FANUC

GE Fanuc Automation

Computer Numerical Control Products

α Series AC Servo Motor

Parameter Manual

GFZ-65150E/03

April 1997

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.**

Table of Contents

1 OVERVIEW

This manual describes the servo parameters of the following NC models using an α servo system. The descriptions include the servo parameter start–up and adjustment procedures. The meaning of each parameter is also explained.

Servo software and modules supported by each NC model

NC product name	Series and edition of applicable servo software	Module
FANUC Series 0–MODEL C FANUC Series 15–MODEL A	Series 9046/001A and subsequent editions (Supporting standard and high–speed positioning) Series 9041/001A and subsequent editions (Supporting dual position feedback)	Serial axis board
FANUC Series 15–MODEL B (Note 2) FANUC Series 16–MODEL A FANUC Series 18–MODEL A	Series 9060/001J and subsequent editions	320C25 module
FANUC Series 20–MODEL A FANUC Series 21–MODEL A FANUC Series 21–MODEL B FANUC Power Mate–MODEL D FANUC Power Mate–MODEL F FANUC Power Mate–MODEL H FANUC Power Mate–MODEL I	Series 9060/001J and subsequent editions (Supporting standard and high–speed positioning) Series 9066/001F and subsequent editions (Supporting FAD & HRV control) (Note 1)	320C25 module
FANUC Series 15–MODEL B (Note 2) FANUC Series 16–MODEL B FANUC Series 18–MODEL B FANUC Series 16–MODEL C FANUC Series 18–MODEL C	Series 9070/001A and subsequent editions	320C51 module 320C52 module
FANUC Series 15–MODEL B (Note 2) FANUC Series 16–MODEL C FANUC Series 18–MODEL C	Series 9080/001E and subsequent editions (Supporting FAD & HRV control and linear motor) Series 9081/001A and subsequent editions (Supporting ultrahigh–precision machining)	320C25 module
FANUC Power Mate–MODEL E	Series 9064/001E and subsequent editions (Standard) Series 9065/001A and subsequent editions (Supporting HRV control)	

NOTE 1 For the Series 21, Power Mate–D, and Power Mate–F, the NC software and servo software are integrated. The NC software of the following series and editions includes servo software supporting the α servo motor.

Series 21	Series 8866/001B and subsequent editions
Power Mate–D	Series 8831/001A and subsequent editions Series 8836/001A and subsequent editions
Power Mate–F	Series 8870/001A and subsequent editions

NOTE 2 The servo software series of the Series 15–B depends on the incorporated servo module, as shown below:

Servo software	CNC CPU	Servo module
Series 9060	68030	320C25 module
Series 9070	68040	320C51 module
Series 9080 Series 9081	68040	320C52 module

Explanations

The models covered by this manual, and their abbreviations are :

NC product name	Abbreviations	
FANUC Series 0–MODEL C	Series 0–C	Series 0
FANUC Series 15–MODEL A	Series 15–A	Series 15 (Note 1)
FANUC Series 15–MODEL B	Series 15–B	
FANUC Series 16–MODEL A	Series 16–A	Series 16 (Note 1)
FANUC Series 16–MODEL B	Series 16–B	
FANUC Series 16–MODEL C	Series 16–C	
FANUC Series 18–MODEL A	Series 18–A	Series 18 (Note 1)
FANUC Series 18–MODEL B	Series 18–B	
FANUC Series 18–MODEL C	Series 18–C	
FANUC Series 20–MODEL A	Series 20–A	Series 20
FANUC Series 21–MODEL A	Series 21–A	Series 21 (Note 1)
FANUC Series 21–MODEL B	Series 21–B	
FANUC Power Mate–MODEL D	Power Mate–D	Power Mate (Note 2)
FANUC Power Mate–MODEL F	Power Mate–F	
FANUC Power Mate–MODEL H	Power Mate–H	
FANUC Power Mate–MODEL I	Power Mate–I	
FANUC Power Mate–MODEL E	Power Mate–E	Power Mate–E (Note 2)

NOTE

1 In this manual, a reference to the Series 15, 16, 18, or 21, without a specific model name refers to all the models of the series.

2 In this manual, Power Mate refers to the Power Mate–D, Power Mate–F, Power Mate–H, and Power Mate I.
The Power Mate–E, which uses different servo software and different parameter numbers, is designated by its full name or as Power Mate–E.

Related manuals

The following ten kinds of manuals are available for FANUC SERVO MOTOR α/β series.
In the table, this manual is marked with an asterisk (*).

Document name	Document number	Major contents	Major usage	
FANUC AC SERVO MOTOR α series DESCRIPTIONS	B–65142E	● Specification ● Characteristics ● External dimensions ● Connections	● Selection of motor ● Connection of motor	
FANUC AC SERVO MOTOR β series DESCRIPTIONS	B–65232EN			
FANUC AC SPINDLE MOTOR α series DESCRIPTIONS	B–65152E			
FANUC CONTROL MOTOR AMPLIFIER α series DESCRIPTIONS	B–65162E	● Specifications and functions ● Installation ● External dimensions and maintenance area ● Connections	● Selection of amplifier ● Connection of amplifier	
FANUC CONTROL MOTOR AMPLIFIER α series (SERVO AMPLIFIER UNIT) DESCRIPTIONS	B–65192EN			
FANUC CONTROL MOTOR α series MAINTENANCE MANUAL	B–65165E	● Start up procedure ● Troubleshooting ● Maintenance of motor	● Start up the system (Hardware) ● Troubleshooting ● Maintenance of motor	
FANUC CONTROL MOTOR AMPLIFIER α series (SERVO AMPLIFIER UNIT) MAINTENANCE MANUAL	B–65195EN	● Start up procedure ● Troubleshooting	● Start up the system (Hardware) ● Troubleshooting	
FANUC SERVO MOTOR β series MAINTENANCE MANUAL	B–65235EN	● Start up procedure ● Troubleshooting ● Maintenance of motor	● Start up the system (Hardware) ● Troubleshooting ● Maintenance of motor	
FANUC AC SERVO MOTOR α series PARAMETER MANUAL	B–65150E	● Initial setting ● Setting parameters ● Description of parameters	● Start up the system (Software) ● Turning the system (Parameters)	*
FANUC AC SPINDLE MOTOR α series PARAMETER MANUAL	B–65160E			

Other manufactures' products referred to in this manual

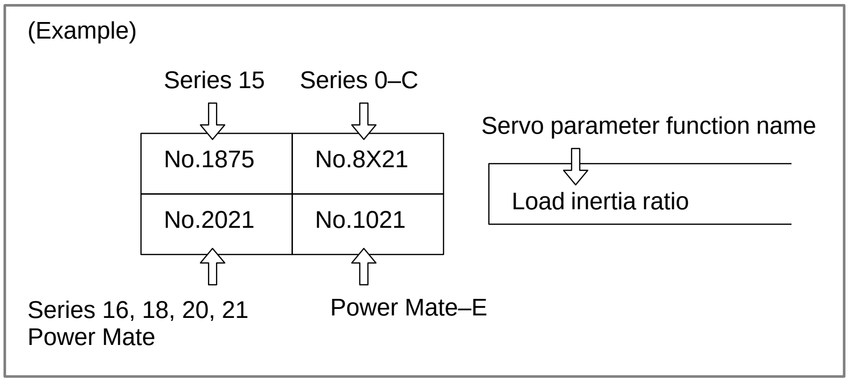
* IBM is registered trademark of International Business Machines Corporation.

* MS–DOS and Windows are registered trademarks of Microsoft Corporation.

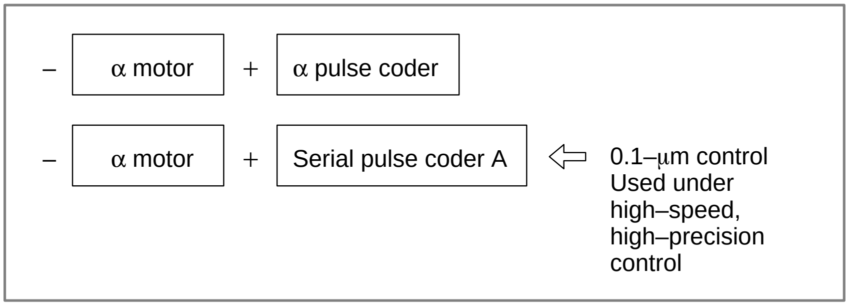
* 486SX and 486DX2 are registered trademarks of Intel corporation.

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

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



The α servo motor can take either of the following configurations:



The following α pulse coders are available.

Pulse coder name	Resolution	Type
αA8	8,192 pulse/rev	Absolute
αA32	32,768 pulse/rev	Absolute
αA64	65,536 pulse/rev	Absolute
αA1000	1,000,000 pulse/rev	Absolute
αI8	8,192 pulse/rev	Incremental
αI32	32,768 pulse/rev	Incremental
αI64	65,536 pulse/rev	Incremental

2

SETTING α SERIES SERVO PARAMETERS

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 15–B)

(2) Servo motor model (ex.: α 6/2000)

(3) Pulse coder built in a motor (ex.: α A1000)

(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
Servo Parameter Initialization Procedure

(1) Switch on the NC in an emergency stop state.

Enable parameter writing (PWE = 1).

(2) Initialize servo parameters on the servo setting screen.

For a Power Mate with no CRT, specify a value for an item number on the servo setting screen. See Fig. 2.1.2.

To display the servo setting screen, follow the procedure below, using the key on the NC.

Series 0–C

Press the PARAM key several times, and the servo setting screen will appear.

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
0389								SVS

SVS (#0) = 0 (to display the servo screen)

Series 15

Press the SERVICE key several times, and the servo setting screen will appear.

Series 16,18,20,21

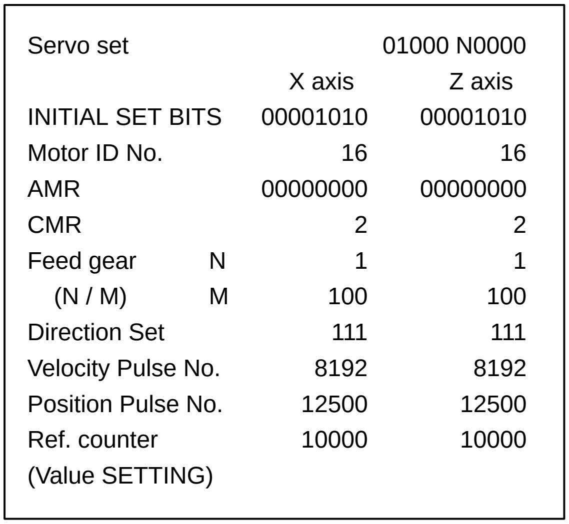
SYSTEM → [SYSTEM] → [▷] → [SV–PRM]

