164	OVC2 LIMIT	3708	927	7007	1752	10315	2579	9058	2265	2982		
2165	MAX CURRENT	25	45	25	45	25	45	45	85	85		
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0		
2304	ACCBSLM	0	0	0	0	0	0	0	0	0		
2305	ACDCEBD	0	0	0	0	0	0	0	0	0		
2310	DCIDBS	0	0	0	0	0	0	0	0	0		
2316	LIMLIM	0	0	0	0	0	0	0	0	0		

Remarks											

9.3 STANDARD PARAMETERS FOR THE LINEAR MOTORS

Series 90G0 (for Series 30*i*/31*i*/32*i*/35*i*-B, Power Motion *i*-A)
Series 90E0 and 90E1 (for Series 30*i*/31*i*/32*i*-A)
Series 90D0 (for Series 30*i*/31*i*-A)
Series 90C5 and 90C8 (for Series 0*i*-D)
Series 90E5 and 90E8 (for Series 0*i*-D)

9.3.1 Linear Motor L*i*S Series [200V]

Linear motor L*i*S series [200V] (1/2)

	Motor model	LiS300 A1/4 (200V)	LiS600 A1/4 (200V)	LiS900 A1/4 (200V)	LiS1500 B1/4 (200V)	LiS3000 B2/2 (200V)	LiS3000 B2/4 (200V)	LiS4500 B2/2 (200V)	LiS4500 B2/4 (200V)	LiS6000 B2/2 (200V)	LiS6000 B2/4 (200V)	LiS7500 B2/2 (200V)
	Motor specification	0441-B200	0442-B200	0443-B200	0444-B210	0445-B110	0445-B210	0446-B110	0446-B210	0447-B110	0447-B210	0448-B110
	Motor ID No.	351	353	355	357	360	362	364	366	368	370	372
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2210		00000000	00000000	00000000	00000000	00000100	00000100	00000100	00000000	00000100	00000000	00000100
2211		00000000	00000000	00000000	00000000	00000000	00000000	00001000	00001000	00000000	00000000	00001000
2300		10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	1968	1868	1594	1512	961	324	2834	4394	961	1401	848
2041	CUR GAIN P	-7138	-6536	-6162	-11488	-5781	-4472	-10862	-21486	-5255	-10722	-5532
2042	CUR GAIN 3	-2618	-2618	-2618	-2647	-2667	-2660	-2696	-2689	-2660	-2660	-2696
2043	VEL GAIN I	16	9	13	19	14	16	10	10	13	15	8
2044	VEL GAIN P	-217	-122	-179	-260	-194	-214	-131	-131	-169	-202	-103
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-8755	-9339	-6367	-4371	-5866	-5321	-8705	-8705	-6746	-5642	-11014
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	-6400	-6400	-6400	0	0	0	0	0	0	0	-7936
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	5826	6554	7282	7282	7282	7282	5462	5462	7282	7282	4551
2061	EMFLMT	120	120	120	120	120	120	120	120	120	120	120
2062	OVC K1	32720	32720	32721	32698	32711	32698	32707	32707	32711	32708	32707
2063	OVC K2	596	596	583	873	719	873	758	768	719	753	765
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	589	589	1326	2590	2131	2590	1199	1214	2131	2233	832
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	-24576	-8192	28672	0	0	0	20480	0	0	0	-24576
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	564	564	847	1184	1074	1184	805	810	1074	1184	671
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	68	137	137	227	502	455	1005	1005	1005	911	2010
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	793	792	786	0	0	0	0	0	0	0	0
2111	DETQLM	0	0	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	25	45	45	45	45	85	85	165	85	165	165
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

When water cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32578	32578	32582	32490	32539	32490	32526	32527	32539	32528	32524
2063	POVC2	2380	2380	2328	3481	2867	3481	3023	3018	2867	3003	3053
2065	POVCLMT	2357	2357	5303	10358	8523	10358	4794	4787	8523	8932	3329
2086	RATED CURRENT	1129	1129	1694	2368	2148	2368	1611	1610	2148	2368	1342
2161	OVCSTP	-	-	-	-	-	-	-	-	-	140	-
2162	POVC21	-	-	-	-	-	-	-	-	-	-	-
2163	POVC22	-	-	-	-	-	-	-	-	-	-	-
2164	POVCLMT2	-	-	-	-	-	-	-	-	-	-	-

Remarks											

Linear motor L*i*S series [200V] (2/2)

	Motor model	LiS7500 B2/4 (200V)	LiS9000 B2/2 (200V)	LiS9000 B2/4 (200V)	LiS3300 C1/2 (200V)	LiS9000 C2/2 (200V)	LiS11000 C2/2 (200V)	LiS11000 C2/4 (200V)	LiS15000 C2/2 (200V)	LiS15000 C2/3 (200V)	LiS10000 C3/2 (200V)	LiS17000 C3/2 (200V)
	Motor specification	0448-B210	0449-B110	0449-B210	0451-B110	0454-B110	0455-B110	0455-B210	0456-B110	0456-B210	0457-B110	0459-B110
	Motor ID No.	374	376	378	380	384	388	390	392	394	396	400
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00000000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00001000	00000110	00001010	00000000	00000000	00000000	00000000	00001010	00000000	00000000	00000000
2014		00001000	00000110	00001010	00000000	00000000	00000000	00000000	00001010	00000000	00000000	00000000
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000000	00000100	00000100	00000100	00000100
2211		00001000	00000000	00000000	00001000	00001000	00001000	00001000	00000000	00000000	00001000	00001000
2300		10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	946	1240	1483	1346	587	431	3736	1704	478	158	2182
2041	CUR GAIN P	-6400	-7877	-7099	-6448	-3839	-3377	-18246	-13440	-3379	-1761	-8540
2042	CUR GAIN 3	-1331	-2660	-2660	-2695	-2696	-2695	-2693	-2663	-2657	-2695	-2696
2043	VEL GAIN I	8	12	10	9	8	10	9	7	10	10	7
2044	VEL GAIN P	-101	-158	-141	-126	-110	-136	-121	-87	-128	-141	-99
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-11240	-7199	-8099	-9048	-10377	-8363	-9409	-13022	-8861	-8077	-11497
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	-7680	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	4046	5917	4855	5462	6372	7282	6877	4855	7282	7282	6887
2061	EMFLMT	120	120	120	120	120	120	120	120	120	120	120
2062	OVC K1	32687	32707	32696	32708	32729	32723	32729	32729	32732	32722	32711
2063	OVC K2	1010	758	895	749	489	560	492	483	452	582	709
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	799	1199	1151	1184	1112	1661	1311	621	1340	1719	981
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	0	0	0	-16384	-24576	0	0	0	-24576	20480
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	658	805	789	801	776	948	842	579	852	964	729
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	2051	2010	2051	741	2087	2087	2348	4656	3168	1865	4197
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	0	0	0	0	0	0	0	0	0	0	0
2111	DETQLM	0	0	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	365	165	365	85	165	165	365	365	365	165	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

When water cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32446	32526	32482	32529	32612	32589	32598	32558	32572	32583	32542
2063	POVC2	4026	3023	3570	2987	1953	2236	2119	2623	2455	2314	2829
2065	POVCLMT	3197	4794	4604	4738	4448	6644	5246	3378	7296	6875	3925
2086	RATED CURRENT	1316	1611	1579	1602	1552	1897	1685	1352	1988	1929	1458
2161	OVCSTP	-	-	-	-	-	-	-	-	140	-	-
2162	POVC21	-	-	-	-	-	-	-	-	-	-	-
2163	POVC22	-	-	-	-	-	-	-	-	-	-	-
2164	POVCLMT2	-	-	-	-	-	-	-	-	-	-	-

Remarks											

9.3.2 Linear Motor L*i*S Series [400V]

Linear motor L*i*S series [400V] (1/2)

	Motor model	LiS1500 B1/4 (400V)	LiS3000 B2/2 (400V)	LiS4500 B2/2HV (400V)	LiS4500 B2/2 (400V)	LiS6000 B2/2HV (400V)	LiS6000 B2/2 (400V)	LiS7500 B2/2HV (400V)	LiS7500 B2/2 (400V)	LiS9000 B2/2 (400V)	LiS3300 C1/2 (400V)	LiS9000 C2/2HV (400V)
	Motor specification	0444-B210	0445-B110	0446-B010	0446-B110	0447-B010	0447-B110	0448-B010	0448-B110	0449-B110	0451-B110	0454-B010
	Motor ID No.	358	361	363	365	367	369	371	373	377	381	383
PRM NO	SERVO PRM.											
2003		00001000	00000000	00001000	00001000	00000000	00001000	00001000	00001000	00000000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000110	00000000	00000000	00001000	00000010	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000110	00000000	00000000	00001000	00000010	00000000	00000000
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000000
2211		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2300		10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000	10000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	409	602	2590	802	1469	766	1742	1123	834	636	1453
2041	CUR GAIN P	-2068	-3127	-6505	-4726	-9936	-4195	-6205	-6625	-4701	-3246	-13899
2042	CUR GAIN 3	-2689	-1330	-2697	-2696	-1330	-2696	-2697	-2696	-1330	-2695	-1321
2043	VEL GAIN I	19	14	11	10	7	13	9	7	9	9	8
2044	VEL GAIN P	-260	-194	-149	-131	-96	-169	-117	-92	-128	-126	-108
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-4371	-5866	-7658	-8705	-11870	-6746	-9690	-12391	-8929	-9048	-10496
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	-7680	0	0	0	-9216	0	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	6554	5462	4369	7282	5462	4046	5259	5462	6372
2061	EMFLMT	120	120	120	120	120	120	120	120	120	120	120
2062	OVC K1	32698	32711	32714	32707	32749	32711	32714	32709	32709	32708	32729
2063	OVC K2	873	719	681	758	232	719	680	739	737	749	489
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	2590	2131	1549	1199	688	2131	1075	858	947	1184	1112
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	0	20480	20480	0	20480	0	20480	0	20480	0	0
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1184	1074	915	805	610	1074	763	671	716	801	776
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	227	502	884	1005	1768	1005	1768	2261	2261	741	2111
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	0	0	0	0	0	0	0	0	0	0	0
2111	DETQLM	0	0	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	45	45	45	85	85	85	85	185	185	85	85
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

When water cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32490	32539	32551	32526	32521	32539	32551	32532	32533	32529	32614
2063	POVC2	3481	2867	2718	3023	3085	2867	2713	2949	2940	2987	1925
2065	POVCLMT	10358	8523	6194	4794	2753	8523	4301	2631	3788	4738	4383
2086	RATED CURRENT	2368	2148	1831	1611	1221	2148	1526	1193	1432	1602	1540
2161	OVCSTP	-	-	-	-	-	-	-	-	140	-	-
2162	POVC21	-	-	-	-	-	-	-	-	-	-	-
2163	POVC22	-	-	-	-	-	-	-	-	-	-	-
2164	POVCLMT2	-	-	-	-	-	-	-	-	-	-	-

Remarks											

Linear motor L*i*S series [400V] (2/2)

	Motor model	LiS9000 C2/2 (400V)	LiS11000 C2/2HV (400V)	LiS11000 C2/2 (400V)	LiS15000 C2/3HV (400V)	LiS15000 C2/2 (400V)	LiS10000 C3/2HV (400V)	LiS10000 C3/2 (400V)	LiS17000 C3/2HV (400V)	LiS17000 C3/2 (400V)
	Motor specification	0454-B110	0455-B010	0455-B110	0456-B010	0456-B110	0457-B010	0457-B110	0459-B010	0459-B110
	Motor ID No.	385	387	389	391	393	395	397	399	401
PRM NO	SERVO PRM.									
2003		00001000	00001000	00001000	00001000	00000000	00001000	00001000	00000000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000000	00000100
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00000100	00000000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00000100	00000000	00000000	00000000
2210		00000100	00000100	00000100	00000100	00000100	00000000	00000100	00000000	00000100
2211		00001000	00001000	00001000	00001000	00000000	00001000	00000000	00000000	00000000
2300		10000000	10000000	10000000	10000000	10000000	10000000	10000000	00000000	10000000
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	910	605	702	989	1243	3010	839	709	253
2041	CUR GAIN P	-4971	-3361	-4479	-6312	-4058	-6519	-4103	-3688	-3693
2042	CUR GAIN 3	-2696	-2694	-2695	-2695	-2697	-2695	-2695	-1330	-2696
2043	VEL GAIN I	7	10	9	10	7	10	9	7	7
2044	VEL GAIN P	-98	-136	-121	-131	-87	-129	-125	-99	-99
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	-11674	-8363	-9409	-8681	-13022	-8849	-9086	-11497	-11497
2048	BLACC CMP	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	-12032	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	5663	7282	6877	7282	4855	7282	6877	5259	6877
2061	EMFLMT	120	120	120	120	120	120	120	120	120
2062	OVC K1	32728	32723	32730	32730	32729	32722	32720	32711	32711
2063	OVC K2	494	560	474	471	483	576	597	709	709
2064	TGALMLV	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	879	1661	1312	1396	621	1707	1358	981	981
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0
2074	AALPH	0	-24576	0	0	0	-4096	20480	-24576	20480
2077-2083		0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	689	948	843	869	578	961	857	729	729
2087-2089		0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	2348	2087	2348	3104	4566	2043	2098	4197	4197
2106-2109		0	0	0	0	0	0	0	0	0
2110	MGSTCM	0	0	0	0	0	0	0	0	0
2111	DETQLM	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	185	85	185	185	365	85	185	185	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0

When water cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32610	32589	32616	32563		32584	32577	32542	32542
2063	POVC2	1972	2236	1894	2557		2298	2384	2829	2829
2065	POVCLMT	3514	6644	5250	7601		6828	5432	3925	3925
2086	RATED CURRENT	1379	1897	1686	2029		1923	1715	1458	1458
2161	OVCSTP	-	-	140	140		-	140	-	-
2162	POVC21	-	-	-	-		-	-	-	-
2163	POVC22	-	-	-	-		-	-	-	-
2164	POVCLMT2	-	-	-	-		-	-	-	-

Remarks									

9.4 STANDARD PARAMETERS FOR THE SYNCHRONOUS BUILT-IN SERVO MOTORS

Series 90G0 (for Series 30*i*/31*i*/32*i*/35*i*-B, Power Motion *i*-A)
Series 90E0 and 90E1 (for Series 30*i*/31*i*/32*i*-A)
Series 90D0 (for Series 30*i*/31*i*-A)
Series 90C5 and 90C8 (for Series 0*i*-D)
Series 90E5 and 90E8 (for Series 0*i*-D)

9.4.1 Synchronous Built-in Servo Motor D*i*S Series [200V]

Synchronous built-in servo motor DiS series [200V] (1/4)

	Motor model	DiS400 250 (200V)	DiS22 600 (200V)	DiS85 400 (200V)	DiS110 300 (200V)	DiS260 300 (200V)	DiS260 600 (200V)	DiS370 300 (200V)	DiS800 250 (200V)	DiS1200 250 (200V)	DiS1500 200 (200V)	DiS2100 150 (200V)
	Motor specification	0485-B20x	0482-B10x	0483-B20x	0484-B10x	0484-B30x	0484-B31x	0484-B40x	0485-B40x	0485-B50x	0486-B30x	0487-B30x
	Motor ID No.	419	421	423	425	427	429	431	433	435	437	439
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00001000	00000000	00001000	00001000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00001000	00000000	00001000	00001000	00000000	00000000
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2211		00001000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2300		10000110	10000110	10000100	10000100	10000100	10000100	10000100	10000100	10000100	10000100	10000100
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	494	621	344	156	313	571	478	738	517	640	637
2041	CUR GAIN P	-1949	-2202	-2368	-1045	-2146	-4138	-3338	-2500	-3361	-4779	-4762
2042	CUR GAIN 3	-2943	-2946	-2491	-2448	-2485	-2573	-2515	-2996	-2408	-2619	-2620
2043	VEL GAIN I	415	157	242	420	326	240	264	386	430	839	1760
2044	VEL GAIN P	-3713	-1410	-2164	-3763	-2919	-2146	-2361	-3461	-3850	-7513	-15770
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	2271	5982	3897	2241	2889	3931	3572	2437	2190	1122	535
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	5352	7282	5648	5648	7282	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32743	32689	32683	32682	32682	32679	32705	32713	32677	32682	32682
2063	OVC K2	308	988	1069	1069	1069	1111	782	690	1113	1069	1069
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	903	2826	3172	3173	3173	1710	2322	1200	1940	3173	3173
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	20480	0	0	0	0	0	0	0	0	0
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	753	1237	1310	1310	1310	963	1121	868	1028	1310	1310
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	8080	448	1167	1510	3570	4857	6020	16519	21246	20598	25635
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	1281	1793	0	0	0	0	0	0	0	0	0
2111	DETQLM	1535	8568	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	16776	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	14	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	120	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	85	25	45	85	85	165	85	165	165	165	165
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32646	32523	32427	32427	32427	32360	32518	32529	32352	32427	32427
2063	POVC2	1528	3069	4258	4260	4260	5100	3121	2989	5196	4259	4259
2065	POVCLMT	4290	8170	12689	12694	12694	6848	9287	4801	7743	12692	12693
2086	RATED CURRENT	1641	2104	2621	2621	2621	1926	2242	1737	2033	2621	2621
2161	OVCSTP	-	-	-	-	-	102	-	107	107	162	162
2162	POVC21	-	-	-	-	-	-	-	-	-	-	-
2163	POVC22	-	-	-	-	-	-	-	-	-	-	-
2164	POVCLMT2	-	-	-	-	-	-	-	-	-	-	-

Remarks	*5	*5									
*5	Supporting servo software is required.										

Synchronous built-in servo motor D*i*S series [200V] (2/4)

	Motor model	DiS3000 150 (200V)	DiS85 1000 (200V)	DiS110 1000 (200V)	DiS260 1000 (200V)	DiS22 1500 (200V)						
	Motor specification	0487-B40x	0483-B22x	0484-B12x	0484-B32x	0482-B12x						
	Motor ID No.	441	443	445	447	449						
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000						
2004		00000011	00000011	00000011	00000011	00000011						
2005		00000000	00000000	00000000	00000000	00000000						
2006		00000000	00000000	00000000	00000000	00000000						
2007		00000000	00000000	00000000	00000000	00000000						
2008		00000000	00000000	00000000	00000000	00000000						
2009		00000000	00000000	00000000	00000000	00000000						
2010		00000000	00000000	00000000	00000000	00000000						
2011		00000000	00000000	00000000	00000000	00000000						
2012		00000000	00000000	00000000	00000000	00000000						
2013		00000000	00000001	00000001	00000001	00000001						
2014		00000000	00000000	00000000	00000000	00000000						
2210		00000100	00000100	00000100	00000100	00000100						
2211		00000000	00001000	00001000	00001000	00001010						
2300		10000100	10000110	10000110	10000110	10000110						
2301		10000000	00000000	00000000	00000000	00000000						
2040	CUR GAIN I	817	480	301	290	562						
2041	CUR GAIN P	-6084	-1395	-1001	-916	-1568						
2042	CUR GAIN 3	-2616	-3002	-3024	-3016	-2948						
2043	VEL GAIN I	1635	220	292	243	202						
2044	VEL GAIN P	-14643	-1971	-2614	-2178	-1811						
2045	VEL GAIN 3	0	0	0	0	0						
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235						
2047	OBSERVER POA1	576	4278	3227	3871	4657						
2048	BLACC CMP	0	0	0	0	0						
2049	DPFMX	0	0	0	0	0						
2050	OBSERVER POK1	956	956	956	956	956						
2051	OBSERVER POK2	510	510	510	510	510						
2052	OVER SPEED	0	0	0	0	0						
2053	DB-CMP PPMAX	21	21	21	21	21						
2054	DB-CMP PDDP	1894	1894	1894	1894	1894						
2055	DB-CMP PHYST	319	319	319	319	319						
2056	EMFCMP	0	0	0	0	0						
2057	D-PHASE CUR	0	-12846	-20535	-10266	-17944						
2058	D-PHASE CUR	0	-2731	-1183	-1821	-2257						
2059	PPBAS	0	0	0	0	0						
2060	TCMD LIMIT	7282	7282	7282	7282	7282						
2061	EMFLMT	0	0	0	0	0						
2062	OVC K1	32682	32346	32434	32580	32439						
2063	OVC K2	1069	5276	4174	2354	4109						
2064	TGALMLV	4	4	4	4	4						
2065	OVC LIMIT	3173	15735	12437	6423	10559						
2066	ACC FB GAIN	0	0	0	0	0						
2067	TCMD FILTER	0	0	0	0	0						
2068-2073		0	0	0	0	0						
2074	AALPH	0	20480	8192	8192	0						
2077-2083		0	0	0	0	0						
2086	RATED CURRENT	1310	2919	2595	1865	2576						
2087-2089		0	0	0	0	0						
2090	ROBSTL	0	0	0	0	0						
2091-2098		0	0	0	0	0						
2099	ONEPSL	400	400	400	400	400						
2100	INPA1	0	0	0	0	0						
2101	INPA2	0	0	0	0	0						
2102	DBLIM	0	0	0	0	0						
2103	ABVOF	0	0	0	0	0						
2104	ABTSH	0	0	0	0	0						
2105	TORQUE CONST.	3667	1281	2175	4784	348						
2106-2109		0	0	0	0	0						
2110	MGSTCM	0	2313	1027	1537	2049						
2111	DETQLM	0	11647	14212	11620	16720						
2112	AMRDML	0	0	0	0	0						
2113	HRV FILT	0	0	0	0	0						
2127	NINTCT	0	0	0	0	0						
2128	MFWKCE	0	10500	15000	9800	6500						
2129	MFWKBL	0	278	533	287	792						
2130-2132	SMOOTH CMP	0	0	0	0	0						
2133	PHDLY1	0	0	0	0	30735						
2134	PHDLY2	0	0	0	0	10270						
2159	DGCSMM	0	0	0	0	0						
2160	TRQCUP	0	0	0	0	0						
2161	OVC STP	0	0	0	0	0						
2162	OVC2 K1	0	0	0	0	0						
2163	OVC2 K2	0	0	0	0	0						
2164	OVC2 LIMIT	0	0	0	0	0						
2165	MAX CURRENT	165	45	85	165	25						
2302	TQLIM AT STOP	0	0	0	0	0						
2304	ACCBSLM	0	0	0	0	0						
2305	ACDCEBD	0	0	0	0	0						
2310	DCIDBS	0	0	0	0	0						
2316	LIMLIM	0	0	0	0	0						

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32427	-	-	-	-						
2063	POVC2	4259	-	-	-	-						
2065	POVCLMT	12693	-	-	-	-						
2086	RATED CURRENT	2621	-	-	-	-						
2161	OVCSTP	162	-	-	-	-						
2162	POVC21	-	-	-	-	-						
2163	POVC22	-	-	-	-	-						
2164	POVCLMT2	-	-	-	-	-						

Remarks		*5	*5	*5	*5						

*5 Supporting servo software is required.

Synchronous built-in servo motor D*i*S series [200V] (3/4)

	Motor model	DiS15 1000 (200V)	DiS60 400 (200V)	DiS70 300 (200V)	DiS150 300 (200V)	DiS200 300 (200V)	DiS250 250 (200V)	DiS500 250 (200V)	DiS1000 200 (200V)	DiS1500 100 (200V)	DiS2000 100 (200V)	DiS2000 150 (200V)
	Motor specification	0492-B100	0493-B200	0494-B100	0494-B300	0494-B400	0495-B200	0495-B400	0496-B300	0497-B300	0497-B400	0497-B490
	Motor ID No.	551	553	555	557	559	561	563	565	567	569	571
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000010	00000010	00000010	00000010	00000010	00000010	00001010	00001010	00001010	00001010
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00001000	00000110	00000110	00000110	00000000	00000000	00000000	00000000	00000000	00000100
2014		00000000	00001000	00000110	00000110	00000110	00000000	00000000	00000000	00000000	00000000	00000100
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2211		00011000	00001000	00001000	00001000	00011000	00001000	00001000	00011000	00011000	00011000	00001000
2300		10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	10010100	10000000	10000000	10000000
2040	CUR GAIN I	309	538	296	379	451	294	321	434	490	637	448
2041	CUR GAIN P	-1713	-3794	-2764	-3215	-3966	-2458	-2569	-2352	-3676	-5353	-3457
2042	CUR GAIN 3	-3067	-3102	-3117	-3128	-3135	-3129	-3138	-3173	-3176	-3177	-3177
2043	VEL GAIN I	69	86	180	149	141	334	297	558	760	689	620
2044	VEL GAIN P	-618	-772	-1614	-1331	-1261	-2996	-2664	-4997	-6812	-6171	-5554
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	13637	10929	5224	6336	6686	2815	3165	1688	1238	1367	1518
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	720	240	180	180	180	150	150	120	60	60	90
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	-1038	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	-489	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	5462	6190	6190	6190	7282	7282	7282	7282	7282	6473
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32675	32675	32684	32714	32721	32707	32723	32677	32682	32709	32707
2063	OVC K2	1160	1160	1056	679	590	761	567	1135	1078	740	763
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	3300	1856	2178	1419	1237	2196	1646	3231	3076	2136	1739
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	-20480	-32768	-24576	-20480	-4096	-4096	20480	-20480	28672	24576	12288
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1440	845	1005	944	881	1175	1062	1421	1390	1176	1045
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	612	2865	3521	7830	11266	10329	20150	3349	5516	8086	8984
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	2305	1793	1793	1793	1793	1793	2049	2049	2049	2049	2049
2111	DETQLM	8854	6174	5173	5173	2625	3890	3890	2680	1184	1244	2218
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	16000	4000	0	4000	6000	7000	5000	10000	5000	15000	10000
2129	MFWKBL	277	6158	0	5134	2581	3861	3861	2588	1042	1042	2069
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	25	45	45	85	85	85	165	165	165	165	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	72	0	0	0	36	0	0	24	12	12	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0
2574	VELOVC	0	0	0	0	0	0	0	0	0	0	0

When liquid cooling is used, modify the following parameters from the values listed above to those listed below. When a 2-axis amplifier αiSV160/160 is used, set the values enclosed in parentheses.

2062	POVC1	32401	32275	32449	32391	32368	32487	32454 (32465)	32344 (32465)	32384 (32453)	32366 (32465)	32369
2063	POVC2	4589	6169	3986	4717	5004	3513	3923 (3783)	5300 (3782)	4796 (3942)	5019 (3782)	4992
2065	POVCLMT	11603	8321	7432	8580	9014	9212	10144 (9830)	13083 (9827)	12041 (10187)	12508 (9827)	9838
2086	RATED CURRENT	2700	2294	2159	2201	2201	2201	2606 (2259)	2606 (2259)	2606 (2259)	2606 (2259)	2492
2161	OVCSTP	125	127	120	120	123	110	110	110	112	110	110
2162	POVC21	32601	32581	32629	32599	32594	32623	32596 (32600)	32686 (32700)	32686 (32700)	32713 (32705)	32705
2163	POVC22	2091	2337	1735	2118	2172	1813	2156 (2103)	1027 (852)	1024 (853)	687 (789)	792
2164	POVCLMT2	8308	5958	5321	6143	6454	6595	7263 (7038)	9367 (7036)	8621 (7294)	8955 (7036)	7044

Remarks	*2, *5	*5	*5	*5	*2, *5	*5	*5	*2, *3, *5	*2, *3*, 5	*2, *3, *5	*3, *5
*2, *3, *5	Supporting servo software is required.										

Synchronous built-in servo motor D*i*S series [200V] (4/4)

PRM NO	SERVO PRM.	DiS60 2000 (200V)	DiS70 1500 (200V)	DiS150 1500 (200V)	DiS500 1000 (200V)
	Motor specification	0493-B220	0494-B120	0494-B320	0495-B420
	Motor ID No.	577	579	581	583
PRM NO	SERVO PRM.	Liquid cooling only	Liquid cooling only	Liquid cooling only	Liquid cooling only
2003		00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000
2006		00001000	00001000	00001000	00001000
2007		00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000
2010		00000001	00000001	00000001	00000001
2011		00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000
2013		00001000	00001000	00001000	00001010
2014		00101000	00101000	00101000	00101010
2210		00000100	00000100	00000100	00000100
2211		00000000	00000000	00000000	00000000
2300		10000100	10000100	10000100	10000100
2301		01000000	01000000	01000000	01000000
2040	CUR GAIN I	337	227	373	469
2041	CUR GAIN P	-1938	-1380	-1809	-2197
2042	CUR GAIN 3	-3094	-3115	-3130	-3131
2043	VEL GAIN I	93	210	172	267
2044	VEL GAIN P	-837	-1883	-1537	-2395
2045	VEL GAIN 3	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	10081	4479	5487	3521
2048	BLACC CMP	0	0	0	0
2049	DPFMX	0	0	0	0
2050	OBSERVER POK1	956	956	956	956
2051	OBSERVER POK2	510	510	510	510
2052	OVER SPEED	1200	1200	1200	720
2053	DB-CMP PPMAX	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319
2056	EMFCMP	-9472	-9472	0	-8960
2057	D-PHASE CUR	-10267	-5147	-2616	-1341
2058	D-PHASE CUR	-1625	-1821	-2048	-1821
2059	PPBAS	0	0	0	0
2060	TCMD LIMIT	5370	5416	5416	5158
2061	EMFLMT	0	0	0	0
2062	OVC K1	32517	32467	32438	32567
2063	OVC K2	3235	3761	4128	2517
2064	TGALMLV	4	4	4	4
2065	OVC LIMIT	4529	5409	5864	3427
2066	ACC FB GAIN	0	0	0	0
2067	TCMD FILTER	0	0	0	0
2068-2073		0	0	0	0
2074	AALPH	-32768	-32768	0	-24576
2077-2083		0	0	0	0
2086	RATED CURRENT	2293	2506	2610	1995
2087-2089		0	0	0	0
2090	ROBSTL	60	70	130	250
2091-2098		0	0	0	0
2099	ONEPSL	400	400	400	400
2100	INPA1	42	44	70	110
2101	INPA2	0	0	0	0
2102	DBLIM	0	0	0	0
2103	ABVOF	0	0	0	0
2104	ABTSH	0	0	0	0
2105	TORQUE CONST.	2642	3019	6781	22416
2106-2109		0	0	0	0
2110	MGSTCM	1793	2049	2049	1793
2111	DETQLM	0	0	0	0
2112	AMRDML	0	0	0	0
2113	HRV FILT	0	0	0	0
2127	NINTCT	0	0	0	0
2128	MFWKCE	0	0	0	0
2129	MFWKBL	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0
2133	PHDLY1	0	0	0	0
2134	PHDLY2	0	0	0	0
2159	DGCSMM	0	0	0	0
2160	TRQCUP	0	0	0	0
2161	OVC STP	106	106	0	0
2162	OVC2 K1	32633	32678	32643	32630
2163	OVC2 K2	1683	1130	1558	1719
2164	OVC2 LIMIT	1389	1024	515	323
2165	MAX CURRENT	85	85	165	365
2302	TQLIM AT STOP	0	0	0	0
2304	ACCBSLM	0	0	0	0
2305	ACDCEBD	0	0	0	0
2310	DCIDBS	0	0	0	0
2316	LIMLIM	0	0	0	0
2574	VELOVC	1200	1200	1200	720

When liquid cooling is used, modify the following parameters from the values listed above to those listed below. When a 2-axis amplifier αiSV160/160 is used, set the values enclosed in parentheses.

PRM NO	SERVO PRM.	DiS60	DiS70	DiS150	DiS500
2062	POVC1	32517	32467	32438	32567
2063	POVC2	3235	3761	4128	2517
2065	POVCLMT	4529	5409	5864	3427
2086	RATED CURRENT	2293	2506	2610	1995
2161	OVCSTP	106	106	0	0
2162	POVC21	32633	32678	32643	32630
2163	POVC22	1683	1130	1558	1719
2164	POVCLMT2	1389	1024	515	32567

Remarks	DiS60	DiS70	DiS150	DiS500
Remarks	*3,*4,*6	*3,*4,*6	*3,*4,*6	*3,*4,*6

*3,*5,*6 Supporting servo software is required.

9.4.2 Synchronous Built-in Servo Motor D*i*S Series [400V]

Synchronous built-in servo motor D*i*S series [400V] (1/4)

	Motor model	DiS400 250 (400V)	DiS22 600 (400V)	DiS85 400 (400V)	DiS110 300 (400V)	DiS260 300 (400V)	DiS260 600 (400V)	DiS370 300 (400V)	DiS800 250 (400V)	DiS1200 250 (400V)	DiS1500 200 (400V)	DiS2100 150 (400V)
	Motor specification	0485-B20x	0482-B10x	0483-B20x	0484-B10x	0484-B30x	0484-B31x	0484-B40x	0485-B40x	0485-B50x	0486-B30x	0487-B30x
	Motor ID No.	420	422	424	426	428	430	432	434	436	438	440
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00000000	00000000	00000000	00000000	00001000	00000000	00001000	00001000	00000000	00000000
2014		00000000	00000000	00000000	00000000	00000000	00001000	00000000	00001000	00001000	00000000	00000000
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2211		00001000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2300		10000110	10000110	10000100	10000100	10000100	10000100	10000100	10000100	10000100	10000100	10000100
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2040	CUR GAIN I	494	374	172	78	157	321	239	496	291	360	359
2041	CUR GAIN P	-1352	-1042	-1184	-523	-1073	-2327	-1669	-1588	-1891	-2688	-2679
2042	CUR GAIN 3	-2943	-2946	-2491	-2448	-2485	-2573	-2515	-2996	-2408	-2619	-2620
2043	VEL GAIN I	415	157	242	420	326	213	264	343	382	746	1565
2044	VEL GAIN P	-3713	-1410	-2164	-3763	-2919	-1907	-2361	-3076	-3422	-6678	-14017
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	2271	5982	3897	2241	2889	4422	3572	2742	2464	1263	602
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	0	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	7282	7282	7282	7282	4758	7282	5020	5020	6473	7282
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32743	32689	32683	32682	32682	32679	32705	32713	32678	32700	32682
2063	OVC K2	308	988	1069	1069	1069	1111	782	690	1130	845	1069
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	903	2826	3172	3173	3173	1351	2322	948	1529	2507	3173
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	20480	0	0	0	0	0	0	0	0	0	0
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	753	1237	1310	1310	1310	856	1121	772	914	1165	1310
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	8080	448	1167	1510	3570	5464	6020	18584	23902	23173	28839
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	1281	1793	0	0	0	0	0	0	0	0	0
2111	DETQLM	0	25660	0	0	0	0	0	0	0	0	0
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	120	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	85	25	45	85	85	185	85	185	185	185	185
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32646	32523	32427	32427	32427	32360	32518	32529	32352	32498	32427
2063	POVC2	1528	3069	4258	4260	4260	5095	3121	2989	5196	3369	4259
2065	POVCLMT	4290	8170	12689	12694	12694	5406	9287	3793	6118	10029	12693
2086	RATED CURRENT	1641	2104	2621	2621	2621	1712	2242	1544	1807	2330	2621
2161	OVCSTP	-	-	-	-	-	-	-	-	-	109	122
2162	POVC21	-	-	-	-	-	-	-	-	-	-	-
2163	POVC22	-	-	-	-	-	-	-	-	-	-	-
2164	POVCLMT2	-	-	-	-	-	-	-	-	-	-	-

Remarks	*5	*5									
*5	Supporting servo software is required.										

Synchronous built-in servo motor D*i*S series [400V] (2/4)

	Motor model	DiS3000 150 (400V)										
	Motor specification	0487-B40x										
	Motor ID No.	442										
PRM NO	SERVO PRM.											
2003		00001000										
2004		00000011										
2005		00000000										
2006		00000000										
2007		00000000										
2008		00000000										
2009		00000000										
2010		00000000										
2011		00000000										
2012		00000000										
2013		00000000										
2014		00000000										
2210		00000100										
2211		00000000										
2300		10000100										
2301		10000000										
2040	CUR GAIN I	459										
2041	CUR GAIN P	-3422										
2042	CUR GAIN 3	-2616										
2043	VEL GAIN I	1453										
2044	VEL GAIN P	-13016										
2045	VEL GAIN 3	0										
2046	VEL GAIN 4	-8235										
2047	OBSERVER POA1	648										
2048	BLACC CMP	0										
2049	DPFMX	0										
2050	OBSERVER POK1	956										
2051	OBSERVER POK2	510										
2052	OVER SPEED	0										
2053	DB-CMP PPMAX	21										
2054	DB-CMP PDDP	1894										
2055	DB-CMP PHYST	319										
2056	EMFCMP	0										
2057	D-PHASE CUR	0										
2058	D-PHASE CUR	0										
2059	PPBAS	0										
2060	TCMD LIMIT	7282										
2061	EMFLMT	0										
2062	OVC K1	32682										
2063	OVC K2	1069										
2064	TGALMLV	4										
2065	OVC LIMIT	3173										
2066	ACC FB GAIN	0										
2067	TCMD FILTER	0										
2068-2073		0										
2074	AALPH	0										
2077-2083		0										
2086	RATED CURRENT	1310										
2087-2089		0										
2090	ROBSTL	0										
2091-2098		0										
2099	ONEPSL	400										
2100	INPA1	0										
2101	INPA2	0										
2102	DBLIM	0										
2103	ABVOF	0										
2104	ABTSH	0										
2105	TORQUE CONST.	4125										
2106-2109		0										
2110	MGSTCM	0										
2111	DETQLM	0										
2112	AMRDML	0										
2113	HRV FILT	0										
2127	NINTCT	0										
2128	MFWKCE	0										
2129	MFWKBL	0										
2130-2132	SMOOTH CMP	0										
2133	PHDLY1	0										
2134	PHDLY2	0										
2159	DGCSMM	0										
2160	TRQCUP	0										
2161	OVC STP	0										
2162	OVC2 K1	0										
2163	OVC2 K2	0										
2164	OVC2 LIMIT	0										
2165	MAX CURRENT	185										
2302	TQLIM AT STOP	0										
2304	ACCBSLM	0										
2305	ACDCEBD	0										
2310	DCIDBS	0										
2316	LIMLIM	0										

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32427										
2063	POVC2	4259										
2065	POVCLMT	12693										
2086	RATED CURRENT	2621										
2161	OVCSTP	122										
2162	POVC21	-										
2163	POVC22	-										
2164	POVCLMT2	-										

Remarks											

Synchronous built-in servo motor D*i*S series [400V] (3/4)

	Motor model	DiS15 1000 (400V)	DiS60 400 (400V)	DiS70 300 (400V)	DiS150 300 (400V)	DiS200 300 (400V)	DiS250 250 (400V)	DiS500 250 (400V)	DiS1000 200 (400V)	DiS1500 100 (400V)	DiS2000 100 (400V)	DiS2000 150 (400V)
	Motor specification	0492-B100	0493-B200	0494-B100	0494-B300	0494-B400	0495-B200	0495-B400	0496-B300	0497-B300	0497-B400	0497-B490
	Motor ID No.	552	554	556	558	560	562	564	566	568	570	572
PRM NO	SERVO PRM.											
2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2006		00000000	00000000	00000000	00000000	00000010	00000010	00000010	00000010	00001010	00001010	00000010
2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2013		00000000	00001000	00000110	00000110	00000110	00000000	00000100	00000100	00000100	00000100	00000100
2014		00000000	00001000	00000110	00000110	00000110	00000000	00000100	00000100	00000100	00000100	00000100
2210		00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100	00000100
2211		00001000	00001000	00001000	00001000	00011000	00001000	00001000	00001000	00001000	00011000	00001000
2300		10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110	10000110
2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	10010100	10000000	10000000	10000000
2040	CUR GAIN I	154	269	148	189	226	158	181	244	276	358	224
2041	CUR GAIN P	-857	-1897	-1382	-1607	-1983	-1150	-1445	-1323	-2068	-3011	-1729
2042	CUR GAIN 3	-3067	-3102	-3117	-3128	-3135	-3129	-3138	-3173	-3176	-3177	-3177
2043	VEL GAIN I	69	86	180	149	141	334	264	496	676	612	620
2044	VEL GAIN P	-618	-772	-1614	-1331	-1261	-2996	-2368	-4442	-6055	-5485	-5554
2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	13637	10929	5224	6336	6686	2815	3561	1899	1393	1537	1518
2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
2052	OVER SPEED	1200	480	360	360	360	300	300	240	120	120	180
2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
2056	EMFCMP	0	0	0	0	0	0	-11264	-11264	-11264	-11264	0
2057	D-PHASE CUR	0	0	0	0	0	0	0	0	0	-2054	0
2058	D-PHASE CUR	0	0	0	0	0	0	0	0	0	-430	0
2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
2060	TCMD LIMIT	7282	5462	6190	6190	6190	7282	6473	6473	6473	6473	6473
2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
2062	OVC K1	32675	32675	32684	32714	32721	32707	32723	32677	32682	32709	32707
2063	OVC K2	1160	1160	1056	679	590	761	567	1135	1078	740	763
2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
2065	OVC LIMIT	3300	1856	2178	1419	1237	2196	1301	2553	2430	1688	1739
2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
2068-2073		0	0	0	0	0	0	0	0	0	0	0
2074	AALPH	-20480	-32768	-24576	-20480	-4096	-8192	20480	-20480	28672	24576	12288
2077-2083		0	0	0	0	0	0	0	0	0	0	0
2086	RATED CURRENT	1440	845	1005	944	881	1175	944	1266	1235	1045	1045
2087-2089		0	0	0	0	0	0	0	0	0	0	0
2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
2091-2098		0	0	0	0	0	0	0	0	0	0	0
2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
2102	DBLIM	0	0	0	0	0	0	0	0	0	0	0
2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
2105	TORQUE CONST.	612	2865	3521	7830	11266	10329	22669	3768	6206	9097	8984
2106-2109		0	0	0	0	0	0	0	0	0	0	0
2110	MGSTCM	2049	1793	1793	1793	1793	1793	2049	2305	2049	2049	2049
2111	DETQLM	0	0	0	0	7710	12900	11311	6229	3212	2161	4727
2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
2128	MFWKCE	0	0	0	0	0	0	0	0	0	0	0
2129	MFWKBL	0	0	0	0	0	0	0	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0	0	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0	0	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
2165	MAX CURRENT	25	45	45	85	85	85	185	185	185	185	365
2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2305	ACDCEBD	0	0	0	0	72	0	0	0	0	24	0
2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0
2574	VELOVC	0	0	0	0	0	0	0	0	0	0	0

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32401	32275	32449	32391	32368	32487	32454	32286	32384	32366	32369
2063	POVC2	4589	6169	3986	4717	5004	3513	3923	6024	4796	5019	4992
2065	POVCLMT	11603	8321	7432	8580	9014	9212	8015	11469	9514	9883	9838
2086	RATED CURRENT	2595	2108	2108	2108	2108	2109	2317	2760	2445	2497	2492
2161	OVCSTP	125	127	120	120	123	110	110	110	112	110	110
2162	POVC21	32601	32581	32629	32599	32594	32623	32596	32686	32686	32713	32705
2163	POVC22	2091	2337	1735	2118	2172	1813	2156	1029	1024	687	792
2164	POVCLMT2	8308	5958	5321	6143	6454	6595	5738	8212	6812	7076	7044

Remarks	*5	*5	*5	*5	*2, *5	*5	*5	*5	*3, *5	*2, *3, *5	
*2, *3, *5	Supporting servo software is required.										

Synchronous built-in servo motor D*i*S series [400V] (4/4)

	Motor model	DiS5000 50 (400V)	DiS60 2000 (400V)	DiS70 1500 (400V)	DiS150 1500 (400V)	DiS500 1000 (400V)
	Motor specification	0488-B400	0493-B220	0494-B120	0494-B320	0495-B420
	Motor ID No.	573	578	580	582	584
PRM NO	SERVO PRM.		Liquid cooling only	Liquid cooling only	Liquid cooling only	Liquid cooling only
2003		00001000	00001000	00001000	00001000	00001000
2004		00000011	00000011	00000011	00000011	00000011
2005		00000000	00000000	00000000	00000000	00000000
2006		00001010	00001000	00001000	00001000	00001000
2007		00000000	00000000	00000000	00000000	00000000
2008		00000000	00000000	00000000	00000000	00000000
2009		00000000	00000000	00000000	00000000	00000000
2010		00000000	00000001	00000001	00000001	00000001
2011		00000000	00000000	00000000	00000000	00000000
2012		00000000	00000000	00000000	00000000	00000000
2013		00000000	00001000	00001000	00001010	00001010
2014		00000000	00101000	00101000	00101010	00101010
2210		00000100	00000100	00000100	00000100	00000100
2211		00011000	00000000	00000000	00000000	00000000
2300		10000110	10000100	10000100	10000100	10000100
2301		10010100	01000000	01000000	01000000	01000000
2040	CUR GAIN I	417	183	128	180	224
2041	CUR GAIN P	-3875	-943	-724	-954	-991
2042	CUR GAIN 3	-3181	-3094	-3115	-3130	-3131
2043	VEL GAIN I	1096	93	210	153	267
2044	VEL GAIN P	-9817	-837	-1883	-1366	-2395
2045	VEL GAIN 3	0	0	0	0	0
2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235
2047	OBSERVER POA1	859	10081	4479	6173	3521
2048	BLACC CMP	0	0	0	0	0
2049	DPFMX	0	0	0	0	0
2050	OBSERVER POK1	956	956	956	956	956
2051	OBSERVER POK2	510	510	510	510	510
2052	OVER SPEED	60	2400	1800	1800	1200
2053	DB-CMP PPMAX	21	21	21	21	21
2054	DB-CMP PDDP	1894	1894	1894	1894	1894
2055	DB-CMP PHYST	319	319	319	319	319
2056	EMFCMP	0	-9472	-9472	-8704	0
2057	D-PHASE CUR	-527	-10267	-5147	-2610	-1341
2058	D-PHASE CUR	-665	-1625	-1821	-1821	-1821
2059	PPBAS	0	0	0	0	0
2060	TCMD LIMIT	7282	5370	5416	4814	5158
2061	EMFLMT	0	0	0	0	0
2062	OVC K1	32731	32517	32467	32438	32567
2063	OVC K2	459	3235	3761	4128	2517
2064	TGALMLV	4	4	4	4	4
2065	OVC LIMIT	1337	4529	5409	4633	3427
2066	ACC FB GAIN	0	0	0	0	0
2067	TCMD FILTER	0	0	0	0	0
2068-2073		0	0	0	0	0
2074	AALPH	24576	-32768	24576	8192	0
2077-2083		0	0	0	0	0
2086	RATED CURRENT	916	2293	2506	2320	1995
2087-2089		0	0	0	0	0
2090	ROBSTL	0	129	150	213	319
2091-2098		0	0	0	0	0
2099	ONEPSL	400	400	400	400	400
2100	INPA1	0	44	44	70	110
2101	INPA2	0	0	0	0	0
2102	DBLIM	0	0	0	0	0
2103	ABVOF	0	0	0	0	0
2104	ABTSH	0	0	0	0	0
2105	TORQUE CONST.	22101	2642	3019	7628	22416
2106-2109		0	0	0	0	0
2110	MGSTCM	1793	1793	2049	2049	1793
2111	DETQLM	767	0	0	0	0
2112	AMRDML	0	0	0	0	0
2113	HRV FILT	0	0	0	0	0
2127	NINTCT	0	0	0	0	0
2128	MFWKCE	16000	0	0	0	0
2129	MFWKBL	540	0	0	0	0
2130-2132	SMOOTH CMP	0	0	0	0	0
2133	PHDLY1	0	0	0	0	0
2134	PHDLY2	0	0	0	0	0
2159	DGCSMM	0	0	0	0	0
2160	TRQCUP	0	0	0	0	0
2161	OVC STP	0	106	106	0	0
2162	OVC2 K1	0	32633	32678	32643	32630
2163	OVC2 K2	0	1683	1130	1558	1719
2164	OVC2 LIMIT	0	347	455	181	116
2165	MAX CURRENT	185	85	85	185	365
2302	TQLIM AT STOP	0	0	0	0	0
2304	ACCBSLM	0	0	0	0	0
2305	ACDCEBD	12	0	0	0	0
2310	DCIDBS	0	0	0	0	0
2316	LIMLIM	0	0	0	0	0
2574	VELOVC	0	2400	1800	1800	1200

When liquid cooling is used, modify the following parameters from the values listed above to those listed below.

2062	POVC1	32559	32517	32467	32438	32567
2063	POVC2	2617	3235	3761	4128	2517
2065	POVCLMT	7076	4529	5409	4633	3427
2086	RATED CURRENT	2097	2293	2506	2320	1995
2161	OVCSTP	110	106	106	0	0
2162	POVC21	32722	32633	32678	32643	32630
2163	POVC22	569	1683	1130	1558	1719
2164	POVCLMT2	5066	1389	455	181	116

Remarks	*2, *3, *5	*3, *4, *6	*3, *4, *6	*3, *4, *6	*3, *4, *6

*2, *3, *5, *6 Supporting servo software is required.

APPENDIX

A ANALOG SERVO ADAPTER SETTING PROCEDURE

(1) Overview

Appendix A describes the method of setting parameters required when using the analog servo function with an analog servo adapter.

> ⚠ **CAUTION**
> 1 For the CNCs that support this function, contact FANUC.
> 2 For analog servo axes, only the feed-forward, backlash compensation, pitch error compensation, and position gain switch functions can be used as digital servo functions.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	J(10) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	J(10) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting parameters

(1) Setting start: Switch on the CNC power from an emergency stop.
(2) Set up the FSSB. Switch the power off and on again.
(3) Initialize the servo parameters. Switch the power off and on again.
(4) Enable the analog servo interface function. Switch the power off and on again. Now setting is completed.

(4) FSSB setting

(a) Connecting the analog servo adapter requires that the FSSB be set up manually. (The FSSB setting screen cannot be used.)

	#7	#6	#5	#4	#3	#2	#1	#0
1902								FMD

FMD (#0) Specifies the FSSB set mode as follows:
0: Automatic setting mode
1: Manual setting mode ← To be set

(b) Directly enter all parameters listed in the following table. Before doing this, understand the meaning of each parameter sufficiently. For detailed descriptions about parameter setting, refer to the respective CNC Connection Manuals and Parameter Manuals. Analog and digital servo axes can be used together as shown in the reference examples below.

Parameter number			Meaning
30*i*-B Series	**30*i*-A Series**	**0*i*-D Series**	
1023	1023	1023	Servo axis number for each axis
-	1905#6,7,1,2	1905#6,7	Selection of interface unit used
24000 to 24031 24032 to 24063	14340 to 14357 14358 to 14375	14340 to 14357	Conversion table value for slave number (*1)
24096	1936	1936	Connector number for interface unit 1 (*2)
24097	1937	1937	Connector number for interface unit 2 (*2)
24098	1938	-	Connector number for interface unit 3 (*2)
24099	1939	-	Connector number for interface unit 4 (*2)
24100	-	-	Connector number for interface unit 5
24101	-	-	Connector number for interface unit 6
24102	-	-	Connector number for interface unit 7
24103	-	-	Connector number for interface unit 8
24104 to 24111	14376 to 14383	14376 to 14383	Conversion table value for connector number of interface unit 1
24112 to 24119	14384 to 14391	14384 to 14391	Conversion table value for connector number of interface unit 2
24120 to 24127	14392 to 14399	-	Conversion table value for connector number of interface unit 3
24128 to 24135	14400 to 14407	-	Conversion table value for connector number of interface unit 4
24136 to 24143	-	-	Conversion table value for connector number of interface unit 5
24144 to 24151	-	-	Conversion table value for connector number of interface unit 6
24152 to 24159	-	-	Conversion table value for connector number of interface unit 7
24160 to 24167	-	-	Conversion table value for connector number of interface unit 8
24064 to 24095	14408 to 14425	-	Conversion table value for slave number on additional-axis board
24168 to 24175	14444 to 14451	-	Conversion table value for connector number of interface unit 1 on additional-axis board
24176 to 24183	14452 to 14459	-	Conversion table value for connector number of interface unit 2 on additional-axis board
24184 to 24191	-	-	Conversion table value for connector number of interface unit 3 on additional-axis board
24192 to 24199	-	-	Conversion table value for connector number of interface unit 4 on additional-axis board

NOTE

1 The FSSB settings for the analog servo adapter are also used for the separate detector interface unit.
(Bits 6, 7, 1, and 2 of No. 1905 (30*i*-A Series, 0*i*-D Series) are shared.)

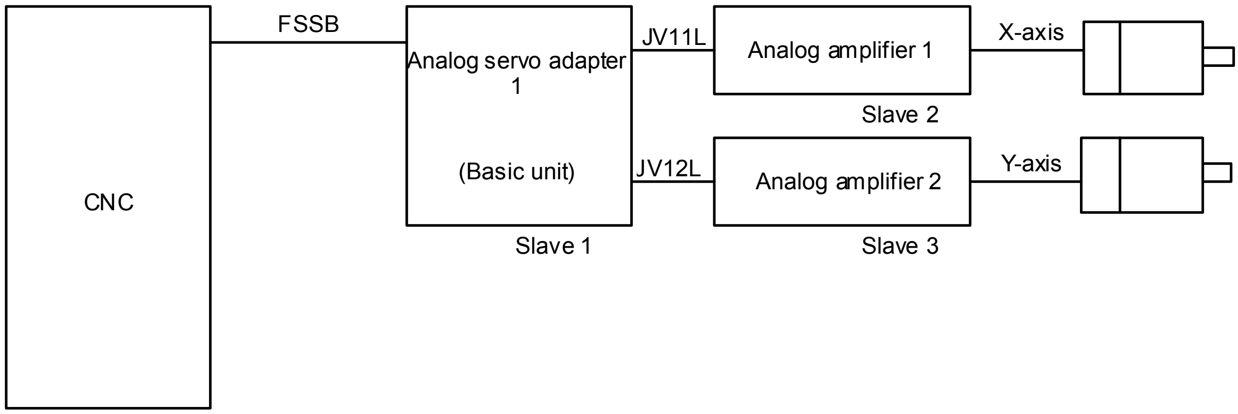
2 The slave number of an analog servo axis must be added to behind the last slave number of the units actually connected to the FSSB line. (See the setting examples provided below.)

3 With the 30*i*-A Series, 0*i*-D Series, up to two interface units (separate detector interface unit and (or) analog servo interface unit) can be connected per FSSB line. Therefore, the first and second interface units are connected to the FSSB1 line, and the third and fourth interface units are connected to the FSSB2 line.
With the 30*i*-B Series, a total of up to four separate detector interface units and analog servo adapters can be connected per FSSB line.

(Reference) FSSB setting example where an analog servo adapter is used

[Setting example 1: Two analog servo axes]

Let the analog servo adapter be slave 1. Assume that analog amplifiers are connected behind the analog servo adapter, and let them be slaves 2 and 3 sequentially.



For 30*i*-B Series

Parameter No.	24000	24001	24002	24003 to 24095
Set value	3001	1001	1002	1000

Parameter No.	1023	24096	24097 to 24103
X axis	1	1	0
Y axis	2	2	0

Parameter No.	24104	24105	24106 to 24111
Set value	1001	1002	1000

For 30*i*-A Series, 0*i*-D Series

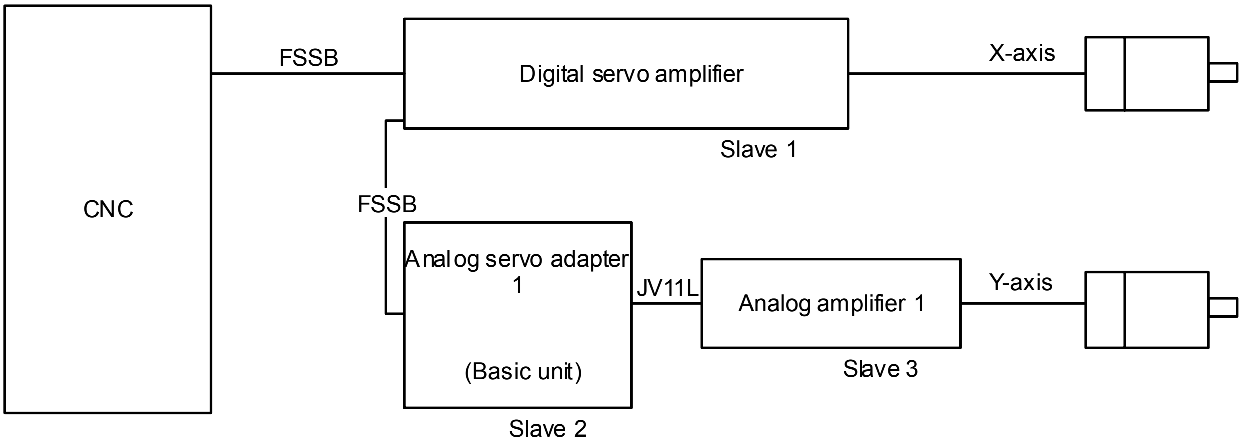
Parameter No.	14340	14341	14342	14343 to 14357
Set value	64	0	1	-96

Parameter No.	1023	1905	1936	1937
X axis	1	01000000	0	0
Y axis	2	01000000	1	0

Parameter No.	14376	14377	14378 to 14407
Set value	0	1	32

[Setting example 2: One digital servo axis + one analog servo axis]

The digital servo amplifier and analog servo adapter are slaves 1 and 2, as in the sequence in which they are connected to the FSSB. Assuming that the axis connected to the analog servo amplifier is behind the analog servo adapter, it is slave 3.



For 30*i*-B Series

Parameter No.	24000	24001	24002	24003 to 24095
Set value	1001	3001	1002	1000

Parameter No.	1023	24096	24097 to 24103
X axis	1	0	0
Y axis	2	1	0

Parameter No.	24104	24105 to 24111
Set value	1002	1000

30*i*-A Series, 0*i*-D Series

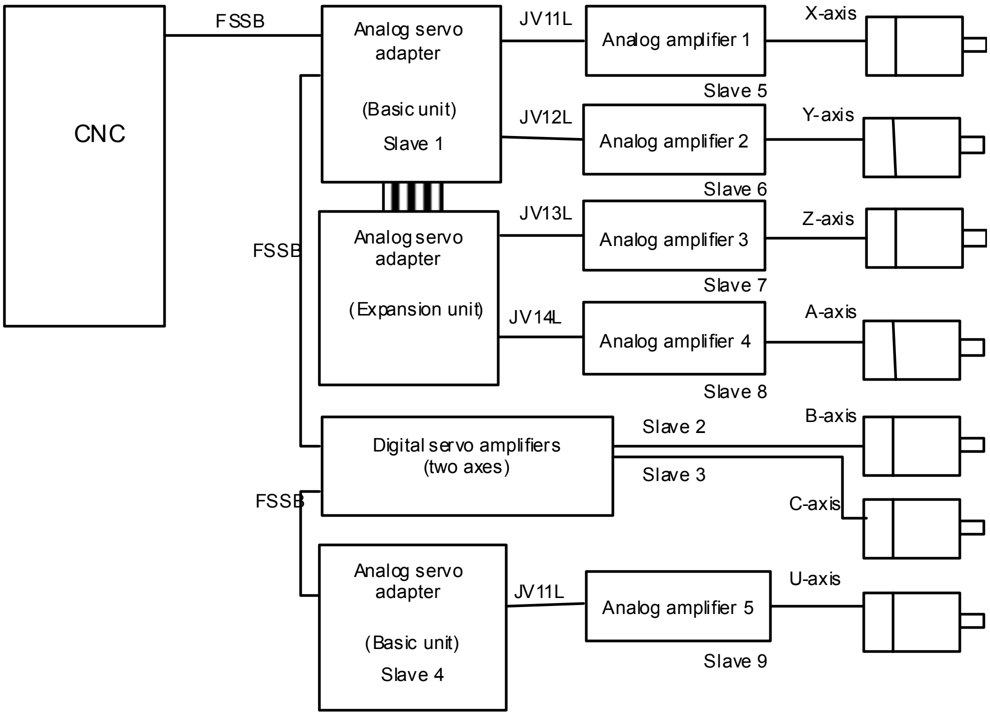
Parameter No.	14340	14341	14342	14343 to 14357
Set value	0	64	1	-96

Parameter No.	1023	1905	1936	1937
X axis	1	00000000	0	0
Y axis	2	01000000	0	0

Parameter No.	14376	14377 to 14407
Set value	1	32

[Setting example 3: Five analog servo axes + two digital servo axes]

The first analog servo adapter (including expansion) is slave 1, two digital servo amplifiers are slaves 2 and 3, the second analog servo adapter is slave 4, as in the sequence in which they are connected to the FSSB. Assuming that the analog amplifiers are connected behind the analog servo adapter, they are slaves 5 to 9.



For 30*i*-B Series

Parameter No.	24000	24001	24002	24003	24004	24005	24006	24007	24009	24010 to 24095
Set value	3001	1005	1006	3002	1001	1002	1003	1004	1007	1000

Parameter No.	1023	24096	24097	24097 to 24103
X axis	1	1	0	0
Y axis	2	2	0	0
Z axis	3	3	0	0
A axis	4	4	0	0
B axis	5	0	0	0
C axis	6	0	0	0
U axis	7	0	1	0

Parameter No.	24104	24105	24106	24107	24108 to 24111	24112	24113 to 24119
Set value	1001	1002	1003	1004	1000	1007	1000

For 30*i*-A Series, 0*i*-D Series

Parameter No.	14340	14341	14342	14343	14344	14345	14346	14347	14348	14349 to 14357
Set value	64	4	5	-56	0	1	2	3	6	-96

Parameter No.	1023	1905	1936	1937
X axis	1	01000000	0	0
Y axis	2	01000000	1	0
Z axis	3	01000000	2	0
A axis	4	01000000	3	0
B axis	5	00000000	0	0
C axis	6	00000000	0	0
U axis	7	10000000	0	0

Parameter No.	14376	14377	14378	14379	14380 to 14383	14384	14385 to 14407
Set value	0	1	2	3	32	6	32

(5) Servo parameter initialization

For axes connected to an analog servo circuit, initialize the servo parameters as listed below.

Parameter No.	Name	Set value
2000	Initialization bit	00000000
2020	Motor ID number	252 (for HRV2)
2001	AMR	00000000
1820	CMR	Perform the same initialization as for digital servo according to your machine tool.
2084	FFG (numerator)	
2085	FFG (denominator)	
2022	Direction of movement	111 (counterclockwise) or −111 (clockwise)
1821	Reference counter	Specify the number of pulses per motor revolution (after FFG) in the same manner as for the digital servo circuit.
2023	Number of velocity pulses	Set value = 1536.797 × E where E is the voltage (V) that corresponds to a velocity command of 1000 min^{-1}.
2024	Number of position pulses	Specify the number of pulses per motor revolution (before FFG) in the same manner as for the digital servo circuit.

NOTE

Although difference in HRV setting is not directly related to analog servo axes, they must be initialized with the same HRV setting by reason of the relationship with the settings of other digital servo axes.

(6) Setting the analog servo function

To enable the analog servo function, set the following parameters for the axes to be connected to an analog servo circuit. (It is also necessary to enable the dummy serial feedback function.)

	#7	#6	#5	#4	#3	#2	#1	#0
2009				ANALOG				DMY

DMY (#0) The serial feedback dummy function is:
0: Not used
1: Used ← To be set

ANALOG (#4) The analog servo interface function is:
0: Not used
1: Used ← To be set

2165	Maximum amplifier current

Specify 0 for the axis to be connected to an analog servo circuit.

B PARAMETERS SET WITH VALUES IN DETECTION UNITS

If the detection unit is changed with a CMR or flexible feed gear, it is also necessary to change the parameters that are set with values in detection units. This appendix lists these parameters.
For details of these parameters, refer to the respective CNC parameter manuals.

Appendix B, "PARAMETERS SET WITH VALUES IN DETECTION UNITS", consists of the following sections:

B.1 PARAMETERS FOR 30*i*-A Series, 30*i*-B Series

No.	Description	30*i* –A Series	30*i*-B Series
1821	Reference counter capacity for individual axis	○	○
1826	Effective area (in-position check) for individual axis	○	○
1827	Effective area (in-position check) for individual axis at cutting feed	○	○
1828	Position error limit for individual axis during movement	○	○
1829	Position error limit for individual axis at stop	○	○
1830	Position error limit for individual axis with servo off	○	○
1832	Position error limit for individual axis with feed at stop	○	○
1836	Servo error amount within which reference position return is assumed to be possible	○	○
1844	Distance to first grid point when reference position shift of reference position shift function is set to 0 or when reference position return is performed with grid shift	○	○
1846	Distance for starting second stage compensation in smooth backlash compensation	○	○
1847	Distance for ending second stage compensation in smooth backlash compensation	○	○
1848	First stage compensation value in smooth backlash compensation	○	○
1850	Grid shift/reference position shift for individual axis	○	○
1851	Backlash compensation for individual axis	○	○
1852	Backlash compensation for individual axis at rapid traverse	○	○
1882	Mark 2 intervals on linear scale interface with absolute address reference mark	○	○
1883	Distance from scale origin to reference position 1 (linear scale with absolute address reference marks) or Distance from base point to reference position 1 (linear scale with an absolute address origin)	○	○
1884	Distance from scale origin to reference position 2 (linear scale with absolute address reference marks) or Distance from base point to reference position 2 (linear scale with an absolute address origin)	○	○
1885	Permissible cumulative movement value during torque control	○	○
1886	Position error with torque control canceled	○	○
2033	For vibration damping control : position pulses conversion coefficient	○	○
2078	Dual position feedback function : conversion coefficient (numerator)	○	○
2079	Dual position feedback function : conversion coefficient (denominator)	○	○
2082	Second stage start/end parameter (when the two-stage backlash acceleration function is used)	○	○
2101	Overshoot compensation enable level	○	○
2103	Unexpected disturbance torque detection amount retrace distance	○	○
2118	Dual position feedback function : alarm detection level of Semi-Full error	○	○
2119	Function for changing the proportional gain in the stop state : stop judgment level	○	○
2173	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=1)	○	○
2263	Detection unit parameter	○	○
2373	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=0)	○	○
2382	Torsion preview control: maximum compensation value (LSTCM)	○	○
2386	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)	○	○
2387	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)	○	○
2388	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)	○	○
2391	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)	○	○
2392	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)	○	○
2393	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)	○	○
2404	Synchronous axes automatic compensation : Maximum compensation	○	○
3627	Pitch error compensation value at reference position when movement to reference position is made in the direction opposite to reference position return direction	○	○

No.	Description	30*i* –A Series	30*i*-B Series
3720	Number of pulses from position coder	○	○
5019	Distance to prevent chattering for direct input of tool offset value measured B	○	○
5184	In-position width for other than hole bottom (normal operation)	○	○
5185	In-position width for other than hole bottom (for retraction in peck drilling cycle)	○	○
5186	In-position width for other than hole bottom (for shift operation in boring cycle (G76, G87))	○	○
5187	In-position width for hole bottom	○	○
5214	Synchronization error width setting for rigid tapping	○	○
5300	First-spindle rigid tapping effective area (in-position check) for tapping axis	○	○
5301	In-position width for spindle in rigid tapping	○	○
5302	Second-spindle rigid tapping effective area (in-position check) for tapping axis	○	○
5304	Third-spindle rigid tapping effective area (in-position check) for tapping axis	○	○
5306	Fourth-spindle rigid tapping effective area (in-position check) for tapping axis	○	○
5310	First-spindle rigid tapping position error limit for tapping axis during movement	○	○
5311	Rigid tapping position error limit for spindle during movement	○	○
5312	First-spindle rigid tapping position error limit for tapping axis at stop	○	○
5213	Rigid tapping position error limit for spindle at stop	○	○
5321	Backlash amount for spindle in rigid tapping (first gear)	○	○
5322	Backlash amount for spindle in rigid tapping (second gear)	○	○
5323	Backlash amount for spindle in rigid tapping (third gear)	○	○
5324	Backlash amount for spindle in rigid tapping (fourth gear)	○	○
5350	Second-spindle rigid tapping position error limit for tapping axis during movement	○	○
5352	Second-spindle rigid tapping position error limit for tapping axis at stop	○	○
5354	Third-spindle rigid tapping position error limit for tapping axis during movement	○	○
5356	Third-spindle rigid tapping position error limit for tapping axis at stop	○	○
5358	Fourth-spindle rigid tapping position error limit for tapping axis during movement	○	○
5360	Fourth-spindle rigid tapping position error limit for tapping axis at stop	○	○
5761	Compensation at compensation point number a for movement axis 1	○	○
5762	Compensation at compensation point number b for movement axis 1	○	○
5763	Compensation at compensation point number c for movement axis 1	○	○
5764	Compensation at compensation point number d for movement axis 1	○	○
5771	Compensation at compensation point number a for movement axis 2	○	○
5772	Compensation at compensation point number b for movement axis 2	○	○
5773	Compensation at compensation point number c for movement axis 2	○	○
5774	Compensation at compensation point number d for movement axis 2	○	○
5781	Compensation at compensation point number a for movement axis 3	○	○
5782	Compensation at compensation point number b for movement axis 3	○	○
5783	Compensation at compensation point number c for movement axis 3	○	○
5784	Compensation at compensation point number d for movement axis 3	○	○
5871	Compensation α at compensation point number a for individual axis (gradient compensation)	○	○
5872	Compensation β at compensation point number b for individual axis (gradient compensation)	○	○
5873	Compensation γ at compensation point number c for individual axis (gradient compensation)	○	○
5874	Compensation ε at compensation point number d for individual axis (gradient compensation)	○	○
6287	Position error limit at torque limit skip	○	○
7772	Number of pulses from position detector per rotation of tool axis	○	○
7773	Number of pulses from position detector per rotation of workpiece axis	○	○
7782	Number of pulses from position detector per rotation of EGB master axis [axis type]	○	○
7783	Number of pulses from position detector per rotation of EGB slave axis [axis type]	○	○
8181	Synchronous error limit for each axis (synchronous and composite control)	○	○
8323	Limit of position error check in feed axis synchronous control	○	○

No.	Description	30*i* –A Series	30*i*-B Series
8326	Difference in reference counter value between master axis and slave axis	○	○
8331	Maximum permissible synchronous error in synchronous error excess alarm 1	○	○
8332	Maximum permissible synchronous error in synchronous error excess alarm 2	○	○
8333	Synchronous error zero width for each axis	○	○
8335	Synchronous error zero width 2 for each axis	○	○
8377	Permissible error at start of chopping compensation	○	○
10864 ~ 10873	Compensation 1 at compensation point 1 for compensated axis 1 of three-dimensional machine position compensation ~ Compensation 10 at compensation point 10 for compensated axis 1 of three-dimensional machine position compensation	○	○
10874 ~ 10883	Compensation 1 at compensation point 1 for compensated axis 2 of three-dimensional machine position compensation ~ Compensation 10 at compensation point 10 for compensated axis 2 of three-dimensional machine position compensation	○	○
10884 ~ 10893	Compensation 1 at compensation point 1 for compensated axis 3 of three-dimensional machine position compensation ~ Compensation 10 at compensation point 10 for compensated axis 3 of three-dimensional machine position compensation	○	○
11013	Position error limit for individual axis during movement	○	○
11014	Position error limit for individual axis at stop	○	○
11211	Linear gradient compensation CMP0	○	○
13351 ~ 13354	Compensation at compensation point number a for movement axis 4 ~ Compensation at compensation point number d for movement axis 4	○	○
13361 ~ 13364	Compensation at compensation point number a for movement axis 5 ~ Compensation at compensation point number d for movement axis 5	○	○
13371 ~ 13374	Compensation at compensation point number a for movement axis 6 ~ Compensation at compensation point number d for movement axis 6	○	○
14010	Maximum permissible movement amount at reference position setup of linear scale with absolute addressing reference marks	○	○

* ○ Supported, – Not supported

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B.2 PARAMETERS FOR Power Motion *i*-A

No.	Description
1821	Reference counter capacity for individual axis
1826	Effective area (in-position check) for individual axis
1827	Effective area (in-position check) for individual axis at cutting feed
1828	Position error limit for individual axis during movement
1829	Position error limit for individual axis at stop
1830	Position error limit for individual axis with servo off
1832	Position error limit for individual axis with feed at stop
1836	Servo error amount within which reference position return is assumed to be possible
1844	Distance to first grid point when reference position shift of reference position shift function is set to 0 or when reference position return is performed with grid shift
1850	Grid shift/reference position shift for individual axis

No.	Description
1851	Backlash compensation for individual axis
1852	Backlash compensation for individual axis at rapid traverse
1872	Servo position error check value
1882	Mark 2 intervals on linear scale interface with absolute address reference mark
1883	Distance from scale origin to reference position 1 (linear scale with absolute address reference marks) or Distance from base point to reference position 1 (linear scale with an absolute address origin)
1884	Distance from scale origin to reference position 2 (linear scale with absolute address reference marks) or Distance from base point to reference position 2 (linear scale with an absolute address origin)
1885	Permissible cumulative movement value during torque control
1886	Position error with torque control canceled
2033	For vibration damping control : position pulses conversion coefficient
2078	Dual position feedback function : conversion coefficient (numerator)
2079	Dual position feedback function : conversion coefficient (denominator)
2082	Second stage start/end parameter (when the two-stage backlash acceleration function is used)
2101	Overshoot compensation enable level
2103	Unexpected disturbance torque detection amount retrace distance
2118	Dual position feedback function : alarm detection level of Semi-Full error
2119	Function for changing the proportional gain in the stop state : stop judgment level
2173	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=1)
2263	Detection unit parameter
2373	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=0)
2382	Torsion preview control: maximum compensation value (LSTCM)
2386	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)
2387	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)
2388	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)
2391	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)
2392	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)
2393	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)
2404	Synchronous axes automatic compensation : Maximum compensation
3627	Pitch error compensation value at reference position when movement to reference position is made in the direction opposite to reference position return direction
6287	Position error limit at torque limit skip
8323	Limit of position error check in feed axis synchronous control
8326	Difference in reference counter value between master axis and slave axis
8331	Maximum permissible synchronous error in synchronous error excess alarm 1
8332	Maximum permissible synchronous error in synchronous error excess alarm 2
8333	Synchronous error zero width for each axis
8335	Synchronous error zero width 2 for each axis
8694	Servo position error limit in pressure and position control mode
14010	Maximum permissible movement amount at reference position setup of linear scale with absolute addressing reference marks

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B.3 PARAMETERS FOR 0*i*-D Series

No.	Description
1821	Reference counter capacity for individual axis
1826	Effective area (in-position check) for individual axis
1827	Effective area (in-position check) for individual axis at cutting feed
1828	Position error limit for individual axis during movement
1829	Position error limit for individual axis at stop
1830	Position error limit for individual axis with servo off
1832	Position error limit for individual axis with feed at stop

No.	Description
1836	Servo error amount within which reference position return is assumed to be possible
1844	Distance from the point at which deceleration dog is turned off to first grid point when reference position shift of the reference position shift function is set to 0
1846	Distance for starting second stage compensation in smooth backlash compensation
1847	Distance for ending second stage compensation in smooth backlash compensation
1848	First stage compensation value in smooth backlash compensation
1850	Grid shift/reference position shift for individual axis
1851	Backlash compensation for individual axis
1852	Backlash compensation for individual axis at rapid traverse
1882	Mark 2 intervals on linear scale interface with absolute address reference mark
1883	Distance from scale origin to reference position 1 (linear scale with absolute address reference marks) or Distance from base point to reference position 1 (linear scale with an absolute address origin)
1884	Distance from scale origin to reference position 2 (linear scale with absolute address reference marks) or Distance from base point to reference position 2 (linear scale with an absolute address origin)
1885	Permissible cumulative movement value during torque control
1886	Position error with torque control canceled
2033	For vibration damping control : position pulses conversion coefficient
2078	Dual position feedback function : conversion coefficient (numerator)
2079	Dual position feedback function : conversion coefficient (denominator)
2082	Second stage start/end parameter (when the two-stage backlash acceleration function is used)
2101	Overshoot compensation enable level
2103	Unexpected disturbance torque detection amount retrace distance
2118	Dual position feedback function : alarm detection level of Semi-Full error
2119	Function for changing the proportional gain in the stop state : stop judgment level
2173	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=1)
2263	Detection unit parameter
2373	Lift amount in lifting function against gravity at emergency stop (Bit 7 of No. 2298=0 when SWDBSx=0)
2382	Torsion preview control: maximum compensation value (LSTCM)
2386	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)
2387	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)
2388	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)
2391	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)
2392	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)
2393	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)
2404	Synchronous axes automatic compensation : Maximum compensation
3627	Pitch error compensation value at reference position when movement to reference position is made in the direction opposite to reference position return direction
3720	Number of pulses from position coder
5214	Synchronization error width setting for rigid tapping
5300	First-spindle rigid tapping effective area (in-position check) for tapping axis
5301	In-position width for spindle in rigid tapping
5302	Second-spindle rigid tapping effective area (in-position check) for tapping axis
5310	First-spindle rigid tapping position error limit for tapping axis during movement
5311	Rigid tapping position error limit for spindle during movement
5312	First-spindle rigid tapping position error limit for tapping axis at stop
5213	Rigid tapping position error limit for spindle at stop
5321	Backlash amount for spindle in rigid tapping (first gear)
5322	Backlash amount for spindle in rigid tapping (second gear)
5323	Backlash amount for spindle in rigid tapping (third gear)
5324	Backlash amount for spindle in rigid tapping (fourth gear)
5350	Second-spindle rigid tapping position error limit for tapping axis during movement
5352	Second-spindle rigid tapping position error limit for tapping axis at stop
5761	Compensation at compensation point number a for movement axis 1
5762	Compensation at compensation point number b for movement axis 1
5763	Compensation at compensation point number c for movement axis 1

No.	Description
5764	Compensation at compensation point number d for movement axis 1
5871	Compensation α at compensation point number a for individual axis (gradient compensation)
5872	Compensation β at compensation point number b for individual axis (gradient compensation)
5873	Compensation γ at compensation point number c for individual axis (gradient compensation)
5874	Compensation ε at compensation point number d for individual axis (gradient compensation)
6287	Position error limit at torque limit skip
7772	Number of pulses from position detector per rotation of tool axis
7773	Number of pulses from position detector per rotation of workpiece axis
8181	Synchronous error limit for each axis (synchronous and composite control)
8323	Limit of position error check in feed axis synchronous control
8326	Difference in reference counter value between master axis and slave axis
11013	Position error limit for individual axis during movement
11014	Position error limit for individual axis at stop
14010	Maximum permissible movement amount at reference position setup of linear scale with absolute addressing reference marks

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B.4 PARAMETERS FOR Series 16*i*, 18*i*, 21*i*, 0*i*/0*i* Mate -C

No.	Description
1821	Reference counter capacity for individual axis
1826	Effective area (in-position check) for individual axis
1827	Effective area (in-position check) for individual axis at cutting feed
1828	Position error limit for individual axis during movement
1829	Position error limit for individual axis at stop
1830	Position error limit for individual axis with servo off
1832	Position error limit for individual axis with feed at stop
1836	Servo error amount within which reference position return is assumed to be possible
1846	Distance for starting second stage compensation in smooth backlash compensation
1847	Distance for ending second stage compensation in smooth backlash compensation
1848	First stage compensation value in smooth backlash compensation
1850	Grid shift/reference position shift for individual axis
1851	Backlash compensation for individual axis
1852	Backlash compensation for individual axis at rapid traverse
1876	Inductosyn 1-pitch interval
1877	Inductosyn shift
1882	Mark 2 intervals on linear scale having reference marks
1883	Distance from origin to reference position on linear scale having reference marks
1884	Distance from origin to reference position on linear scale having reference marks
1885	Permissible cumulative movement value during torque control (PMC axis control)
1886	Position error with torque control canceled (PMC axis control)
2033	For vibration damping control : position pulses conversion coefficient
2078	Dual position feedback function : conversion coefficient (numerator)
2079	Dual position feedback function : conversion coefficient (denominator)
2082	Second stage start/end parameter (when the two-stage backlash acceleration function is used)
2101	Overshoot compensation enable level
2103	Unexpected disturbance torque detection amount retrace distance
2118	Dual position feedback function : alarm detection level of Semi-Full error
2119	Function for changing the proportional gain in the stop state : stop judgment level
2173	Lifting function against gravity at emergency stop : distance to lift (When SWDBSx=1)
2263	Detection unit parameter
2373	Lifting function against gravity at emergency stop : distance to lift (When SWDBSx=0)

No.	Description
2382	Torsion preview control: maximum compensation value (LSTCM)
2386	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)
2387	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)
2388	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)
2391	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)
2392	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)
2393	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)
2404	Synchronous axes automatic compensation : Maximum compensation
3623	Pitch error compensation magnification for individual axis
5300	Rigid tapping effective area (in-position check) for tapping axis
5302	Second-spindle rigid tapping effective area (in-position check) for tapping axis
5304	Third-spindle rigid tapping effective area (in-position check) for tapping axis
5310	Rigid tapping position error limit for tapping axis during movement
5312	Rigid tapping position error limit for tapping axis at stop
5314	Rigid tapping position error limit for tapping axis during movement
5350	Second-spindle rigid tapping position error limit for tapping axis during movement
5352	Second-spindle rigid tapping position error limit for tapping axis at stop
5354	Third-spindle rigid tapping position error limit for tapping axis during movement
5356	Third-spindle rigid tapping position error limit for tapping axis at stop
5761	Compensation at compensation point number a for movement axis 1 (straightness compensation)
5762	Compensation at compensation point number b for movement axis 1 (straightness compensation)
5763	Compensation at compensation point number c for movement axis 1 (straightness compensation)
5764	Compensation at compensation point number d for movement axis 1 (straightness compensation)
5771	Compensation at compensation point number a for movement axis 2 (straightness compensation)
5772	Compensation at compensation point number b for movement axis 2 (straightness compensation)
5773	Compensation at compensation point number c for movement axis 2 (straightness compensation)
5774	Compensation at compensation point number d for movement axis 2 (straightness compensation)
5781	Compensation at compensation point number a for movement axis 3 (straightness compensation)
5782	Compensation at compensation point number b for movement axis 3 (straightness compensation)
5783	Compensation at compensation point number c for movement axis 3 (straightness compensation)
5784	Compensation at compensation point number d for movement axis 3 (straightness compensation)
5871	Compensation α at compensation point number a for individual axis (gradient compensation)
5872	Compensation β at compensation point number b for individual axis (gradient compensation)
5873	Compensation γ at compensation point number c for individual axis (gradient compensation)
5874	Compensation ε at compensation point number d for individual axis (gradient compensation)
8313	Limit to difference in position error between master and slave axes (pair under simplified synchronization control)
8315	Maximum compensation for synchronization (pair under simplified synchronization control)
8316	Difference in reference counter value between master axis and slave axis (pair under simplified synchronization control)
8323	Limit to difference in position error between master and slave axes (more than one pair under simplified synchronization control)
8325	Maximum compensation for synchronization (more than one pair under simplified synchronization control)
8326	Difference in reference counter value between master axis and slave axis (more than one pair under simplified synchronization control)

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B.5 PARAMETERS FOR Power Mate *i*

No.	Description
1821	Reference counter capacity for individual axis
1826	Effective area (in-position check) for individual axis

No.	Description
1827	Effective area (in-position check) for individual axis at cutting feed
1828	Position error limit for individual axis during movement
1829	Position error limit for individual axis at stop
1830	Position error limit for individual axis with servo off
1832	Position error limit for individual axis with feed at stop
1836	Servo error amount within which reference position return is assumed to be possible (This parameter is used when ISC is used.)
1850	Grid shift/reference position shift for individual axis
1851	Backlash compensation for individual axis
1852	Backlash compensation for individual axis at rapid traverse
1872*	Servo position error check value
1882	Mark 2 intervals on linear scale having reference marks
1883	Distance from origin to reference position on linear scale having reference marks
1884	Distance from origin to reference position on linear scale having reference marks
1885	Permissible cumulative movement value during torque control (PMC axis control)
1886	Position error with torque control canceled (PMC axis control)
2033	For vibration damping control : position pulses conversion coefficient
2078	Dual position feedback function : conversion coefficient (numerator)
2079	Dual position feedback function : conversion coefficient (denominator)
2082	Second stage start/end parameter (when the two-stage backlash acceleration function is used)
2101	Overshoot compensation enable level
2103	Unexpected disturbance torque detection amount retrace distance
2118	Dual position feedback function : alarm detection level of Semi-Full error
2119	Function for changing the proportional gain in the stop state : stop judgment level
2173	Lifting function against gravity at emergency stop : distance to lift (When SWDBSx=1)
2263	Detection unit parameter
2373	Lifting function against gravity at emergency stop : distance to lift (When SWDBSx=0)
2404	Synchronous axes automatic compensation : Maximum compensation
3623	Pitch error compensation magnification for individual axis (H is optional.)
5300(D)	Rigid tapping effective area (in-position check) for tapping axis
5310(D)	Rigid tapping position error limit for tapping axis during movement
5312(D)	Rigid tapping position error limit for tapping axis at stop
5314(D)	Rigid tapping position error limit for tapping axis during movement
5761	Compensation at compensation point number a for movement axis 1 (straightness compensation)
5762	Compensation at compensation point number b for movement axis 1 (straightness compensation)
5763	Compensation at compensation point number c for movement axis 1 (straightness compensation)
5764	Compensation at compensation point number d for movement axis 1 (straightness compensation)
5771	Compensation at compensation point number a for movement axis 2 (straightness compensation)
5772	Compensation at compensation point number b for movement axis 2 (straightness compensation)
5773	Compensation at compensation point number c for movement axis 2 (straightness compensation)
5774	Compensation at compensation point number d for movement axis 2 (straightness compensation)
5781	Compensation at compensation point number a for movement axis 3 (straightness compensation)
5782	Compensation at compensation point number b for movement axis 3 (straightness compensation)
5783	Compensation at compensation point number c for movement axis 3 (straightness compensation)
5784	Compensation at compensation point number d for movement axis 3 (straightness compensation)
8313	Limit to difference in position error between master and slave axes (pair under simplified synchronization control)
8315	Maximum compensation for synchronization (pair under simplified synchronization control)
8316	Difference in reference counter value between master axis and slave axis (pair under simplified synchronization control)
8323(H)	Limit to difference in position error between master and slave axes (more than one pair under simplified synchronization control)
8325(H)	Maximum compensation for synchronization (more than one pair under simplified synchronization control)
8326(H)	Difference in reference counter value between master axis and slave axis (more than one pair under simplified synchronization control)

The parameter No. indicated with an asterisk (*) is related to a function unique to the Power Mate.
The parameter No. suffixed with "(D)" are related to the functions dedicated to the Power Mate *i*-D.
The parameter No. suffixed with "(H)" are related to the functions dedicated to the Power Mate *i*-H.

B.6 PARAMETERS FOR Series 15*i*

No.	Description
1718	For vibration damping control : position pulses conversion coefficient
1729	Dual position feedback function : alarm detection level of Semi-Full error
1730	Function for changing the proportional gain in the stop state : stop judgment level
1827	Effective area (in-position check) for individual axis
1828	Position error limit for individual axis during movement
1829	Position error limit for individual axis at stop
1830	Position error limit for individual axis with servo off
1832	Position error limit for individual axis with feed at stop
1837	Rigid tapping position error limit during movement
1841	Servo error amount within which reference position return is assumed to be possible
1843	Position error limit at torque limit skip
1844	Grid shift for reference position shift function
1846	Distance for starting second stage compensation in smooth backlash compensation
1847	Distance for ending second stage compensation in smooth backlash compensation
1848	First stage compensation value in smooth backlash compensation
1849	Backlash compensation for individual axis at rapid traverse
1850	Grid shift for individual axis
1851	Backlash compensation for individual axis
1881	Permissible error at start of chopping compensation
1896	Mark 1 intervals on linear scale interface with absolute address reference mark
1912	Synchronous error zero width for each axis
1913	Maximum permissible synchronization error for each axis at rapid traverse
1914	Maximum permissible synchronization error for each axis at stop
1917	Synchronous error zero width 2 for each axis
1971	Dual position feedback function : conversion coefficient (numerator)
1972	Dual position feedback function : conversion coefficient (denominator)
1975	Second stage start/end parameter (when the two-stage backlash acceleration function is used)
1994	Overshoot compensation enable level
1996	Unexpected disturbance torque detection amount retrace distance
2676	Detection unit parameter
2786	Lift amount in lifting function against gravity at emergency stop
2795	Torsion preview control: maximum compensation value (LSTCM)
2799	Torsion preview control: Acceleration torsion compensation value K1 (LSTK1)
2800	Torsion preview control: Acceleration torsion compensation value K2 (LSTK2)
2801	Torsion preview control: Acceleration torsion compensation value K3 (LSTK3)
2804	Torsion preview control: Acceleration torsion compensation value K1N (LSTK1N)
2805	Torsion preview control: Acceleration torsion compensation value K2N (LSTK2N)
2806	Torsion preview control: Acceleration torsion compensation value K3N (LSTK3N)
2817	Synchronous axes automatic compensation : Maximum compensation
5226	Mark 2 intervals on linear scale having reference marks
5227	Distance from origin to reference position on linear scale having reference marks
5423	Pitch error compensation magnification
5433	Second cyclic pitch error compensation magnification
5428	Pitch error compensation value at reference position when movement to reference position is made in the direction opposite to reference position return direction（absolute value）
5449	Three-dimensional error compensation magnification
5450	Three-dimensional error compensation magnification

No.	Description
5451	Three-dimensional error compensation magnification
5471	Compensation α at compensation point number a for individual axis
5472	Compensation β at compensation point number b for individual axis
5473	Compensation γ at compensation point number c for individual axis
5474	Compensation ε at compensation point number d for individual axis
5504	Compensation point number d for movement axis 1 subjected to straightness compensation
5551	Compensation at compensation point number a for movement axis 1
5552	Compensation at compensation point number b for movement axis 1
5553	Compensation at compensation point number c for movement axis 1
5554	Compensation at compensation point number d for movement axis 1
5561	Compensation at compensation point number a for movement axis 2
5562	Compensation at compensation point number b for movement axis 2
5563	Compensation at compensation point number c for movement axis 2
5564	Compensation at compensation point number d for movement axis 2
5571	Compensation at compensation point number a for movement axis 3
5572	Compensation at compensation point number b for movement axis 3
5573	Compensation at compensation point number c for movement axis 3
5574	Compensation at compensation point number d for movement axis 3
5591	Compensation magnification for movement axis 1 subjected to straightness compensation
5592	Compensation magnification for movement axis 2 subjected to straightness compensation
5593	Compensation magnification for movement axis 3 subjected to straightness compensation
5594	Compensation magnification for movement axis 4 subjected to straightness compensation
5595	Compensation magnification for movement axis 5 subjected to straightness compensation

C PARAMETERS RELATED TO HIGH-SPEED AND HIGH PRECISION OPERATIONS

The *i* series CNCs are provided with some functions for high-speed and high precision operations. This appendix lists parameters categorized by model and function and their standard setting values so as to make it easy to tune the functions.
Appendix D consists of the following two items:

(1) CNC model-specific information
This section lists high-speed and high precision functions and parameters related to them for individual CNC models.
The parameter tables in this section contain standard setting values.

(2) Servo parameters
This section lists servo parameters common to all CNC models and standard setting values for them.

NOTE

1 Use the standard setting values included in the parameter tables as reference data for initialization.
If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.
To reduce machining time, change parameters from standard settings to speed priority I to speed priority II while checking the operation status. (The settings for speed priority II can reduce much more machining time than the settings for speed priority I.)

2 For the specifications of CNC models and detailed explanations about their functions, refer to the respective CNC manuals.

3 In the following table, the circle indicates that the item is supported, the triangle indicates partial support, and the cross indicates non-support.

Appendix C, "PARAMETERS SET WITH VALUES IN DETECTION UNITS", consists of the following sections:

C.1 MODEL-SPECIFIC INFORMATION

C.1.1 Series 30*i*/31*i*/32*i*-A/B

[Functions related to high-speed and high precision operations]

High-speed high precision functions	AI contour control I	AI contour control II (Note 1)	AI contour control II + High-speed processing (Note 2)
Series30*i*-A/B	○	○	○
Series31*i*-A/B / A5/B5	○	○	○
Series32*i*-A/B	○	○	×
Acc./dec. before interpolation			
Type	Linear/ Bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped
Acceleration setting for each axis	○	○	○
Velocity control			
Velocity control by speed difference among axes	○	○	○
Velocity control by acceleration in circular interpolation	○	○	○
Acceleration-based velocity control	○	○	○
Cutting load-based velocity control	×	○	○
Jerk control	×	○	○
Optimum torque acc./dec.	○	○	○
Other functions			
Nano interpolation	○	○	○
5-axis machining functions (Note 3)	○	○	○
Smooth interpolation (Note 4)	○	○	○
NURBS (Note 4)	○	○	○
Nano smoothing (Note 5)	○	○	○

NOTE

1. In FS30*i* systems controlling more than four paths and more than 20 axes, this function cannot be used.
2. In FS30*i* and FS31*i* systems controlling more than two paths and more than 12 axes, this function cannot be used.
3. These functions can be used with the FS30*i*-A/B and FS31*i*-A5/B5 only.
4. These functions cannot be used with the FS32*i*.
5. These functions cannot be used with the FS32*i*-A.

[Parameters]

Described below are the parameters that must be specified for individual high-speed and high precision cutting machines separately.

Use the standard setting values included in the parameter tables as reference data for initialization. If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.

- Standard settings (precision priority)
  When there is vibration or significant impact, or when machining is to be performed more precisely, make settings based on the standard settings.

- Cutting time-priority setting
  To reduce machining time, make settings for speed priority I then for speed priority II in stages. The settings for speed priority II can reduce much more machining time than the settings for speed priority I.

(1) AI contour control I, AI contour control II

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1420	-	-	-	Maximum rapid traverse rate (mm/min) for individual axes
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
11242	24	16	16	Time constant (msec) for acc./dec. after rapid traverse interpolation for individual axes in acc./dec. mode before rapid traverse interpolation
1769	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation for individual axes
1660	700.0	2000.0	4000.0	Acceleration in acc./dec. before cutting feed interpolation (for constant-acceleration part) (Acceleration is specified in mm/sec^2 for individual axes.)
1772	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (msec) (for constant-acceleration part)
1783	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1737	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration (Acceleration is specified in mm/sec^2 for individual axes.)
1735	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (Acceleration is specified in mm/sec^2 for individual axes.)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1401#1	0	Rapid traverse is of a non-linear type.
	1	Rapid traverse is of a linear type (Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.)
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type
	1,1	Acc./dec. after interpolation is of a bell-shaped type (Note 1)
7055#3	1/0	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.
7066	mm / inch 10000.0/3937.0	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation
19501#5	0/1	Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.
19503#0	0/1	When using smooth velocity control as velocity control by acceleration, set 1. (Note 2)
8451#4	0/1	Set this parameter to 1 if cutting load-dependent override is to be used. (This parameter is used if the mechanical rigidity of the Z-axis is low.) (Note 2)
19515#1	0/1	When using the slant type for override by cutting load, set 1. (Note 2)

Parameter No.	Standard setting value	Description
19516	80	Region 1 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 or bit 1 of parameter No. 19515 = 0) (Note 2)
8456	80	Region 2 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)
8457	70	Region 3 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)
8458	60	Region 4 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)

NOTE
1 To perform bell-shaped acc./dec. after cutting feed interpolation, the option for bell-shaped acc./dec. after cutting feed interpolation is required.
2 These functions cannot be used with AI contour control I.

C.1.2 Series 35*i*-B, Power Motion *i*-A

[Functions related to high-speed and high precision operations]

High-speed high precision functions	Advanced preview control	
	Series 35*i*-B	Power Motion *i*-A
Acc./dec. before interpolation		
Type	Linear	
Acceleration setting for each axis	○	
Velocity control		
Velocity control by speed difference among axes	○	
Velocity control by acceleration in circular interpolation	×	○
Acceleration-based velocity control	×	
Cutting load-based velocity control	×	
Jerk control	×	
Optimum torque acc./dec.	×	
Other functions		
Nano interpolation	×	
5-axis machining functions	×	
Smooth interpolation	×	
NURBS	×	
Nano smoothing	×	

[Parameters]

Described below are the parameters that must be specified for individual high-speed and high precision cutting machines separately.
Use the standard setting values included in the parameter tables as reference data for initialization. If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.

- Standard settings (precision priority)
  When there is vibration or significant impact, or when machining is to be performed more precisely, make settings based on the standard settings.
- Cutting time-priority setting

To reduce machining time, make settings for speed priority I then for speed priority II in stages. The settings for speed priority II can reduce much more machining time than the settings for speed priority I.

(1) Advanced preview control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1420	-	-	-	Rrapid traverse rate (mm/min) for individual axes
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
11242	24	16	16	Time constant (msec) for acc./dec. after rapid traverse interpolation for individual axes in acc./dec. mode before rapid traverse interpolation
1769	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation for individual axes
1660	700.0	2000.0	4000.0	Acceleration in acc./dec. before cutting feed interpolation (for constant-acceleration part) (Acceleration is specified in mm/sec^2 for individual axes.)
1783	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1735	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (Acceleration is specified in mm/sec^2 for individual axes.) (Note 1)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1401#1	0	Rapid traverse is of a non-linear type.
	1	Rapid traverse is of a linear type (Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.)
1602#6	#6	Set this parameter to 1 if linear-type acc./dec. after interpolation is to be used.
19501#5	0/1	Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.

NOTE

1 These functions cannot be used with the FS35*i*-B.

C.1.3 Series 0*i*/0*i* Mate-D

[Functions related to high-speed and high precision operations]

High-speed high precision functions	Advanced preview control	AI advanced preview control	AI contour control I	AI contour control II
Series0*i*-MD	×	○	○	○
Series0*i*-TD	○	×	○	○
Series0*i* Mate-MD	×	○	○	×
Series0*i* Mate-TD	×	×	○	×
Acc./dec. before interpolation				
Type	Linear	Linear	Linear/ Bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped
Acceleration setting for each axis	○	○	○	○
Function for changing the time constant of bell-shaped acc./dec. (Note 1)	×	×	○	○
Velocity control				
Velocity control by speed difference among axes	○	○	○	○
Velocity control by acceleration in circular interpolation	○	○	○	○
Acceleration-based velocity control	×	○	○	○
Smooth velocity control	×	×	×	○
Cutting load-based velocity control	×	×	×	○
Jerk control	×	×	×	○
Function for ignoring the velocity command	×	×	×	○
Other functions				
Nano interpolation	○	○	○	○
Nano smoothing	×	×	×	○

> **NOTE**
> 1 The function for changing the time constant of bell-shaped acc./dec. is contained in the option for bell-shaped acc./dec. before look ahead interpolation.

[Parameters]

Described below are the parameters that must be specified for individual high-speed and high precision cutting machines separately.

Use the standard setting values included in the parameter tables as reference data for initialization. If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.

- Standard settings (precision priority)
  When there is vibration or significant impact, or when machining is to be performed more precisely, make settings based on the standard settings.
- Cutting time-priority setting
  To reduce machining time, make settings for speed priority I then for speed priority II in stages. The settings for speed priority II can reduce much more machining time than the settings for speed priority I.

(1) Advanced preview control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1420	-	-	-	Rrapid traverse rate (mm/min) for individual axes
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes / Time constant T1 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1769	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation for individual axes
1660	700.0	2000.0	4000.0	Acceleration of acc./dec. before interpolation (portion with the acceleration fixed) (Acceleration is specified in mm/sec^2 for individual axes.)
1783	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1737	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration (Acceleration is specified in mm/sec^2 for individual axes.)
1735	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (Acceleration is specified in mm/sec^2 for individual axes.)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1401#1	0	Rapid traverse is of a non-linear type.
	1	Rapid traverse is of a linear type (Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.)
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type
	0,1	Acc./dec. after interpolation is of a bell-shaped type (Note 1)
19501#5	0/1	Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.

NOTE

1 Performing bell-shaped acc./dec. after cutting feed interpolation requires the bell-shaped acc./dec. after cutting feed interpolation option (FS0*i*-MD). With the FS0*i*-TD, bell-shaped acc./dec. after cutting feed interpolation cannot be used.

(2) AI advanced preview control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1420	-	-	-	Rrapid traverse rate (mm/min) for individual axes
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes / Time constant T1 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1769	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation for individual axes
1660	700.0	2000.0	4000.0	Acceleration of acc./dec. before interpolation (portion with the acceleration fixed) (Acceleration is specified in mm/sec^2 for individual axes.)
1783	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1737	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration (Note 1) (Acceleration is specified in mm/sec^2 for individual axes.)
1735	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (Acceleration is specified in mm/sec^2 for individual axes.)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1401#1	0	Rapid traverse is of a non-linear type.
	1	Rapid traverse is of a linear type (Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.)
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type
	0,1	Acc./dec. after interpolation is of a bell-shaped type (Note 2)
19501#5	0/1	Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.

NOTE
1 This function cannot be used with advanced preview control.
2 Performing bell-shaped acc./dec. after cutting feed interpolation requires the bell-shaped acc./dec. after cutting feed interpolation option (FS0*i*-MD). With the FS0*i*-TD, bell-shaped acc./dec. after cutting feed interpolation cannot be used.

(3) AI contour control I, AI contour control II

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1420	-	-	-	Rrapid traverse rate (mm/min) for individual axes
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes / Time constant T1 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1769	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation for individual axes
1660	700.0	2000.0	4000.0	Acceleration of acc./dec. before interpolation (portion with the acceleration fixed) (Acceleration is specified in mm/sec^2 for individual axes.)
1772	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (msec) (for constant-acceleration part)
1783	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1737	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration (Acceleration is specified in mm/sec^2 for individual axes.)
1735	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (Acceleration is specified in mm/sec^2 for individual axes.)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1401#1	0	Rapid traverse is of a non-linear type.
	1	Rapid traverse is of a linear type (Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.)
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type
	0,1	Acc./dec. after interpolation is of a bell-shaped type (Note 1)
7055#3	0/1	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.
7066	mm / inch 10000.0/3937.0	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation
19501#5	0/1	Set this parameter to 1 if acc./dec. before rapid traverse interpolation is to be used.
19503#0	0/1	When using smooth velocity control as velocity control by acceleration, set 1. (Note 2)
8451#4	0/1	Set this parameter to 1 if cutting load-dependent override is to be used. (This parameter is used if the mechanical rigidity of the Z-axis is low.) (Note 2)
8451#7	0/1	Set this parameter to 1 if the function for ignoring the velocity command is to be used. (Note 2)
19515#1	0/1	When using the slant type for override by cutting load, set 1. (Note 2)
19516	80	Region 1 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 or bit 1 of parameter No. 19515 = 0) (Note 2)
8456	80	Region 2 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)
8457	70	Region 3 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)
8458	60	Region 4 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0) (Note 2)

NOTE

1 Performing bell-shaped acc./dec. after cutting feed interpolation requires the bell-shaped acc./dec. after cutting feed interpolation option (FS0*i*-MD). With the FS0*i*-TD, bell-shaped acc./dec. after cutting feed interpolation cannot be used.

2 These functions can be used only with AI contour control II.

C.1.4 Series 16*i*/18*i*/21*i*/0*i*/0*i*Mate-MB, 0*i*/0*i* Mate-MC/20*i*-FB

[Functions related to high-speed and high precision operations]

High-speed high precision functions	Advanced preview control (APC)	AI advanced preview control (AI－APC)	AI contour control (AICC)	AI nano contour control (AI nano CC)	High precision contour control (HPCC)	AI high precision contour control (AI-HPCC)	AI nano high precision contour control (AI nano HPCC)
Series 0*i* Mate -MC	×	○	×	×	×	×	×
Series 0*i*-MC	×	○	○	×	×	×	×
Series20*i*-FB	○	×	○	×	×	×	×
Series 0*i* Mate -MB	×	○	×	×	×	×	×
Series 0*i*-MB	×	○	○	×	×	×	×
Series21*i*-MB	○	○	○	○	×	×	×
Series18*i*-MB	○	×	○	○	○	○	○
Series16*i*-MB	○	×	○	○	○	○	○
Acc./dec. before interpolation							
Type	Linear	Linear/ Bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped	Linear/ Bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped
Time constant setting for individual axes	×	×	×	×	×	○	○
Velocity control							
Automatic corner deceleration	○	○	○	○	○	○	○
Arc radius-based velocity control	○	○	○	○	○	○	○
Acceleration-based velocity control	×	○	○	○	○	○	○
Cutting load-based velocity control	×	×	×	×	○	○	○
Jerk control (Note 1)	×	×	Δ	Δ	×	○	○
Optimum torque acc./dec.	×	×	×	×	×	○	○
Other functions							
Nano interpolation	×	×	×	○	×	×	○
5-axis machining functions	×	×	×	×	×	○	○
Smooth interpolation	×	×	×	×	○	○	○
NURBS	×	×	×	×	○	○	○
Nano smoothing	×	×	×	×	×	○	○
Additional hardware	None	None	None	None	RISC board is necessary.		

NOTE

1 Jerk control can be used in the Series 16*i*-MB/18*i*-MB.

[Parameters]

Described below are the parameters that must be specified for individual high-speed and high precision cutting machines separately.
Use the standard setting values included in the parameter tables as reference data for initialization. If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.

- Standard settings (precision priority)
  When there is vibration or significant impact, or when machining is to be performed more precisely, make settings based on the standard settings.
- Cutting time-priority setting
  To reduce machining time, make settings for speed priority I then for speed priority II in stages. The settings for speed priority II can reduce much more machining time than the settings for speed priority I.

NOTE
1. Performing bell-shaped acc./dec. after interpolation requires the look-ahead bell-shaped acc./dec. after interpolation option.
2. Performing linear-shaped acc./dec. after cutting feed interpolation requires the linear-shaped acc./dec. after cutting feed interpolation option.
3. To perform bell-shaped acc./dec. after cutting feed interpolation, the option for bell-shaped acc./dec. after cutting feed interpolation is required.
4. Performing bell-shaped acc./dec. in rapid-traverse requires the bell-shaped acc./dec. in rapid-traverse option.

(1) Advanced preview control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1730	3060	5150	7275	Feedrate upper limit (mm/min) for arc radius R
1731	5000	5000	5000	Arc radius R (1 μm) for arc radius-based feedrate upper limit
1732	100	100	100	Arc radius-based feedrate clamp lower speed limit (mm/min)
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
1770	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
1771	240	80	40	Time (msec) allowed before a maximum cutting feedrate during acc./dec. before interpolation is reached
1783	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1784	-	-	-	Speed (mm/min) at occurrence of overtravel alarm To be specified according to the overrun distance at overtravel

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#0	1	The type of linear-shaped acc./dec. before interpolation is B.

Parameter No.	Standard setting value	Description
1602#4	1	Automatic deceleration at corners is under speed difference-dependent control
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (to be specified when FAD is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (to be specified when FAD is not used)
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).
3403#0	1	To be set to the standard setting value.

(2) AI advanced preview control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1730	3060	5150	7275	Feedrate upper limit (mm/min) for arc radius R
1731	5000	5000	5000	Arc radius R (1 μm) for arc radius-based feedrate upper limit
1732	100	100	100	Arc radius-based feedrate clamp lower speed limit (mm/min)
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
1770	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
1771	240	80	40	Time (msec) allowed before a maximum cutting feedrate during acc./dec. before interpolation is reached
1772	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (for constant-time part) (msec)
1783	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1784	-	-	-	Speed (mm/min) at occurrence of overtravel alarm To be specified according to the overrun distance at overtravel
1785	320	112	56	Parameter (msec) for determining an allowable acceleration in determining acceleration-dependent speed. The parameter is to be set with the time allowed before a maximum cutting feedrate (parameter No. 1432) is reached. A maximum cutting feedrate of 10000 mm/min is used as the standard setting value.

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (to be specified when FAD is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (to be specified when FAD is not used)
1603#7	1	Acc./dec. before interpolation is of bell-shaped type. (0: Linear-shaped acc./dec. before interpolation)

Parameter No.	Standard setting value	Description
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).