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 (to display 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                              01000 N0000
                           X axis         Z axis
INITIAL SET BITS        00001010       00001010
Motor ID No.                  16             16
AMR                     00000000       00000000
CMR                            2              2
Feed gear       N              1              1
   (N / M)      M            100            100
Direction Set                111            111
Velocity Pulse No.          8192           8192
Position Pulse No.         12500          12500
Ref. counter               10000          10000
(Value SETTING)
```

⇦

Power Mate	Power Mate–E
No. 2000	No. 1000
2020	1020
2001	1001
1820	0100
2084	1084
2085	1085
2022	1022
2023	1023
2024	1024
1821	0324

Fig. 2.1.2 Servo setting menu ⇑ **Correspondence of Power Mate**

(3) Start initialization.

	#7	#6	#5	#4	#3	#2	#1	#0
INITIAL SET BIT					PRMC (Note)		DGPR	PLCO

Start initialization (Keep the NC power on until step (11).)

↓

DGPR (#1) =0 ⇦ Automatically set to 1 after initialization.

NOTE

Once initialization has been completed, the Series 0–C and Series 15–A automatically set bit 3 (PRMC) for initialization to 0, while other NC models set the bit to 1. Note that the bit 3 (PRMC) bit must be set to 0 for the Series 0–C and Series 15–A.

(4) Specify the motor ID No.

Select the motor ID No. of the servo motor to be used, according to the motor model and drawing number (the middle four digits of A06B–XXXX–BXXX) listed in the tables on subsequent pages.

☐ α series servo motor

Motor model	α0.5	α1/3000	α2/2000	α2.5/3000	α3/3000
Motor specification	0113	0371	0372	0374	0123
Motor type No.	13	61	46	84	15

Motor model	α6/2000	α6/3000	α12/2000	α12/3000	α22/1500
Motor specification	0127	0128	0142	0143	0146
Motor type No.	16	17	18	19	27

Motor model	α22/2000	α22/3000	α30/1200	α30/2000	α30/3000
Motor specification	0147	0148	0151	0152	0153
Motor type No.	20	21	28	22	23

Motor model	α40/FAN	α40/2000	α65	α100	α150
Motor specification	0158	0157	0331	0332	0333
Motor type No.	29	30	39	40	41

☐ αL series servo motor

Motor model	αL3/3000	αL6/2000	αL9/3000	αL25/3000	αL50/2000
Motor specification	0561	0562	0564	0571	0572
Motor type No.	56 or 68	57 or 69	58 or 70	59	60

☐ αC series servo motor

Motor model	αC3/2000	αC6/2000	αC12/2000	αC22/1500
Motor specification	0121	0126	0141	0145
Motor type No.	7	8	9	10

☐ αHV series servo motor

Motor model	α3HV	α6HV	α12HV	α22HV	α30HV
Motor specification	0171	0172	0176	0177	0178
Motor type No.	1	2	3	4	5

❑αE, β series servo motor

Motor model	β0.5	β1/3000 αE1/3000	β2/3000 αE2/3000	β3/3000 αE3/3000	β6/2000 αE6/2000
Motor specification	0113	0101	0102	0105	0106
Motor type No.	13	35	36	33	34

❑αM series servo motor

Motor model	αM2/3000	αM2.5/3000	αM3/3000	αM6/3000	αM9/3000
Motor specification	0376	0377	0161	0162	0163
Motor type No.	97	98	24	25	26

Motor model	αM22/3000	αM30/3000	αM50/3000
Motor specification	0165	0166	169
Motor type No.	100	101	108

Motor model	αM6HV	αM9HV	αM22HV	αM30HV
Motor specification	0182	0183	0185	0186
Motor type No.	104	105	106	107

❑Linear motor

Motor model	1500A	3000B	6000B	9000B
Motor specification	0410	0411	0412	0413
Motor type No.	90	91	92	93

These motor type Nos. may not be supported depending on the servo software being used.

The following lists the motor type Nos. together with the applicable servo software series and editions.

☐ α series servo motor

Servo software series / **Motor model and motor type number**		**9041**	**9046**	**9060**	**9066**	**9070**	**9080**	**9081**	**9064**	**9065**
α0.5/3000	13	A	B	M	A	C	A	C	E	A
α1/3000	61	A	B	M	A	C	A	C	E	A
α2/2000	46	A	B	M	A	C	A	C	E	A
α2/3000	62	A	B	M	A	C	A	C	E	A
α2.5/3000	84	A	B	M	A	C	A	C	E	A
α3/3000	15	A	B	M	A	C	A	C	E	A
α6/2000	16	A	B	M	A	C	A	C	E	A
α6/3000	17	A	B	M	A	C	A	C	E	A
α12/2000	18	A	B	M	A	C	A	C	E	A
α12/3000	19	A	B	M	A	C	A	C	E	A
α22/1500	27	A	B	M	A	C	A	C	E	A
α22/2000	20	A	B	M	A	C	A	C	E	A
α22/3000	21	A	B	M	A	C	A	C	E	A
α30/1200	28	A	B	M	A	C	A	C	E	A
α30/2000	22	A	B	M	A	C	A	C	E	A
α30/3000	23	A	B	M	A	C	A	C	E	A
α40/FAN	29	A	B	M	A	C	A	C	E	A
α40/2000	30	A	B	M	A	C	A	C	E	A
α65	39	A	B	M	A	C	A	C	E	A
α100	40	A	B	M	A	C	A	C	E	A
α150	41	A	B	M	A	C	A	C	E	A

❑αL series servo motor

Servo software series / Motor model and motor type number		9041	9046	9060	9066	9070	9080	9081	9064	9065
αL3/3000	56 68	A	B	M	A I	C	A K	C E	E	A
αL6/3000	57 69	A	B	M	A I	C	A K	C E	E	A
αL9/3000	58 70	A	B	M	A I	C	A K	C E	E	A
αL25/3000	59	A	B	M	A	C	A	C	E	A
αL50/3000	60	A	B	M	A	C	A	C	E	A

❑αC series servo motor

Servo software series / Motor model and motor type number		9041	9046	9060	9066	9070	9080	9081	9064	9065
αC3/2000	7	A	B	M	A	C	A	C	E	A
αC6/2000	8	A	B	M	A	C	A	C	E	A
αC12/2000	9	A	B	M	A	C	A	C	E	A
αC22/1500	10	A	B	M	A	C	A	C	E	A

❑αHV series servo motor

Servo software series / Motor model and motor type number		9041	9046	9060	9066	9070	9080	9081	9064	9065
α12HV	3	A	B	M	A	C	A	C	E	A
α22HV	4	A	B	M	A	C	A	C	E	A
α30HV	5	A	B	M	A	C	A	C	E	A

❑αE, β series servo motor

Servo software series / Motor model and motor type number		9041	9046	9060	9066	9070	9080	9081	9064	9065
β0.5/3000	13	A	B	M	A	C	A	C	E	A
αE1/3000 β1/3000	35	A	B	M	A	C	A	C	E	A
αE2/3000 β2/3000	36	A	B	M	A	C	A	C	E	A
β3/3000	33		G	W	B	H	A	C	F	A
αE6/2000 β6/2000	34	A	B	M	A	C	A	C	E	A

❑αM series servo motor

Servo software series / Motor model and motor type number		9041	9046	9060	9066	9070	9080	9081	9064	9065
αM2/3000	98				I		K	E		
αM2.5/3000	99				I		K	E		
αM3/3000	24	A	B	M	A	C	A	C	E	A
αM6/3000	25	A	B	M	A	C	A	C	E	A
αM9/3000	26	A	B	M	A	C	A	C	E	A
αM22/3000	100				I		K	E		
αM30/3000	101				I		K	E		
αM50/3000	108				I		K	E		
αM6HV	104				I		K	E		
αM9HV	105				I		K	E		
αM22HV	106				I		K	E		
αM30HV	107				I		K	E		

NOTE

If your servo software is obsolete, obtain the new edition, or enter standard parameter values using the following procedure:

1) Specify 48 as the motor ID No., and follow the procedure up to step (11).
2) Enter the standard parameter of chapter 7 parameter table directly except for the initialization bit 1 (DGPR) and motor ID No. If you are using 9060 or 9070 Series, and the standard parameter POA1 (No. 1859, 2047) takes a negative value, set it as POA1 × (–10).

(5) Set AMR as described below:

α pulse coder or serial pulse coder A	00000000

(6) Set CMR with the scale of a distance the NC instructs the machine to move.

CMR = Command unit / Detection unit

CMR 1/2 to 48	Setting value = CMR×2

Usually, CMR = 1, so specify 2.

(7) 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 pulse coder or separate detector.

Setting for the α pulse coder and serial pulse coder A in the semi–closed mode

$$\frac{\text{F·FG numerator } (\leqq 32767)\ \overset{\Downarrow\ \text{(Note 1)}}{}}{\text{F·FG denominator } (\leqq 32767)} = \frac{\text{Necessary position feedback pulses per motor revolution}}{1{,}000{,}000 \Leftarrow \text{(Note 2)}} \quad \text{(as irreducible fraction)}$$

NOTE

1 For both F·FG numerator and denominator, the maximum setting value (after reduced) is 32767.

2 α 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

For detection in 1 μm units, specify as follows:

Ball screw lead (mm/rev)	Number of necessary position pulses (pulses/rev)	F·FG
10	10000	1/100
20	20000	2/100 or 1/50
30	30000	3/100

Example of setting

If the machine is set to detection in 1,000 degree units with a gear reduction ratio of 10:1 for the rotation axis, the table rotates by 360/10 degrees each time the motor makes one turn. 1000 position pulses are necessary for the table to rotate through one degree. The number of position pulses necessary for the motor to make one turn is:

$360/10 \times 1000 = 36000$ (with reference counter = 36000 at (10))

$$\frac{\text{F·FG numerator}}{\text{F·FG denominator}} = \frac{36000}{1{,}000{,}000} = \frac{36}{1000}$$

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

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

DMR can also be used with the separate position detector, provided that F·FG = 0.

Example of setting

To detect a distance of 1 μm using a 0.5–μm scale, set the following:

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

(8) Specify the direction in which the motor rotates.

111	Clockwise as viewed from the pulse coder
–111	Counterclockwise as viewed from the pulse coder

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

	Semi–closed			**Full–closed**					
				Parallel type		**Serial liner scale**		**Serial rotary scale**	
Command unit (μm)	1	0.1		1	0.1	1	0.1	1	0.1
Initialization bit	#0=0	#0=1	#0=0	#0=0	#0=1	#0=0	#0=1	#0=0	#0=0
Number of velocity pulses	8192	819	8192	8192	819	8192	819	8192	8192
Number of position pulses	12500	1250	12500	Ns	Ns/10	Ns	Ns/10	12500	12500

Ns : Number of position pulses from the separate detector when the motor makes one turn

(Value after multiplication by four, where DMR and the flexible feed gear are not considered)

Conventionally, the initialization bit, bit 0, was changed according to the command unit. This relationship between the command unit and initialization bit has been eliminated in all CNCs except the Series 0–C and Series 15–A.

Of course, the conventional setting method may also be used. For easier setting, however, set the bit as follows:

Semi–closed: Initialization bit bit 0 = 0
Full–closed: Initialization bit bit 0 = 1
Only when the number of position pulses exceeds 32767.

In the above table, the number of position pulses is likely to exceed 32767 when the command unit is 0.1 μm in full–closed mode.

When using a separate detector (full–closed mode), also specify the following parameters:

Series 0–C

	#7	#6	#5	#4	#3	#2	#1	#0
0037			STP8	STP7	STP4	STPZ	STPY	STPX

STPX to 8 The separate position detector is:

0 : Not used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, or eighth axis
1 : Used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, and eighth axis

Series 15, 16, 18, 20, 21, Power Mate

	#7	#6	#5	#4	#3	#2	#1	#0
1807 —					PFSE			

⇧ Must be specified only for Series 15

PFSE (#3) The separate position detector is:

0 : Not used
1 : Used

CAUTION
This parameter is used only for Series 15.

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

⇧ Must be specified for all NCs.

OPTX (#1) The separate position detector is:

0 : Not used
1 : Used

> **NOTE**
> For Series 16, 18, 20, and 21, setting this parameter causes bit 3 of parameter No. 2002 to be set to 1 automatically.

Power Mate–E

	#7	#6	#5	#4	#3	#2	#1	#0
1002	GRSL				PFSE			

GRSL (#7), PFSE (#3) The separate position detector is:

0 : Not used
1 : Used

Specify the same value for both GRSL and PFSE.

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

Semi–closed loop

Count on the reference counter = Number of position pulses corresponding to a single motor revolution or the same number divided by an integer value

Example of setting

α pulse coder 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. Should this occur, eliminate the difference by changing the detection unit.

Example of setting

System using a detection unit of 1 μm, a ball screw lead of 20 mm/revolution, a gear reduction ratio of 1/17, the number of position pulses corresponding to a single motor revolution set to 1176.47, and the reference counter set to 1176

Make the following modifications and set the detection unit to 1/17 μm:

Parameter modification		Series 0–C	Series 15, 16, 18, 20, 21, Power Mate	Power Mate–E
F·FG	×17	Servo screen	Servo screen	Parameters 1084, 1085
CMR	×17	Servo screen	Servo screen	Parameter 100
Reference counter	×17	Servo screen	Servo screen	Parameter 324
Effective area	×17	Parameters 500 to 503	Parameters 1826, 1827	Parameter 200
Position error limit in traveling	×17	Parameters 504 to 507	Parameter 1828	Parameter 202
Position error limit in the stop state	×17	Parameters 593 to 596	Parameter 1829	Parameter 231
Backlash	×17	Parameters 535 to 538	Parameter 1851, 1852	Parameter 221

(All other CNC parameters set in detection units, such as the amount of grid shift and pitch error compensation magnification, are also multiplied by 17.)

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

NOTE

In rotation axis control for the Series 16, 18, and Power Mate, continuous revolution in the same direction will result in an error if the result of the following calculation is other than an integer, even if the reference counter setting is an integer. Therefore, set parameter No. 1260 so that the result of the calculation is an integer.

(Amount of travel per rotation of the rotation axis (parameter No. 1260)) × CMR
× (reciprocal of flexible feed gear) × $2^{21}/10^{6}$

Full–closed loop

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

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 rotation axis is used and the detection unit is 0.001° :
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.

(11) When using an S–series amplifier, set the following parameters:

1809	8X04
2004	1004

#7	#6	#5	#4	#3	#2	#1	#0
DLY1	DLY0	TIB1	TIB2	TRW1	TRW0	TIB0	TIA0
0	1	0	0	0	1	1	0

(⇧ S–series amplifier)

1866	8X54
2054	1054

Current dead band compensation (PDDP)

Set value 3787 (S–series amplifier)

(12) Switch the NC off and on again.

This completes servo parameter initialization. If an invalid servo parameter setting alarm occurs, go to Subsec. 2.1.4.

If a servo alarm related to pulse coders occurs for an axis for which a servo motor or amplifier is not connected, specify the following parameter.

A feedback connector is used in conventional Series 0–C and 15–A models. However it cannot be used in a system designed for operation with an α pulse coder. This parameter should be specified instead of the dummy connector.

1953	8X09
2009	1009

#7	#6	#5	#4	#3	#2	#1	#0
							SERD

SERD (#0) The dummy serial feedback function is: (See 4.6 for function detail)

0 : Not used

1 : Used

(13) When you are going to use an α pulse coder as an absolute pulse coder, use the following procedure. This procedure is somewhat different from one for conventional pulse coders. (Steps **3** to **5** have been added.)

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

Series 0–C

	#7	#6	#5	#4	#3	#2	#1	#0
0021			APC8	APC7	APC4	APCZ	APCY	APCX

APCX to 8(#0 to #5) The absolute position detector is:

0 : Not used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, or eighth axis.

1 : Used for the X–axis, Y–axis, Z–axis, fourth axis, seventh axis, and eighth axis.

Series 15, 16, 18, 20, 21, Power Mate

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

APCX (#5) The position detector to be used is:

0 : Other than an absolute position detector

1 : Absolute position detector

Power Mate–E

	#7	#6	#5	#4	#3	#2	#1	#0
0017								APCX

APCX (#0) An absolute position detector is:

0 : Not used
1 : Used

2 After making sure that the battery for the pulse coder is connected, switch the NC on.

3 A request to return to the reference position is displayed.

4 Cause the motor to make one turn by jogging.

5 Turn off and on the CNC.

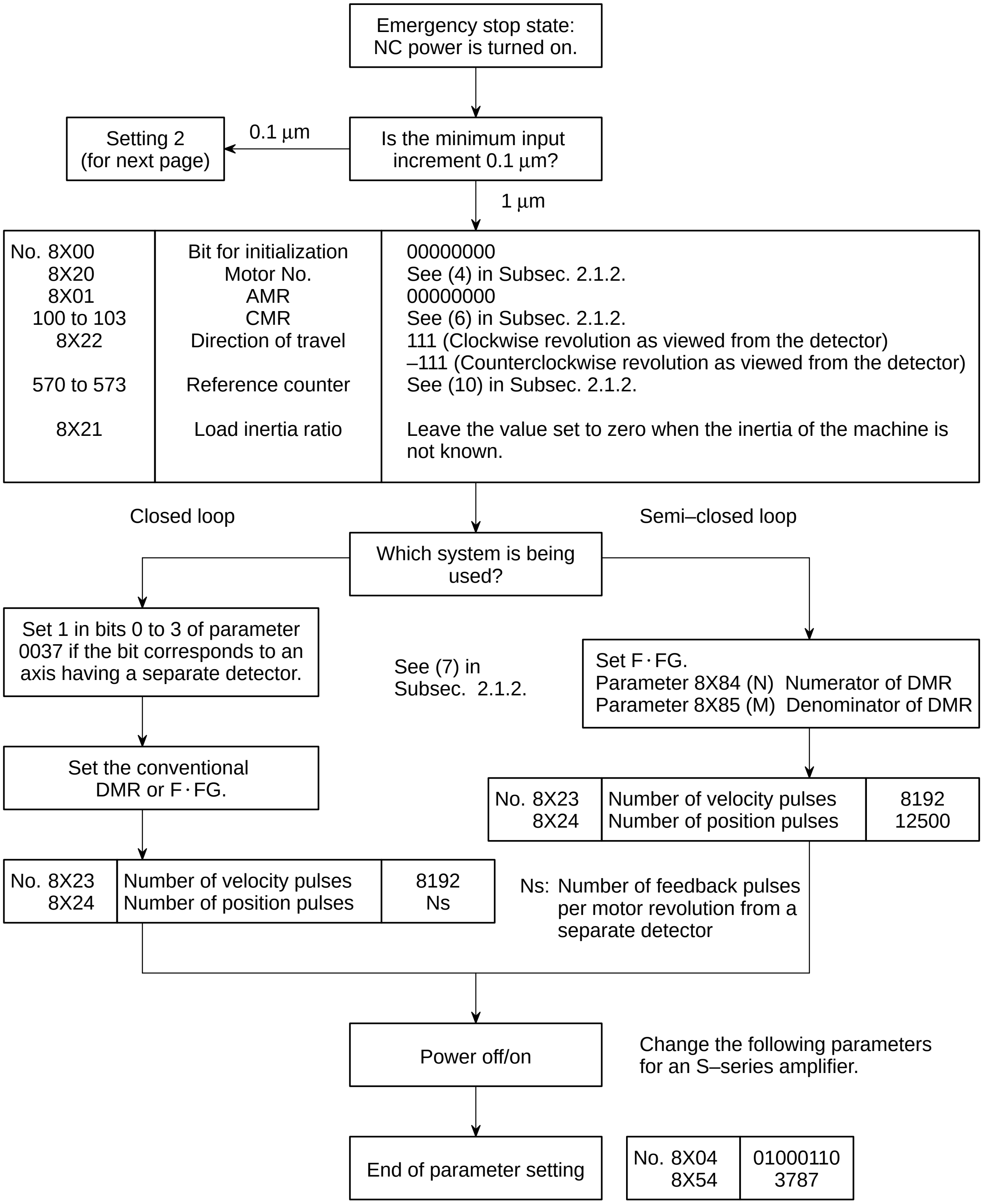
These steps were added for the α pulse coder.

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

7 Do the zero return.

2.1.3
Initialization Flow of Parameters

Initialization flow of Series 0–C servo parameters
(1–μm input increment, α pulse coder, α or C–series amplifier used)



No. 8X00	Bit for initialization	00000000
8X20	Motor No.	See (4) in Subsec. 2.1.2.
8X01	AMR	00000000
100 to 103	CMR	See (6) in Subsec. 2.1.2.
8X22	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
570 to 573	Reference counter	See (10) in Subsec. 2.1.2.
8X21	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

Closed loop:

No. 8X23	Number of velocity pulses	8192
8X24	Number of position pulses	Ns

Ns: Number of feedback pulses per motor revolution from a separate detector

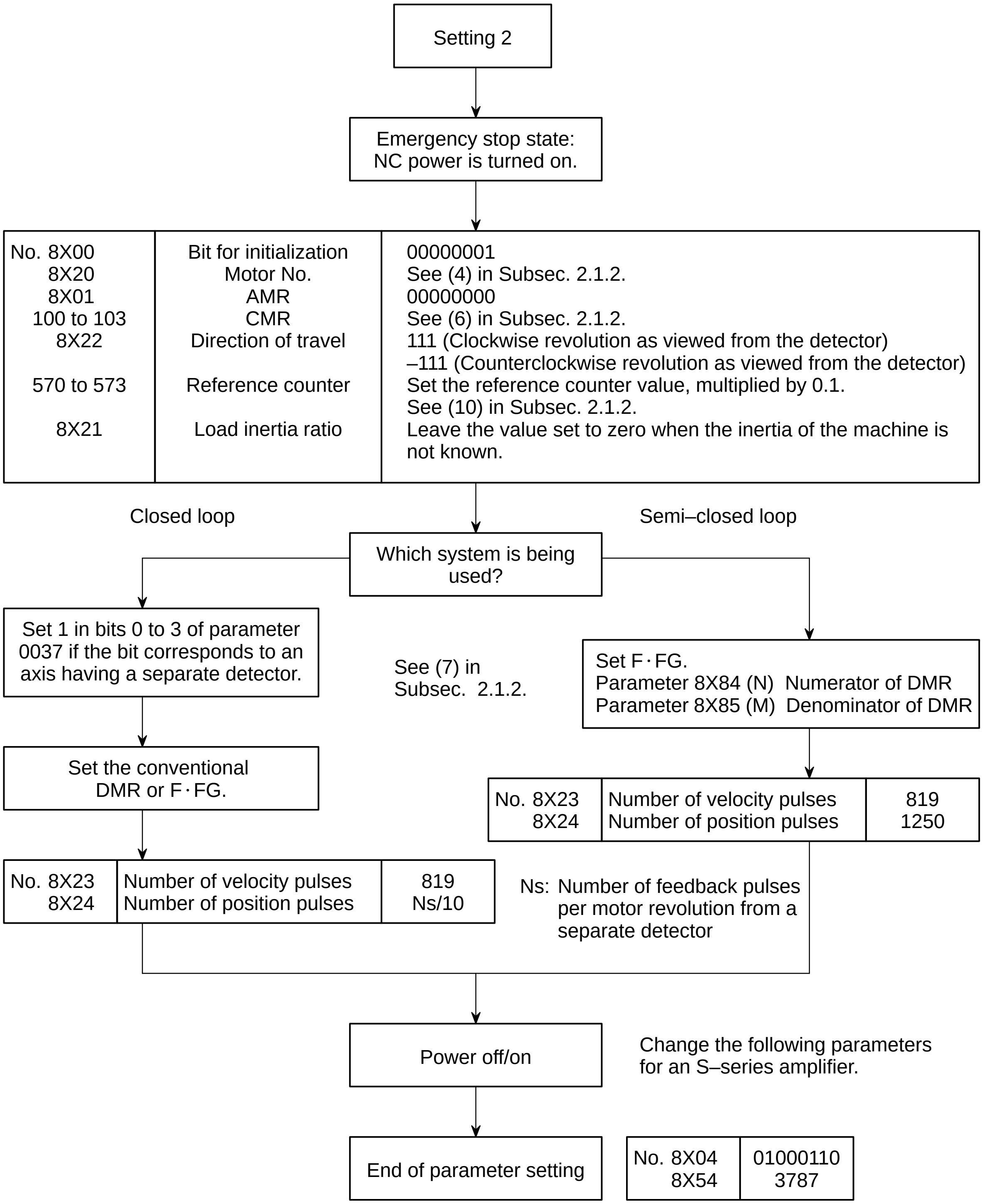
Semi–closed loop:

No. 8X23	Number of velocity pulses	8192
8X24	Number of position pulses	12500

Change the following parameters for an S–series amplifier.

No. 8X04	01000110
8X54	3787

Initialization flow of Series 0–C servo parameters
(0.1–μm input increment, α pulse coder, α or C–series amplifier used)



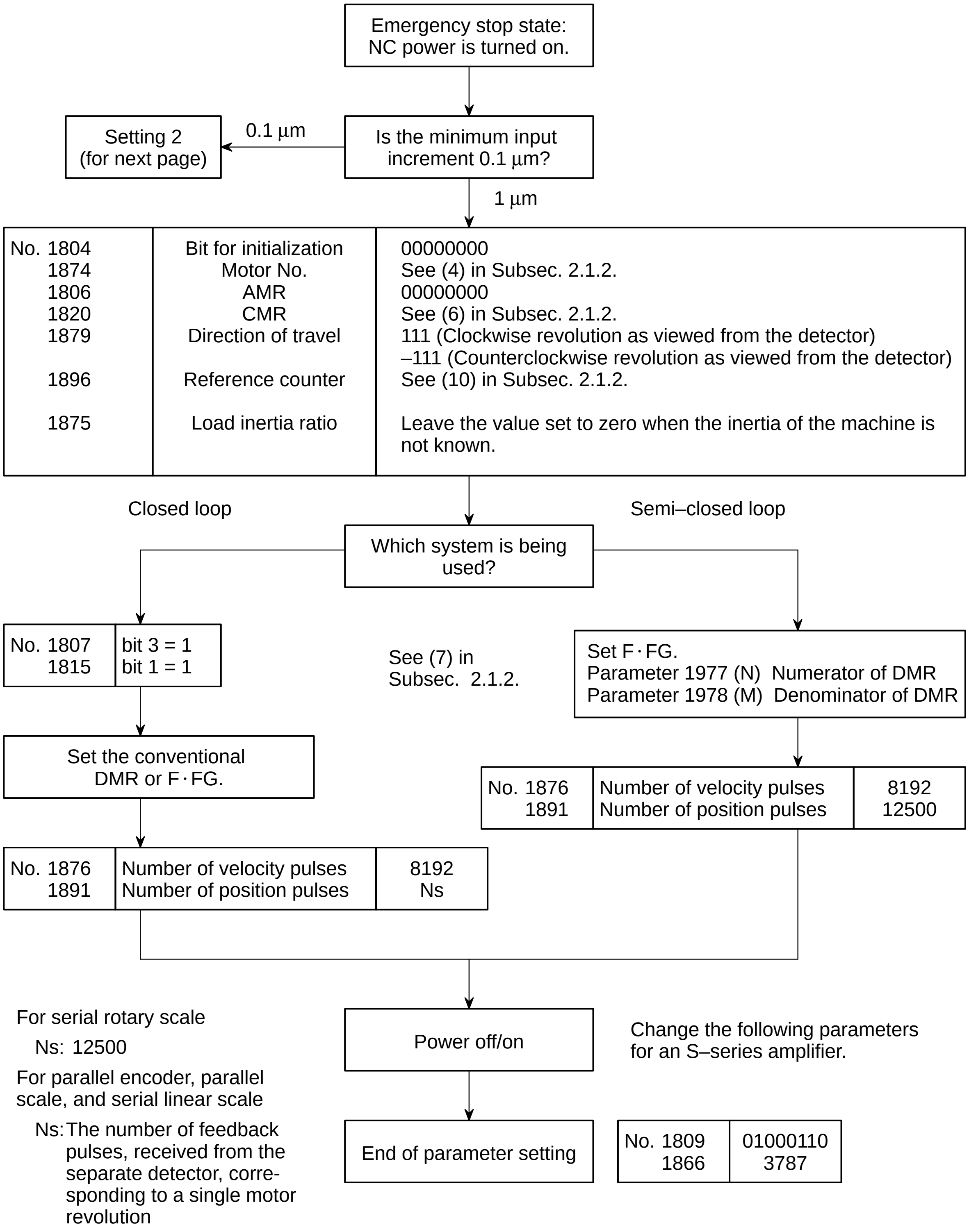
No. 8X00	Bit for initialization	00000001
8X20	Motor No.	See (4) in Subsec. 2.1.2.
8X01	AMR	00000000
100 to 103	CMR	See (6) in Subsec. 2.1.2.
8X22	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
570 to 573	Reference counter	Set the reference counter value, multiplied by 0.1. See (10) in Subsec. 2.1.2.
8X21	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

No. 8X23	Number of velocity pulses	819
8X24	Number of position pulses	Ns/10

No. 8X23	Number of velocity pulses	819
8X24	Number of position pulses	1250

No. 8X04	01000110
8X54	3787

Initialization flow of Series 15 servo parameters
(1–μm input increment, α pulse coder, α or C–series amplifier used)



No. 1804	Bit for initialization	00000000
1874	Motor No.	See (4) in Subsec. 2.1.2.
1806	AMR	00000000
1820	CMR	See (6) in Subsec. 2.1.2.
1879	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
1896	Reference counter	See (10) in Subsec. 2.1.2.
1875	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

No. 1807	bit 3 = 1
1815	bit 1 = 1

No. 1876	Number of velocity pulses	8192
1891	Number of position pulses	Ns

Set F⋅FG.
Parameter 1977 (N) Numerator of DMR
Parameter 1978 (M) Denominator of DMR

No. 1876	Number of velocity pulses	8192
1891	Number of position pulses	12500

For serial rotary scale

Ns: 12500

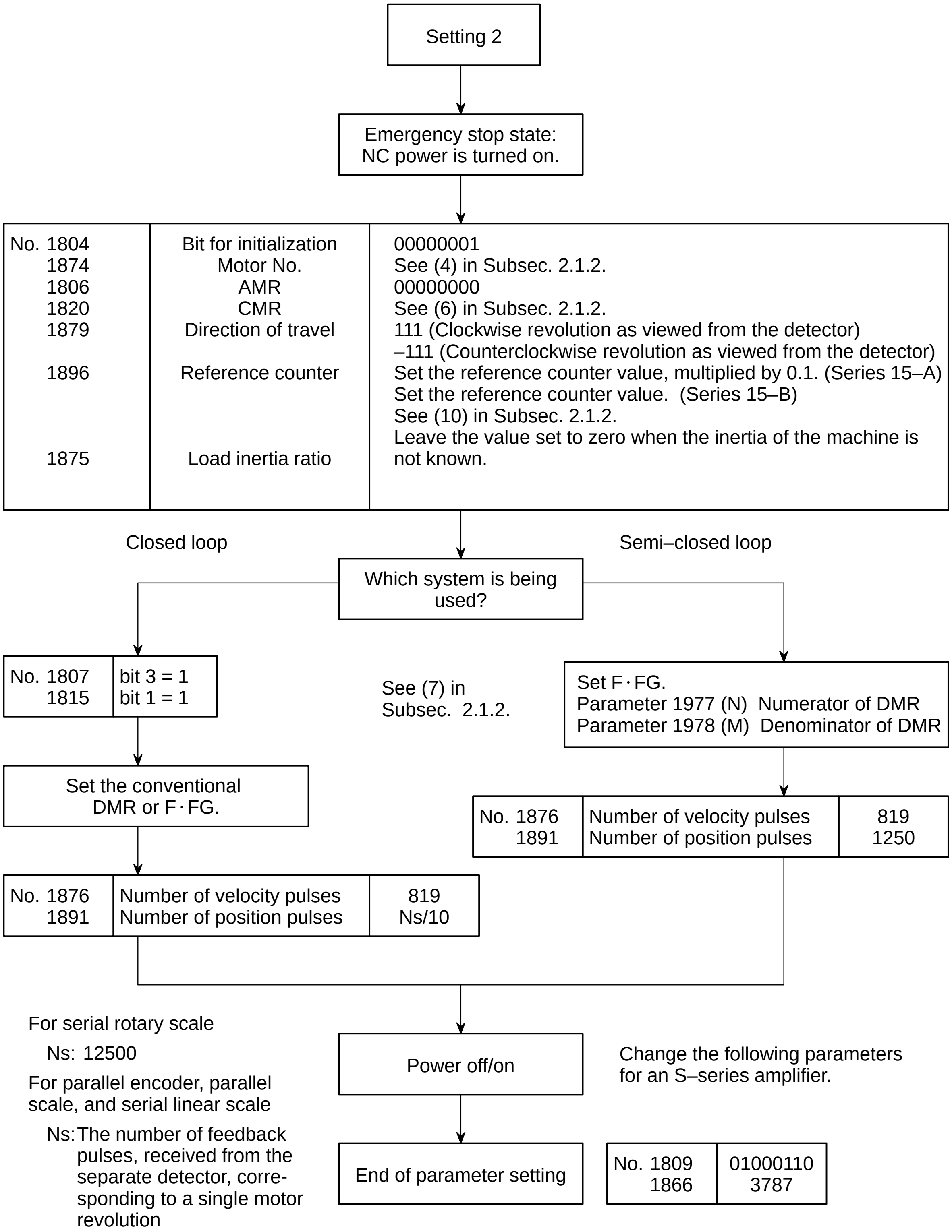
For parallel encoder, parallel scale, and serial linear scale

Ns: The number of feedback pulses, received from the separate detector, corresponding to a single motor revolution

Change the following parameters for an S–series amplifier.

No. 1809	01000110
1866	3787

Initialization flow of Series 15 servo parameters
(0.1–μm input increment, α pulse coder, α or C–series amplifier used)



No. 1804	Bit for initialization	00000001
1874	Motor No.	See (4) in Subsec. 2.1.2.
1806	AMR	00000000
1820	CMR	See (6) in Subsec. 2.1.2.
1879	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
1896	Reference counter	Set the reference counter value, multiplied by 0.1. (Series 15–A) Set the reference counter value. (Series 15–B) See (10) in Subsec. 2.1.2.
1875	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

Closed loop:

No. 1807	bit 3 = 1
1815	bit 1 = 1

No. 1876	Number of velocity pulses	819
1891	Number of position pulses	Ns/10

Semi–closed loop:

No. 1876	Number of velocity pulses	819
1891	Number of position pulses	1250

For an S–series amplifier:

No. 1809	01000110
1866	3787

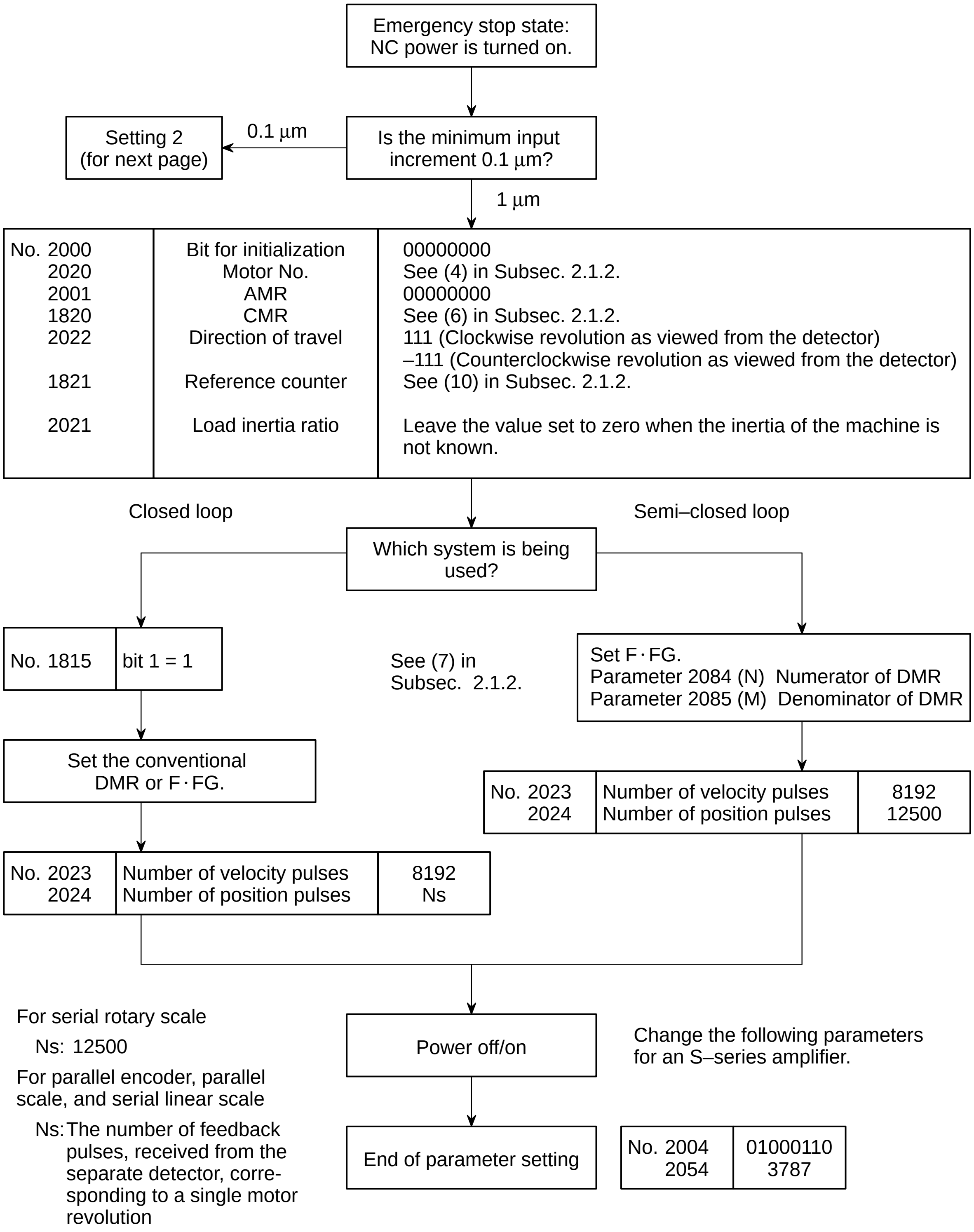
For serial rotary scale

Ns: 12500

For parallel encoder, parallel scale, and serial linear scale

Ns: The number of feedback pulses, received from the separate detector, corresponding to a single motor revolution

Initialization flow of Series 16, 18, 20, 21, Power Mate servo parameters
(1–μm input increment, α pulse coder, α or C–series amplifier used)



No. 2000	Bit for initialization	00000000
2020	Motor No.	See (4) in Subsec. 2.1.2.
2001	AMR	00000000
1820	CMR	See (6) in Subsec. 2.1.2.
2022	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
1821	Reference counter	See (10) in Subsec. 2.1.2.
2021	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

Closed loop:

No. 1815	bit 1 = 1

No. 2023	Number of velocity pulses	8192
2024	Number of position pulses	Ns

Semi–closed loop:

Set F･FG.
Parameter 2084 (N) Numerator of DMR
Parameter 2085 (M) Denominator of DMR

No. 2023	Number of velocity pulses	8192
2024	Number of position pulses	12500

For serial rotary scale

Ns: 12500

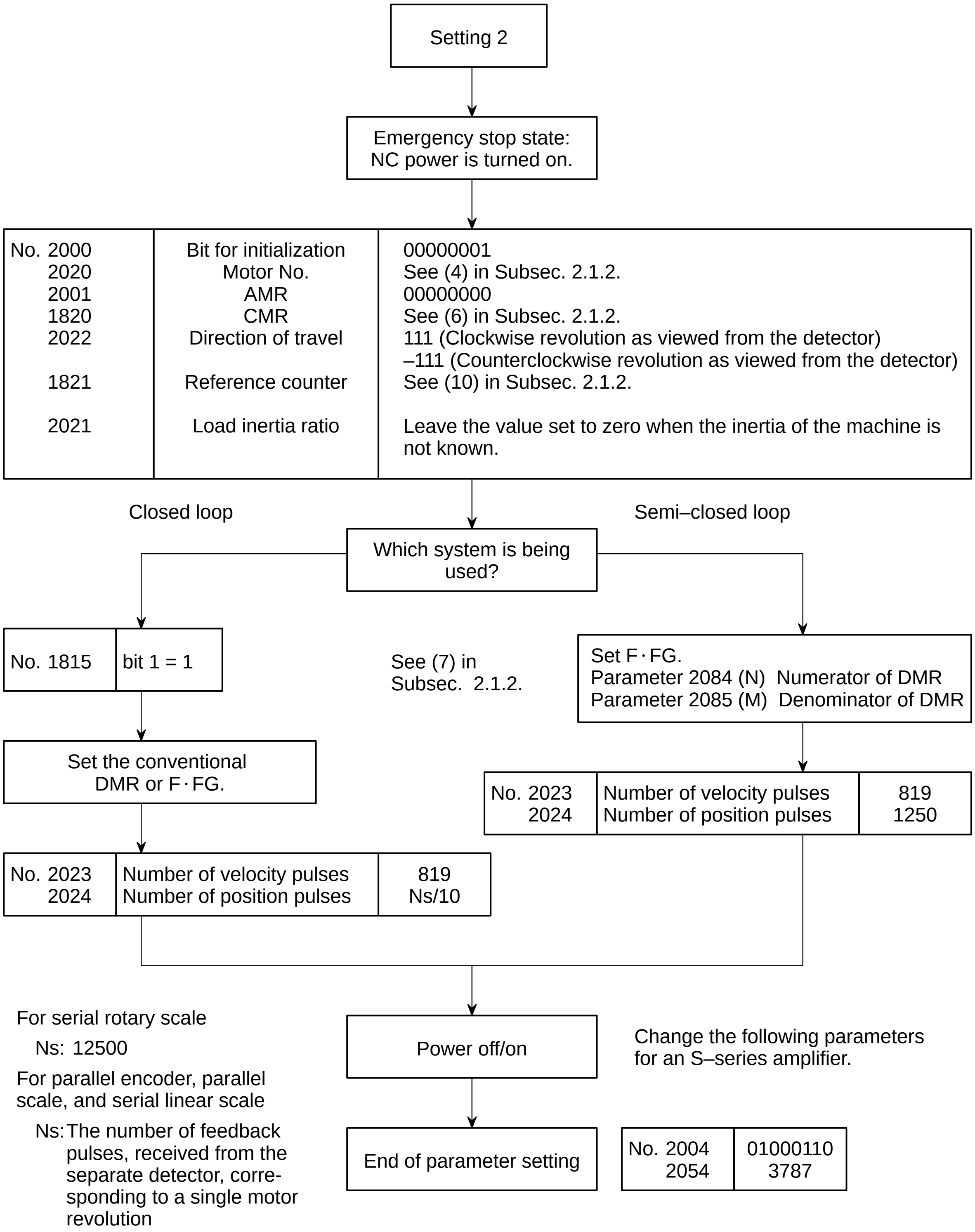
For parallel encoder, parallel scale, and serial linear scale

Ns: The number of feedback pulses, received from the separate detector, corresponding to a single motor revolution

Change the following parameters for an S–series amplifier.

No. 2004	01000110
2054	3787

Initialization flow of Series 16, 18, 20, 21, Power Mate servo parameters
(0.1–µm input increment, α pulse coder, α or C–series amplifier used)



No. 2000	Bit for initialization	00000001
2020	Motor No.	See (4) in Subsec. 2.1.2.
2001	AMR	00000000
1820	CMR	See (6) in Subsec. 2.1.2.
2022	Direction of travel	111 (Clockwise revolution as viewed from the detector) –111 (Counterclockwise revolution as viewed from the detector)
1821	Reference counter	See (10) in Subsec. 2.1.2.
2021	Load inertia ratio	Leave the value set to zero when the inertia of the machine is not known.

No. 1815	bit 1 = 1

Set F･FG.
Parameter 2084 (N) Numerator of DMR
Parameter 2085 (M) Denominator of DMR

No. 2023	Number of velocity pulses	819
2024	Number of position pulses	Ns/10

No. 2023	Number of velocity pulses	819
2024	Number of position pulses	1250

For serial rotary scale

Ns: 12500

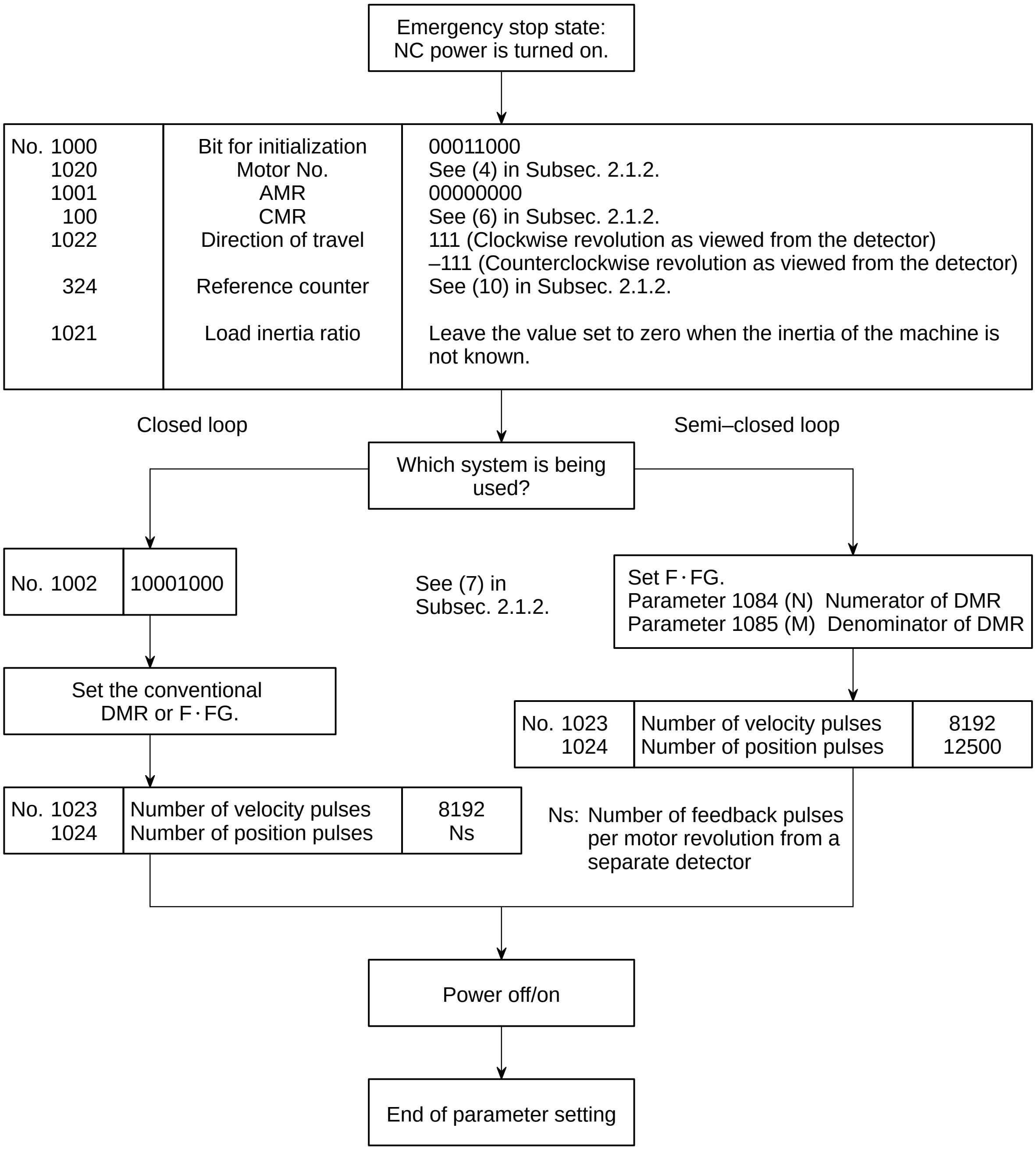
For parallel encoder, parallel scale, and serial linear scale

Ns: The number of feedback pulses, received from the separate detector, corresponding to a single motor revolution

Change the following parameters for an S–series amplifier.

No. 2004	01000110
2054	3787

Initialization flow of Power Mate–E servo parameters (α pulse coder used)



2.1.4

Actions for Invalid Servo Parameter Setting Alarms

The following table contains actions to be taken for invalid servo parameter setting alarms.

Find the relevant guideline under “Decision criterion,” and proceed to the corresponding “Adjustment item.”

Alarm	Decision criterion	Adjustment item
POA1 overflow	Try resetting POA1 to 0. Parameter: No. 8X47–1859–2047–1047 = 0	Adjustment 1
N pulse suppression level overflow	Disable the N pulse suppression function. Function bit: No. 8X03–1808–2003–1003, B4 = 0	Adjustment 2
Feed–forward coefficient overflow	Reset the feed–forward coefficient to 0. Parameter: No. 8X68–1961–2068–1068 = 0 No. 8X92–1985–2092–1092 (advance) = 0	Adjustment 3
Position gain overflow	Reset the position gain to 0. Parameter: No. 0517–1825–1825–0209 = 0	Adjustment 4
Number of position pulses overflow	The number of position pulses is greater than 13100 (with initialization bit 0 = 1). Parameter: No. 8X00–1804–2000–1000, B0	Adjustment 5
Motor ID No.	Check whether the motor ID No. is correct. Parameter: No. 8X20–1874–2020–1020	Adjustment 6
Invalid axis selection parameter setting	Check whether the setting is correct. Series 0–C: No. 269 to 274 Series 15, 16, 18, 20, 21: No. 1023	
Others	Number of position pulses ≦ 0 Number of velocity pulses ≦ 0 Direction of travel = 0 Flexible feed gear numerator < 0, denominator < 0 For semi–closed mode, numerator > denominator The AMR conversion coefficient has not been set when a linear motor is driven.	

NOTE

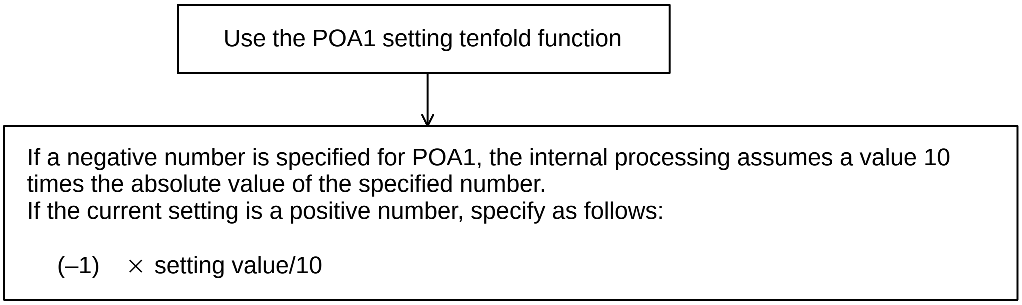
The parameter numbers in the table are in the following order:

No. (Series 0–C)–(Series 15)–(Series 16, 18, 20, 21, Power Mate) –(Power Mate–E)

Adjustments

- **Adjustment 1: POA1 overflow**

(No. 8X47–1859–2047–1047)



Use the POA1 setting tenfold function

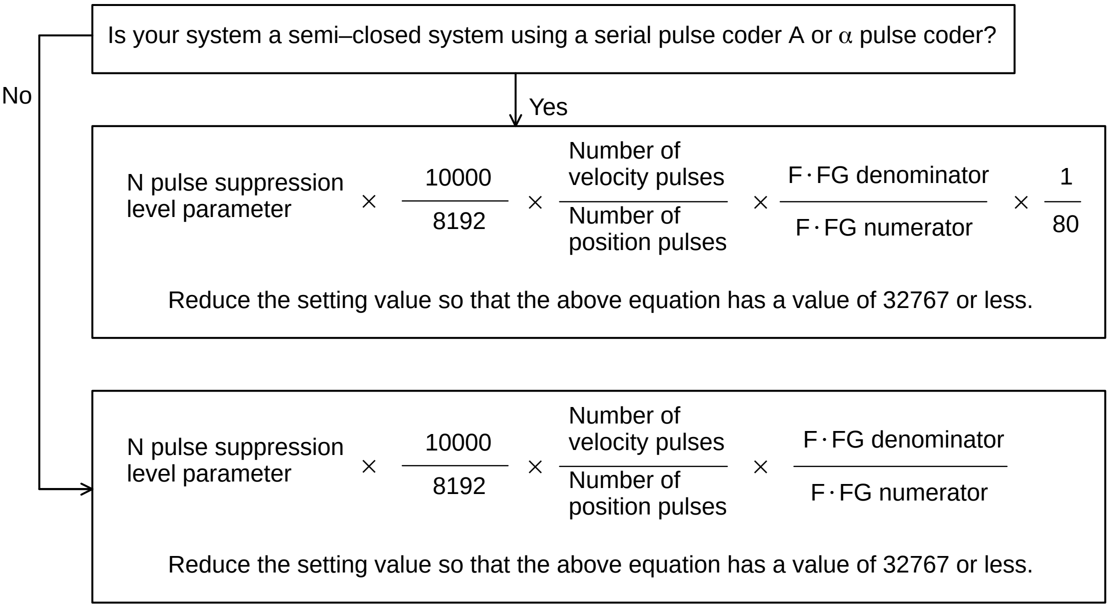
If a negative number is specified for POA1, the internal processing assumes a value 10 times the absolute value of the specified number.
If the current setting is a positive number, specify as follows:

(–1) × setting value/10

- **Adjustment 2: N pulse suppression**

(No. ———1992–2099–1099)

Reduce the setting value according to the following flowchart. For Series 0–C, however, specify the function bit (bit 4 of parameter No. 8X03) = 0 if an overflow occurs, because the N pulse suppression level parameter is fixed at 400.



Is your system a semi–closed system using a serial pulse coder A or α pulse coder?

$$\text{N pulse suppression level parameter} \times \frac{10000}{8192} \times \frac{\text{Number of velocity pulses}}{\text{Number of position pulses}} \times \frac{\text{F·FG denominator}}{\text{F·FG numerator}} \times \frac{1}{80}$$

Reduce the setting value so that the above equation has a value of 32767 or less.

$$\text{N pulse suppression level parameter} \times \frac{10000}{8192} \times \frac{\text{Number of velocity pulses}}{\text{Number of position pulses}} \times \frac{\text{F·FG denominator}}{\text{F·FG numerator}}$$

Reduce the setting value so that the above equation has a value of 32767 or less.

Number of velocity pulses	(No. 8X23–1876–2023–1023)
Number of position pulses	(No. 8X24–1891–2024–1024)
F·FG numerator	(No. 8X84–1977–2084–1084)
F·FG denominator	(No. 8X85–1978–2085–1085)

- **Adjustment 3: Feed forward coefficient**

(No. 8X68–1961–2068–1068, No. 8X92–1985–2092–1092 (advance))

Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E

> Specify the position gain setting range expansion function.
>
> Function bit: No. 1804–2000–1000, bit 4 = 1

The function also expands the feed–forward coefficient range.

Series 0–C, 15–A

If a negative number is specified for the feed–forward coefficient, the internal processing assumes a value ten times the absolute number of the specified number.

If the calculation result obtained during parameter setting exceeds 32767, specify as follows:

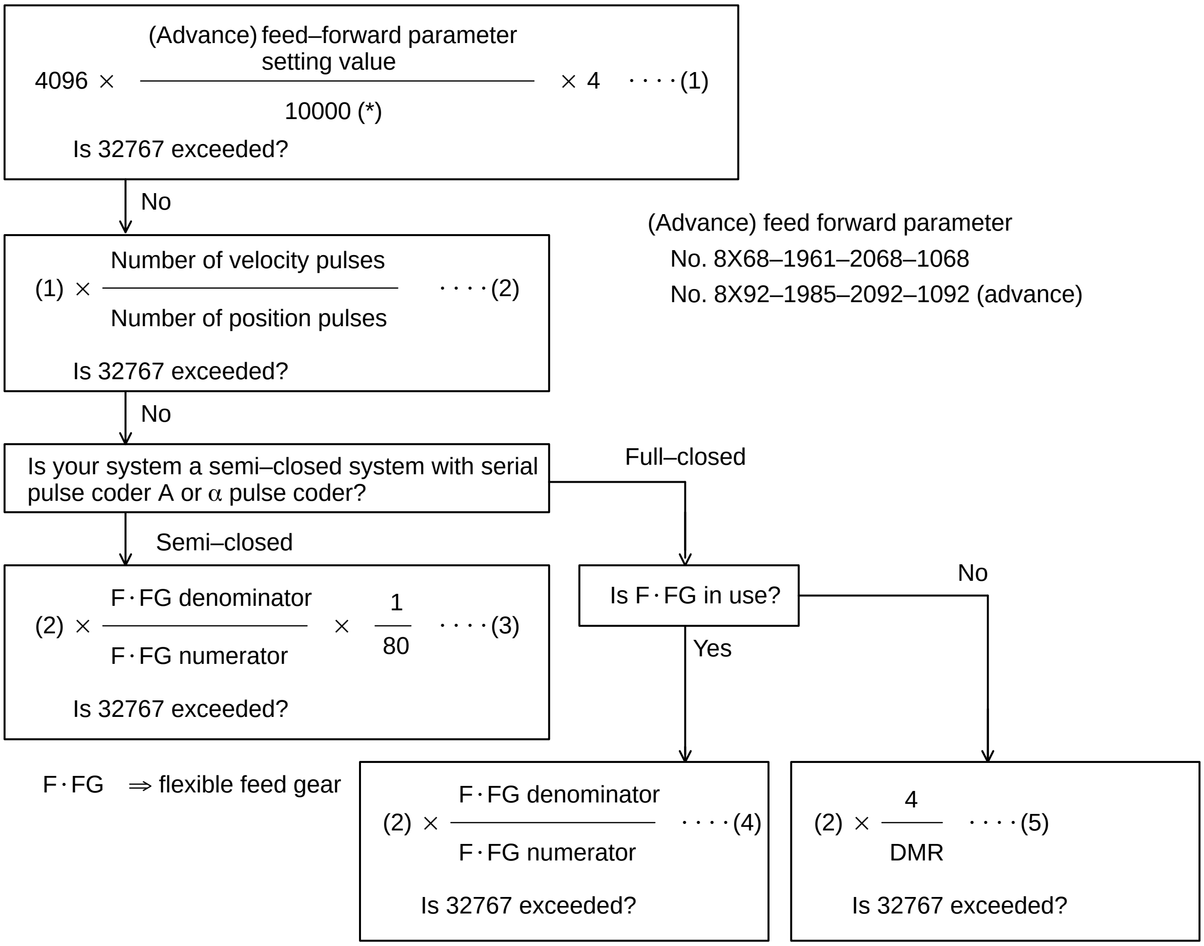
(–1) × calculation result/10

Reference

Feed–forward coefficient overflow check

(Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E)

If the result of any of the following calculations exceed 32767, an invalid parameter setting alarm occurs.



NOTE

If the parameter setting value is 100 or less, use 100 instead of 10000 at a term indicated with *.

- **Adjustment 4: Position gain**

Use the position gain setting range expansion function.

Setting : No. 8X11–1955, bit 5 = 1 (Series 0–C)–(Series 15–A)
Multiply 8X24–1891 by 8 and re–enter it.
No. 1804–2000–1000, bit 4 = 1
(Series 15–B)–(Series 16, 18, 20, Power Mate)–(Power Mate–E)
Set No.1891–2024–1024 as it is.

If an overflow still occurs:

(1) Multiply the value of the flexible feed gear (or DMR) by integer A.
(2) Multiply the following setting values by A.

Parameter	Series 0–C	Series 15, 16, 18, 20, 21, Power Mate	Power Mate–E
CMR	No. 100 to 103	No. 1820	No. 100
Effective area	500 to 503	1826, 1827	200
Limit to a position error during travel	504 to 507	1828	202
Limit to a position error at a halt	593 to 596	1829	231
Backlash	535 to 538	1851, 1852	221
Reference counter	570 to 573	1896 (Series 15)–1821	324
Grid shift	508 to 511	1850	204

(Example)

The position gain overflows internally under the following conditions:

α pulse coder
Reduction gear ratio: 1/20
Ball screw: 1 mm/rev
Position gain: 30sec^{-1} (with 1 μm scale)

In this case, specify the position gain setting range expansion function. For Series 0–C and 15–A, multiply the number of position pulses by 8.

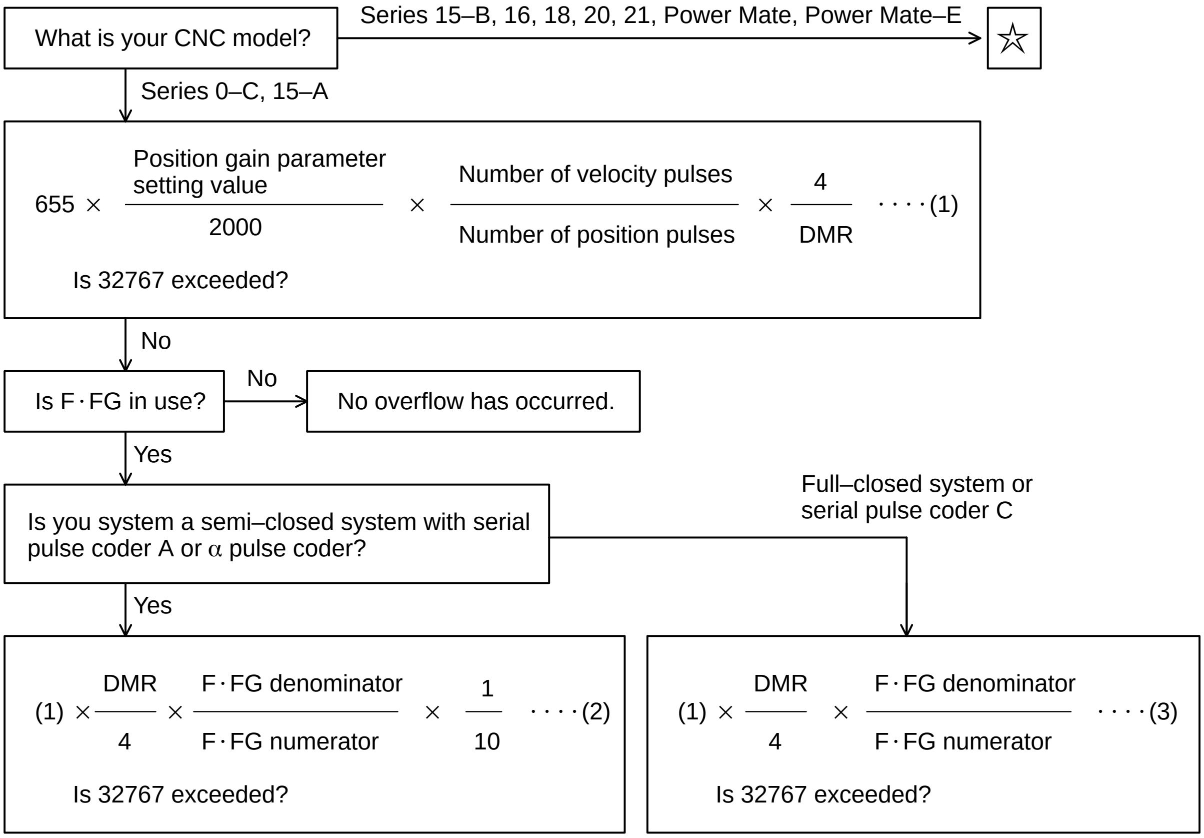
Number of position pulses
(No. 8X24–1891)

$$1000/20 = 50 \xrightarrow{\times 8} 400$$

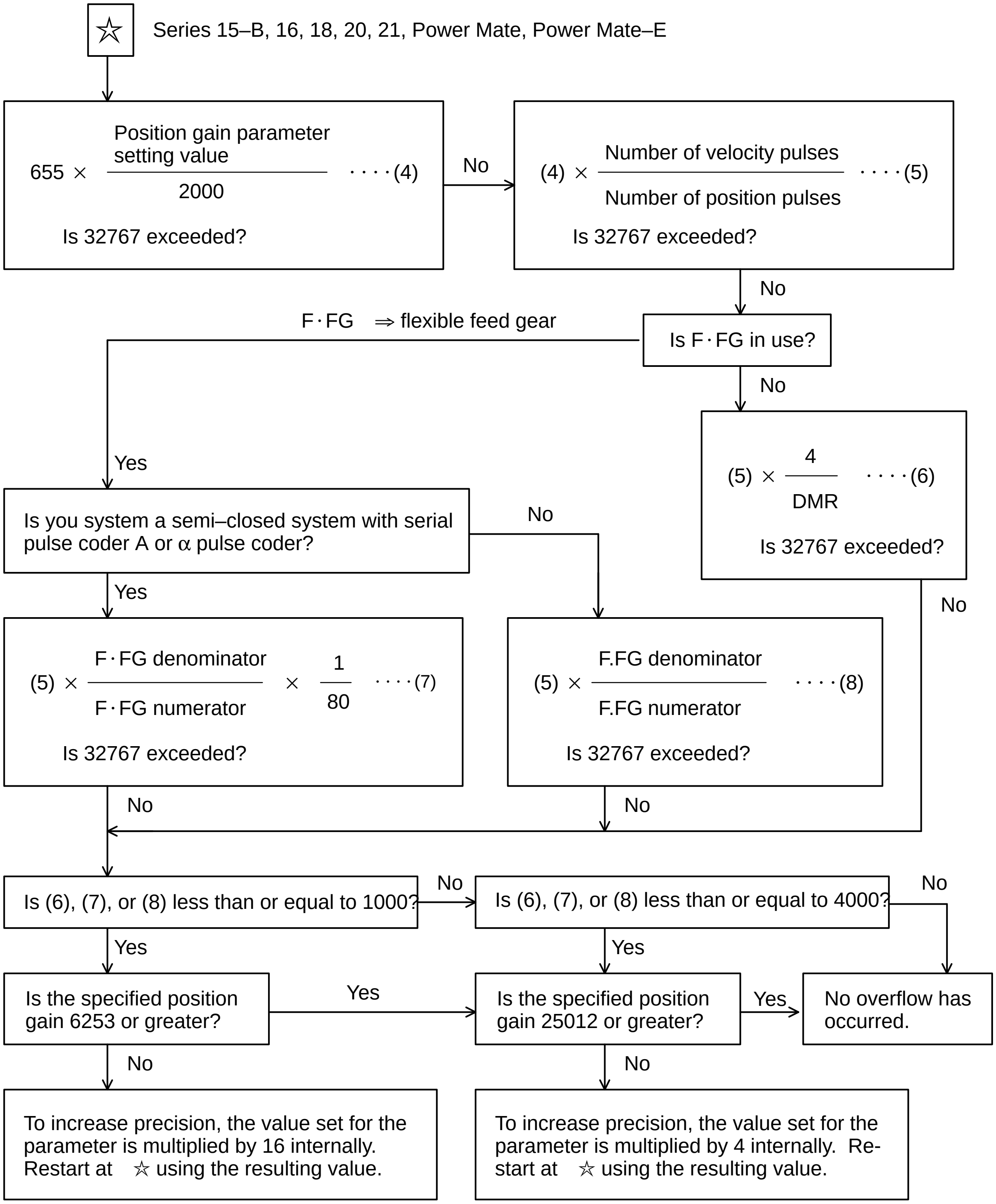
Reduction gear ratio
1000 pulses per revolution of ball screw

Reference

Position gain overflow check



F·FG ⇒ flexible feed gear


☆
Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E
655 × (Position gain parameter setting value / 2000) · · · · (4)
Is 32767 exceeded?
No
(4) × (Number of velocity pulses / Number of position pulses) · · · · (5)
Is 32767 exceeded?
No
F · FG ⇒ flexible feed gear
Is F · FG in use?
No
(5) × (4 / DMR) · · · · (6)
Is 32767 exceeded?
No
Yes
Is you system a semi–closed system with serial pulse coder A or α pulse coder?
No
Yes
(5) × (F · FG denominator / F · FG numerator) × (1 / 80) · · · · (7)
Is 32767 exceeded?
(5) × (F.FG denominator / F.FG numerator) · · · · (8)
Is 32767 exceeded?
No
No
Is (6), (7), or (8) less than or equal to 1000?
No
Is (6), (7), or (8) less than or equal to 4000?
No
Yes
Yes
Is the specified position gain 6253 or greater?
Yes
Is the specified position gain 25012 or greater?
Yes
No overflow has occurred.
No
No
To increase precision, the value set for the parameter is multiplied by 16 internally. Restart at ☆ using the resulting value.
To increase precision, the value set for the parameter is multiplied by 4 internally. Restart at ☆ using the resulting value.

- **Adjustment 5: Number of position pulses**

Make the changes listed below. Value E must satisfy the following:

Number of current position pulses/E < 13100

Current setting value/E				
Series 0–C	**Series 15**	**Series 16, 18, 20, 21, Power Mate–D, F**	**Power Mate–E**	**Change parameter**
No. 8X23	No. 1876	No. 2023	No. 1023	Current value/E
8X24	1891	2024	1024	Current value/E
8X43	1855	2043	1043	Current value/E
8X44	1856	2044	1044	Current value/E
8X53	1865	2053	1053	Current value × E
8X54	1866	2054	1054	Current value/E
8X56	1868	2056	1056	Current value/E
8X57	1869	2057	1057	Current value/E
8X59	1871	2059	1059	Current value × E
8X74	1967	2074	1074	Current value/E
8X76	1969	2076	1076	Current value/E

CAUTION

1 In the above table, parameters No. 1868 and 1869 (Series 15–B), 2056 and 2057 (Series 16, 18, 20, 21, or Power Mate), or 1056 and 1057 (Power Mate–E) need not be modified if they have been set to negative values.

2 When changing parameter No. 1967 (Series 15–B), No. 2074 (Series 16, 18, 20, 21, Power Mate), or No. 1074 (Power Mate–E) in the above table, note the following:

(a) Check the servo software series/edition.

(1) For the following series/editions, the calculation indicated in the table is not needed:
Series 9065/001A and subsequent editions, Series 9066/001F and subsequent editions, Series 9080/001E and subsequent editions, Series 9081/001C and subsequent editions
For details of other servo software series/editions, see (b).

(b) Changing the parameter

(1) Check the parameter setting.
- If the setting is 4096 or less, perform conversion as indicated in the table.
- If the setting is 4097 or more, go to (2).

(2) Convert the setting to a 4–digit hexadecimal number.

(3) Convert the lowest three digits of the hexadecimal number back into a decimal number, then divide it by E.

(4) Convert the result of (3) into a hexadecimal number. Add the fourth digit of the original hexadecimal number to the 3–digit conversion result, then convert it into a decimal number.

(5) The change of the parameter has now been completed.

Example:

For the α6/2000, the setting of parameter No. 2074 for the Series 16 is 12288. Assume E = 2, then:

(1) The setting is 4097 or more.

(2) When 12288 is converted into a hexadecimal number, 3000 is obtained.

(3) The lower three digits are 000. When these are converted into a decimal number then divided by 2, the result will be 0.

(4) When decimal 0 is converted into a hexadecimal number, then the fourth digit of the original hexadecimal number is added to the converted hexadecimal number, 3000 will be obtained. This is then converted into a decimal number. The result will be 12288.

Example:

For the α12/2000, the setting of parameter No. 2074 of the Series 16 is 18384.
Assume E = 2, then:

(1) The setting is 4097 or more.

(2) When 18384 is converted into a hexadecimal number, 47d0 will be obtained.

(3) The lower three digits are 7d0. When these are converted into a decimal number then divided by 2, the result will be 1000.

(4) When decimal 1000 is converted into a hexadecimal number, then the fourth digit of the original hexadecimal number is added to the converted hexadecimal number, 43E8 will be obtained. Then, it is converted into a decimal number. The result will be 17384.

- **Adjustment 6: Motor ID No.**

The motor ID numbers valid for each series of models are listed below. An invalid parameter setting alarm occurs if a specified number does not fall in any of the following corresponding ranges.

Servo software series/edition	Motor ID number
Series 9041/001A and subsequent editions	3 to 89
Series 9046/001A and subsequent editions Series 9046/001B and subsequent editions	15 to 89 3 to 89
Series 9060/001K and subsequent editions Series 9060/001M and subsequent editions	15 to 89 3 to 89
Series 9064/001E and subsequent editions	3 to 89
Series 9065/001A and subsequent editions	3 to 89
Series 9066/001A and subsequent editions Series 9066/001C and subsequent editions Series 9066/001I and subsequent editions	3 to 89 3 to 93 3 to 108
Series 9070/001C and subsequent editions	3 to 89
Series 9080/001A and subsequent editions Series 9080/001K and subsequent editions	3 to 93 3 to 108
Series 9081/001C and subsequent editions Series 9081/001E and subsequent editions	3 to 93 3 to 108

3

α SERIES PARAMETER ADJUSTMENT

3.1 SERVO ADJUSTMENT SCREEN

Cause the servo adjustment screen to appear, and check the position error, actual current, and actual speed on it.

Using the keys on the CNC, enter the required value according to the following procedure.
(For the Power Mate DPL/MDI, there is no servo adjustment screen.)

Series 0–C

Press the PARAM key several times to cause the servo setting screen to appear. Then press the page keys ↑PAGE PAGE↓, and the servo adjustment screen will appear.

If the servo setting screen does not appear, specify the following parameter, then switch the NC off and on again.

	#7	#6	#5	b4	#3	#2	#1	#0
0389								SVS

SVS (#0) =0 (to display the servo setting screen)

Series 15

Press the SERVICE key several times to cause the servo setting screen to appear. Then press the cursor key ↓, and the servo adjustment screen will appear.

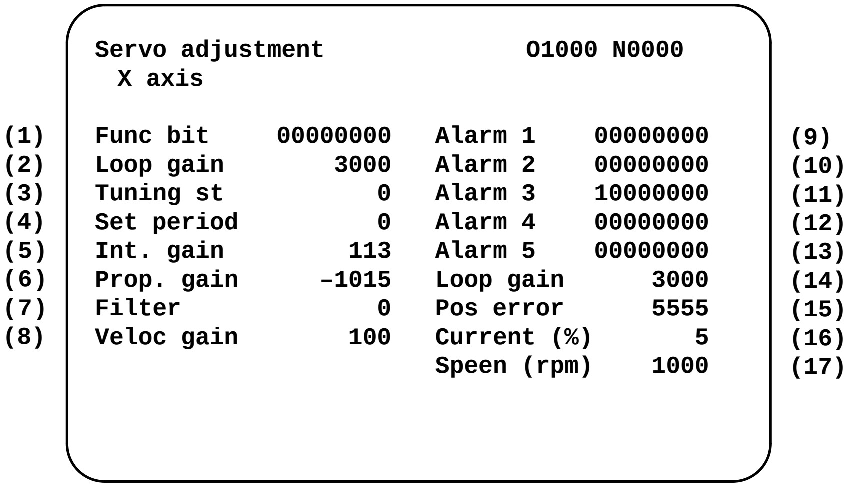
Series 16, 18, 20, 21

SYSTEM → [SYSTEM] → [▷] → [SV–PRM] → [SV–TUN]

If the servo setting screen does not appear, specify the following parameter, then switch the NC off and on again.

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

SVS (#0) =1 (to display the servo setting screen)