(3) AI contour control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1730	3060	5150	7275	Feedrate upper limit (mm/min) for arc radius R
1731	5000	5000	5000	Arc radius R (1 μm) for arc radius-based feedrate upper limit
1732	100	100	100	Arc radius-based feedrate clamp lower speed limit (mm/min)
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
1770	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
1771	240	80	40	Time (msec) allowed before a maximum cutting feedrate during acc./dec. before interpolation is reached
1772	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (for constant-time part) (msec)
1783	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1784	-	-	-	Speed (mm/min) at occurrence of overtravel alarm To be specified according to the overrun distance at overtravel
1785	320	112	56	Parameter (msec) for determining an allowable acceleration in determining acceleration-dependent speed. The parameter is to be set with the time allowed before a maximum cutting feedrate (parameter No. 1432) is reached. A maximum cutting feedrate of 10000 mm/min is used as the standard setting value.

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (if bell-shaped acc./dec. before interpolation is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (if linear-shaped acc./dec. before interpolation is used)
1603#7	1	Acc./dec. before interpolation is of bell-shaped type. (0: Linear-shaped acc./dec. before interpolation)
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).
7050#5	1	To be set to the standard setting value.
7050#6	0	To be set to the standard setting value.
7052#0	0/1	To be set to 1 for the PMC and Cs axes.
7055#3	1/0	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.

Parameter No.	Standard setting value	Description
7058	0	To be set to the standard setting value.
7066	mm / inch 10000/3937	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation

(4) AI nano contour control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1730	3060	5150	7275	Feedrate upper limit (mm/min) for arc radius R
1731	5000	5000	5000	Arc radius R (1 μm) for arc radius-based feedrate upper limit
1732	100	100	100	Arc radius-based feedrate clamp lower speed limit (mm/min)
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
1770	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
1771	240	80	40	Time (msec) allowed before a maximum cutting feedrate during acc./dec. before interpolation is reached
1772	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (for constant-time part) (msec)
1783	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1784	-	-	-	Speed (mm/min) at occurrence of overtravel alarm To be specified according to the overrun distance at overtravel
1785	320	112	56	Parameter (msec) for determining an allowable acceleration in determining acceleration-dependent speed. The parameter is to be set with the time allowed before a maximum cutting feedrate (parameter No. 1432) is reached. A maximum cutting feedrate of 10000 mm/min is used as the standard setting value.

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (if bell-shaped acc./dec. before interpolation is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (if linear-shaped acc./dec. before interpolation is used)
1603#7	1	Acc./dec. before interpolation is of bell-shaped type. (0: Linear-shaped acc./dec. before interpolation)
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).
7052#0	0/1	To be set to 1 for the PMC and Cs axes.
7053#0	0	AI nano contour control (1: AI contour control is enabled.)
7055#3	1/0	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.

Parameter No.	Standard setting value	Description
7058	0	To be set to the standard setting value.
7066	mm / inch 10000/3937	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation

(5) High-precision contour control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
8400	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
8401	240	80	40	Time (msec) allowed before a maximum cutting feedrate during acc./dec. before interpolation is reached
8410	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
8416	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (for constant-time part) (msec)
8470	320	112	56	Parameter (msec) for determining an allowable acceleration in determining acceleration-dependent speed. The parameter is to be set with the time allowed before a maximum cutting feedrate (parameter No. 1432) is reached. A maximum cutting feedrate of 10000 mm/min is used as the standard setting value.

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (if bell-shaped acc./dec. before interpolation is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (if linear-shaped acc./dec. before interpolation is used)
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).
7510	-	Largest of controlled-axis numbers for which high precision contour control is performed
8402#7,#1, 1603#3	1,1, 1	Acc./dec. before interpolation is of bell-shaped type. (with the acceleration change fixed)
8402#4	0	To be set to the standard setting value.
8402#5	1	To be set to the standard setting value.
8403#7,#1, 8404#1,#0	1,1 1,1	No alarm is raised on an M, S, T, B, or rapid traverse command. Rapid traverse is processed on the RISC side.
8420	180	Number of blocks to be looked ahead (0: 120 blocks)
8451#0	1	To be set to the standard setting value.
8451#4	0/1	Set this parameter to 1 if cutting load-dependent override is to be used. (This parameter is used if the mechanical rigidity of the Z-axis is low.)

Parameter No.	Standard setting value	Description
8456	80	Region 2 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8457	70	Region 3 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8458	60	Region 4 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8459#0	0	To be set to the standard setting value.
8459#1	1	To be set to the standard setting value.
8475#2	1	Automatic deceleration at corners is enabled.
8475#3	1	Acceleration-dependent determination of speed during arc interpolation is enabled.
8480#4	0/1	To be set to 1 if the software series on the RISC side is B435. Otherwise, to be reset to 0.
8480#5	0	To be set to the standard setting value.
8480#6	0	To be set to the standard setting value.
8485#0	1/0	Scaling/coordinate system rotation in high precision contour control mode is enabled/disabled. (An option is necessary.)
8485#1	1/0	A canned cycle in high precision contour control mode is enabled/disabled. (An option is necessary.)
8485#2	1/0	A helical interpolation in high precision contour control mode is enabled/disabled. (An option is necessary.)
8485#4	1/0	A involute interpolation in high precision contour control mode is enabled/disabled. (An option is necessary.)
8485#5	1/0	A smooth interpolation in high precision contour control mode is enabled/disabled. (An option is necessary.)

(6) AI high precision contour control, AI nano high precision contour control

- **Parameters that need tuning based on the machine type**

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1432	-	-	-	Maximum cutting feedrate (mm/min) for individual axes
1620	-	-	-	Time constant (msec) for linear-shaped acc./dec. in rapid-traverse for individual axes
1621	-	-	-	Time constant T2 (msec) for bell-shaped acc./dec. in rapid-traverse for individual axes
1768	24	16	16	Time constant (msec) for acc./dec. after cutting feed interpolation
8400	10000	10000	10000	Maximum cutting feedrate (mm/min) during acc./dec. before interpolation
19510	240	80	40	Time (msec) allowed before a maximum cutting feedrate is reached for an individual axis during acc./dec. before interpolation. If this parameter is 0, a setting in parameter No. 8401 is used.
8410	400	500	1000	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
8416	64	48	32	Time constant of bell-shaped acc./dec. before interpolation (for constant-time part) (msec)

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
8470	320	112	56	Parameter (msec) for determining an allowable acceleration in determining acceleration-dependent speed. The parameter is to be set with the time allowed before a maximum cutting feedrate (parameter No. 1432) is reached. A maximum cutting feedrate of 10000 mm/min is used as the standard setting value.

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1602#6,#3	#6,#3	
	1,0	Acc./dec. after interpolation is of a linear type (if bell-shaped acc./dec. before interpolation is used)
	1,1	Acc./dec. after interpolation is of a bell-shaped type (if linear-shaped acc./dec. before interpolation is used)
1802#7	0/1	To be set to 1 if the CMR setting is 2 or greater (parameter No. 1820 setting is 4 or greater).
7510	-	Largest of controlled-axis numbers for which high precision contour control is performed
8402#7,#1,	1,1,	Acc./dec. before interpolation is of bell-shaped type. (with the acceleration change fixed)
8403#1	1	No alarm is raised on an M, S, T, B, or rapid traverse command.
8451#4	0/1	Set this parameter to 1 if cutting load-dependent override is to be used. (This parameter is used if the mechanical rigidity of the Z-axis is low.)
19516	80	Region 1 override (%) for the cutting load-based deceleration function (needn’t be specified if bit 4 of parameter No. 8451 = 0)
8456	80	Region 2 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8457	70	Region 3 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8458	60	Region 4 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 8451 = 0)
8480#4	0	To be set to the standard setting value.
8480#5	0	To be set to the standard setting value.
8480#6	0	To be set to the standard setting value.
19501#6	1/0	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.
19504#0	1	Bell-shaped rapid traverse acc./dec. is used.
19520	mm / inch 10000/3937	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation
19600#0	0/1	Scaling is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)
19600#1	0/1	Programmable mirror image is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)
19600#2	0/1	Rotary dynamic fixture offset is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)
19600#3	0/1	Coordinate rotation is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)
19600#4	0/1	Three-dimensional coordinate conversion is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)
19600#5	0/1	Cutter compensation C is performed on the CNC side or, as 5-axis control mode, on the RISC side. (An option is necessary.)

C.1.5 Series 15*i*-MB

[Functions related to high-speed and high precision operations]

High-speed high precision functions		Look-ahead acc./dec. before interpolation	Fine HPCC
Series 15*i*-MB		○	○
Acc./dec. before interpolation			
	Type	Linear/ Bell-shaped	Linear/ Bell-shaped/ Smooth bell-shaped
	Time constant setting for individual axes	○	○
Velocity control			
	Automatic corner deceleration	○	○
	Arc radius-based velocity control	○	○
	Acceleration-based velocity control	×	○
	Cutting load-based velocity control	×	○
	Jerk control	×	○
	Optimum torque acc./dec.	○	○
Other functions			
	Nano interpolation	○	○
	5-axis machining functions	○	○
	Smooth interpolation	○	○
	NURBS	○	○
	Nano smoothing	○	○
Additional hardware		None	None

[Parameters]

Use the standard setting values included in the parameter tables as reference data for initialization. If a parameter needs tuning based on the machine type, determine a final setting for the parameter according to the characteristic of the machine and how to use it.

- Standard settings (precision priority)
  When there is vibration or significant impact, or when machining is to be performed more precisely, make settings based on the standard settings.
- Cutting time-priority setting
  To reduce machining time, make settings for speed priority I then for speed priority II in stages. The settings for speed priority II can reduce much more machining time than the settings for speed priority I.

• Parameters that need tuning based on the machine type

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1478	400.0	500.0	1000.0	Allowable speed difference (mm/min) in acceleration-dependent on speed difference at corners
1635	24	16	16	Time constant (msec) for acc./dec. after interpolation
1656	64	48	32	Time constant (msec) for bell-shaped acc./dec. before interpolation (portion with the time fixed)
1660	700.0	2000.0	4000.0	Acceleration of linear-/bell-shaped acc./dec. before interpolation (portion with the acceleration fixed) (Acceleration is specified in mm/sec^2 for individual axes.)
1663	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration (HPCC mode) (Acceleration is specified in mm/sec^2 for individual axes.)

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
1665	525.0	1500.0	3000.0	Permissible acceleration in deceleration by acceleration in circular interpolation (non-HPCC mode) (Acceleration is specified in mm/sec^2 for individual axes.)

- **Parameters that do not usually need tuning so often and can be left at fixed values**

Parameter No.	Standard setting value	Description
1483	100.0	Lower speed limit to acceleration-dependent deceleration (HPCC mode) (mm/min)
1491	100.0	Lower speed limit to deceleration acceleration-dependent (non-HPCC mode) (mm/min)
1517#6	0	Speed difference- or acceleration-dependent deceleration type 0: Compatible with the 15B (by making the most of allowable speed difference and acceleration for each axis) 1: Fixed speed regardless of the direction of movement as long as the same contour is involved.
1600#4	0	0: Linear- or bell-shaped acc./dec. after interpolation enabled (Note 1) 1: Exponential acc./dec. after interpolation enabled
1603#6	1/0	To be set to 1 if a function of changing the time constant for bell-shaped acc./dec. before interpolation is to be used.
1473	mm / inch 10000.0/3937.0	Reference speed (mm/min / inch/min) for a function of changing the time constant for bell-shaped acc./dec. before interpolation
2401#6	0	Setting this parameter to 1 enables look-ahead acc./dec. before interpolation and multibuffer when the power is switched on and in the cleared state. Fine HPCC is also enabled if available. If it is reset to 0, it is turned on with the G05.1Q1 command.
7565#7	0	Setting this parameter to 1 causes a specified speed to be ignored and assumes that a speed set in parameter No. 7567 is specified
7567	0	Specified clamp value in the fine HPCC mode (mm/min (input unit)) If the parameter setting is 0, no clamp takes place except for the maximum cutting speed specified in parameter No. 1422.
7565#4	0/1	Set this parameter to 1 if the cutting load-based deceleration function is to be enabled. (This parameter is used if the mechanical rigidity of the Z-axis is low.)
7697#1	0/1	When using the slant type for override by cutting load, set 1. (Note 2)
7698	80	Override of area 1 in deceleration by cutting load (This setting is unnecessary if bit 4 of parameter No. 7565 is set to 0 or bit 1 of parameter No. 7697 is set to 0.) (%) (Note 2)
7591	80	Region 2 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 7565 = 0)
7592	70	Region 3 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 7565 = 0)
7593	60	Region 4 override (%) for the cutting load-based deceleration function (needn't be specified if bit 4 of parameter No. 7565 = 0)
8495#0	0/1	When using smooth velocity control as velocity control by acceleration, set 1. (Note 2)

NOTE

1 To perform bell-shaped acc./dec. after cutting feed interpolation, the option for bell-shaped acc./dec. after cutting feed interpolation is required.

2 Only fine HPCC can be used.

C.2 SERVO PARAMETERS RELATED TO HIGH-SPEED AND HIGH PRECISION OPERATIONS

Described below are the servo parameters that need setting and tuning for high-speed and high precision operations.
To specify parameters, follow this procedure.

1. First specify one of items (1) to (3) about fixed parameters that are dependent on the CNC model and mode to be used.
2. Specify item (4) about parameters to be tuned in common to all CNC models and modes. (See Chapters 3 and 4 of this parameter manual for explanations about how to tune the parameters and detailed descriptions of the related functions.)
3. If you want to use SERVO HRV control, specify item (5).

(1) When HRV2 and fine ACC./Dec. is used (Series 16*i*/18*i*/21*i*/20*i*/0*i*-B/C)

- Using advanced preview control in the Series 16*i*/18*i*/21*i*
- Using AI advanced preview control in the Series 21*i*/20*i*/0*i*-B/C (servo software Series 90B0)

For the above cases, make the following settings for using HRV2 control and fine acc./dec.

- Parameters that do not usually need tuning so often and can be left at fixed values

Parameter No. FS16*i*, etc.	Standard setting value	Description
2003#3	1	Enables PI control function
2003#5	1	Enables backlash acceleration
2004	0X000011 (Note 1)	HRV2 current control
2005#1	1	Enables feed-forward
2006#4	1	Uses the latest feedback data for velocity feedback.
2007#6	1	Enables FAD (Fine acc./dec.)
2015#6	1	Enables stage-2 backlash acceleration.
2016#3	1	Enables variable proportional gain in the stop state
2017#7	1	Enables velocity loop high cycle management function
2018#2	1	Changes the second override format for stage-2 backlash acceleration.
2040	Standard parameter for HRV2 (Note 2)	Current integral gain
2041	Standard parameter for HRV2 (Note 2)	Current proportional gain
2092	10000	Advanced preview (position) feed-forward coefficient
2119	2 (detection unit 1 μm) 20 (detection unit 0.1μm)	For variable proportional gain function in the stop state : judgment level for stop state (specified in detection units)
2146	50	Stage-2 backlash acceleration end timer
2202#1	1	Cutting/rapid traverse velocity loop gain variable
2209#2	1	Enables FAD of linear type.

NOTE

1. Keep the bit indicated with X (bit 6) at the standard setting.
2. For motors not supporting the HRV2 standard parameters, change the parameter settings to the settings for HRV2 according to the instructions described in Section G.4.

- Parameters whose settings must be changed according to the size of the machine but needn't tuning once set up

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
2109	24	16	16	FAD time constant

(2) When HRV2 is used, but fine acc./dec. is not (Series 30*i*/31*i*/32*i*/15*i*/16*i*/18*i*/21*i*/0*i*)

When using AI contour control I, AI contour control II, look-ahead acc./dec. before interpolation, Fine HPCC, AI nano high precision contour control, AI high precision contour control, AI nano contour control, AI contour control, or high precision contour control, make the following settings.

- Parameters that do not usually need tuning so often and can be left at fixed values

Parameter No. FS30*i*,16*i*, etc. FS15*i*	Standard setting value	Description
2003#3 1808#3	1	Enables PI control function
2003#5 1808#5	1	Enables backlash acceleration
2004 1809	0X000011 (Note 1)	HRV2 current control
2005#1 1883#1	1	Enables feed-forward
2006#4 1884#4	1	Uses the latest feedback data for velocity feedback.
2015#6 1957#6	1	Enables two-stage backlash acceleration
2016#3 1958#3	1	Enables variable proportional gain in the stop state
2017#7 1959#7	1	Enables velocity loop high cycle management function
2018#2 1960#2	1	Changes the second override format for stage-2 backlash acceleration.
2040 1852	Standard parameter for HRV2 (Note 2)	Current integral gain
2041 1853	Standard parameter for HRV2 (Note 2)	Current proportional gain
2092 1985	10000	Advanced preview (position) feed-forward coefficient
2119 1730	2 (detection unit 1 μm) 20 (detection unit 0.1 μm)	For variable proportional gain function in the stop state : judgment level for stop state (specified in detection units)
2146 1769	50	Stage-2 backlash acceleration end timer
2202#1 1742#1	1	Cutting/rapid traverse velocity loop gain variable

NOTE

1. Keep the bit indicated with X (bit 6) at the standard setting.
2. For motors not supporting the HRV2 standard parameters, change the parameter settings to the settings for HRV2 according to the instructions described in Section G.4.

(3) When using HRV1 and FAD (Series 21*i*/0*i*-B/C)

To use AI advanced preview control in the Series 21*i*/0*i*-B/C (servo software Series 9096), make the following settings for using HRV1 control and fine acc./dec.

- Parameters that do not usually need tuning so often and can be left at fixed values

Parameter No. FS21*i*	Standard setting value	Description
2003#3	1	Enables PI control function
2003#5	1	Enables backlash acceleration
2004	Standard parameter for HRV1	HRV1 current control
2005#1	1	Enables feed-forward
2006#4	1	Uses the latest feedback data for velocity feedback.
2007#6	1	Enables FAD (Fine acc./dec.)
2015#6	1	Enables two-stage backlash acceleration
2016#3	1	Enables variable proportional gain in the stop state
2017#7	1	Enables velocity loop high cycle management function
2018#2	1	Changes the second override format for stage-2 backlash acceleration.
2040	Standard parameter for HRV1	Current integral gain
2041	Standard parameter for HRV1	Current proportional gain
2092	10000	Advanced preview (position) feed-forward coefficient
2119	2 (detection unit 1 μm) 20 (detection unit 0.1μm)	For variable proportional gain function in the stop state : judgment level for stop state (specified in detection units)
2146	50	Stage-2 backlash acceleration end timer
2202#1	1	Cutting/rapid traverse velocity loop gain variable
2209#2	1	Enables FAD of linear type.

- Parameters whose settings must be changed according to the size of the machine but needn't tuning once set up

Parameter No.	Standard setting value			Description
	Standard setting	Speed priority I	Speed priority II	
2109	24	16	16	FAD time constant

(4) Parameters common to all CNC models (requiring tuning)

- Parameters requiring tuning for finding optimum values

Parameter No. FS30*i* ,16*i*, etc. FS15*i*	Setting at tuning start	Description	Items to be referenced in tuning
2021 1875	300	Load inertia ratio (velocity gain) * When the cutting/rapid velocity gain switching function is used, this parameter is applied to rapid traverse.	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit. → See 4.3.1(6)
2107 1700	150	Cutting load inertia ratio override (in % units) * When the cutting/rapid velocity gain switching function is used, the gain magnified by this parameter setting is applied to cutting.	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit. → See 4.3.1(6) and 5.2.
1825	Standard: 3000 Speed priority I: 5000 Speed priority II: 10000	Position gain	After determining the velocity loop gain, find the upper limit of the range in which hunting (low frequency vibration) does not occur. → See 4.3.1(7).
2069 1962	Standard: 50 When nano interpolation is used, see Note 2. 200	Velocity feed-forward coefficient	Make adjustment while observing the shape of rounded corners. → See 4.3.1(9).
2047 1859	Standard parameter	Observer parameter	Make adjustment while observing estimated disturbance value on the SERVO GUIDE. → See 5.9.1.
2087 1980	0	Torque offset	Make adjustment while measuring positive and negative torque commands at a constant low feedrate.
2048 1860	30	Stage-1 acceleration amount for two-stage backlash acceleration	Make adjustment while observing the quadrant protrusion size. → See 5.5.5.
2039 1724	100	2nd-stage acceleration amount	Make adjustment while observing the quadrant protrusion size.
2082 1975	10	Stage-2 start distance (detection unit)	Make adjustment while observing the quadrant protrusion size.
2089 1982	50	Stage-2 end distance (set with a ratio to the start distance specified in 10% units)	Make adjustment while observing the quadrant protrusion size.
2114 1725	10	Stage-2 override	Make adjustment while observing the quadrant protrusion size.

NOTE

1 There is the following relationship between the load inertia ratio and velocity loop gain (%).
Velocity loop gain (%) = (1 + load inertia ratio/256) × 100

NOTE

2 The phrase "using nano interpolation" means using AI contour control I, AI contour control II, Fine HPCC, look-ahead acc./dec. before interpolation, AI nano high precision contour control, or AI nano contour control.

(5) Parameters common to all CNC models (parameters needed to use HRV3)

- Parameters that do not usually need tuning so often and can be left at fixed values

Parameter No. FS30*i*, 16*i*, etc. FS15*i*	Standard setting value	Description
2004 1809	0X000011 (Note 1)	HRV2 current control (in a mode other than high-speed HRV control)
2013#0 1707#0	1	In the G05.4Q1 command, high-speed HRV control (HRV3 current control)
2202#1 1742#1	1	Cutting/rapid velocity loop gain switching function
2040 1852	Standard parameter for HRV2 (Note 2)	Current integral gain
2041 1853	Standard parameter for HRV2 (Note 2)	Current proportional gain
2334 2747	150	Current loop gain magnification for high-speed HRV current control

NOTE

1 Keep the bit indicated with X (bit 6) at the standard setting.

2 For motors not supporting the HRV2 standard parameters, change the parameter settings to the settings for HRV2 according to the instructions described in Section G.4.

- Parameters that need tuning

Parameter No. FS30*i*, 16*i*, etc. FS15*i*	Setting	Description	Items to be referenced in tuning
2107 1700	150	Cutting load inertia ratio override (in % units)	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit.
2335 2748	200	Cutting load inertia ratio override (in % units) when high-speed HRV current control is in use	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit.

(6) Parameters for Series 30*i*/31*i*-A/B (parameters needed to use HRV4)

- Parameters that do not usually need tuning so often and can be left at fixed values

Parameter No. FS30*i*	Standard setting value	Description
2004	0X000011 (Note 1)	HRV3 current control (in a mode other than high-speed HRV control)
2014#0	1	In the G05.4Q1 command, high-speed HRV control (HRV4 current control)

Parameter No. FS30*i*	Standard setting value	Description
2300#0	1	Extended HRV function
2202#1	1	Cutting/rapid velocity loop gain switching function
2040	Standard parameter for HRV2	Current integral gain
2041	Standard parameter for HRV2	Current proportional gain
2334	150	Current loop gain magnification for high-speed HRV current control

NOTE
1 Keep the bit indicated with X (bit 6) at the standard setting.

- Parameters that need tuning

Parameter No. FS30*i*, etc.	Setting	Description	Items to be referenced in tuning
2107	150	Cutting load inertia ratio override (in % units)	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit.
2335	200	Cutting load inertia ratio override (in % units) when high-speed HRV current control is in use	While checking vibration at stop, abnormal sound during low-speed movement, vibration during high-speed rotation, and so on, find the vibration limit, and set about 70% of the limit.

D VELOCITY LIMIT VALUES IN SERVO SOFTWARE

(1) Overview

The feed axis velocity is subject to the feedrate limits that depend on the internal processing of the system itself and that of the servo software. These velocity limit values on the feed axis are explained below.

NOTE

The permissible speeds listed below do not take detector hardware limitations into account.
- For the maximum permissible speed of a motor, refer to the specifications of the motor.
- For the maximum permissible speed of a detector itself, refer to the specifications of the detector.

(2) Velocity feedback (rotation speed) limit

[Limit values related to rotary motors]

The following limits apply to the rotation speed of motors according to the type of motor speed detector.

Detector type	Resolution	Allowable rotation speed (30*i*A ,0*i*D)	Allowable rotation speed (30*i*B)
α*i* Pulsecoder	2^{20},2^{24}pulse/rev	7500min^{-1}	7500min^{-1}
Heidenhain RCN223F, 723F	2^{23}pulse/rev	937min^{-1} (*1)	7500min^{-1}
Heidenhain RCN727F	2^{27}pulse/rev	937min^{-1} (*1)	7500min^{-1}

[Limit values related to linear motors]

The following limits apply to the feedrate according to the type of linear motor speed detector (linear scale).

Detector type	Resolution	Allowable speed (30*i*A, 0*i*D)	Allowable speed (30*i*B)
Heidenhain LS486 (incremental) with linear motor position detection circuit	20/512 μm/pulse	614m/min	609m/min
Magnescale BS75A (incremental) with linear motor position detection circuit	0.1379/512μm/pulse	4.2m/min(*1)	33m/min
Heidenhain LC193F (absolute)	0.01μm/pulse	157.2m/min	125.8m/min
Heidenhain LC493F (absolute)	0.05μm/pulse	786m/min	609m/min

(*1) The following servo software enables these permissible speeds to be increased to 7500 min^{-1} (rotary motor) or 33 m/min (linear motor) by setting bit 6 of parameter No. 2271 to 1.

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*-A	90E0	P(16) and subsequent editions	
	90E1	01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	P(16) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Position feedback (axis feedrate) limits

The following feedrate limits may be applied according to each of the functions because of a weight on data that is handled in detection units within the servo software.

- When ordinary position control is exercised

Function used		Allowable feedrate			
Hi-speed and high precision function	Feed-forward	Detection unit of 1 μm	Detection unit of 0.1 μm	Detection unit of 0.01 μm	Detection unit of 0.001 μm
None	Not performed/ performed (advanced preview type)	IS-B:999m/min IS-C:100m/min	IS-B:999m/min IS-C:100m/min	IS-D:10m/min →100m/min(*1)	IS-E:1m/min →100m/min(*1)
AI contour control I AI contour control II	Not performed/ performed (advanced preview type)				
Electric gear box	Performed (advanced preview type))	IS-B:240m/min IS-C:100m/min	24m/min →100m/min(*1)	2.4m/min →100m/min(*1)	0.24m/min →100m/min(*1)

- When the spindle control function by a servo motor is used

Function used		Allowable feedrate			
Extension of permissible speed	Upper speed limit increase by a factor of 10	Detection unit of 1/1000 deg	Detection unit of 1/10000 deg	Detection unit of 1/100000 deg	Detection unit of 1/1000000 deg
Performed (No.1013#7=0)	Performed (No.1408#3=0)	IS-B:2777min^{-1} IS-C: 277min^{-1}	IS-B:2777min^{-1} IS-C: 277min^{-1}	IS-D:27min^{-1}	IS-E:2min^{-1}
	Performed (No.1408#3=1)	IS-B:27777min^{-1} IS-C: 2777min^{-1}	IS-B:27777min^{-1} IS-C: 2777min^{-1}	IS-D:277min^{-1}	IS-E:27min^{-1}
Performed (No.1013#7=1) (No.2282#3=1)	Performed (No.1408#3=0)	IS-B:2777min^{-1} IS-C: 277min^{-1}	IS-B:2777min^{-1} IS-C: 277min^{-1}	IS-D:277min^{-1}	IS-E:27min^{-1}
	Performed (No.1408#3=1)	IS-B:27777min^{-1} IS-C: 27777min^{-1}	IS-B:27777min^{-1} IS-C: 2777min^{-1}	IS-D:2777min^{-1}	IS-E:349min^{-1}

* In the table, the values enclosed in a box are the limits due to the internal processing of the servo software. For the limits due to the internal processing of the servo software, if CMR is increased to decrease the detection unit, the permissible feedrate decreases in proportion to the detection unit. (Reducing the detection unit from 0.1 μm to 0.05 μm causes the permissible feedrate to be halved.)

* If a semi-closed system (rotary or linear motor) where a detector with a high resolution is used, using also nano interpolation enables these functions to be used for position control at the highest limit to the detector resolution even if the detection unit is not subdivided.

* If you are using these functions with a larger detection unit because of feedrate limits placed by the detection units stated above, velocity feedback data that can seriously affect velocity loop control is used for control at the highest limit to the detector resolution.

(*1) With the servo software and system software indicated below, the allowable feedrate value applicable when an increment system is selected from IS-D and IS-E is extended. A feedrate of up to 100 m/min can be specified with the increment system IS-C, IS-D, or IS-E by using matching servo software and system software and setting the following parameters:

- Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	J(10) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

- Series and editions of applicable system software

CNC	System software	
	Series	Edition
Series 30*i*-A	G00C,G01C,G02C	27 and subsequent editions
	G004,G014,G024	01 and subsequent editions
Series 31*i*-A5	G12C,G13C	27 and subsequent editions
	G124,G134	01 and subsequent editions
Series 31*i*-A	G103,G113	01 and subsequent editions
	G104,G114	01 and subsequent editions
Series 32*i*-A	G203	01 and subsequent editions (IS-E is not supported.)
	G204	01 and subsequent editions (IS-E is not supported.)
Series 0*i*-MD	D4F1	01 and subsequent editions (IS-D and IS-E are not supported.)
Series 0*i*-TD	D6F1	01 and subsequent editions (IS-D and IS-E are not supported.)
Series 0*i* Mate-MD	D5F1	01 and subsequent editions (IS-D and IS-E are not supported.)
Series 0*i* Mate-TD	D7F1	01 and subsequent editions (IS-D and IS-E are not supported.)

For the Series 30*i*/31*i*/32*i*/35*i*-B and Power Motion *i*-A, all series and editions support this function. (However, for the Series 32*i*-B, IS-E is not supported, and for the Series 35*i*-B and Power Motion *i*-A, IS-D and IS-E are not supported.)

- Parameter setting method
  To extend the feedrate with the increment system IS-C, IS-D, or IS-E, both of parameter No. 1013 and No. 2282 must be set to 1. (The increment systems IS-C, IS-D, or IS-E are optional functions.)

	#7	#6	#5	#4	#3	#2	#1	#0
1013	IESP							

IESP(#7) When the increment system IS-C, IS-D, or IS-E is used, the function that can set a value range wider than the conventionally allowed one for speed and acceleration parameters is:
0: Not used.
1: Used.

With an axis for which this parameter is set, a value range wider than the conventionally allowed one can be set for parameters to be set in speed and acceleration units when the increment system IS-C, IS-D, or IS-E is selected.
Moreover, a movement can be made at a parameter-set speed.
The number of fractional digits displayed on the parameter input screen for an axis with this parameter set is also modified. When IS-C or IS-D is used, the number of fractional digits is reduced by 1 from the conventional number of fractional digits. When IS-E is used, the number of fractional digits is reduced by 2 from the conventional number of fractional digits.

NOTE
When this parameter is set, the power must be turned off before operation is continued.

	#7	#6	#5	#4	#3	#2	#1	#0
2282					ISE64			

ISE64(#3) The speed limit on feed-forward (bit 1 (FEED) of parameter No. 2005 = 1) is:
0: Applied as conventionally done.
1: Extended.
When feed-forward is enabled, the speed limit on an axis for which this parameter is set is extended.

E DETAILS OF HIGH-SPEED AND HIGH-PRECISION ADJUSTMENT

(1) Overview

Appendix E explains in detail the adjustment procedure described in Section 4.3, "ADJUSTING PARAMETERS FOR HIGH-SPEED AND HIGH-PRECISION MACHINING".

Appendix E, "DETAILS OF HIGH-SPEED AND HIGH-PRECISION ADJUSTMENT", consists of the following sections:

(2) Feed-forward coefficient adjustment (using an arc of R10/F4000)

[Purpose of adjustment]

In a conventional position control loop where feed-forward control is not exercised, a velocity command is output based on (positional deviation) × (position loop gain). This means that the machine moves only when there is a difference between the specification of a command and the machine position. When the position gain is 30 [1/s], for example, a feedrate of 10 m/min generates a positional deviation of 5.56 mm. In linear feed, this positional deviation does not cause a figure error. For an arc or corner, however, this positional deviation causes a large figure error.
A function for eliminating such a positional deviation is feed-forward. Feed-forward converts the position command from the CNC to a velocity command for velocity command compensation. Feed-forward can reduce a positional deviation (to almost 0, theoretically). Accordingly, feed-forward can reduce arc and corner figure errors. However, the servo response is improved, so that a shock can occur. To prevent a shock from occurring, acc./dec. before interpolation must be used at the same time.

[Guideline for adjustment value setting]

Theoretically, a feed-forward coefficient of 100% leads to a positional deviation of 0, and eliminates figure errors. Actually, however, there is a delay in velocity loop response. So, a value slightly less than 100% produces a specified figure. Usually, a value between 95% to 99% (settings of 9500 to 9900) is optimum. As the default, use 9800.
First, adjust the feed-forward coefficient while viewing an arc figure. (Set a velocity feed-forward coefficient of 50% before starting adjustment.)

[Actual adjustment]

Create a program as indicated below for circular movement by R10/F4000, and measure the path with SERVO GUIDE SD. G05Q1 and G05Q0 in the program are G codes for starting and ending the AI contour control mode, respectively. For a mode to be used, select the corresponding G codes from Table E (a).

```
G91;
G05Q1;
G17G02I-10.F4000.;
I-10.;
I-10.;
G05Q0;
G04X3.;
M99;
```

Table E (a) Codes for starting and ending each mode

	Start	**End**
FS0*i*-D + Advanced preview control	G08P1	G08P0
FS30*i* + AI contour control I **FS30*i* + AI contour control II** **FS0*i*-D + AI advanced preview control** **FS0*i*-D + AI contour control I** **FS0*i*-D + AI contour control II**	G05.1Q1	G05.1Q0

In Fig. E (a), the feed-forward coefficient is insufficient, resulting in a radius reduction of about 5 μm. In addition, the velocity loop gain is low, so that swells and quadrant protrusions are observed. By adjusting the feed-forward coefficient as shown in Fig. E (b), the arc radius reduction can be reduced to nearly 0.

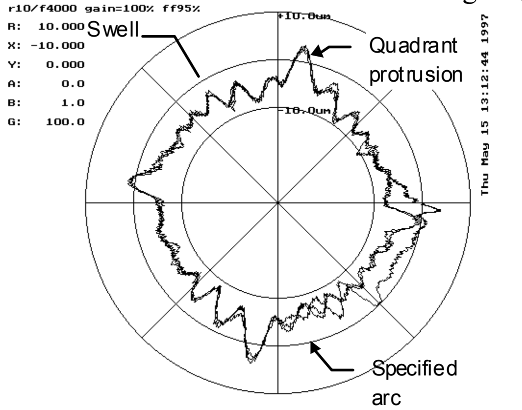


Fig. E (a) Feed-forward adjustment
Velocity loop gain: 100%
Advanced preview feed-forward coefficient: 95%

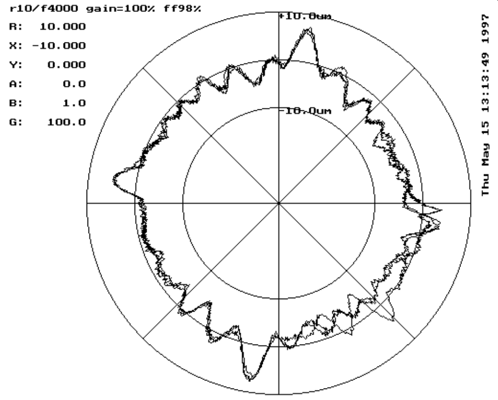


Fig. E (b) Feed-forward adjustment
Velocity loop gain: 100%
<u>Advanced preview feed-forward coefficient: 98%</u>

In the figures above, a low velocity loop gain is used for measurement. By using an increased velocity loop gain, swells and quadrant protrusions can be reduced (Fig. E (c)). Increase the velocity loop gain to 70% to 80% of the limit. Adjust the feed-forward coefficient finely, and apply quadrant protrusion compensation (backlash acc./dec.) to reduce the quadrant protrusions and improve the roundness (Fig. E (d)).

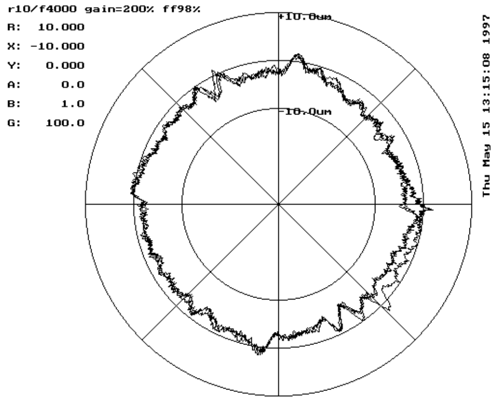


Fig. E (c) Effect of velocity loop gain
Velocity loop gain: 200%
Advanced preview feed-forward coefficient: 98%

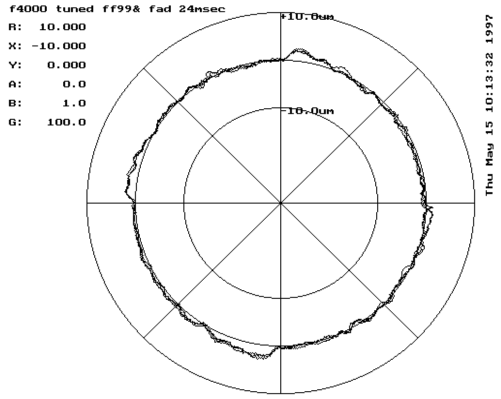


Fig. E (d) Effect of velocity loop gain
Velocity loop gain: 300%
Advanced preview feed-forward coefficient: 99%

(3) Velocity feed-forward coefficient adjustment (example using a square figure with 1/4 arcs)

[Purpose of adjustment]

Feed-forward coefficient adjustment can reduce positional deviation and figure errors. If the response of the velocity loop for executing a velocity command is low, velocity control cannot be exercised as specified where the specified acceleration varies to a large extent, thus causing a figure error. The response of the velocity loop can be improved by increasing the velocity loop gain and by adjusting the velocity feed-forward coefficient.

Velocity feed-forward multiplies a specified rate of variation (acceleration) by an appropriate coefficient for torque command compensation. In the servo velocity loop (PI control), a compensation torque occurs only when a difference (velocity deviation) between a specified velocity and actual velocity actually occurs. On the other hand, velocity feed-forward performs torque command compensation according to an acceleration value specified beforehand. So, a figure error that occurs due to a velocity loop delay can be reduced.

[Guideline for adjustment value setting]

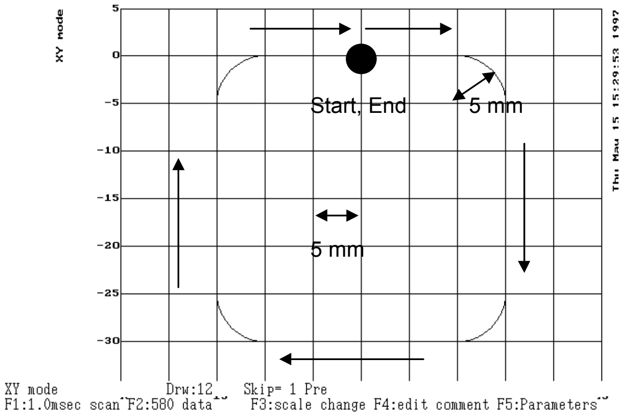
The formula below is applicable. In actual adjustment, however, make an adjustment starting with a velocity feed-forward coefficient of 100.

(Velocity feed-forward coefficient) =

100 × (Motor rotor inertia + load inertia) / Motor rotor inertia

[Actual adjustment]

Make a velocity feed-forward coefficient adjustment by using a square figure with four 1/4 arcs of a 5-mm radius. In this adjustment, disable the velocity clamp function based on an arc radius. (Disable the function, or in the example below, ensure that a velocity equal to or greater than F4000 can be specified.)




```
G91;
G08P1;
G01X10.F4000;
G02X5.Y-5.R5.;
G01Y-20.;
G02X-5.Y-5.R5.;
G01X-20.;
G02X-5.Y5.R5.;
G01Y20.;
G02X5.Y5.R5.;
G01X10.;
G08P0;
G04X3.;
M99;
```

Fig. E (e) Programmed figure

When the actual path is measured in a mode for displaying a reference path, the actual path and reference path are plotted at the same time as shown below:

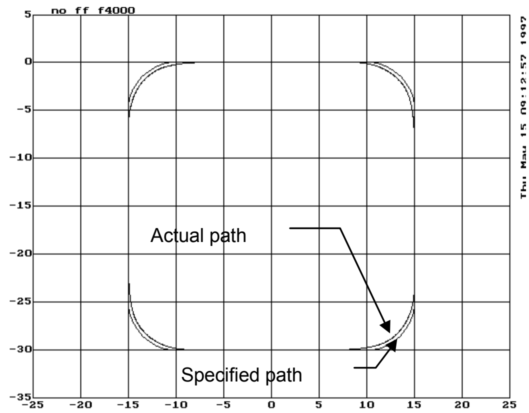


Fig. H (f) Specified path and actual path

When advanced preview feed-forward is disabled, a figure error of hundreds μm occurs as shown in Fig. E (f), and therefore can be viewed even in the XY mode. However, if advanced preview feed-forward is enabled for figure error reduction, it is difficult to evaluate a figure error correctly unless the error is enlarged.
In such a case, use the figure comparison mode (contour mode) for enlarging errors only for display (Ctrl O).
In addition, set an error display magnification with F3 (scale change). For Fig. E (g), a display magnification of 100 is set.

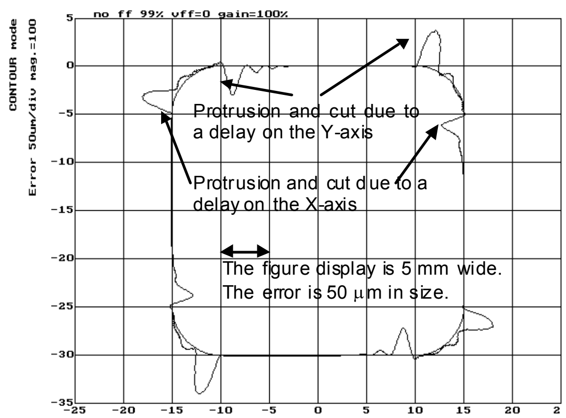


Fig. E (g) Velocity feed-forward adjustment
Velocity feed-forward: 0%

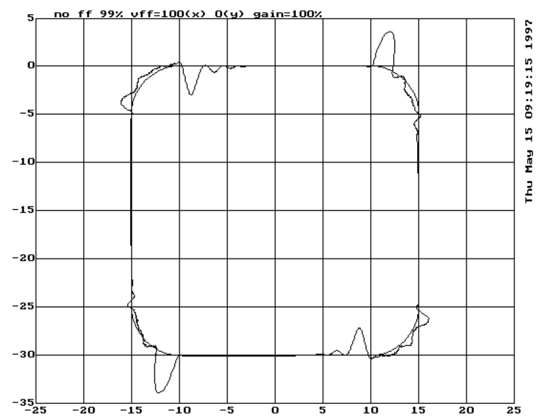


Fig. E (h) Velocity feed-forward adjustment
Velocity feed-forward: X100%

In Fig. E (g), the velocity feed-forward coefficient is not specified, so that the movement along each axis delays where acceleration changes to a large extent. As the result, a protrusion occurs at the joint of a straight line with an arc, and a cut occurs at the joint of an arc with a straight line. In Fig. E (h), a velocity feed-forward coefficient is set for the X-axis only. The response of the X-axis has improved, so that a figure improvement can be seen in the areas where acceleration changes to a large extent along the X-axis.

In Fig. E (i), excessively large velocity feed-forward coefficients are specified, so that the protrusions shown in Fig. E (g) have changed to cuts, and the cuts have changed to protrusions. This means that optimum velocity feed-forward coefficients exist and they are less than the values of Fig. E (i). Fig. E (j) shows the result of adjustment to the optimum values. Fig. E (k) enlarges the errors only for display.

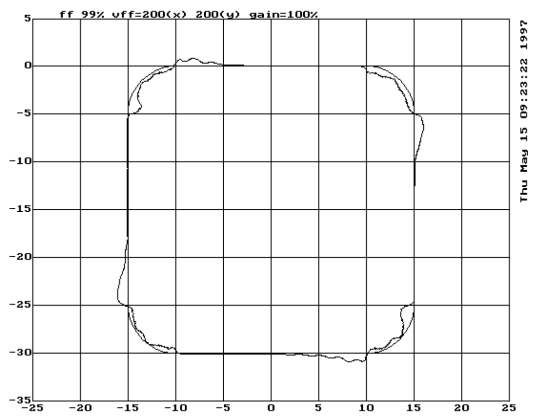


Fig. E (i) Velocity feed-forward adjustment
Velocity feed-forward: X200%, Y200%

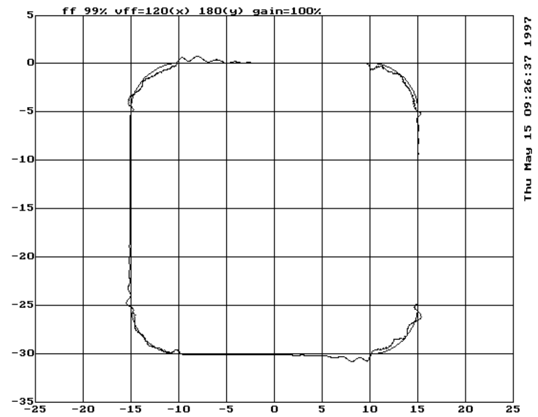


Fig. E (j) Velocity feed-forward adjustment
Velocity feed-forward: X120%, Y180%

When the enlarged range is viewed, it is seen that the machine is vibrating in the arc areas. This vibration is caused by a low velocity loop gain. To reduce this vibration, two methods are available. One method increases the velocity loop gain. (This method cannot be used when the velocity loop gain has already been increased to the oscillation limit.) The other method decreases the feedrate in the arc areas with the arc radius based feedrate clamp function as described in Item E (4).

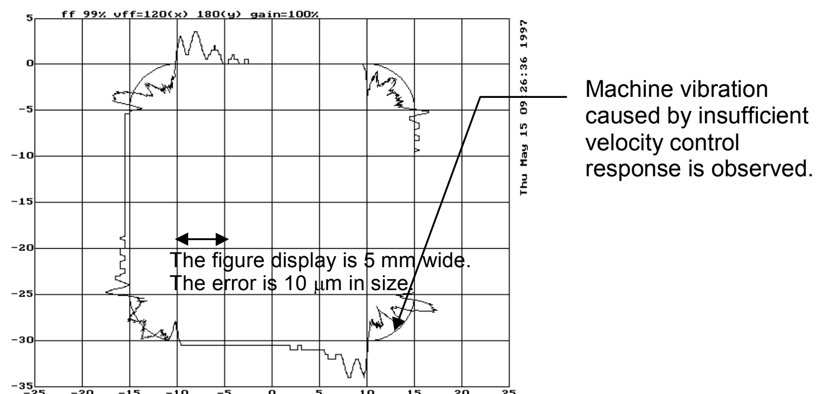


Fig. E (k) Velocity feed-forward adjustment

Swells in the arc areas can be reduced by increasing the velocity loop gain (Fig. E (l)). However, figure errors that occur at the joints of straight lines and arcs cannot be fully eliminated. Swells can be additionally reduced by fine adjustment of the velocity feed-forward coefficient or by using the arc radius based feedrate clamp function described in Item E (4).

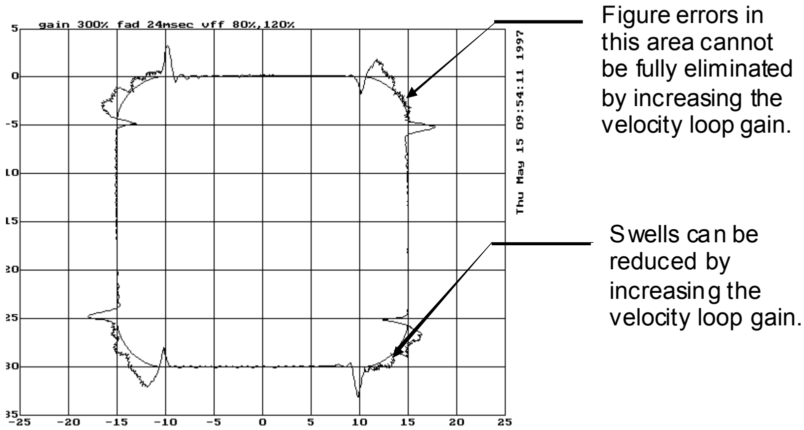


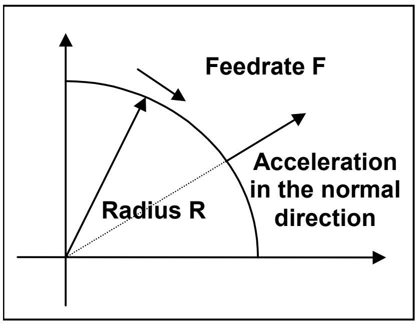
Fig. E (I) Velocity feed-forward adjustment
<u>Velocity loop gain: 300%</u>
Velocity feed-forward: X120%, Y180%

(4) Adjustment of the parameters for arc radius based feedrate clamping

[Purpose of adjustment]

As mentioned above, velocity feed-forward coefficient adjustment can improve a velocity loop response delay, thus reducing figure errors in areas where specified acceleration changes to a large extent. However, velocity feed-forward coefficient adjustment alone cannot fully eliminate figure errors. Moreover, if the rigidity of a machine itself is low, the machine may vibrate due to a change in acceleration.

To reduce variation in specified acceleration in areas where acceleration changes to a large extent, the specified feedrate in the tangent direction is reduced. In part machining (advanced preview control), the arc radius based feedrate clamp function performs this feedrate reduction. By adjusting the parameter of this function, an acceleration value in the normal direction allowable with a machine can be found. As detailed below, such an acceleration value can be used as a guideline for setting the parameter for feedrate reduction by acceleration in high-precision contour control (small successive blocks).



In the above figure, let R be the radius of the arc, and F be the feedrate. Then, the acceleration in the normal direction is F^2/R. The arc radius based feedrate clamp function specifies R and F as its parameters to ensure that the acceleration in the normal direction at a specified arc does not exceed the specified value.

For example, suppose that when R = 5 mm and F = 4000 mm/min are specified as the parameters of the arc radius based feedrate clamp function, the acceleration in the normal direction at the arc is:

$F^2/R = (4000/60)^2/5 = 889\ \text{mm/sec}^2$

When using the high-precision contour control function, set about the same value as this acceleration as the parameter for feedrate reduction function based on acceleration in small blocks. In the example above, if a cutting feedrate of F4000 (mm/min) is set, the time required to reach this feedrate is calculated as follows:

$4000/60/889 \times 1000 = 75\ \text{msec}$

When the feedrate at an arc is reduced using the arc radius based feedrate clamp function, figure precision improves. However, a longer machining time is required as a side effect. Fig. E (m) shows a tangent feedrate and processing time when the arc radius based feedrate clamp function is not used with the adjustment program used in (5) and later. Fig. E (m) indicates that the tangent feedrate remains to be F4000. On the other hand, when feedrate reduction to F3000 at R5 mm is specified with the arc radius based feedrate clamp function, the tangent feedrate is reduced to F3000 at corners as shown in Fig. E (n), but the machining time has increased by 200 msec.

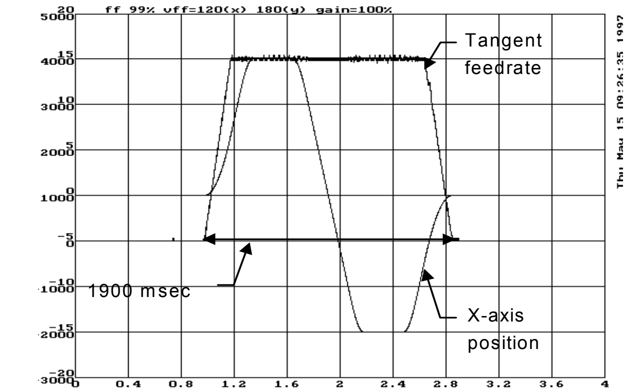


Fig. E (m) When the arc radius based feedrate clamp function is not used

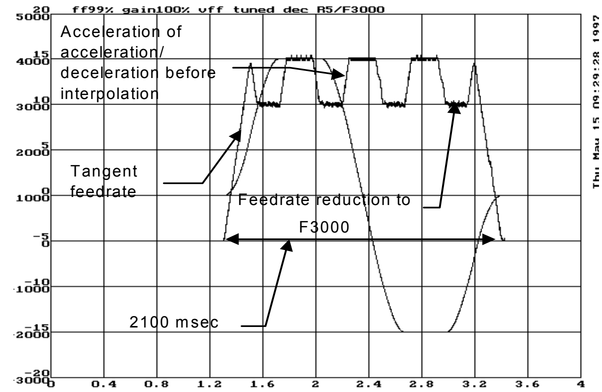


Fig. E (n) When the arc radius based feedrate clamp function is used

[Guideline for adjustment value setting]

Empirically, the values below are adequate. For the parameter numbers, refer to the parameter manual of each CNC.

Standard: F3060 for R5 (527 mm/sec^2)

Speed priority I: F5150 for R5 (1473 mm/sec^2)

Speed priority II: F7275 for R5 (2940 mm/sec^2)

[Actual adjustment]

Fig. E (o) shows the results of setting R5 mm and F3000 with the arc radius based feedrate clamp function for Fig. E (k). Fig. E (o) indicates that the figure errors at the entries and exits of the arc areas have been reduced.