```
       Servo adjustment              O1000 N0000
         X axis

 (1)   Func bit     00000000   Alarm 1    00000000    (9)
 (2)   Loop gain        3000   Alarm 2    00000000    (10)
 (3)   Tuning st           0   Alarm 3    10000000    (11)
 (4)   Set period          0   Alarm 4    00000000    (12)
 (5)   Int. gain         113   Alarm 5    00000000    (13)
 (6)   Prop. gain      -1015   Loop gain      3000    (14)
 (7)   Filter              0   Pos error      5555    (15)
 (8)   Veloc gain        100   Current (%)       5    (16)
                               Speen (rpm)    1000    (17)
```

Fig. 3.1 Servo adjustment screen

Reference

The items on the servo adjustment screen correspond to the parameter numbers listed below.

(Variable X is an axis number; X = 1, 2, 3, ...)	Series 0–C	Series15	Series 16, 18, 20	Power Mate–E (Referenc)
(1) Function bit (2) Loop gain	No. 8X03 0517	No. 1808 1825	No. 2003 1825	No. 1003 0209
(3) Tuning start bit (4) Setting period	Used for the servo automatic adjustment function Used for the servo automatic adjustment function			Not supported
(5) Integral gain (6) Proportional gain (7) Filter	No. 8X43 8X44 8X67	No. 1855 1856 1895	No. 2043 2044 2067	No. 1043 1044 1067
(8) Velocity gain	No. 8X21	No. 1875	No. 2021	Not supported
	The load inertia ratio is displayed in percent. Speed gain = (1 + LDINT/256) *100(%)			
(9) Alarm 1 diagnostic (10) Alarm 2 (11) Alarm 3 (12) Alarm 4 (13) Alarm 5	No. 720 to 723 730 to 733 760 to 763 770 to 773 ———	No.3014+20(X–1) 3015+20(X–1) 3016+20(X–1) 3017+20(X–1) 3018+20(X–1)	No. 200 201 202 203 204	No. 2711 2710 2713 2712 2714
(14) Loop gain	The actual servo loop gain is displayed.			Not supported
(15) Position error diagnostic	No. 800 to 803	No. 3000	No. 300	No. 3040
	The position error is displayed. Position error = $\frac{\text{Feedrate (mm/min)}}{\text{Least increment} \times 60 \times \text{loop gain} \times 0.01 \text{ (mm)}}$			
(16) Current value (%) (17) Current speed (rpm)	The actual current is displayed as percentage of the rated current. The actual speed is displayed.			Not supported Not supported

- **Alarm indication**

	#7	#6	#5	#4	#3	#2	#1	#0
Alarm 1	OVL	LVAL	OVC	HCAL	HVAL	DCAL	FBAL	OFAL
Alarm 2	ALDF			EXPC			*	
Alarm 3	*	CSAL	BLAL	PHAL	RCAL	BZAL	CKAL	SPH
Alarm 4	DTER	CRC	STB	PRM				
Alarm 5		OSER	MCAL	LDAL	PMAL	FSAL		

NOTE

Although the bits indicated by * (#1 of alarm 2 and #7 of alarm 3) are not alarm codes, they may be set to 1.

(1) Alarms related to the amplifier and motor
These alarms are identified from alarms 1, 2, and 5.

(a) Type A interface

Alarm 1							Alarm 5		Alarm 2		Description
OVL	**LVAL**	**OVC**	**HCAL**	**HVAL**	**DCAL**	**FBAL**	**MCAL**	**FSAL**	**ALDF**	**EXPC**	
			1								Overcurrent alarm
				1							Excessive voltage alarm
					1						Excessive regenerative discharge alarm
							1				MCC fusing, precharge
	1										Alarm indicating insufficient power voltage
1									0	0	Amplifier overheat
1									1	0	Motor overheat

(b) Type B interface

Alarm 1							Alarm 5		Alarm 2		Description
OVL	**LVAL**	**OVC**	**HCAL**	**HVAL**	**DCAL**	**FBAL**	**MCAL**	**FSAL**	**ALDF**	**EXPC**	
			1						0	0	Converter overcurrent alarm
			1						0	1	Inverter overheat alarm
				1							Excessive voltage alarm
					1						Excessive regenerative discharge alarm
	1								0	0	Insufficient converter power voltage
	1								1	0	Insufficient converter DC link voltage
	1								0	1	Insufficient inverter control power voltage
	1								1	1	Insufficient inverter DC link voltage
1									0	0	Converter overheat
1									1	0	Motor overheat
							1				MCC fusing, precharge
								1	0	0	Converter fan stopped
								1	0	1	Inverter fan stopped

(2) Alarms related to the pulse coder

These alarms are identified from alarms 1, 2, 3, and 5. The meanings of the bits are as follows:

Alarm 3							**Alarm 5**		**1**	**Alarm 2**		**Description**
CSAL	**BLAL**	**PHAL**	**RCAL**	**BZAL**	**CKAL**	**SPH**	**LDAL**	**PMAL**	**FBAL**	**ALDF**	**EXPC**	
						1						Soft phase alarm (abnormal pulse coder or feedback cable, or malfunction caused by noise)
					1							Clock alarm (serial A)
				1								Zero voltage in pulse coder battery
			1						0	0	0	Abnormal speed (serial A)
			1						1	1	0	Count error alarm (α pulse coder)
		1										Phase alarm (pulse coder or feedback cable abnormality (serial A))
	1											Voltage drop in pulse coder battery (warning)
1												Checksum alarm (serial A)
								1				Pulse error alarm (α pulse coder)
							1					LED abnormality alarm (α pulse coder)

(3) Alarms related to serial communication

These alarms are identified from alarm 4.

Alarm 4								**Description**
DTER	**CRC**	**STB**	**PRM**					
1								Abnormal pulse coder or feedback cable, or servo module failure
	1							
		1						

(4) Alarms related to a separate detector (A/B phase type)

Alarm 1							Alarm 5		Alarm 2		Description
OVL	**LVAL**	**OVC**	**HCAL**	**HVAL**	**DCAL**	**FBAL**	**MCAL**	**FSAL**	**ALDF**	**EXPC**	
						1			1	1	Hardware disconnection
						1			0	0	Software disconnection

(5) Other alarms

Alarm bit	Description
OFAL (alarm 1 #0)	Overflow alarm (A 2–word overflow occurred in the digital servo software.)
OSER (alarm 5 #6)	Current detection error alarm (Current detection offset error)
PRM (alarm 4 #4)	Parameter error alarm (An illegal parameter is detected in the digital servo software.)

3.2 VIBRATION DURING STOP

(1) If wavelike variation (low frequency) occurs, go to 5.
If an unusual (high–frequency) sound is heard, use the 250–μs acceleration feedback function.

1894	8X66
2066	1066

250 μsec acceleration feedback gain

[Standard setting] –10(–10 to –20)

1959 (Series 15–B)	—
2017 (Series 16)	—

#7	#6	#5	#4	#3	#2	#1	#0
PK2V25							

PK2V25 (#7) 1 : Enables the high–speed velocity loop proportional processing function.
0 : Disables the high–speed velocity loop proportional processing function.

(2) Reduce the load inertia ratio.

1875	8X21
2021	1021

Load inertia ratio (LDINT)

The load inertia ratio is calculated on the assumption that the motor is connected to the machine tightly. If there is friction or backlash, use of the calculation result may result in vibration.

(3) Enable the N pulse suppression function. (See Subsec. 4.2.1.)

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
			NPSP				

NPSP (#4) 1 : (to enable the N pulse suppression function)

1992	—
2099	1099

N–pulse suppression level parameter (ONEPSL)

[Valid data range] 0 to 32767

[Standard setting] 400

For Series 0–C, the level parameter is fixed at 400.

(4) Enable the function used to change the proportional gain in the stop state. Note that the parameter numbers used by the Series 0–C and Series 15–A differ from those used by other models.
(See Subsec. 4.2.2.)

Series 15–B, 16, 18, 20, 21, Power Mate

1958 (Series 15–B)	—
2016	—

#7	#6	#5	#4	#3	#2	#1	#0
				K2VC			

K2VC (#3) 1 : (The function for changing the proportional gain in the stop state is used.)

1730 (Series 15–B)	—
2119	—

Function for changing the proportional gain in the stop state: Stop judgement level

[Increment system] : Detection unit

[Valid data range] : 2 to 10 (Detection unit: 1 μm)
20 to 100 (Detection unit: 0.1 μm)

Series 0–C, 15–A

1953 (Series 15–A)	8X09
—	—

#7	#6	#5	#4	#3	#2	#1	#0
				K2VC			

K2VC (#3) 1 : (The function for changing the proportional gain in the stop state is used.)

1982 (Series 15–A)	8X89
—	—

Function for changing the proportional gain in the stop state: Stop judgement level

[Increment system] : Detection unit

[Valid data range] : 2 to 10 (Detection unit: 1 μm)
20 to 100 (Detection unit: 0.1 μm)

(5) If drift (low frequency) occurs, enable PI control.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (PI control is selected.)

(6) Use the 250–μs acceleration feedback or high–speed velocity loop proportional processing function, and increase the load inertia ratio.

1875	8X21
2021	1021

Load inertia ratio

Setting value ≦ 70% of the level where the motor is about to start vibrating

(7) Return the load inertia ratio to the initial value, reduce the velocity loop integral gain (PK1V) by 20% at a time.

1855	8X43
2043	1043

Velocity loop integral gain (PK1V)

Setting value ≧ standard value × 0.3
Too much reduction impairs response or servo rigidity during travel.

(8) Increase the absolute value of the velocity loop proportional gain (PK2V) by 20% at a time.

1856	8X44
2044	1044

Velocity loop proportional gain (PK2V)

Setting value ≦ 70% of the level where the motor is about to start vibrating.

3.3
VIBRATION DURING TRAVEL

(1) Check whether the motor vibrates at a halt. ⇒ 3.2
If there is wavelike vibration (low frequency, hunting) occurs, go to Step (6).

(2) If an unusual (high–frequency) sound is heard, use the 250–μs acceleration feedback function.

1894	8X66	250–μs acceleration feedback
2066	1066	

[Standard setting] –10 (–10 to –20)

(3) Reduce the load inertia ratio by 20% at a time.

1875	8X21	Load inertia ratio
2021	1021	

Setting value ≦ 70% of the level where the motor is about to start vibrating

(4) Use the torque command filter

1895	8X67	Torque command filter
2067	1067	

(5) If vibration cannot be eliminated by using the torque command filter, use the observer function.

		#7	#6	#5	#4	#3	#2	#1	#0
1808	8X03					PIEN	OBEN		
2003	1003								

OBEN (#2) 1 : (The observer function is used.)

(6) If there is wavelike variation (low frequency), decrease the load inertia ratio.

1875	8X21	Load inertia ratio
2021	1021	

Setting value ≦ 70% of the level where the motor is about to start vibrating

If the wavelike variation (low frequency) is eliminated, increase the load inertia while eliminating the high frequency vibration using the 250 μs acceleration feedback function.

(7) Enable PI control.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (PI control is selected.)

(8) Return the load inertia ratio to the initial setting, and repeat to increase the velocity integral gain (PK1V) by 20% at a time.

1855	8X43	Velocity loop integral gain (PK1V)
2043	1043	

Setting value ≧ standard value × 0.3
Too much reduction impairs response or rigidity during travel.

(9) Reduce the position gain.

1825	0517	Position gain
1825	0209	

(10) Observe the TCMD waveform between channels 2 and 4 on the check board. ⇒ See Sec. 4.11.
If the TCMD waveform is output 4.4 V or more during acceleration/deceleration, the acceleration/deceleration time constant setting is too short increase the time.

3.4 VIBRATION DURING TRAVEL (FULL–CLOSED SYSTEM)

(1) Adjust the parameters according to Sec. 3.3.

(2) If the motor is stable in semi–closed mode, but vibrates in full–closed mode, enable the machine speed feedback function.

Pay attention, parameter of Series 0–C and 15–A are different from others. (See Subsec. 4.3.2.)

1956	8X12
2012	1012

#7	#6	#5	#4	#3	#2	#1	#0
						MSFE	

MSFE (#1) 1 : (to enable the machine speed feedback function.)

1981	8X88
2088	1088

Machine speed feedback gain

Series 15–B, 16, 18, 20, 21, Power Mate

Standard setting: 30 (30 to 100)

Series 0–C, 15–A

$$\text{Standard setting} = \alpha \times 4096 \times \frac{8192}{\text{Number of position feedback pulses/motor revolution (detection unit)}}$$

(α = 0.1 to 0.3)

(3) If the motor is stable in semi–closed mode, but vibrates in full–closed mode, and the 9070, 9080, or 9081 series servo software is being used, the vibration–damping control function can also be used.

1718 (Series 15–B)	—
2033 (Series 16–B)	—

Number of position feedback pulses for vibration–damping control function conversion coefficient

1719 (Series 15–B)	—
2034 (Series 16–B)	—

Vibration–damping control gain

[Typical setting] 500

While observing the vibration, adjust the value in steps of about 100. Too large a value will amplify the vibration. If a positive value amplifies the vibration, try setting a negative value.

(4) If high–frequency oscillation is generated by setting (2) and (3) above, use a torque command filter of around 150 Hz.

1895	8X67	Torque command filter
2067	1067	

[Typical setting] 1596 (for 150 Hz)

(5) If the motor is stable in the semi–closed mode, but vibrates in the full–closed mode, enable the dual position feedback function.
(For 9046 series, in which this option is not supported, go to step 3 of this section.) (See Subsec. 4.3.5.)

		#7	#6	#5	#4	#3	#2	#1	#0
1955 (15–A) 1709 (15–B)	8X11	DPFB							
2019	1011								

DPFB (#7) 1 : (to enable the dual position feedback function)

1971	8X78	Dual position feedback conversion coefficient (numerator)
2078	1078	

1972	8X79	Dual position feedback conversion coefficient (denominator)
2079	1079	

$$\text{Conversion coefficient} \left(\frac{\text{Numerator}}{\text{Denominator}} \right) = \frac{\begin{array}{l}\text{Number of position feedback}\\ \text{pulses/motor revolution}\\ \text{(value obtained by being}\\ \text{multiplied by feed gear)}\end{array}}{1{,}000{,}000} \quad \text{(as irreducible fraction)}$$

(Example)

With a machine travel distance of 10 mm/motor revolution for the α pulse coder (1 μm/pulse):

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

1973	8X80	Primary delay time constant of dual position feedback
2080	1080	

[Typical setting] 100 (10 to 100)

If hunting occurs, increase the setting. Otherwise, reduce the setting.

1974	8X81	Dual position feedback zero–point amplitude
2081	1081	

[Setting value] = 0 (0 to 2)

If the motor vibrates at a halt, set the parameter to a non– zero value.

(Reference)

		#7	#6	#5	#4	#3	#2	#1	#0
1954	8X10			HBBL	HBPE				
2010	1010								

HBBL (#5) Backlash compensation is added to the error count of:

1 : The closed loop.

0 : The semi–closed loop. ⇐ (Standard setting)

HBPE (#4) Pitch error compensation is added to the error count of:

1 : The semi–closed loop.

0 : The closed loop. ⇐ (Standard setting)

(6) Reduce the position gain.

1825	0517	Position gain
1825	0209	

3.5 CUMULATIVE FEED

(1) If there is no overshoot, go to Step (2) of this section.
If there is an overshoot, go to Sec. 3.6.

(2) If the velocity loop gain (PK3V) has been specified, increase it to such an extent that no problem arises with the overshoot.

1857	8X45
2045	1045

Velocity loop incomplete integral gain (PK3V)

Bring the setting value near 32767.

(3) Enable PI control, and increase the velocity loop gain (PK1V).

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (to enable PI control)

1855	8X43
2043	1043

Velocity loop integral gain (PK1V)

Setting value ≦ 70% of the level where the motor is about to start vibrating during travel

(4) Enable the VCMD offset function.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
VOFS							

VOFS (#7) 1 : (The VCMD offset function is enabled.)

3.6 OVERSHOOT

(1) Enable PI control.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (to enable PI control)

(2) Increase the load inertia.

1875	8X21
2021	1021

Load inertia ratio

Setting value ≦ 70% of the level where the motor is about to start vibrating

(3) Enable the overshoot prevention function, and adjust the velocity loop gain (PK3V). (See Sec. 4.4)

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
	OVSC						

OVSC (#6) 1 : (to enable the overshoot prevention function).

1857	8X45
2045	1045

Velocity loop incomplete integral gain (PK3V)

[Typical setting] 30000 (32700 to 20000)

If the motor vibrates ± 1 pulse at stop, adjust the overshoot prevention counter.

1970	8X77
2077	1077

Overshoot prevention counter

[Typical setting] 50 (0 to 100)

If there is still an overshoot, increase the counter value by 10 at a time.
If the motor vibrates at stop, reduce the counter value by 10 at a time.

* When the motor vibrates by about ± 1 pulse at stop

1742	—
2202	—

#7	#6	#5	#4	#3	#2	#1	#0
				OVCTP2			

OVCTP2 (#3) 1 : (to enable overshoot compensation type 2)
(Series 9080/001K and subsequent editions)

(4) Cancel the setting specified in Art. (3) and adjust the velocity loop gain (PK3V) only.

1857	8X45	Velocity loop incomplete integral gain (PK3V)
2045	1045	

[Typical setting] 32760 (32767 to 32000)

Make sure that no position error remains when stopped.

(5) If an overshoot occurs during fast traverse or cutting feed, observe the TCMD waveform between channels 2 and 4 on the check board.
⇒ See Sec. 4.11.
If the TCMD waveform is output 4.4 V or more during acceleration/deceleration, the acceleration/deceleration time constant is too short increase the time.

3.7 A QUADRANT PROTRUSION OCCURS

(1) Enable PI control, and increase the load inertia ratio. Also enable PI control for any other axis related to circular cutting.

1808	8X03
2003	—

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (to enable PI control)

1875	8X21	Load inertia ratio
2021	—	

Setting value ≦ 70% of the level where the motor is about to start vibrating

While eliminating vibration by using the 250–μs acceleration feedback function or high–speed velocity loop proportional processing function, increase the load inertia ratio.

(Use whichever function enables the higher load inertia ratio to be set while maintaining stable motor operation.)

1894	8X66	250 μsec acceleration feedback gain
2066	—	

[Typical setting] –10 (–10 to –20)

1959 (Series 15–B)	—
2017 (Series 16)	—

#7	#6	#5	#4	#3	#2	#1	#0
PK2V25							

1 : Enables the high–speed velocity loop proportional processing function.

0 : Disables the high–speed velocity loop proportional processing function.

(2) Adjust the backlash acceleration function.
(See Subsec. 4.5.4 to 4.5.6.)
Specify the backlash compensation value.

1851	0535 to 0538	Backlash compensation value
1851	—	

For semi–closed mode, specify the machine backlash value (minimum 1).
For full–closed mode, set the backlash to 1, and specify the following parameter.

1884	8X06
2006	—

#7	#6	#5	#4	#3	#2	#1	#0
		Only for full–closed mode, set ⇨					FCBL

FCBL (#0) 1 : (Backlash compensation does not affect the position during full–closed mode).

Use the check board for the following adjustments. ⇒ See Sec. 4.11.
Specify the following parameter.

1808	8X03
2003	—

#7	#6	#5	#4	#3	#2	#1	#0
		BLEN					

BLEN (#5) 1 : (to enable backlash acceleration)

There are three methods of adjusting the backlash acceleration, as follows:

- Conventional backlash acceleration: See Art. (3).
- New type backlash acceleration: See Art. (4).
- Two–stage backlash acceleration: See Art. (5).

NOTE
Series 0–C and Series 15–A do not support two–stage backlash acceleration.

(3) For the conventional backlash acceleration function, set the following:

1860	8X48
2048	—

Backlash acceleration amount

[Typical setting] 600

1964	8X71
2071	—

Period during which backlash acceleration is effective (in units of 1 ms)

[Typical setting] 50 to 100

If a reverse cut is performed, use the backlash acceleration stop function.

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
BLST							

BLST (#7) 1 : (to enable the backlash acceleration stop function)

1975	8X82
2082	—

Backlash acceleration stop timing

[Typical setting] 5

Adjust the above backlash acceleration and stop timing parameters to eliminate a quadrant protrusion.

(4) The new type backlash acceleration function is set as follows:

1956	8X12
2012	—

#7	#6	#5	#4	#3	#2	#1	#0
		VCM2					

VCM2 (#5) 1 : (VCMD waveform magnification: 234 rpm/5 V)

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
					ADBL		

ADBL (#2) 1 : (to enable a new type of backlash acceleration)

1860	8X48	Backlash acceleration amount
2048	—	

[Typical setting] 600

1964	8X71	Time during which backlash acceleration is effective
2071	—	

[Typical setting] 50

Run a circular cutting program to observe the VCMD waveform between channels 1 and 3. Pay attention to the VCMD waveform when the motor reverses (that is, the VCMD waveform crosses the ground level).

If the compensation is too large (a reverse cut occurs), specify the following parameters.

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
BLST							

BLST (#7) 1 : (to enable a backlash acceleration stop)

1975	8X82	Backlash acceleration stop timing
2082	—	

[Typical setting] 5 (Adjust this parameter to eliminate the reverse protrusion.)

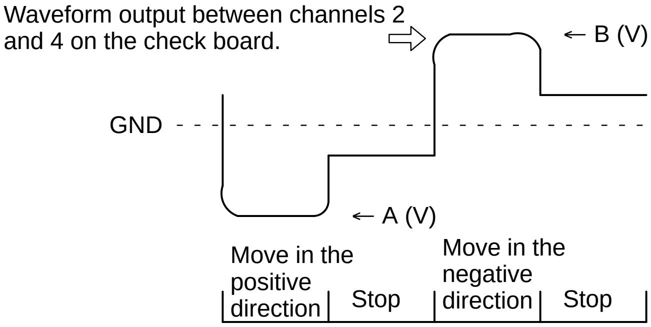
(5) Two–stage backlash acceleration is set as follows:

		#7	#6	#5	#4	#3	#2	#1	#0
1957			BLAT	TDOU					
2015									

TDOU (#5) 1 : (to output the estimated disturbance torque to thecheck board)

BLAT (#6) 1 : (to enable two–stage backlash acceleration)

Run a program for linear reciprocating movement, and observe the waveform between channels 2 and 4 on the check board.
Adjust the observer parameter (POA1) so that the waveform shown below is obtained.



Adjust POA1 so that the estimated disturbance torque waveform shown at the left (ideal waveform) is obtained. In other words, do not allow an overshoot or undershoot on the estimated disturbance torque during travel. (The friction torque remains constant during travel at constant speed.) Start adjustment with an increment of 500 .

If the absolute value is different between A and B, adjust the torque offset.

1859	—	Observer Parameter (POA1)
2047	—	

Adjust with an increment of 500.

1980	—	Torque offset
2087	—	

[Setting value] –830 × (A+B)

Where A and B contain arithmetic signs. (Unit: V)

Also specify the following parameters.

		#7	#6	#5	#4	#3	#2	#1	#0
1956	—			VCM2					
2012	—								

VCM2 (#5) 1 : (VCMD waveform magnification of 234 rpm/5 V)

		#7	#6	#5	#4	#3	#2	#1	#0
1957	—			TDOU					
2015	—								

TDOU (#5) 0 : (Estimated disturbance torque output)

1860	—	Stage 1 backlash acceleration amount (%)
2048	—	

[Unit of data] % (Backlash acceleration amount necessary to reverse the torque that is equal to the friction torque in amount is assumed to be100%.)

[Typical setting] 50
(Optimum values range from 0% to 100%. Acceleration is performed even if 0% is set.)

1987	—	Stage 1 acceleration amount from negative direction to positive direction (%)
2094	—	

[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.

1975	—	Stage 2 start/end parameter
2082	—	

[Unit of data] Detection unit

[Typical setting] 10 (For a detection unit of 1 μm)
100 (For a detection unit of 0.1 μm)

1982	—	Stage 2 end scale factor
2089	—	

In units of 0.1

[Valid data range] 0 to 647 (multiplication by 0 to 64.7)

[Typical setting] Normally, this value may be set to 0.

Run a circular cutting program (F500) to observe the VCMD waveform between channels 1 and 3. Pay attention to the VCMD waveform when the motor reverses (that is, the VCMD waveform crosses the zero level).

If a protrusion occurs, increase the backlash acceleration. Note that if the acceleration is too big, a reverse protrusion occurs.

Change the circular cutting program to F2000. If a protrusion occurs immediately after the motor reverses, adjust the observer parameter (POA1).

1859	—	Observer parameter (POA1)
2047	—	

[Setting value] Current setting ± 100

If the protrusion still occurs, make the following adjustments.

1724	—	Stage 2 acceleration for the two–stage backlash acceleration function
2039	—	

[Setting value] 100
(Specifying too large a value leads to a under cut at low speed.)

1790	—	Stage 2 offset for two–stage backlash acceleration
2167	—	

Normally, set 0.

When using the stage 1 acceleration override function, set the following. (Normally, this setting is not needed.)

1760	—	Stage 1 acceleration override
2137	—	

[Valid data range] 0 to 32767

$$\text{Circular acceleration} = \frac{\{\frac{2}{R}(\frac{F}{60}\times 0.008)^2\}}{\text{Detection unit}}$$

R: Arc radius (mm), F: Speed of circular movement (mm/min)

$$\text{(Stage 1 acceleration)} \quad \times \frac{1024 + \text{(Circular acceleration)} \times \text{(Stage 1 override setting)}}{1024}$$

When using the stage 2 acceleration override function, set the following. (Normally, this setting is not needed.)

		#7	#6	#5	#4	#3	#2	#1	#0
1960	—						OVR8		
2018	—								

OVR8 (#2) 1 : (The format of the stage 2 acceleration override is determined.)

1725	—	Stage 2 acceleration override
2114	—	

[Valid data range] 0 to 32767

$$\text{Circular acceleration} = \frac{\{\frac{2}{R}(\frac{F}{60}\times 0.008)^2\}}{\text{Detection unit}}$$

R: Arc radius (mm), F: Speed of circular movement (mm/min)

$$\text{(Stage 2 acceleration)} \quad \times \frac{256 + \text{(Circular acceleration)} \times \text{(Stage 2 override setting)}}{256}$$

NOTE
Stage 2 override is effective for stage 2 offset.

Not to use the backlash acceleration function for handle feed, set the following parameter:

1953	—
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
	BLCU						

BLCU (#6) 1 : (to enable the backlash acceleration function for cutting feed only.)

3.8 SHORTENING THE CYCLE TIME FOR HIGH SPEED POSITION

Adjust the parameters while observing the VCMD waveform between channels 1 and 3 on the check board. (See Sec. 4.11.)

(1) Enable PI control.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (to enable PI control).

(2) Increase the absolute value of velocity loop proportional gain PK2V up to 70% of the limit for starting vibration in the stop state.

1856	8X44
2044	1044

Velocity loop proportional gain (PK2V)

Reduce the velocity loop integral gain (PK1V) to such a level that a hunting does not occur during acceleration/deceleration or travel, and make sure that there is no problem with response and rigidity.

1855	8X43
2043	1043

Velocity loop integral gain (PK1V)

[Setting value] Setting value ≧ standard setting × 0.3

(3) If the VCMD waveform overshoots when it almost ends, increase PK2V further, while eliminating vibration using the 250 μs acceleration feedback function.
If the VCMD waveform undershoots, reduce the absolute value of PK2V.

1894	8X66
2066	1066

250 μsec acceleration feedback gain

[Typical setting] –10 (–10 to –20)

1959	—
2017	—

#7	#6	#5	#4	#3	#2	#1	#0
PK2V25							

PK2V25 (#7) 1 : (High–speed velocity loop proportional processing function)

High–speed positioning can be used in the following cases:

(a) 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 punch press

(b) To speed up positioning in rapid traverse while errors in shape during cutting must be minimized (reduction of cycle time)

In case (a), the position gain switch function and the low–speed integration function are effective. See Step (4) and Step (5).

In case (b) the fine acceleration/deceleration (FAD) function is effective. See Step (6).

(4) Enable the position gain switch function (Note)

Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E

1957	—
2015	1015

#7	#6	#5	#4	#3	#2	#1	#0
							PGTW

PGTW (#0) 1 : (to enable the position switch function)

1713	—	Maximum speed to allow position switching (in 0.01 rpm units)
2028	1028	

The position gain is doubled at this speed or lower.

[Typical setting] 5000 (0 to 32767)

Series 0–C, 15–A

(Supported by Series 9046 only; not supported by Series 9041)

1954	8X10
—	—

#7	#6	#5	#4	#3	#2	#1	#0
		PGTW					

PGTW (#5) 1 : (The position gain switch function is used.)

1974	8X81	Valid speed for position gain switching (0.01–rpm unit)
—	—	

The position gain is doubled at speeds lower than or equal to that indicated above.

[Standard setting] : = 5000 (0 to 32767)

(5) Enable the low–speed integration function. (Note)

Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E

1957	—
2015	1015

#7	#6	#5	#4	#3	#2	#1	#0
						SSG1	