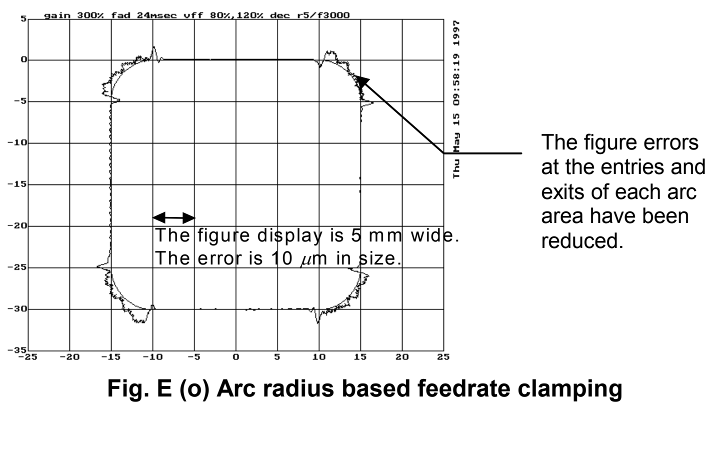


Fig. E (o) Arc radius based feedrate clamping

(5) Adjustment of an allowable feedrate difference of the feedrate difference based corner deceleration function

[Purpose of adjustment]

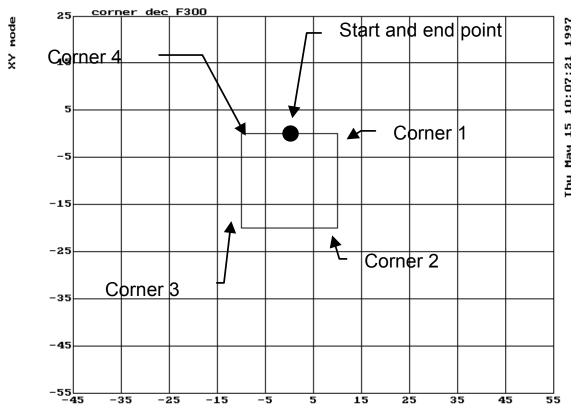
In the program shown in Fig. E (p), the feedrate along each axis changes to a great extent at each block joint. With a high-precision high-speed system, the CNC reads programmed figures beforehand. If the feedrate along each axis changes at a block joint, such a system can decrease the feedrate by a parameter-specified allowable feedrate difference to reduce a shock and figure error at the block joint. Acc./dec. is performed based on the time constant for acc./dec. before interpolation. A more reduced corner feedrate makes a figure error improvement to a greater extent, but requires a longer machining time. Set a reduced corner feedrate to a highest possible value as long as an allowable figure error is obtained.

[Guideline for setting]

For the parameter number, refer to the parameter manual of each CNC.
Standard: F400 for R5
Speed priority I: F500 for R5
Speed priority II: F1000 for R5

[Actual adjustment procedure]

Execute the following program, and measure the actual path.




```
G91;
G08P1;
G01X10.F4000;
G01Y-20.;
G01X-20.;
G01Y20.;
G01X10.;
G08P0;
G04X3.;
M99;
```

Fig. E (p) Programmed figure

The XY mode (Ctrl-X) is used for drawing. To observe an overshoot along an axis to be stopped, the figure is enlarged in the direction of the axis to be stopped. Corner 1 and corner 3 in Fig. E (p) are enlarged in the X-axis direction, and corner 2 and corner 4 are enlarged in the Y-axis direction. In the examples below, corner 1 is displayed using 0.01 mm/div in the X-axis direction and 0.1 mm/div in the Y-axis direction.

In Fig. E (q) where a reduced corner feedrate of F1000 is set, an overshoot of 10 μm or more has occurred. In Fig. E (r), however, the overshoot is reduced to about 3 μm.

If an overshoot cannot be removed by setting a reduced corner feedrate close to 0, the acceleration of acc./dec. before interpolation may be too large. In such a case, set a longer time for acc./dec. before interpolation. (In this case, a longer machining time results.)

Fig. E (s) shows the feedrate along the X-axis and Y-axis (corner 1) when the corner deceleration function is used.

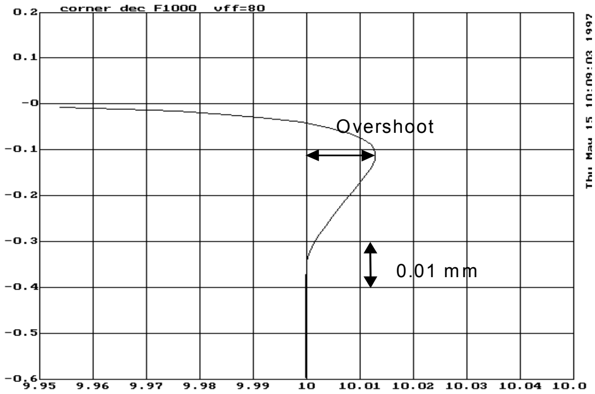


Fig. E (q) Reduced corner feedrate F1000

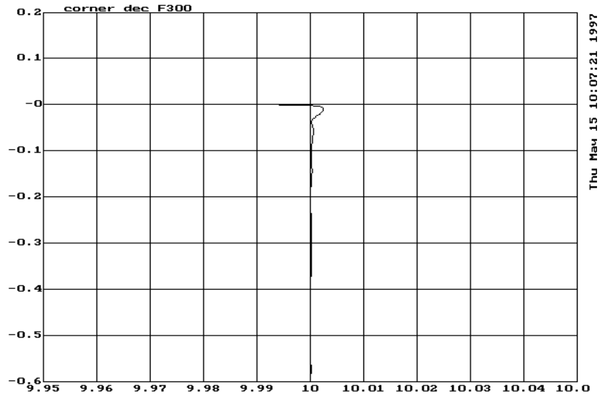


Fig. E (r) Reduced corner feedrate F300

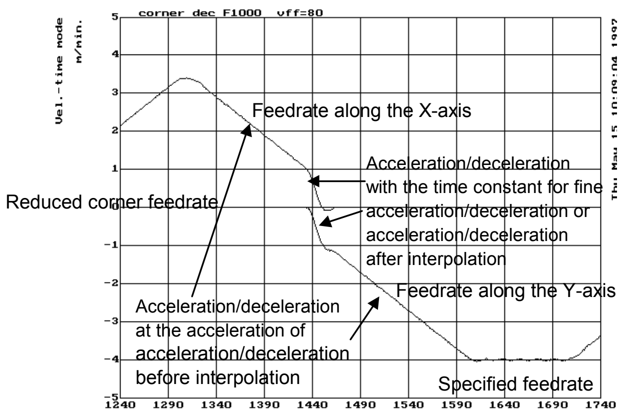


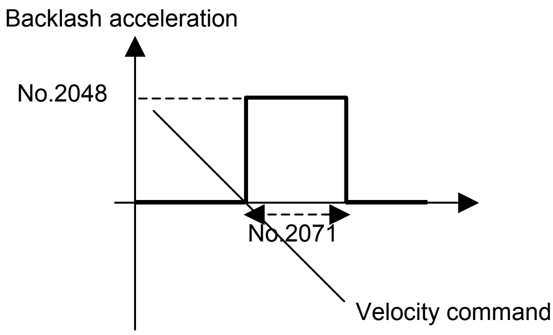
Fig. E (s) Time and feedrate relationship for reduced corner feedrate F1000

(6) Adjustment of backlash acceleration

(a) Backlash acceleration function

A simple figure as shown below is formed by the compensation value of backlash acceleration. The acceleration compensation value is added to the velocity command to help inversion of the velocity integral gain when the motor is reversed. This effect can reduce the path error in the reverse operation.

(Standard backlash acceleration)



Basically, the above two parameters are considered. Parameter No. 2071 is the backlash acceleration time, and its recommended value is 20. Normally, this value need not be adjusted. Parameter No. 2048 is the backlash acceleration amount. In the initial adjustment stage, set 100 in this parameter. Adjust this value while observing the arc figure.

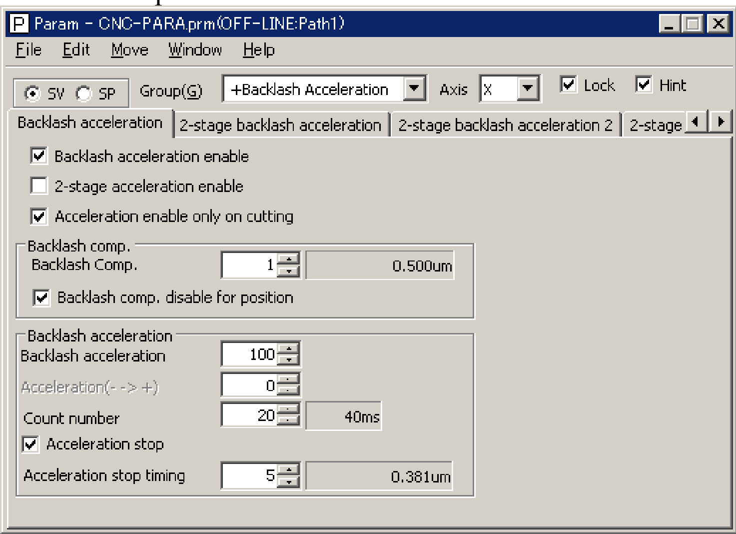
(b) Setting initial parameters for backlash acceleration

Before starting backlash acceleration adjustment, set the following initial parameters:

[Basic parameters for backlash acceleration]

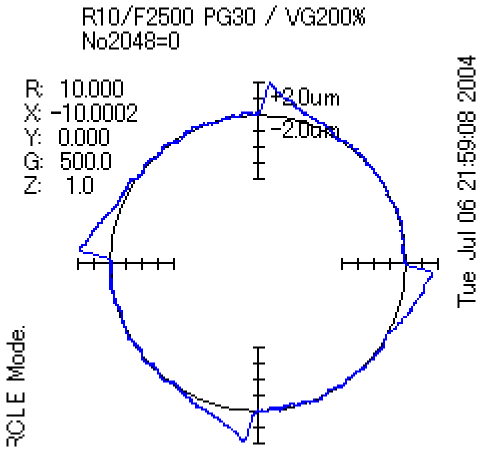
Parameter No.	Recommended value	Description
1851	1 以上	Backlash compensation
2003 #5	1	Enables backlash acceleration function
2006 #0	0/1	0: Semi-closed loop, 1: Full-closed loop
2009 #7	1	Stop of backlash acceleration
2223 #7	1	Enables backlash acceleration during cutting only.
2015 #6	0	Disables the two-stage backlash acceleration function.
2048	100	Backlash acceleration amount
2082	5 (1μm detection) 50(0.1μm detection)	Backlash acceleration stop distance (in detection unit)
2071	20	Backlash acceleration time

These parameters can be set in the parameter window of SERVO GUIDE.

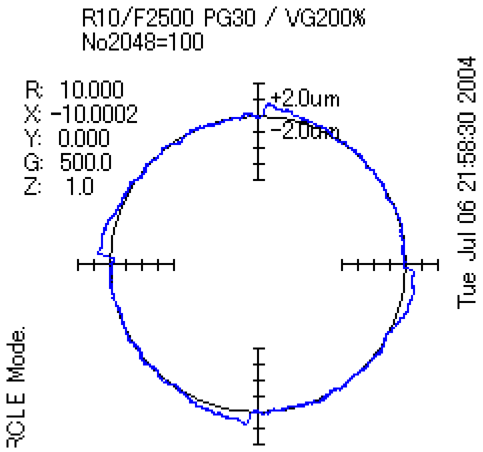


(c) Adjusting backlash acceleration

The following figure shows an arc figure before servo adjustment. Quadrant protrusions of about 4 μm appear on the X- and Y-axes.

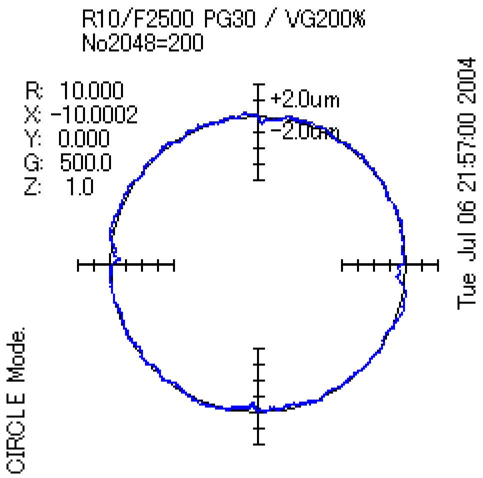


The figure below shows the result of a backlash acceleration adjustment made according to the parameter settings in item (b). By setting recommended values for backlash acceleration, quadrant protrusions can be suppressed.



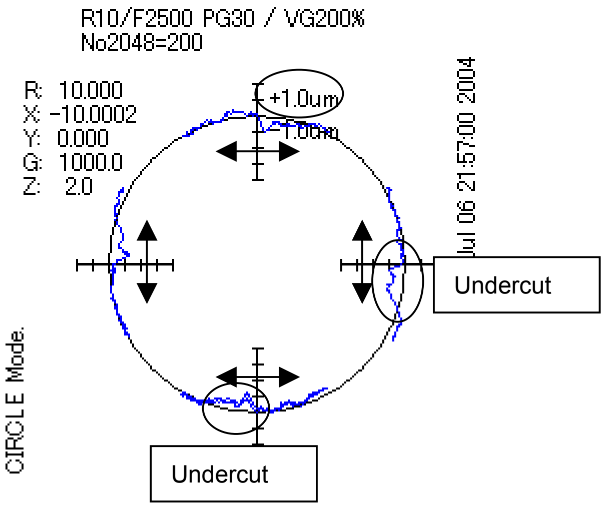
(c)-1 Determining the end of adjustment

First, it is necessary to understand when the backlash acceleration adjustment is ended. The figure below shows the result of an adjustment made by setting parameter No. 2048 to 200. An undercut occurs at the reverse points. Undercuts damage the surface of the machined workpiece, so they must be avoided. Therefore, it is necessary to end the adjustment of parameter No. 2048 just when no undercut occurs.



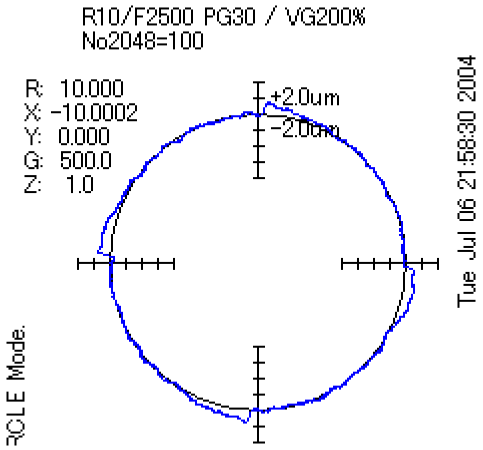
By enlarging the positional deviation at a reverse point, the generation of an undercut can be determined easily. Pressing z widens the figure while pressing Z shrinks the width. Pressing u decreases one grid size while pressing d increases the grid size.

When z and u are pressed, a figure as shown below is obtained:



(c)-2 Effect of gain adjustment

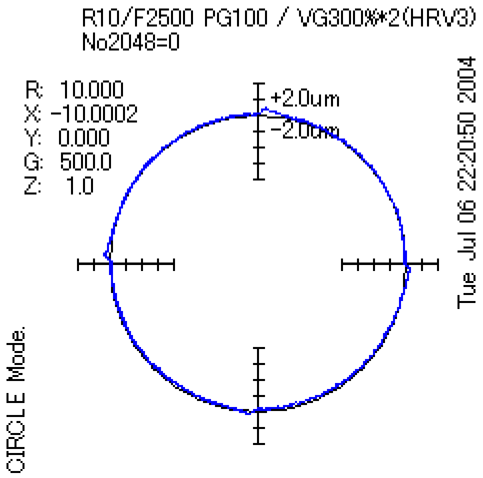
According to the description in item (c)-3 - (1), the final value of parameter No. 2048 must be determined to be 100. However, small protrusions are still left at the reverse points. This is because the gain adjustment is insufficient in this example. The power to suppress the position gain and velocity loop gain protrusions is strong and stable. Therefore, it is necessary to make gain adjustments thoroughly before the backlash acceleration adjustment.



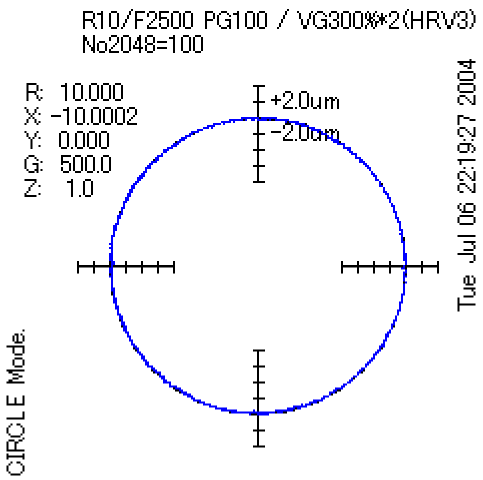
The figure shown below is the result of the gain adjustment, where backlash acceleration is not used. Even when backlash acceleration is not used, protrusions are almost eliminated. Therefore, the importance of gain adjustment can be understood.

(Adjustment items)

- Application of high-speed HRV current control
- Velocity loop gain: 600% (200% in the above example)
- Position gain: 100/s (30/s in the above example)



After a thorough gain adjustment, backlash acceleration can be adjusted easily. The figure shown below is the result obtained after the initial parameters of backlash acceleration listed in item (c)-3 - (2) are set. Thanks to the effect of the gain adjustment and a little backlash acceleration, protrusions are completely eliminated.

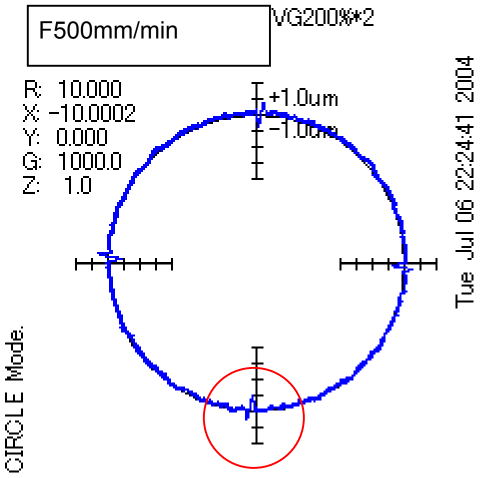


As indicated by this figure, the most important item to eliminate quadrant protrusions is gain adjustment. If gain adjustment is made successfully, backlash acceleration can be adjusted easily. Therefore, backlash acceleration does not play the leading role for suppressing quadrant protrusions.

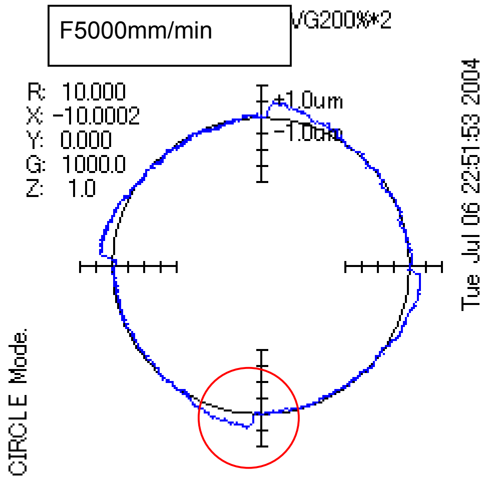
(c)-3 Override function

The two figures shown below indicate the difference by feedrate. In this example, the same acceleration amount (parameter No. 2048 is set to 100) is used, but the results are completely reversed. This example shows that a low feedrate requires a small backlash acceleration amount and that a high feedrate requires a large acceleration amount. This means that the backlash acceleration amount must be changed according to the feedrate.

An actually optimum acceleration amount is almost proportional to the acceleration. Therefore, an override function is required to change the acceleration amount according to the acceleration.



For F500 mm/min, 100 set in parameter No. 2048 is too large.



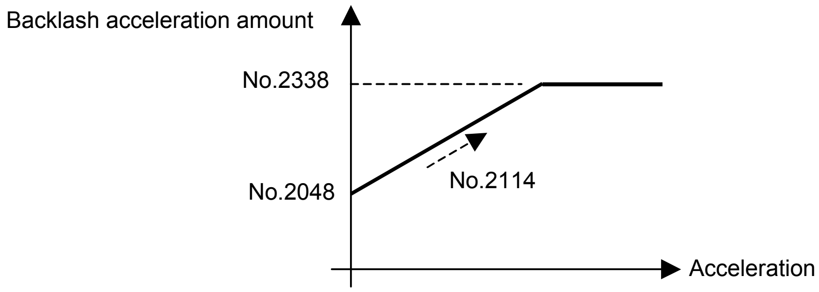
For F5000 mm/min, 100 set in parameter No. 2048 is too small.

* In this chapter, PG is assumed to be 50, and VG is assumed to be 400%.

The override function has two parameters. Parameter No. 2114 specifies an override coefficient, and parameter No. 2338 specifies a limit. These parameters may be adjusted easily if steps (1) through (3) explained below are followed.

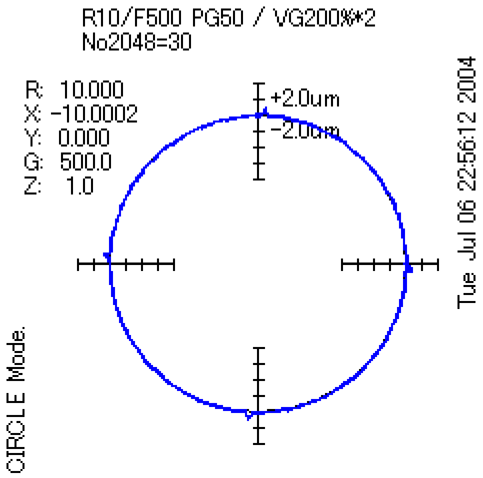
[Parameters for the override function]

Parameter No.	Standard value	Description
2048	100	Backlash acceleration amount
2114	0	Backlash acceleration override coefficient
2338	0	Backlash acceleration limit



(1) Determining parameter No. 2048

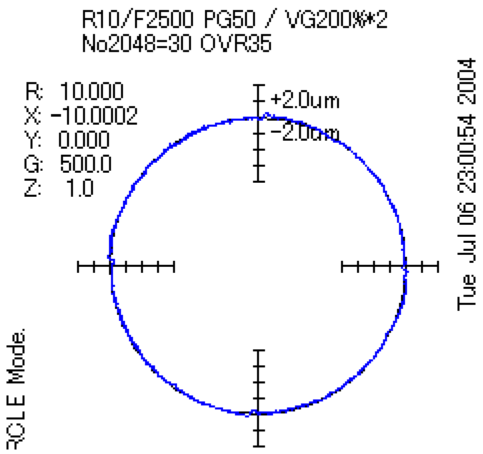
To determine parameter No. 2048, an adjustment must be made at low feedrate. This example assumes a feedrate of F500 mm/min and a radius of 10 mm. Adjust an optimum value at a low feedrate, and set it in parameter No. 2048. The figure below shows the result of setting 30 in parameter No. 2048. Here, this value is set in parameter No. 2048.



(2) Determining parameter No. 2114

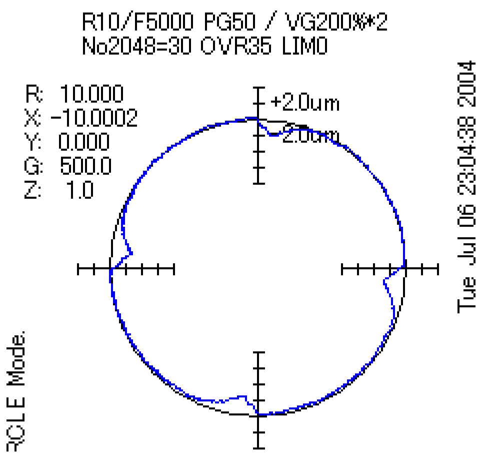
Parameter No. 2114 must be set after the adjustment of parameter No. 2048. About a half of the maximum cutting feedrate is used to determine the value to be set in parameter No. 2114. In this example, F2500 mm/min is used. By increasing the value in parameter No. 2114, determine an optimum value that does not cause undercuts. Increasing the value in parameter No. 2114 increases the actual acceleration amount.

The following figure shows the result of the adjustment of parameter No. 2114. Quadrant protrusions can be suppressed satisfactory.

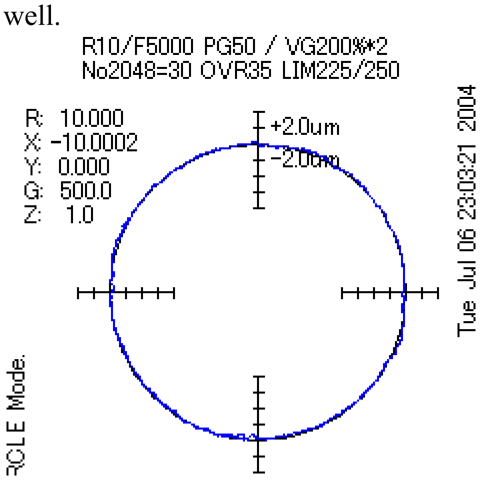


(3) Determining parameter No. 2338

Finally, set parameter No.2338. With an override coefficient determined using a middle feedrate, a large acceleration amount is output when the feedrate is set to a high feedrate. For this reason, the acceleration amount must be limited for high feedrate. In this example, F5000 mm/min is used.



The following shows the result of the adjustment of parameter No. 2338 at high speed. Quadrant protrusions are suppressed well.

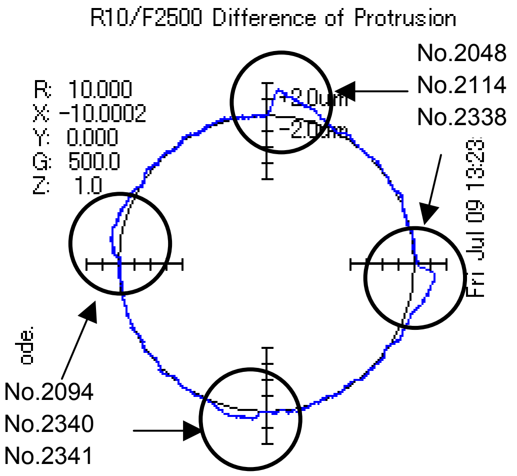


(d) Acceleration amount for each direction

There may be difference in size between the right and left quadrant protrusions or between the top and bottom quadrant protrusions. In such a case, an acceleration amount must be set separately.
If parameter No. 2094 is not 0, parameter No. 2094 is used for the left and bottom reverse points. Parameter No. 2340 is used as the override coefficient for parameter No. 2094, and parameter No. 2341 is used as the limit for parameter No. 2094.

[Parameters of acceleration amount for each direction]

Parameter No.	Standard value	Description
2048	50	Backlash acceleration amount
2114	0	Backlash acceleration override coefficient
2338	0	Backlash acceleration limit
2094	0	Backlash acceleration amount (- to +)
2340	0	Backlash acceleration override coefficient (- to +)
2341	0	Backlash acceleration limit (- to +)



(e) Disabling backlash acceleration after stop

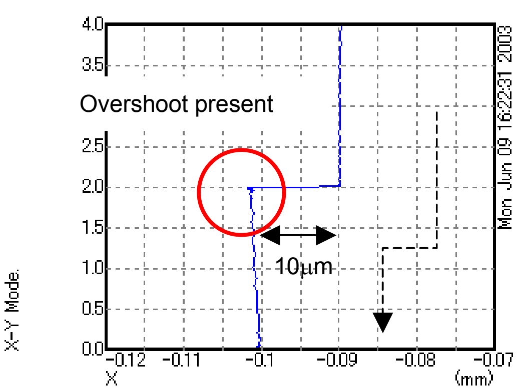
The optimum acceleration amount after a long stop may slightly be different from that at the time of adjustment using an arc. This phenomenon is due to the difference in friction, backlash, and machine torsion in the stopped state. The figure given below shows the bad effect of backlash acceleration, where a 3-μm overshoot is generated at the time of 10-μm step movement. As a solution to this problem, backlash acceleration can be disabled after a stop.

[Parameters for the function for disabling backlash acceleration after a stop]

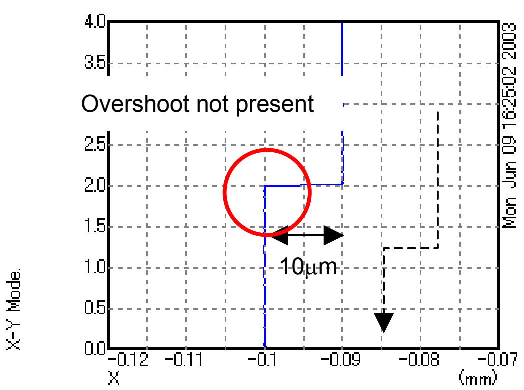
Parameter No.	Standard value	Description
2005#7	1	Static friction compensation function
2283#7	1	Function for disabling backlash acceleration after a stop
2073	5	Judgment parameter for stop state (ITP)
2071	0	Static friction compensation function enable time
2072	0	Static friction compensation value

(*) This function uses the parameters for the static friction compensation function.

When this function is disabled



When this function is enabled



F USING THE SERVO CHECK INTERFACE UNIT

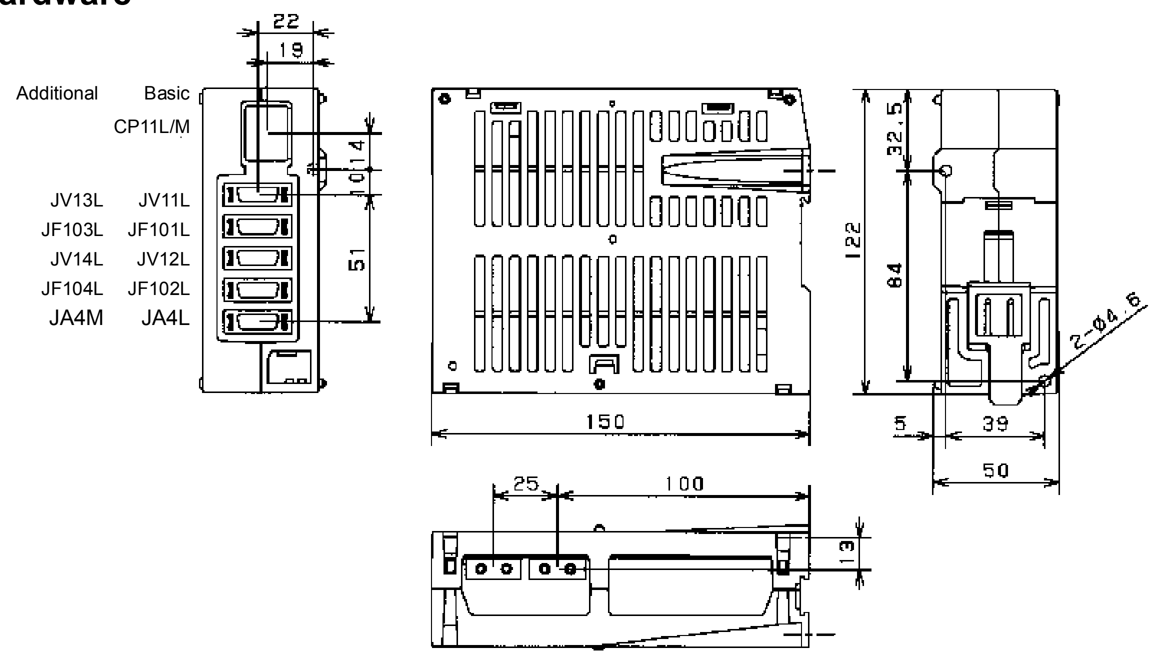
(1) Overview

With CNCs of the FS30*i* Series or later, SERVO GUIDE is basically used for servo adjustment and the servo check board connectable to conventional CNCs is not supported. Instead, a servo check interface unit is available. The servo check interface unit is connected to the FSSB (FANUC serial servo bus) and can be used, for example, to measure a VCMD waveform, which has been measurable with the conventional servo check board, by using an external measuring instrument directly.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	08.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0 90E1	N(14) and subsequent editions 01.0 and subsequent editions	
Series 30*i*/31*i*-A	90D0	N(14) and subsequent editions	HRV4
Series 0*i*-D	90C5 90C8	A(01) and subsequent editions A(01) and subsequent editions	
	90E5 90E8	A(01) and subsequent editions A(01) and subsequent editions	

(3) Hardware



Name	NC	Specification	Remarks
Servo check interface unit: Basic unit	30*i*-B Series	A02B-0323-C206	Up to two channels
	30*i*-A Series, 0*i*-D Series	A02B-0303-C206	
Additional unit	30*i*-B Series	A02B-0323-C181	Up to two channels
	30*i*-A Series, 0*i*-D Series	A02B-0259-C181	

A servo check interface unit has two types of connectors, one for analog signal output and the other for detector data input, for one CNC axis. Each of a basic unit and an additional unit has four connectors and two channels of analog voltage output ports and separate detector interfaces each.

JV1xL : Connector for analog signal output
JF10xL : Connector for detector data input

(4) Parameter setting

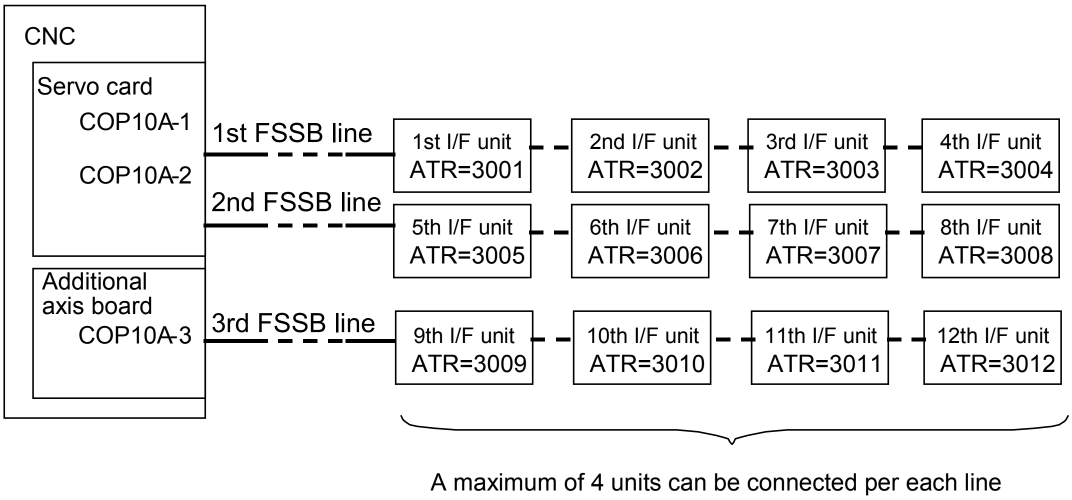


Fig. J.1 (a) Servo check interface unit connection diagram for 30*i*-B Series

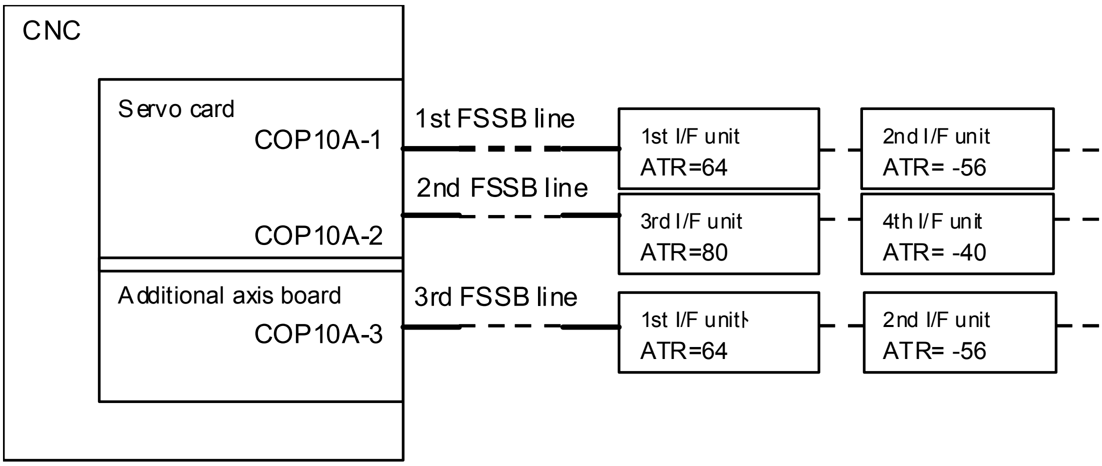


Fig. J.1 (b) Servo check interface unit connection diagram for 30*i*-A Series

	#7	#6	#5	#4	#3	#2	#1	#0
2278					PM2SCB	PM1SCB		

PM1SCB(#2) The first or third servo check interface unit is:
0: Not used.
1: Used.

PM2SCB(#3) The second or fourth servo check interface unit is:
0: Not used.
1: Used.

> **NOTE**
> 1 When these parameters are set, the power must be turned off before operation is continued.
> 2 When two servo check interface units are used with one axis on the CNC, neither a pair of the first and third units nor a pair of the second and fourth units may be set. One unit must be selected from the first and third units, and the other unit must be selected from the second and fourth units.

With the parameter below, set the type of data to be output to the servo check interface unit.

2315	Servo check interface unit output signal setting

- When using one servo check interface unit with one axis on the CNC → Set a 2-digit number (decimal).

	Tens digit	Ones digit
Setting	Axis number(*1)	Data number(*2)

- When using two servo check interface units with one axis on the CNC → Set a 4-digit number (decimal).

	Setting for data 2		Setting for data 1	
	Thousands digit	Hundreds digits	Tens digit	Ones digit
Setting	Axis number(*1)	Data number(*2)	Axis number(*1)	Data number(*2)

Data 1: Output from the first or third servo check interface unit
Data 2: Output from the second or fourth servo check interface unit

(*1) Axis number

Axis number	No. 1023 for axis to be measured		
	Series 90G0	Series 90E0,E1,90E5,E8	Series 90D0,90C5,C8
1	8n+1	4n+1	2n+1
2	8n+2	4n+2	2n+2
3	8n+3	4n+3	
4	8n+4	4n+4	
5	8n+5		
6	8n+6		

(n=0, 1, 2, ...)

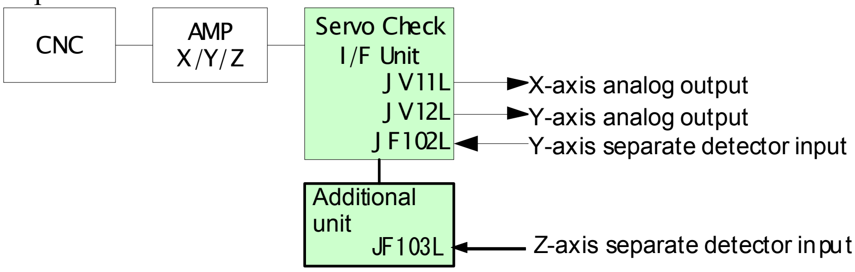
(*2) Data number

Data number	Description of measurement data
0	Velocity command (VCMD)
1	Torque command (TCMD)
2	Actual speed (SPEED)
4	Position (POSF)
5	Data 1 for adjustment
6	Data 2 for adjustment

(5) Examples of setting

[Connection example 1]

Configuration where the X-axis is a semi-closed axis and the Y-axis and Z-axis are full-closed axes
Velocity command data is output from the X-axis.
Position data is output from the Y-axis.
No data is output from the Z-axis.



For the 30*i*-B Series

No.	Signal	Value
1023X,Y,Z		X: 1, Y: 2, Z: 3
1815X,Y,Z#1	OPTx	X: 0, Y: 1, Z: 1
1902#0	FMD	1
24096X,Y,Z		X: 1, Y: 2, Z: 3
24097X,Y,Z		X: 0, Y: 0, Z: 0
24000 to 24031	ATR	1001,1002,1003,3001 The others are 1000.
24032 to 24063	ATR	All 1000
24064 to 24095	ATR	All 1000
24104 to 24111	ATRC	1001,1002,1003 The others are 1000.
24112 to 24119	ATRC	All 1000
24120 to 24127	ATRC	All 1000
24128 to 24135	ATRC	All 1000
24136 to 24143	ATRC	All 1000
24144 to 24151	ATRC	All 1000
2278#3	PM2SCB	X: 0, Y: 0, Z: 0
2278#2	PM1SCB	X: 1, Y: 1, Z: 0
2315		X: 10, Y: 24, Z: 0

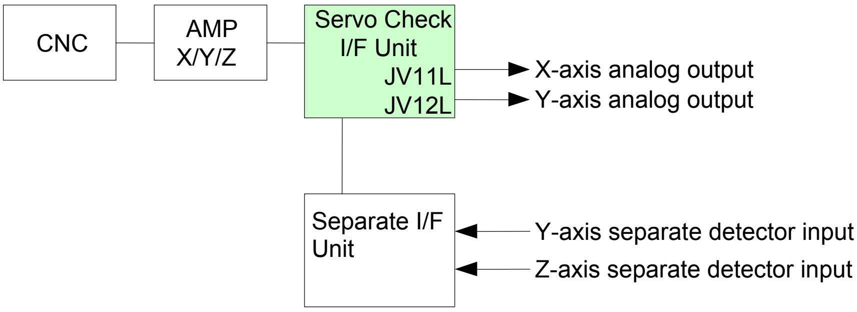
For the 30*i*-A Series

No.	Signal	Value
1023X,Y,Z		X: 1, Y: 2, Z: 3
1815X,Y,Z#1	OPTx	X: 0, Y: 1, Z: 1
1902#0	FMD	1
1905X,Y,Z#7	PM2	X: 0, Y: 0, Z: 0
1905X,Y,Z#6	PM1	X: 1, Y: 1, Z: 1
1936X,Y,Z		X: 0, Y: 1, Z: 2
1937X,Y,Z		X: 0, Y: 0, Z: 0
14340 to 14357	ATR	0,1,2,64 The others are –96.
14358 to 14375	ATR	All -96
14408 to 14425	ATR	All -96
14376 to 14383	ATRC	0,1,2,32,32,32,32,32
14384 to 14391	ATRC	All 32
14392 to 14399	ATRC	All 32
14400 to 14407	ATRC	All 32
14444 to 14451	ATRC	All 32
14452 to 14459	ATRC	All 32
2278#3	PM2SCB	X: 0, Y: 0, Z: 0

No.	Signal	Value
2278#2	PM1SCB	X: 1, Y: 1, Z: 0
2315		X: 10, Y: 24, Z: 0

[Connection example 2]

Configuration where the X-axis is a semi-closed axis and the Y-axis and Z-axis are full-closed axes
Velocity data is output from the X-axis.
Torque command data is output from the Y-axis.
No data is output from the Z-axis.



For the 30*i*-B Series

No.	Signal	Value
1023X,Y,Z		X: 1, Y: 2, Z: 3
1815X,Y,Z#1	OPTx	X: 0, Y: 1, Z: 1
1902#0	FMD	1
24096X,Y,Z		X: 1, Y: 2, Z: 0
24097X,Y,Z		X: 0, Y: 1, Z: 2
24000 to 24031	ATR	1001,1002,1003,3001,3002 The others are 1000.
24032 to 24063	ATR	All 1000
24064 to 24095	ATR	All 1000
24104 to 24111	ATRC	1001,1002 The others are 1000.
24112 to 24119	ATRC	1002,1003 The others are 1000.
24120 to 24127	ATRC	All 1000
24128 to 24135	ATRC	All 1000
24136 to 24143	ATRC	All 1000
24144 to 24151	ATRC	All 1000
2278#3	PM2SCB	X: 0, Y: 0, Z: 0
2278#2	PM1SCB	X: 1, Y: 1, Z: 0
2315		X: 12, Y: 21, Z: 0

For the 30*i*-A Series

No.	Signal	Value
1023X,Y,Z		X: 1, Y: 2, Z: 3
1815X,Y,Z#1	OPTx	X: 0, Y: 1, Z: 1
1902	FMD	1
1905X,Y,Z#7	PM2	X: 0, Y: 1, Z: 1
1905X,Y,Z#6	PM1	X: 1, Y: 1, Z: 0
1936X,Y,Z		X: 0, Y: 1, Z: 0
1937X,Y,Z		X: 0, Y: 0, Z: 1
14340 to 14357	ATR	0,1,2,64,-56 The others are -96.
14358 to 14375	ATR	All -96
14408 to 14425	ATR	All -96
14376 to 14383	ATRC	0,1,32,32,32,32,32,32

No.	Signal	Value
14384 to 14391	ATRC	1,2,32,32,32,32,32,32
14392 to 14399	ATRC	All 32
14400 to 14407	ATRC	All 32
14444 to 14451	ATRC	All 32
14452 to 14459	ATRC	All 32
2278#3	PM2SCB	X: 0, Y: 0, Z: 0
2278#2	PM1SCB	X: 1, Y: 1, Z: 0
2315		X: 12, Y: 21, Z: 0

(6) Changing the output signal units and so forth

To the servo check interface unit, a voltage within ±10 V is output. The table below indicates the default output unit of each data item.

Data number	Description of data	Data output unit (Default)
0	Velocity command (VCMD)	0.9155min^{-1}/5V
1	Torque command (TCMD)	Max. amplifier current A/4.4V
2	Actual speed (SPEED)	3750min^{-1}/5V
4	Position (POSF)	3276.7[detection unit]/1V
5	Data 1 for adjustment	-
6	Data 2 for adjustment	-

With the parameters below, the output units and so forth of a velocity command, torque command, and actual speed can be changed as with conventional check board output.

	#7	#6	#5	#4	#3	#2	#1	#0
2015			TDOUT					

TDOUT(#5) Instead of a torque command, a disturbance torque is:
0: Not output.
1: Output.

	#7	#6	#5	#4	#3	#2	#1	#0
2012			VCM2	VCM1				

When a rotary motor is used

VCM2	VCM1	Specified speed/5V
0	0	0.9155min^{-1}
0	1	14min^{-1}
1	0	234min^{-1}
1	1	3750min^{-1}

When a linear motor is used (Incremental: P=Signal pitch [μm])
(Absolute: P=Resolution [μm] × 512)

VCM2	VCM1	Specified speed/5V
0	0	0.00375 × P m/min
0	1	0.06 × P m/min
1	0	0.96 × P m/min
1	1	15.36 × P m/min

Observe the entire movement in the DC mode with an oscilloscope then extend the range in the AC mode to check for fine fluctuations and positional variations.

	#7	#6	#5	#4	#3	#2	#1	#0
2225						TSA05	TCMD05	

TCMD05(#1) The TCMD signal check board output voltage is:
0: Ordinary (default).
1: Halved.
* The actual output voltage is affected by the function bit (TCMD4X) indicated below.

TSA05(#2) The SPEED signal check board output voltage is:
0: Ordinary (3750min^{-1}/5V) (default).
1: Halved (7500min^{-1}/5V).

The function bit (TCMD4X) indicated below increases the TCMD output voltage weight by a factor of 10 when compared with the conventional value. This function bit can be used together with the bit above (TCMD05).

	#7	#6	#5	#4	#3	#2	#1	#0
2203			TCMD4X					

TCMD4X(#5) The TCMD signal check board output voltage is:
0: Ordinary (default).
1: Increased by a factor of 4.

By using these function bits, the output ranges of the TCMD signal and SPEED signal can be changed as indicated below.

- TCMD signal output range

TCMD4X	TCMD05	TCMD value/4.4V	Remarks
0	1	Max. amplifier current × 2 (A)	
0	0	Max. amplifier current (A)	Conventional mode
1	1	Max. amplifier current/2 (A)	
1	0	Max. amplifier current/4 (A)	×4 compared with conventional mode

Example:
Relationship between the output voltage and TCMD value [A] when an 80-A amplifier is used

TCMD4X	TCMD05	TCMD value/4.4V
0	1	160 [A]
0	0	80 [A]
1	1	40 [A]
1	0	20 [A]

- SPEED signal output range

TSA05	Actual speed/5V Rotary motor	Actual speed/5V Linear motor	Remarks
0	3750 [min^{-1}]	15.36 × P [m/min]	Conventional mode
1	7500 [min^{-1}]	30.72 × P [m/min]	

* When a linear motor is used, the meaning of P depends on the type of scale.

♦ When a high resolution serial output circuit manufactured by FANUC is used
(Incremental scale) → P=Signal pitch [μm]

♦ When a scale supporting the FANUC serial interface is used
(Absolute scale) → P=Resolution [μm] × 512

G SERVO FUNCTIONS THAT ARE NOT USED WITH THE 30*i* AND 0*i*-D Series

Appendix G, "SERVO FUNCTIONS THAT ARE NOT USED WITH THE 30*i* AND 0*i*-D Series", consists of the following sections:

G.1 FINE ACCELERATION/DECELERATION (FAD) FUNCTION

(1) Overview

The fine acceleration/deceleration (fine acc./dec.) function enables smooth acc./dec. This is done by using servo software to perform some acc./dec. processing, which previously has been performed by the CNC not supporting nano interpolation. With this function, the mechanical stress and strain resulting from acc./dec. can be reduced.

(2) Features

- Acc./dec. is controlled by servo software at short intervals, allowing smooth acc./dec.
- Smooth acc./dec. can reduce the stress and strain applied to the machine.
- Because of the reduced stress and strain on the machine, a shorter time constant can be set (within the motor acceleration capability range).
- Two acc./dec. command types are supported: bell-shaped and linear acc./dec. types.
- An application of the fine acc./dec. function is found in the cutting and rapid traverse operations; for each operation, the FAD time constant, feed-forward coefficient, and velocity feed-forward coefficient can be used separately.

(3) Series and editions of applicable servo software

(Series 15*i*-B,16*i*-B,18*i*-B,21*i*-B,0*i*-B,0*i* Mate-B,Power Mate *i*)

Series 9096/A(01) and subsequent editions
Series 90B0/A(01) and subsequent editions
Series 90B1/A(01) and subsequent editions
Series 90B6/A(01) and subsequent editions

(Series 0*i*-C,0*i* Mate-C,20*i*-B)

Series 90B5/A(01) and subsequent editions
Series 90B8/A(01) and subsequent editions

> **NOTE**
> In the30*i* Series or 0*i*-D Series, smooth acc./dec. is always performed by nano interpolation, so the fine acc./dec. function is unnecessary. (The settings for the function are also ignored.)

(4) Setting basic parameters

	#7	#6	#5	#4	#3	#2	#1	#0
1951(FS15*i*) / 2007(FS16*i*)		FAD						

FAD (#6) 1: Enables the fine acc./dec. function.

> **NOTE**
> When this parameter is set, the power must be turned off before operation is continued.

	#7	#6	#5	#4	#3	#2	#1	#0
1749(FS15*i*)						FADL		
2209(FS16*i*)								

FADL (#2) 0: FAD bell-shaped
1: FAD linear type
* Set 1 (linear type) usually .

> **NOTE**
> When this parameter is set, the power must be turned off before operation is continued.

1702(FS15*i*)	Fine acc./dec. time constant (ms)
2109(FS16*i*)	

[Valid data range] 8 to 64 (Standard setting: 24)
A value exceeding the valid data range is clamped to the upper or lower limit of the range.
When the fine acc./dec. and feed-forward functions are used together, set the coefficient in the following parameter.
(The parameter No. is the same as that used for advanced preview control.)

1985(FS15*i*)	Position feed-forward coefficient (in units of 0.01%)
2092(FS16*i*)	

[Valid data range] 100 to 10000

> **NOTE**
> 1 Feed-forward control is enabled by setting bit 1 of No. 1883 (Series 15*i*) or No. 2005 (Series 16*i* and so on) to 1.
> 2 The velocity feed-forward coefficient is set in parameter No. 1962 (Series 15*i*) or No. 2069 (Series 16*i* and so on) which is the same parameter as that used for normal operation.
> 3 Generally, the fine acc./dec. function is enabled in cutting mode only.
> 4 If bit 3 of No. 1800 is set to 1, the FAD function is enabled both for cutting and rapid traverse mode.

(5) Setting parameters for the fine acc./dec. function, used separately for cutting and rapid traverse

As mentioned above, set the fine acc./dec. function bit and the bit for selecting the bell-shaped or linear type.
Then, set the following:

	#7	#6	#5	#4	#3	#2	#1	#0
1800(FS15*i*)					FFR			
1800(FS16*i*)								

FFR (#3) 1: Enables feed-forward in rapid traverse also.

	#7	#6	#5	#4	#3	#2	#1	#0
1742(FS15*i*)								FADCH
2202(FS16*i*)								

FADCH (#0) 1: Enables the fine acc./dec. function, used separately for cutting and rapid traverse.

> **NOTE**
> When this parameter is set, the power must be turned off before operation is continued.

In cutting mode, the following parameters are used:

1766(FS15*i*) / 2143(FS16*i*)	**Fine acc./dec. time constant 2 (ms)**

[Valid data range] 8 to 64
A value that falls outside this range, if specified, is clamped to the upper or lower limit.

1767(FS15*i*) / 2144(FS16*i*)	**Position feed-forward coefficient for cutting (in units of 0.01%)**

1768(FS15*i*) / 2145(FS16*i*)	**Velocity feed-forward coefficient for cutting (%)**

In rapid traverse mode, the following parameters are used:

1702(FS15*i*) / 2109(FS16*i*)	**Fine acc./dec. time constant (ms)**

[Valid data range] 8 to 64
A value that falls outside this range, if specified, is clamped to the upper or lower limit.

1985(FS15*i*) / 2092(FS16*i*)	**Position feed-forward coefficient for rapid traverse (in units of 0.01%)**

1962(FS15*i*) / 2069(FS16*i*)	**Velocity feed-forward coefficient for rapid traverse (%))**

> **NOTE**
> 1 When the settings above are made, both of the fine acc./dec. time constant and feed-forward coefficient can be automatically switched for cutting feed or rapid traverse. To switch the feed-forward coefficient only, use the cutting feed/rapid traverse switchable feed-forward function. (See Subsection 5.5.2.)
> 2 When FAD, used separately for cutting and rapid traverse, is applied to axes under simple synchronous control, set the function bit for both the master and slave axes. When the function is enabled for the master axis only, switching between cutting and rapid traverse modes cannot be performed.

Table G.1 (a) Feed-forward coefficient and fine acc./dec. time constant parameters classified by use

Series 16*i*, 18*i*, 21*i*, 0*i*

	Parameter setting				Parameters for cutting			Parameters for rapid traverse		
	No.2005 #1	No.2007 #6	No.1800 #3	No.2202 #0	Position FF coefficient	Velocity FF coefficient	FAD time constant	Position FF coefficient	Velocity FF coefficient	FAD time constant
Cutting FF	1	0	0	0	No. 2068 No. 2092	No. 2069	-	-	-	-
Usual FF (cutting FF + rapid traverse FF)	1	0	1	0	No. 2068 No. 2092	No. 2069	-	No. 2068 No. 2092	No. 2069	-
Cutting FAD	0	1	0	0	-	-	No. 2109	-	-	-
Cutting/rapid traverse-specific FAD	0	1	1	1	-	-	No. 2143	-	-	No. 2109
Cutting FAD + cutting FF	1	1	0	0	No. 2092	No. 2069	No. 2109	-	-	-
Cutting FAD + usual FF	1	1	1	0	No. 2092	No. 2069	No. 2109	No. 2092	No. 2069	-
Cutting/rapid traverse-specific FAD + cutting/rapid traverse-specific FF	1	1	1	1	No. 2144	No. 2145	No. 2143	No. 2092	No. 2069	No. 2109

Series 15*i*

	Parameter setting				Parameters for cutting			Parameters for rapid traverse		
	No.1883 #1	No.1951 #6	No.1800 #3	No.1742 #0	Position FF coefficient	Velocity FF coefficient	FAD time constant	Position FF coefficient	Velocity FF coefficient	FAD time constant
Cutting FF	1	0	0	0	No. 1961 No. 1985	No. 1962	-	-	-	-
Usual FF	1	0	1	0	No. 1961 No. 1985	No. 1962	-	No. 1961 No. 1985	No. 1962	-
Cutting FAD	0	1	0	0	-	-	No. 1702	-	-	-
Cutting/rapid traverse-specific FAD	0	1	1	1	-	-	No. 1766	-	-	No. 1702
Cutting FAD + cutting FF	1	1	0	0	No. 1985	No. 1962	No. 1702	-	-	-
Cutting FAD + usual FF	1	1	1	0	No. 1985	No. 1962	No. 1702	No. 1985	No. 1962	-
Cutting/rapid traverse-specific FAD + cutting/rapid traverse-specific FF	1	1	1	1	No. 1767	No. 1768	No. 1766	No. 1985	No. 1962	No. 1702

NOTE

1. In the above tables, the abbreviations "FF" and "FAD" refer to the feed-forward function and fine acc./dec. function, respectively.
2. Of two parameter numbers stacked one on the other in each field of the above tables, the upper one is used in non-advance mode, and the lower one, in advance mode.

(6) Cautions for combined use of the synchronization function with the spindle axis and fine acc./dec.

The restrictions listed below are imposed on the combined use of the synchronization function between the servo axis and spindle axis and the fine acc./dec. function.

(Disable the fine acc./dec. function if the combine use is impossible.)

Function	Use of FAD for servo axis		Cautions for combined use
	When FAD is disabled for spindle axis	When FAD is enabled for spindle axis	
Rigid tapping	Allowed	Allowed	**When FAD is disabled for spindle axis :** During rigid tapping, FAD and feed-forward control are disabled. For synchronization, the position gain for the servo axis must be changed. See (7). **When FAD is enabled for spindle axis :** The same FAD time constant, acc./dec. type, feed-forward coefficient, and position gain must be used for the servo axis (during cutting) and the spindle axis.
Advanced preview control rigid tapping	Not allowed	Allowed	The same FAD time constant, acc./dec. type, feed-forward coefficient, and position gain must be used for the servo axis (during cutting) and the spindle axis.
Cs axis contour control	Not allowed	Allowed	The same FAD time constant, acc./dec. type, feed-forward coefficient, and position gain must be used for the servo axis (during cutting) and the spindle axis.
Hob function	Not allowed	Not allowed	Disable the fine acc./dec. function.
EGB function	Not allowed	Not allowed	Disable the fine acc./dec. function.
Flexible synchronization	Not allowed	Allowed	The same FAD time constant, acc./dec. type, feed-forward coefficient, and position gain must be used for the servo axis (during cutting) and the spindle axis.

NOTE

The spindle FAD function can be used when an α*i* spindle amplifier and FANUC Series 16*i*/18*i*/21*i* MODEL B CNC are used.

Spindle software : Series 9D50/E(05) and subsequent editions

CNC software : M series : Series B0H1/M(13) and subsequent editions,
Series BDH1M(13) and subsequent editions,
Series DDH1/M(13) and subsequent editions,
Series BDH5/C(03) and subsequent editions
T series : Series B1H1/M(13) and subsequent editions
Series BEH1/M(13) and subsequent editions
Series DEH1/M(13) and subsequent editions

For details of the spindle FAD function, refer to "FANUC AC SPINDLE MOTOR α*i* series, FANUC AC SPINDLE MOTOR β*i* series, FANUC AC BUILT-IN SPINDLE MOTOR B*i* series Parameter Manual (B-65280EN)".

Function	Combined use with FAD function	Cautions for combined use
Flexible synchronization (between servo axes)	Allowed	For the axes to be synchronized with each other, the same FAD time constant, feed-forward coefficient, and position gain must be set.

(7) Rigid tapping synchronization when spindle axis FAD is disabled

(a) Overview

Because using fine acc./dec. causes the servo axis delay (error) to increase by 1 ms, rigid tapping with fine acc./dec. set up results in an increase of synchronization error against the spindle. To avoid this increase, use the following procedure to change the servo axis position gain for rigid tapping.

> **NOTE**
> In advanced preview control mode, rigid tapping cannot be used together with fine acc./dec. In this case, disable fine acc./dec.

(b) Setup procedure

By setting the parameter below, the position gain can be automatically changed only for the servo axis to establish synchronization.

(Parameter)

	#7	#6	#5	#4	#3	#2	#1	#0
1749(FS15*i*) **2209(FS16*i*)**					**FADPGC**			

FADPGC (#3) Specifies whether to perform synchronization in rigid tapping mode when FAD is set up, as follows:

0: Not to perform

1: <u>To perform ← To be set</u>

> **NOTE**
> 1 When this parameter is set, the power must be turned off before operation is continued.
> 2 If this parameter is set, the servo position gain is changed when rigid tapping is not used.
> 3 It is necessary to set this parameter for all axes that are subjected to contouring.

(Reference)

With Series 16*i* and so on, two types of parameters are available for position gain setting. By setting the parameters as described below, a position gain match can be ensured between the servo axis and spindle.

> **NOTE**
> Do not make following setting when FADPGC = 1 is set.

a. Nos. 4065 to 4068: Spindle servo mode position gain

b. Nos. 5280 to 5284: Rigid tapping position loop gain

Parameter type "a" corresponds to the spindle position loop gain for rigid tapping, and parameter type b, to the servo axis position loop gain. Usually, both parameter types take the same values. For a servo axis with fine acc./dec. specified, however, set parameter type b with the values obtained using the following calculation:

$$\text{Newly set position gain value} \quad \frac{100000}{100000 - \text{Usually set position gain value}} \times \text{Usually set position gain value}$$

Example of parameter setting)

Position gain (1/s)	Usually set value	Newly set value
15	1500	1523
16.66	1666	1694
20	2000	2041
25	2500	2564
30	3000	3093
33.33	3333	3448
35	2500	3627
40	4000	4167
45	4500	4712
50	5000	5263

(8) Other specifications to note regarding the fine acc./dec. function

- Advanced preview control and fine acc./dec. can be used together. (The time constants before and after advanced preview interpolation, and the fine acc./dec. time constant are effective.)
- If FAD is set, then the G05 P10000 command is issued with HPCC, FAD is disabled.
- Using the FAD function increases the position error as follows:
  - For FAD bell-shaped

$$\text{Deviation incerase (pulses)} = \frac{\text{Feedrate (mm/min)}}{60 \times 1000 \times \text{Detection unit (mm)}} \times \left(\frac{\text{FAD time constant (ms)}}{2} + 1 \right)$$

  - For FAD linear type

$$\text{Deviation incerase (pulses)} = \frac{\text{Feedrate (mm/min)}}{60 \times 1000 \times \text{Detection unit (mm)}} \times \left(\frac{\text{FAD time constant (ms)} + 1}{2} + 1 \right)$$

Example)

When feed operation is performed using F1800 with a position gain of 30 (1/s) and a detection unit of 0.001 mm, the position error is normally expressed as follows:

$$\text{Normal deviation (pulses)} = \frac{\text{Feedrate (mm/min)}}{60 \times \text{Position gain (1/s)} \times \text{Detection unit (mm)}}$$

$$= \frac{1800}{60 \times 30 \times 0.001} = 1000(\mathit{pulses})$$

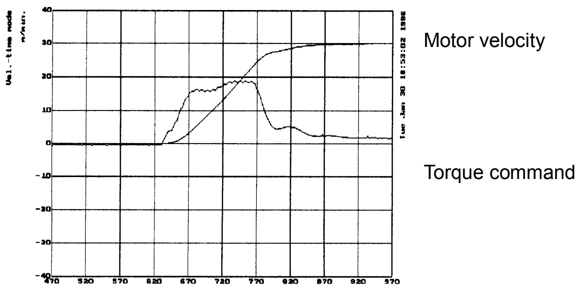
When the FAD function (FAD bell-shaped) is used with the time constant set to 64 ms, the deviation increases as follows:

$$\text{Deviation incerase (pulses)} = \frac{1800}{60 \times 1000 \times 0.01} \times \left(\frac{64}{2} + 1 \right) = 990(\mathit{pulses})$$

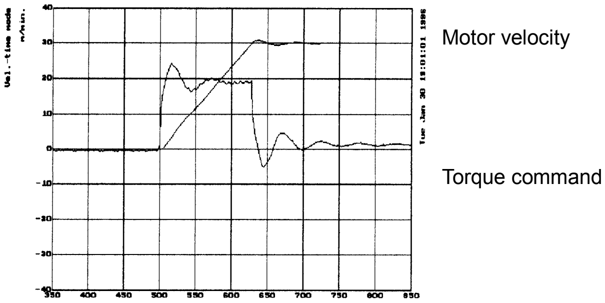
When FAD is used, the entire deviation is then obtained as follows:
Deviation when FAD is used (pulses) = 1000 + 990 = 1990 (pulses)

The combined use of the FAD function and the feed-forward function does not increase the position error so much as expected, because the feed-forward function decreases a delay against the command. When the FAD function is used alone, however, a higher error overestimation level must be set, considering the increase in the deviation.

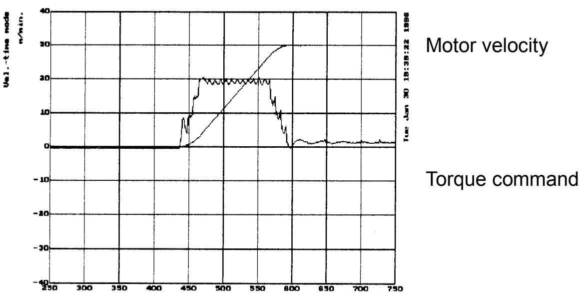
(9) Examples of applying the fine acc./dec. function



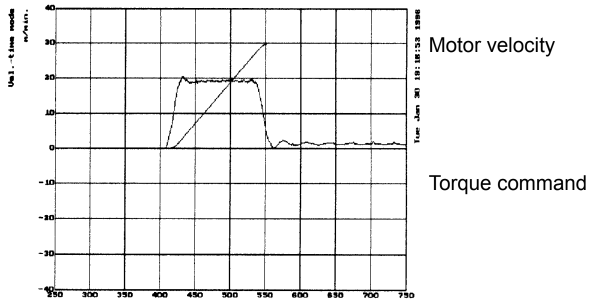
Conventional control in which the feed-forward function is not used



When the feed-forward function is used



When the feed-forward and rapid traverse bell-shaped acc./dec. (Acc./dec. by the CNC)functions are used



When the feed-forward and fine acceleration/ deceleration functions are used

G.2 RISC FEED-FORWARD FUNCTION

(1) Overview

The feed-forward system is used during high precision contour control based on RISC (HPCC mode) or AI contour control (AICC mode) in order to shorten the interpolation cycle, improving the performance of high-speed, high precision machining.
(This function is insignificant for AI nano-contour control complying with nano-interpolation as a distribution system, AI high-precision contour control, AI nano high-precision contour control, and fine HPCC.)
By using this function, the response of the servo side can be improved when the distribution period is 4 ms, 2 ms, or 1 ms.

(2) Series and editions of applicable servo software

(Series 15*i*-B,16*i*-B,18*i*-B,21*i*-B,0*i*-B,0*i* Mate-B,Power Mate *i*)
Series 9096/A(01) and subsequent editions(*)
Series 90B0/A(01) and subsequent editions
Series 90B1/A(01) and subsequent editions
Series 90B6/A(01) and subsequent editions
(Series 0*i*-C,0*i* Mate-C,20*i*-B)
Series 90B5/A(01) and subsequent editions
Series 90B8/A(01) and subsequent editions

(*) Series 9096 supports distribution periods of 1 ms and 2 ms only, and it does not support 4 ms.

(3) Setting parameters

<1> Set the following parameters in the same way as for the advanced preview feed-forward function.
<2> Set the parameters (RISCFF and RISCMC) below.

	#7	#6	#5	#4	#3	#2	#1	#0
1959(FS15*i*) 2017(FS30*i*,16*i*)			RISCFF					

RISCFF (#5) 0: Feed-forward response remains unchanged when RISC is used.
1: Feed-forward response improves when RISC is used.

	#7	#6	#5	#4	#3	#2	#1	#0
1740(FS15*i*) 2200(FS30*i*,16i)			RISCMC					

RISCMC (#5) When RISC is used:
0: Feed-forward response remains unchanged.
1: Feed-forward response improves.

<3> By specifying a G code in the program, each mode is enabled, and the advanced preview feed-forward function set above is applied.

G code		Mode
Mode ON	Mode OFF	
G05.1Q1	G05.1Q0	AI contour control mode
G05P10000	G05P0	HPCC mode

* Appendix C lists the supported CNCs.

If the modes above are off, the normal feed-forward coefficient is enabled.

NOTE
1 Use this function only when very high command response is required.
2 When using this function, set a detection unit of 0.1 μm wherever possible. (To set a detection unit of 0.1 μm, the IS-C system must be used, or the CMR and flexible feed gear must be multiplied by 10 with the IS-B system.)

H METHODS OF STARTING UP THE MACHINE WITHOUT CONNECTING AMPLIFIERS AND FEEDBACK CABLES

Appendix H, " METHODS OF STARTING UP THE MACHINE WITHOUT CONNECTING AMPLIFIERS AND FEEDBACK CABLES ", consists of the following sections:

H.1 FEEDBACK DUMMY FUNCTION

(1) Overview

The feedback dummy function ignores servo alarms of axes to which neither servo amplifier nor servo motor is connected.

(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0	03.0 and subsequent editions	
Series 30*i*/31*i*/32*i*-A	90E0	A(01) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	A(01) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

(3) Setting the feedback dummy function

Setting the following function bit enables alarms related to the built-in Pulsecoder and servo amplifier for an axis which is not connected to a servo amplifier or servo motor.

	#7	#6	#5	#4	#3	#2	#1	#0
2009								DMY

DMY(#0) The feedback dummy function is:
0: Disabled.
1: Enabled.

2165	Set 0.

To use the feedback dummy function, a value other than 0 must be entered as the motor number.

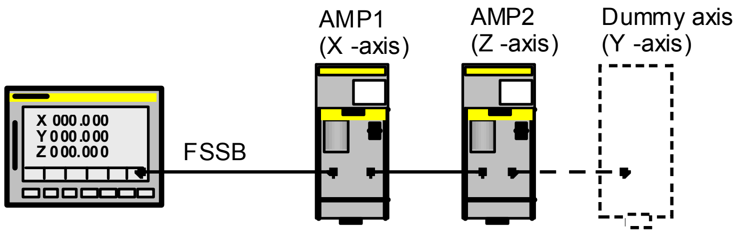
2020	Motor number

Enter an appropriate value other than 0.
Example 252

(4) Caution for setting the FSSB

In an *i* series CNC, the number of amplifiers must match that of axes for reasons of the FSSB setting. If an axis to be set as a dummy axis has not amplifier, make FSSB settings as if a series of existing amplifiers were followed by another amplifier.

Example When there are only two amplifiers for a three-axis NC



Let us consider how to make the Y-axis (second axis) a dummy axis in the above configuration.
Set up the parameters as follows:

(30*i*-A Series, 0*i*-D Series)

No.1023 X:1 **Y:2** Z:3
No.1902 bit1=0, bit0=1
No.1905 bit0 X:0 Y:0 Z:0
No.14340= 0
No.14341= 2
No.14342= 1
No.14343 to 14375= -96
No.2009 bit0 Y:1
No.2165 Y:0

(30*i*-B Series)

No.1023 X:1 **Y:2** Z:3
No.1902 bit1=0, bit0=1
No.24000= 1001
No.24001= 1003
No.24002= 1002
No.24002 to 24031= 1000
No.2009 bit0 Y:1
No.2165 Y:0

* For details of FSSB-related setting, refer to the respective CNC parameter manuals.

(5) Separate detector-based dummy feedback

The separate detector-based dummy feedback function is provided to ignore alarms for an axis when the separate detector is temporarily disconnected from the axis. Set the following bit.

	#7	#6	#5	#4	#3	#2	#1	#0
2205						FULDMY		

FULDMY(#2) The separate detector-based dummy feedback function is:
0: Disabled.
1: Enabled.

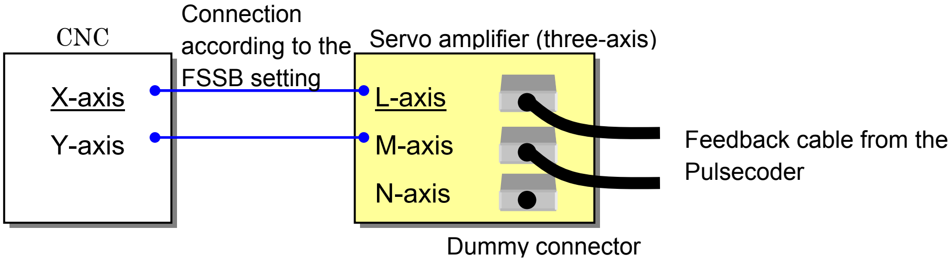
NOTE

1. The relationships of this function with the built-in Pulsecoder feedback dummy function are as follows:
   When only the built-in Pulsecoder feedback dummy function is enabled:
   Alarms related to the built-in Pulsecoder and amplifier are ignored.
   When only the separate detector-based dummy feedback function is enabled:
   Alarms related to the separate detector are ignored.
   When both functions are enabled:
   Alarms related to the built-in Pulsecoder, separate detector, and amplifier are ignored.
2. When using the feedback dummy function, match the control cycle (HRV) with other axes (non-dummy axes).
   Related parameter numbers: No.2004, No.2013 #0, No.2014 #0

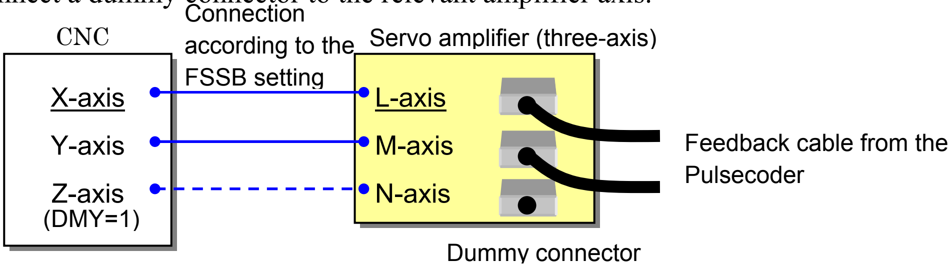
H.2 USING THE DUMMY FEEDBACK FUNCTION FOR A MULTIAXIS SERVO AMPLIFIER WHEN AN AXIS IS NOT IN USE

If an amplifier axis (L, M, or N) is not used for a multiaxis amplifier other than that for the 30*i*-B, it is necessary to connect a dummy connector to the unused amplifier axis.

Information about the dummy connector	Location
Jumper between pins 11 and 12.	JFx



If you want to place a certain CNC axis using an multiaxis amplifier other than a servo amplifier for the 30*i*-B in the unused state using the feedback dummy function setting (DMY = 1) described in Section H.1, it is necessary to connect a dummy connector to the relevant amplifier axis.



When the servo software indicated below is used, the setting of the parameter below enables a multiaxis amplifier to be operated without inserting a dummy connector.

CNC	Servo software		Remarks
	Series	Edition	
Series 30*i*/31*i*/32*i*-A	90E0	L(12) and subsequent editions	
	90E1	01.0	
Series 30*i*/31*i*-A	90D0	L(12) and subsequent editions	HRV4
Series 0*i*-D	90C5	A(01) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	A(01) and subsequent editions	
	90E8	A(01) and subsequent editions	

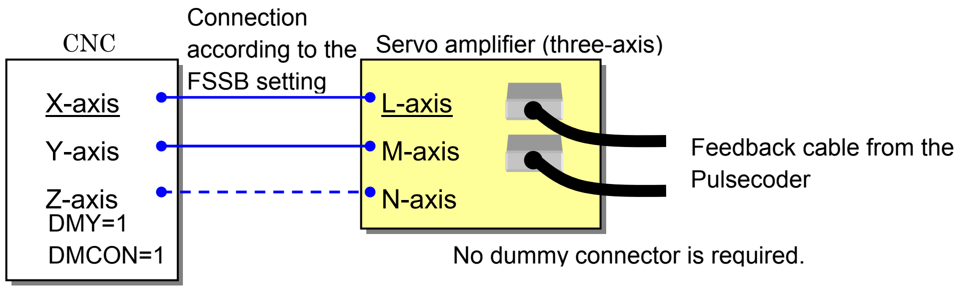
	#7	#6	#5	#4	#3	#2	#1	#0
2279								DMCON

DMCON(#0) In emergency stop cancellation with the feedback dummy function enabled (DMY = 1):
0: The ready signal is not output to the amplifier.
1: The ready signal is output to the amplifier.

* To use this parameter, it is necessary to enable the feedback dummy function (set bit 0 of parameter No. 2009 to 1).

NOTE

- According to the status of the ready signal sent from system software to servo control software, DMCON is turned off and on. For this reason, the ready signal to the amplifier is immediately turned off at emergency stop. If you want to use this parameter with a multiaxis amplifier other than that of the 30*i*-B, make sure that the brake control function and quick stop function are not used for another axis using the same multiaxis amplifier. If any of these functions is used, do not use this parameter, and be sure to use a dummy connector.
- When the control axis detach function is used, the ready signal to the amplifier is turned off during detach operation. If you want to keep the ready signal on, set bit 6 (MCCx) of parameter No. 1005 to 1.
  (For details of the control axis detach function, refer to "Series 30*i*-B CONNECTION MANUAL (FUNCTION) (B-64483EN-1)" and other manuals.)



I HRV1 CONTROL PARAMETERS

Series 9096 (for Series 21*i*/ 0*i*-B, Power Mate *i*)
Series 90B0 (for Series 15*i*/16*i*/ 0*i*-B, Power Mate *i*)
Series 90B1 and 90B8 (for Series 15*i*/16*i*/20*i*-B/0*i*-C/0*i* Mate-C, Power Mate *i*)
Series 90B5 and 90B6 (for Series 15*i*/16*i*/20*i*-B/0*i*-C/0*i* Mate-C, Power Mate *i*)

		Motor model	L1500 B1/4is	L3000 B2/2is	L6000 B2/2is	L9000 B2/2is	L15000 C2/2is	αis 300 2000	L3000 B2/4is	L6000 B2/4is	L9000 B2/4is	L15000 C2/3is	L300 A1/4is
		Motor specification	444-B210	445-B110	447-B110	449-B110	456-B110	456-B110	445-B210	447-B210	449-B210	456-B210	441-B200
FS15i	FS16i,etc.	Motor ID No.	90	91	92	93	94	115	120	121	122	123	124
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	01000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000100	00000100	00000100	00000100	00000100	00000000	00000100	00000100	00000100	00000100	00000100
1955	2011		00000000	00000000	00000000	00000000	00000000	00100000	00000000	00000000	00000000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1708	2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000100	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2713	2300		10000000	10000000	10000000	10000000	10000000	00000000	10000000	10000000	10000000	10000000	10000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	1890	4804	4804	5036	1420	1357	1620	2626	4944	2392	526
1853	2041	CUR GAIN P	-7180	-14453	-13138	-16000	-5600	-4212	-11180	-10051	-11831	-8448	-2141
1854	2042	CUR GAIN 3	-2647	-2660	-2660	-2660	-2663	-2710	-2660	-2660	-2660	-2657	-2618
1855	2043	VEL GAIN I	19	16	16	14	10	114	16	10	16	10	16
1856	2044	VEL GAIN P	-260	-214	-214	-195	-131	-1023	-214	-135	-211	-128	-217
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	-4371	-5321	-5321	-5849	-8681	3709	-5321	-8463	-5399	-8861	-8755
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	3787	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
1869	2057	D-PHASE CUR	0	0	0	0	0	-3850	0	0	0	0	0
1870	2058	D-PHASE CUR	0	0	0	0	0	-800	0	0	0	0	0
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	4855	7282	7282	5826
1873	2061	EMFLMT	120	120	120	120	120	120	120	120	120	120	120
1877	2062	OVC K1	32670	32670	32670	32685	32712	32352	32698	32740	32698	32732	32720
1878	2063	OVC K2	1222	1222	1222	1041	703	5196	873	345	873	452	596
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	3626	3626	3626	3087	2086	15494	2590	1024	2590	1340	589
1894	2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	0	0	0	0	0	12288	0	0	0	0	0
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	1402	1402	1402	1293	1063	2385	1184	744	1184	852	564
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	0	0	0	0	0	15000	0	0	0	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	227	455	911	1481	3104	10931	455	1450	1367	3168	52
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	0	0	0	0	0	16	0	0	0	0	0
1704	2111	TQLIM IN DEC.	0	0	0	0	0	1606	0	0	0	0	0
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	0	0	0	0	0	0	0	0	0	0	0
1736	2128	MFWKCE	0	0	0	0	0	5500	0	0	0	0	0
1752	2129	MFWKBL	0	0	0	0	0	791	0	0	0	0	0
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	0	0	0	0	0	1556	0	0	0	0	0
1757	2134	PHDLY2	0	0	0	0	0	20494	0	0	0	0	0
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
1785	2162	OVC2 K1	0	0	0	0	0	0	0	0	0	0	0
1786	2163	OVC2 K2	0	0	0	0	0	0	0	0	0	0	0
1787	2164	OVC2 LIMIT	0	0	0	0	0	0	0	0	0	0	0
1788	2165	MAX CURRENT	45	45	85	135	245	365	85	245	245	365	25
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	L600 A1/4is	L900 A1/4is	L6000 B2/4is	L9000 B2/2is	L9000 B2/4is	L15000 C2/2is					
		Motor specification	442-B200	443-B200	(160A)	(160A)	(360A)	(360A)					
FS15i	FS16i,etc.	Motor ID No.	125	126	127	128	129	130					
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000					
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110					
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000					
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000					
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000					
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000					
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000					
1954	2010		00000100	00000100	00000100	00000100	00000100	00000100					
1955	2011		00000000	00000000	00000000	00000000	00000000	00000000					
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000					
1707	2013		00000000	00000000	00000000	00000110	00001010	00001010					
1708	2014		00000000	00000000	00000000	00000110	00001010	00001010					
1750	2210		00000000	00000000	00000000	00000000	00000000	00000100					
1751	2211		00000000	00000000	00000000	00000000	00000000	00000000					
2713	2300		10000000	10000000	10000000	10000000	10000000	10000000					
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000					
1852	2040	CUR GAIN I	717	390	1751	6198	7416	2130					
1853	2041	CUR GAIN P	-3333	-2009	-6701	-19692	-17747	-8400					
1854	2042	CUR GAIN 3	-2618	-2618	-2660	-2660	-2660	-2663					
1855	2043	VEL GAIN I	9	13	15	12	10	7					
1856	2044	VEL GAIN P	-122	-179	-202	-158	-141	-87					
1857	2045	VEL GAIN 3	0	0	0	0	0	0					
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235					
1859	2047	OBSERVER POA1	-9339	-6367	-5642	-7199	-8099	-13022					
1860	2048	BLACC CMP	0	0	0	0	0	0					
1861	2049	DPFMX	0	0	0	0	0	0					
1862	2050	OBSERVER POK1	956	956	956	956	956	956					
1863	2051	OBSERVER POK2	510	510	510	510	510	510					
1864	2052	OVER SPEED	0	0	0	0	0	0					
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21					
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894					
1867	2055	DB-CMP PHYST	319	319	319	319	319	319					
1868	2056	EMFCMP	0	0	0	0	0	0					
1869	2057	D-PHASE CUR	0	0	0	0	0	0					
1870	2058	D-PHASE CUR	0	0	0	0	0	0					
1871	2059	PPBAS	0	0	0	0	0	0					
1872	2060	TCMD LIMIT	6554	7282	7282	5917	4855	4855					
1873	2061	EMFLMT	120	120	120	120	120	120					
1877	2062	OVC K1	32720	32721	32706	32713	32737	32743					
1878	2063	OVC K2	596	583	777	687	388	313					
1892	2064	TGALMLV	4	4	4	4	4	4					
1893	2065	OVC LIMIT	589	1326	2304	2038	1151	927					
1894	2066	ACC FB GAIN	0	0	0	0	0	0					
1895	2067	TCMD FILTER	0	0	0	0	0	0					
1961-1966	2068-2073		0	0	0	0	0	0					
1967	2074	AALPH	0	0	0	0	0	0					
1970-1976	2077-2083		0	0	0	0	0	0					
1979	2086	RATED CURRENT	564	847	1117	1050	789	708					
1980-1982	2087-2089		0	0	0	0	0	0					
1983	2090	ROBSTL	0	0	0	0	0	0					
1984-1991	2091-2098		0	0	0	0	0	0					
1992	2099	ONEPSL	400	400	400	400	400	400					
1993	2100	INPA1	0	0	0	0	0	0					
1994	2101	INPA2	0	0	0	0	0	0					
1995	2102	DBLIM	0	0	0	0	0	0					
1996	2103	ABVOF	0	0	0	0	0	0					
1997	2104	ABTSH	0	0	0	0	0	0					
1998	2105	TORQUE CONST.	104	104	966	1823	2051	4656					
1999	2106	LP24PA	0	0	0	0	0	0					
1700-1702	2107-2109		0	0	0	0	0	0					
1703	2110	MGSTCM	0	0	0	0	0	0					
1704	2111	TQLIM IN DEC.	0	0	0	0	0	0					
1705	2112	AMRDML	0	0	0	0	0	0					
1706	2113	HRV FILT	0	0	0	0	0	0					
1735	2127	NINTCT	0	0	0	0	0	0					
1736	2128	MFWKCE	0	0	0	0	0	0					
1752	2129	MFWKBL	0	0	0	0	0	0					
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0					
1756	2133	PHDLY1	0	0	0	0	0	0					
1757	2134	PHDLY2	0	0	0	0	0	0					
1782	2159	DGCSMM	0	0	0	0	0	0					
1783	2160	TRQCUP	0	0	0	0	0	0					
1784	2161	OVC STP	0	0	0	0	0	0					
1785	2162	OVC2 K1	0	0	0	0	0	0					
1786	2163	OVC2 K2	0	0	0	0	0	0					
1787	2164	OVC2 LIMIT	0	0	0	0	0	0					
1788	2165	MAX CURRENT	45	45	165	165	365	365					
2716	2302	TQLIM AT STOP	0	0	0	0	0	0					
2717	2304	ACCBSLM	0	0	0	0	0	0					
2718	2305	ACDCEBD	0	0	0	0	0	0					
2723	2310	DCIDBS	0	0	0	0	0	0					
2729	2316	LIMLIM	0	0	0	0	0	0					

Remarks											

		Motor model	βiS2 4000HV	αiF1 5000	βiS2 4000	βiS2/4000 40A	αiF2 5000	βiS4 4000	βiS4/4000 40A	βiS8 3000	βiS8/3000 40A	αiS2 5000	αiS2 5000HV
		Motor specification	0062	0202	0061-Bxx3	0061-Bxx3	0205	0063-Bxx3	0063-Bxx3	0075-Bxx3	0075-Bxx3	0212	0213
FS15i	FS16i, etc.	Motor ID No.	151	152	153	154	155	156	157	158	159	162	163
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00100000	00000000	00100000	00100000	00100000	00000000	00000000	00000000	00000000	00000000	00100000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000100	00000000	00000100	00010000	00000000	00000000	00001110	00000000	00001110	00000000	00000000
1708	2014		00000100	00000000	00000100	00010000	00000000	00000000	00001110	00000000	00001110	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00000010	00000010	00000010	00000010	00000010	00001110	00001110	00001110	00001110	00000010	00000010
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	225	672	280	560	680	288	576	450	900	600	420
1853	2041	CUR GAIN P	-1100	-2294	-1080	-2160	-2247	-960	-1920	-1840	-3680	-1900	-1369
1854	2042	CUR GAIN 3	-2467	-2514	-1112	-1112	-2568	-1144	-1144	-1234	-1234	-2504	-2504
1855	2043	VEL GAIN I	78	66	78	39	76	112	56	164	82	39	39
1856	2044	VEL GAIN P	-700	-594	-698	-349	-680	-1008	-504	-1476	-738	-350	-351
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	-1085	6384	-1089	-2178	5578	-753	-1506	5143	-1029	10853	-1081
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	5600	7000	5600	5600	7000	5600	5600	4200	4200	7000	7000
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	-30	0	0	-30	-20	-20	0	-30	-30	0
1869	2057	D-PHASE CUR	-10250	0	-10250	-10245	-10256	-7700	-7690	-5144	-5133	-10250	-10254
1870	2058	D-PHASE CUR	-1000	0	-1000	-500	-3300	-2240	-1120	-2700	-1350	-2000	-2300
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	6554	7282	6554	3277	7282	7282	3641	7282	3641	7282	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32538	32613	32531	32531	32497	32289	32289	32289	32289	32528	32532
1878	2063	OVC K2	2879	1933	2963	2963	3390	5988	5988	5994	5994	3005	2953
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	8560	5739	8811	2203	10085	17873	4468	17889	4472	8936	8782
1894	2066	ACC FB GAIN	-10	0	-10	-5	0	-10	-5	-10	-5	0	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	20480	0	20480	0	4096	20480	0	16384	0	8192	16384
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	1507	1234	1529	764	1636	2178	1089	2780	1390	1540	1526
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	10000	0	15000	7500	12000	0	0	0	0	0	7500
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	119	72	119	238	109	146	292	226	452	117	117
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	1050	32	1050	564	32	782	284	1805	794	40	40
1704	2111	TQLIM IN DEC.	11600	7710	11600	11600	6460	7790	7790	7930	7930	7745	7700
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	2345	1188	1172	1172	1276	796	796	1442	1442	1137	1137
1736	2128	MFWKCE	1000	570	3000	6000	855	1000	2000	3500	7000	1000	1250
1752	2129	MFWKBL	2574	3211	2574	2574	3211	3130	3130	1552	1552	3851	3847
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	7188	2571	7188	7188	2565	7691	7691	3852	3852	2565	7688
1757	2134	PHDLY2	8990	12850	8990	8990	12850	8976	8976	8990	8990	12825	12850
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
1785	2162	OVC2 K1	32766	32767	32766	32766	32766	32765	32765	32762	32762	32766	32766
1786	2163	OVC2 K2	19	13	20	20	23	42	42	74	74	20	20
1787	2164	OVC2 LIMIT	3617	2425	3723	931	4261	7551	1888	12305	3076	3776	3711
1788	2165	MAX CURRENT	10	25	25	45	25	25	45	25	45	25	10
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	βiS4 4000HV	αiS4 5000	αiS4 5000HV	βiS8 3000HV	βiS12/2000 40A	βiS12 2000	βiS12 3000HV	αC4 3000i	βiS12 3000	αiF4 4000	βiS22 2000
		Motor specification	0064	0215	0216	0076	0077-Bxx3	0077-Bxx3	0079	0221	0078	0223	0085
FS15i	FS16i,etc.	Motor ID No.	164	165	166	167	168	169	170	171	172	173	174
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00000000	00100000	00100000	00000000	00000000	00000000	00000000	00000000	00000000	00100000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00000000	00001110	00000000	00000000	00000000	00000000	00000000	00000000
1708	2014		00000000	00000000	00000000	00000000	00001110	00000000	00000000	00000000	00000000	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00001110	00000010	00000010	00001110	00001110	00001110	00001110	00001000	00001110	00000010	00001110
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	309	400	280	580	951	320	361	926	400	659	750
1853	2041	CUR GAIN P	-1092	-1154	-988	-2070	-3525	-1958	-1521	-4063	-1550	-2463	-3280
1854	2042	CUR GAIN 3	-2496	-2553	-2533	-2600	-1246	-1246	-2604	-2619	-1243	-2623	-1296
1855	2043	VEL GAIN I	112	64	64	166	115	230	170	115	170	106	242
1856	2044	VEL GAIN P	-1010	-574	-574	-1482	-1027	-2054	-1524	-1034	-1530	-953	-2172
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	-751	6614	-661	5118	7390	3695	4978	3670	4960	3980	3496
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	5600	7000	7000	4200	2800	2800	4200	4200	4200	5600	2700
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	-5140	0	0	0	0	0	0	-30	-20	0
1869	2057	D-PHASE CUR	-7700	-10262	-8978	-5144	-3862	-3884	-5140	-5915	-5140	-11789	-3616
1870	2058	D-PHASE CUR	-3000	-3500	-4000	-3500	-2200	-4400	-3200	-1500	-2700	-180	-2800
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	7282	7282	3641	7282	7282	7282	7282	8010	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32299	32289	32289	32301	32646	32284	32435	32406	32205	32446	32106
1878	2063	OVC K2	5865	5994	5994	5842	1520	6045	4164	4529	7041	4029	8275
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	17504	17889	17889	17435	4511	18045	12399	13493	21044	11998	24770
1894	2066	ACC FB GAIN	-10	0	0	-10	-10	-10	-10	0	-10	0	-10
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	8192	0	12288	12288	0	8192	20480	12288	16384	8192	12288
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	2155	2824	2824	2793	1563	3126	2356	1892	2363	1784	2618
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	0	0	8500	0	0	0	0	0	0	15000	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	146	127	127	225	630	315	420	190	418	201	692
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	777	24	32	1805	1282	1	1814	1289	1814	32	0
1704	2111	TQLIM IN DEC.	7790	10310	10290	7930	3940	3940	7930	3900	7930	5130	2866
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	1592	646	500	2885	1350	1350	2388	2544	1194	1443	2459
1736	2128	MFWKCE	1000	2500	3000	1500	8000	4000	3000	5000	3000	2000	4500
1752	2129	MFWKBL	3339	3847	5122	1552	280	280	2056	1812	2056	3338	562
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	7686	2563	7692	3848	1812	1832	5133	3855	5133	6670	3089
1757	2134	PHDLY2	8976	12820	12850	8990	7700	8980	8978	8995	8978	8980	8982
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
1785	2162	OVC2 K1	32765	32762	32762	32762	32766	32760	32764	32766	32764	32766	32763
1786	2163	OVC2 K2	41	77	77	75	21	99	50	31	51	27	64
1787	2164	OVC2 LIMIT	7395	12702	12702	12424	3890	15559	8836	5701	8891	5069	10913
1788	2165	MAX CURRENT	10	25	10	10	45	25	25	25	45	45	45
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	αiF4 4000HV	αC8 2000i	αiF8 3000	βiS22 2000HV	αiF8 3000HV	βiS0.5 6000	βiS1 6000	βiSc8 3000	αiS8 4000	αiS8 4000HV	αiS12 4000
		Motor specification	0225	0226	0227	0086	0229	0115	0116	0075-Bxx7	0235	0236	0238
FS15i	FS16i, etc.	Motor ID No.	175	176	177	178	179	181	182	183	185	186	188
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00100000	00000000	00000000	00000000	00100000	00000000	00000000	00000000	00000000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1708	2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00000010	00001010	00001010	00001110	00000000	00000010	00000010	00001110	00001010	00001010	00001010
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	525	1096	712	1025	886	141	398	450	544	694	657
1853	2041	CUR GAIN P	-2056	-4638	-3187	-4010	-3174	-511	-1137	-1840	-2352	-2700	-2522
1854	2042	CUR GAIN 3	-2619	-2651	-2651	-2665	-2645	-2415	-2388	-1234	-2616	-2636	-2639
1855	2043	VEL GAIN I	113	150	113	244	113	7	6	164	33	34	52
1856	2044	VEL GAIN P	-1009	-1342	-1009	-2182	-1008	-59	-53	-1476	-294	-306	-466
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	3762	2827	3760	3478	3764	-6462	-7176	5143	-1289	-1240	-815
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	5400	2800	4200	2700	3900	7500	7500	4200	5600	5600	5600
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	0	0	0	0	-12850	-12850	-30	0	0	0
1869	2057	D-PHASE CUR	0	-3854	-6418	-3616	-6159	0	-11530	-5144	-7691	-7690	-5904
1870	2058	D-PHASE CUR	0	-1236	-3000	-2800	-1261	0	-1000	-2700	-2000	-2000	-2400
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	8010	7282	8010	6918	7282	7282	7282	7282	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32433	32289	32383	32433	32433	32674	32695	32381	32609	32596	32534
1878	2063	OVC K2	4184	5994	4807	4185	4184	1178	915	4835	1993	2153	2923
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	12461	17889	14327	12462	12461	3497	2714	14410	5920	6396	8692
1894	2066	ACC FB GAIN	0	0	0	-10	0	0	0	-10	0	0	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	12288	8192	12288	12288	16384	20480	20480	16384	8192	8192	4096
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	1888	2593	1950	2611	1948	1376	1212	2780	1253	1302	1518
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	15000	0	0	0	15000	0	0	0	0	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	190	277	369	689	369	42	89	226	562	541	696
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	1032	1552	786	0	782	30	30	1805	519	519	521
1704	2111	TQLIM IN DEC.	12388	3880	5180	2866	0	10290	10290	7930	7780	7268	5170
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	2573	2380	2103	5149	4191	1009	1763	1442	2106	5103	1592
1736	2128	MFWKCE	4000	4500	1500	2500	6000	0	0	3500	4000	4500	3000
1752	2129	MFWKBL	3348	1550	1815	562	1810	0	0	1552	2580	2580	2570
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	6670	3860	5140	3089	0	7690	11560	3852	5652	5150	5135
1757	2134	PHDLY2	8980	8990	8985	8982	0	12820	12880	8990	8990	8990	9000
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
1785	2162	OVC2 K1	32766	32763	32765	32763	32765	32767	32767	32764	32767	32767	32766
1786	2163	OVC2 K2	31	63	33	64	33	16	12	51	13	14	19
1787	2164	OVC2 LIMIT	5676	10709	6053	10854	6042	3015	2340	8896	2501	2702	3672
1788	2165	MAX CURRENT	25	25	45	25	25	25	25	25	85	45	85
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	αiS12 4000HV	αC12 2000i	αiF12 3000	βiSc8/3000 40A	αiF12 3000HV	αC22 2000i	αiF22 3000	βiSc12 2000	αiF22 3000HV	βiSc12/2000 40A	αC30 1500i
		Motor specification	0239	0241	0243	0075-Bxx7	0245	0246	0247	0077-Bxx7	0249	0077-Bxx7	0251
FS15i	FS16i,etc.	Motor ID No.	189	191	193	194	195	196	197	198	199	200	201
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00000000	00100000	00100000	00000000	00100000	00000000	00100000	00000000	00100000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00001110	00000000	00000000	00000000	00000000	00000000	00001110	00000000
1708	2014		00000000	00000000	00000000	00001110	00000000	00000000	00000000	00000000	00000000	00001110	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00001010	00000010	00000000	00001110	00000000	00001010	00000000	00001110	00000000	00001110	00001010
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	783	3809	1072	900	1044	1755	1458	320	1532	951	2644
1853	2041	CUR GAIN P	-3006	-8197	-3835	-3680	-3677	-6536	-5416	-1958	-5641	-3525	-10345
1854	2042	CUR GAIN 3	-2666	-2679	-2630	-1234	-2679	-2694	-2690	-1246	-2692	-1246	-2695
1855	2043	VEL GAIN I	52	280	192	82	193	271	198	230	197	115	166
1856	2044	VEL GAIN P	-470	-2504	-1721	-738	-1727	-2426	-1775	-2054	-1765	-1027	-1486
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	-808	1516	2204	-1029	2197	1565	2137	3695	2150	7390	2553
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	5600	2800	4800	4200	4800	2400	3600	2800	3600	2800	2100
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	-20	0	-5140	0	-20	0	-2590	0	0	0	0
1869	2057	D-PHASE CUR	-5904	-1804	-8199	-5133	-8214	-2597	-5136	-3884	-4392	-3862	-1545
1870	2058	D-PHASE CUR	-3000	-2500	-747	-1350	-2350	-1942	-2800	-4400	-2824	-2200	-1300
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	7282	3641	7282	8010	7282	7282	7282	3641	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32530	32289	32520	32671	32548	32114	32520	32323	32548	32646	32520
1878	2063	OVC K2	2976	5994	3101	1214	2755	8171	3101	5566	2755	1520	3101
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	8848	17889	9224	3603	8192	24454	9224	16603	8192	4511	9224
1894	2066	ACC FB GAIN	0	0	0	-5	0	0	0	-10	0	-10	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	8192	8192	8192	0	12288	8192	8192	8192	8192	0	8192
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	1532	3020	2085	1390	2092	2911	2131	3126	2118	1563	1655
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	0	15000	15000	0	15000	0	15000	0	15000	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	690	350	517	452	516	680	929	315	934	630	1630
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	521	0	32	794	774	1548	1291	1	787	1282	2059
1704	2111	TQLIM IN DEC.	6159	2168	0	7930	0	2600	0	3940	0	3940	2148
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	4904	4150	2388	1442	4787	3695	3272	1350	6547	1350	6680
1736	2128	MFWKCE	2000	12000	2000	7000	4000	4000	4500	4000	6000	8000	14000
1752	2129	MFWKBL	2575	1044	2568	1552	2320	1046	1301	280	1808	280	539
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	6174	5150	0	3852	0	2070	0	1832	0	1812	1054
1757	2134	PHDLY2	8990	8990	0	8990	0	9000	0	8980	0	7700	9000
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	0	0	0	0	0	0	0	0	0	0
1785	2162	OVC2 K1	32766	32761	32765	32767	32765	32761	32765	32763	32765	32767	32766
1786	2163	OVC2 K2	20	91	38	12	39	83	40	60	40	15	23
1787	2164	OVC2 LIMIT	3738	14518	6924	2224	6969	13493	7229	10250	7142	2785	4361
1788	2165	MAX CURRENT	45	25	85	45	45	45	85	25	45	45	85
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	βiS22/1500 FS0i	αiF30 3000	βiS22/1500 FS0i 40A	βiSc2 4000	αiF40 3000	αiF40 3000Fan	βiSc2/4000 40A	βiSc4 4000	βiSc4/4000 40A	βiS22 3000	βiS22 3000HV
		Motor specification	0084-Bxx6	0253	0084-Bxx6	0061-Bxx7	0257	0257	0061-Bxx7	0063-Bxx7	0063-Bxx7	0082	0083
FS15i	FS16i, etc.	Motor ID No.	202	203	205	206	207	208	210	211	212	213	214
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00000000	00000000	00000000	00100000	00100000	00100000	00100000	00000000	00000000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00001110	00000100	00000000	00000000	00010000	00000000	00001110	00001000	00001000
1708	2014		00000000	00000000	00001110	00000100	00000000	00000000	00010000	00000000	00001110	00001000	00001000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00001110	00001010	00001110	00000010	00001010	00001010	00000010	00001110	00001110	00001110	00001110
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	1048	597	4342	280	1289	1289	560	288	576	646	775
1853	2041	CUR GAIN P	-4337	-2334	-11170	-1080	-5048	-5048	-2160	-960	-1920	-2486	-3580
1854	2042	CUR GAIN 3	-2659	-2694	-1329	-1112	-2696	-2696	-1112	-1144	-1144	-1298	-2663
1855	2043	VEL GAIN I	280	230	140	78	191	191	39	112	56	198	192
1856	2044	VEL GAIN P	-2507	-2057	-1254	-698	-1712	-1712	-349	-1008	-504	-1766	-1722
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	3027	1845	6054	-1089	2216	2216	-2178	-753	-1506	4297	4406
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	1800	4800	1800	5600	4200	4200	5600	5600	5600	4200	4200
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	0	0	0	0	0	0	-20	0	0	0
1869	2057	D-PHASE CUR	-2110	-5170	-2079	-10250	-2570	-2570	-10245	-7700	-7690	-6174	-6174
1870	2058	D-PHASE CUR	-4691	-1000	-2342	-1000	-2000	-2000	-500	-2240	-1120	-2843	-2843
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	3641	6554	7282	7282	3277	7282	3641	5462	5462
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32319	32515	32655	32652	32515	32431	32739	32532	32709	32520	32548
1878	2063	OVC K2	5617	3166	1411	1455	3166	4212	364	2945	738	3097	2755
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	16756	9418	4189	4317	9418	12545	1079	8758	2189	9212	8192
1894	2066	ACC FB GAIN	-10	0	-10	-10	0	0	-5	-10	-5	-10	-10
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	8192	8192	0	20480	8192	8192	0	20480	0	8192	8192
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	3012	2306	1506	1529	1957	2593	764	2178	1089	2121	2069
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	0	0	0	15000	15000	15000	7500	0	0	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	597	1170	1194	119	1839	1839	238	146	292	848	869
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	1025	1032	514	1050	1291	1291	564	782	284	1289	1289
1704	2111	TQLIM IN DEC.	2248	7735	2248	11600	5140	5140	11600	7790	7790	7268	7268
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	3290	1688	3290	1172	3041	3041	1172	796	796	1967	3894
1736	2128	MFWKCE	5500	2500	11000	3000	2000	2000	6000	1000	2000	6000	6000
1752	2129	MFWKBL	1032	2829	1032	2574	1553	1553	2574	3130	3130	2315	2315
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	2580	5140	2580	7188	3087	3087	7188	7691	7691	5647	5647
1757	2134	PHDLY2	8990	8995	4382	8990	8990	8990	8990	8976	8976	12820	12820
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	0	128	0	120	128	128	120	120	120	0	0
1785	2162	OVC2 K1	32763	32764	32767	32757	32764	32717	32765	32745	32762	32765	32765
1786	2163	OVC2 K2	60	48	14	140	46	637	34	294	70	40	38
1787	2164	OVC2 LIMIT	10345	8124	2586	2665	8124	10815	666	5407	1352	7166	6815
1788	2165	MAX CURRENT	25	165	45	25	165	165	45	25	45	85	45
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	αiS22 4000	αiS22 4000HV	αiS30 4000	αiS30 4000HV	αiS40 4000	αiS40 4000HV	αiS50 3000	αiS50 3000Fan	αiS50 3000HVFan	αiS50 3000HV	αiS100 2500Fan
		Motor specification	0265	0266	0268	0269	0272	0273	0275	0275	0276	0276	0285
FS15i	FS16i, etc.	Motor ID No.	215	216	218	219	222	223	224	225	226	227	230
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	01000110	01000110	00000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1708	2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010	00001010
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	714	709	689	816	748	860	528	528	680	680	874
1853	2041	CUR GAIN P	-2904	-2806	-2675	-3277	-3055	-3457	-2088	-2088	-2961	-2961	-4483
1854	2042	CUR GAIN 3	-2674	-1345	-2683	-2696	-2682	-2700	-2690	-2690	-2697	-2697	-2717
1855	2043	VEL GAIN I	69	76	82	82	92	93	69	69	70	70	91
1856	2044	VEL GAIN P	-616	-685	-733	-738	-827	-831	-622	-622	-628	-628	-819
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	6163	5538	5175	5143	4589	4569	6099	6099	6039	6039	4632
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	5600	5600	5400	5400	4800	4800	4200	4200	4200	4200	0
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	31979	31979	31979	31979	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	3	3	3	3	1894
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
1869	2057	D-PHASE CUR	-7689	-7684	-6415	-6415	-5648	-5652	-5646	-5646	-5646	-5646	-4368
1870	2058	D-PHASE CUR	-2000	-1000	-3000	-3000	-3000	-3600	-2000	-2000	-2000	-2000	-1359
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32515	32501	32515	32501	32515	32501	32558	32348	32371	32554	32309
1878	2063	OVC K2	3166	3332	3166	3332	3166	3332	2627	5245	4967	2680	5734
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	9418	9912	9418	9912	9418	9912	7810	15639	14807	7968	27346
1894	2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	4096	8192	4096	4096	4096	4096	4096	4096	0	0	20480
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	1627	1810	1836	1847	2073	2083	1439	2037	2057	1454	2848
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	0	0	0	15000	15000	15000	7500	0	0	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	1216	1093	1470	1460	1701	1693	3312	3312	3279	3279	4589
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	519	513	775	775	776	769	519	519	519	519	776
1704	2111	TQLIM IN DEC.	6224	6194	6450	6430	5682	5682	6174	6174	6174	6174	3787
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	2041	4264	1871	5117	1853	5230	2046	2046	4861	4861	3520
1736	2128	MFWKCE	2500	2000	4000	3000	4000	4000	6500	6500	2500	2500	6500
1752	2129	MFWKBL	2580	3092	2574	2574	2063	2063	2063	2063	2068	2068	1297
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	5150	5150	5150	5150	5150	5150	5150	5150	5140	5140	2570
1757	2134	PHDLY2	8990	8990	8990	8990	8988	8988	8990	8990	9000	9000	8970
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	128	0	128	0	128	0	0	0	0	0	140
1785	2162	OVC2 K1	32766	32766	32765	32766	32765	32765	32754	32739	32738	32754	32745
1786	2163	OVC2 K2	28	28	37	30	38	38	174	365	373	178	292
1787	2164	OVC2 LIMIT	5177	5218	6687	5432	6846	6908	3300	6608	6736	3366	13952
1788	2165	MAX CURRENT	165	85	165	85	165	85	365	365	185	185	365
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	αiS100 2500HVFan	αiS200 2500Fan	αiS100 2500	αiS100 2500HV	αiS200 2500HVFan	αiS200 2500	αiS200 2500HV	αiS300 2000	αiS300 2000HV	αiS500 2000	αiS500 2000HV
		Motor specification	0286	0288	0285	0286	0289	0288	0289	0292	0293	0295	0296
FS15i	FS16i,etc.	Motor ID No.	231	234	235	236	237	238	239	242	243	245	246
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
1809	2004		00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	01000110	00000110	01000110
1883	2005		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1884	2006		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1951	2007		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1952	2008		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1953	2009		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1954	2010		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1955	2011		00100000	00000000	00000000	00100000	00000000	00000000	00000000	00100000	00000000	00000000	00000000
1956	2012		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1707	2013		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1708	2014		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1750	2210		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1751	2211		00000000	00001010	00001010	00000000	00001010	00001010	00001010	00000000	00001010	00001010	00001010
2713	2300		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
2714	2301		00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
1852	2040	CUR GAIN I	980	1309	874	980	1194	1309	1194	1357	1077	1943	1713
1853	2041	CUR GAIN P	-4082	-5199	-4483	-4082	-5535	-5199	-5535	-4212	-5101	-6970	-6505
1854	2042	CUR GAIN 3	-2718	-2719	-2717	-2718	-2719	-2719	-2719	-2710	-2712	-2711	-2713
1855	2043	VEL GAIN I	91	115	91	91	115	115	115	114	114	134	134
1856	2044	VEL GAIN P	-819	-1026	-819	-819	-1026	-1026	-1026	-1023	-1025	-1199	-1199
1857	2045	VEL GAIN 3	0	0	0	0	0	0	0	0	0	0	0
1858	2046	VEL GAIN 4	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235	-8235
1859	2047	OBSERVER POA1	4636	3699	4632	4636	3699	3699	3699	3709	3703	3164	3164
1860	2048	BLACC CMP	0	0	0	0	0	0	0	0	0	0	0
1861	2049	DPFMX	0	0	0	0	0	0	0	0	0	0	0
1862	2050	OBSERVER POK1	956	956	956	956	956	956	956	956	956	956	956
1863	2051	OBSERVER POK2	510	510	510	510	510	510	510	510	510	510	510
1864	2052	OVER SPEED	0	0	0	0	0	0	0	0	0	0	0
1865	2053	DB-CMP PPMAX	21	21	21	21	21	21	21	21	21	21	21
1866	2054	DB-CMP PDDP	1894	1894	1894	1894	1894	1894	1894	3787	3787	1894	3787
1867	2055	DB-CMP PHYST	319	319	319	319	319	319	319	319	319	319	319
1868	2056	EMFCMP	0	0	0	0	0	0	0	0	0	0	0
1869	2057	D-PHASE CUR	-3846	-3090	-4368	-3846	-3088	-3090	-3088	-3850	-3846	-2068	-2070
1870	2058	D-PHASE CUR	-900	-2700	-1359	-900	-3000	-2700	-3000	-800	-900	-2600	-2700
1871	2059	PPBAS	0	0	0	0	0	0	0	0	0	0	0
1872	2060	TCMD LIMIT	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
1873	2061	EMFLMT	0	0	0	0	0	0	0	0	0	0	0
1877	2062	OVC K1	32309	32309	32310	32474	32309	32309	32309	32391	32391	32309	32309
1878	2063	OVC K2	5734	5734	5728	3672	5734	5734	5734	4714	4714	5734	5734
1892	2064	TGALMLV	4	4	4	4	4	4	4	4	4	4	4
1893	2065	OVC LIMIT	27346	27346	15662	15982	27346	27346	27346	23263	23263	27346	27346
1894	2066	ACC FB GAIN	0	0	0	0	0	0	0	0	0	0	0
1895	2067	TCMD FILTER	0	0	0	0	0	0	0	0	0	0	0
1961-1966	2068-2073		0	0	0	0	0	0	0	0	0	0	0
1967	2074	AALPH	12288	12288	20480	12288	12288	12288	12288	12288	12288	12288	12288
1970-1976	2077-2083		0	0	0	0	0	0	0	0	0	0	0
1979	2086	RATED CURRENT	2848	3013	1960	2033	3013	2712	2712	2483	2483	2980	2980
1980-1982	2087-2089		0	0	0	0	0	0	0	0	0	0	0
1983	2090	ROBSTL	0	0	0	0	0	0	0	0	0	0	0
1984-1991	2091-2098		0	0	0	0	0	0	0	0	0	0	0
1992	2099	ONEPSL	400	400	400	400	400	400	400	400	400	400	400
1993	2100	INPA1	0	0	0	0	0	0	0	0	0	0	0
1994	2101	INPA2	0	0	0	0	0	0	0	0	0	0	0
1995	2102	DBLIM	10000	0	0	10000	0	0	0	15000	0	0	0
1996	2103	ABVOF	0	0	0	0	0	0	0	0	0	0	0
1997	2104	ABTSH	0	0	0	0	0	0	0	0	0	0	0
1998	2105	TORQUE CONST.	4423	5973	4589	4423	5973	5973	5973	10871	10871	15096	15096
1999	2106	LP24PA	0	0	0	0	0	0	0	0	0	0	0
1700-1702	2107-2109		0	0	0	0	0	0	0	0	0	0	0
1703	2110	MGSTCM	1291	1290	776	1291	1291	1290	1291	16	1296	1296	1293
1704	2111	TQLIM IN DEC.	0	0	3787	0	3428	0	3428	1606	0	0	3714
1705	2112	AMRDML	0	0	0	0	0	0	0	0	0	0	0
1706	2113	HRV FILT	0	0	0	0	0	0	0	0	0	0	0
1735	2127	NINTCT	6952	3518	3520	6952	6729	3518	6729	0	7634	4175	8341
1736	2128	MFWKCE	2000	4000	6500	2000	4000	4000	4000	5500	5000	4000	4500
1752	2129	MFWKBL	1549	1298	1297	1549	1551	1298	1551	791	1301	1041	788
1753-1755	2130-2132	SMOOTH CMP	0	0	0	0	0	0	0	0	0	0	0
1756	2133	PHDLY1	0	2068	2570	0	2575	2068	2575	1556	2574	2069	2324
1757	2134	PHDLY2	0	12820	8970	0	8984	12820	8984	20494	12814	8981	8984
1782	2159	DGCSMM	0	0	0	0	0	0	0	0	0	0	0
1783	2160	TRQCUP	0	0	0	0	0	0	0	0	0	0	0
1784	2161	OVC STP	140	140	106	140	140	140	140	140	140	140	140
1785	2162	OVC2 K1	32745	32745	32750	32759	32745	32745	32745	32738	32738	32745	32745
1786	2163	OVC2 K2	292	292	223	112	292	292	292	375	375	292	292
1787	2164	OVC2 LIMIT	13952	13952	6581	6752	13952	13952	13952	13952	13952	13952	13952
1788	2165	MAX CURRENT	185	365	365	185	185	365	185	365	365	365	365
2716	2302	TQLIM AT STOP	0	0	0	0	0	0	0	0	0	0	0
2717	2304	ACCBSLM	0	0	0	0	0	0	0	0	0	0	0
2718	2305	ACDCEBD	0	0	0	0	0	0	0	0	0	0	0
2723	2310	DCIDBS	0	0	0	0	0	0	0	0	0	0	0
2729	2316	LIMLIM	0	0	0	0	0	0	0	0	0	0	0