SSG1 (#1) 1 : (to enable the low–speed integration function)

1714	—	Minimum speed to disable integration gain (in 0.01 rpm units) for low–speed integration
2029	1029	

Integration gain is disabled at this speed or higher during acceleration.

[Typical setting] 1000 (0 to 32767)

1715	—	Low–speed integration: Maximum speed to enable integration gain (in 0.01 rpm units)
2030	1030	

Integration gain is enabled at this speed or lower during deceleration.

[Typical setting] 1500 (0 to 32767)

Series 0–C, 15–A

(Not supported by series 9041)

1954	8X10
—	—

#7	#6	#5	#4	#3	#2	#1	#0
	SSG1						

SSG1 (#6) 1 : (The low–speed integration function is used.)

1972	8X79	Limit speed for disabling low–speed integration in acceleration (0.01–rpm unit)
—	—	

The integral gain is disabled when the speed indicated above is attained during acceleration.

[Standard setting] : 1000 (0 to 32767)

1973	8X80	Limit speed for enabling low–speed integration in deceleration (0.01–rpm unit)
—	—	

The integral gain is enabled when the speed indicated above is attained during deceleration.

[Standard setting] 1500 (0 to 32767)

NOTE

The position gain switch function doubles the position gain in low–speed mode, thus speeding–up positioning.

The low–speed integration function enables the integrator of the velocity loop in low–speed mode, but disables it in high–speed mode. This prevents the stability from being degraded when the position gain is increased.

These functions are usable only for axes to which positioning is applied. (If simultaneous interpolation is performed for two or more axes, the cut figure may not be correct.)

(6) Use the fine acceleration/deceleration (FAD) function.

This function is supported by Series 9066, 9080, and 9081 only.

1951	—
2007	—

#7	#6	#5	#4	#3	#2	#1	#0
	FAD						

FAD (#6) 1 : (to enable the fine acceleration/deceleration function.)

NOTE

For this bit setting to become effective, the power must be turned off, then back on.

1749	—
2209	—

#7	#6	#5	#4	#3	#2	#1	#0
					FADL		

FADL (#2) 0 : Bell–shaped FAD

1 : Linear FAD

> **NOTE**
> For this bit setting to become effective, the power must be turned off, then back on.

1702	—	Fine acceleration/deceleration time constant (ms)
2109	—	

[Valid data range] 8 to 64 (Standard setting: 40)
If the specified value falls outside this range, the time constant is clamped to the upper or lower limit of the range.

When using the fine acceleration/deceleration function together with the feed–forward function, set the coefficient in the following parameter:

1985	—	Position feed–forward coefficient (0.01%)
2092	—	

[Valid data range] 100 to 10000

> **NOTE**
> 1 Feed forward is enabled when bit 1 of No. 1883 (Series 15) or No. 2005 (Series 16) is set to 1.
> 2 The velocity feed–forward coefficient is set in the same parameter as that used for normal setting; No. 1962 (Series 15) or No. 2069 (Series 16).
> 3 Normally, the fine acceleration/deceleration function is enabled for cutting only.
> 4 To enable the FAD function for rapid traverse also, set bit 3 of parameter No. 1800 to 1 (Series 15/16).

4

SERVO FUNCTION DETAILS

4.1 SERVO FUNCTIONS LIST

Servo software series Function name	9041	9046	9060	9064	9065	9066	9070	9080	9081	Related section of this manual	Remarks Related section of B–65005E/07
Abnormal load detection function	—	—	I	E	A	A	A	A	C	4.10	
Abnormal load detection (at HRV control)	—	—	—	—	A	G	—	G	—	4.10	
Abnormal load detection (applied separately for cutting/rapid traverse)	—	—	—	—	—	H	—	J	—	4.10.1	
Acceleration feedback A (1 ms)	A	A	C	B	A	A	A	A	C		II.2.3.1
Acceleration feedback C (250 μs)	A	A	C	B	A	A	A	A	C	4.3.1	II.2.3.1
Advanced preview control	A	A	C	—	—	A	A	A	C	4.5.2	
Advanced preview control (High–precision contour control using RISC)	A	A	C	—	—	A	A	A	C	4.5.2	
Advanced preview control (High–precision contour control using RISC (type 2))	—	—	—	—	—	—	—	C	C	4.5.3	
Analog interface	A	A	C	—	—	A	A	A	C		
Serial output of arbitrary data	A	B	G	E	A	A	A	A	C		
Servo parameter area expansion	—	—	—	—	A	F	F	A	C		
Support of serial pulse coder (type A or B)	A	A	C	B	A	A	A	A	C		I.3.4.4
Support of serial pulse coder (type C)	—	—	C	B	A	—	A	A	C		I.3.4.4
Support of α pulse coder	A	A	J	E	A	A	A	A	C	2.1.3	
Support of α amplifier (three PWMs)	—	—	S	—	—	A	G	A	C		
Backlash acceleration function (two–stage type)	—	—	Q	—	—	A	F	A	C	4.5.6	
Backlash acceleration function (new type)	A	A	C	B	A	A	A	A	C	4.5.5	
Backlash acceleration function (new type + 125%)	—	—	C	B	A	A	A	A	C		
Backlash acceleration function C	A	A	C	B	A	A	A	A	C	4.5.4	II.2.5.2
Backlash acceleration function D (stop function)	A	A	C	B	A	A	A	A	C		II.2.5.2
Backlash acceleration function E (tenfold acceleration)	A	A	C	B	A	A	A	A	C		
Backlash compensation (negative value setting)	A	A	C	B	A	A	A	A	C		

Servo software series Function name	9041	9046	9060	9064	9065	9066	9070	9080	9081	Related section of this manual	Remarks Related section of B–65005E/07
Brake control function	A	A	C	B	A	A	A	A	C	4.8	
Check board OVC data output	—	—	—	D	A	—	—	—	—		
Check board arc radius error output	A	A	C	—	—	—	A	A	C		
Check board position feedback output	A	A	C	—	—	A	C	A	C		
Check board variable VCMD output	A	A	C	B	A	A	A	A	C	4.11	
Support of automatic adjustment using personal computer	—	—	W	—	—	F	H	A	C	4.19	
Function for obtaining current offsets (at emergency stop)	—	—	—	—	—	—	—	A	C	4.15	
Back electromotive force voltage compensation	A	A	C	B	A	A	A	A	C		II.2.8.3
Back electromotive force voltage compensation at deceleration	A	A	C	B	A	A	A	A	C		
Function for changing current–command–dependent current loop gain	A	A	J	—	—	A	A	A	C		
Function for changing speed–dependent current loop gain	A	A	C	B	A	A	A	A	C		II.2.8.3
Current control period 125 μsec	—	—	—	—	—	—	—	F	E	4.18	
Compensation of current phase lead at deceleration	A	A	C	B	A	A	A	A	C		II.2.8.5
Compensation of serial pulse coder current phase lead	A	A	E	B	A	A	A	A	C		
Function for changing current–command–dependent current phase lead	A	A	E	B	A	A	A	A	C		
Dual position feedback function	A	—	C	B	A	A	A	A	C	4.3.5	
Dual position feedback function (zero width)	—	—	Y	I	A	F	L	F	C	4.3.5	
Dual position feedback function (zero width improvement)	—	—	—	—	—	—	—	K	—	4.3.5	
EGB function	—	—	C	—	—	A	A	A	C		
Function for expanding the position gain setting range	A	A	C	B	A	A	A	A	C	2.1.4	
Feed–forward A	A	A	C	B	A	A	A	A	C	4.5.1	
Feed–forward B (velocity FF, smoothing)	A	A	C	B	A	A	A	A	C	4.5.1	
Feed–forward C (tenfold setting)	A	A	C	B	A	A	A	A	C		
Disconnection alarm t (TG) (Type D)	A	A	C	B	A	A	A	A	C		I.7.3.2

Servo software series **Function name**	**9041**	**9046**	**9060**	**9064**	**9065**	**9066**	**9070**	**9080**	**9081**	**Related section of this manual**	**Remarks** **Related section of B–65005E/07**
FAD function	—	—	—	—	—	D	—	E	C	4.9	
FAD function (used separately for cutting/rapid traverse)	—	—	—	—	—	—	—	J	—	4.9	
FAD function (linear)	—	—	—	—	—	—	—	K	—	4.9	
Flexible feed gear	A	A	C	B	A	A	A	A	C	2.1.2	
Machine speed feedback function	A	A	C	B	A	A	A	A	C	4.3.2	
Machine speed feedback function (normalization)	A	—	N	—	—	A	D	F	C	4.3.2	
HRV function	—	—	—	—	A	F	—	E	C	4.17	
High–speed distribution 1 msec, 2 axes/1DSP	A	A	C	B	A	A	A	A	C		
Position gain polygonal line & low–speed integration function	—	A	C	—	—	A	A	A	C	4.9	
I–P control/P–I control switching	A	A	C	B	A	A	A	A	C		II.2.9.1
Support of linear motor	—	—	—	—	—	D	—	A	C	4.12.1	
Linear motor thrust ripple compensation	—	—	—	—	—	—	—	D	C	4.12.2	
High–speed velocity loop proportional processing function	—	—	—	—	—	B	G	A	C	4.2.3	
Support of ultrahigh–precision machining	—	—	—	—	—	—	—	—	C	4.13	
Velocity gain override	—	—	—	—	—	—	F	A	C		
Actual current peak hold function	—	—	—	—	—	—	—	G	—	4.16	
Non–linear control	A	A	C	B	A	A	A	A	C		III.7.5
Notch filter	—	—	G	—	—	A	A	A	C	4.3.7	
Observer function	A	A	C	B	A	A	A	A	C	4.3.3	
Function for disabling the observer in the stop state	—	—	W	—	—	B	H	A	C	4.3.3	
N–pulse suppress function	A	A	C	B	A	A	A	A	C	4.2.1	
OVC alarm (excessive current alarm)	A	A	C	B	A	A	A	A	C		I.7.3.3
Overshoot compensation (setting of enable level)	—	—	Q	—	—	A	E	A	C	4.4	
Overshoot compensation B (setting of compensation count)	A	A	C	B	A	A	A	A	C	4.4	
Overshoot compensation (type 2)	—	—	—	—	—	—	—	K	—	4.4	

Servo software series **Function name**	**9041**	**9046**	**9060**	**9064**	**9065**	**9066**	**9070**	**9080**	**9081**	**Related section of this manual**	**Remarks** **Related section of B–65005E/07**
PMC axis torque control function (type 1)	—	—	—	—	—	E	—	F	—	4.14	
PMC axis torque control function (type 2)	—	—	—	—	—	H	—	—	—	4.14	
Function for changing the proportional gain in the stop state	—	D	Q	—	—	A	F	A	C	4.2.2	
Vibration–damping control	—	—	—	—	—	—	D	A	C	4.3.6	
Dummy serial feedback function	B	D	Q	B	A	A	E	A	C	4.6	
Support of servo screen (display of actual current and actual speed)	A	A	C	B	A	A	A	A	C	3.1	
Static friction compensation function	A	A	C	B	A	A	A	A	C	4.5.7	
DB stop distance reduction function	A	B	L	—	—	A	C	A	C	4.7	
Tandem control function	—	—	F	—	—	—	—	A	—	4.20	
Tandem control function (damping compensation)	—	—	P	—	—	—	—	A	—	4.20.2	
Tandem control function (full preload function)	—	—	N	—	—	—	—	A	—	4.20.5	
Tandem control function (position feedback switching)	—	—	P	—	—	—	—	A	—	4.20.6	
Tandem control function (velocity tandem)	—	—	N	—	—	—	—	A	—	4.20.7	
Tandem control function (feedback sharing)	—	—	—	—	—	—	—	A	—	4.20.8	
Torque command filter	A	A	C	B	A	A	A	A	C	4.3.4	
Torque compensation (PK2VAUX)	A	A	C	B	A	A	A	A	C		II.2.2.1
Function for changing signed torque limit	—	—	C	B	A	A	A	A	C		
Actual current limit function	A	A	E	B	A	A	A	A	C		
Torque offset function	A	A	C	B	A	A	A	A	C	4.5.5	
Torque ripple compensation	A	B	M	F	A	A	A	A	C		
Vcmd offset function	A	A	C	B	A	A	A	A	C		II.2.6
Velocity control cycle 1 msec	A	A	C	B	A	A	A	A	C		II.1.2

4.2 VIBRATION SUPPRESSION AT STOP

4.2.1 N Pulse Suppression Function

(1) Parameter setting

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
			NPSP				

NPSP (#4) 1 : (to enable the N pulse suppression function)

1992	—
2099	1099

N–pulse suppresion level parameter (ONEPSL)

[Valid data range] : 0 to 32767

[Standard setting] : 400

For Series 0–C, the level parameter is fixed at 400.

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Description of the functions

Even a very small movement of the motor in the stop state may be amplified by a proportional element of the velocity loop, thus resulting in vibration. The N pulse suppression function suppresses this vibration in the stop state.

When vibration occurs as shown in Fig. 4.2.1 (a), the velocity feedback at point B generates an upward torque command to cause a return to point A. A downward torque command, generated by the velocity feedback at point A is greater than the friction of the machine, causing another return to point B. This cycle repeats itself, thus causing the vibration.

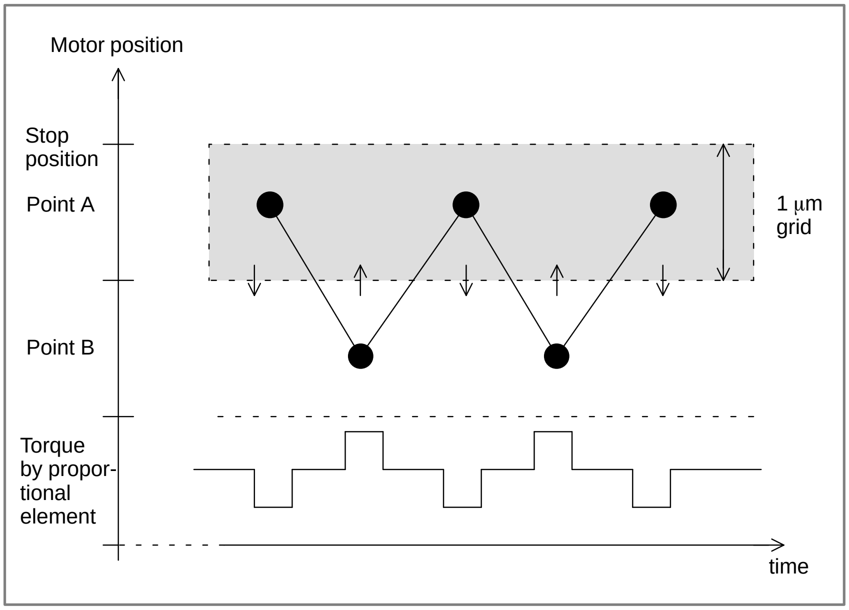


Fig.4.2.1 (a) N pulse suppression function disabled (Torque due to the proportional term keeps up, leading to vibration.)

To suppress such vibration, it is necessary to exclude from the velocity loop proportional term the speed feedback pulses generated when the motor returns from point B to point A.

If the N pulse suppression function is enabled as shown in Fig. 4.2.1 (b), the feedback pulses generated when the motor returns from point B to point A are excluded from the velocity loop proportional term. The standard setting of the grid width at point A is 1 µm. It can be changed by specifying the level parameter.

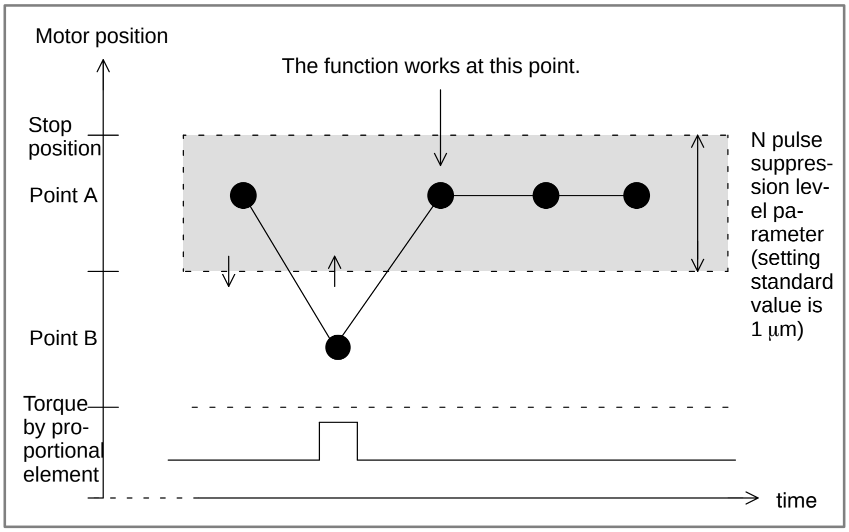


Fig.4.2.1 (b) N pulse suppression function disabled (The N pulse suppression function restricts the torques due to the proportional term, thus eliminating vibration.)

4.2.2
Function for Changing the Proportional Gain 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 changes the proportional gain of the velocity loop (PK2V) to 75% of the setting in the stop state. 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

Series 9046/001D and subsequent editions (Series 0–C, 15–A)
Series 9060/001Q and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001F and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

- **Series 15–B, 16, 18, 20**

		#7	#6	#5	#4	#3	#2	#1	#0
1958 (Series 15–B)	—					K2VC			
2016	—								

K2VC (#3) 1 : (The function for changing the proportional gain in the stop state is used.)

1730 (Series 15–B)	—	Function for changing the proportional gain in the stop state: Stop judgement level
2119	—	

[Increment system] : Detection unit

[Valid data range] : 2 to 10 (Detection unit: 1 μm)
20 to 100 (Detection unit: 0.1 μm)

Series 0–C, 15–A

1953 (Series 15–A)	8X09
—	—

#7	#6	#5	#4	#3	#2	#1	#0
			K2VC				

K2VC (#4) 1 : (The function for changing the proportional gain in the stop state is used.)

1982 (Series 15–A)	8X89
—	—

Function for changing the proportional gain in the stop state: Stop judgement level

[Increment system] Detection unit

[Valid data range] 2 to 10

This function is not effective when the high–speed velocity loop proportional processing function (see Subsec. 4.2.3) is used.

When the absolute value of an error is lower than the stop judgement level, the function changes the proportional gain of the velocity loop (PK2V) to 75% 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 judgement level. The function cannot stop the vibration of a machine in the stop state when the current velocity loop proportional gain is too high. Should this occur, reduce the velocity loop proportional gain.

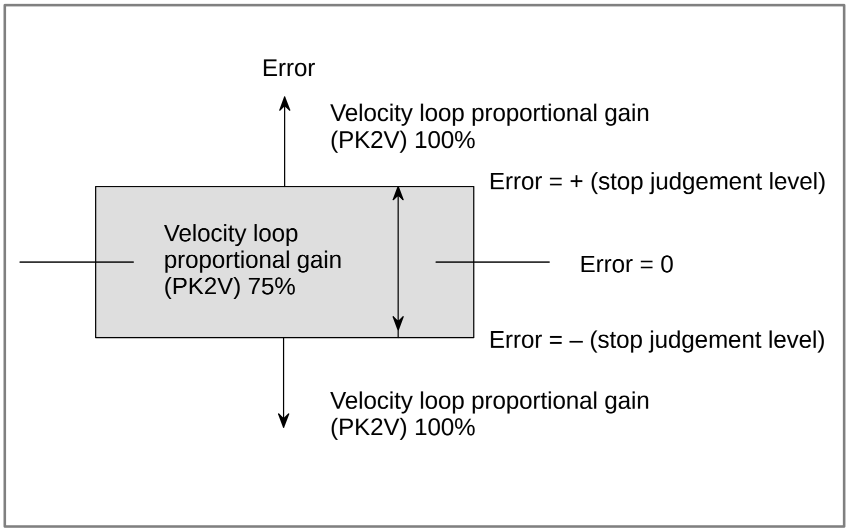


Fig.4.2.2 Relationship between Error and Velocity Loop Proportional Gain (PK2V)

4.2.3
High–speed Velocity Loop Proportional Processing Function

(1) Overview

This function improves the velocity loop gain oscillation threshold. This is done by performing velocity loop proportional calculation at high speed, which determines the velocity loop oscillation threshold.

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

- Velocity loop control method supported by PI only

  Series 9066/001B and subsequent editions (Series 20, 21, Power Mate)
  Series 9070/001G and subsequent editions (Series 15–B, 16–B, 18–B)

- Velocity loop control method supported by both PI and I–P

  Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
  Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

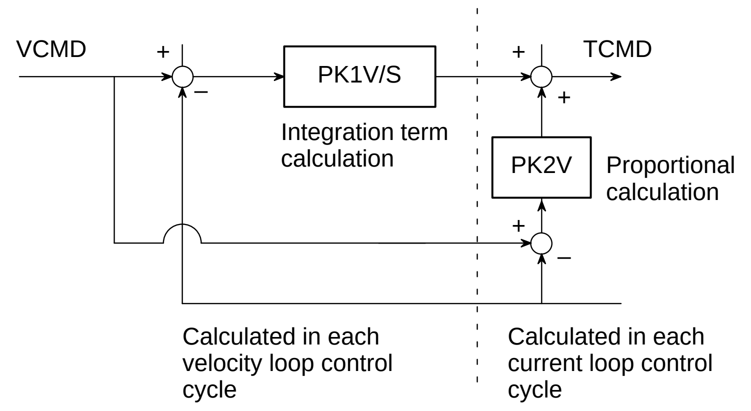
(3) Parameter setting

Series 15–B, 16, 18

		#7	#6	#5	#4	#3	#2	#1	#0
1959 (Series 15–B)	—	PK25							
2017	—								

PK25 (#7) 1 : (The high–speed velocity loop proportional processing function is used.)

Configuration of the control system (for PI control)



(4) Performance comparison with the 250–μs acceleration feedback function

	250–μs acceleration feedback function	**High–speed velocity loop proportional processing function**
Control method	Acceleration fed back every 250 μs	Only proportional calculated every 250 μs
Adjustment method	Set a value of –10 to –20.	Set the function bit.
Effect	This function may prove more effective than the high–speed velocity loop proportional processing function, depending on the machine system resonance frequency and intensity.	In general, this function is more effective than the 250–μs acceleration feedback function in improving the velocity loop gain.

(5) Caution and notes on use

CAUTION

Depending on the resonant frequency 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 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 When this function is used, some functions are restricted as follows:

Unavailable function	**Restricted function**
Velocity loop gain override	Machine speed feedback; normalization not performed
Function for changing the proportional gain in the stop state	Observer used for abnormal load detection
Non–linear control	
Notch filter	
250–μs acceleration feedback	
N–pulse suppression function	

4.3 MACHINE–RESONANCE SUPPRESSION FUNCTION

4.3.1
250μsec 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 can stabilize unstable servo :

- When motor and machine have a spring coupling.
- When the external inertia is great compared to the motor inertia.

This is effective when vibration is about 50 to 150 Hz.

Fig 4.3.1 is a velocity loop block diagram that includes acceleration feedback function.

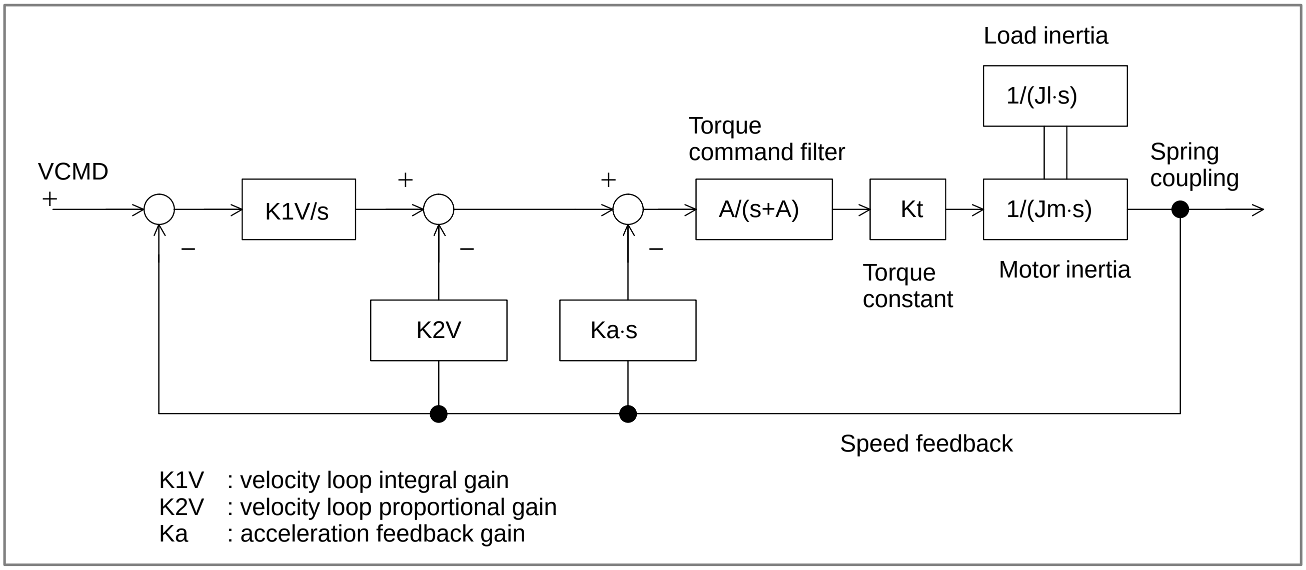


Fig.4.3.1 Velocity loop block diagram that includes acceleration feedback function

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Specifying parameters

Specifying the following parameters as a negative value enables the 250 μs acceleration feedback function.

1894	8X66	250 μsec acceleration feedback gain
2066	1066	

[Setting value] –10 to –20

(4) Caution and note

CAUTION
If the acceleration feedback gain is too large, abnormal sound or vibration can occur during acceleration/ deceleration. To solve this problem, reduce the gain.

NOTE
This function is disabled when the high–speed velocity loop proportional processing function (see Subsec. 4.2.3) is used.

4.3.2
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 pulse coder 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

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Control block diagram

Fig.4.3.2 is a control block diagram

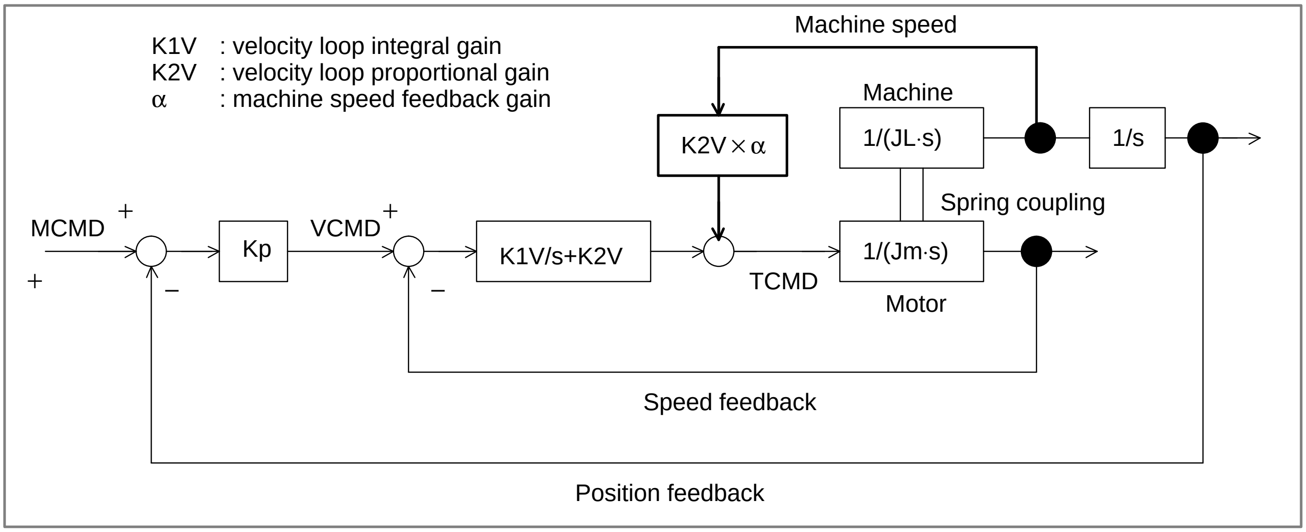


Fig.4.3.2 Position loop block diagram that includes machine speed feedback function

As shown in Fig.4.3.2, 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.

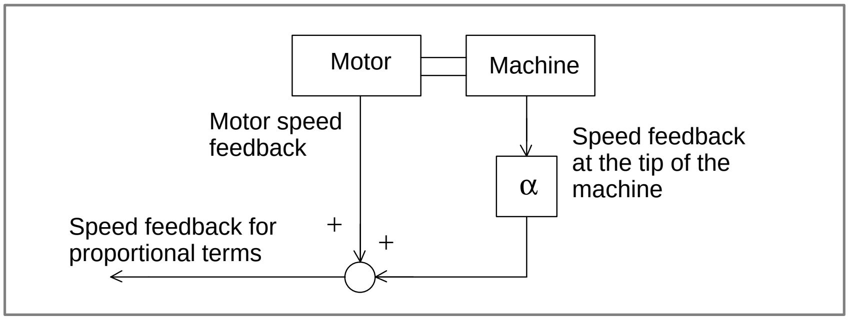
---

(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. 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.

---

(5) Series and editions of applicable servo software

The following series and editions support the normalization function.

Series 9041/001A and subsequent editions (Series 0)
Series 9060/001N and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001D and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001F and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

---

(6) Specifying parameters

1956	8X12
2012	1012

#7	#6	#5	#4	#3	#2	#1	#0
						MSFE	

MSFE (#1) 1 : (to enable the machine speed feedback function)

1981	8X88	Machine speed feedback gain (MCNFB)
2088	1088	

Methods to specify the parameter vary with the servo ROM series.

Series 0–C and 15–A
(servo ROM series 9041 or 9046)

$$\boxed{\text{MCNFB} = 4096 \times \alpha \times \frac{8192}{\text{Number of position feedback pulses per motor revolution}}}$$

Typical values for α range from 0.3 to 1.0.

When the normalization function is used

The normalization function cannot be used with Series 9046.

When using the normalization function with Series 9041, set the following parameter:

		#7	#6	#5	#4	#3	#2	#1	#0
Series 0-C	8X10		MVFBFM						
Series 15–A	1954								

MVFBFM (#6) The machine speed feedback normalization function is:

0 : Disabled.
<u>1 : Enabled. ← Set this value.</u>

Series 15–B, 16, 18, 20, 21, and Power Mate
(servo soft series 9060, 9066, 9070, 9080, and 9081)

☆ Flexible feed gear (No. 2084, 2085, 1977, 1978) = 1/1

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

When the normalization function is not used:

MCNFB = 3000 to 10000

When the normalization function is used:

MCNFB = –3000 to –10000

Power Mate–E
(servo ROM series 9064 and 9065)

☆ Regardless of what the flexible feed gear (No. 1084, 1085) is:

MCNFB = 30 to 100

The normalization function is not supported, because there is no possibility of simultaneous operation of two axes.

(7) Note

NOTE

If 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 (⇒Subsec.4.3.3)
  (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 (⇒Subsec.4.3.4)

4.3.3
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. 4.3.3 (a) shows a block diagram of the velocity loop including an observer.

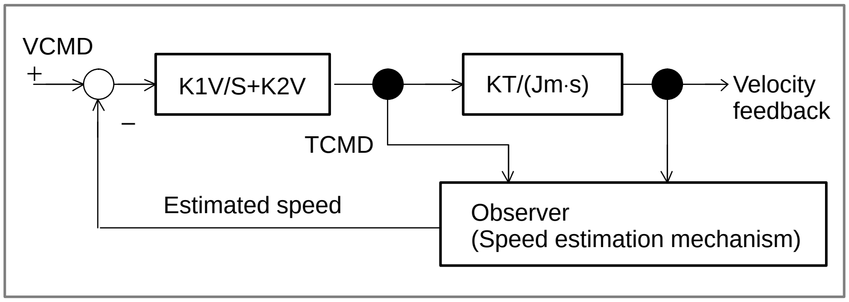


Fig.4.3.3 (a) Configuration of velocity loop including observer

Fig. 4.3.3 (b) shows a block diagram of the observer.

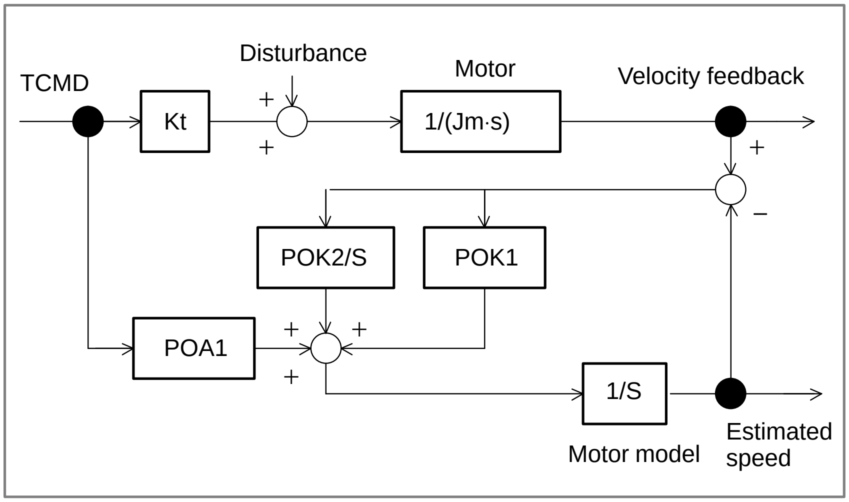


Fig.4.3.3 (b) Block diagram of the observer

POA1, POK1, and POK2 in Fig. 4.3.3 (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 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 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. 4.3.3 (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, and make 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. (6) of this section.

(3) Specifying parameters

		#7	#6	#5	#4	#3	#2	#1	#0
1808	8X03						OBEN		
2003	1003								

OBEN (#2) 1 : (to enable the observer function)

1859	8X47	Observer coefficient (POA1)
2047	1047	

Usually, use the standard setting.

1862	8X50	Observer coefficient (POK1)
2050	1050	

Usually, use the standard setting.

1863	8X51	Observer coefficient (POK2)
2051	1051	

Usually, use the standard setting.

(4) Note

NOTE

The parameter is initially set to such a value (standard setting) that the cutoff frequency of the filter becomes 30 Hz. With this setting, the effect of filtering becomes significant at a resonance frequency of 150 Hz or higher. To change the cutoff frequency, set parameters POK1 and POK2 to a value listed below, while paying attention to the Table 4.3.3: 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 4.3.3 Changing the observer cutoff frequency

Cutoff fequency (Hz)	POK1	POK2
10	348	62
20	666	237
30	956	510
40	1220	867
50	1460	1297
60	1677	1788
70	1874	2332

(5) Setting when the abnormal load detection function is used

The abnormal load detection function (see Sec. 4.10) uses the observer circuit shown in Fig. 4.3.3 (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 Sec. 4.10.

When the observer function and abnormal load detection function are used together, however, the defaults for POA1, POK1, and POK2 must be used as is.

(6) Series and editions of applicable servo software

Function for disabling the observer in the stop state

Series 9060/001W and subsequent editions (Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001B and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001H and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(7) Parameter setting

(a) Function bit

		#7	#6	#5	#4	#3	#2	#1	#0
1960	—							MOVO	
2018	—								

MOVO (#1) The function for disabling the observer in the stop state is:

0 : Disabled
1 : Enabled → Set this value.

(b) Level at which the observer is determined as being disabled

1730	—	Level at which the observer is determined as being disabled
2119	—	

[Increment system] Detection unit

[Typical setting] 1 to 10

If the absolute value of the positional deviation 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 function for changing the proportional gain in the stop state.

(Usage)

If, when the observer function is enabled, the machine is unstable in the machine stop state, 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 positional deviation.

4.3.4
Torque Command Filter

(1) Overview

The torque command filter applies a primary low–pass filter to the torque command.

If the machine resonates at a high frequency of one hundred Hz and over, this function eliminates resonance at such high frequencies.

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Explanation

Fig. 4.3.4 shows the configuration of a velocity loop including the torque command filter.

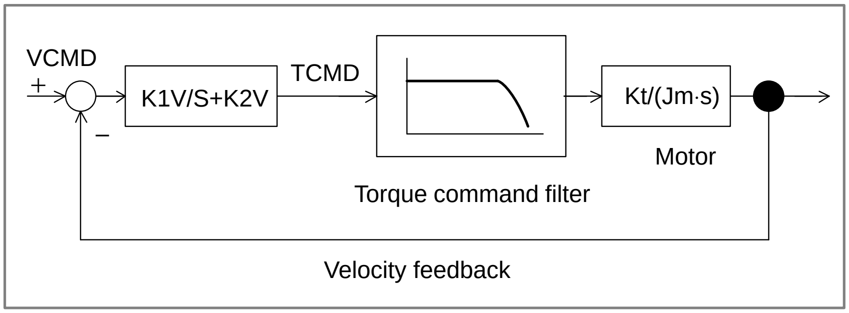


Fig.4.3.4 Configuration of velocity loop including torque command filter

As shown in Fig. 4.3.4, the torque command filter applies a low-pass filter to the torque command. When a mechanical system contains a high resonant frequency of more than 100Hz, the resonant frequency component is also contained in the velocity feedback shown in Fig. 4.3.4 and may be amplified by proportional term. However, the resonance is prevented by interrupting the high-frequency component of the torque command using the filter.

(4) Prope user 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) Specifying parameters

1895	8X67	Torque command filter (FILTER)
2067	1067	

[Setting value] 1166 (200Hz) to 2327 (90Hz)

When changing the torque command filter setting, see the Table 4.3.4. Use 50% of the frequency of vibration as the cutoff frequency.

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 4.3.4 Parameter setting value of torque command filter

Cutoff frequency (Hz)	Parameter	Cutoff frequency (Hz)	Parameter
60	2810	140	1700
65	2723	150	1596
70	2638	160	1499
75	2557	170	1408
80	2478	180	1322
85	2401	190	1241
90	2327	200	1166
95	2255	220	1028
100	2185	240	907
110	2052	260	800
120	1927	280	705
130	1810	300	622

4.3.5
Dual Position Feedback 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.

(2) Control method

The following block diagram shows the general method of dual position feedback control:

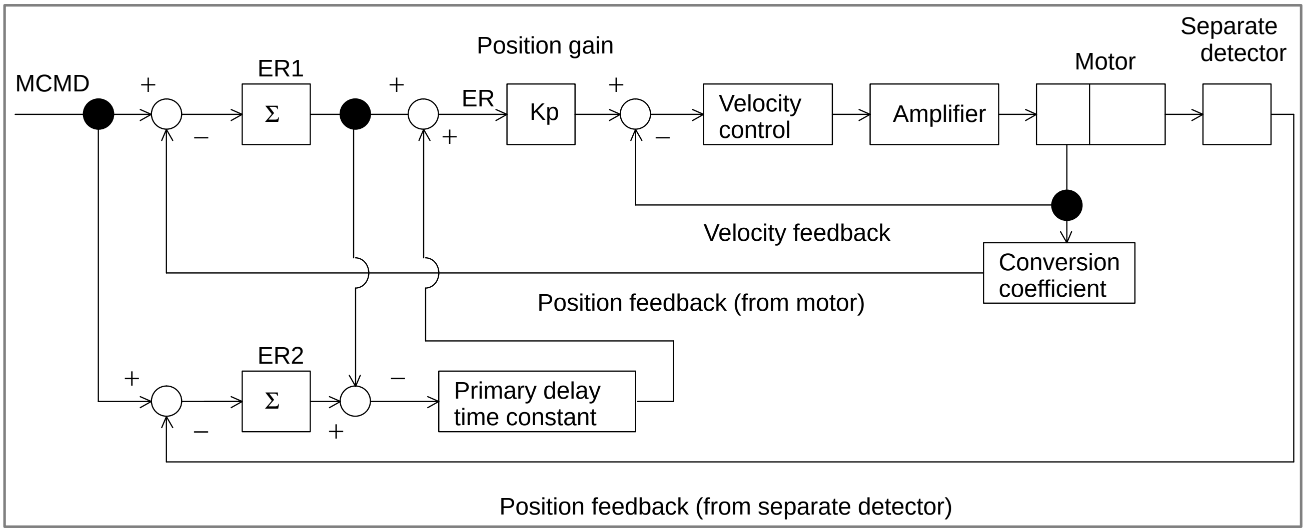


Fig 4.3.5 Block diagram of dual position feedback control

As shown in Fig. 4.3.5, error counter ER1 in the semi-closed loop system and error counter ER2 in the closed loop system are used. The primary delay time constant is calculated as follows:

Primary delay time constant=$(1+\tau s)^{-1}$

The actual error, ER, depends on the time constant, as described below:

(a) When time constant τ is $0 \cdot\cdot\cdot\cdot (1+\tau s)^{-1}=1$
ER=ER1+(ER2–ER1)=ER2 (error counter of the full–closed loop system)

(b) When time constant t is $\infty \cdot\cdot\cdot\cdot (1+\tau s)^{-1}=0$
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) Applicable servo ROM series/edition

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

NOTE
Series 9046 does not support the dual position feedback function. To use this function with the Series 0–C or 15–A, therefore, specify the Series 9041.

(4) Specifying parameters

This function is optional, so optional parameters as well as the following parameter are necessary.

		#7	#6	#5	#4	#3	#2	#1	#0
1955 (Series 15–A) 1709 (Series 15–B)	8X11	DPFB							
2019	1019								

DPFB (#7) 1 : (to enable dual position feedback)

1861	8X49	Dual position feedback maximum amplitude
2049	1049	

[Setting value] : Maximum amplitude (μm)/minimum detection unit for full–closed mode × 64)
This parameter should normally be set to 0.

[Increment system] : 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.

1971	8X78
2078	1078

Dual position feedback conversion coefficient (numerator)

1972	8X79
2079	1079

Dual position feedback conversion coefficient (denominator)

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

$$\frac{\text{Conversion coefficient (numerator)}}{\text{Conversion coefficient (denominator)}} = \frac{\text{Number of position feedback pulses per motor revolution (Value obtained after connecting the feed gear)}}{\text{1 million}}$$

With this setting method, however, cancellation in the servo software internal coefficient may occur depending on constants such as the machine deceleration ratio, causing the motor to vibrate. In such a case, the setting must be changed.

For details, see Art. (7) in this section.

(Example)

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

Conversion coefficient (Numerator/Denominator)
= 10 × 1000/1,000,000 = 1/100

1973	8X80
2080	1080

Dual position feedback primary delay time constant

[Setting value] : Set to a value in a range of 10 to 300 ms or so.

[Increment system] : msec

Normally, set a value of around 100 msec as the initial value. If hunting occurs during acceleration/deceleration, 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.