Remarks											

		Motor model	αiS1000 2000HV										
		Motor specification	0298										
FS15i	FS16i,etc.	Motor ID No.	248										
PRM. NO.	PRM. NO.	SYMBOL											
1808	2003		00001000										
1809	2004		01000110										
1883	2005		00000000										
1884	2006		00000000										
1951	2007		00000000										
1952	2008		00000000										
1953	2009		00000000										
1954	2010		00000000										
1955	2011		00100000										
1956	2012		00000000										
1707	2013		00000000										
1708	2014		00000000										
1750	2210		00000000										
1751	2211		00000010										
2713	2300		00000000										
2714	2301		00000000										
1852	2040	CUR GAIN I	1053										
1853	2041	CUR GAIN P	-3316										
1854	2042	CUR GAIN 3	-2722										
1855	2043	VEL GAIN I	234										
1856	2044	VEL GAIN P	-2096										
1857	2045	VEL GAIN 3	0										
1858	2046	VEL GAIN 4	-8235										
1859	2047	OBSERVER POA1	1811										
1860	2048	BLACC CMP	0										
1861	2049	DPFMX	0										
1862	2050	OBSERVER POK1	956										
1863	2051	OBSERVER POK2	510										
1864	2052	OVER SPEED	0										
1865	2053	DB-CMP PPMAX	21										
1866	2054	DB-CMP PDDP	3787										
1867	2055	DB-CMP PHYST	319										
1868	2056	EMFCMP	0										
1869	2057	D-PHASE CUR	-3097										
1870	2058	D-PHASE CUR	-2000										
1871	2059	PPBAS	0										
1872	2060	TCMD LIMIT	7282										
1873	2061	EMFLMT	0										
1877	2062	OVC K1	32309										
1878	2063	OVC K2	5734										
1892	2064	TGALMLV	4										
1893	2065	OVC LIMIT	27346										
1894	2066	ACC FB GAIN	0										
1895	2067	TCMD FILTER	0										
1961-1966	2068-2073		0										
1967	2074	AALPH	12288										
1970-1976	2077-2083		0										
1979	2086	RATED CURRENT	2834										
1980-1982	2087-2089		0										
1983	2090	ROBSTL	0										
1984-1991	2091-2098		0										
1992	2099	ONEPSL	400										
1993	2100	INPA1	0										
1994	2101	INPA2	0										
1995	2102	DBLIM	15000										
1996	2103	ABVOF	0										
1997	2104	ABTSH	0										
1998	2105	TORQUE CONST.	28573										
1999	2106	LP24PA	0										
1700-1702	2107-2109		0										
1703	2110	MGSTCM	1296										
1704	2111	TQLIM IN DEC.	3172										
1705	2112	AMRDML	0										
1706	2113	HRV FILT	0										
1735	2127	NINTCT	8637										
1736	2128	MFWKCE	6000										
1752	2129	MFWKBL	1047										
1753-1755	2130-2132	SMOOTH CMP	0										
1756	2133	PHDLY1	2580										
1757	2134	PHDLY2	8985										
1782	2159	DGCSMM	0										
1783	2160	TRQCUP	0										
1784	2161	OVC STP	140										
1785	2162	OVC2 K1	32745										
1786	2163	OVC2 K2	292										
1787	2164	OVC2 LIMIT	13952										
1788	2165	MAX CURRENT	365										
2716	2302	TQLIM AT STOP	0										
2717	2304	ACCBSLM	0										
2718	2305	ACDCEBD	0										
2723	2310	DCIDBS	0										
2729	2316	LIMLIM	0										

Remarks											

J SETTINGS FOR THE POWER CONSUMPTION MONITOR FUNCTION

Appendix J, " SETTINGS FOR THE POWER CONSUMPTION MONITOR FUNCTION ", consists of the following sections:

J.1 INTERNAL UNIT SETTINGS AND COIL RESISTANCE SETTINGS

Table J.1(a) Internal unit settings and coil resistance setting for each motor model

Series	Motor model	Specification	Unit setting (No.2281)		Coil resistance	Remarks
			#1	#0	No.2468	
αiS(200V)	αiS2/5000	A06B-0212-B□0□	1	0	5734	
	αiS2/6000	A06B-0218-B□0□	1	0	5734	
	αiS4/5000	A06B-0215-B□0□	1	0	2499	
	αiS4/6000	A06B-0210-B□0□	1	0	2499	
	αiS8/4000	A06B-0235-B□0□	1	0	1270	
	αiS8/6000	A06B-0232-B□0□	1	0	532	
	αiS12/4000	A06B-0238-B□0□	1	0	737	
	αiS12/6000	A06B-0230-B□0□	0	1	266	
	αiS22/4000	A06B-0265-B□0□	0	1	307	
	αiS22/6000	A06B-0262-B□0□	0	1	160	
	αiS30/4000	A06B-0268-B□0□	0	1	254	
	αiS40/4000	A06B-0272-B□0□,-B□2□	0	1	238	
	αiS50/2000	A06B-0042-B□0□,-B□2□	0	1	315	
	αiS60/2000	A06B-0044-B□0□,-B□2□	0	1	303	
	αiS50/3000FAN	A06B-0275-B□1□,-B□3□	0	1	98	
	αiS60/3000FAN	A06B-0278-B□1□,-B□3□	0	1	135	
	αiS100/2500	A06B-0285-B□00	0	1	53	
	αiS100/2500FAN	A06B-0285-B□10	0	1	53	
	αiS200/2500	A06B-0288-B□00	0	1	45	
	αiS200/2500FAN	A06B-0288-B□10	0	1	45	
	αiS300/2000	A06B-0292-B□10	0	1	49	*1
	αiS500/2000	A06B-0295-B□10	0	1	49	*1
αiS(400V)	αiS2/5000HV	A06B-0213-B□0□	1	0	22118	
	αiS2/6000HV	A06B-0219-B□0□	1	0	22938	
	αiS4/5000HV	A06B-0216-B□0□	1	0	11469	
	αiS4/6000HV	A06B-0214-B□0□	1	0	11469	
	αiS8/4000HV	A06B-0236-B□0□	1	0	5325	
	αiS8/6000HV	A06B-0233-B□0□	1	0	2048	
	αiS12/4000HV	A06B-0239-B□0□	1	0	3441	
	αiS12/6000HV	A06B-0237-B□0□	0	1	1065	
	αiS22/4000HV	A06B-0266-B□0□	1	0	1024	
	αiS22/6000HV	A06B-0263-B□0□	0	1	655	
	αiS30/4000HV	A06B-0269-B□0□	0	1	1024	
	αiS40/4000HV	A06B-0273-B□0□,-B□2□	0	1	942	

Series	Motor model	Specification	Unit setting (No.2281)		Coil resistance	Remarks
			#1	#0	No.2468	
α*i*S(400V)	α*i*S50/2000HV	A06B-0043-B□0□,-B□2□	0	1	1270	
	α*i*S60/2000HV	A06B-0043-B□0□,-B□2□	0	1	1229	
	α*i*S50/3000HVFAN	A06B-0276-B□1□,-B□3□	0	1	410	
	α*i*S60/3000HVFAN	A06B-0279-B□1□,-B□3□	0	1	532	
	α*i*S100/2500HV	A06B-0286-B□00	0	1	213	
	α*i*S100/2500HVFAN	A06B-0286-B□10	0	1	213	
	α*i*S200/2500HV	A06B-0289-B□00	0	1	188	
	α*i*S200/2500HVFAN	A06B-0289-B□10	0	1	188	
	α*i*S300/2000HV	A06B-0293-B□10	0	1	197	*1
	α*i*S300/3000HV	A06B-0290-B□10	0	1	119	
	α*i*S500/2000HV	A06B-0296-B□10	0	1	205	*1
	α*i*S500/3000HV	A06B-0297-B□10	0	0	106	
	α*i*S1000/2000HV	A06B-0098-B□10	0	0	41	*1
	α*i*S1000/3000HV	A06B-0099-B050	0	0	20	*1
	α*i*S2000/2000HV	A06B-0091-B□40	0	0	16	*1, *2
	α*i*S3000/2000HV	A06B-0092-B□40	0	0	14	*1, *2
α*i*F(200V)	α*i*F1/5000	A06B-0202-B□0□	1	1	5734	
	α*i*F2/5000	A06B-0205-B□0□	1	0	4506	
	α*i*F4/4000	A06B-0223-B□0□	1	0	1638	
	α*i*F8/3000	A06B-0227-B□0□	1	0	2089	
	α*i*F12/3000	A06B-0243-B□0□	1	0	655	
	α*i*F22/3000	A06B-0247-B□0□	1	0	655	
	α*i*F30/3000	A06B-0253-B□0□	1	0	164	
	α*i*F40/3000	A06B-0257-B□0□,-B□2□	0	1	279	
	α*i*F40/3000FAN	A06B-0257-B□1□,-B□3□	0	1	279	
α*i*F(400V)	α*i*F4/4000HV	A06B-0225-B□0□	1	0	6144	
	α*i*F8/3000HV	A06B-0229-B□0□	1	0	7782	
	α*i*F12/3000HV	A06B-0245-B□0□	1	0	2662	
	α*i*F22/3000HV	A06B-0249-B□0□	1	0	2703	
β*i*S(200V)	β*i*S0.2/5000	A06B-0111-B□03	1	1	24576	
	β*i*S0.3/5000	A06B-0112-B□03	1	1	32767	
	β*i*S0.4/5000	A06B-0114-B□03	1	1	2253	
	β*i*S0.5/6000	A06B-0115-B□03	1	1	3482	
	β*i*S1/6000	A06B-0116-B□03	1	0	6144	
	β*i*S2/4000	A06B-0061-B□03, -B□06	1	1	6554	
	β*i*S4/4000	A06B-0063-B□03, -B□06	1	0	3850	
	β*i*S8/3000	A06B-0075-B□03, -B□06	1	0	4096	
	β*i*S12/2000	A06B-0077-B□03, -B□06	1	0	3564	
	β*i*S12/3000	A06B-0078-B□03	1	0	1597	
	β*i*S22/2000	A06B-0085-B□03	1	0	1802	
	β*i*S22/3000	A06B-0082-B□03	1	0	696	
	β*i*S30/2000	A06B-0087-B□03	1	0	614	
	β*i*S40/2000	A06B-0089-B□03	1	0	696	
β*i*S(400V)	β*i*S2/4000HV	A06B-0062-B□03	1	1	27034	
	β*i*S4/4000HV	A06B-0064-B□03	1	0	16384	
	β*i*S8/3000HV	A06B-0076-B□03	1	0	15974	
	β*i*S12/3000HV	A06B-0079-B□03	1	0	6554	
	β*i*S22/2000HV	A06B-0086-B□03	1	0	7373	
	β*i*S22/3000HV	A06B-0083-B□03	1	0	2785	
	β*i*S30/2000HV	A06B-0088-B□03	1	0	2499	
	β*i*S40/2000HV	A06B-0090-B□03	1	0	2703	

Series	Motor model	Specification	Unit setting (No.2281) #1	Unit setting (No.2281) #0	Coil resistance No.2468	Remarks
β*i*Sc	β*i*Sc2/4000	A06B-0061-B□07	1	1	6554	
	β*i*Sc4/4000	A06B-0063-B□07	1	0	3850	
	β*i*Sc8/3000	A06B-0075-B□07	1	0	4096	
	β*i*Sc12/3000	A06B-0077-B□07	1	0	3564	
D*i*S(200V)	D*i*S15/1000(200V)	A06B-0492-B100	1	1	17367	
	D*i*S22/600(200V)	A06B-0482-B100	1	1	20091	
	D*i*S22/1500(200V)	A06B-0482-B12□	1	1	13312	
	D*i*S60/400(200V)	A06B-0493-B200	1	1	13844	
	D*i*S70/300(200V)	A06B-0494-B100	1	1	12042	
	D*i*S85/400(200V)	A06B-0483-B200	1	1	7373	
	D*i*S85/1000(200V)	A06B-0483-B22□	1	0	4649	
	D*i*S110/400(200V)	A06B-0484-B100	1	1	1905	
	D*i*S110/1000(200V)	A06B-0484-B12□	1	0	1802	
	D*i*S150/300(200V)	A06B-0494-B300	1	0	5304	
	D*i*S200/300(200V)	A06B-0494-B400	1	0	6881	
	D*i*S250/250(200V)	A06B-0495-B200	1	0	4178	
	D*i*S260/300(200V)	A06B-0484-B300	1	1	3277	
	D*i*S260/1000(200V)	A06B-0484-B32□	1	0	922	
	D*i*S370/300(200V)	A06B-0484-B400	1	0	4301	
	D*i*S400/250(200V)	A06B-0485-B204	1	0	6144	
	D*i*S500/250(200V)	A06B-0495-B400	1	0	1761	
	D*i*S800/250(200V)	A06B-0485-B400	1	0	2540	
	D*i*S1000/200(200V)	A06B-0496-B300	1	0	1618	
	D*i*S1200/250(200V)	A06B-0485-B500	1	0	3707	
	D*i*S1500/100(200V)	A06B-0497-B300	1	0	2150	
	D*i*S1500/250(200V)	A06B-0486-B300	1	0	1556	
	D*i*S2000/100(200V)	A06B-0497-B400	1	0	2847	
	D*i*S2000/150(200V)	A06B-0497-B490	1	0	717	
D*i*S(400V)	D*i*S15/1000(400V)	A06B-0492-B100	1	0	17367	
	D*i*S22/600(400V)	A06B-0482-B102	1	1	20091	
	D*i*S60/400(400V)	A06B-0493-B200	1	0	13844	
	D*i*S70/300(400V)	A06B-0494-B100	1	0	12042	
	D*i*S85/400(400V)	A06B-0483-B202	1	1	7373	
	D*i*S110/400(400V)	A06B-0484-B102	1	1	1905	
	D*i*S150/300(400V)	A06B-0494-B300	1	0	5304	
	D*i*S200/300(400V)	A06B-0494-B400	1	0	6881	
	D*i*S250/250(400V)	A06B-0495-B200	1	0	4178	
	D*i*S260/300(400V)	A06B-0484-B302	1	0	3277	
	D*i*S370/300(400V)	A06B-0484-B402	1	0	4301	
	D*i*S400/250(400V)	A06B-0485-B205	1	0	6144	
	D*i*S500/250(400V)	A06B-0495-B400	1	0	1761	
	D*i*S800/250(400V)	A06B-0485-B402	1	0	2540	
	D*i*S1000/200(400V)	A06B-0496-B300	1	0	1618	
	D*i*S1200/250(400V)	A06B-0485-B502	1	0	3707	
	D*i*S1500/100(400V)	A06B-0497-B300	1	0	2150	
	D*i*S1500/250(400V)	A06B-0486-B302	0	1	1556	
	D*i*S2000/100(400V)	A06B-0497-B400	1	0	2847	
	D*i*S2000/150(400V)	A06B-0497-B490	0	1	717	
	D*i*S5000/50(400V)	A06B-0488-B400	1	0	5468	

Series	Motor model	Specification	Unit setting (No.2281)		Coil resistance	Remarks
			#1	#0	No.2468	
L*i*S(200V)	L*i*S300A1/4(200V)	A06B-0441-B200	1	1	12288	
	L*i*S600A1/4(200V)	A06B-0442-B200	1	1	6144	
	L*i*S900A1/4(200V)	A06B-0443-B200	1	1	4096	
	L*i*S1500B1/4(200V)	A06B-0444-B2□0	1	0	6267	
	L*i*S3000B2/2(200V)	A06B-0445-B1□0	1	0	10691	
	L*i*S3000B2/4(200V)	A06B-0445-B2□0	1	0	2662	
	L*i*S3300C1/2(200V)	A06B-0451-B1□0	1	0	5079	
	L*i*S4500B2/2(200V)	A06B-0446-B1□0	1	0	6963	
	L*i*S6000B2/2(200V)	A06B-0447-B1□0	1	0	5243	
	L*i*S6000B2/4(200V)	A06B-0447-B2□0	1	0	1311	
	L*i*S7500B2/2(200V)	A06B-0448-B1□0	1	0	4301	
	L*i*S9000B2/2(200V)	A06B-0449-B1□0	1	0	3564	
	L*i*S9000B2/4(200V)	A06B-0449-B210	1	0	901	
	L*i*S9000C2/2(200V)	A06B-0454-B1□0	1	0	3236	
	L*i*S10000C3/2(200V)	A06B-0457-B1□0	1	0	2949	
	L*i*S11000C2/2(200V)	A06B-0455-B1□0	1	0	2540	
	L*i*S15000C2/2(200V)	A06B-0456-B1□0	1	0	1843	
	L*i*S15000C2/3(200V)	A06B-0456-B2□0	1	0	819	
	L*i*S17000C3/2(200V)	A06B-0459-B1□0	1	0	1720	
L*i*S(400V)	L*i*S3000B2/2(400V)	A06B-0445-B1□0	1	0	10691	
	L*i*S3300C1/2(400V)	A06B-0451-B1□0	1	0	5079	
	L*i*S4500B2/2HV	A06B-0446-B0□0	1	0	19825	
	L*i*S4500B2/2(400V)	A06B-0446-B1□0	1	0	6963	
	L*i*S6000B2/2HV	A06B-0447-B0□0	1	0	15114	
	L*i*S6000B2/2(400V)	A06B-0447-B1□0	1	0	5243	
	L*i*S7500B2/2HV	A06B-0448-B0□0	1	0	11551	
	L*i*S7500B2/2(400V)	A06B-0448-B1□0	1	0	4301	
	L*i*S9000B2/2(400V)	A06B-0449-B1□0	1	0	3564	
	L*i*S9000C2/2HV	A06B-0454-B0□0	1	0	14008	
	L*i*S9000C2/2(400V)	A06B-0454-B1□0	1	0	3236	
	L*i*S10000C3/2HV	A06B-0457-B0□0	1	0	11756	
	L*i*S10000C3/2(400V)	A06B-0457-B1□0	1	0	2949	
	L*i*S11000C2/2HV	A06B-0455-B0□0	1	0	11018	
	L*i*S11000C2/2(400V)	A06B-0455-B1□0	1	0	2540	
	L*i*S15000C2/3HV	A06B-0456-B0□0	1	0	3686	
	L*i*S15000C2/2(400V)	A06B-0456-B1□0	1	0	1843	
	L*i*S17000C3/2HV	A06B-0459-B0□0	1	0	6922	
	L*i*S17000C3/2(400V)	A06B-0459-B1□0	0	1	1720	

*1 If you want to use the power consumption monitor function for an axis for which a motor with plural windings is used, set the parameters only for the main axis. (For details, see the descriptions of the relevant parameters.)

*2 If the torque control function is used for an axis for which one of the above motors is used, the power consumption monitor function cannot be used.

J.2 SETTINGS FOR SERVO AMPLIFIER LOSS COEFFICIENTS A AND B

Table J.2(a) Settings for servo amplifier loss coefficients A and B

Series	Motor model	Specification	Axis	Loss coefficient A	Loss coefficient B No.2490		
				No.2469	HRV2	HRV3	HRV4
αiSV(200V)	αiSV4	A06B-6240-H101	L	832	307	397	576
	αiSV20	A06B-6240-H103	L	832	307	397	576
	αiSV40	A06B-6240-H104	L	832	269	339	486
	αiSV80	A06B-6240-H105	L	832	262	352	518
	αiSV160	A06B-6240-H106	L	1152	288	371	538
	αiSV360	A06B-6240-H109	L	1600	301	352	480
	αiSV4/4	A06B-6240-H201	L	608	307	397	576
			M	608	307	397	576
	αiSV4/20	A06B-6240-H203	L	608	307	397	576
			M	608	307	397	576
	αiSV20/20	A06B-6240-H205	L	608	307	397	576
			M	608	307	397	576
	αiSV20/40	A06B-6240-H206	L	608	307	397	576
			M	608	269	339	486
	αiSV40/40	A06B-6240-H207	L	672	269	339	486
			M	672	269	339	486
	αiSV40/80	A06B-6240-H208	L	672	269	339	486
			M	672	262	352	518
	αiSV80/80	A06B-6240-H209	L	672	262	352	518
			M	672	262	352	518
	αiSV80/160	A06B-6240-H210	L	736	262	352	518
			M	736	288	371	538
	αiSV160/160	A06B-6240-H211	L	736	288	371	538
			M	736	288	371	538
	αiSV4/4/4	A06B-6240-H301	L	555	307	397	576
			M	555	307	397	576
			N	555	307	397	576
	αiSV20/20/20	A06B-6240-H305	L	555	307	397	576
			M	555	307	397	576
			N	555	307	397	576
	αiSV20/20/40	A06B-6240-H306	L	555	307	397	576
			M	555	307	397	576
			N	555	269	339	486
	αiSV40/40/40	A06B-6240-H308	L	661	269	339	486
			M	661	269	339	486
			N	661	269	339	486
	αiSV4	A06B-6117-H101	L	832	320	416	-
	αiSV20	A06B-6117-H103	L	832	320	416	-
	αiSV40	A06B-6117-H104	L	832	294	378	-
	αiSV80	A06B-6117-H105	L	832	275	371	-
	αiSV160	A06B-6117-H106	L	1088	301	390	-
	αiSV360	A06B-6117-H109	L	1600	314	371	506
	αiSV20L	A06B-6117-H153	L	896	320	416	602
	αiSV40L	A06B-6117-H154	L	896	294	378	538
	αiSV80L	A06B-6117-H155	L	1152	275	371	544
	αiSV160L	A06B-6117-H156	L	1024	301	390	563

Series	Motor model	Specification	Axis	Loss coefficient A	Loss coefficient B No.2490		
				No.2469	HRV2	HRV3	HRV4
αiSV(200V)	αiSV4/4	A06B-6117-H201	L	544	320	416	-
			M	544	320	416	-
	αiSV4/20	A06B-6117-H203	L	544	320	416	-
			M	544	320	416	-
	αiSV20/20	A06B-6117-H205	L	544	320	416	-
			M	544	320	416	-
	αiSV20/40	A06B-6117-H206	L	544	320	416	-
			M	544	294	378	-
	αiSV40/40	A06B-6117-H207	L	608	294	378	-
			M	608	294	378	-
	αiSV40/80	A06B-6117-H208	L	608	294	378	-
			M	608	275	371	-
	αiSV80/80	A06B-6117-H209	L	608	275	371	-
			M	608	275	371	-
	αiSV80/160	A06B-6117-H210	L	608	275	371	-
			M	608	301	390	-
	αiSV160/160	A06B-6117-H211	L	608	301	390	-
			M	608	301	390	-
	αiSV20/20L	A06B-6117-H255	L	672	320	416	602
			M	672	320	416	602
	αiSV20/40L	A06B-6117-H256	L	672	320	416	602
			M	672	294	378	538
	αiSV40/40L	A06B-6117-H257	L	736	294	378	538
			M	736	294	378	538
	αiSV40/80L	A06B-6117-H258	L	672	294	378	538
			M	672	275	371	544
	αiSV80/80L	A06B-6117-H259	L	672	275	371	544
			M	672	275	371	544
	αiSV4/4/4	A06B-6117-H301	L	512	320	416	-
			M	512	320	416	-
			N	512	320	416	-
	αiSV20/20/20	A06B-6117-H303	L	512	320	416	-
			M	512	320	416	-
			N	512	320	416	-
	αiSV20/20/40	A06B-6117-H304	L	512	320	416	-
			M	512	320	416	-
			N	512	294	378	-
	αiSV40S/40S/40	A06B-6117-H306	L	448	288	365	-
			M	448	288	365	-
			N	448	294	378	-
αiSV(400V)	αiSV10HV	A06B-6290-H102	L	832	499	902	1606
	αiSV20HV	A06B-6290-H103	L	832	538	883	1530
	αiSV40HV	A06B-6290-H104	L	832	538	928	1651
	αiSV80HV	A06B-6290-H105	L	1152	550	749	1440
	αiSV180HV	A06B-6290-H106	L	1600	538	749	1421
	αiSV360HV	A06B-6290-H109	L	2176	474	672	1107
	αiSV540HV	A06B-6290-H110	L	2752	512	-	-
	αiSV10/10HV	A06B-6290-H202	L	608	499	902	1606
			M	608	499	902	1606
	αiSV10/20HV	A06B-6290-H204	L	608	499	902	1606
			M	608	538	883	1530

Series	Motor model	Specification	Axis	Loss coefficient A	Loss coefficient B No.2490		
				No.2469	HRV2	HRV3	HRV4
αiSV(400V)	αiSV20/20HV	A06B-6290-H205	L	672	538	883	1530
			M	672	538	883	1530
	αiSV20/40HV	A06B-6290-H206	L	672	538	883	1530
			M	672	538	928	1651
	αiSV40/40HV	A06B-6290-H207	L	672	538	928	1651
			M	672	538	928	1651
	αiSV40/80HV	A06B-6290-H208	L	736	538	928	1651
			M	736	550	749	1440
	αiSV80/80HV	A06B-6290-H209	L	736	550	749	1440
			M	736	550	749	1440
	αiSV10/10/10HV	A06B-6290-H302	L	555	499	902	1606
			M	555	499	902	1606
			N	555	499	902	1606
	αiSV10/10/20HV	A06B-6290-H303	L	555	499	902	1606
			M	555	499	902	1606
			N	555	538	883	1530
	αiSV20/20/20HV	A06B-6290-H305	L	661	538	883	1530
			M	661	538	883	1530
			N	661	538	883	1530
	αiSV10HV	A06B-6127-H102	L	832	525	947	-
	αiSV20HV	A06B-6127-H103	L	832	563	928	-
	αiSV40HV	A06B-6127-H104	L	832	563	979	-
	αiSV80HV	A06B-6127-H105	L	1088	576	787	-
	αiSV180HV	A06B-6127-H106	L	1600	563	787	1498
	αiSV360HV	A06B-6127-H109	L	2176	499	704	1165
	αiSV10HVL	A06B-6127-H152	L	896	525	947	1690
	αiSV20HVL	A06B-6127-H153	L	896	563	928	1613
	αiSV40HVL	A06B-6127-H154	L	1152	563	979	1741
	αiSV80HVL	A06B-6127-H155	L	1024	576	787	1517
	αiSV10/10HV	A06B-6127-H202	L	544	525	947	-
			M	544	525	947	-
	αiSV20/20HV	A06B-6127-H205	L	544	563	928	-
			M	544	563	928	-
	αiSV20/40HV	A06B-6127-H206	L	608	563	928	-
			M	608	563	979	-
	αiSV40/40HV	A06B-6127-H207	L	608	563	979	-
			M	608	563	979	-
	αiSV40/80HV	A06B-6127-H208	L	608	563	979	-
			M	608	576	787	-
	αiSV80/80HV	A06B-6127-H209	L	608	576	787	-
			M	608	576	787	-
	αiSV10/10HVL	A06B-6127-H252	L	608	525	947	1690
			M	608	525	947	1690
	αiSV20/20HVL	A06B-6127-H255	L	672	563	928	1613
			M	672	563	928	1613
	αiSV20/40HVL	A06B-6127-H256	L	672	563	928	1613
			M	672	563	979	1741
	αiSV40/40HVL	A06B-6127-H257	L	672	563	979	1741
			M	672	563	979	1741

Series	Motor model	Specification	Axis	Loss coefficient A	Loss coefficient B No.2490		
				No.2469	HRV2	HRV3	HRV4
β*i*SV	β*i*SV4	A-06B-6160-H001	L	960	320	416	-
	β*i*SV20	A-06B-6160-H002	L	960	320	416	-
	β*i*SV40	A-06B-6160-H003	L	960	294	378	-
	β*i*SV80	A-06B-6160-H004	L	960	275	371	-
	β*i*SV20/20	A-06B-6166-H201	L	512	320	416	-
			M	512	320	416	-
	β*i*SV40/40	A-06B-6166-H203	L	512	288	365	-
			L	512	288	365	-
	β*i*SV4	A-06B-6130-H001	L	960	320	416	-
	β*i*SV20	A-06B-6130-H002	L	960	320	416	-
	β*i*SV40	A-06B-6130-H003	L	960	294	378	-
	β*i*SV80	A-06B-6130-H004	L	960	275	371	-
	β*i*SV20/20	A-06B-6136-H201	L	512	320	416	-
			M	512	320	416	-
	β*i*SV40/40	A-06B-6136-H203	L	512	288	365	-
			L	512	288	365	-
β*i*SV(400V)	β*i*SV10HV	A-06B-6161-H001	L	960	525	947	-
	β*i*SV20HV	A-06B-6161-H002	L	960	563	928	-
	β*i*SV40HV	A-06B-6161-H003	L	960	563	979	-
	β*i*SV10HV	A-06B-6131-H001	L	960	525	947	-
	β*i*SV20HV	A-06B-6131-H002	L	960	563	928	-
	β*i*SV40HV	A-06B-6131-H003	L	960	563	979	-
β*i*SVSP	β*i*SVSP 40/40-18	A06B-6164-H224#H580	L	0	294	378	-
			M	0	294	378	-
	β*i*SVSP 40/40/80-18	A06B-6164-H344#H580	L	0	294	378	-
			M	0	294	378	-
			N	0	275	371	-
	β*i*SVSP 80/80/80-18	A06B-6164-H364#H580	L	0	275	371	-
			M	0	275	371	-
			N	0	275	371	-
	β*i*SVSP 20/20-7.5	A06B-616*-H201#H5*0	L	0	320	416	-
			M	0	320	416	-
	β*i*SVSP 20/20-11	A06B-616*-H202#H5*0	L	0	320	416	-
			M	0	320	416	-
	β*i*SVSP 40/40-15	A06B-616*-H223#H5*0	L	0	294	378	-
			M	0	294	378	-
	β*i*SVSP 20/20/40-7.5	A06B-616*-H311#H5*0	L	0	320	416	-
			M	0	320	416	-
			N	0	294	378	-
	β*i*SVSP 20/20/40-11	A06B-616*-H312#H5*0	L	0	320	416	-
			M	0	320	416	-
			N	0	294	378	-
	β*i*SVSP 40/40/40-15	A06B-616*-H333#H5*0	L	0	294	378	-
			M	0	294	378	-
			N	0	294	378	-
	β*i*SVSP 40/40/80-15	A06B-616*-H343#H5*0	L	0	294	378	-
			M	0	294	378	-
			N	0	275	371	-
	β*i*SVSP 20/20-5.5	A06B-6134-H201#A,C	L	0	294	378	-
			M	0	294	378	-

Series	Motor model	Specification	Axis	Loss coefficient A No.2469	Loss coefficient B No.2490 HRV2	HRV3	HRV4
βiSVSP	βiSVSP 20/20-7.5	A06B-6134-H201#D	L	0	320	416	-
			M	0	320	416	-
	βiSVSP 20/20-11	A06B-6134-H202#A,C	L	0	294	378	-
			M	0	294	378	-
		A06B-6134-H202#D	L	0	320	416	-
			M	0	320	416	-
	βiSVSP 40/40-15	A06B-6134-H203#A,C,D	L	0	294	378	-
			M	0	294	378	-
	βiSVSP 20/20/40-5.5	A06B-6134-H301#A,C	L	0	294	378	-
			M	0	294	378	-
			N	0	294	378	-
	βiSVSP 20/20/40-7.5	A06B-6134-H301#D	L	0	320	416	-
			M	0	320	416	-
			N	0	294	378	-
	βiSVSP 20/20/40-11	A06B-6134-H302#A,C	L	0	294	378	-
			M	0	294	378	-
			N	0	294	378	-
		A06B-6134-H302#D	L	0	320	416	-
			M	0	320	416	-
			N	0	294	378	-
	βiSVSP 40/40/40-15	A06B-6134-H303#A,C,D	L	0	294	378	-
			M	0	294	378	-
			N	0	294	378	-
	βiSVSP 40/40/80-15	A06B-6134-H313#D	L	0	294	378	-
			M	0	294	378	-
			N	0	275	371	-
βiSVSPc	βiSVSPc 20/20-7.5	A06B-6167-H201#H560	L	0	320	416	-
			M	0	320	416	-
	βiSVSPc 20/20-7.5L	A06B-6167-H209#H560	L	0	320	416	-
			M	0	320	416	-
	βiSVSPc 20/20-11	A06B-6167-H202#H560	L	0	320	416	-
			M	0	320	416	-
	βiSVSPc 20/20/20-7.5	A06B-6167-H301#H560	L	0	320	416	-
			M	0	320	416	-
			N	0	320	416	-
	βiSVSPc 20/20/20-7.5L	A06B-6167-H309#H560	L	0	320	416	-
			M	0	320	416	-
			N	0	320	416	-
	βiSVSPc 20/20/20-11	A06B-6167-H302#H560	L	0	320	416	-
			M	0	320	416	-
			N	0	320	416	-

J.3 SETTINGS FOR POWER SUPPLY MODULE LOSS COEFFICIENTS C AND D

Table J.3(a) Settings for power supply module loss coefficients C and D for the αiPS (200 V)

Series	Motor model	Specification	Loss coefficient C	Loss coefficient DNo.2491		Resistance regeneration
			No.2463	Three-phase input	Single-phase input	No.2281#2
α*i*PS(200V)	α*i*PS7.5	A06B-6200-H008	1037	659	-	0
	α*i*PS11	A06B-6200-H011	1037	659	-	0
	α*i*PS15	A06B-6200-H015	1037	653	-	0
	α*i*PS26	A06B-6200-H026	1344	717	-	0
	α*i*PS30	A06B-6200-H030	1344	704	-	0
	α*i*PS37	A06B-6200-H037	1344	723	-	0
	α*i*PS55	A06B-6200-H055	2266	672	-	0
	α*i*PS5.5	A06B-6140-H006	2234	659	-	0
	α*i*PS11	A06B-6140-H011	2477	659	-	0
	α*i*PS15	A06B-6140-H015	2477	653	-	0
	α*i*PS26	A06B-6140-H026	2925	717	-	0
	α*i*PS30	A06B-6140-H030	2925	704	-	0
	α*i*PS37	A06B-6140-H037	2925	723	-	0
	α*i*PS55	A06B-6140-H055	3712	672	-	0
α*i*PS(400V)	α*i*PS11HV	A06B-6250-H011	1120	397	-	0
	α*i*PS18HV	A06B-6250-H018	1120	378	-	0
	α*i*PS30HV	A06B-6250-H030	1427	499	-	0
	α*i*PS45HV	A06B-6250-H045	1427	486	-	0
	α*i*PS60HV	A06B-6250-H060	1427	486	-	0
	α*i*PS75HV	A06B-6250-H075	2349	480	-	0
	α*i*PS100HV	A06B-6250-H100	2349	480	-	0
	α*i*PS11HV	A06B-6150-H011	2906	397	-	0
	α*i*PS18HV	A06B-6150-H018	2906	378	-	0
	α*i*PS30HV	A06B-6150-H030	3584	499	-	0
	α*i*PS45HV	A06B-6150-H045	4237	486	-	0
	α*i*PS60HV	A06B-6150-H060	4237	486	-	0
	α*i*PS75HV	A06B-6150-H75	4134	480	-	0
	α*i*PS100HV	A06B-6150-H100	4134	480	-	0
α*i*PSR	α*i*PSR3	A06B-6115-H003	973	659	-	1
	α*i*PSR5.5	A06B-6115-H006	973	659	-	1
β*i*SV(200V)	β*i*SV4	A06B-6160-H001	0	621	1024	1
	β*i*SV20	A06B-6160-H002	0	621	1024	1
	β*i*SV40	A06B-6160-H003	0	646	-	1
	β*i*SV80	A06B-6160-H004	0	646	-	1
	β*i*SV20/20	A06B-6166-H201	0	710	-	1
	β*i*SV40/40	A06B-6166-H203	0	710	-	1
	β*i*SV4	A06B-6130-H001	0	621	1024	1
	β*i*SV20	A06B-6130-H002	0	621	1024	1
	β*i*SV40	A06B-6130-H003	0	646	-	1
	β*i*SV80	A06B-6130-H004	0	646	-	1
	β*i*SV20/20	A06B-6136-H201	0	710	-	1
	β*i*SV40/40	A06B-6136-H203	0	710	-	1

Series	Motor model	Specification	Loss coefficient C	Loss coefficient DNo.2491		Resistance regeneration
			No.2463	Three-phase input	Single-phase input	No.2281#2
βiSV(400V)	βiSV10HV	A06B-6161-H001	0	320	-	1
	βiSV20HV	A06B-6161-H002	0	320	-	1
	βiSV40HV	A06B-6161-H003	0	320	-	1
	βiSV10HV	A06B-6131-H001	0	320	-	1
	βiSV20HV	A06B-6131-H002	0	320	-	1
	βiSV40HV	A06B-6131-H003	0	320	-	1
βiSVSP	βiSVSP 40/40-18	A06B-6164-H224#H580	1984	659	-	0
	βiSVSP 40/40/80-18	A06B-6164-H344#H580	2048	653	-	0
	βiSVSP 80/80/80-18	A06B-6164-H364#H580	2048	653	-	0
	βiSVSP 20/20-7.5	A06B-616*-H201#H5*0	1984	659	-	0
	βiSVSP 20/20-11	A06B-616*-H202#H5*0	1984	659	-	0
	βiSVSP 40/40-15	A06B-616*-H223#H5*0	1984	653	-	0
	βiSVSP 20/20/40-7.5	A06B-616*-H311#H5*0	2048	659	-	0
	βiSVSP 20/20/40-11	A06B-616*-H312#H5*0	2048	659	-	0
	βiSVSP 40/40/40-15	A06B-616*-H333#H5*0	2048	653	-	0
	βiSVSP 40/40/80-15	A06B-616*-H343#H5*0	2048	653	-	0
	βiSVSP 20/20-5.5	A06B-6134-H201#A,C	1664	659	-	0
	βiSVSP 20/20-7.5	A06B-6134-H201#D	1664	659	-	0
	βiSVSP 20/20-11	A06B-6134-H202#A,C	1664	659	-	0
		A06B-6134-H202#D	1664	659	-	0
	βiSVSP 40/40-15	A06B-6134-H203#A,C,D	1664	653	-	0
	βiSVSP 20/20/40-5.5	A06B-6134-H301#A,C	1728	659	-	0
	βiSVSP 20/20/40-7.5	A06B-6134-H301#D	1728	659	-	0
	βiSVSP 20/20/40-11	A06B-6134-H302#A,C	1728	659	-	0
		A06B-6134-H302#D	1728	659	-	0
	βiSVSP 40/40/40-15	A06B-6134-H303#A,C,D	1728	653	-	0
	βiSVSP 40/40/80-15	A06B-6134-H313#D	1728	653	-	0
βiSVSPc	βiSVSPc 20/20-7.5	A06B-6167-H201#H560	1984	659	-	0
	βiSVSPc 20/20-7.5L	A06B-6167-H209#H560	1984	659	-	0
	βiSVSPc 20/20-11	A06B-6167-H202#H560	1984	659	-	0
	βiSVSPc 20/20/20-7.5	A06B-6167-H301#H560	1984	653	-	0
	βiSVSPc 20/20/20-7.5L	A06B-6167-H309#H560	1984	653	-	0
	βiSVSPc 20/20/20-11	A06B-6167-H302#H560	1984	653	-	0

K CORRESPONDENCE OF SERVO PARAMETER NUMBERS BETWEEN Series 15*i*, AND Series 30*i*, 0*i*, AND OTHERS

The following table lists the correspondence of servo parameter numbers between Series 15*i*, and Series 30*i*, 0*i*, and others.

Series 30*i*, 0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*
1815	1815	2040	1852	2085	1978
1817	1817	2041	1853	2086	1979
1821	1896	2042	1854	2087	1980
1825	1825	2043	1855	2088	1981
1851	1851	2044	1856	2089	1982
2000	1804	2045	1857	2090	1983
2001	1806	2046	1858	2091	1984
2002	1807	2047	1859	2092	1985
2003	1808	2048	1860	2093	1986
2004	1809	2049	1861	2094	1987
2005	1883	2050	1862	2095	1988
2006	1884	2051	1863	2096	1989
2007	1951	2052	1864	2097	1990
2008	1952	2053	1865	2098	1991
2009	1953	2054	1866	2099	1992
2010	1954	2055	1867	2100	1993
2011	1955	2056	1868	2101	1994
2012	1956	2057	1869	2102	1995
2013	1707	2058	1870	2103	1996
2014	1708	2059	1871	2104	1997
2015	1957	2060	1872	2105	1998
2016	1958	2061	1873	2106	1999
2017	1959	2062	1877	2107	1700
2018	1960	2063	1878	2108	1701
2019	1709	2064	1892	2109	1702
2020	1874	2065	1893	2110	1703
2021	1875	2066	1894	2111	1704
2022	1879	2067	1895	2112	1705
2023	1876	2068	1961	2113	1706
2024	1891	2069	1962	2114	1725
2025	1710	2070	1963	2115	1726
2026	1717	2071	1964	2116	1727
2027	1712	2072	1965	2117	1728
2028	1713	2073	1966	2118	1729
2029	1714	2074	1967	2119	1730
2030	1715	2075	1968	2120	1731
2031	1716	2076	1969	2121	1732
2032	1717	2077	1970	2122	1733
2033	1718	2078	1971	2123	1734
2034	1719	2079	1972	2124	1739
2035	1720	2080	1973	2125	
2036	1721	2081	1974	2126	1737

Series 30*i*, 0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*
2037	1722	2082	1975	2127	1735
2038	1723	2083	1976	2128	1736
2039	1724	2084	1977	2129	1752
2130	1753	2180	2623	2230	2643
2131	1754	2181	2624	2231	2644
2132	1755	2182	2625	2232	2645
2133	1756	2183	2626	2233	2646
2134	1757	2184	2627	2234	2647
2135	1758	2185	2628	2235	2648
2136	1759	2186	2629	2236	2649
2137	1760	2187	2630	2237	2650
2138	1761	2188	2631	2238	2651
2139	1762	2189	2632	2239	2652
2140	1763	2190	2633	2240	2653
2141	1764	2191	2634	2241	2654
2142	1765	2192	2635	2242	2655
2143	1766	2193	2636	2243	2656
2144	1767	2194	2637	2244	2657
2145	1768	2195	2638	2245	2658
2146	1769	2196	2639	2246	2659
2147	1770	2197	2640	2247	2660
2148	1771	2198	2641	2248	2661
2149	1772	2199	2642	2249	2662
2150	1773	2200	1740	2250	2663
2151	1774	2201	1741	2251	2664
2152	1775	2202	1742	2252	2665
2153	1776	2203	1743	2253	2666
2154	1777	2204	1744	2254	2667
2155	1778	2205	1745	2255	2668
2156	1779	2206	1746	2256	2669
2157	1780	2207	1747	2257	2670
2158	1781	2208	1748	2258	2671
2159	1782	2209	1749	2259	2672
2160	1783	2210	1750	2260	2673
2161	1784	2211	1751	2261	2674
2162	1785	2212	2600	2262	2675
2163	1786	2213	2601	2263	2676
2164	1787	2214	2602	2264	2677
2165	1788	2215	2603	2265	2678
2166	1789	2216	2604	2266	2679
2167	1790	2217	2605	2267	2680
2168	1791	2218	2606	2268	2681
2169	1792	2219	2607	2269	2682
2170	1793	2220	2608	2270	2683
2171	1794	2221	2609	2271	2684
2172	1795	2222	2610	2272	2685
2173	1796	2223	2611	2273	2686
2174	1797	2224	2612	2274	2687
2175	1798	2225	2613	2275	2688
2176	1799	2226	2614	2276	2689
2177	2620	2227	2615	2277	2690
2178	2621	2228	2616	2278	2691
2179	2622	2229	2617	2279	2692
2280	2693	2330	2743	2380	2793

Series 30*i*, 0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*
2281	2694	2331	2744	2381	2794
2282	2695	2332	2745	2382	2795
2283	2696	2333	2746	2383	2796
2284	2697	2334	2747	2384	2797
2285	2698	2335	2748	2385	2798
2286	2699	2336	2749	2386	2799
2287	2700	2337	2750	2387	2800
2288	2701	2338	2751	2388	2801
2289	2702	2339	2752	2389	2802
2290	2703	2340	2753	2390	2803
2291	2704	2341	2754	2391	2804
2292	2705	2342	2755	2392	2805
2293	2706	2343	2756	2393	2806
2294	2707	2344	2757	2394	2807
2295	2708	2345	2758	2395	2808
2296	2709	2346	2759	2396	2809
2297	2710	2347	2760	2397	2810
2298	2711	2348	2761	2398	2811
2299	2712	2349	2762	2399	2812
2300	2713	2350	2763	2400	2813
2301	2714	2351	2764	2401	2814
2302	2715	2352	2765	2402	2815
2303	2716	2353	2766	2403	2816
2304	2717	2354	2767	2404	2817
2305	2718	2355	2768	2405	2818
2306	2719	2356	2769	2406	2819
2307	2720	2357	2770	2407	2820
2308	2721	2358	2771	2408	2821
2309	2722	2359	2772	2409	2822
2310	2723	2360	2773	2410	2823
2311	2724	2361	2774	2411	2824
2312	2725	2362	2775	2412	2825
2313	2726	2363	2776	2413	2826
2314	2727	2364	2777	2414	2827
2315	2728	2365	2778	2415	2828
2316	2729	2366	2779	2416	2829
2317	2730	2367	2780	2417	2830
2318	2731	2368	2781	2418	2831
2319	2732	2369	2782	2419	2832
2320	2733	2370	2783	2420	2833
2321	2734	2371	2784	2421	2834
2322	2735	2372	2785	2422	2835
2323	2736	2373	2786	2423	2836
2324	2737	2374	2787	2424	2837
2325	2738	2375	2788	2425	2838
2326	2739	2376	2789	2426	2839
2327	2740	2377	2790	2427	2840
2328	2741	2378	2791	2428	2841
2329	2742	2379	2792	2429	2842
2430	2843	2480	2893	2530	2945
2431	2844	2481	2894	2531	2946
2432	2845	2482	2895	2532	2947
2433	2846	2483	2896	2533	2948
2434	2847	2484	2897	2534	2949

Series 30*i*, 0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*	Series 30*i*,0*i*, and others	Series15*i*
2435	2848	2485	2898	2535	2950
2436	2849	2486	2899	2536	2951
2437	2850	2487	2902	2537	2952
2438	2851	2488	2903	2538	2953
2439	2852	2489	2904	2539	2954
2440	2853	2490	2905	2540	2955
2441	2854	2491	2906	2541	2956
2442	2855	2492	2907	2542	2957
2443	2856	2493	2908	2543	2958
2444	2857	2494	2909	2544	2959
2445	2858	2495	2910	2545	2960
2446	2859	2496	2911	2546	2961
2447	2860	2497	2912	2547	2962
2448	2861	2498	2913	2548	2963
2449	2862	2499	2914	2549	2964
2450	2863	2500	2915	2550	2965
2451	2864	2501	2916	2551	2966
2452	2865	2502	2917	2552	2967
2453	2866	2503	2918	2553	2968
2454	2867	2504	2919	2554	2969
2455	2868	2505	2920	2555	2970
2456	2869	2506	2921	2556	2971
2457	2870	2507	2922	2557	2972
2458	2871	2508	2923		
2459	2872	2509	2924		
2460	2873	2510	2925		
2461	2874	2511	2926		
2462	2875	2512	2927		
2463	2876	2513	2928		
2464	2877	2514	2929		
2465	2878	2515	2930		
2466	2879	2516	2931		
2467	2880	2517	2932		
2468	2881	2518	2933		
2469	2882	2519	2934		
2470	2883	2520	2935		
2471	2884	2521	2936		
2472	2885	2522	2937		
2473	2886	2523	2938		
2474	2887	2524	2939		
2475	2888	2525	2940		
2476	2889	2526	2941		
2477	2890	2527	2942		
2478	2891	2528	2943		
2479	2892	2529	2944		

L CONNECTING A LARGE SERVO MOTOR USING A PWM DISTRIBUTION MODULE

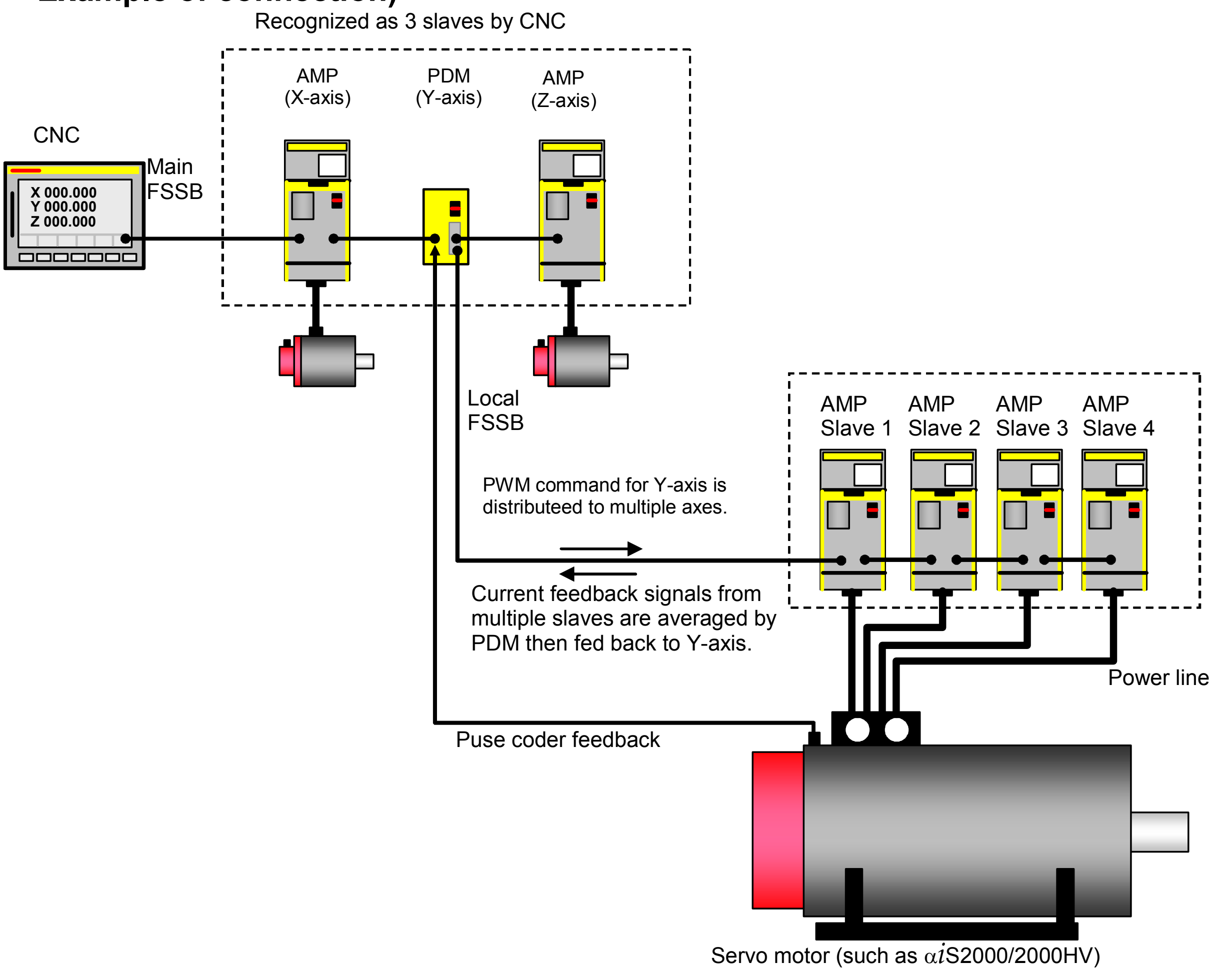
L.1 SETTING PARAMETERS FOR A PWM DISTRIBUTION MODULE (PDM)

(1) Overview

The PWM distribution module (PDM) has a function for copying a PWM command for one axis received from the CNC and distributing the command copy to multiple servo amplifiers and a function for finding an average current per servo amplifier from current feedback signals received from multiple servo amplifiers and transferring the average current to the CNC. Multiple servo amplifiers connected to a PDM can be viewed from the CNC as being connected to one axis. So, by using a PDM, high power can be achieved through parallel driving without increasing the number of CNC controlled axes.