1974	8X81	Dual position feedback zero–point amplitude
2081	1081	

[Setting value] : Zero width (μm)/minimum detection unit for full–closed mode

[Increment system] : 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 positional deviation may remain. For details, see Art. (5) in this section.

1729	—	Dual position feedback: Level on which the difference in error between the semi–closed and full–closed modes becomes too large
2118	—	

[Setting value] Level on which the difference in error is too large (μm)/minimum detection unit for full–closed mode

[Increment system] Minimum detection unit (μm/p) for full–closed mode

If the difference between the pulse coder 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.

		#7	#6	#5	#4	#3	#2	#1	#0
1954	8X10			HBBL	HBPE				
2010	1010								

HBBL (#5) The backlash compensation is added to the error count of:
1 : The closed loop.
0 : The semi–closed loop. (Standard setting)

HBPE (#4) The pitch error compensation is added to the error count of:
1 : The semi–closed loop.
0 : The closed loop. (Standard setting)

(5) Zero–width setting for a machine with a large backlash or twist

When servo software earlier than the series and editions indicated below is used, and the 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 positional deviation 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:

(i) Use the digital servo software of the edition indicated below or later.
(ii) Set the dual position feedback zero–width parameter to 0.

- An improvement in the zero–width function has been made to Series 9080/001K and subsequent editions. With these software series and editions, this problem can be solved without setting the zero–width parameter to 0. For details, see Art. (6) below.

(a) Series and editions of applicable servo software
Series 9060/001Y and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001F and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001I and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001L and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001F and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(6) Improvement in zero–width setting

(a) Series and editions of applicable servo software

Series 9080/001K and subsequent editions (Series 15–B, 16–C, 18–C)

(b) Parameter setting

To use the improvement, set the following parameter:

		#7	#6	#5	#4	#3	#2	#1	#0
1742	—				DUAL0W				
2202	—								

DUAL0W (#4) The zero–width determination is performed with:

0 : Setting = 0 only.
1 : Setting. ← Set this value.

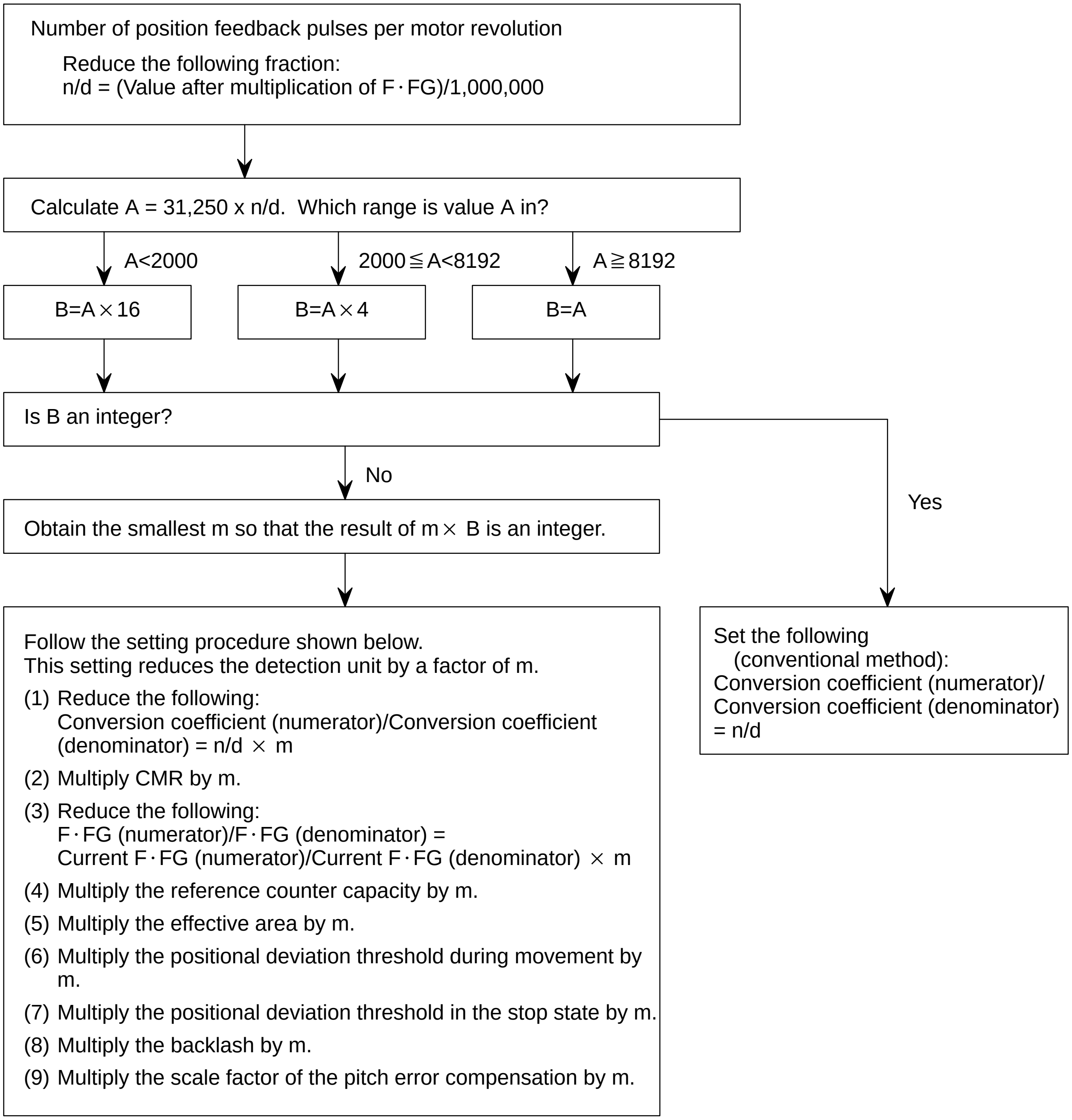
(7) Cautions on setting of the dual position feedback conversion coefficient

CAUTION

The dual position feedback conversion coefficient is set as explained in Art. (4). With the conventional calculation method, however, cancellation may occur in the conversion coefficient of the servo software depending on constants such as the machine deceleration ratio. If cancellation in the conversion coefficient occurs, feedback errors in the semi–closed loop system are accumulated. In some cases, this may result in motor oscillation.

To prevent this problem, calculate and set the dual position feedback conversion coefficient by following the procedure given below.

(a) Series 9041



Number of position feedback pulses per motor revolution

Reduce the following fraction:
n/d = (Value after multiplication of F･FG)/1,000,000

Calculate A = 31,250 x n/d. Which range is value A in?

Obtain the smallest m so that the result of m× B is an integer.

Follow the setting procedure shown below.
This setting reduces the detection unit by a factor of m.

(1) Reduce the following:
Conversion coefficient (numerator)/Conversion coefficient (denominator) = n/d × m

(2) Multiply CMR by m.

(3) Reduce the following:
F･FG (numerator)/F･FG (denominator) =
Current F･FG (numerator)/Current F･FG (denominator) × m

(4) Multiply the reference counter capacity by m.

(5) Multiply the effective area by m.

(6) Multiply the positional deviation threshold during movement by m.

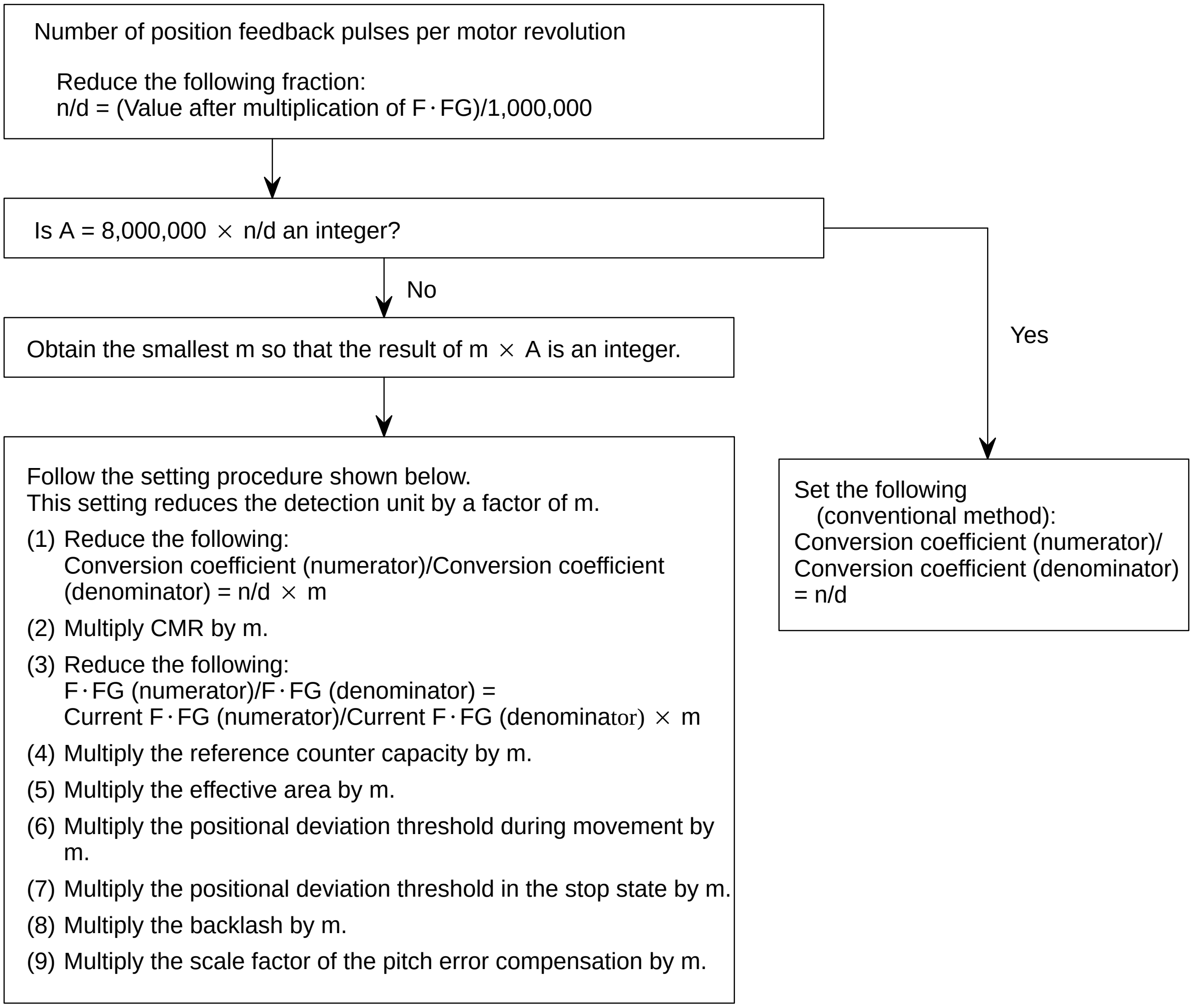
(7) Multiply the positional deviation threshold in the stop state by m.

(8) Multiply the backlash by m.

(9) Multiply the scale factor of the pitch error compensation by m.

Set the following
(conventional method):
Conversion coefficient (numerator)/
Conversion coefficient (denominator)
= n/d

(b) Series 9060, 9064, 9065, 9070, 9080, and 9081



Number of position feedback pulses per motor revolution

Reduce the following fraction:
n/d = (Value after multiplication of F·FG)/1,000,000

Is A = 8,000,000 × n/d an integer?

Obtain the smallest m so that the result of m × A is an integer.

Follow the setting procedure shown below.
This setting reduces the detection unit by a factor of m.

(1) Reduce the following:
Conversion coefficient (numerator)/Conversion coefficient (denominator) = n/d × m

(2) Multiply CMR by m.

(3) Reduce the following:
F·FG (numerator)/F·FG (denominator) =
Current F·FG (numerator)/Current F·FG (denominator) × m

(4) Multiply the reference counter capacity by m.

(5) Multiply the effective area by m.

(6) Multiply the positional deviation threshold during movement by m.

(7) Multiply the positional deviation threshold in the stop state by m.

(8) Multiply the backlash by m.

(9) Multiply the scale factor of the pitch error compensation by m.

Set the following
(conventional method):
Conversion coefficient (numerator)/
Conversion coefficient (denominator)
= n/d

4.3.6 Vibration–damping Control Function

(1) Overview

In a closed–loop system, the pulse coder 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 may be distorted, causing the speed transferred to the machine to slightly differ from the actual motor speed. In such a case, it is difficult to properly control the machine (reduce vibration on the machine).

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.

(2) Control method

The following figure shows the block diagram for vibration–damping control:

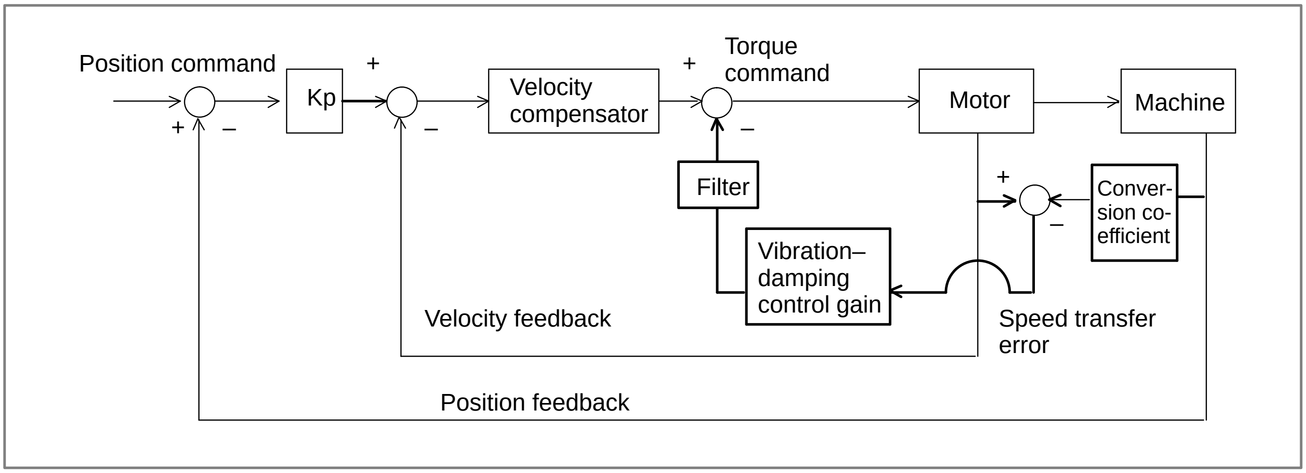


Fig. 4.3.6 Block diagram for vibration–damping control

(3) Applicable servo software series/edition

Series 9070/001D and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(4) Parameter setting

1718 (Series 15–B)	—	Number of position feedback pulses for vibration–damping control conversion coefficient
2033 (Series 16–B)	—	

[Valid data range] : 0 to 32767

When 0 is set, this function is disabled.

When DMR is used and a flexible feed gear (F·FG) is not used

$$\text{Set value} = \frac{\text{Number of feedback pulses per motor revolution, received from separate detector} \times (\text{DMR}/4)}{8}$$

(Example 1)

With a 5 mm/rev ball screw, 0.5 μm/pulse separate detector (value obtained from a quadrupling circuit), and a detection unit of 1 μm, the DMR setting is 2. Then,

Set value = 10,000 × (2/4)/8 = 625

When a flexible feed gear (F·FG) is used (In the case of using the A/B phase separate type detector)
Set value = $\dfrac{\text{Number of feedback pulses per motor revolution, received from a separate detector}}{8}$ (The DMR setting does not affect the set value.)

(Example 2)

If a flexible feed gear is used under the conditions described in example 1 above, F·FG = 1/2

Then,

Set value = 10,000/8 = 1250

When a flexible feed gear (F·FG) is used (In the case of using the serial separate type detector)
Set value = $\dfrac{\text{Number of feedback pulses per motor revolution, received from a separate detector (after feedback pulse)}}{8}$ (The DMR setting does not affect the set value.)

(Example 3)

If a flexible feed gear is used under the conditions described in example 1 above,

Set value = 10,000/8 = 1250

NOTE

If the above expression is indivisible, set the nearest integer.

1719 (Series 15–B)	—	Vibration–damping control gain
2034 (Series 16–B)	—	

[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.

4.3.7
Notch Filter

(1) Overview

When position control is performed with the servo motor, the velocity loop gain must be increased to improve the servo rigidity. Because of the resonance of the machine system, the velocity loop gain sometimes cannot be increased sufficiently.

Conventionally, a torque command filter and observer (a filter for the feedback signal) were used to prevent such resonance. To use these functions, a cutoff frequency which is sufficiently lower than the actual resonant frequency must be set. However, using a filter with an extremely low cutoff frequency may lower the servo rigidity.

The notch filter function prevents resonance by applying a filter with a sharp attenuation characteristic to a narrow frequency band centering around the machine resonant frequency.

This function is effective when a strong resonance is apparent at a particular frequency.

(2) Outline of control

Fig. 4.3.7 shows a velocity loop configuration including a torque command filter and notch filter.

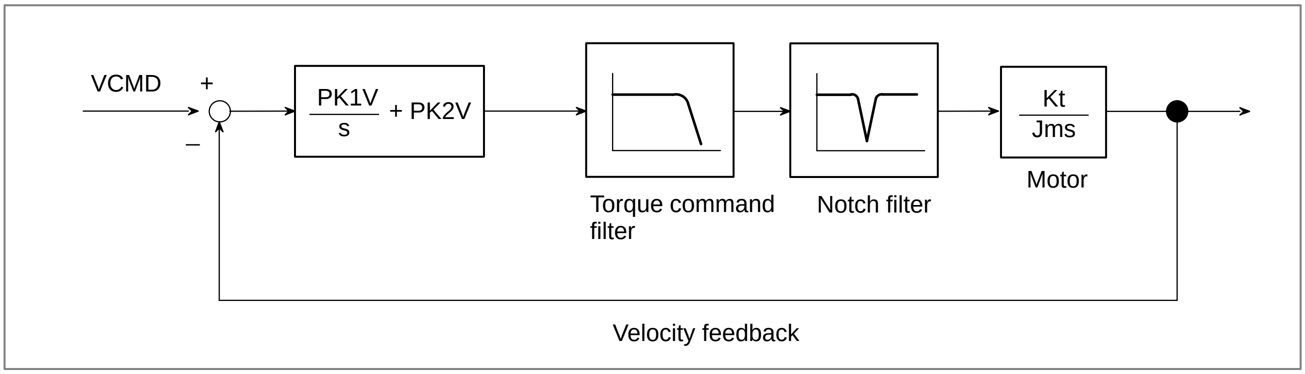


Fig. 4.3.7 Configuration of velocity loop including a notch filter

(3) Series and editions of applicable servo software

Series 9060/001G and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(4) Parameter setting

(a) Function bit

		#7	#6	#5	#4	#3	#2	#1	#0
1958	—	NFIL8	NFIL7	NFIL5					
2016	—								

NFIL8 (#7) 1 : Cutoff frequency band =
(0.8 × center frequency) to (1.25 × center frequency)

NFIL7 (#6) 1 : Cutoff frequency band =
(0.7 × center frequency) to (1.4 × center frequency)

NFIL5 (#5) 1 : Cutoff frequency band =
(0.5 × center frequency) to (2.0 × center frequency)

(b) Center frequency

1706	—	Center frequency of notch filter (Hz)
2113	—	

(5) Caution and Notes

CAUTION

In a system with multiple resonant frequencies, vibration at around the center frequency can be eliminated, but vibration at other frequencies may be amplified.

NOTE

1 If a function bit is set, but the center frequency is not specified, a filter with a center frequency of 40 Hz is applied.
2 If more than one function bit is set, priority is given first to bit 7, then to bit 6, and finally to bit 5.
3 This function is disabled when the high–speed velocity loop proportional processing function (see Subsec. 4.2.3) is used.

(6) Usage

(a) If resonance is generated, its vibration frequency can be measured by observing the torque command signal.

(b) Set the measured frequency as the center frequency of the notch filter. As the initial cutoff frequency band, set bit 7.

(c) If vibration still exists, change the function bit setting to bit 6, then to bit 5, to widen the cutoff frequency band.

4.4 OVERSHOOT COMPENSATION

(1) Parameter setting

		#7	#6	#5	#4	#3	#2	#1	#0
1808	8X03		OVSC						
2003	1003								

OVSC (#6) 1 : (to enable the overshoot prevention function)

1857	8X45	Velocity loop incomplete integral gain (PK3V)
2045	1045	

[Valid data range] : 0 to 32767

[Typical setting] : 30000

1970	8X77	Overshoot protection counter (OSCTP)
2077	1077	

[Valid data range] : 0 to 32767

[Typical setting] : 20

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)

Series 9046/001A and subsequent editions (Series 0–C, 15–A)

Series 9060/001C and subsequent editions (Series 15–B, 16–A, 18–A, 20, 21, Power Mate)

Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)

Series 9064/001B and subsequent editions (Power Mate–E)

Series 9065/001A and subsequent editions (Power Mate–E)

Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)

Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)

Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Explanation

(a) Servo system configuration

Fig. 4.4(a) shows the servo system configuration. Fig. 4.4(b) shows the velocity loop configuration.

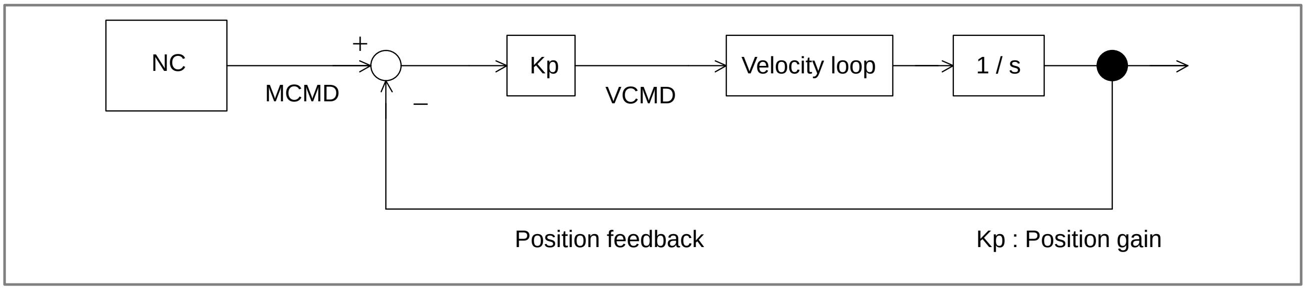


Fig. 4.4 (a) Digital servo system configuration

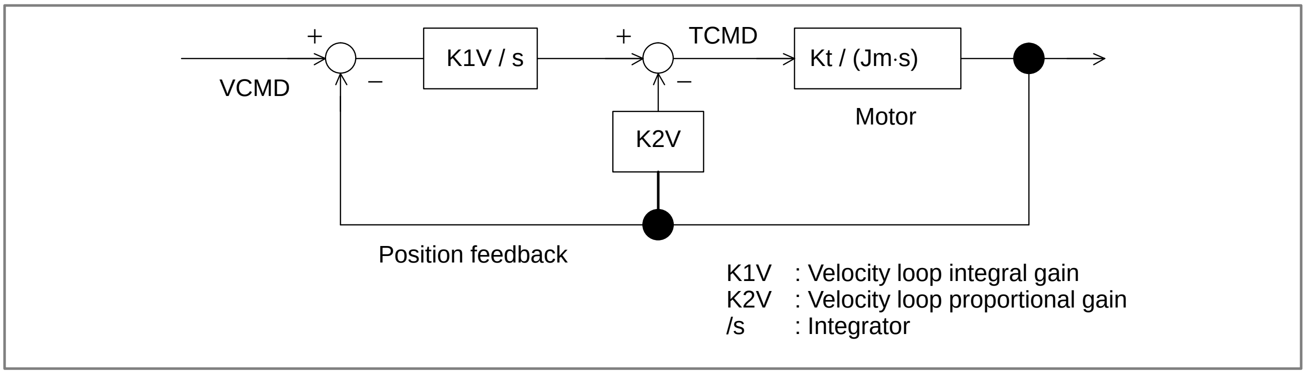


Fig. 4.4 (b) Velocity loop configuration

(b) When incomplete integration and overshoot compensation are not used.

First, the 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 over come 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. 4.4 (c).

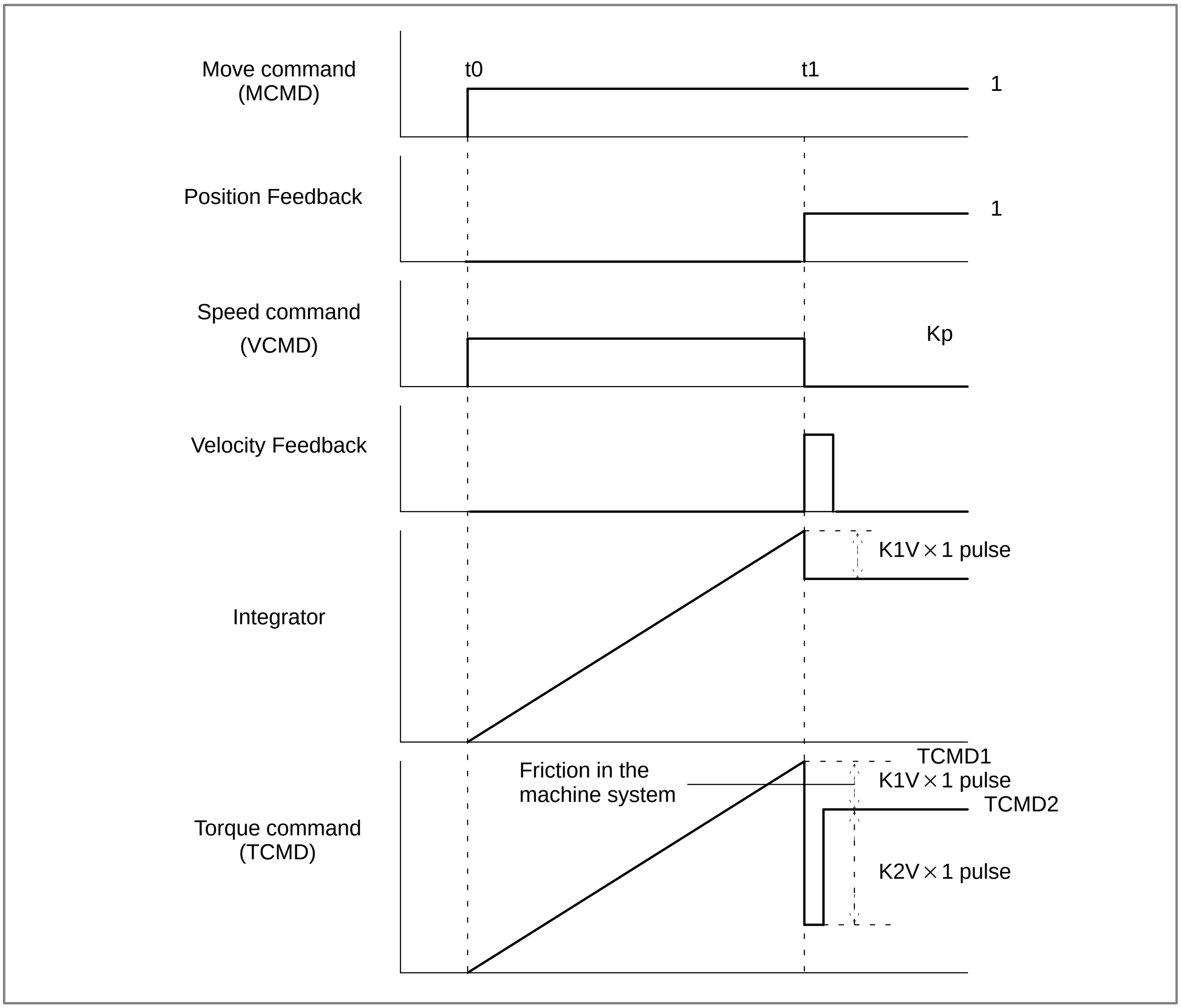


Fig. 4.4 (c) Response to 1 pulse movement commands

If Fig. 4.4 (c) on the previous page, the torque (TCMD1) when movement has started becomes even greater than the machine static friction level. Furthermore, when the motor has moved 1 pulse, it finally comes settled 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. 4.4 (c) is smaller than the moving friction level, the motor will stop at the place where it has moved 1 pulse, Fig. 4.4 (d). When the TCMD2 is greater than the moving friction level the motor cannot stop and overshoot will occur Fig. 4.4 (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)

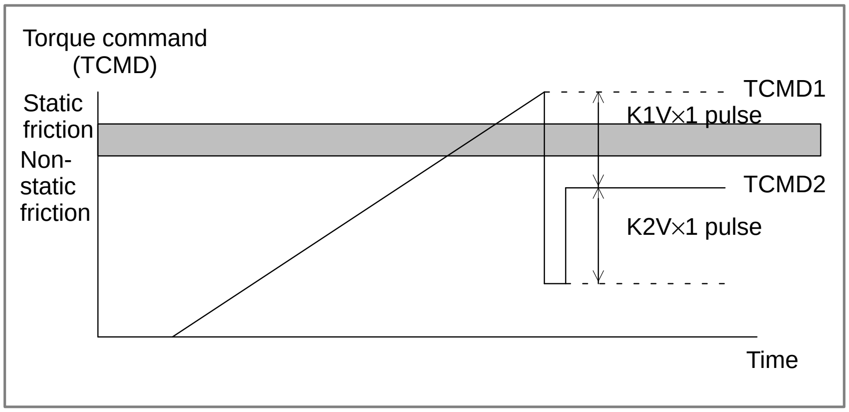


Fig. 4.4 (d) Torque commands (when there is no overshoot)

(ii) Torque commands for standard settings (during overshoot)

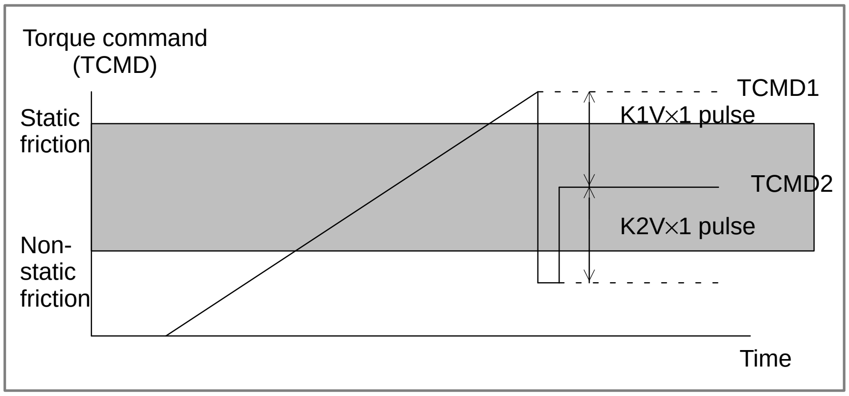


Fig. 4.4 (e) Torque commands (during overshoot)

Conditions to prevent further overshoot are as follows.
When

TCMD1 > static friction > non-static friction
> TCMD2 · · · · · · (1)

and there is a relationship there to

TCMD1 > static friction > TCMD2
> non-static friction · · · · · · (2)

regarding static and non-static 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

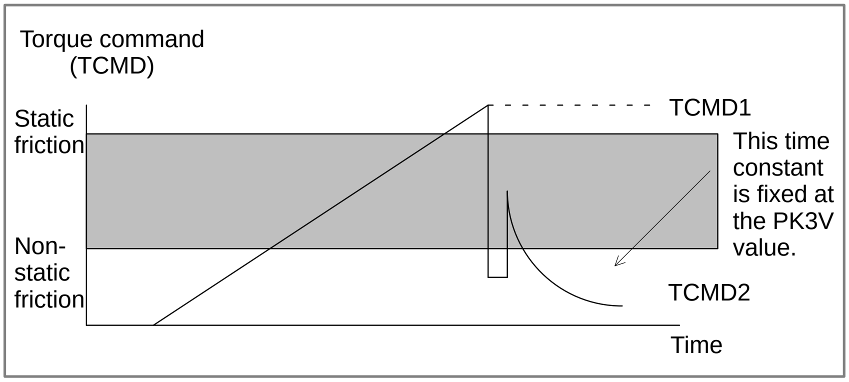


Fig. 4.4 (f) Torque command (when overshoot is used)

If this overshoot compensation function is used, it is possible to prevent overshoot so that the relationship between machine static and non-static 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 32300 (Incomplete integral coefficient)
OSCTP : around 50 (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.

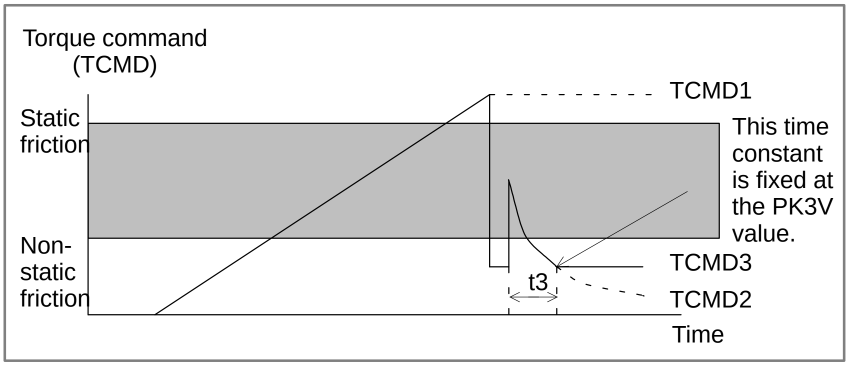


Fig. 4.4 (g) Torque command (using improved type overshoot compensation)

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 non-static 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) Series and editions of applicable servo software

Series 9060/001Q and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001E and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(c) Parameter setting

1994	—	Overshoot compensation enable level
2101	—	

[Valid data range] 0 to 32767

[Increment system] Detection unit

[Standard setting] 1 (detection unit: 1 μm)
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.

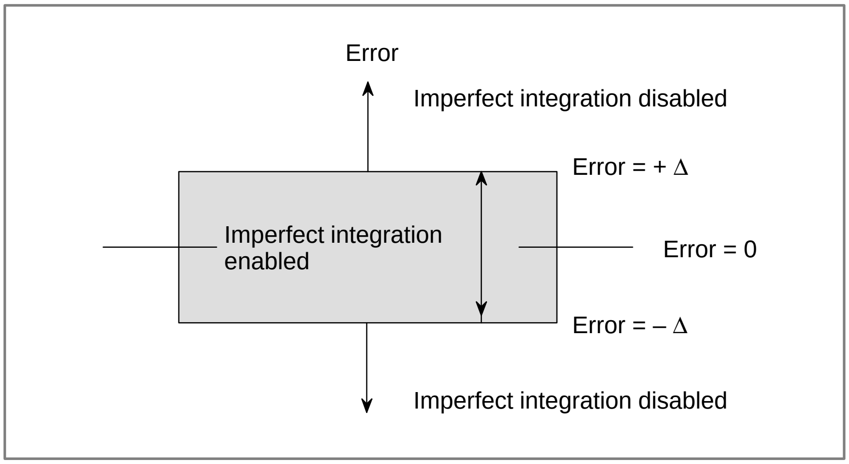


Fig.4.4 (h) Relationship between error and overshoot compensation

---

(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 integrations is set.

This is caused by the repeated occurrence of the following phenomena:

- While the machine is in the stopped state, the positional deviation falls within the threshold, and the integrator is rewritten. Subsequently, the motor is pushed back by a machine element such as a machine spring element, causing the positional deviation to exceed the threshold.
- While the positional deviation is beyond the threshold, a torque command is output to decrease the positional deviation, then it decreases to below the threshold again.

In such a case, set the bit indicated below to suppress the minute vibration.

(b) Series and editions of applicable servo software

Series 9080/001K and subsequent editions (Series 15–B, 16–C, 18–C)

(c) Parameter setting

		#7	#6	#5	#4	#3	#2	#1	#0
1742	—					OVS1			
2202	—								

OVS1 (#3) 1 : (Overshoot compensation is enabled only once after the termination of a move command.)

4.5 SHAPE–ERROR SUPPRESSION FUNCTION

4.5.1 Feed–forward Function

(1) Principle

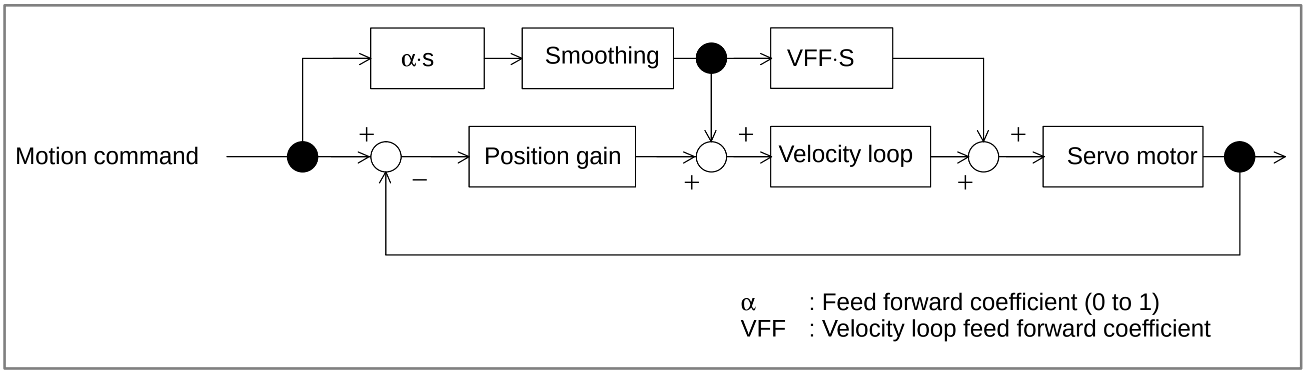


Fig.4.5.1 (a) Feed forward control block diagram

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 $(1 - \alpha^2)$.

$$\Delta \text{R1 (mm)} = \frac{\text{Feedrate}^2 \text{ (mm/s)}^2}{2 \times \text{position gain}^2 \times \text{radius (mm)}} \times (1 - \alpha^2)$$

(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 acceleration/deceleration time constant is applied after interpolation for two axes.

Therefore, total radial figure error ΔR during circular cutting is:

$$\Delta R = \Delta R1 + \Delta R2$$

The shape error in the direction of the radius during circular cutting is as shown in Fig. 4.5.1 (b) below.

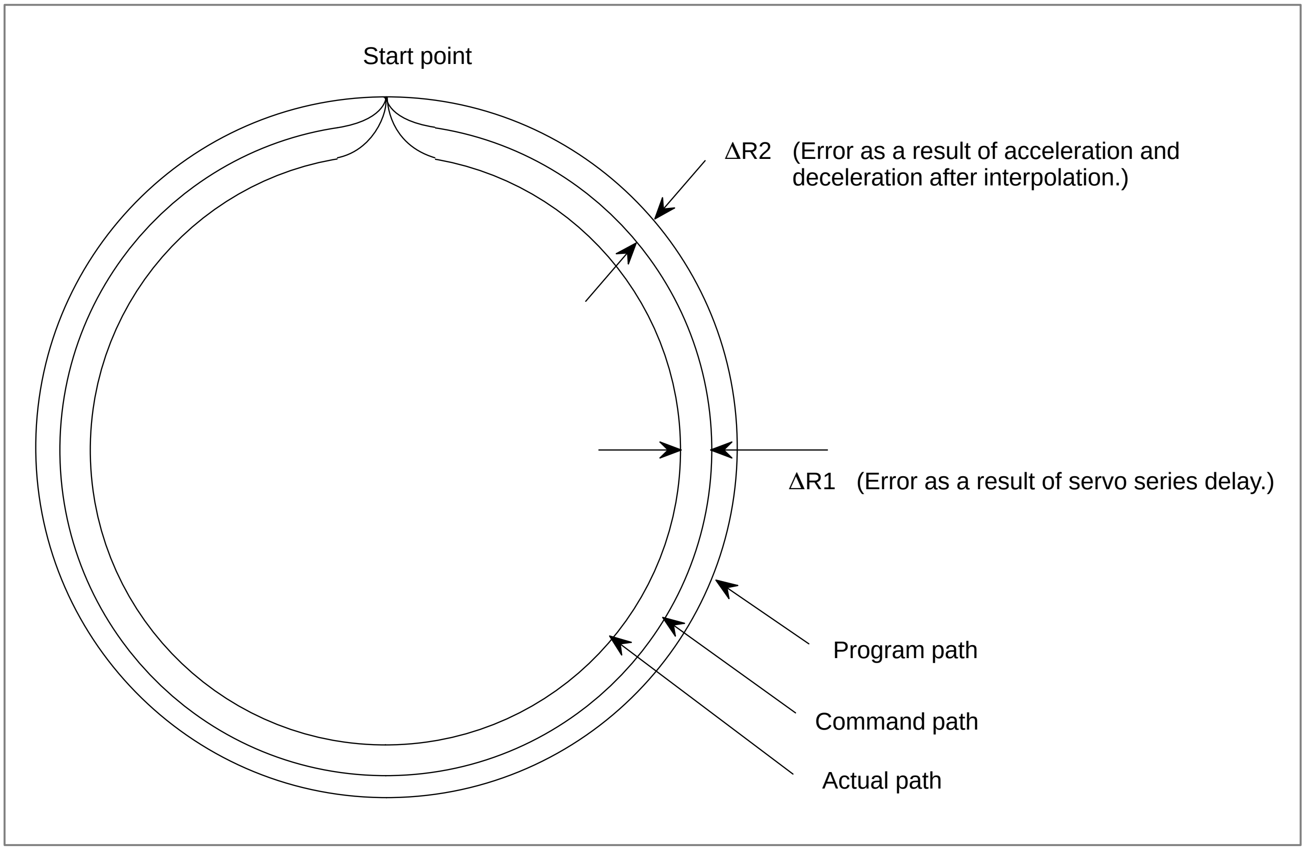


Fig.4.5.1 (b) Path error during circular cutting

As the feed forward is made larger, the shape error ΔR1 due to delay in servo system becomes smaller and the shape error becomes theoretically 0 in the case of α=1.
However, 1 cannot be set for the actual servo system, because doing so would result in an overshoot during acceleration/deceleration and apply excessive strain on the motor and table during acceleration/deceleration.
However, when the acceleration/deceleration time constant in motion command is increased, the shock decreases and the feed forward term can be large. However, the error ΔR2 increases.

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Specifying parameters

(a) Enable PI control and the feed–forward function.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
				PIEN			

PIEN (#3) 1 : (to enable PI control)

1883	8X05
2005	1005

#7	#6	#5	#4	#3	#2	#1	#0
						FEED	

FEED (#1) 1 : (to enable the feed–forward function)

(b) Specify the feed–forward coefficient.

1961	8X68	Feed forward coefficient (FALPH)
2068	1068	

For Series 0–C, 15–A

$$\text{FALPH} = \alpha \times 4096 \times \frac{8192}{\text{Position feedback pulses per revolution of the motor}}$$

For Series 15–B, 16, 18, 20, 21, Power Mate

$$\text{FALPH} = \alpha \times 100 \text{ or } \alpha \times 1000$$

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

(c) Specify the velocity feed–forward coefficient.

1962	8X69	Velocity feedforward coefficient (VFFLT)
2069	1069	

For Series 0–C, 15–A

$$\text{VFFLT} = (-\ \text{PK2V}) \times \frac{\text{Load inertia + rotor inertia}}{\text{Rotor inertia}} \times \frac{0.04 \times 8000}{\text{Position feedback pulses per revolution of the motor}}$$

For Series 15–B, 16, 18, 20, 21, Power Mate

VFFLT = 50 (50 to 200)

(d) Switch the NC off, attach the servo check board, then switch the NC on again. ⇒ See Sec. 4.11.

Run a program to operate the axis for cutting feed at maximum feedrate. Under this condition, check whether the VCMD waveform observed between channels 1 and 3 on 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 acceleration/deceleration time constant, or reduce α.

⇒ If an overshoot does not occur, and the shock is small, reduce the acceleration/deceleration time constant, or increase α.

Linear acceleration/deceleration is more effective than exponential acceleration/deceleration.

Using acceleration/deceleration before interpolation can further reduce the figure error.

4.5.2
Advanced Preview Feed–forward Function

(1) Overview

The advanced preview feed–forward function is part of the advanced preview control function. It enables high–speed high–precision machining. The function creates feed–forward data according to a command which is one ITP ahead, and reduces the delay caused by smoothing. This new function can upgrade the high–speed, high–precision machining implemented under conventional feed–forward control.

The conventional feed–forward control function executes smoothing in order to eliminate the velocity error of each ITP (see Fig. 4.5.2 (a)). This smoothing, however, causes a delay in the feed–forward data.

The new advanced preview feed–forward control function uses the distribution data which is one ITP ahead and generates delay–free feed–forward data (Fig. 4.5.2 (b)). The function can provide higher controllability than the conventional feed–forward control function.

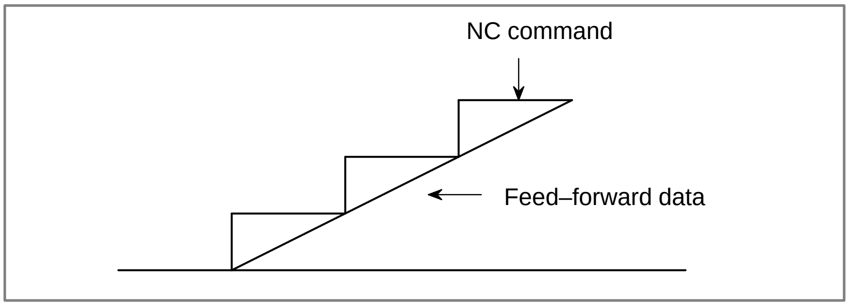


Fig. 4.5.2 (a) Conventional feed–forward control

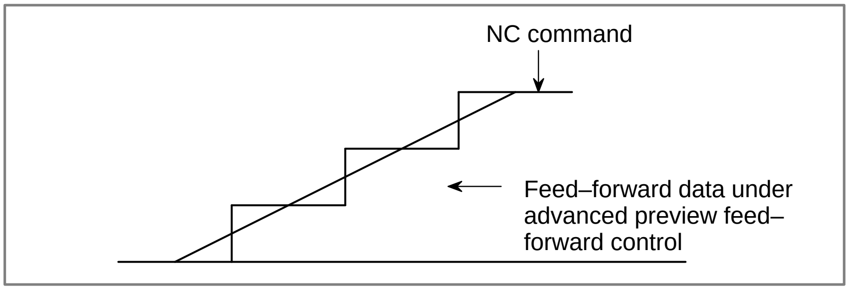


Fig. 4.5.2 (b) Advanced preview feed–forward control

(2) Series and editions of applicable servo soft

Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

(a) Set the following parameters in the same way as for conventional feed–forward control.

		#7	#6	#5	#4	#3	#2	#1	#0
1808	—					PIEN			
2003	—								

PIEN (#3) 1 : (PI control is selected.)

		#7	#6	#5	#4	#3	#2	#1	#0
1883	—							FEED	
2005	—								

FEED (#1) 1 : (The feed–forward function is enabled.)

1962	—	Velocity feed–forward coefficient (VFFLT)
2069	—	

[Standard setting] 50 (50 to 200)

(b) Set the coefficient for advanced preview feed–forward control.

1985	—	Advanced preview feed–forward coefficient (ADFF1)
2092	—	

Advanced preview feed–forward coefficient (0.01% unit)
= $\alpha \times 10000$ ($0 \leqq \alpha \leqq 1$)

[Standard setting] 9850

(Example)
When α equals 98.5%, ADFF1 is 9850.
Feed–forward control is configured as shown below:

Feed–forward control

- Deceleration algorithm and function of acceleration/deceleration before interpolation of CNC
  - Acceleration/deceleration method causing no figure errors
  - Deceleration at a point where a large impact would be expected
- Advanced preview feed–forward function of digital servo
  - Improving the tracking ability of the servo system

Because of this configuration, the function can improve the feed–forward coefficient up to about 1 without impact and also reduce figure error.

NOTE
For the Series 15–A and 15–B, set bit 2 of parameter No. 1811 to 1, in addition to making the above setting.

(c) To enable feed–forward control, specify the following G code in a program. The G code also enables advanced preview feed–forward control.

(Series 16 or 18)

G08 P1;	Enters feed–forward control mode.
G08 P0;	Exits from feed–forward control mode.

(Series 15–B)

G05.1 Q1;	Enters feed–forward control mode.
G05.1 Q0;	Exits from feed–forward control mode.

When the system exits from feed–forward control mode, a standard feed–forward coefficient is enabled.

4.5.3

RISC Feed–Forward Function (Type 2)

(1) Overview

In a feed–forward system using RISC, multiple distribution data items (two, four, or eight items) are passed from the CNC to the servo system within one ITP to shorten the interpolation cycle. This improves the high–speed high–precision machining performance.

This function improves the servo system response characteristics under feed–forward control using a distribution RISC.

(2) Series and editions of applicable servo software

Series 9080/001C and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

		#7	#6	#5	#4	#3	#2	#1	#0
1959	—			RISCFF					
2017	—								

RISCFF 0 : The conventional feed–forward response characteristics are maintained while a RISC is being used.

1 : The feed–forward response characteristics are improved when a RISC is used.

NOTE

1 This function is effective only when the software ITP (distribution data interpolation period) is 2 ms or 1 ms.

2 Use this function only when high–level command response characteristics are required.

3 When using this function, set the detection unit to 0.1 μm where possible. Use IS–C. Alternatively, in an IS–B system, multiply the CMR and flexible feed gear by ten.

4 When this function is enabled, the machine response to commands is improved. Depending on the machine’s resonant frequency, vibration may be induced. If this occurs, do not use this function. Instead, use the conventional control method.

4.5.4
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.

For Series 0–C and 15–A, the new backlash acceleration function also can be used. (⇒ Subsec.4.5.5)

For Series 15–B, 16, 18, 20, and 21, also the two–stage backlash acceleration function also can be used. (⇒ Subsec.4.5.6)

Using the servo check board makes it easy to adjust the backlash acceleration function.

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

(a) Set the backlash compensation.

1851	0535 to 0538	Backlash compensation
1851	—	

Always set a positive value. If a negative value is set, the backlash acceleration function is not enabled.

In semi–closed mode:
Set the machine backlash. (Minimum value = 1)

In full–closed mode:
Set the minimum value of 1. To prevent the backlash compensation from being reflected in positions, set the following:

		#7	#6	#5	#4	#3	#2	#1	#0
1884	8X06								FCBL
2006	—								

FCBL (#0) 1 : (Do not reflect the backlash compensation in positions.)

Generally, for a machine in full–closed mode, backlash compensation is not reflected in positions, so this bit is set.

(b) Enable the backlash acceleration function.

1808	8X03
2003	—

#7	#6	#5	#4	#3	#2	#1	#0
		BLEN					

BLEN (#5) 1 : (to enable backlash acceleration)

1860	8X48
2048	—

Backlash acceleration amount

[Typical setting] 600

1964	8X71
2071	—

Period during which backlash acceleration remains effective (in units of 2 msec)

[Typical setting] 50 to 100

(c) If a reverse cut occurs, use the backlash acceleration stop function.

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
BLST							

BLST (#7) 1 : (to enable the backlash acceleration stop function)

1975	8X82
2082	—

Timing at which the backlash acceleration is stopped

[Typical setting] 5

This completes the general setting procedure for the backlash acceleration function.

To disable the backlash acceleration function at handle feed, set the following:

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
	BLCU						

BLCU (#6) 1 : (to enable the backlash acceleration function during cutting feed only)

This function is effective when the new type backlash function and two–stage backlash function are used.

When this function is used with the two–stage backlash function, the applicable series and editions of the servo software will be as follows:

Series 9070/001K and subsequent editions
Series 9080/001K and subsequent editions

4.5.5

New Backlash Acceleration Function

(1) Overview

This function simplifies a procedure to set the parameters for backlash acceleration, thereby enabling optimum acceleration compensation with the same parameter setting under different cutting conditions (with varying friction and feedrate).

With the conventional method, the backlash acceleration remains constant. To the contrary, the new method changes the backlash acceleration exponentially, thus allowing just enough acceleration.

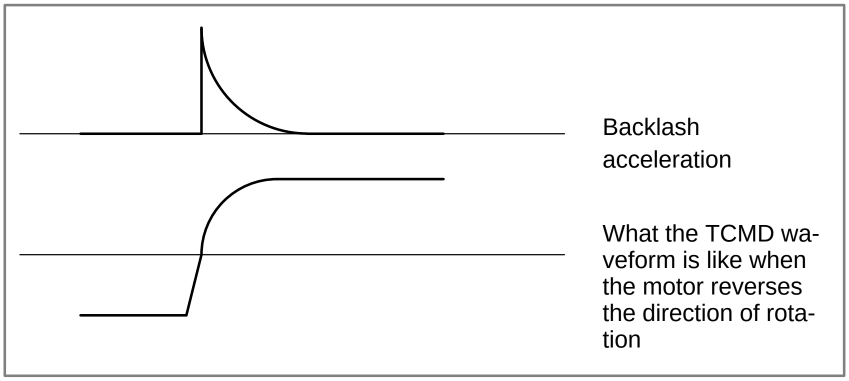


Fig.4.5.5 Backlash acceleration controlled by the new backlash acceleration function

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Specifying parameters

(a) Specify the backlash compensation value.

1851	0535 to 0538	Backlash compensation value
1851	—	

For semi–closed mode, specify the machine backlash (minimum of 1). For full–closed mode, specify 1, then specify the following parameters.

1884	8X06
2006	—

#7	#6	#5	#4	#3	#2	#1	#0
							FCBL

FCBL (#0) 1 : (Backlash compensation is not performed for the position in the full–closed mode.)

This bit is set because a machine with a closed loop generally does not reflect backlash compensation on positions.

(b) Enable the new backlash acceleration function.

1808	8X03
2003	—

#7	#6	#5	#4	#3	#2	#1	#0
		BLEN					

BLEN (#5) 1 : (to enable backlash acceleration)

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
					ADBL		

ADBL (#2) 1 : (to enable backlash acceleration of the new type)

1860	8X48	Backlash constant
2048	—	

[α pulse coder] 600 or so