> **NOTE**
> When a PWM distribution module is used, HRV3 needs to be set. So, one FSSB path cannot connect more than four slaves consisting of amplifiers and a PDM.

Example of connection)



(2) Series and editions of applicable servo software

CNC	Servo software		Remarks
	Series	Edition	
Series 0*i*-D	90C5	D(04) and subsequent editions	
	90C8	A(01) and subsequent editions	
	90E5	D(04) and subsequent editions	
	90E8	A(01) and subsequent editions	
Series 16*i*/18*i*/21*i*-B Power Mate *i*-D/H	90B1	A(01) and subsequent editions	

To use a PDM, the following system software is needed:

CNC	System software	
	Series	Edition
Series 0*i*-MD	D4F1	01 and subsequent editions
Series 0*i*-TD	D6F1	01 and subsequent editions
Series 0*i* Mate-MD	D5F1	01 and subsequent editions
Series 0*i* Mate-TD	D7F1	01 and subsequent editions
Series 16*i*-MB	B0M1,B0N1	01 and subsequent editions
Series 16*i*-TB	-	-
Series 18*i*-MB5	BDM5,BDN5	01 and subsequent editions
Series 18*i*-MB	BDM1,BDN1	01 and subsequent editions
Series 18*i*-TB	-	-
Series 18*i*-LNB	-	-
Series 21*i*-MB	DDHA	17 and subsequent editions
	DDHK,DDK1	01 and subsequent editions
Series 21*i*-TB	-	-
Power Mate *i*-D	88E1	01 and subsequent editions
	88E3	01 and subsequent editions
Power Mate *i*-H	88F2	08 and subsequent editions
	88F3	01 and subsequent editions
DSA(HSSB)	881G	06 and subsequent editions
Pulse input type DSA	881H	02 and subsequent editions

(*) The PDM cannot be used with the 30*i* Series.

(3) Setting parameters

(a) Setting for a PDM

For axes that use a PDM, servo HRV3 control needs to be set. Set the parameters below.

Set the parameter for servo HRV2 control beforehand. Next, set the parameter below for servo HRV3 control (HR3=1).(For each axis)

	#7	#6	#5	#4	#3	#2	#1	#0
2013								HR3

HR3(#0) 0: Does not use servo HRV3 control.

1: Uses servo HRV3 control.

* When using a PDM, set HR3=1. In actual operation, this control is equivalent to HRV2 control. (The G5.4-based high-speed current control mode cannot be switched either.)

For those axes that uses a PDM, set the following parameter in addition to the setting of HR3 above:

2165	Set 0.

If this parameter is not set, "Invalid motor/amplifier combination" may be issued.
Note that because this parameter needs to be set to 0 when a PDM is used, the servo tuning screen does not provide an actual current indication (ampere indication). (A % indication is provided.)

L.2 DATA MEASUREMENT AND DIAGNOSIS WITH A PWM DISTRIBUTION MODULE (PDM)

(1) Overview

In a configuration that uses a PWM distribution module, many motor power lines are used. If an error occurs, error location isolation may be difficult in some cases. To facilitate troubleshooting, the following functions are available:

(a) PDM current monitor
- The actual current flowing through each amplifier is monitored using SERVO GUIDE.

(b) PDM's slave ready output
- The ready state of each amplifier present when the VRDY-OFF alarm is issued is displayed on the diagnosis screen of the CNC.

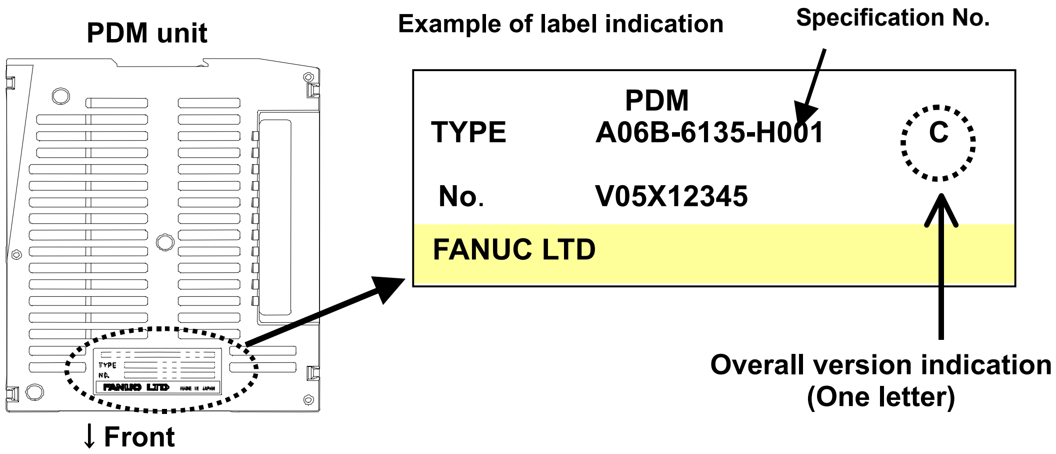
For the method of PDM-based troubleshooting, refer to "Troubleshooting of Large Servo Motors by Using a PDM (PWM Distribution Module) (A-72562-034)" as well.

(2) Series and editions of applicable servo software

The PDM diagnosis functions are available with the following series and editions:

Function	Applicable servo software series and edition	Applicable PDM version(*)	Applicable SERVO GUIDE version
PDM current monitor function	Series 90C5,E5/D(04) or later Series 90C8,E8/A(01) or later Series 90B1/F(06) or later	Overall version C or later	Ver3.20
PDM's slave ready output	Series 90C5,E5/D(04) or later Series 90C8,E8/A(01 or later Series 90B1/G(07) or later	Overall version C or later	-

* The overall version of a PDM can be checked with the indication provided on the label of the PDM.



The following table lists the series and editions of system software supporting SV648 and diagnosis 656 with PDM's slave ready output.

CNC	System software	
	Series	Edition
Series 0*i*-MD	D4F1	06 and subsequent editions
Series 0*i*-TD	D6F1	06 and subsequent editions
Series 0*i* Mate-MD	D5F1	06 and subsequent editions
Series 0*i* Mate-TD	D7F1	06 and subsequent editions
Series 16*i*-MB	B0M1,B0N1	01 and subsequent editions
Series 16*i*-TB	-	-
Series 18*i*-MB5	BDM5,BDN5	01 and subsequent editions
Series 18*i*-MB	BDM1,BDN1	01 and subsequent editions
Series 18*i*-TB	-	-
Series 18*i*-LNB	-	-
Series 21*i*-MB	DDHK,DDK1	01 and subsequent editions
Series 21*i*-TB	-	-
Power Mate *i*-D	88E1	06 and subsequent editions
	88E3	04 and subsequent editions
Power Mate *i*-H	88F2	13 and subsequent editions
	88F3	04 and subsequent editions
Pulse input type DSA	-	-

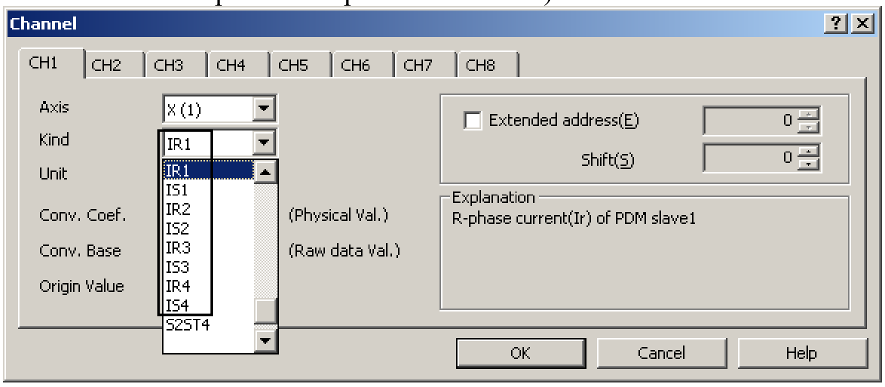
(3) PDM-related functions

(a) PDM current monitor function

By using SERVO GUIDE, the actual current of each amplifier connected to a PDM can be measured.

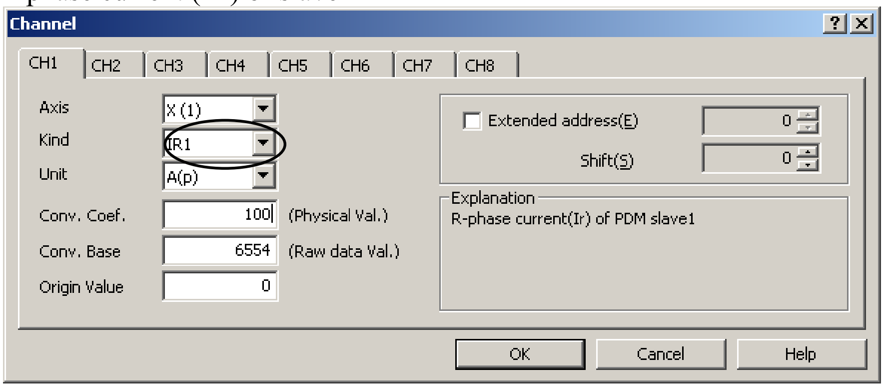
• Method of setting SERVO GUIDE

From "Type", select a type of current to be measured. (Counting from the closest to the PDM of the amplifiers connected to the local FSSB, the R phase current of the n-th amplifier is represented as IRn and the S phase current of the n-th amplifier is represented as ISn.)



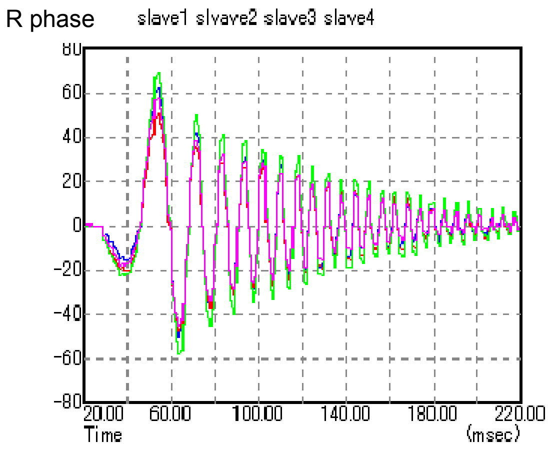
Example)

When the R phase current (IR) of slave 1



NOTE
The update interval of this data is 1 msec.

[Example of waveform measurement]



(b) PDM's slave ready output

With an axis that uses a PDM, the VRDY-OFF alarm is issued if there is one or more servo amplifiers that are connected to the PDM and are not placed in the ready state. To facilitate troubleshooting in such a case, the ready state of each amplifier present when the VRDY-OFF alarm is issued is displayed on the diagnosis screen of the CNC.
The diagnosis number for referencing the ready state differs depending on the alarm number. Check the diagnosis number corresponding to the displayed alarm number.

Alarm number	Alarm message	Diagnosis number
648	PDM VRDY OFF (DGN656)	Diagnosis 656
401	VRDY OFF	Diagnosis 353

- Diagnosis screen display when alarm 648 is issued

	#7	#6	#5	#4	#3	#2	#1	#0
Diagnosis 656					**VRDY4 (slave 4)**	**VRDY3 (slave 3)**	**VRDY2 (slave 2)**	**VRDY1 (slave 1)**

VREDY4-1(#3-0) Displays the ready state when VRDY OFF is issued for each amplifier of slave 1 to 4.
0: Not-ready state
1: Ready state (amplifier ready state)

You can check the bits of diagnosis 656 to determine the amplifier which causes the VRDY OFF alarm.

- Setting parameters when alarm 401 is issued

If alarm 401 is displayed, by setting the parameters below, the ready state of each amplifier present when the VRDY OFF alarm is issued can be displayed on diagnosis No. 353. Note that the values to be set in the parameters vary, depending on whether an odd number or even number is set in parameter No. 1023 for the axis.

Parameter No. to be set	When an odd number is set in No. 1023 for the axis	When an even number is set in No. 1023 for the axis
No.2115	0	0
No.2151	3094	3222

- Diagnosis screen display when alarm 401 is issued

Diagnosis 353	Amplifier ready state when the VRDY-OFF alarm is issued (in decimal)

By checking the decimal value displayed in diagnosis No. 353, the amplifier that caused the VRDY-OFF alarm to be issued can be identified. (See the table below.)

Value displayed by diagnosis No. 353	Ready state of each slave amplifier (○: Ready state, ×: Not-ready state)			
	Slave 1	Slave 2	Slave 3	Slave 4
0	○	○	○	○
1	×	○	○	○
2	○	×	○	○
3	×	×	○	○
4	○	○	×	○
5	×	○	×	○
6	○	×	×	○
7	×	×	×	○
8	○	○	○	×
9	×	○	○	×
10	○	×	○	×
11	×	×	○	×
12	○	○	×	×
13	×	○	×	×
14	○	×	×	×
15	×	×	×	×

M QUADRANT PROTRUSION TUNING USING SERVO GUIDE

(1) Overview

Quadrant protrusion compensation using Tuning Navigator of SERVO GUIDE enables you to determine optimum parameters for the quadrant protrusion compensation function for Tuning Navigator by operating SERVO GUIDE and CNC according to instructions shown in wizard form.

Compensation parameters are determined by performing the following operations in wizard form:

- Set the items required for tuning.
- Make a circular motion several times at three different feedrates to measure the optimum quadrant protrusion compensation (learning).
- Based on the measured compensation, parameters for setting the quadrant protrusion compensation function for Tuning Navigator are displayed.
- Check the operation by applying the displayed parameters.

This appendix describes the items to be set according to the wizard and items to be tuned.

Quadrant protrusion compensation using Tuning Navigator automatically tunes the parameters for the quadrant protrusion compensation function for Tuning Navigator. It does not automatically tune the parameters for the conventional backlash acceleration function or two-stage backlash acceleration function. During tuning, some parameters are changed so that these functions are not enabled. To use the conventional backlash acceleration function or two-stage backlash acceleration function together, additionally set the required parameters after tuning.
For the specification of SERVO GUIDE and restrictions on Tuning Navigator, refer to the "FANUC SERVO GUIDE OPERATOR'S MANUAL (B-65404EN), online help of SERVO GUIDE, and relevant technical reports.

(2) Series and editions of applicable software

To use quadrant protrusion compensation navigation, the following series and editions of applicable software are required.

Servo software	Applicable series and editions
SERVO GUIDE	4.00 and subsequent editions 4.10 and subsequent editions (supports synchronous axes.) 6.00 and subsequent editions (supports trapezoidal acceleration.) 6.30 and subsequent editions (supports rotary axes.)

Servo software	Applicable series and editions
CNC software *	
Series 30*i*-A	G004/01 and subsequent editions, G014/01 and subsequent editions, G024/01 and subsequent editions G00C/01 and subsequent editions, G01C/01 and subsequent editions, G02C/01 and subsequent editions
Series 31*i*-A5	G124/01 and subsequent editions, G134/01 and subsequent editions G12C/01 and subsequent editions, G13C/01 and subsequent editions
Series 31*i*-A	G104/01 and subsequent editions, G114/01 and subsequent editions G103/01 and subsequent editions, G113/01 and subsequent editions
Series 0*i*-MD Series 0*i*-TD Series 0*i* Mate-MD Series 0*i* Mate-TD	D4F1/01 and subsequent editions D6F1/01 and subsequent editions D5F1/01 and subsequent editions D7F1/01 and subsequent editions
Servo software	
Series 30*i*/31*i*/32*i*/35*i*-B	90G0/06.0 and subsequent editions
Power Motion *i* -A	90G0/06.0 and subsequent editions
Series 30*i*/31*i*/32*i*-A	90D0/L(12) and subsequent editions, 90E0/L(12) and subsequent editions 90D0/O(15) and subsequent editions, 90E0/O(15) and subsequent editions(supports synchronous axes.) 90D0/P(16) and subsequent editions, 90E0/P(16) and subsequent editions(supports synchronous axes and trapezoidal acceleration.) 90E1/01 and subsequent editions (supports synchronous axes and trapezoidal acceleration.)
Series 0*i*-D	90C5/A(01) and subsequent editions, 90E5/A(01) and subsequent editions (supports synchronous axes and trapezoidal acceleration.) 90C8/A(01) and subsequent editions, 90E8/A(01) and subsequent editions (supports synchronous axes and trapezoidal acceleration.)

* For the Series 30*i*/31*i*/32*i*-B/35*i* -B and Power Motion *i*-A, all series and editions of system software support this function.

(3) Related parameters

The following parameters are set by quadrant protrusion tuning using Tuning Navigator.

A) Function bit

	#7	#6	#5	#4	#3	#2	#1	#0
2415	LDMPQ	LACCO2	LBLACC	LBLFIL	SQRACC	LBLIN2		

LDMPQ (#7) Damping override setting for quadrant protrusion compensation for Tuning Navigator (1 or 0)

LACCO2(#6) Acceleration amount override setting for quadrant protrusion compensation for Tuning Navigator (Normally 1)

LBLACC(#5) Quadrant protrusion compensation for Tuning Navigator is:
0: Not used.
1: Used.

LBLFIL(#4) (Normally 0)

SQRACC(#3) Acceleration amount override setting for quadrant protrusion compensation for Tuning Navigator (Normally 1)

LBLIN2(#2) (Normally 0)

To use quadrant protrusion compensation for Tuning Navigator, it is necessary to enable backlash acceleration.

	#7	#6	#5	#4	#3	#2	#1	#0
2003			BLEN					

BLEN (#5) The backlash acceleration function is:
0 : Not used.
1 : Used.

	#7	#6	#5	#4	#3	#2	#1	#0
2018					OVR11	OVR8		

OVR11,OVR8(#3,#2)

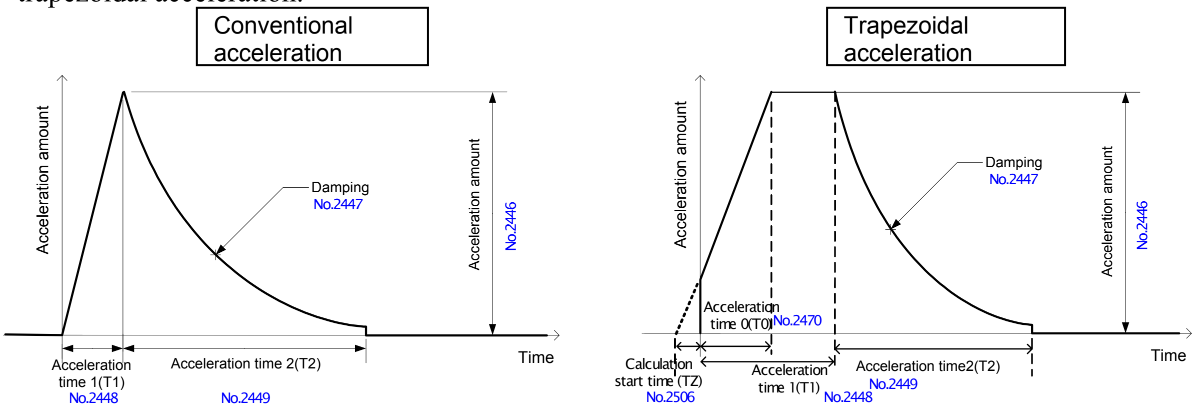
Setting of the acceleration override of two-stage backlash acceleration or quadrant protrusion compensation for Tuning Navigator

When bit 6 of parameter No. 2415 is set to 0, quadrant protrusion compensation for Tuning Navigator is also referenced.

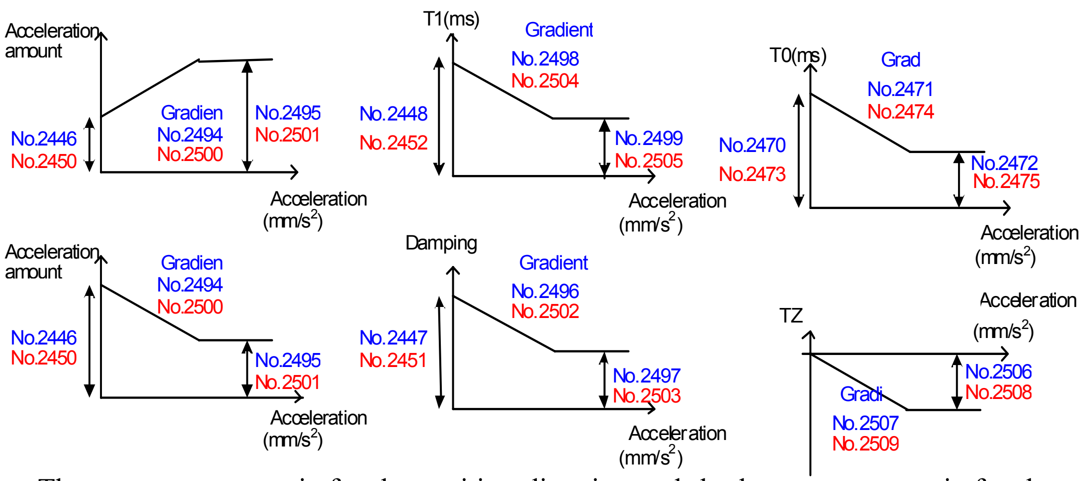
When bit 6 of parameter No. 2415 is set to 1, quadrant protrusion compensation for Tuning Navigator is not referenced.

B) Tuning parameters

Conventional acceleration and trapezoidal acceleration are available for quadrant protrusion compensation for Tuning Navigator. When servo software applicable to trapezoidal acceleration is used, the "Use improvement" check box is automatically checked at the start of the wizard to select trapezoidal acceleration.



The override can be applied to the acceleration, acceleration time 1 (T1), damping, acceleration time 0 (T0), and calculation start time (TZ).



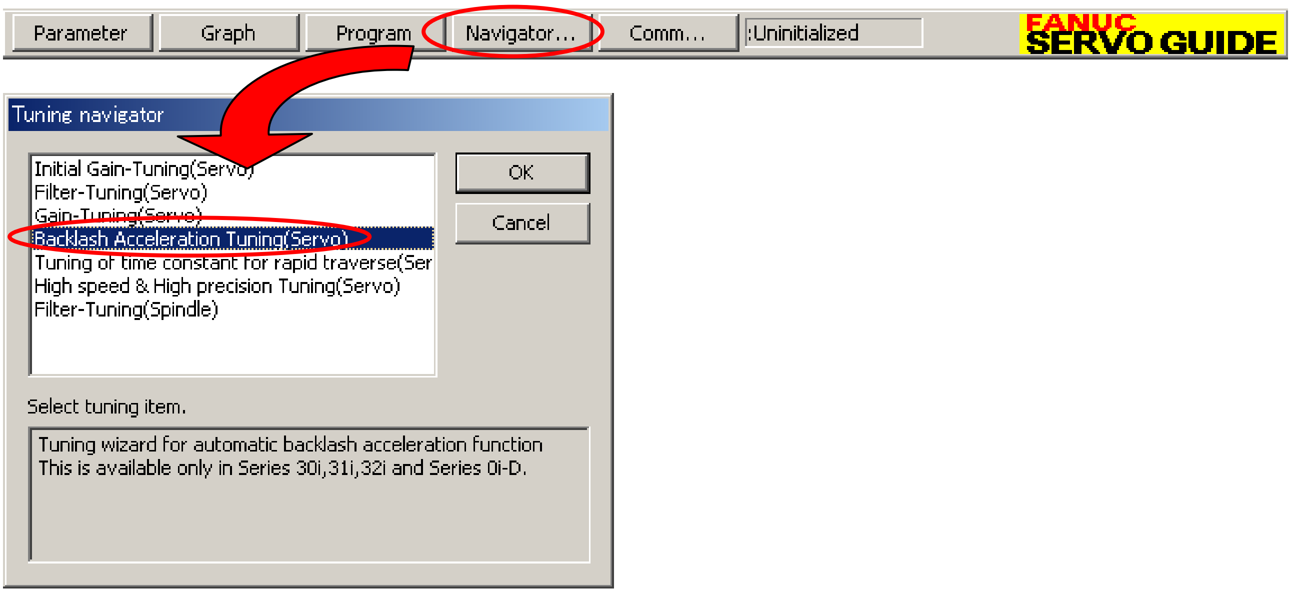
* The upper parameter is for the position direction and the lower parameter is for the negative direction.

Item	Basic setting		Override gradient		Override limit	
	Positive direction	Negative direction	Positive direction	Negative direction	Positive direction	Negative direction
Acceleration amount	No.2446	No.2450	No.2494	No.2500	No.2495	No.2501
Damping	No.2447	No.2451	No.2496	No.2502	No.2497	No.2503
TZ	No.2506	No.2508	No.2507	No.2509	No.2506	No.2508
T0	No.2470	No.2473	No.2471	No.2474	No.2472	No.2475
T1	No.2448	No.2452	No.2498	No.2504	No.2499	No.2505
T2	No.2449	No.2453	—	—	—	—

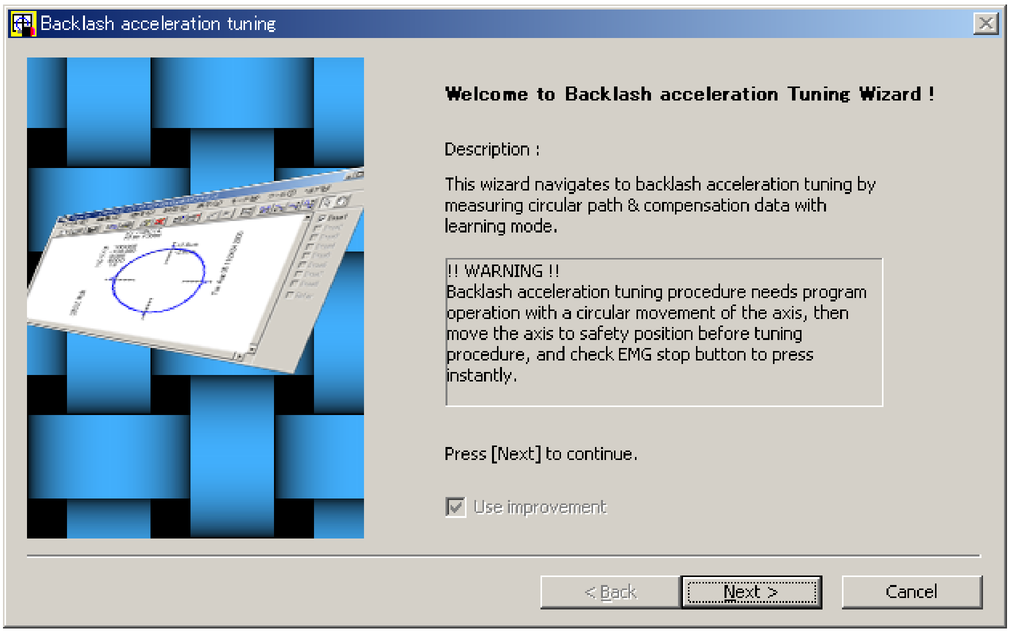
* When bit 5 of parameter No. 2415 is set to 0, the compensation according to the setting of the above parameters is disabled.

(4) Flow of quadrant protrusion tuning using Tuning Navigator

<1> On the Main Bar of SERVO GUIDE, click the **[Navigator…]** button to start Tuning Navigator. From tuning items of Tuning Navigator, select Backlash Acceleration Tuning and click **[OK]**.



<2> The start screen of the backlash acceleration tuning wizard appears. Click **[Next]**. When servo software applicable to trapezoidal acceleration is used, the "Use improvement" check box is automatically checked.

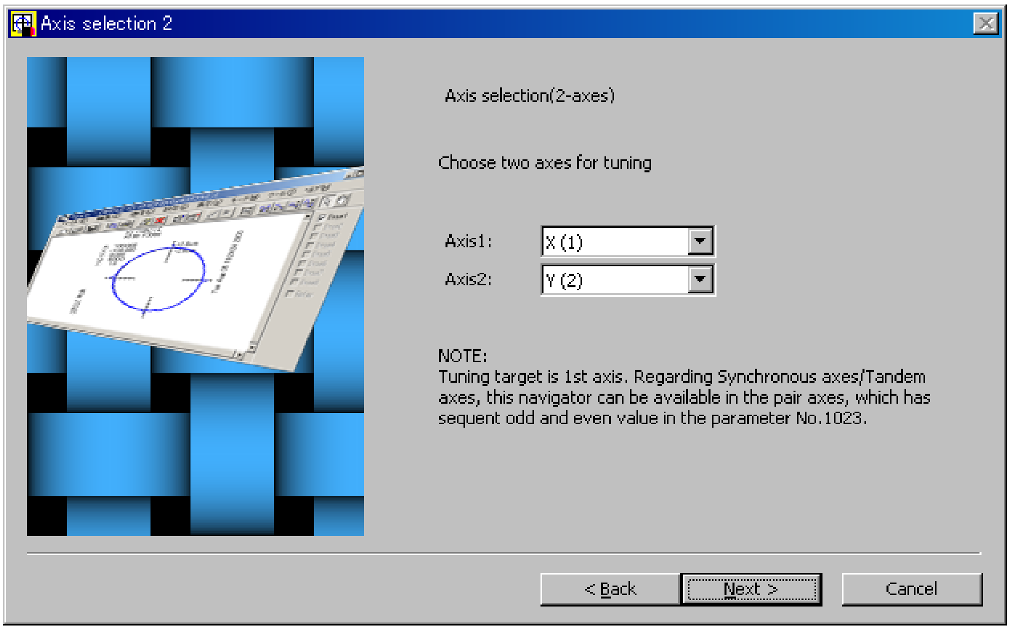


⚠ CAUTION

1 Since the procedure involves a program operation, move the axis to a safe position in advance.

2 Be prepared to readily press the emergency stop button in case of an abnormal operation.

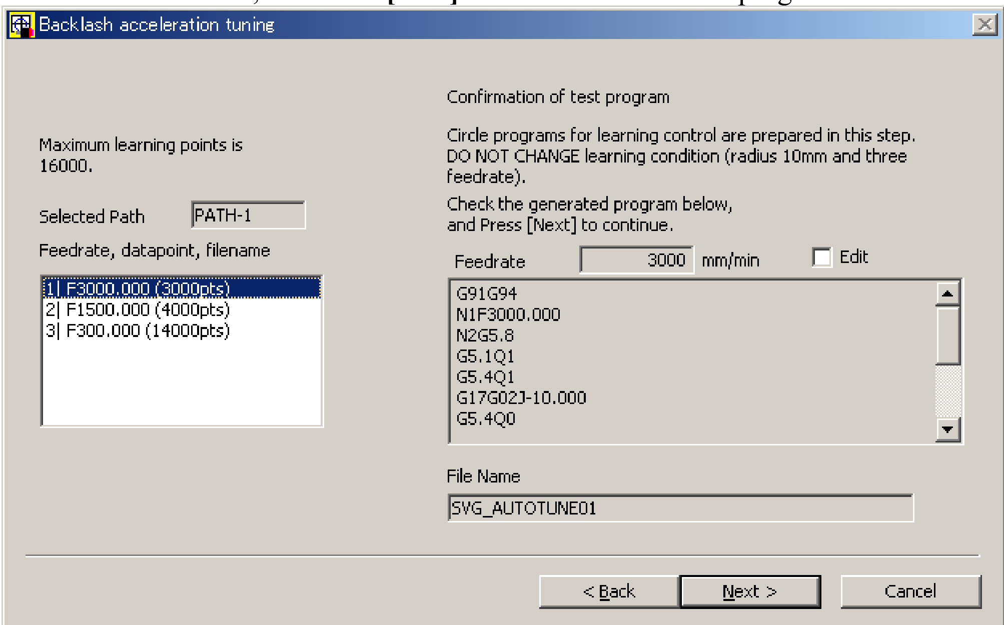
<3> Select two target axes for circular motions.
Select a target axis for quadrant protrusion tuning in **[Axis1]** and a target axis for circular motions together with that axis in **[Axis2]**.
If you want to tune two axes, after the completion of the tuning of one axis, restart the wizard and select the axis selected for **[Axis1]** in **[Axis2]** and the axis selected for **[Axis2]** in **[Axis1]** for tuning.
In the case of synchronous axes or tandem axes, select the master axis.
If you select the slave axis, the servo guide will automatically switch to the master axis.
This tuning is not available for synchronous axes having multiple slave axes.
Use a series and edition of servo software that is applicable to synchronous/tandem axis tuning.



NOTE

1. When you have selected rotary axes, perform tuning by specifying a sine wave shaped position command for one axis and a sine wave whose phase is 90 degrees different for the other axis. (As the tuning program, a minute line segment program is automatically generated.)
2. The backlash acceleration tuning wizard automatically changes some servo parameters during tuning. It restores the values of parameters other than those for backlash acceleration tuning to those before tuning when tuning ends or the cancel button is clicked. If the tuning ends abnormally before it is completed, see the backup file and restore the parameters to their previous settings.
   Backup file: My Documents¥SERVO GUIDE¥SVGBLA.DAT

<4> Confirm the test programs and click **[Next]**.
Quadrant protrusion compensation is tuned using circular motions with a radius of 10 and feedrates of 300, 1500, and 3000. (The circle radius and feedrates cannot be changed.) If it is necessary to add an M code and other items, check the **[Edit]** check box and edit the program.

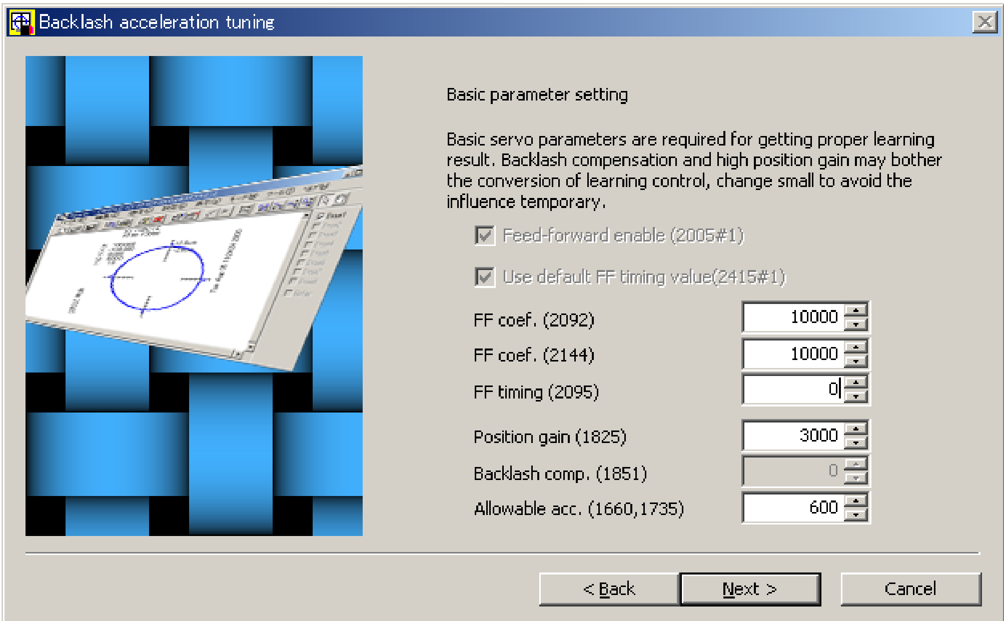


NOTE

If you select rotary axes, a minute line segment program is automatically generated as the tuning program.
Note the following points:

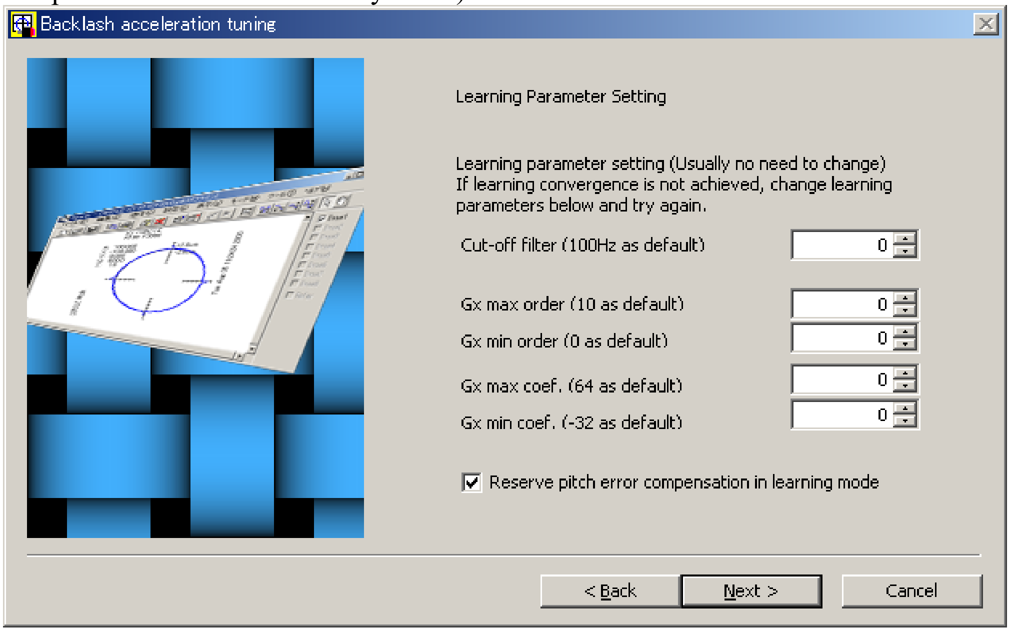
- An environment is necessary in which the minute line segment program can be executed normally. Specifically, AI contour control (or AI advanced preview control) is required. (The program cannot be executed with normal control or advanced preview control.)
- The 30*i* series requires the AI contour control I or II option.
- In the case of 0*i*-D, the program can be used only with the M series (AI advanced preview control or AI contour control option).
- Inch input is not supported. Inch machines are not supported, either.
- An incremental command-based program is generated for an axis that supports incremental commands.
- In the case of an axis that does not support incremental commands (axes A and B of G code system A of the T series), a program is generated using absolute commands with the start point being the location where the axis is at the time of program generation.

<5> Set basic parameters.
Normally, you do not need to change the default values. Click **[Next]**.
Change values only when a shock or vibration occurs with the default values, which affects operation as shown below.



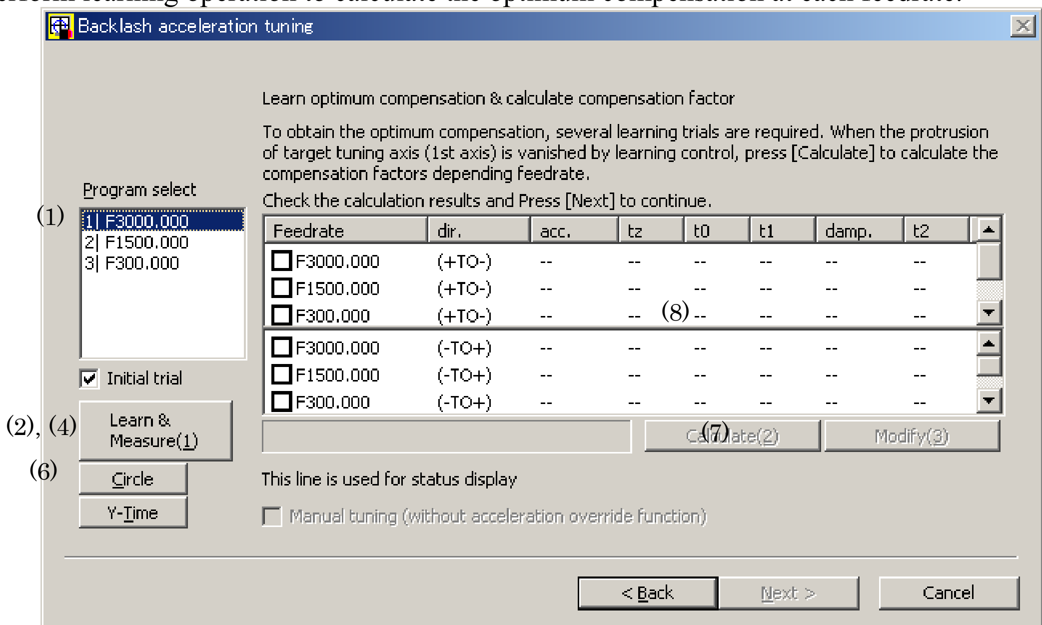
- The optimum position gain of the machine is lower than 3000. When the position gain is set to 3000, vibration occurs.
  → Decrease the position gain to the optimum value of the machine. (In this case, it is necessary to change values for learning parameter setting.)
- A large shock occurs at the start and end of a circular motion and affects the measured axis (axis selected for Axis1) when the quadrant changes.
  → Decrease the allowable acceleration to a range between 250 mm/s^2 and 600 mm/s^2.

<6> Set the parameters for learning control.
Normally, you do not need to change the default values. Click **[Next]**.
Change values only when optimum compensation calculation performed in the next step fails (the quadrant protrusion is not sufficiently small) with the default values as shown below.



- For a full-closed system with a large distortion
  → Check the result of learning in step <7>. If the learning process does not end (the quadrant protrusion is not sufficiently small), increase the value of **[Gx max order]** to 0, 15, and 20 in this order so that the learning process ends.

<7> Perform learning operation to calculate the optimum compensation at each feedrate.



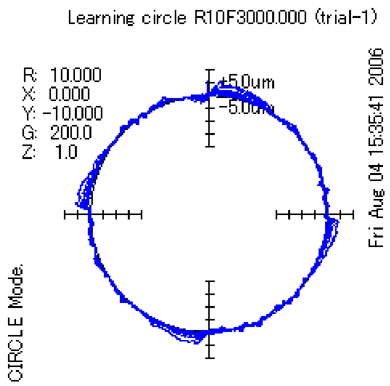
<Procedure for calculating compensation factors>

(1) Select a feedrate for tuning from the [Program select] list.
(2) Check that [Initial trial] is checked and click the [Learn&Measure] button.
(3) Press the "Cycle Start" button on the machine operator's panel. (Five to ten circular motions are performed.)

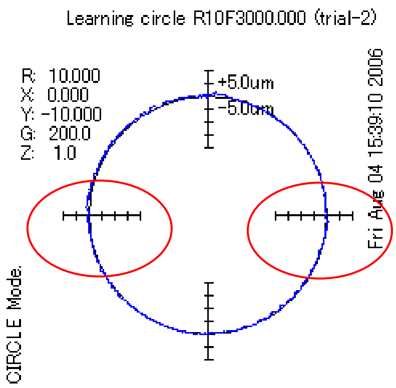
(4) Check that [Initial trial] is not checked and click the [Learn&Measure] button again. (Additional learning and check)
(5) Press the "Cycle Start" button on the machine operator's panel. (A circular motion is performed.)
(6) Click the [Circle] button to check the shape of the circle. When the quadrant protrusion is sufficiently small for the tuned axis (horizontal axis), proceed to step (7). If the protrusion is not small, repeat steps (4) to (7) until the protrusion is sufficiently small. (*)
(7) Click the [Calculate] button. Compensation factors are automatically calculated based on the currently obtained waveforms and added to the compensation factor list at the center of the dialog box.
(8) Perform steps (1) to (7) above for each program (F3000, F1500, and F300). When all required compensation factors are added to the list, click the [Next] button.

* If the shape of the circle is not improved (the protrusion is not sufficiently small) after performing steps (4) to (7) about 10 times, click the **[Back]** button. Then, change the value of a learning parameter (Gx max order) and perform steps (1) to (8) above again. (-> See the description of step <8>.)

<Example of measurement>

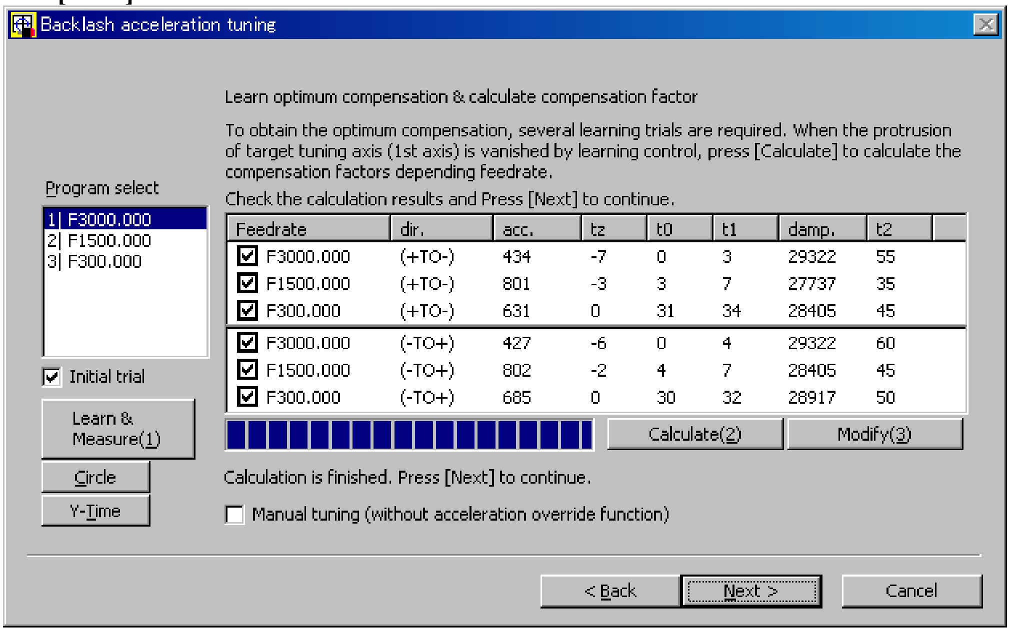


Initial learning (step (3))
The paths of five to ten circular motions are displayed at a time. This figure shows that the quadrant protrusion becomes small as learning progresses.

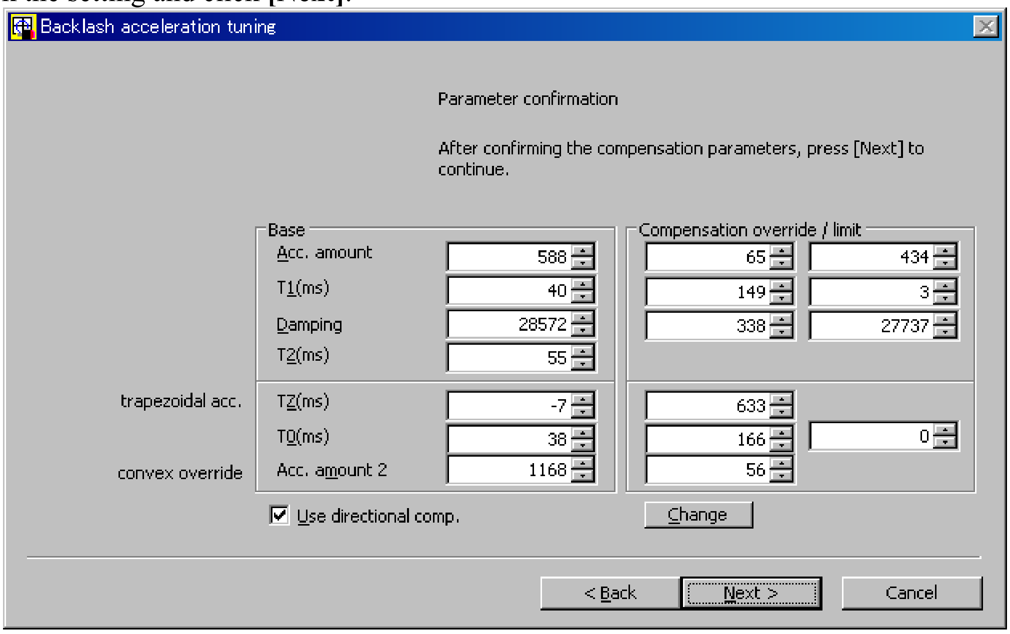


Additional learning and check (step (6))
When the quadrant protrusion is sufficiently small for the tuned axis, click the **[Calculate]** button.

<8> Calculate the compensation at all feedrates. When all required compensation factors are added to the list, click **[Next]**.



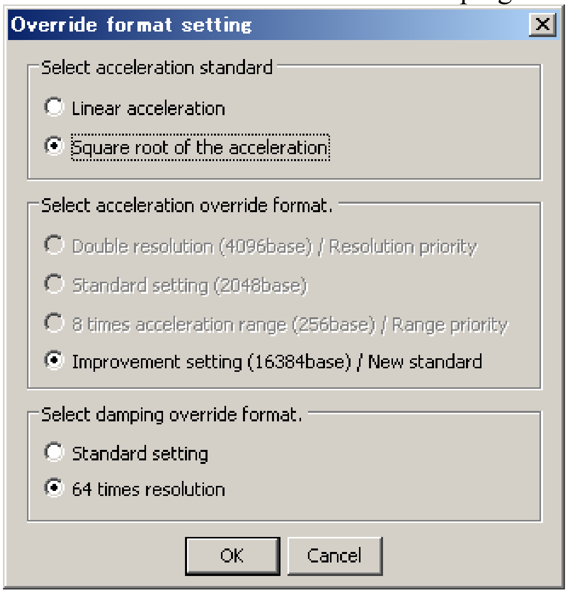
<9> The override is calculated based on the optimum compensation factors obtained in the previous step. Check the setting and click **[Next]**.