1964	8X71	Time during which backlash acceleration remains effective (in 2 ms units)
2071	—	

[Typical setting] 50 (50 to 100)

If the protrusion remains, also enable the backlash acceleration stop function.

1953	8X09
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
BLST							

BLST (#7) 1 : (to enable backlash acceleration stop)

1975	8X82	Timing at which the backlash acceleration is stopped
2082	—	

[α pulse coder] 5 or so

(c) If the necessary torque varies with the direction of feed (for example, on a vertical axis), adjust the torque offset.

1980	8X87	Torque offset
2087	—	

(4) Method to measure the torque offset on the servo check board

Feed an axis in the positive and negative directions at very slow feedrate, and observe the waveform between channels 2 and 4 on the servo check board.

Specify the value:

$$830 \times (Va + Vb)$$

where Va is the voltage observed when the feeding is in the positive direction, and Vb in the negative direction (with an arithmetic sign included).

(Example) With Va = 1.4 V and Vb = –0.4 V:

Torque offset = 830 × (1.4 – 0.4) = 830

4.5.6 Two–stage Backlash Acceleration Function

(1) Overview

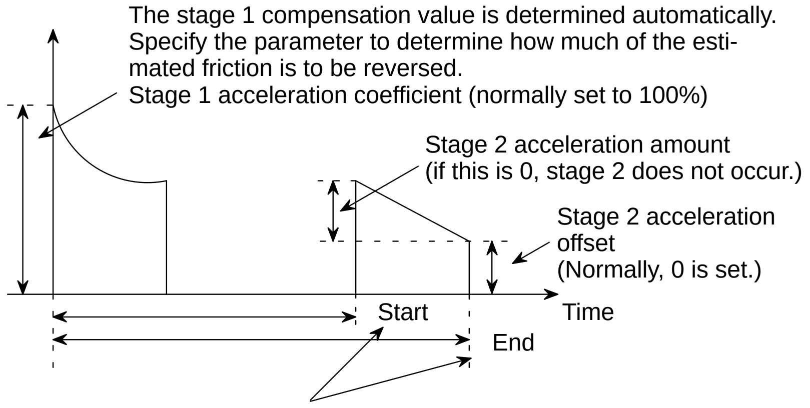
When the machine reverses the direction of feed, two types of delay are likely to occur; one type due to friction in the motor and the other due to friction in the machine.

The conventional method does not distinguish the two types of delay for compensation. The new method compensates for the two types separately, hence two–stage compensation.

Two–stage compensation
- Stage 1: The friction torque is canceled when the motor reverses.
- Stage 2: The friction torque in the machine is canceled.

Further improvement has been performed for stage 1 compensation to maintain optimum constant compensation against changing speed and load.

The two–stage backlash acceleration function performs compensation as shown below:



The stage 1 compensation value is determined automatically. Specify the parameter to determine how much of the estimated friction is to be reversed.
Stage 1 acceleration coefficient (normally set to 100%)

Stage 2 acceleration amount
(if this is 0, stage 2 does not occur.)

Stage 2 acceleration offset
(Normally, 0 is set.)

Stage 2 start and end parameters (detection unit)
The start point of stage 2 is specified as a distance relative to the start of stage 1.
The end point is determined automatically. Normally, if the setting is positive, the end point is set at a distance two times greater than the start point distance. If the setting is negative, the end point is set at a distance three times greater than the start point distance. An arbitrary end point can also be set by setting the end scale factor parameter.

Fig.4.5.6 (a) Backlash acceleration under control of the two–stage backlash acceleration function

(2) Series and editions of applicable servo software

Series 9060/001Q and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001F and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Specifying Parameters

(a) Specify the backlash compensation value.

1851	—	Backlash compensation value
1851	—	

For semi–closed mode, specify the machine backlash (minimum of 1).

For full–closed mode, specify 1.

To prevent backlash compensation from being reflected on positions, set the following parameters:

		#7	#6	#5	#4	#3	#2	#1	#0
1884	—								FCBL
2006	—								

FCBL (#0) 1 : (Backlash compensation is not performed for the position in the full–closed mode.)

This bit is set because a machine with a closed loop generally does not reflect backlash compensation on positions.

(b) Adjusting the velocity loop gain

Enable PI control, and increase the velocity loop gain (load inertia ratio) as much as possible. Changing the velocity loop gain during the later adjustment makes the adjustment complicated. At this step, therefore, increase the gain sufficiently using the 250 μs acceleration feedback function or a similar function.

		#7	#6	#5	#4	#3	#2	#1	#0
1808	—					PIEN			
2003	—								

PIEN (#3) 1 : (to enable PI control).

1875	—	Load inertia ratio
2021	—	

[Setting value] Setting value ≦ 70% of the level where the motor is about to start vibrating

1894	—	250 μsec acceleration feedback gain
2066	—	

[α pulse coder] –10 (–10 to –20)

		#7	#6	#5	#4	#3	#2	#1	#0
1959	—	PK25							
2017	—								

PK25 (#7) 1 : (to enable the high–speed velocity loop proportional processing function)

NOTE

The acceleration feedback gain and high–speed velocity loop proportional processing functions cannot be used at the same time. Only one of these functions can be used at any one time.

(c) Run the motor, and observe the VCMD signal between channels 1 and 3 on the servo check board for each axis. Make sure that no low–frequency vibration is found on the VCMD signal for low to high feedrates. See Sec. 4.11.

(d) Adjust observer parameter POA1.
To extract the friction torque as an estimated external disturbance, adjust parameter POA1 (to convert the torque to an acceleration) according to the inertia for each axis.

Enable the two–stage backlash acceleration function.

		#7	#6	#5	#4	#3	#2	#1	#0
1808	—			BLEN					
2003	—								

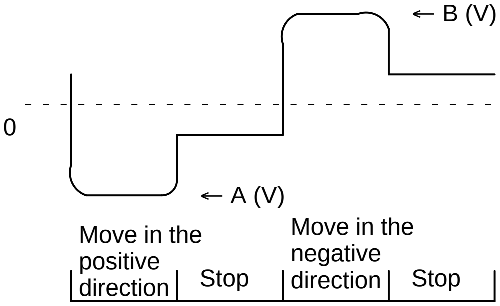
BLEN (#5) 1 : (to enable backlash acceleration)

		#7	#6	#5	#4	#3	#2	#1	#0
1957	—		BLAT	TDOU					
2015	—								

TDOU (#5) 1 : (to output an estimated disturbance torque)

BLAT (#6) 1 : (to enable two–stage backlash acceleration)

Move the machine linearly back and forth at maximum cutting feedrate, and observe the TSA and estimated external disturbance torque.
The TSA is output at channels 5 and 6 on the servo check board, and the estimated disturbance torque at channels 2 and 4.



Adjust POA1 so that the estimated disturbance torque waveform shown at the right (ideal waveform) is obtained. In other words, do not allow an overshoot or undershoot on the estimated disturbance torque during travel. (The friction torque is constant during travel at constant feedrate.) Start adjustment with an increment of 500.
If the absolute value is different between A and B for the vertical axis, adjust the torque offset.

Fig.4.5.6 (b) Adjusting POA1 for two–stage backlash acceleration

1859	—	Observer Parameter (POA1)
2047	—	

Adjust with an increment of 500.

If the absolute value is different between A and B for the vertical axis, specify the torque offset with the value of the following formula to make A and B equal. (It would be easier to adjust with low feedrate.)

1980	—	Torque offset
2087	—	

[Setting value] $-830 \times (A+B)$

Where A and B contain arithmetic signs. (Unit: V)

(e) Adjusting the stage 1 acceleration
Specify the following parameters.

		#7	#6	#5	#4	#3	#2	#1	#0
1957	—			TDOU					
2015	—								

TDOU (#5) 0 : (To output an estimated disturbance torque)

1860	—	Stage 1 backlash acceleration amount (%)
2048	—	

[Unit of data] % (Backlash acceleration amount necessary to reverse the torque that is equal to the friction torque in amount is assumed to be 100%.)

[Typical setting] 100 (Optimum values range from 50% to 150%.)

1987	—	Stage 1 acceleration amount from negative direction to positive direction (%)
2094	—	

[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. 1860 (Series 15) or No. 2048 (Series 16) specifies the stage 1 positive–to–negative backlash acceleration amount.

1975	—	Stage 2 start/end parameter (detection unit)
2082	—	

[Unit of data] Detection unit

[Typical setting] 10 (For a detection unit of 1 μm)

100(For a detection unit of 0.1 μm)

1982	—	Stage 2 end scale factor
2089	—	

[Unit of data] In units of 0.1

[Valid data range] 0 to 647 (multiplication by 0 to 64.7)

Normally, this value may be set to 0.

If parameter No. 1982 (Series 15) or No. 2089 (Series 16) is set to 0, the start of stage 2 acceleration is determined by the absolute value of the setting in No. 1975 (Series 15) or No. 2082 (Series 16). Stage 2 acceleration ends at a distance two times greater than the start point distance if the value set in No. 1975 (Series 15) or No. 2082 (Series 16) is positive; if the value is negative, stage 2 acceleration ends at a distance three times greater than the start point distance.

If No. 1982 (Series 15) or No. 2089 (Series 16) is set to a non–zero value, the end point of the stage 2 acceleration can be set to an arbitrary point.

(Example)

When No. 1975 (Series 15) or No. 2082 (Series 16) = 10, and No. 1982 (Series 15) or No. 2089 (Series 16) = 50 (meaning multiplication by 5), acceleration is performed as follows:

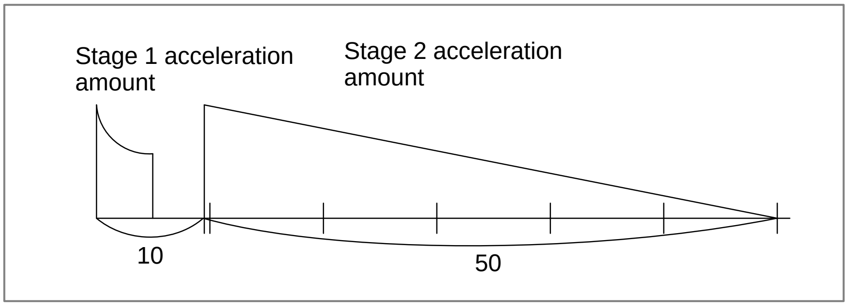


Fig. 4.5.6 (c) Stage 2 end scale factor

Run a circular cutting program for F500 to observe the VCMD waveform between channels 1 and 3. Pay attention to the VCMD waveform when the motor reverses (that is, the VCMD waveform crosses the ground level).

If a protrusion occurs, increase the backlash acceleration. Note that if the acceleration is too big, a reverse cut occurs.

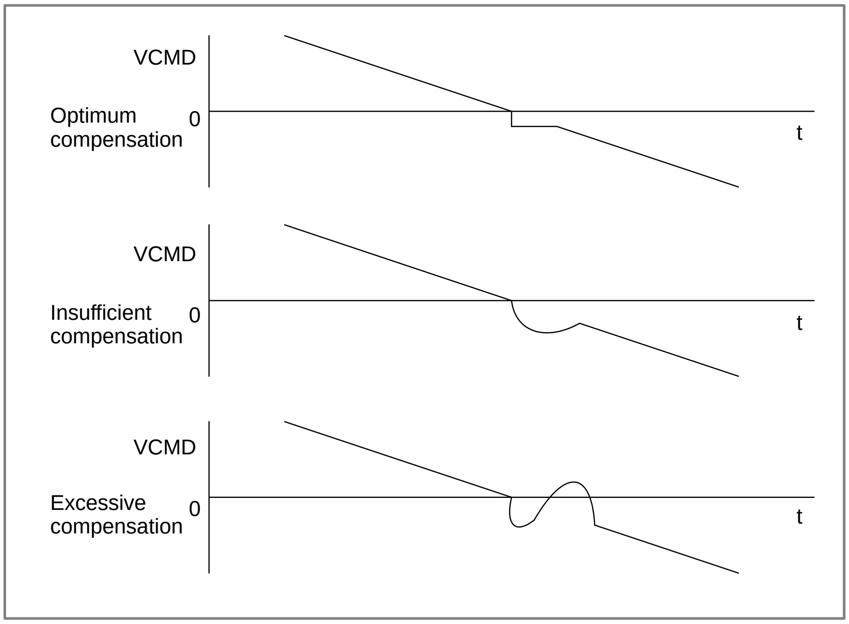


Fig.4.5.6 (d) Two–stage backlash adjustment using the VCMD waveform

Next, observe the VCMD waveform for higher feedrate using the same procedure.

If a protrusion still occurs, fine–adjust POA1 (± 100 or so).

NOTE

Note that the two–stage backlash acceleration cannot be used together with the backlash stop function.

(f) Stage 2 acceleration adjustment

The newly developed two–stage backlash acceleration function has effect even if only stage 1 is used. However, a protrusion may linger because of machine friction. In such a case stage 2 is useful.

Adjust the stage 2 acceleration so that it falls in a range where no cut occurs.

1724	—
2039	—

Stage 2 acceleration amount for two–stage backlash acceleration

[Typical setting] 100 (Too large a value could cause a cut at low feedrate.)

1790	—
2167	—

Stage 2 offset for two–stage backlash acceleration

Normally, set 0.

(g) Stage 1 and stage 2 acceleration override adjustment

Stage 1 and stage 2 acceleration amounts can be overridden according to the circular acceleration.

When using the stage 1 acceleration override function, set the following. (Normally, this setting is not needed.)

1760	—	Stage 1 acceleration override
2137	—	

[Valid data range] 0 to 32767

$$\text{Circular acceleration} = \frac{\{\frac{2}{R}(\frac{F}{60} \times 0.008)^2\}}{\text{Detection unit}}$$

R: Arc radius (mm), F: Speed of circular movement (mm/min)

$$(\text{Stage 1 acceleration}) \times \frac{1024 + (\text{Circular acceleration}) \times (\text{Stage 1 override setting})}{1024}$$

When using the stage 2 acceleration override function, set the following.

		#7	#6	#5	#4	#3	#2	#1	#0
1960	—						OVR8		
2018	—								

OVR8 (#2) 1 : (The format of the stage 2 acceleration override is determined.)

1725	—	Stage 2 acceleration override
2114	—	

[Valid data range] 0 to 32767

$$\text{Circular acceleration} = \frac{\{\frac{2}{R}(\frac{F}{60} \times 0.008)^2\}}{\text{Detection unit}}$$

R: Arc radius (mm), F: Speed of circular movement (mm/min)

$$(\text{Stage 2 acceleration}) \times \frac{256 + (\text{Circular acceleration}) \times (\text{Stage 2 override setting})}{256}$$

NOTE

Stage 2 override is effective for stage 2 offset.

(4) Neglecting backlash acceleration during feeding by the handle

1953	—
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
	BLCU						

BLCU (#6) 1 : (to enable backlash acceleration only during cutting feed)

When the two–stage backlash function is used, this setting is effective with the following servo software series and editions:

Series 9070/001K and subsequent editions
Series 9080/001K and subsequent editions

4.5.7
Static Friction Compensation Function

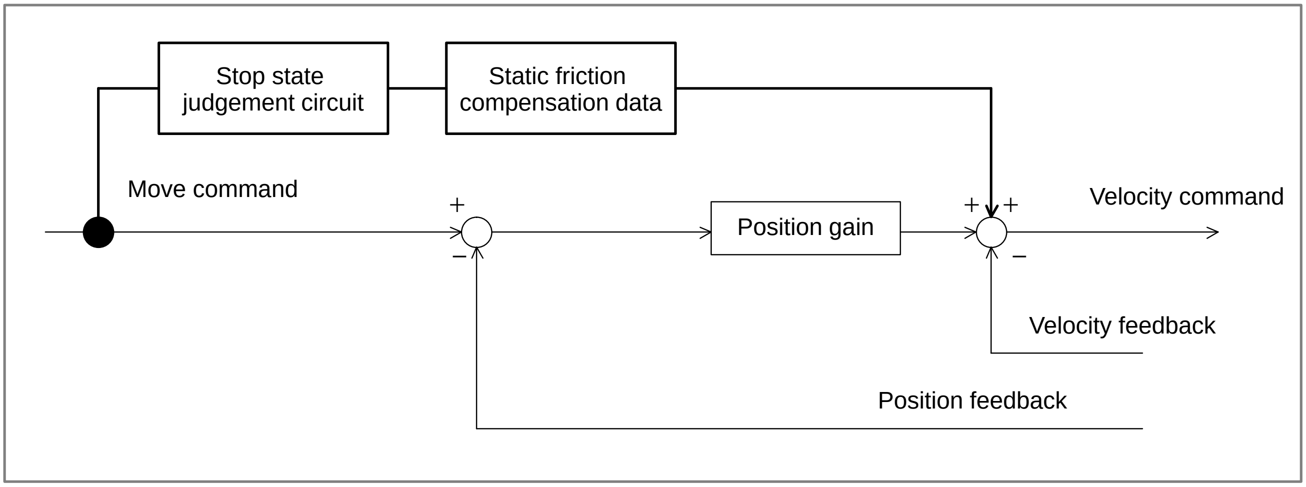
(1) Overview

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 Subsec. 4.5.4) 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

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001A and subsequent editions (Series 0–C, 15–A)
Series 9060/001C and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9064/001B and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9070/001A and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Block diagram



(4) Parameter setting

(a) Enable this function.

1808	8X03
2003	1003

#7	#6	#5	#4	#3	#2	#1	#0
		BLEN					

BLEN (#5) 1 : (The backlash acceleration function is enabled.)

1883	8X05
2005	1005

#7	#6	#5	#4	#3	#2	#1	#0
SFCM							

SFCM (#7) 1 : (The static friction compensation function is enabled.)

(b) Set adjustment parameters.

1964	8X71	Compensation count
2071	1071	

[Valid data range] 0 to 32767

[Standard setting] 10

1965	8X72	Static friction compensation
2072	1072	

[Valid data range] 0 to 32767

[Standard setting] 100

1966	8X73	Stop state judgement parameter
2073	1073	

Stop judgement time = (Value set in the parameter) × 8 ms

When the machine starts moving after it has been stopped for an interval corresponding to this parameter or longer, the compensation function is enabled.

When the compensation becomes excessive, use this function to release the static friction compensation.

1953	8X09
2009	1009

#7	#6	#5	#4	#3	#2	#1	#0
BLST							

BLST (#7) 1 : (The function used to release static friction compensation is enabled.)

1990	8X97	Parameter for stopping static friction compensation
2097	1097	

[Valid data range] 0 to 32767

[Standard setting] 5

4.6 DUMMY SERIAL FEEDBACK FUNCTION

(1) Overview

This function is used to enable the ignoring of all servo alarms for an axis of motion which is not equipped with a servo–mechanism.

(2) Parameter setting

The servo software supporting the α servo–mechanism provides the following dummy serial feedback function for an axis of motion which is not fitted with a servo–mechanism. When this function is enabled, any servo alarms related to a servo amplifier and pulse coder are ignored.

		#7	#6	#5	#4	#3	#2	#1	#0
1953	8X09								SERD
2009	1009								

SERD (#0) The dummy serial feedback function is:

0 : Disabled.
1 : Enabled.

If this function is enabled with software of the following series and edition or earlier, the V–READY signal remains on.

Series 9041/edition 001A	(Series 0–C, 15–A)
Series 9046/edition 001C	(Series 0–C, 15–A)
Series 9060/edition 001P	(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9070/edition 001D	(Series 15–B, 16–B, 18–B)

As a result, the following servo alarm is issued:

404	VRDY ON	(Series 0–C, 16, 18, 20, 21, Power Mate)
SV014	IMPROPER V–READY ON	(Series 15)

If this occurs, set the following. Subsequently, the servo alarm will be ignored.

Series 0–C

	b7	b6	b5	b4	b3	b2	b1	b0
0010						OFFVY		

OFFVY (#2) If VRDY is turned on before PRDY is output,

0 : A servo alarm occurs.

Set this value.⇒ 1 : A servo alarm does not occur.

Other than Series 0–C

	b7	b6	b5	b4	b3	b2	b1	b0
1800							CVR	

CVR (#1) If VRDY is turned on before PRDY is output,

Set this value.⇒ 1 : A servo alarm does not occur.

4.7
STOP DISTANCE REDUCTION FUNCTION

(1) Overview

This function reduces the distance required for the motor to stop by enabling active deceleration by the servo software during the interval between an emergency stop or overtravel occurring and deceleration by a dynamic brake starting.

(2) Series and editions of applicable servo software

Series 9041/001A and subsequent editions (Series 0–C, 15–A)
Series 9046/001B and subsequent editions (Series 0–C, 15–A)
Series 9060/001L and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9066/001A and subsequent editions (Series 20, 21, Power Mate)
Series 9070/001C and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

Some series and editions of the NC software do not support this function.

Series 15–B, 16, 18, 20, Power Mate

		#7	#6	#5	#4	#3	#2	#1	#0
1959	—								DBST
2017	—								

DBST (#0) 1 : (The stop distance reduction function is used.)

Series 0–C, 15–A

		#7	#6	#5	#4	#3	#2	#1	#0
1884	8X06							DBST	
—	—								

DBST (#1) 1 : (The stop distance reduction function is used.)

Brake control function

		#7	#6	#5	#4	#3	#2	#1	#0
1883	8X05		BRKC						
2005	—								

BRKC (#6) 1 : (The brake control function is used.) ⇒ (See Sec. 4.8.)

1976	8X83	Brake control timer
2083	—	

[Increment system] : msec

[Setting value] : 50

To use the stop distance reduction function, set the brake control function for all axes.

(4) Timing diagram

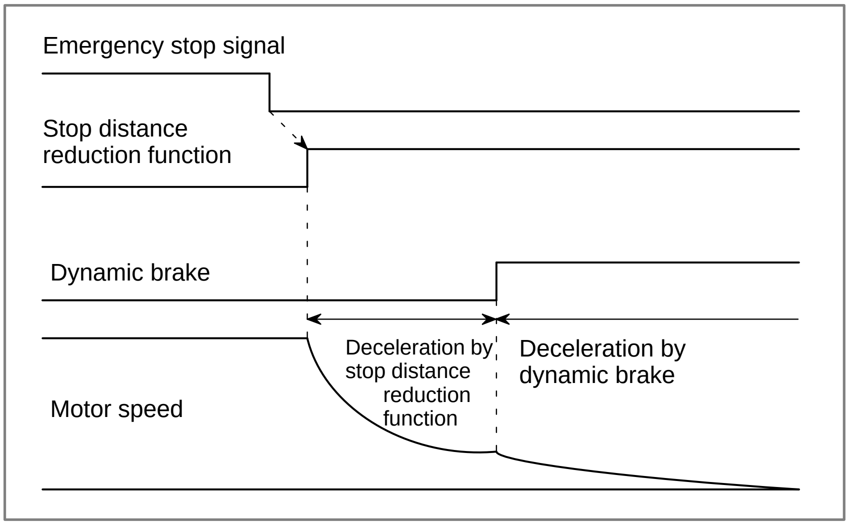


Fig. 4.7 (a) Timing diagram of stop distance reduction function

(5) Connecting an amplifier

(a) α series amplifier

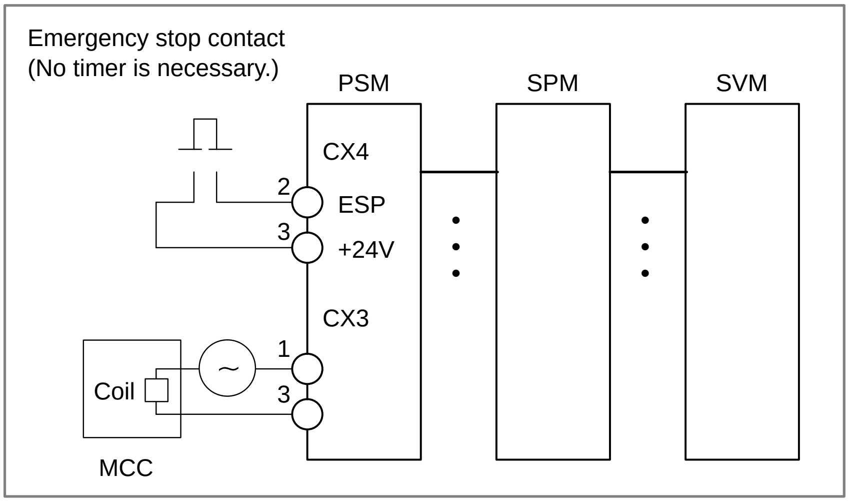


Fig. 4.7 (b) α series amplifier

(b) C–series amplifier

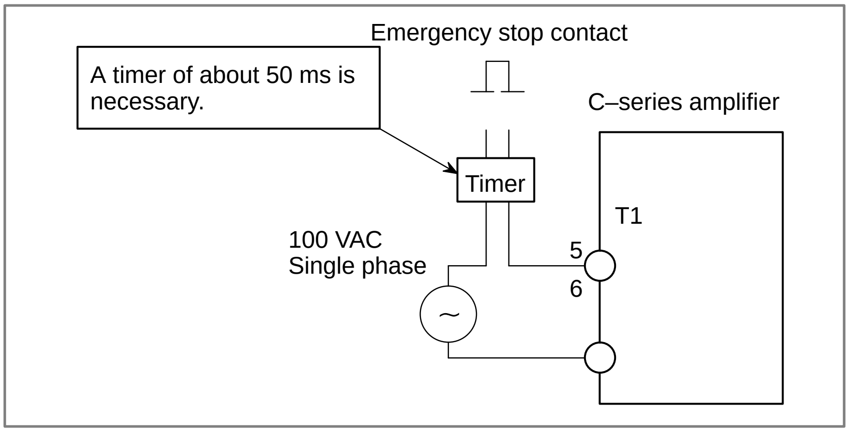


Fig. 4.7 (c) C–series amplifier

4.8 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

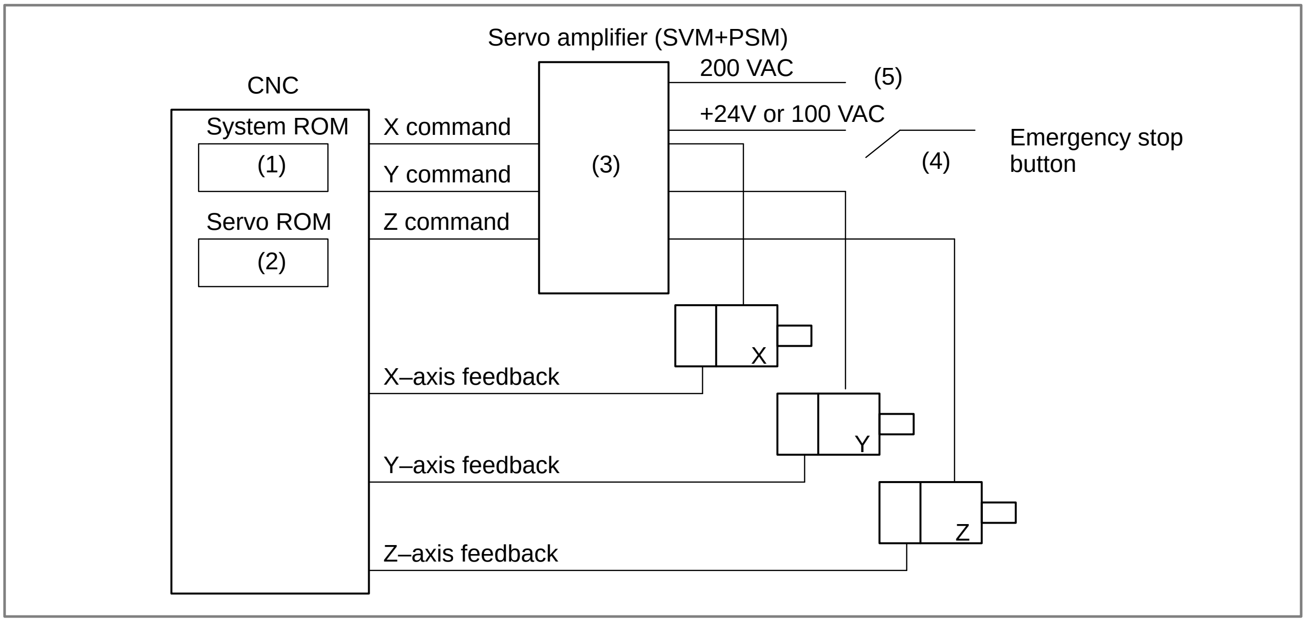


Fig. 4.8 (a) Example of configuration

The numbers of the following descriptions correspond to those in the figure:

(a) Applicable system soft

Any system soft can be used.

(b) Applicable servo soft

Any servo soft can be used.

(c) Servo amplifier

Use a single–axis servo amplifier(NOTE) (SVM1 or single–axis SVU, SVUC, or C–series amplifier for an axis) to which the brake control function is applied. For an axis to which the brake control function is not applied, any servo amplifier can be used.

NOTE

When brake control is applied for a two–, or three–axis amplifier, set the brake control parameters for all the axes to be controlled. If an alarm is generated for any of the axes connected to the two– or three–axis amplifier, brake control does not operate effectively.

(d) Emergency stop button

(α servo system)

If the +24 V supply to PSM is cut, the brake control function cannot operate. To maintain the +24 V supply longer than the brake control function is applied, connect a timer to the emergency stop button and the +24 V contact signal.

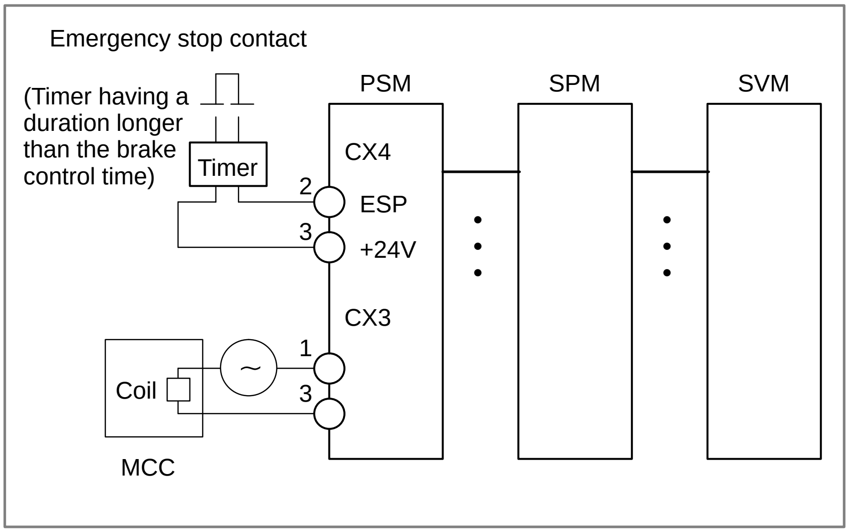


Fig. 4.8 (b) α series amplifier

(C–series amplifier)

If the 100 VAC supply to the servo amplifier is cut, the brake control function cannot operate. To maintain the 100–VAC supply longer than the brake control function is applied, connect a timer to the emergency stop button and the 100–VAC contact signal.

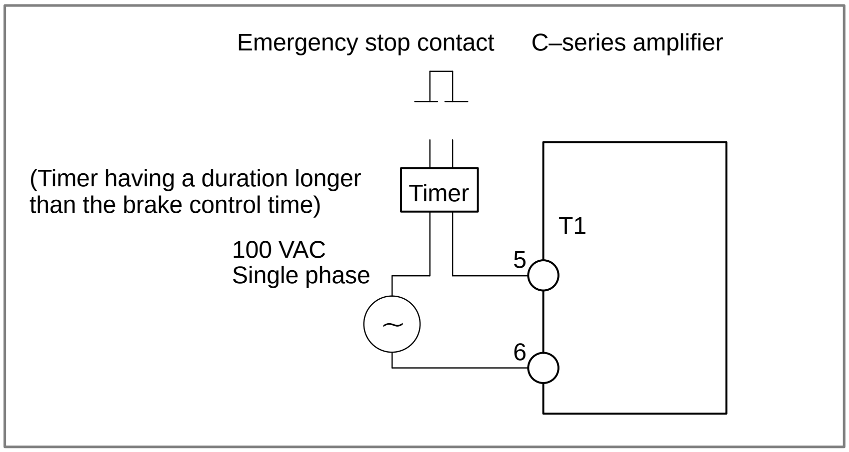


Fig. 4.8 (c) C–series amplifier

(e) 200 VAC

If the 200 VAC supply to the servo amplifier is cut, the brake control function cannot operate. Generally, the servo amplifier's 200–VAC supply is cut when the NC is turned off. The brake control function cannot be enabled.

(3) Parameter setting

(a) Brake control function enable/disable bit

		#7	#6	#5	#4	#3	#2	#1	#0
1883	8X05		BRKC						
2005	—								

BRKC (#6) 1 : (The brake control function is enabled.)

(b) Activation delay

1976	8X83	Brake control timer
2083	—	

[Increment system] msec

[Valid data range] 0 to 16000

(Example)

To set an activation delay of 200 ms, set 200 in the brake control timer parameter. Connect a timer of at least 200 ms to the emergency stop contact.

(4) Detailed operation

Suppose that there is a machine (with the FANUC CNC) having horizontal and vertical axes of motion. When a servo alarm(*) occurs on the horizontal axis but no error occurs on the vertical axis, the MCCs of the amplifiers for all axes are turned off. When the emergency stop button is pressed, the MCCs of the amplifiers for all axes are turned off.

Standard machines have a mechanical brake that prevents the tool from dropping vertically in such cases. The mechanical brake may actually function according to the timing shown in Fig. 4.8 (d). If this occurs, the tool will drop vertically, causing the tool or workpiece to be damaged.

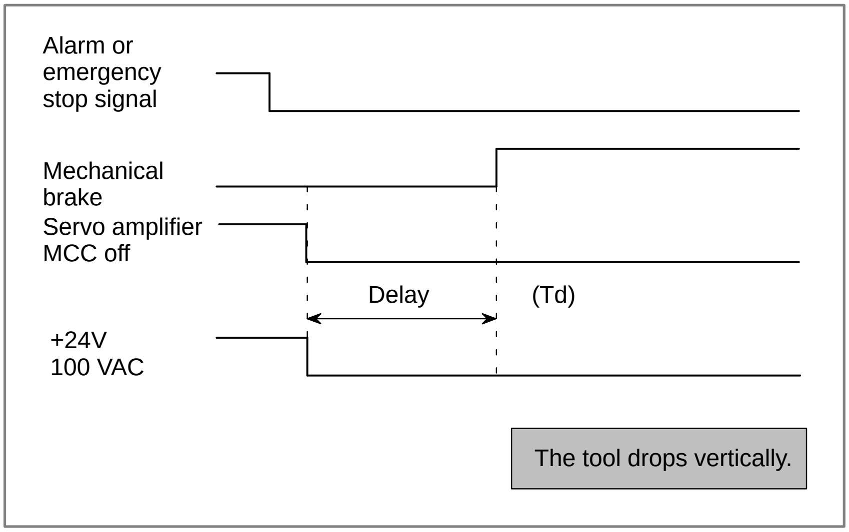


Fig. 4.8 (d)

This function changes the timing to force MCC off, using a software timer, thus preventing the tool from dropping. Fig. 4.8 (e) shows the timing diagram.

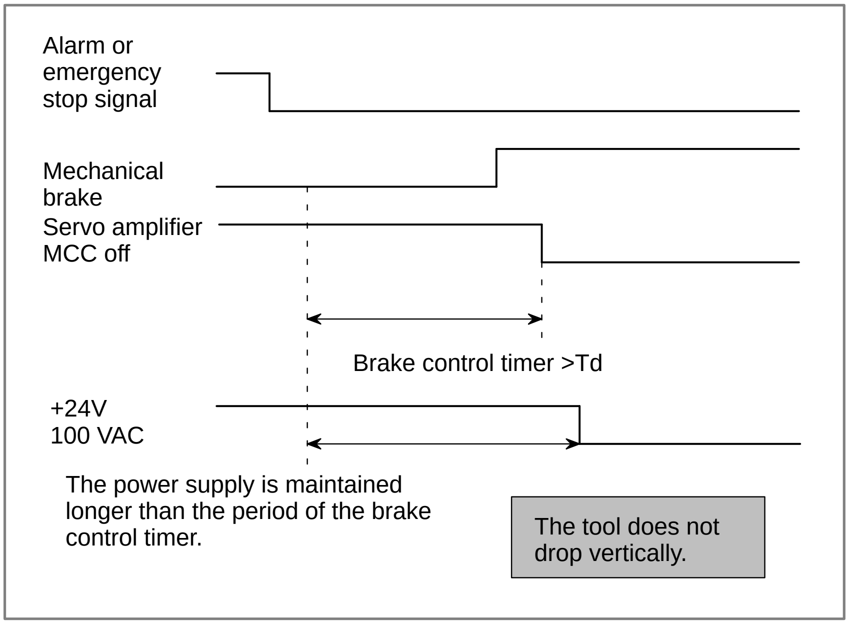


Fig. 4.8 (e)

> **NOTE**
> (*) The servo alarm described above may be a servo alarm detected by the software (OVC alarm, motor overheat alarm, software disconnection alarm, etc.) or an alarm which causes an LED to light on the servo amplifier.
> The alarm drops the MCC and may cause the brake to drop.

Differences between the stop distance reduction function and brake control function

	Purpose	**Activation delay**	**Timer for emergency stop signal**
Stop distance reduction function	Decelerates as much as possible before DB resistance is applied to make a DB stop when an emergency stop occurs during rotation.	About 50 ms	α amplifier: Unnecessary C or S amplifier: About 50 ms
Brake control function	Keeps the motor activated during the interval between an emergency stop occurring for a vertical axis and the brake operating, thus preventing the tool from dropping along the vertical axis.	Time until the brake starts operating (approximately 100 msec)	Necessary for an α, C or S amplifier. Set a timer which operates for longer than the time specified in the parameter of the brake control timer.

4.9 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 switch function and the low–speed integration function are effective. In case 2, the fine acceleration/deceleration (FAD) function is effective. This section explains these functions.

4.9.1
Position Gain Switch 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.

(2) Parameter setting

- Series 9046 (When this function is used with the Series 15–A and 0–C, specify the parameter for the Series 9046.)

		#7	#6	#5	#4	#3	#2	#1	#0
1954 (Series 15–A)	8X10			PGTW					

- Other than Series 9046

		#7	#6	#5	#4	#3	#2	#1	#0
1957 (Series 15–B)	—								PGTW
2015	1015								

PGTW 1 : (The position gain switch function is used.)

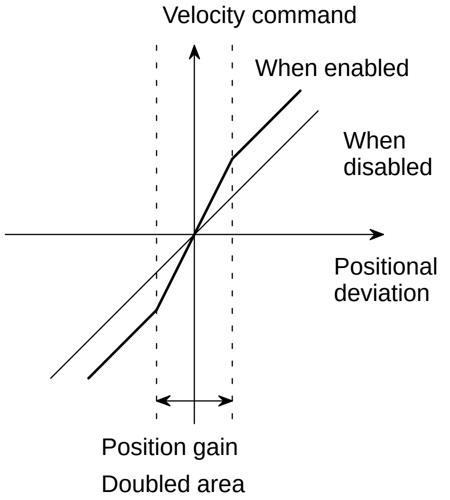
> **NOTE**
> Exercise care when setting this bit. The setting location for the Series 15–A and 0–C differs from that for other systems.

1974 (Series 15–A) 1713 (Series 15–B)	8X81	Limit speed for enabling position gain switching (in units of 0.01 rpm)
2028	1028	

The position gain is doubled with a speed lower than or equal to the speed specified above.

[Typical setting] 5000 (0 to 32767)

The relationship between the positional deviation and velocity command is shown in Fig. 4.9.1 (a). Adjust them with the position gain.



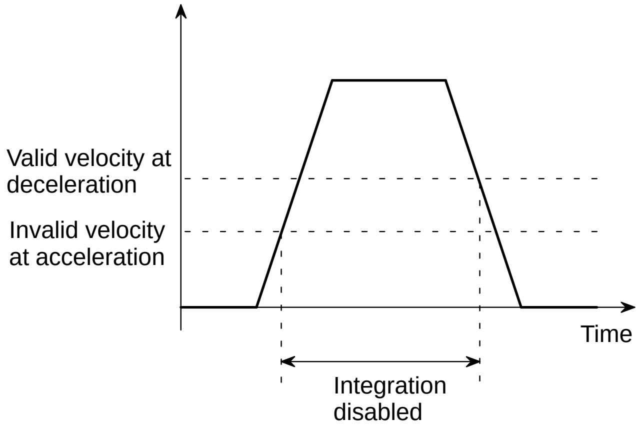


Fig. 4.9.1 (a) Position gain switching

Fig. 4.9.1 (b) Integration invalid range at low–speed integration

4.9.2
Low–speed Integration 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 integration 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) Parameter setting

- Series 9046 (When this function is used with Series 15–A and 0–C, specify the parameter for the Series 9046.)

		#7	#6	#5	#4	#3	#2	#1	#0
1954 (Series 15–A)	8X10		SSG1						

- Other than Series 9046

1957 (Series 15–B)	—							SSG1	
2015	1015								

SSG1 1 : (The low–speed integration function is used.)

1972 (Series 15–A) 1714 (Series 15–B)	8X79	Limit speed for disabling low–speed integration at acceleration (in units of 0.01 rpm)
2029	1029	

The integral gain is invalidated during acceleration at a speed higher than or equal to the specified speed.

[Typical setting] 1000 (0 to 32767)

1973 (Series 15–A) 1715 (Series 15–B)	8X80	Limit speed for enabling low–speed integration at deceleration (in units of 0.01 rpm)
2030	1030	

The integral gain is validated during deceleration at a speed lower than or equal to the specified speed.

[Typical setting] 1500 (0 to 32767)

The speed for enabling and disabling the velocity loop integration term is set separately for acceleration and deceleration. Then, the low–speed integration function operates as shown in Fig. 4.9.1 (b) in Subsec. 4.9.1.

4.9.3
Fine Acceleration/ Deceleration (FAD) Function

(1) Overview

The fine acceleration/deceleration function enables smooth acceleration/deceleration. This is done by using servo software to perform acceleration/deceleration processing, which previously has been performed by the CNC. With this function, the mechanical stress and strain resulting from acceleration/deceleration can be reduced.

(2) Features

- Acceleration/deceleration is controlled by servo software at short intervals, allowing smooth acceleration/deceleration.
- Smooth acceleration/deceleration 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 acceleration/deceleration command types are supported: bell–shaped and linear acceleration/deceleration types.
- An application of the fine acceleration/deceleration 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 supported servo software

Series 9080/001E to 001I:
The fine acceleration/deceleration function (bell–shaped only) is supported.

Series 9081/001C and subsequent editions:
The fine acceleration/deceleration function (bell–shaped only) is supported.

Series 9066/001D and subsequent editions:
The fine acceleration/deceleration function (bell–shaped only) is supported.

Series 9080/001J and subsequent editions:
The fine acceleration/deceleration function, used separately for cutting and rapid traverse, is supported.

Series 9080/001K and subsequent editions:
The linear fine acceleration/deceleration function is also supported.

NOTE

With Series 9066, the fine acceleration/deceleration function, used separately for cutting and rapid traverse, and the linear fine acceleration/deceleration function cannot be used. (Future support of these functions is not scheduled.)

(4) Basic parameter setting

1951	—
2007	—

#7	#6	#5	#4	#3	#2	#1	#0
	FAD						

FAD 1 : Enables the fine acceleration/deceleration function.

> **NOTE**
> To enable this bit setting, the power must be turned off then back on.

1749	—
2209	—

#7	#6	#5	#4	#3	#2	#1	#0
					FADL		

FADL 0 : FAD bell–shaped
1 : FAD linear type

> **NOTE**
> To enable this bit setting, the power must be turned off then back on.

1702	—	Fine acceleration/deceleration time constant (ms)
2109	—	

[Valid data range] 8 to 64 (Standard setting: 40)

A value exceeding the valid data range is clamped to the upper or lower limit of the range.

When the fine acceleration/deceleration 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	—	Position feed–forward coefficient (in units of 0.01%)
2092	—	

[Valid data range] 100 to 10000

> **NOTE**
> 1 Feed–forward control is enabled by setting bit 1 of No. 1883 (Series 15) or No. 2005 (Series 16) to 1.
> 2 The velocity feed–forward coefficient is set in parameter No. 1962 (Series 15) or No. 2069 (Series 16) which is the same parameter as that used for normal operation.
> 3 Generally, the fine acceleration/deceleration function is enabled in cutting mode only.
> 4 If No. 1800 #3 = 1, the FAD function is enabled both for cutting and rapid traverse mode.

Reference:

Using the bell–shaped type and linear type effectively

The bell–shaped time constant and linear time constant have the following features:

Bell–shaped:

Stress and strain caused by acceleration/deceleration can be reduced more effectively than with the linear type.

Linear type:

In rapid traverse, this time constant is used with the CNC rapid traverse linear time constant. When feed–forward is applied to perform high–speed positioning, the linear type requires a shorter operation time and a smaller torque than the bell–shaped type if the acceleration/deceleration period is the same.

Therefore, use the bell–shaped type and linear type as follows:

(a) To reduce the time required for acceleration/deceleration as much as possible, by making full use of the motor acceleration capability when feed–forward is applied to rapid traverse: Use the linear type.

(b) To reduce stress and strain when the rapid traverse acceleration capability need not be fully used: Use the bell–shaped type.

(5) Parameter setting for the fine acceleration/deceleration function, used separately for cutting and rapid traverse

As mentioned above, set the fine acceleration/deceleration function bit and the bit for selecting the bell–shaped or linear type.

Then, set the following:

—	—
1800	—

#7	#6	#5	#4	#3	#2	#1	#0
				FFR			

FFR 1 : Enables feed–forward in rapid traverse also.

—	—
2202	—

#7	#6	#5	#4	#3	#2	#1	#0
							FAG0

FAG0 1 : Enables the fine acceleration/deceleration function, used separately for cutting and rapid traverse.

> **NOTE**
> To enable this bit setting, the power must be turned off then back on.

In cutting mode, the following parameters are used:

—	—	
2143	—	Fine acceleration/deceleration 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.

—	—	Position feed–forward coefficient for cutting (in units of 0.01%)
2144	—	

—	—	Velocity feed–forward coefficient for cutting (%)
2145	—	

In rapid traverse mode, the following parameters are used:

—	—	Fine acceleration/deceleration time constant (ms)
2109	—	

[Valid data range] 8 to 64
A value that falls outside this range, if specified, is clamped to the upper or lower limit.

—	—	Position feed–forward coefficient for rapid traverse (in units of 0.01%)
2092	—	

—	—	Velocity feed forward coefficient for rapid traverse (%)
2069	—	

CAUTION

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.

NOTE

1 When using the fine acceleration/deceleration function, used separately for cutting and rapid traverse, the system software supporting this function must also be used. The following lists the support software as of September 1996:
Series 16–MC B0B1/E or later
Series 16–TC B1B1/C or later
Series 18–MC BDB1/C or later
Series 18–TC BEB1/C or later
NCs other than the above do not support the function as of September 1996.

2 Chopping axes cannot be switched between cutting mode and rapid traverse mode. Therefore, even when the bit for FAD, used separately for cutting and rapid traverse, is set for a chopping axis, the parameters for rapid traverse are always used.

3 In the same way as for the chopping axes, PMC–controlled axes cannot be switched between cutting and rapid traverse modes.

---

(6) Other specifications to note regarding the fine acceleration/deceleration function

- Advanced preview control and fine acceleration/deceleration can be used together. (The time constants before and after advanced preview interpolation, and the fine acceleration/deceleration time constant are effective.)
- If FAD is set, then the G05 P10000 command is issued with HPCC, FAD is disabled.
- When the G05 P10000 command is issued with Series 9066. the FAD function must be disabled.
- Using the FAD function increases the positional deviation as follows:

$$\text{Deviation increase (pulses)} = \frac{\text{Feedrate (mm/min)}}{60 \times 1000 \times \text{Detection unit (mm)}} \times \left(\frac{\text{FAD time constant (ms)}}{2} + 1 \right)$$

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 positional deviation is normally expressed as follows:

$$\text{Normal deviation (pulses)} = \frac{\text{Feedrate (mm/min)}}{60 \times \text{Position gain (1/s)} \times \text{Detection unit (mm)}}$$

$$= \frac{1800}{60 \times 30 \times 0.001} = 1000 \text{ (pulses)}$$

When the FAD function is used with the time constant set to 64 ms, the deviation increases as follows:

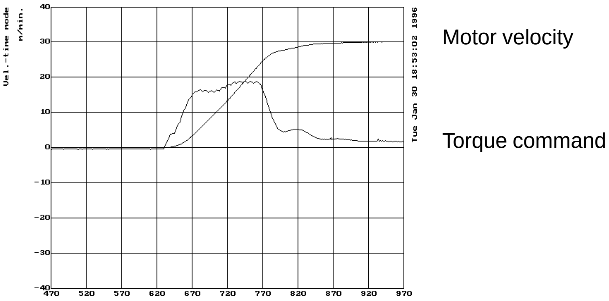
$$\text{Deviation increase (pulses)} = \frac{1800}{60 \times 1000 \times 0.001} \times \left(\frac{64}{2} + 1 \right) = 990 \text{ (pulses)}$$

When FAD is used, the entire deviation is then obtained as follows:

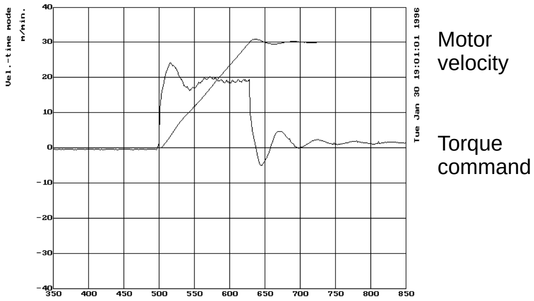
Deviation when FAD is used (pulses) = 1000 + 990 = 1990 (pulses)

When the FAD function and feed–forward function are used together, any increase in the positional deviation is not large. When the FAD function is used alone, however, a higher error overestimation level must be set, considering the increase in the deviation.

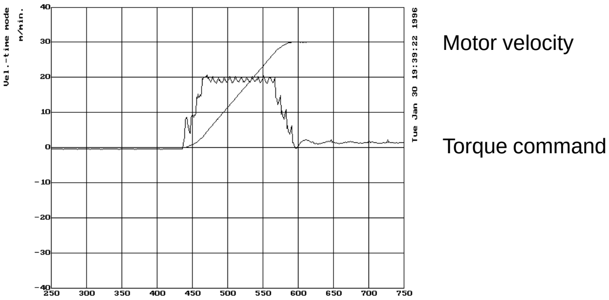
(7) Examples of applying the fine acceleration/deceleration function



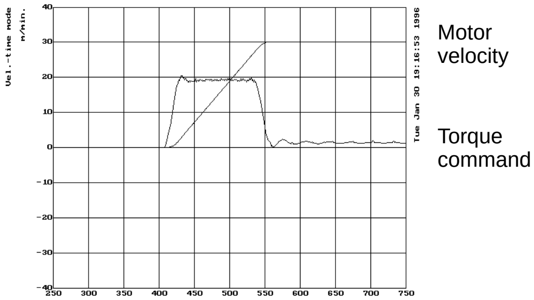
Conventional control in which the feed–forward function is not used



When the feed–forward function is used



When the feed–forward and rapid traverse bell–shaped acceleration/deceleration (acceleration/deceleration by system software) functions are used



When the feed–forward and fine acceleration/deceleration functions are used

4.10 ABNORMAL LOAD 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 detects the load torque applied to the motor and sends the data, as an estimated load torque, via CNC to PMC. When the estimated load torque reaches a predetermined level, the function outputs an alarm. To minimize damage, the function immediately stops or reverses the motor, as required.
Optional parameters are necessary to enable the use of this function.

(2) Series and editions of applicable servo software

Series 9060/001I and subsequent editions
(Series 15–B, 16–A, 18–A, 20, 21, Power Mate)
Series 9070/001B and subsequent editions (Series 15–B, 16–B, 18–B)
Series 9064/001E and subsequent editions (Power Mate–E)
Series 9065/001A and subsequent editions (Power Mate–E)
Series 9066/001G and subsequent editions (Series 20, 21, Power Mate)
Series 9080/001G and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9065, 9066, 9080, and 9081 are series supporting HRV control.

(3) Parameter setting

The NC software of some series and editions may not support this function.

(a) Connect a servo check board and prepare channels 2, 5 (L–axis), 4, and 6 (M–axis) for measurement with an oscilloscope. ⇒ See Sec. 4.11. (Measurement ranges are 100 mV to 1 V per division and 100 ms to 1 s per division.)

(b) Turn the NC power on.

(c) Enable the abnormal load detection function.

		#7	#6	#5	#4	#3	#2	#1	#0
1957	—			TDOU					
2015	1015								

TDOU (#5) 1 : (The estimated load is output to the diagnostic board.)

		#7	#6	#5	#4	#3	#2	#1	#0
1958	—								ABNT
2016	1016								

ABNT (#0) 1 : (The abnormal load detection function is used.)
The estimated load torque applied to the motor is output to channel 2 (L–axis) and channel 4 (M–axis) of the diagnostic board. Make the following adjustment, while observing the display on the oscilloscope.

When a motor with a large back electromotive force (for example, the α12/2000) is being used, the saturation of a voltage command may prevent the load torque from being estimated correctly at a point near the end of rapid traverse acceleration.

When servo software supporting HRV control (Series 9080, 9081, 9066, and 9065) is used, this problem can be avoided by setting the following parameter. Set the parameter.

1740	—
2200	1200

#7	#6	#5	#4	#3	#2	#1	#0
					IQOB		

IQOB 1 : (The influence of voltage saturation is eliminated in abnormal load detection.)

When Series 9066 is being used, the following parameter has the same meaning as the above parameter. Set one of these parameters.

—	—
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
						IQOB	

NOTE

“Series and editions of applicable servo software” in item (2) includes servo software that does not support HRV control, such as the Series 9070. Because of the voltage saturation problem mentioned above, however, the abnormal load detection function sometimes cannot be used with these servo software series.

The abnormal load detection function should, therefore, be used with software supporting HRV control, by setting IQOB to 1.

(d) Adjust the estimated load.

Change the following parameters.

1862	—	Observer gain
2050	1050	

[Standard setting] Change the default from 956 to 3559.

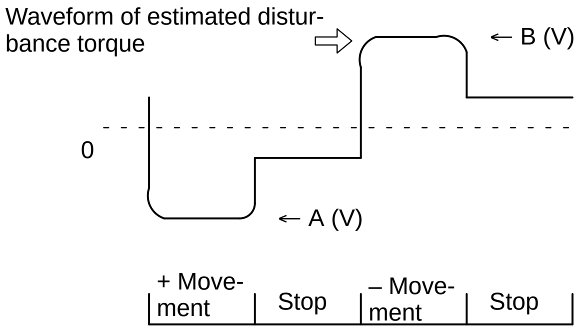
1863	—	Observer gain
2051	1051	

[Standard setting] Change the default from 510 to 3329.

NOTE

When using this function with the observer (bit 2 of parameter No. 1808, 2003, and 1003 are 1), do not change the defaults indicated above.

Repeat a linear movement with the servo motor at a speed of 1000 rpm and observe TSA and the estimated disturbance torque. TSA is output to channels 5 and 6 on the servo check board (TSA conversion: 1.3 V/1000 rpm). The estimated disturbance torque is output to channels 2 and 4 on the servo check board.



Adjust POA1 so that the ideal waveform of the estimated disturbance torque is observed as shown on the left. That is, adjust POA1 so that there will be no overshoot or undershoot in the estimated disturbance torque during the movement.

If the movement is made on a vertical axis and if the absolute values of A and B are different, set a torque offset.

Fig. 4.10 Adjusting the Disturbance Load Torque

1859	—	Observer parameter (POA1)
2047	1047	

1980	—	Torque offset
2087	1087	

[Setting value] –830 × (A+B) A, B: Sign included (Unit: V)

Compensation is made for a velocity–dependent dynamic friction component included in the disturbance load data. Observe the estimated load torque during steady rotation at 1000 rpm. (An average read function, if provided by the oscilloscope, is helpful in this case.)

Set the absolute value of the estimated load torque at 1000 rpm, obtained from the oscilloscope in units of 10 mV, in the following parameters.

The estimated load torque becomes a positive or negative value, relative to GRD. If the maximum positive value differs from the maximum negative value, use the average of them.

1727	—	Dynamic friction compensation
2116	1116	

[Increment system] 10 mV

[Valid data range] 0 to 32767

(e) Set an alarm level for detecting an abnormal load.

Observe the estimated load torque (channels 2 and 4) during multiple operations (for example, machining sample program execution, all–axis simultaneous rapid traverse), and measure the maximum value, using an oscilloscope.

Set an alarm level.

Calculate the alarm level by using the following expression:

$$\text{Alarm level} > \frac{\text{Maximum value of estimated load torque (channel 2, 4) (V)}}{4.4} \times 7282$$

1997	—	Alarm level at which an abnormal load is detected
2104	1104	

[Valid data range] 0 to 7282

Set the value obtained from the above expression, plus a value of between 500 and 1000. When zero is set, no abnormal load alarm is detected.

NOTE

When setting the alarm level, add some margin to it.

(f) Set an amount of retraction when an abnormal load is detected.

1996	—	Amount of retraction
2103	1103	

[Increment system] Detection unit

[Valid data range] 3 to 5 mm

NOTE

If the movement speed is lower than that indicated below, the motor is not retracted but is instead stopped at the position where an abnormal load is detected.

Suppose that the amount of retraction specified in the parameter is A.

When the movement speed is lower than or equal to

A/8 × (detection unit) × 1000 [mm/min]

⇒ The movement is stopped at that position.

When the speed is higher than

A/8 × (detection unit) × 1000 [mm/min]

⇒ The motor is retracted and stopped.

(g) Run the program again.

If the operation of the abnormal load detection function is incorrect, increase the alarm level.

(h) Disable the output of the estimated load torque to the check board. This completes the adjustment.

		#7	#6	#5	#4	#3	#2	#1	#0
1957	—			TDOU					
2015	1015								

TDOU (#5) 0 : (Output of the estimated load to the check board is disabled.)

4.10.1

Abnormal Load Detection Performed Separately for Cutting and Rapid Traverse

(1) Overview

An improvement has been made so that the alarm threshold for abnormal load detection can be set separately for rapid traverse and cutting.

(2) Series and editions of applicable servo software

Series 9066/001H and subsequent editions (Series 20, 21, Power Mate)
Series 9080/001J and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

A threshold can be set separately for cutting and rapid traverse by setting the following bit when the abnormal load detection function is used:

		#7	#6	#5	#4	#3	#2	#1	#0
1740	—					ABG0			
2200	—								

Alarm thresholds for abnormal load detection are set in the following parameters:

1997	—	Abnormal load detection threshold for cutting (same as the conventional setting)
2104	—	

[Valid data range] 0 to 7282

1765	—	Abnormal load detection threshold for rapid traverse
2141	—	

[Valid data range] 0 to 7282

NOTE

1 When the threshold for cutting is 0, abnormal load detection is not performed during cutting. When the threshold for rapid traverse is 0, abnormal load detection is not performed during rapid traverse. When both parameters are 0, abnormal load detection is not performed at any time.

2 If bit 3 of parameter No. 1800 is 1, the abnormal load detection threshold for cutting is always used. Switching to the threshold for rapid traverse cannot be performed.

4.11 USE OF THE SERVO CHECK BOARD

(1) Overview

The servo checkboard receives the digital value used for control inside the digital servo as numerial data and converts it to an analog form.

(2) Servo check board configuration

Series 0–C, 15–A, 21–TA, Power Mate	Servo check board (A06B–6057–H602) PC board (A16B–1600–0320 or A20B–1006–0490) Cable (A660–2001–T998#16A0400)
Series 15–B,16,18,20, 21–TB	Servo check board + servo adaptor board (A06B–6057–H602) (A02B–0120–C211)
Power Mate E	Servo check board + special servo adaptor board (A06B–6057–H602) (A02B–0168–K021)

(3) Servo check board connection

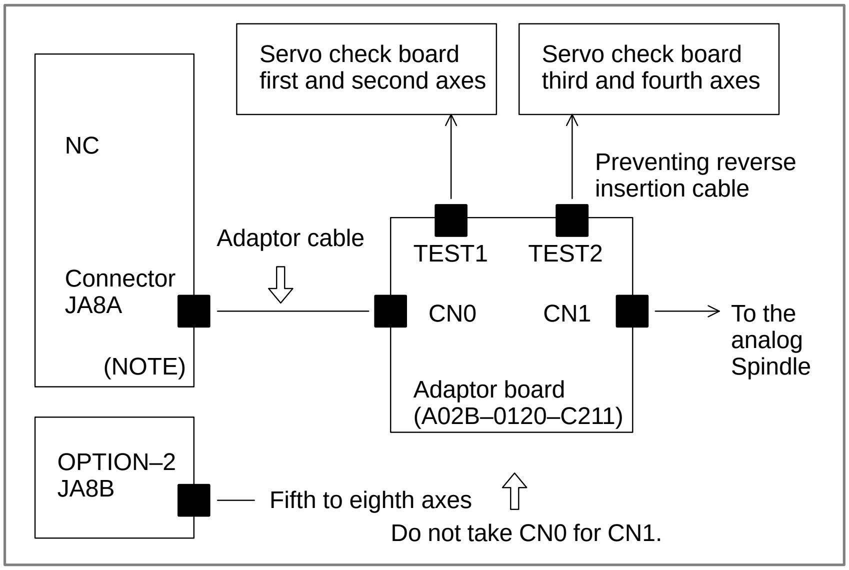
CAUTION

When connecting the servo check board, keep the NC switched off.

NOTE

Install a jumper plug on the 5 MHz side of clock setting pin S1 on the check board.

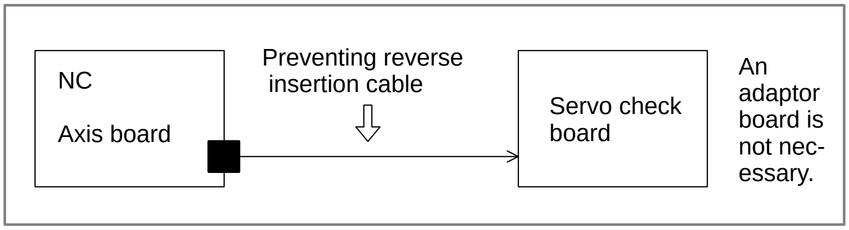
Series 15–B,16,18,20,21–TB



NOTE

For the six–axis main board of the Series 16–B, 16–C, 18–B, or 18–C, connect cable JA26 if data for the 5th and 6th axes are to be read.

Series 0–C,15–A,21–TA,Power Mate



Power Mate–E

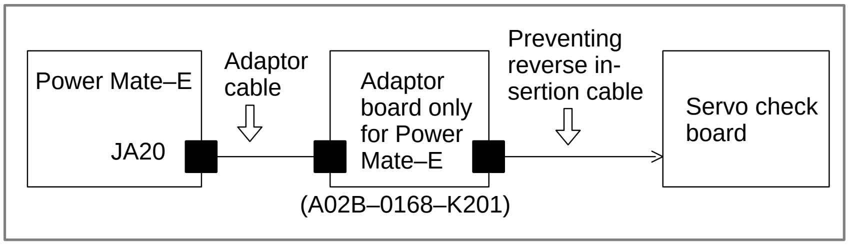


Fig. 4.11 (a) Servo check board connection

---

(4) Location of signal output

Check Pin	TSAL	TSAM	CH1	CH2	CH3	CH4	CH5	CH6
Signal	——	——	L axis VCMD	L axis TCMD	M axis VCMD	M axis TCMD	L axis TSA	M axis TSA

(Check terminal TSAL or TSAM is not used.)

(5) VCMD signal

When the feed–forward function is not used, the VCMD signal is used to output a velocity command. It can also be used to measure a very small vibration or uneven movement of the motor. When the feed–forward function is used, the VCMD signal is used to indicate the positional deviation instead of a velocity command. Therefore, the signal can be used to measure vibration or erratic movement of the motor. The VCMD signal conversion mode can be switched by a parameter. Because the VCMD signal is clamped at ± 5 V, the waveform may become difficult to observe. In such a case, switch for easier observation.

		#7	#6	#5	#4	#3	#2	#1	#0
1956	8X12			VCM2	VCM1				
2012	1012								

Rotary motor

VCM2	VCM1	Velocity command speed/5 V
0	0	0.9155 rpm
0	1	14 rpm
1	0	234 rpm
1	1	3750 rpm

Linear motor

VCM2	VCM1	Velocity command/5 V
0	0	0.075 m/min
0	1	1.2 m/min
1	0	19.2 m/min
1	1	307.2 m/min

To check minute vibrations, monitor the entire vibration on the DC mode of the oscilloscope then enlarge monitor the desired range on the AC mode.

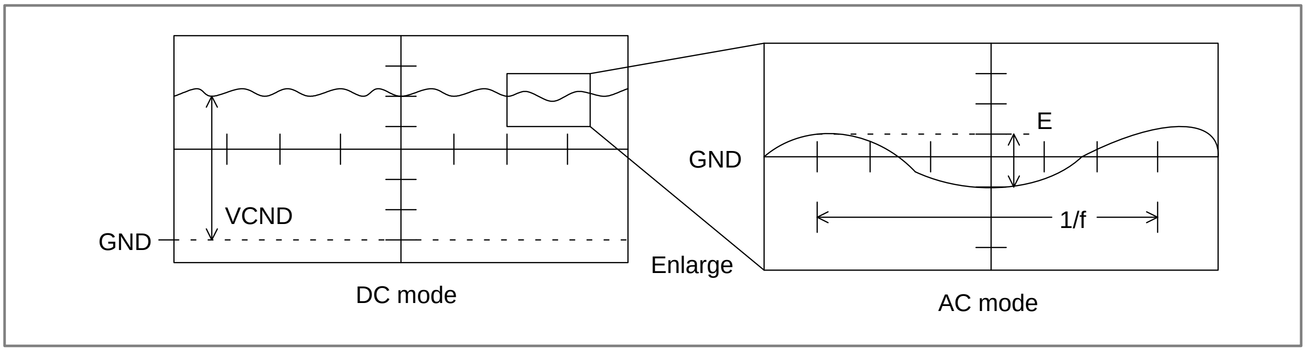


Fig. 4.11 (b) VCMD signal observation

The following table lists the numbers of positional deviation pulses for 5 V of VCMD:

Table 4.11 (a) Number of positional deviation pulses for 5 V of VCMD in semi–closed mode

VCM2	VCM1	Number of positional deviation pulses for 5 V of VCMD
0	0	15,258 × F · FG/Kp
0	1	244,133 × F · FG/Kp
1	0	3,906,133 × F · FG/Kp
1	1	62,498,133 × F · FG/Kp

Kp: Position gain (s^{-1})
F · FG: Flexible feed gear (numerator/denominator)

Table 4.11(b) Number of positional deviation pulses for 5 V of VCMD in full–closed mode

VCM2	VCM1	Number of positional deviation pulses for 5 V of VCMD
0	0	0.0153 × (number of position feedback pulses/motor 1 rev) /Kp
0	1	0.2441 × (number of position feedback pulses/motor 1 rev)/Kp
1	0	3.9061 × (number of position feedback pulses/motor 1 rev)/Kp
1	1	62.5 × (number of position feedback pulses/motor 1 rev)/Kp

Kp: Position gain (s^{-1})

(Example)

Assume the following conditions:
Position gain = 30 (S^{-1}), semi–closed mode, 1 μm/pulse, flexible feed gear = 1/100, VCM2 = 0, VCM1 = 1 (VCMD waveform signal conversion)
If a waveform with E = 0.3 mv and 1/f = 20 ms is observed:

Number of positional deviation pulses for 5 V of VCMD = 244133/100/30 = 81 pulses

Table vibration = 81 × 0.3/5 = 4.88 μm

Vibration frequency = 50 Hz

(6) TCMD signal

The TCMD signal outputs a motor torque command. It may be different from the actual current (IR, IS) of the motor rotating at high speed, because the motor produces a back electromotive force.

Table. 4.11 (b) TCMD Waveform Conversion

Maximum current	Signal output for maximum current	Ap/V	Applicable servo motor
12Ap	4.44V	2.7	β0.5 (α0.5) α1/3000, α2/2000, α2/3000 β1/3000 (αE1/3000) β2/3000 (αE2/3000)
20Ap	4.44V	4.5	αC3/2000, αC6/2000, αC12/2000 αM2/3000, αM2.5/3000 β3/3000 (αE3/3000) β6/2000 (αE6/2000)
40Ap	4.44V	9	α2.5/3000, α3/3000, α6/2000 α12/2000, α22/1500 αL3/3000 α12HV, α22HV, α30HV αC22/1500, αC30/1200 αM3/3000, αM6HV, αM9HV 1500A, 3000B
60Ap	4.44V	14	αM22HV, αM30HV
80Ap	4.44V	18	α6/3000, α12/3000 α22/2000, α30/1200 αL6/3000, αL9/3000 αM6/3000, αM9/3000, 6000B
130Ap	4.44V	29	α22/3000, α30/2000 α30/3000, α40/2000, α40/FAN αL25/3000, αL50/2000 αM22/3000, αM30/3000 9000B
240Ap	4.44V	55	α65/2000
360Ap	4.44V	82	α100/2000, α150/2000

Root mean square value (RMS) = TCMD signal output (Ap) × 0.71

(7) TSA signal

The TSA signal outputs a motor speed.

Signal conversion	3750 rpm/5 V

For a linear motor

Signal conversion	307.2 (m/min)/5 V

If the TSA signal is clamped at 5 V, check whether the following parameter is specified.

1983 (Series 15–A) 1726 (Series 15–B)	8X90
2115	1115

Not used

Must always be 0.

4.12 LINEAR MOTOR PARAMETER SETTING

4.12.1 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) Applicable servo software series and editions

Series 9066/001D and subsequent editions (Power Mate–D)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting procedure

The position and speed of a linear motor are detected by connecting a linear encoder (described Table 4.12.1) to the linear position detection circuit (A860–0333–T001). Those linear encoders that are currently supported are listed below.

The procedure for setting the linear motor parameters depends on the signal pitch of the scale being used. So, check the signal pitch first.

Table 4.12.1 Supported linear encoders

Scale manufacturer	Model	Signal pitch (μm)
Heiden Hein	LS486	20
Heiden Hein	LS186	20
Heiden Hein	LB381	100
Heiden Hein	LF481	4
Heiden Hein	LT181	20
Heiden Hein	LIP481	2
Heiden Hein	LIF181	4
Heiden Hein	LIDA185	40
Mitsutoyo	AT402	20
Optodyne	LDS	40.513167

For details, refer to the Descriptions (B–65202EN) for FANUC LINEAR MOTOR series.

(Step 1)

1804	—	Initialization bits
2000	—	

Set the bits as follows:
When a scale other than the LB381 is used: 00000000
When the LB381 is used: 00000001

(See the procedure for setting the number of velocity pulses and the number of position pulses.)

(Step 2)

1806	—	AMR
2001	—	

Set 00000000.

(Step 3)

1879	—	Direction of movement
2022	—	

111 : Forwards as viewed from the magnetic pole detector
–111 : Backwards as viewed from the magnetic pole detector

(Step 4)

1874	—	Motor number
2020	—	

As of September, 1996, four linear motor models are supported. The table below indicates the specification and motor type number of each linear motor.

Motor model	1500A	3000B	6000B	9000B
Motor specification	0410	0411	0412	0413
Motor type number	90	91	92	93

(Step 5)

1977	—	Numerator of the flexible feed gear
2084	—	

1978	—	Denominator of the flexible feed gear
2085	—	

Set the flexible feed gear parameters as follows:

$$F \cdot FG = \frac{5}{128} \times \frac{(\text{Scale signal pitch } [\mu]/20)}{(\text{Detection unit } [\mu])}$$

(Example 1)
When the LS486 (20–μ pitch) is being used for 1–μ detection
F · FG = 5/128 × (20/20)/1 = 5/128

(Example 2)
When the LS486 (20–μ pitch) is being used for 0.1–μ detection
F · FG = 5/128 × (20/20)/0.1 = 50/128

(Example 3)
When the LB381 (100–μ pitch) is being used for 1–μ detection
F · FG = 5/128 × (100/20)/1 = 25/128

(Step 6)

1876	—	Number of velocity pulses
2023	—	

(Setting) = 5000 × 20/(signal pitch)

(Example 1)
When the signal pitch is 20μ : Setting = 5000

(Example 2)
When the signal pitch is 100μ : Setting = 5000 × 20/100 = 1000

(Example 3)
When the signal pitch is 4μ : Setting = 5000 × 20/4 = 25000
In this case, set bit 0 (high–resolution bit) of parameter No. 1804 (Series 15–B) or parameter No. 2000 (Series 16–B, 18–B) to 1, and set 2500 as the number of velocity pulses.

(Step 7)

1891	—	Number of position pulses
2024	—	

(Setting) = 16000 × 20/(signal pitch)

(Example 1)
When the signal pitch is 20μ : Setting = 16000

(Example 2)
When the signal pitch is 100μ : Setting = 16000 × 20/100 = 3200

(Example 3)
When the signal pitch is 4μ : Setting = 16000 × 20/4 = 80000
In this case, set bit 0 (high–resolution bit) of parameter No. 1804 (Series 15–B) or parameter No. 2000 (Series 16–B, 18–B) to 1, and specify 8000 as the number of position pulses.

(Step 8)

Then, turn the CNC power off, then back on again. With the Series 9080/001F and subsequent editions, a parameter error alarm is issued because a check is made to determine whether the AMR conversion coefficients have been set. Set the AMR conversion coefficients, then turn the power off, then back on again.

(Step 9)

1705	—	AMR conversion coefficient 1
2112	—	

(Setting) =
512 × (magnetic pole interval of motor [mm]/signal pitch of scale being used [μm])

The magnetic pole interval of the linear motors currently in use is 60 mm.

(Example 1)
When the LS486 (20–μ pitch) is being used
(Setting) = 512 × (60/20) = 1536

(Example 2)
When the LS481 (4–μ pitch) is being used
(Setting) = 512 × (60/4) = 7680

1761	—	AMR conversion coefficient 2
2138	—	

If an integer not exceeding a single word (32767 or less) is set for AMR conversion coefficient 1, set 0 for AMR conversion coefficient 2. AMR conversion coefficient 1 may, however, exceed a single word or be a non–integer value, depending on the magnetic pole interval of the scale used. In such a case, AMR conversion coefficient 2 is used.

First, calculate the feedback pulses between magnetic poles as follows:
(Feedback pulses between magnetic poles) =
60,000 × 512 / (scale pitch [μ])

Set this value as follows:
(Feedback pulses between magnetic poles) =
(conversion coefficient 1) × $2^{\text{(conversion coefficient 2)}}$

(Example)
When the LB381 (100–μ pitch) is being used
(Feedback pulses between magnetic poles) =
60,000 × 512/100 = 307,200 = $1200*2^{8}$

Accordingly, set 1200 for AMR conversion coefficient 1, and set 8 for AMR conversion coefficient 2.

(Step 10)

After setting the AMR conversion coefficients, turn the power off then back on again.

(Step 11)

			#7	#6	#5	#4	#3	#2	#1	#0
1954	—							LINEAR		
2010	—									

LINEAR (#2) 1 : Controls the linear motor.

The above parameter is automatically set when the parameters of the linear motor are initialized. Check that this parameter has been set before attempting to operate the linear motor.

(4) Parameter error alarm issued when a linear motor is used

When a linear motor is used, a parameter error alarm for a rotary motor is issued in the following cases:

- When the system is in full–closed loop mode (for using a separate position detector)
- When the AMR conversion coefficients have not been set

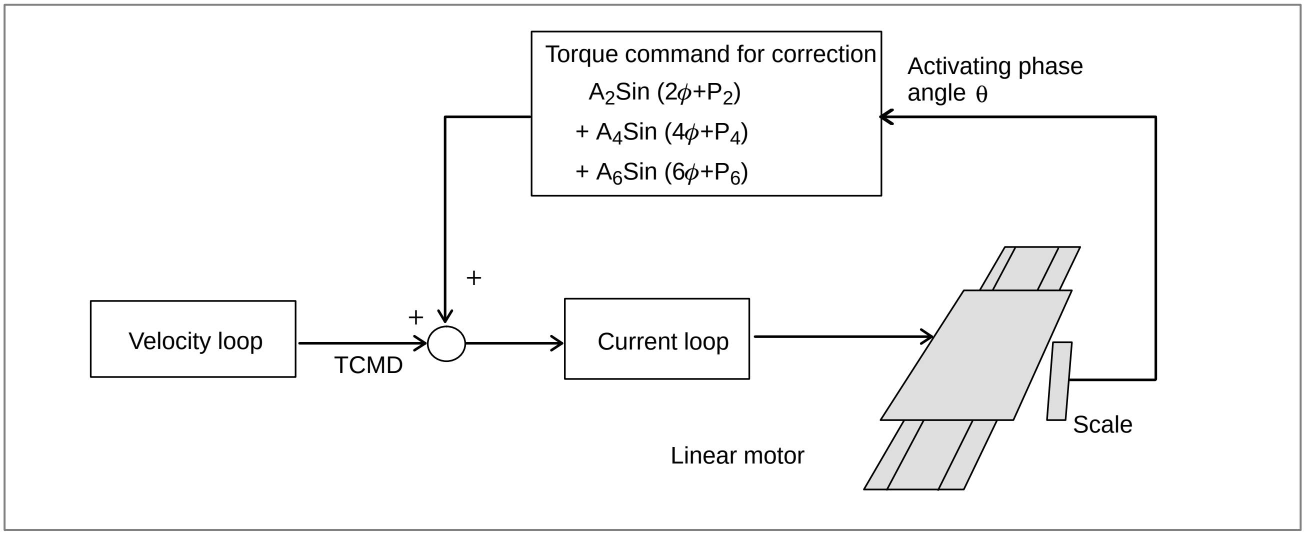
WARNING

An alarm is issued if the AMR conversion coefficients have not been set. No alarm is issued, however, if an invalid AMR conversion coefficient is set. In this case, the correct operation of the linear motor is disabled immediately after it passes the Z phase; in some cases, the linear motor may move within one magnetic pole (60 mm).

4.12.2 Linear Motor Thrust Ripple Correction

(1) Overview

A linear motor has 10–mm, 15–mm, and 30–mm “ripples” that result from its structure (in the case of 60 mm per magnetic pole pair), which tend to aggravate the motor feed irregularity. The occurrence of these ripples depends solely on the motor position. So, the feed irregularity can be improved by applying an offset to the current command.



(2) Applicable software series and editions

Series 9080/001D and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(The Series 9066 does not support this function.)

(3) Parameter setting

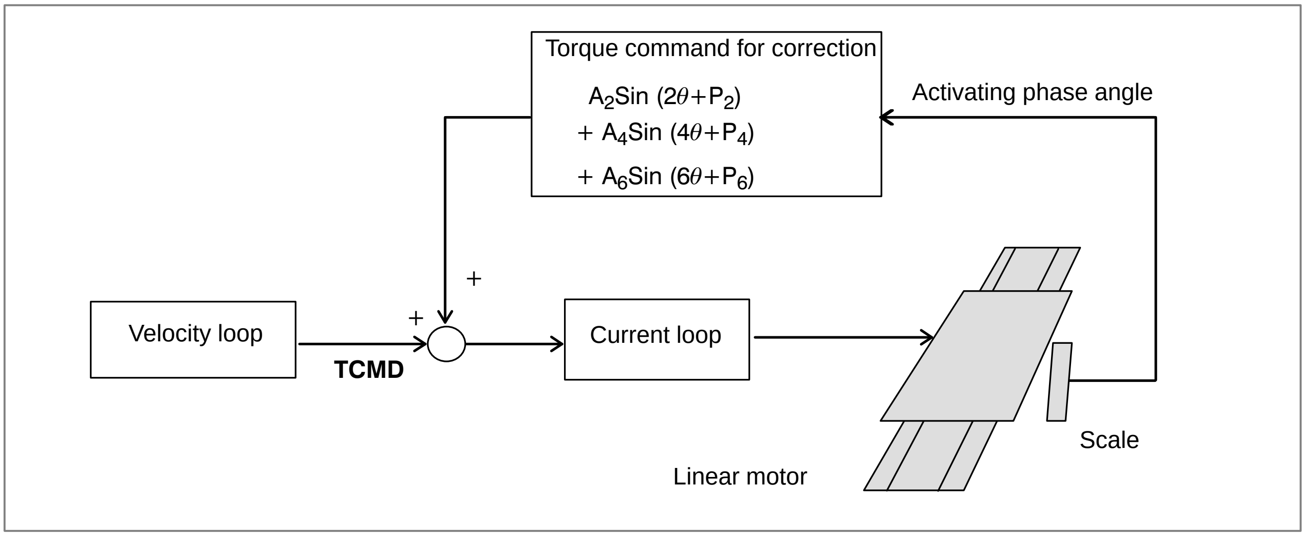
1753	—	Correction of two thrust ripples per magnetic pole pair
2130	—	
1754	—	Correction of four thrust ripples per magnetic pole pair
2131	—	
1755	—	Correction of six thrust ripples per magnetic pole pair
2132	—	

The parameters for thrust ripple correction vary from one linear motor to another. The parameters must be determined by using a servo track tool.

4.12.3 Linear Motor Torque Ripple Correction

(1) Overview

A linear motor has 10–mm, 15–mm, and 30–mm “ripples” that are caused by its structure (60 mm per magnetic pole pair), which tend to aggravate the motor feed irregularity. The occurrence of these ripples depends solely on the motor position. So, the feed irregularity can be improved by applying an offset to the current command.



(2) Parameter setting

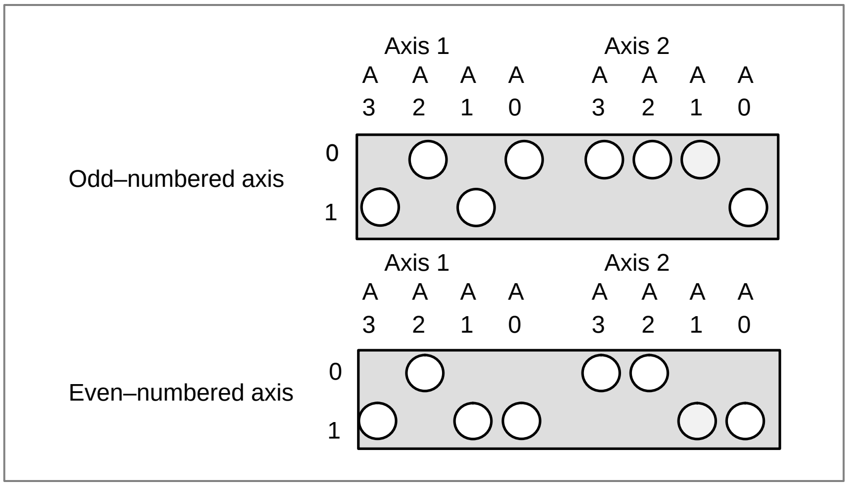
The correction parameters must be determined specifically for each individual motor, because the nature of the ripples varies with the motor (individual motor, not the model). SD (a PC–based trajectory analysis tool) is used to determine the parameters.

The torque command ripples which occur at each position during low–speed motor revolution are assumed to be the ripples specific to the motor. A torque command having the same ripples as these specific ripples is created to enable correction.

(a) To measure an odd–numbered axis, set a dummy bit to 1 for the even–numbered axis paired with it (bit 0 of No. 1953 for the Series 15–B or bit 0 of No. 2009 for the Series 16–B/C). To measure an even–numbered axis, set a dummy bit to 1 for the odd–numbered axis paired with it.

If a linear motor is used in tandem control, however, do not set a dummy bit for the paired axis.

(b) Set the DIP switches on the digital check board as follows (when the automatic adjustment board is being used, pay particularly careful attention to these switch positions):



(c) Set the following parameter (regardless of whether an even–numbered or odd–numbered axis is to be measured):

Series 15–B : No. 1726
Series 16–B/C : No. 2115

1328 (series 9080/001E and subsequent editions)
1456 (series 9080/001D)

The setting of this parameter enables the SD software to read the motor activating phase angle through CH0. The setting made in step (b) enables the measurement of a torque command through CH1.

(d) Start SD, then make the following settings (example for 3000B):