<Changing the override formats>

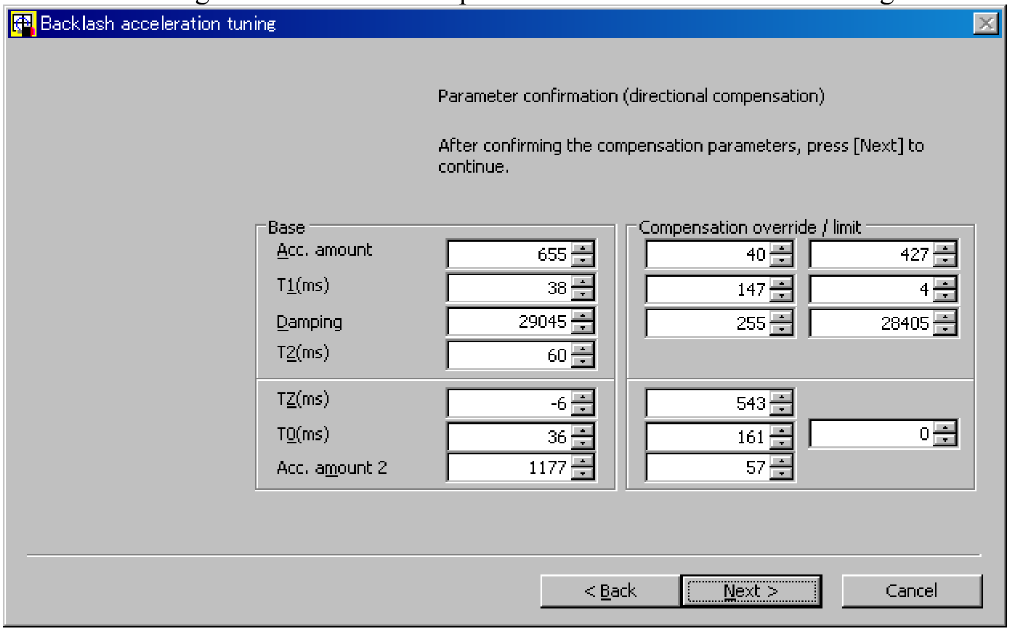
If you press the <Change> button in the parameter confirmation window, the Override format setting dialog box is displayed.

You can change the acceleration override format and damping override format.

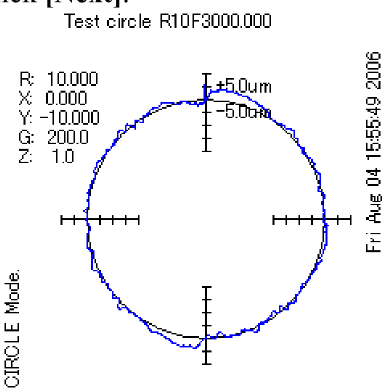


- Select acceleration standard
  Linear acceleration
  The acceleration override is calculated using the acceleration standard.
  Square root of the acceleration
  The acceleration override is calculated using the square root of the acceleration (improvement).
- Select acceleration override format
  Double resolution (4096base) / Resolution priority
  Priority is placed on the acceleration resolution. The maximum acceleration is limited.
  Standard setting (2048base)
  Default weight
  8 times acceleration range (256base) / Range priority
  The maximum acceleration will be larger. But the resolution will be worse. When the target machine has the high acceleration specification, please select this.
  Improvement setting (16484base) / New standard
  Setting not based on the detection unit (improvement)
- Select damping override format.
  Standard setting
  Default weight
  64 times resolution (In case that larger override value is necessary than standard setting)
  The resolution of the damping override format is changed.

<10>When **[Use directional comp.]** is checked in the previous step, different compensation factors can be used for "reverse operation from the positive direction to the negative direction" and "reverse operation from the negative direction to the positive direction". Check the settings and click **[Next]**.

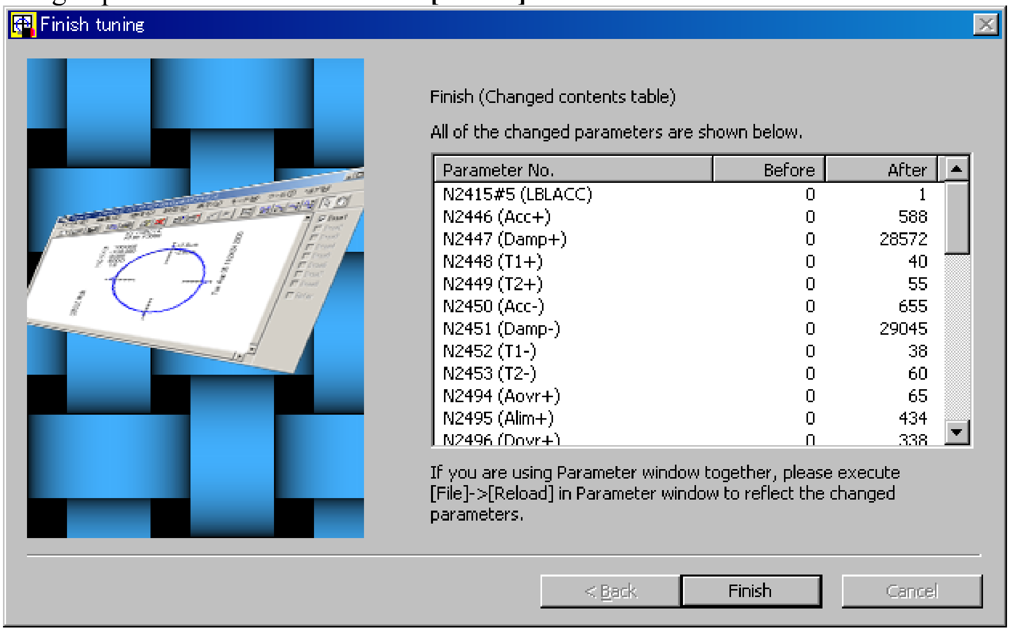


<11>Check the effect of quadrant protrusion compensation using the compensation factors determined in the previous steps. Select a feedrate from **[Program select]** and click the **[Start]** button. When there is no problem with the shape of the circle (the quadrant protrusion is improved), check **[Is it O.K.?]** and click **[Next]**.



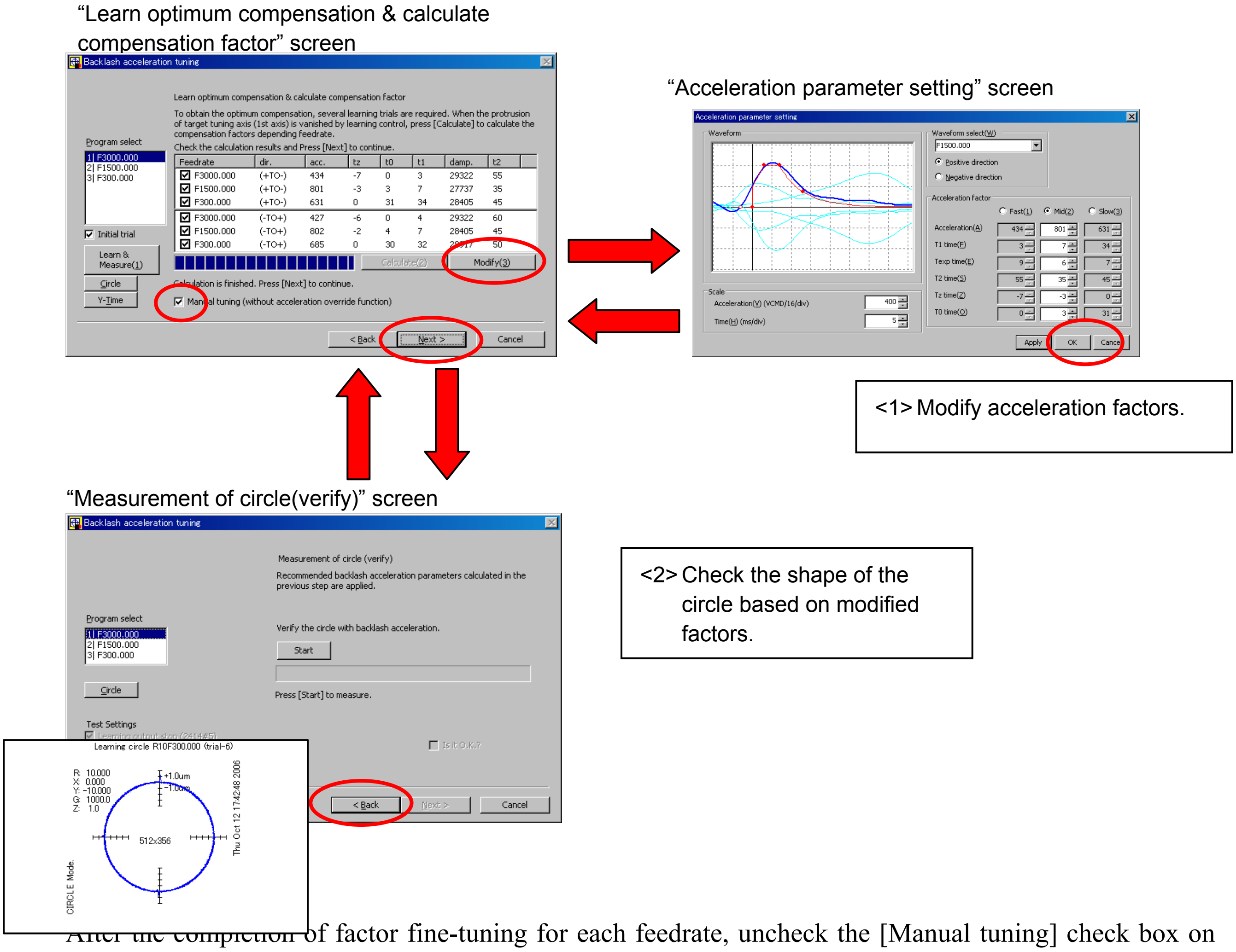
Example of a waveform at check
Check the effect of the application of the quadrant protrusion compensation factors for the reduction of the quadrant protrusion. The compensation factors are applied only to the tuned axis (horizontal axis).

<12>The changed parameters are listed. Click **[Finish]** and exit the wizard.

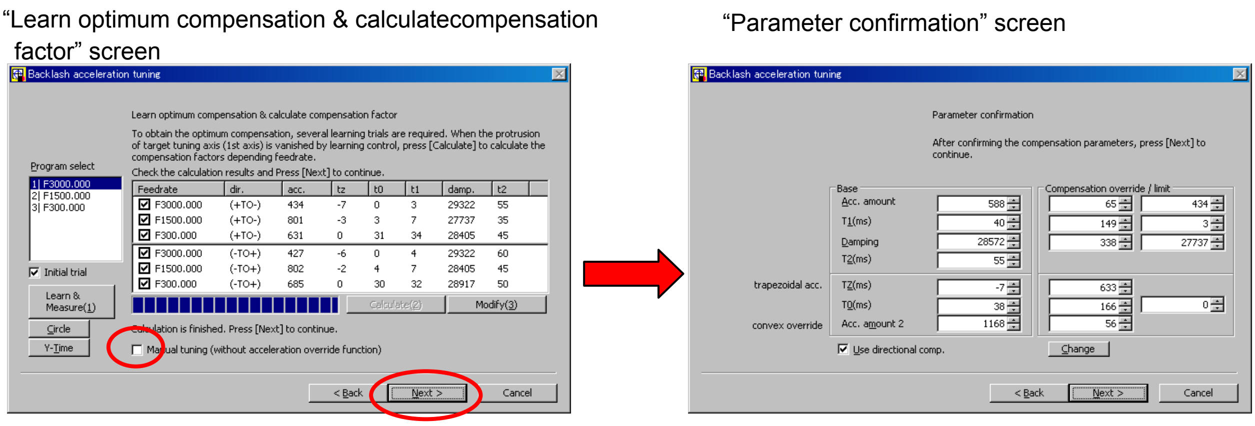


(5) Manually fine-tuning compensation factors

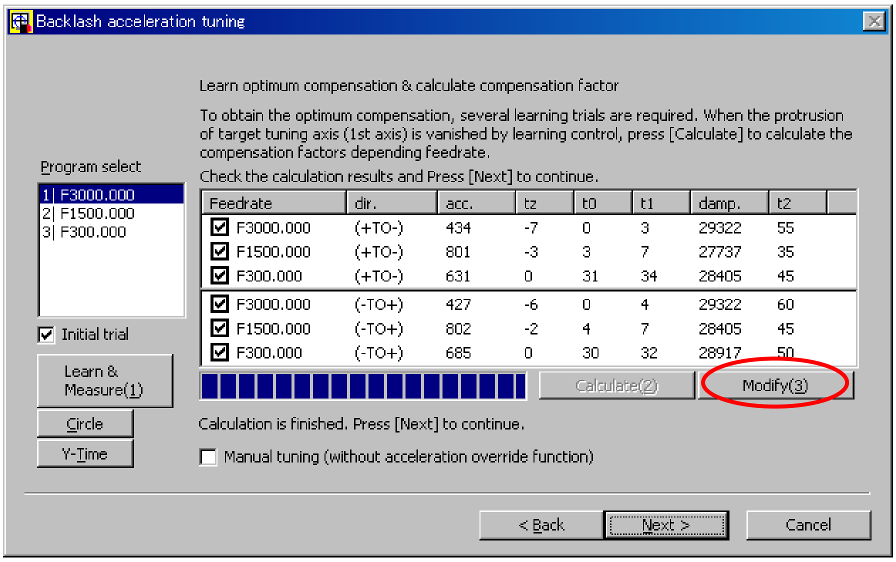
You can move back and force among the following three screens: "Learn optimum compensation & calculate compensation factor", "Acceleration setting optimize", and "Measurement of circle (verify)" to manually fine-tune optimum compensation factors for each feedrate.

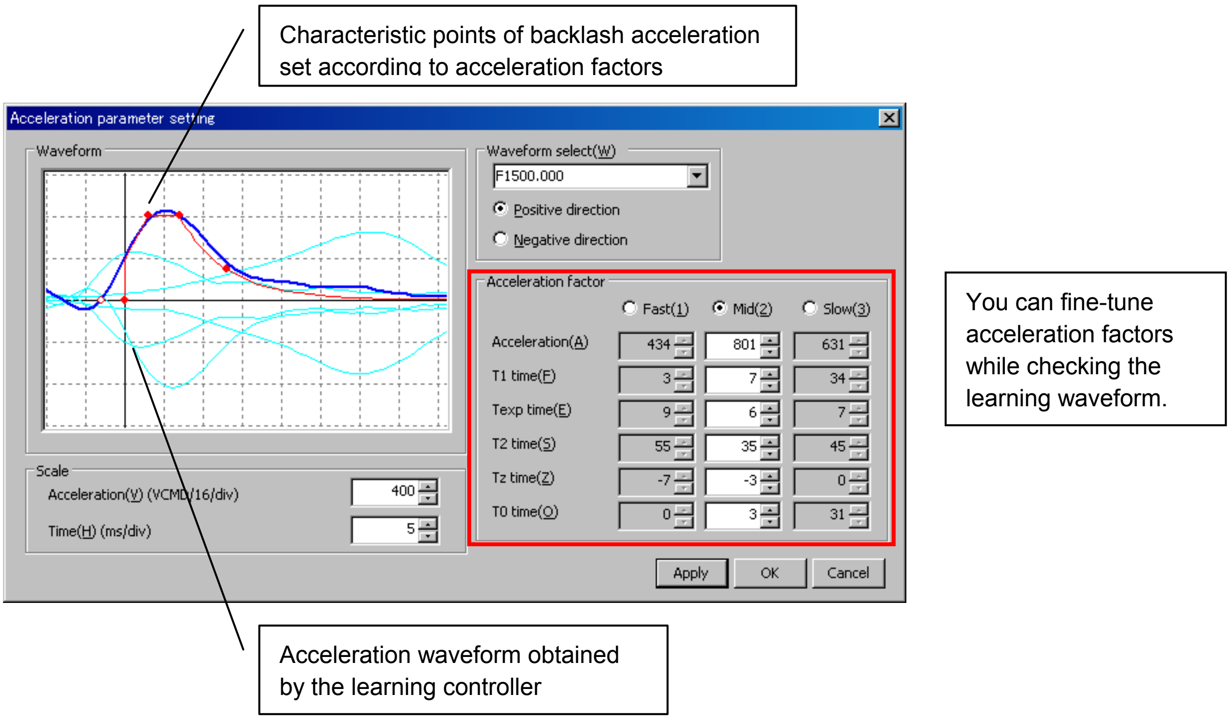


After the completion of factor fine-tuning for each feedrate, uncheck the [Manual tuning] check box on the "Learn optimum compensation & calculate compensation factor" screen and click the **[Next]** button. The "Parameter confirmation" screen appears and the override is calculated based on the acceleration factors determined above.

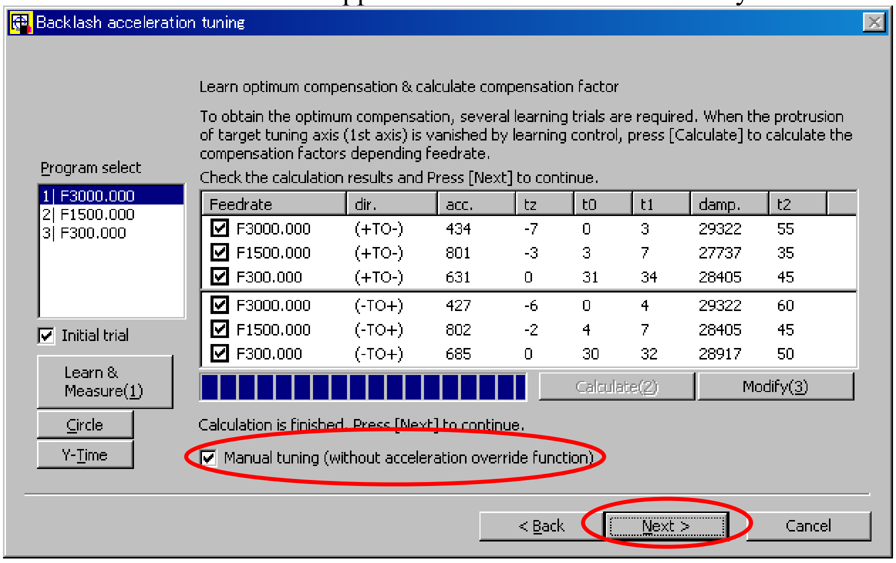


After the acceleration factors are calculated according to the result of learning, on the "Learn optimum compensation & calculate compensation factor" screen, click the **[Modify]** button. A screen appears, which allows the output of learning data at each feedrate and fine-tuning of characteristic points for compensation calculation. On this screen, you can set acceleration factors while checking the learning waveform.

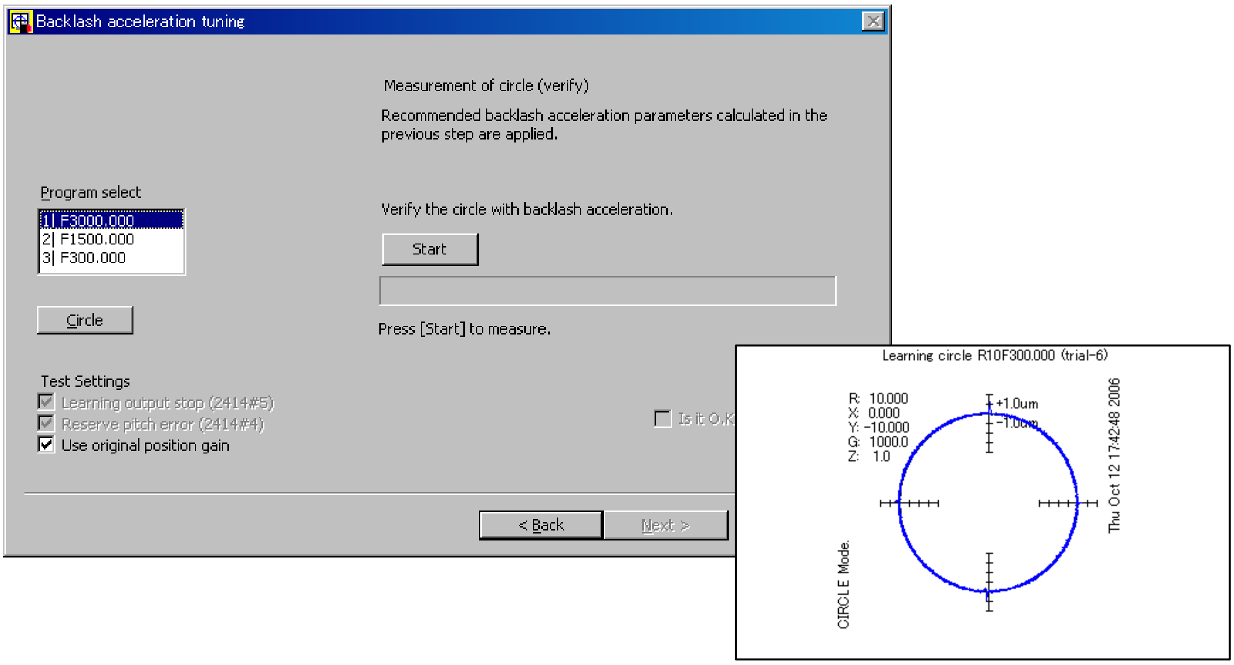




On the "Learn optimum compensation & calculate compensation factor" screen, check the **[Manual tuning]** check box and click the **[Next]** button. The "Measurement of circle (verify)" screen appears. On this screen, you can check the result of the application of acceleration factors you set.



* The Manual tuning (without acceleration override function) check box is available with SERVO GUIDE 4.10 or later.



INDEX

REVISION RECORD

Edition	Date	Contents
08	Jun., 2013	• Applied to 30*i*-B series and 0*i*-D series • Addition of functions added after issue of Edition 07 • Correction of errors
07	Feb., 2008	• Addition of functions added after issue of Edition 06 • Correction of errors
06	Feb., 2006	• Model name change • Addition of the D*i*S series motor • Addition of functions added after issue of Edition 05 • Correction of errors
05	May., 2005	• Applied to Series30*i*/31*i*/32*i* • Addition of HRV4 control • Total revision of chapter of Parameter Adjustment • Addition of functions added after issue of Edition 04 • Correction of errors
04	Oct., 2003	• Addition of the SERVO MOTOR β*i*s series • Addition of functions added after issue of Edition 03 • Correction of errors
03	Mar., 2003	• Addition of the SERVO MOTOR α*i*s series • Addition of item for SERVO GUIDE(Ver 2.00) • Addition of functions added after issue of Edition 02 • Correction of errors
02	Sep., 2002	• Addition of the parameter tables for αHV*i* • Addition of item for SERVO GUIDE • Addition of functions added after issue of Edition 01 • Correction of errors
01	May, 2001	

ADDITIONAL INFORMATION

Pole Position Detection Function

1. Type of applied documents

Name	FANUC AC SERVO MOTOR αi series FANUC AC SERVO MOTOR βi series FANUC LINEAR MOTOR L*i*S series FANUC SYNCHRONOUS BUILT-IN SERVO MOTOR D*i*S series Parameter manual
Spec. No./Ver.	B - 65270EN / 08 - 001

2. Summary of Change

Group	Name / Outline	New, Add Correct, Del	Applicable Date
Basic Function	Add direct exciting method to 3.2.1.2 Procedure for Setting the Initial Parameters (Pole position detection).	Add	On the day
Optional Function			
Unit			
Maintenance Parts			
Notice			
Correction			
Another			

3.2.1.2 Procedure for Setting the Initial Parameters (Pole position detection) (Option function)

To drive a synchronous built-in servo motor, the pole detection function (option) is required. This section describes pole detection function.

(1) Outline

The pole detection function (option) detects the pole position of a motor driven when the relationship between the pole position of the motor and the phase of the encoder is unknown.

⚠ **WARNING**

1. If the correct pole position can't be detected depending on condition, motor might move unexpectedly. To avoid this dangerous situation, the following conditions must be satisfied until completion of detection:
   1) Torque limit parameter (No.2060) must be kept less than 150% of a rated current (No.2086).
   2) The setting of excessive error at stop time must be 100 μm or 0.1 degree or less. The setting of excessive error at move time must be 120% of the logical positional deviation or less. In case of the direct exciting method (No.2009#5=1), it must be set to180 degree of the corresponding value.
   3) While the detecting operation is in progress and a subsequent move operation is executed, a protection doors must be closed.

   If these conditions are not satisfied and detecting operation is not finished normally, the motor will make an unpredictable movement with the maximum torque until CNC detects an excessive error alarm. For safety, please create the following sequence with PMC by using the state signal for pole detection signal:
   1) Don't start detecting operation while the protection doors are opened.
   2) If a protection door is opened during detecting operation (Fn158=1), the operation is reset.
   3) When detecting operation is uncompleted (Fn159=0), don't give any command to relevant axes.
   4) When detecting operation is uncompleted (Fn159=0), don't release a brake for the gravity axis. (For brake operation, please watch not only the SA signal but also the pole detection completion signal (Fn159).)

   In general, this function can't be applied to the following motors and conditions:
   1) Linear motor
   2) Axis for which control axis detach function is used. (See Item (9))
   3) When the joint rigidity between the motor and encoder is low.
   4) When axis is completely locked.

   When this function is unavoidably applied to linear motor depending on condition, the case using the absolute encoder and paying attention to safety is only approved the application of this function to linear motor.

2. When encoder is exchanged, detection operation must be executed again after AMR offset (No.2139) is set to zero.

⚠ CAUTION

1. When two axes are controlled by Tandem control or Feed axis synchronous control, and each axis has rotary encoder, detecting operation is performed at either axis under making another axis servo-off. In case of Tandem control, servo alarm two-axis monitor function (No.2007#0) should be turned off during detection.
2. When motor feedback sharing function (No. 2018#7) is used with Tandem control, detecting operation should be started simultaneously with both axes to avoid incorrect detection.
3. The following encoders are recommended for pole detection.
   1) If possible, use an absolute encoder.
   2) If incremental encoder is unavoidable, use an incremental encoder with a reference signal.

*1) Detecting method

Direct exciting method

This method excites current at any two different positions and detects pole position from stay position of motor at that time. Motor is moved maximum 180 degree as electric angle during detection. It takes about 5 seconds as detecting time. It's only used for initial starting of motor. (90G0/19.0, 90G3/5.0, 90E1/13.0, 90E3/8.0 or later)

Minute moving method

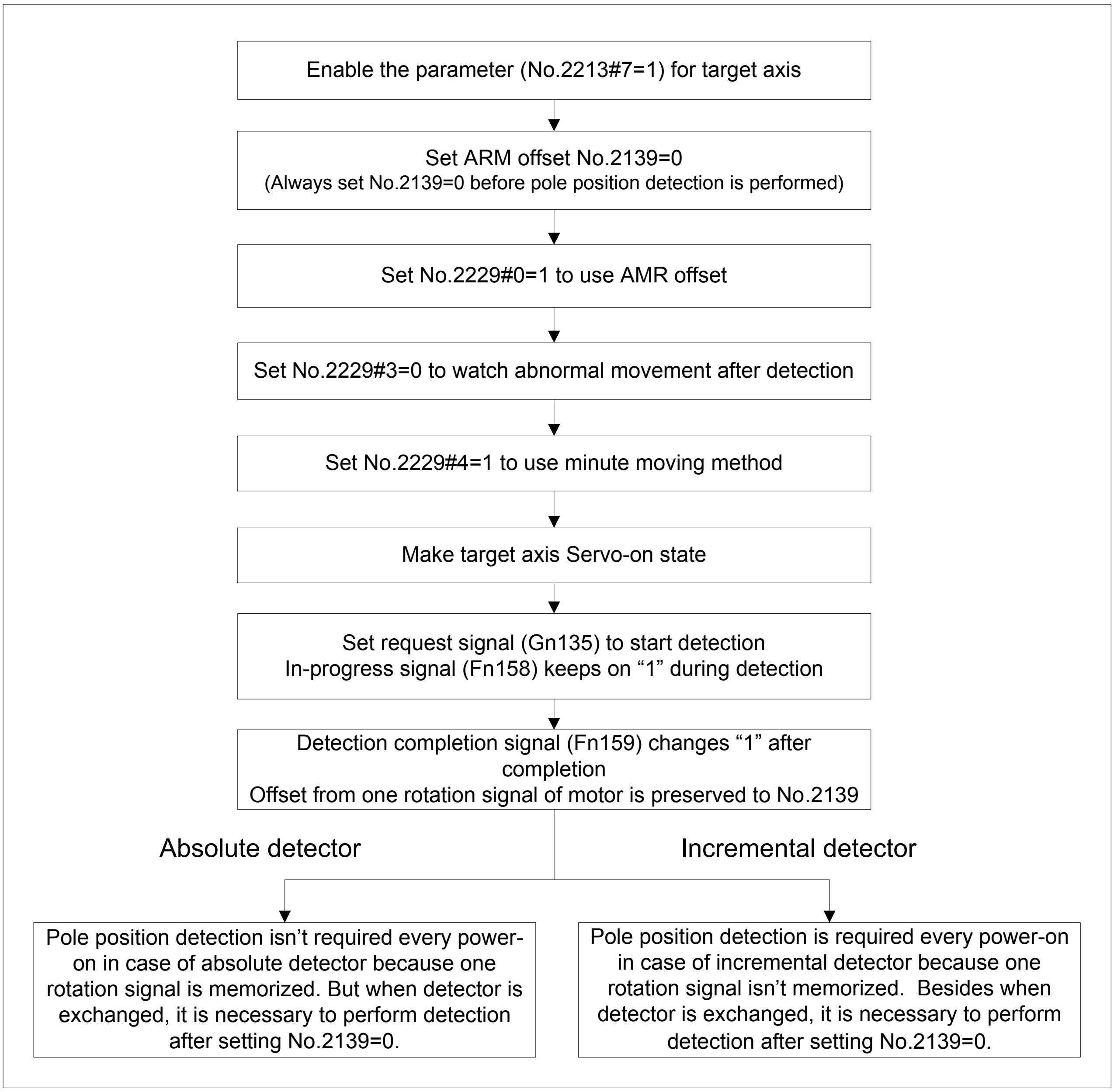
This method excites current at any plural different positions and detects pole position from movement of motor at that time. Motor is moved maximum 5 degree as **mechanical a**ngle during detection. It takes about 2 seconds as detecting time. It's only used for starting of motor except initial.

(2) Applicable software

CNC	Servo software series	Servo software Version	Remark
Series 30*i*/31*i*/32*i*/35*i*-B	90G0	03.0 or later	
Power Motion *i*-A	90G3	01.0 or later	
Series 30*i*/31*i*/32*i*-A	90E0	J(10) or later	
	90E1	01.0 or later	
	90E3	01.0 or later	
Series 30*i*/31*i*-A	90D0	J(10) or later	HRV4
Series 0*i*-D	90C5	A(01) or later	
	90C8	A(01) or later	
	90E5	A(01) or later	
	90E8	A(01) or later	

(3) Procedure for pole position detection function

Flowchart



Remark

- Set parameter (No. 2213#7) to the target axis. Detecting operation is performed by request signal (Gn135). The request signal is ignored in unavailable axis.
- Set the servo-on state. The brake for vertical axis must not be released until the detection completes (Fn159=1) to prevent a fall of axis.
- Don’t perform detecting operation in the servo-off state and don’t set the servo-off state during detecting operation.
- When the pole position detection request signal (Gn135) is set to 1, detecting operation starts and the pole

position detection in-progress signal (Fn158) is set to 1.
• Once detecting operation starts, it continues even if the request signal is turned off.
• Motor operation during pole detection is not under control of CNC. But CNC performs follow-up operation during detection.
• If detecting operation terminates abnormally for a mechanical cause, the servo alarm "POLE DETECTION ERROR SV0454" occurs.
• Turn off the power of CNC because this alarm can't be released by reset key.
• When a reset is performed during detection, detecting operation is suspended. To restart detection again, set the pole position detection request signal to 1 after 0.
• Once detection is completed, detecting operation can't be performed again without power off except detach operation.
• Always set the parameter (No. 2229#0) to 1. The result of detection is stored in the parameter (No.2139) after detection is completed and motor gets reference signal. In case of absolute encoder, the detection need not to be performed every power on.
• In case of MDI, MEM, or EDIT mode, the result of detection is reflected on the screen immediately. In case of REF or JOG mode, it is reflected on the screen when the reset key is pressed or the mode is switched to MDI mode.
• In order to restart pole detection again, clear the parameter (No. 2139) to 0 and turn off CNC power.

NOTE

- When an absolute encoder is used and the parameter (No. 2229#0) is set to 1, the pole position detection completion signal (Fn159) is set to 1 immediately after power-on if the parameter (No. 2139) is not set to 0.
- Create logic for confirming the pole position detection completion signal (Fn159) before giving a move command immediately after power-on.
- If alarm such as count miss alarm of encoder occurs by fault of encoder, the pole position detection completion signal (Fn159) is returned to 0. In this case, it is necessary to perform pole detection again.

(4) Parameter

If the following parameters are changed, necessarily turn NC power off.

No.	#7	#6	#5	#4	#3	#2	#1	#0
2213	OCM							

OCM (#7) 0: Pole position detection is ineffective.
1: Pole position detection is effective.

No.	#7	#6	#5	#4	#3	#2	#1	#0
2229				FORME	WATRA			ABSEN

ABSEN (#0) 0: AMR offset isn't available.
1: AMR offset is available.

Please always set ABSEN=1.

In case of absolute encoder, the result (AMR offset) of pole position detection is memorized to parameter (No.2139) and it isn't necessary to execute pole position detection every power on. In case of incremental encoder, the result of pole position detection is also memorized to parameter after the reference signal of encoder is caught. In this case it is necessary to execute pole position detection every power on, but AMR offset memorized to parameter before is applied after reference signal is caught. In this case it is possible to suppress fluctuation of the torque constant by the variation in pole position detection every power on.

WATRA (#3) 0: unexpected motion is watched after detection
1: unexpected motion isn't watched after detection

When the wrong pole position is detected, it is possible to avoid unexpected motion of motor by this function. If the motor moved unexpectedly after detection, alarm 454 would occur. Please set WATRA=1 in case of Vcmd mode.

FORME (#4) 0: Applied Auto select mode (minute moving + stop state mode)
1: Applied Minute moving mode

Please always set FORME=1.

No.	#7	#6	#5	#4	#3	#2	#1	#0
2009			PDDDM					

*1) PDDDM (#5) 0: Minute moving method
1: Direct exciting method.

Please always set PDDDM=1

When AMR offset (No.2139) is 0, detection is used direct exciting method. In this case, torque is limited to less than the rated current (No.2086) until reference signal of encoder is caught.
(90G0/19.0, 90G3/5.0, 90E1/13.0, 90E3/8.0 or later)

> ⚠ **CAUTION**
> Pay attention to motor movement because motor might move max.180 degree as electric angle during detection.

No.	
2139	(AMROFS) AMR offset

Data unit degree
Valid data range 1 to 360
Initial setting 0

In case of ABSEN=1 (No.2229#0=1), the result of pole position detection is memorized to this parameter, which is the electric angle. If it is necessary to detect again, clear this parameter.

> ⚠ **CAUTION**
> After the pole position was detected, you never manually change this value. However if it is necessary to adjust and to change this value, power must be off after modification.

No.	
2182	(DTCCRT_A) Current value A for pole position detection

*1) Data unit 7282 means the maximum current of servo amplifier.
Valid data range 0 to 7282
Standard setting 0

Set current for pole position detection. When it is 0, the rated current parameter (No.2086) is adopted. When alarm "ILLEGAL ROTOR POS DETECT SV0454" occurs during detection for large static friction, this parameter is set to more than the rated current. This parameter is limited by torque limit parameter (No.2060).

No.	
2198	Repetitive number

*1)

Data unit Number
Valid data range -1 to 30
Standard setting 0

In minute moving method (No.2229#4=1, No.2009#5=0), the detection is repeated up to number which adds on 1 to this parameter, and the average of result is calculated.
In direct exciting method (No.2229#4=1, No.2009#5=1), if this parameter is negative, direct exciting method is used as detection method regardless of the value of No.2139.
(90G0/19.0, 90G3/5.0, 90E1/13.0, 90E3/8.0 or later)

No.	
2199	Permissible electric angle

*1)

Data unit degree (Electric angle)
Valid data range 0 to 45
Standard setting 0 (If 0 is set, this parameter is internally handled as 10 degree.)

In direct exciting method (No.2229#4=1, No.2009#5=1), this parameter sets the permissible range for detecting accuracy. 0 means range from -10 degree to +10 degree. If the detection result is out of range, “ILLEGAL ROTOR POS DETECT SV0454“ occurs.
(90G0/19.0, 90G3/5.0, 90E1/13.0, 90E3/8.0 or later)

No.	
2268	(MFMPMD) Permissible mechanical angle

Data unit %
Valid data range -1000 to 1000 (Positive only)
Standard setting 0 (If 0 is set, this parameter is internally handled as 100%.)

In case of positive value
This parameter sets permissible range for movement during detection. Permissible mechanical angle is from -5 degree to 5 degree and it’s handled as 100%. If movement during detection exceeds the permissible range, “ILLEGAL ROTOR POS DETECT SV0454“ occurs. In this case, this parameter should be set to more than 100%, such as 200%.
In case of negative value
It is possible to change the speed level (detecting sensitivity) for stop & move in minute moving method or direct exciting method. It is set to under 100% for high sensitivity and over 100% for low sensitivity. If velocity feedback is noisy, make low sensitivity (from -200 to -500). Meanwhile if the axis has large inertia, make high sensitivity (from -10 to -20).

(5) Signals

Pole position detection request signal : Gn135.0 – Gn135.7 (RPREQ1 – RPREQ8)

Classification Input signal

Function Request to execute the pole position detection. A number appended to a signal represents the controlled axis number.

Operation CNC starts the pole position detection.

Pole position detecting signal : Fn158.0 – Fn158.7 (RPDET1 - RPDET8)

Classification Output signal

Function These signals indicate that CNC is detecting the pole position of each axis. A number appended to a signal represents the controlled axis number.

Output Condition These signals turn to “1” when:
CNC is detecting the pole position

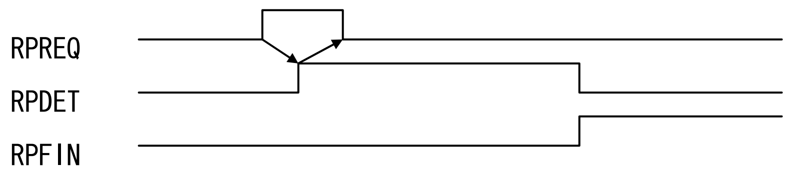
These signals turn to 0 when:
The pole position detection completes.
The pole position detection stops illegally.
The pole position detection stops by reset.

Pole position detection completion signal : Fn159.0 – Fn159.7 (RPFIN1 - RPFIN8)

Classification Output signal

Function These signals indicate that the pole position detection of each axis completes.
A number appended to a signal represents the controlled axis number.

Output Condition These signals turn to “1” when:
The pole position detection completes.
These signals do not turn to “0” except power-off.



> Note
> In case of absolute encoder and No.2229#0=1, if once detection completes, Fn158.x=1 is kept even if CNC power is turned off. Meanwhile if No.2139 =0 and CNC power is turned off, Fn158.x turns into 0.

No.	#7	#6	#5	#4	#3	#2	#1	#0
G135	RPREQ8	RPREQ7	RPREQ6	RPREQ5	RPREQ4	RPREQ3	RPREQ2	RPREQ1
F158	RPDET8	RPDET7	RPDET6	RPDET5	RPDET4	RPDET3	RPDET2	RPDET1
F159	RPFIN8	RPFIN7	RPFIN6	RPFIN5	RPFIN4	RPFIN3	RPFIN2	RPFIN1

(6) Detection alarm

*1) When “ILLEGAL ROTOR POS DETECT SV0454“ occurs, it is possible to confirm the detail No. of alarm by diagnosis display N352. (90G0/19.0, 90G3/5.0, 90E1/13.0, 90E3/8.0 or later)

Alarm detail

Detail No.	Factor	Estimated cause
1	Motor speed doesn’t get to under stop level in minute moving method.	Velocity feedback might be noisy. Decrease detecting sensitivity (No.2268=-200… -500)
2	Motor movement exceeds permissible range even if No.2182 is smaller in minute moving method.	Mechanical friction might be small. Increase detecting sensitivity (No.2268=-10…-20)
3	Motor speed doesn’t get to over stop level even if No.2182 is larger in minute moving method.	Motor might be fixed or inertia might be larger. If inertia is larger, increase detecting sensitivity (No.2268=-10…-20)
5	Direction of torque is different from direction of motor rotation.	Mistake about conection of motor power line.
6	Motor speed doesn’t get to under stop level in direct exciting method.	Velocity feedback might be noisy. Decrease detecting sensitivity (No.2268=-200… -500)
7	Direction of torque is different from direction of motor rotation.	Mistake about conection of motor power line.
8	Motor movement exceeds permissible range in direct exciting method.	Mistake about parameter setting of pole number, or motor is fixed, or mechanical friction is larger.

(7) Countermeasure to trouble

Phenomenon	Detail	Request G135	Detecting F158	Finish F159	Cause	Measures
Before detection						
Detection doesn't start	Motor doesn't move at all.	0	0	0	Request signal OFF (G135=0)	Set request signal (G135=1)
		1	0	0	Function is invalid	Confirm function parameter (No.2213#7) or option.
					SERVO OFF	Set SERVO ON
Detection doesn't finish	Motor seems to move only a little, but detection doesn't finish and any alarm doesn't occur.	1	1	0	Friction is smaller.	Decrease current No.2182.
					Detection unit of encoder is rough or fine.	Change detecting sensitivity (negative No.2268).
					Velocity feedback is noisy.	Take measures of feedback signal noise.
Excess error for stop	Excess error occurs during detection. (SV0410)	1	0	0	Friction is smaller.	Set excess error to larger. Or set current No.2182 to less than rated current.
Illegal detection alarm	Illegal detection alarm occurs. (SV0454)	1	0	0	Friction is larger.	Set current No.2182 to more than rated current.
					Current loop gain is small	Set current loop gain to appropriate value.
After detection						
Oscillation		–	0	1	Relation between phase sequence of motor power line and direction of sensor is inconsistent. (*1-1)	Change phase sequence of motor power line. (*1-2)
					Mistake about parameter setting for encoder. (*2-1)	Set correct detection unit of encoder. (*2-2)
					Mistake about parameter setting for pole of motor. (*3-1)	Set correct pole number of motor. (*3-2)
					High velocity loop gain	Tune up velocity loop gain.
Excess error in motion	Motor moves unexpectedly, or doesn't move in spite of giving command.	–	0	1	Refer to (*1-1) (*2-1) (*3-1).	Refer to (*1-2) (*2-2) (*3-2).
					scale with distance-coded reference marks + circuit C	Apply servo software 90D0, E0/10.0 or later
AMR offset isn't updated.	After detection, detection result isn't written in AMR offset (No.2139).	–	0	1	No.2229#0=0	Set parameter No.2229#0=1.
					not MDI mode	Change MDI mode.
					Incremental encoder	Rotate motor over one revolution.
Illegal detection alarm	Illegal detection alarm occurs. (SV0454)	–	0	1->0	VCMD mode	No.2229#3=1
After restart						
Motionless in spite of giving command	Motor doesn't move in spite that command is given and AMR offset isn't zero.	—	—	—	Incremental encoder	Need to detect every power-on.
					Some alarm for sensor	Try pole detection again.
Dispersion of detection result	Detection result has dispersion each detection.	—	—	—	Friction is larger.	Set current No.2182 to more than rated current No.2086.

(8) Detection of the pole position detection request alarm

The pole position detection function specifies that no torque occurs on an axis where pole position detection is not completed (servo-off state). So, conventionally, the customer's ladder needs to monitor the pole position detection completion signal in order to judge whether to release the brake of an axis or to specify a move command for an axis.

The servo software and CNC software indicated below execute the following processing when pole position detection is not completed [pole position detection enabled (bit 7 of No. 2213=1) and the pole position detection completion signal is off (Fn159=0)]:

1) The interlock state is set.
   (Interlock is applied onto each axis. "INTER/START LOCK ON" on the diagnosis screen No. 0000 displays 1.)
2) The servo ready signal SA is turned off (the SA signal for all axes is turned off.)
3) Alarm DS0650 is displayed (cleared by a reset).

Safety is thus ensured even if the customer's ladder processing is not performed. [Applicable servo software]

[Applicable servo software]

CNC	Servo software		Remark
	series	version	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0 90G3	03.0 or later 01.0 or later	
Series 30*i*/31*i*/32*i*-A	90E0 90E1 90E3	M(13) or later 01.0 or later 01.0 or later	
Series 30*i*/31*i*-A	90D0	M(13) or later	HRV4
Series 0*i*-D	90C5 90C8	A(01) or later A(01) or later	
	90E5 90E8	A(01) or later A(01) or later	

[Applicable system software]

CNC	System software	
	series	version
Series 30*i*-A	G00C,G01C,G02C	27.0 or later
	G004,G014,G024	1.0 or later
Series 31*i*-A5	G12C,G13C	27.0 or later
	G124,G134	1.0 or later
Series 31*i*-A	G103,G113	4.0 or later
	G104,G114	1.0 or later
Series 32*i*-A	G203	4.0 or later
	G204	1.0 or later
Series 0*i*-MD	D4F1	01 or later
Series 0*i*-TD	D6F1	01 or later
Series 0*i* Mate-MD	D5F1	01 or later
Series 0*i* Mate-TD	D7F1	01 or later

Series 30i/31i/32i/35i-B, Power Motion i-A are supported with all version.

The alarm number and message are indicated below.

Number	Message	Message Description
DS0650	POLE DETECTION REQUEST	With an absolute detection axis (bit 5 of No. 1815=1), pole position detection is not completed (Fn159=0). With a non-absolute detection axis (bit 5 of No.1815=0), pole position detection is once completed then the state is changed to the pole position detection uncompleted state (Fn159=0).

With the parameters below, operation to be performed when pole position detection is not completed can be changed.

No.	#7	#6	#5	#4	#3	#2	#1	#0
1809							PAO	SAN

[Input type] Parameter input
[Data type] Bit path

#0 SAN

When the pole position detection function is used, pole position detection is enabled (bit 7 of No. 2213=1), and pole position detection is not completed (Fn159=0) with an axis, the servo ready signal SA <Fn000.6> of the path to which the axis belongs and the servo ready signals SA8 to SA1 <Fn186.7 to Fn186.0> for all axes that belong to the path are:

0: Not set to 0.
1: Set to 0.

> ⚠ **CAUTION**
>
> When applying pole position detection to a gravity axis, basically release the brake after confirming pole position detection completion (Fn159=1) and the servo ready signal. When releasing the brake by checking the servo ready signal alone for an avoidable reason, set this parameter to 1.

#1 PAO

When the pole position detection function is used, pole position detection is enabled (bit 7 of No. 2213=1), and pole position detection is not completed (Fn159=0) with an axis:

0: Alarm DS0650 (POLE DETECTION REQUEST) is issued.
1: Alarm DS0650 (POLE DETECTION REQUEST) is not issued.

> **NOTE**
>
> 1 The issue condition of alarm DS0650 varies, depending on whether the axis in question is an absolute detection axis, as described below.
> - The alarm is issued with an absolute detection
> axis (bit 5 of No. 1815=1) when pole position detection is not completed (Fn159=0).
> - The alarm is issued with a non-absolute detection axis (bit 5 of No. 1815=0) when pole position detection is once completed then the state is changed to the pole position detection uncompleted state (Fn159=0).
>
> 2 If this alarm is issued, detect a pole position again. After a pole position is detected again, this alarm is cleared by a reset.

(9) Using the pole position detection function and control axis detach function together

When the pole position detection function is used with an axis of a synchronous built-in servo motor, motor switching using the detach function is conventionally impossible. However, the servo software and CNC software of the series and editions indicated below enable the pole position detection function and detach function to be used at the same time.

[Applicable servo software]

CNC	Servo software		Remark
	series	version	
Series 30*i*/31*i*/32*i*/35*i*-B Power Motion *i*-A	90G0 90G3	03.0 or later 01.0 or later	
Series 30*i*/31*i*/32*i*-A	90E0 90E1 90E3	M(13) or later 02.0 or later 01.0 or later	
Series 30*i*/31*i*-A	90D0	M(13) or later	HRV4
Series 0*i*-D	90C5 90C8	A(01) or later A(01) or later	
	90E5 90E8	A(01) or later A(01) or later	

[Applicable system software]

CNC	System software	
	series	version
Series 30*i*-A	G00C,G01C,G02C	27.0 or later
	G004,G014,G024	1.0 or later
Series 31*i*-A5	G12C,G13C	27.0 or later
	G124,G134	1.0 or later
Series 31*i*-A	G103,G113	4.0 or later
	G104,G114	1.0 or later
Series 32*i*-A	G203	4.0 or later
	G204	1.0 or later
Series 0*i*-MD	D4F1	01 or later
Series 0*i*-TD	D6F1	01 or later

Series 30i/31i/32i/35i-B, Power Motion i-A are supported with all version.

⚠ **CAUTION**

1 When switching is made by using the detach function among those motors that need the pole position detection function, the motors and encoders need to be of the same type.

2 The detach function is supported only by a combination of the CNC software and servo software indicated above. When CNC software and servo software not listed above are used, the pole position detection function and detach function cannot be used at the same time.

When the detach function is used, the relationship of the Z phase of the encoder with the pole position of the motor may vary. So, pole position detection needs to be performed again or the AMR offset (No.2139) needs to be rewritten to a proper value. To perform pole position detection again and rewrite the AMR offset, however, the conventional specification requires that the power be turned off then back on. With the servo software and CNC software listed above, the power to the CNC need not be turned off then back on to perform pole position detection again and rewrite the AMR offset.

When detaching an axis to which pole position detection is applied, use the procedure below.

- Start detach operation with Gn124 or bit 7 of parameter No. 12.

(Pole position detection completion signal Fn159=0)

- Rewrite the AMR offset (No. 2139) to a proper value manually or by using G10 (*1)
- Cancel detach operation.
- Pole position detection request alarm DS0650 is issued (*2).
- If an absolute encoder is used and the AMR offset value is other than 0, the alarm can be canceled by a reset to enable operation (pole position detection completion signal Fn159=1).
- If an absolute encoder is used and the AMR offset value is 0, the alarm can be canceled by a reset after executing pole position detection to enable operation (pole position detection completion signal Fn159=0 changed to Fn159=1 after pole position detection completion).
- If an incremental encoder is used, the alarm can be canceled after pole position detection to enable operation (pole position detection completion signal Fn159=0 changed to Fn159=1 after pole position detection completion).

*1 : By setting bit 0 of No. 1809 to 1, the servo ready signal SA can be turned off when pole position detection is not completed.

*2 : By setting bit 1 of No. 1809 to 1, alarm display can be disabled even when pole position detection is not completed. If the AMR offset is rewritten not during detach operation, a power-off request is issued. When performing pole position detection with an absolute

Notice of the Update of Digital Servo Software for Series 30*i*/ 31*i*/ 32*i*/ 35*i*-B/Power Motion *i* -A (90G0)

1. Update Edition

ROM series	New edition	Available CNC
90G0	21 .0	Series 30*i*/ 31*i*/ 32*i*/ 35*i* -B/Power Motion *i* -A

2. Contents of change

- Servo/Spindle synchronous control (FSSB TYPE)

  Servo/Spindle synchronous control (FSSB TYPE) has been supported.

- The smooth backlash compensation to error counter in semi-closed loop

  The smooth backlash compensation to error counter in semi-closed loop has been supported when Dual Position Feedback Function is enabled. Please refer attached file “ About Dual Position Feedback Function with Smooth Backlash Compensation ” for detail.

Ed.	Date	Design	Description
01	13.04.17	Tang	Newly designed

TITLE Notice of the Update of Digital Servo Software for Series 30*i*/ 31*i*/ 32*i*/ 35*i*-B/Power Motion*i* -A (90G0)

DRAW. No. A-81017-066 EN

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SHEET 1/2

About Dual Position Feedback Function with Smooth Backlash Compensation

(1) Outline

Dual Position Feedback function has two position control loop. The one is scale position feedback loop (full-closed loop), the other is PULSECODER potision feedback loop (semi-closed loop).

Using Dual Position Feedback Function with Smooth Backlash Function, the conpensation onto semi-closed side has been supported.

(2) Notice

・ When servo software is not supported (90G0/20.0 or former), semi-full error increases.

(3) Parameter

	#7	#6	#5	#4	#3	#2	#1	#0
11601		SBN						

SBN (#6) When both of smooth backlash compensation and Dual Position Feedback are enabled, a smooth backlash compensation value is :

0: Used for compensation on the semi-closed side.

1: Dependent on the settings of bit 4 of No.2206 and bit 5 of No.2010.

Notice of the Update of Digital Servo Software for Series 30*i*/ 31*i*/ 32*i*/ 35*i*-B/Power Motion *i* -A (90G0)

1. Update Edition

ROM series	New edition	Available CNC
90G0	22 .0	Series 30*i*/ 31*i*/ 32*i*/ 35*i* –B/ Power Motion *i* -A

2. Contents of change

- Feedrate constant type of Servo delay compensation for chopping setting screen (R614)

  Chopping feedrate constant type of Servo delay compensation (No.8360#1) has been supported.
  For detail please refer TMN11/039
  "FANUC Series 30*i*/31*i*/32*i*-MODEL A FANUC Series 30*i*/31*i*/32*i*-MODEL B
  Chopping setting screen"

				TITLE Notice of the Update of Digital Servo Software for Series 30*i*/ 31*i*/ 32*i*/ 35*i*-B/Power Motion*i* -A (90G0)	
				DRAW. No. A-81017-069 EN	CUST.
01	13.05.27	Tang	Newly designed		
Ed.	Date	Design	Description	FANUC CORPORATION	SHEET 1/1