```
DOS prompt > SD INIT (Enter)
o  (origin:  lowercase letter “o”)
F9 (System setting)
   0            (CH0)
   2 (Enter)    (TCMD)
   1.0 (Enter)  (1.0A)
   1            (CH1)
   2 (Enter)    (TCMD)
   40 (Enter)   (current rating for servo
                 amplifier to be used:
                 40 A in this case)
   F10          (return to main menu)

(Ctrl)T (XTYT mode selection)
F2 (Data number)
   6000 (Enter) (number of data items to be measured)

F5 (Parameter)
   F3 (trigger area setting)
   X Lower Trigger area  0 (Enter)
   X Upper Trigger area  (Enter only)
   Y Lower Trigger area  (Enter only)
   Y Upper Trigger area  (Enter only)
   F10                   (return to main menu)
```

(e) Operate the linear motor at F1200 (mm/min), using 200–mm strokes.

(f) Press the F1 key (to start measurement) while the activating phase angle is negative. Data is displayed as shown in Fig. 4.12.3 (check that two waves of the activating phase angle are measured and that the activating phase angle starts from 0).

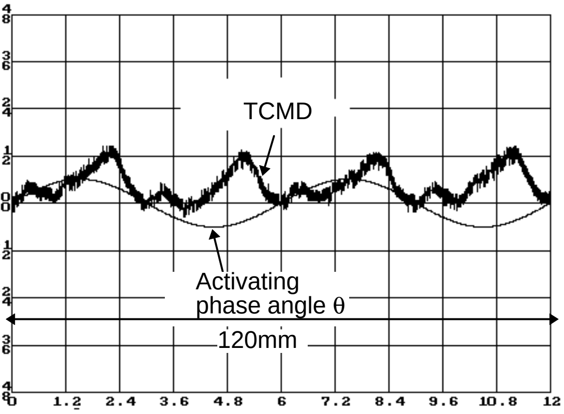
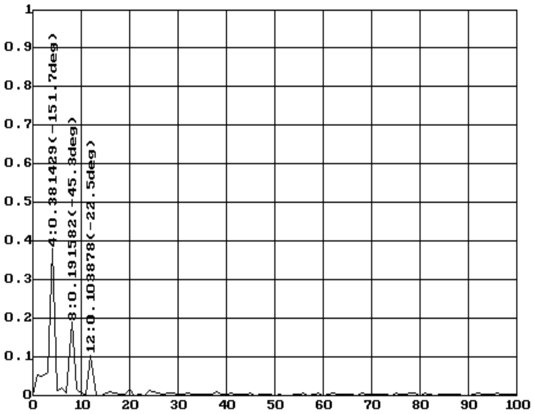


Fig. 4.12.3 Measurement display screen

(g) Press CTRL+F to display the frequency components of the torque command. As the amount of travel for this example is 120 mm, the ripple components per two pairs of magnetic poles are displayed. The addresses to which each correction parameter is assigned are shown below, together with how to determine their values.



Analysis of each frequency component
(per two pairs of magnetic poles)
The displayed phase angles indicate the difference from θ.

2/rev (LP2GP)

No. 1753 (Series 15–B)	Correction gain A_2	Correction phase P_2
No. 2130 (Series 16–B)		

4/rev (LP4GP)

No. 1754 (Series 15–B)	Correction gain A_4	Correction phase P_4
No. 2131 (Series 16–B)		

6/rev (LP6GP)

No. 1755 (Series 15–B)	Correction gain A_6	Correction phase P_6
No. 2132 (Series 16–B)	1byte = 8bit	1byte = 8bit

Correction value =
256 × [1+INT (current obtained by analysis ÷ servo amplifier current rating × 7282 × 2)]+INT (phase angle ÷ 360 × 256)
(INT: Rounding to an integer)

LP2GP = 256*[1+INT($\underline{0.381}$/$\underline{40}$*7282*2)]+INT[($\underline{360–152}$)/360*256]= 35731 (= –29805)

LP4GP = 256*[1+INT($\underline{0.192}$/$\underline{40}$*7282*2)]+INT[($\underline{360–45}$)/360*256] = 18144

LP6GP = 256*[1+INT($\underline{0.104}$/$\underline{40}$*7282*2)]+INT[($\underline{360–23}$)/360*256] = 9967

CAUTION

1 “40” in the above example is the current rating for the servo amplifier being used (3000B).

2 The correction phase must fall within a range of 0 to 255. If it is negative, add 360 to bring it within the range.

3 If a calculated parameter value exceeds 32767, set the value obtained by subtracting 65536 from the calculated value.

4.13 USING THE SERVO SOFTWARE FOR ULTRAHIGH–PRECISION MACHINING

(1) Overview

For servo systems used for ultrahigh–precision machines, a special setting may be required in addition to the conventional settings of 1μm and 0.1μm as detection unit.

In the cases described below, the ultrahigh–precision function of the Series 9081 digital servo software must be used.

1 When the position detection unit of the laser or scale is 0.01 μm or 0.001 μm, and the number of position pulses per motor revolution is 130,000 or more

In this case, a servo parameter causes an overflow in the digital servo system, so that the Series 9081 must be used. For an explanation of how to make this setting, see (3) in this section.

(Example)

When the amount of travel per motor revolution is 4 mm, and 0.01–μm position detection is performed (when the number of position pulses per motor revolution is 400,000)

2 When an amplifier with a smaller capacity than a regular amplifier is used to place emphasis on smooth feed rather than maximum motor torque

In this case, the current loop and velocity loop parameters must be modified. With the Series 9081, the required conversions can be made only by setting a conversion coefficient parameter. For an explanation of how to make this setting, see (4) in this section.

(Example)

When the α3/3000 (usually driven by a 40–A amplifier) is driven using the 12–A amplifier designed for the α2/2000

3 When a reduced voltage is applied to the amplifier to place emphasis on smooth feed rather than maximum motor speed

In this case, the current loop parameter must be modified. With the Series 9081, required conversions can be made only by setting a bit parameter. For an explanation of how to make this setting, see (5) in this section.

(Example)

When the supply voltage for driving the motor is changed from 200 V to 60 V (In this case, an amplifier modification is also required.)

4 When the position detection unit of the laser or scale is 0.001 μm, and the number of position pulses per motor revolution exceeds 1,000,000 (resolution of serial pulse coder A)

In this case, the number of position feedback pulses becomes greater than the number of velocity feedback pulses (1,000,000 pulses for αA1000 or serial pulse coder A), so that stable positioning cannot be performed. In such a system, a separate velocity detector must also be used as described in (6) of this section.

(Example)

When the amount of travel per motor revolution is 5 mm, and 0.001–μm position detection is performed (when the number of position pulses per motor revolution is 5,000,000)

---

(2) Applicable servo software series and editions

Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

---

(3) Using a separate position detector with 130,000 pulses per motor revolution

(a) In this case, a servo parameter causes an overflow in the digital servo system, so that the number of velocity pulses and the number of position pulses must be set as follows:

1732	—	Conversion coefficient for the number of feedback pulses (SBPDNL)
2121	—	

The value specified in this parameter is used to divide the number of velocity pulses and the number of position pulses to produce a value not exceeding 32,767. For this parameter, set as small a value as possible.

Typical setting: 100 or 1,000

1876	—	Number of velocity pulses (PULCO)
2023	—	

When a Serial A or αA1000 built–in pulse coder is used, set 8,192/SBPDNL.

1891	—	Number of position pulses (PPLS)
2024	—	

When a Serial A or αA1000 built–in pulse coder is used, set the following:

$$\frac{\text{Number of feedback pulses from separate detector/motor revolution}}{8{,}192} \times \text{PULCO}$$

		#7	#6	#5	#4	#3	#2	#1	#0
1804	—								PLC0
2000	—								

PLC0 (#0) The number of velocity pulses and the number of position pulses are:

0 : Used as is ← To be set
1 : Used after multiplication by 10

Example of setting

When the Series 15–B and serial pulse coder A are used, and a 0.01–μm separate position detector is used with a machine having a travel of 4 mm per motor revolution
No.1804#0=0
No.1732 = 100
No.1876 = 8192 ÷ 100 = 82
No.1891 = (400,000 ÷ 8,192) × 82 = 4,004

NOTE

When PMC velocity control is used, and a very small value is set as the number of velocity pulses (PULCO), the difference between a specified velocity and actual velocity may become large. In such a case, set the number of velocity pulses as described in (b) below.

(b) Notes on using PMC velocity control

When PMC velocity control is used, and a very small value is set as the number of velocity pulses (PULCO), the difference between a specified velocity and actual velocity may become large. In such a case, modify the settings as described below.

		#7	#6	#5	#4	#3	#2	#1	#0
1741	—				SPVCMD				
2201	—								

SPVCMD (#4) The setting of the number of velocity pulses when the conversion coefficient (SBPDNL) is not used is:

0 : Disabled
1 : Enabled ← To be set

1876	—	Number of velocity pulses (PULCO)
2023	—	

When a Serial A or αA1000 built–in pulse coder is used, set 8,192.

Example of setting

Make the following modifications when PMC velocity control is used in the example of (a) of (3) above:
No.1741#4=1
No.1876 = 8,192

(4) Using a smaller–current amplifier

By using a smaller–current amplifier instead of the normal amplifier, the current detection resolution can be increased, hence smoother control can be achieved.

Note, however, that the maximum torque of the motor becomes smaller as a result of reducing the maximum current.

To enable this modification, set the following parameter:

1733	—	Detection resistance conversion coefficient (SBAMPL)
2122	—	

Set the following:

$$\frac{\text{Maximum current of amplifier that is actually used}}{\text{Maximum current of amplifier that is usually used}} \times 100$$

Example of setting

When the α3/3000 (normally driven by a 40–A amplifier) is driven using the amplifier designed for the α2/2000 (12 A maximum)
No.1733 = (12/40) × 100 = 30

(5) Changing the amplifier input voltage

By maintaining the supply voltage to the servo amplifier control unit at 200 V (the regular voltage) and changing the supply voltage to the inverter to 60 V (normally 200 V), the voltage command resolution can be increased, enabling finer control to be exercised.

For this purpose, a power transformer (A06B–6047–H011 for the Japanese market, or A06B–6047–H021 for overseas markets) is used.

Note, however, that the maximum speed of the motor is reduced as the voltage decreases.

Moreover, the amplifier must be modified.
The C series servo amplifier must be modified according to modification specification #J008.
The α series servo unit (SVU) must be modified according to modification specification #J003.
The α series servo unit (SVUC) must be modified according to modification specification #J001.
Note that modification specifications for the α series servo unit are available only for the following amplifiers:

SVU: A06B–6089–H101 to H105, H201 to H210
SVUC: A06B–6090–H002 to H008, H222 to H226

To enable this modification, set the following parameter:

1884	—
2006	—

#7	#6	#5	#4	#3	#2	#1	#0
						SBSMAP	

SBSMAP (#1) An amplifier input voltage change from 200 V to 60 V is:

0 : Not made
1 : Made ← To be set

Example of setting

When the amplifier input voltage is reduced from 200 V to 60 V (Series 15–B)
No.1884#1 = 1

---

(6) Using a separate position detector (1,000,000 pulses or more per motor revolution)

When a machine is used for which the number of feedback pulses from a separate position detector per motor revolution exceeds 1,000,000, stable control cannot be achieved if serial pulse coder A or the αA1000 (pulse coder built into the motor) is used as the velocity detector.
In this case, a velocity detector with a greater number of pulses is required.
When a velocity detector with a greater number of pulses is used, a special system, like that shown Fig. 4.13, must be configured.

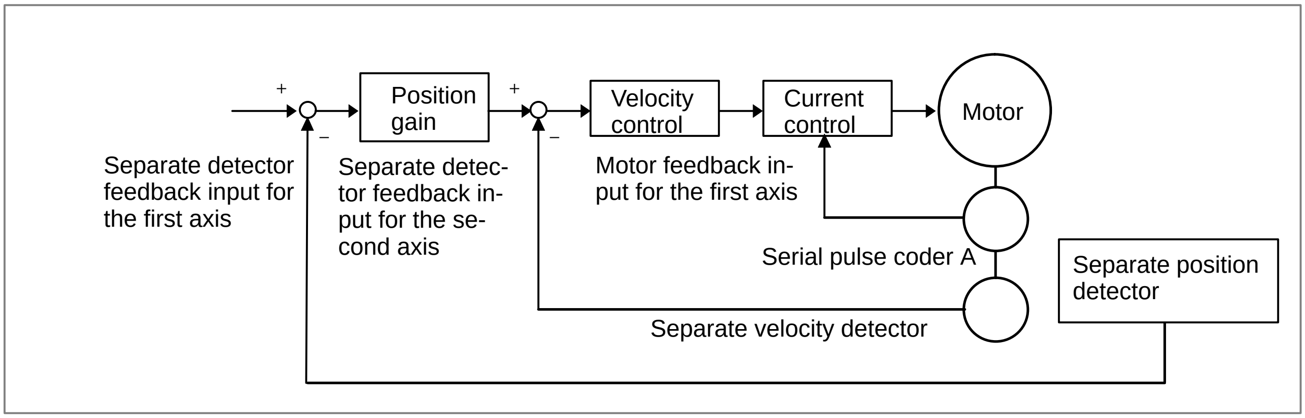


Fig. 4.13 Special system for ultrahigh–precision machining

Thus, the one axis of this system is driven using the normal two axes.

To configure a system like that described above, modify the settings of the following parameters.

Function bits

Series 15–B	Series 16–C, 18–C	Function bit	Axis	Function
No.1807	———	Bit 3 = 1	First axis and second axis	Enables a separate position detector.
No.1815	No.1815	Bit 1 = 1	First axis and second axis	Enables a separate position detector.
No.1953	No.2009	Bit 0 = 1	Second axis	Enables dummy bits.
No.1884	No.2006	Bit 3 = 1	First axis	Enables the system.
No.1709	No.2019	Bit 4 = 1	First axis	Enables the system.

1732	—
2121	—

Conversion coefficient for the number of feedback pulses (SBPDNL)

The value specified in this parameter is used to divide the number of velocity pulses and the number of position pulses to produce a value not greater than 32,767. For this parameter, set as small a value as possible.

Typical setting: 100 or 1,000

1876	—
2023	—

Number of velocity pulses (PULCO)

Set (number of feedback pulses from a separate velocity detector per motor revolution)/SBPDNL.

1891	—
2024	—

Number of position pulses (PPLS)

Set (number of feedback pulses from a separate position detector per motor revolution)/SBPDNL.

1804	—
2000	—

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

PLC0 (#0) The number of velocity pulses and the number of position pulses are:

0 : Used as is ← To be set
1 : Used after multiplication by 10

Example of setting

When a separate velocity detector of 3,000,000 pulses/revolution and separate position detector of 1,000,000 pulses/revolution are used (Series 15–B)
No. 1807#3 = 1 (first axis, second axis)
No. 1815#1 = 1 (first axis, second axis)
No. 1953#0 = 1 (second axis)
No. 1884#3 = 1 (first axis)
No. 1709#4 = 1 (first axis)
No. 1732 = 1,000
No. 1876 = 3,000,000/1,000 = 3,000
No. 1891 = 1,000,000/1,000 = 1,000
No. 1804#0 = 0 (first axis)

4.14 TORQUE CONTROL FUNCTION

(1) Overview

In PMC axis control, the torque control function 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. 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 is issued if the speed of the motor exceeds the excessive speed alarm level specified by the PMC.

A block diagram of torque control type 1 is shown below.

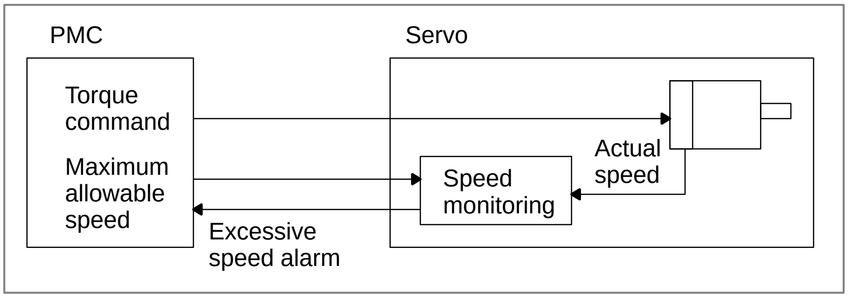


Fig. 4.14 (a) Torque control type 1

(ii) Torque control type 2

The motor produces a torque according to a torque command specified by the PMC. The speed of the motor is clamped to the maximum allowable speed specified by the PMC. (No excessive speed alarm is issued.) While the speed of the motor is clamped, the torque produced by the motor is clamped to the value specified by the torque command.

A block diagram of torque control type 2 is shown below.

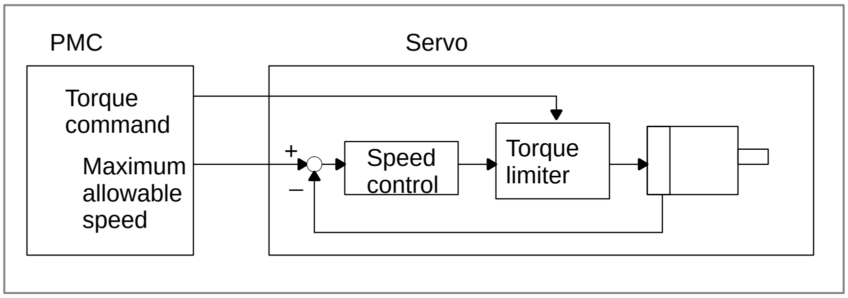


Fig. 4.14 (b) Torque control type 2

(3) Applicable servo software series and editions

(i) Torque control type 1

Series 9066/001E and subsequent editions (Power Mate–H)
Series 9080/001F and subsequent editions (Series 15–B, 16–C, 18–C)

(ii) Torque control type 2

Series 9066/001H and subsequent editions (Power Mate–H)

(4) Parameter setting

This manual describes servo–related parameters only.

(a) Setting for torque control type 1

		#7	#6	#5	#4	#3	#2	#1	#0
1951	—	FRCAXS							
2007	—								

FRCAXS (#7) Torque control is:

0 : Not exercised
1 : Exercised ← To be set

1998	—	Torque constant
2105	—	

This parameter is used to specify a motor–specific torque constant. The units are as follows:

0.00001 Nm/torque command for a rotary motor
0.001 N/torque command for a linear motor

When the initial parameter setting function (Sec. 2.1) is used, a motor–specific value is set automatically.

(b) Setting for torque control type 2

		#7	#6	#5	#4	#3	#2	#1	#0
1808	—					PIEN			
2003	—								

PIEN (#3) The velocity control method to be used is:

0 : I–P control
1 : P–I control ← To be set

		#7	#6	#5	#4	#3	#2	#1	#0
1951	—	FRCAXS							
2007	—								

FRCAXS (#7) Torque control is:

0 : Not exercised
1 : Exercised ← To be set

		#7	#6	#5	#4	#3	#2	#1	#0
1743	—				FRCAX2				
2203	—								

FRCAX2 (#4) Torque control type 2 is:

0 : Not exercised
1 : Exercised ← To be set

1998	—	Torque constant
2105	—	

This parameter is used to specify a motor–specific torque constant. The units are as follows:

0.00001 Nm/torque command for a rotary motor
0.001 N/torque command for a linear motor

When the initial parameter setting function (Sec. 2.1) is used, a motor–specific value is set automatically.

4.15 FUNCTION FOR OBTAINING CURRENT OFFSETS AT EMERGENCY STOP

(1) Overview

A current offset is an offset value arising from an analog offset voltage associated with an A/D converter. If such an offset value is not obtained correctly, the feedback current of the motor is adversely affected, resulting in slight irregularities in the rotation of the motor (four times/revolution). At present, a current offset is obtained once when the power to the NC is turned on as standard. The offset value varies, depending on the temperature of the A/D converter. Use this function to cope with such variations in time.

(2) Applicable servo software series and editions

Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

		#7	#6	#5	#4	#3	#2	#1	#0
1741	—								CROFS
2201	—								

CROFS (#0) 1 : (Enables the current offset to be obtained upon the occurrence of an emergency stop.)

4.16 ACTUAL CURRENT DISPLAY PEAK HOLD FUNCTION

(1) Overview

On the servo adjustment screen, the ratio of the actual current to the rated current is displayed. However, this display does not allow the user to check abrupt changes in the current, like those that occur in the case of acceleration/deceleration. This function displays the peak current for about three seconds, allowing the user to read the maximum current during acceleration/deceleration.

(2) Applicable servo software series and editions

Series 9080/001G and subsequent editions (Series 15–B, 16–C, 18–C)

(3) Parameter setting

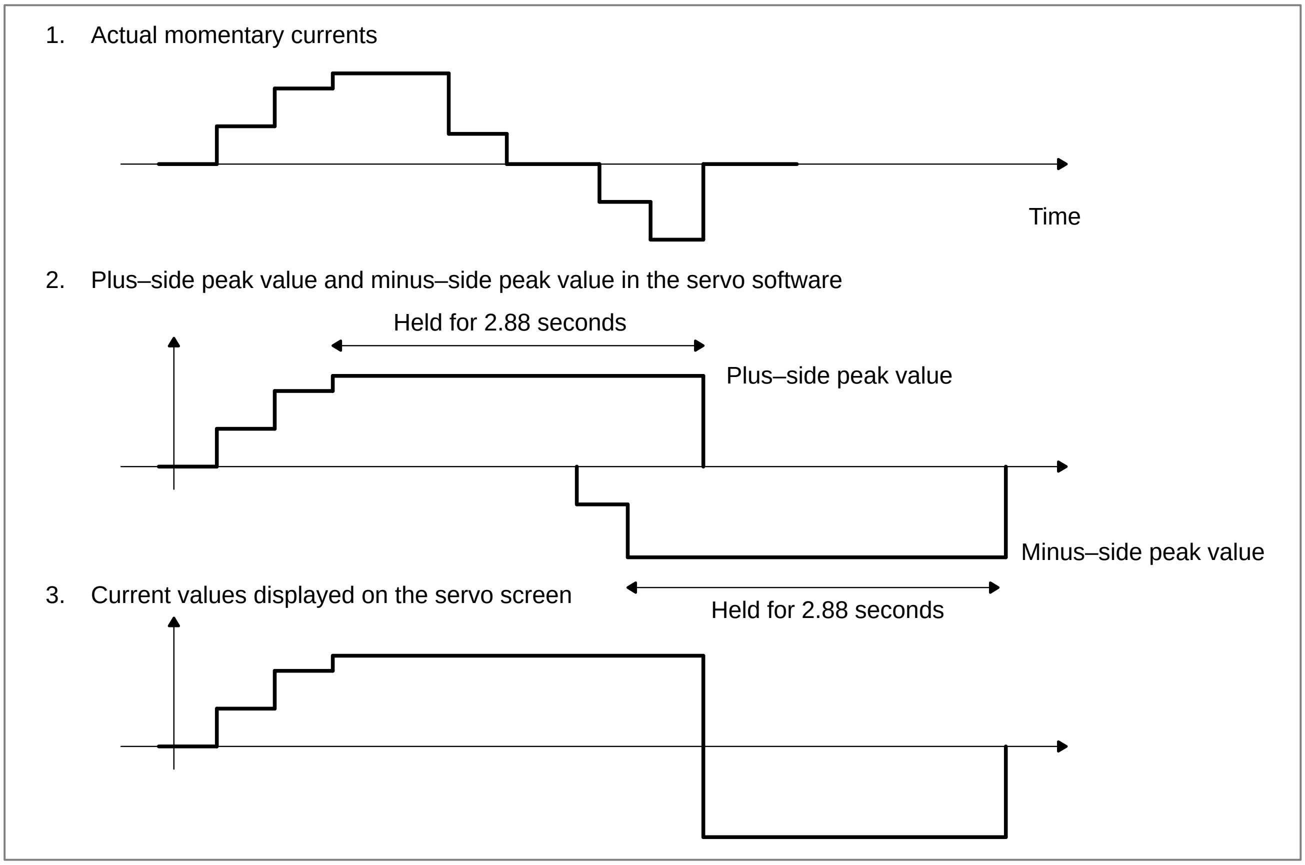
Function bit

	#7	#6	#5	#4	#3	#2	#1	#0
2201 (Series 16) 1741 (Series 15–B)		CPEEKH						

CPEEKH 1 : Holds the display of the peak current.

0 : Ordinary

When the current display peak hold function is used, the servo screen displays the current values as shown below.



4.17 HRV CONTROL

(1) Overview

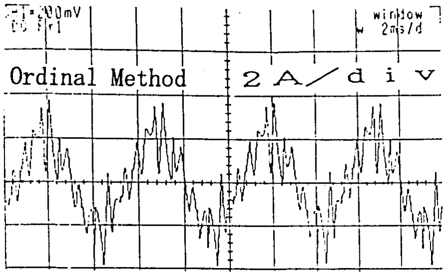
The HRV control function improves the digital servo current loop characteristics. The HRV control function also improves the speed control characteristics during high–speed operation by minimizing the delay that occurs in current control while high–speed rotation is being performed. In addition, the HRV control function can improve the maximum torque of the αL and αM motors, and can increase the OVC alarm limit for heavy–load cutting.

(2) Features

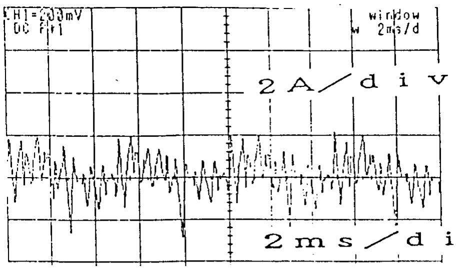
The HRV control function provides the features described below.

(a) Dead current is eliminated during high–speed or steady–state rotation, thus reducing motor heat dissipation.

(Example) α3/3000 dead current comparison at 3000 rpm

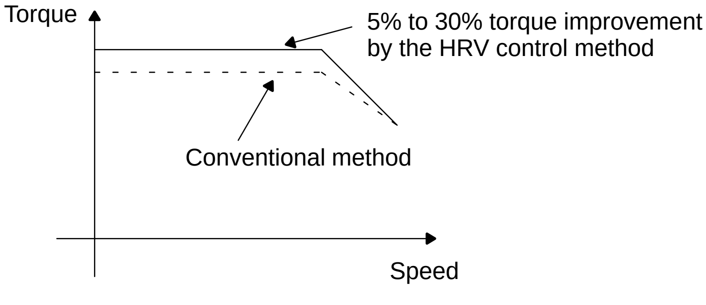


Conventional method



HRV control method

(b) With the αL and αM servo motors, the maximum torque characteristics at low to medium speeds are improved.



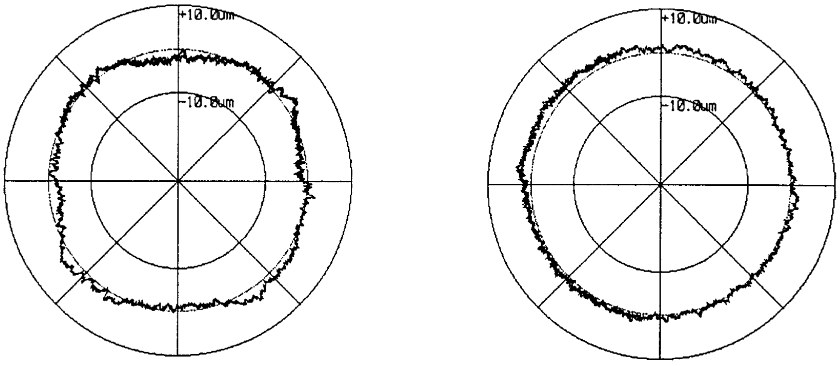
NOTE

For details, refer to the specifications of each motor. When the torque characteristics of a servo motor are improved by the application of HRV control, PSM reselection is required.

(c) Current loop delay in high–speed machining is eliminated, so that the velocity loop characteristics are also improved for high–speed rotation. In high–speed machining using a motor rotating at more than 1500 rpm, an improvement in the machined figure can be achieved.

(Example)

Figure error in high–speed machining (Lead 5 mm. R100/F18000)

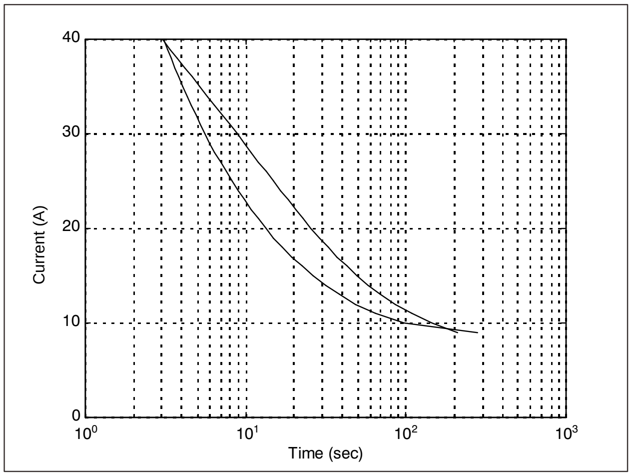


Conventional method

HRV control method

Motor speed:
3600 rpm
10 μm/div

(d) The OVC alarm limit for heavy–load cutting is improved.



Example of OVC protection characteristics
Lower line: Conventional characteristics
Upper line: Improved characteristics
(The alarm limit is improved in the middle time range.)

(3) Applicable servo software series and editions

The HRV control function can be used with the following servo software:
Series 9080/001F and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9081/001C and subsequent editions (Series 15–B, 16–C, 18–C)
Series 9066/001F and subsequent editions (Series 20, 21, Power Mate)
Series 9065/001A and subsequent editions (Power Mate–E)

The above servo software supports only HRV control for current control. (The conventional method cannot be used.)

To make full use of the HRV control function, the motor–specific parameters for HRV control must be set. For details of the HRV control parameters, see Chapter 7. (The servo software listed above holds an HRV control parameter table internally. So, the parameters can also be called by automatic setting.)

(4) Parameter setting for OVC alarm improvement

The current OVC alarm characteristics are rather overprotective in the middle time range (20 to 200 sec) with respect to the characteristics of the servo motor and servo amplifier to be protected. The HRV control function can be used to relax the OVC alarm level in the middle time range to match the actual characteristics of the servo motor and servo amplifier so that the user can make full use of the functions of the servo motor and servo amplifier.

To use this function, the following parameter must be set.

1959	—
2017	1017

#7	#6	#5	#4	#3	#2	#1	#0
	OVCR						

OVCR 1 : Enables OVC alarm improvement.

In addition, the OVC parameters must be modified.

OVC parameters:

POVC 1 :
No.1877 (Series 15), No.2062 (Series 16), No.1062 (Power Mate–E)

POVC 2 :
No.1878 (Series 15), No.2063 (Series 16), No.1063 (Power Mate–E)

POVCLIM:
No.1893 (Series 15), No.2065(Series 16), No.1065 (Power Mate–E)

		Conventional settings			Settings for improvement		
ID,No.	MOTOR	POVC1	POVC2	POVCLMT	POVC1	POVC2	POVCLMT
1	3HV	32686	1031	3059	32738	379	2247
2	6HV	32637	1639	4866	32720	603	3575
3	12HV	32568	2505	7445	32694	922	5470
4	22HV	32370	4981	14847	32621	1837	10908
5	30HV	32359	5110	15235	32617	1884	11193
7	aC3	32686	1030	3056	32738	379	2245
8	aC6	32637	1636	4858	32720	602	3569
9	aC12	32412	4446	13245	32637	1639	9731
10	aC22	32370	4981	14847	32621	1837	10908
11	aC30	32343	5315	15850	32611	1960	11645
12	aC40	32528	2997	8911	32680	1103	6547
13	a0.5	32585	2288	6797	32701	842	4994
15	a3/3000	32713	690	2045	32748	253	1502
16	a6/2000	32689	991	2940	32739	364	2160
17	a6/3000	32698	877	2601	32742	322	1911
18	a12/2000	32568	2505	7445	32694	922	5470
19	a12/3000	32614	1922	5709	32711	707	4194
20	a22/2000	32543	2811	8358	32685	1035	6141
21	a22/3000	32518	3128	9305	32676	1152	6836
22	a30/2000	32668	1245	3695	32731	458	2715
23	a30/3000	32493	3443	10245	32667	1268	7527
24	aM3	32697	886	2627	32742	326	1930
25	aM6	32727	516	1529	32753	190	1124
26	aM9	32692	955	2832	32740	351	2080
27	a22/1500	32370	4981	14847	32621	1837	10908
28	a30/1200	32665	1283	3809	32730	472	2798
29	a40/FAN	32361	5090	15175	32618	1877	11149
30	a40/2000	32579	2358	7007	32699	868	5148
33	b3	32456	3897	11600	32653	1436	8523
34	b6	32456	3897	11600	32653	1436	8523
35	b1	32617	1884	5594	32713	693	4110
36	b2	32540	2850	8474	32684	1049	6226
39	a65	32419	4365	13002	32641	1585	9408
40	a100	32499	3358	9990	32669	1237	7340
41	a150	32281	6086	18168	32588	2246	13348
46	a2/2000	32627	1766	5245	32716	650	3854
56	aL3	32695	912	2706	32741	335	1988
57	aL6	32698	877	2602	32742	322	1912
58	aL9	32614	1928	5727	32711	708	4199
59	aL25	32489	3482	10360	32665	1283	7612
60	aL50	32237	6640	19834	32572	2452	14572
61	a1/3000	32623	1811	5377	32715	666	3951
62	a2/3000	32519	3112	9256	32664	1294	7680
90	1500A	32670	1222	3626	32732	449	2664
91	3000B	32670	1222	3626	32732	449	2664
92	6000A	32670	1222	3626	32732	449	2664
93	9000B	32685	1041	3087	32737	383	2268

4.18

CURRENT LOOP 125μSEC FUNCTION

(1) Overview

The current loop 125 μsec function improves the current control response characteristics by controlling, with one DSP, each of those axes that require an especially high response and high precision. At the same time, this function improves the velocity loop response characteristics to achieve a high level of control.

This function improves the current loop response characteristics, so that the velocity loop oscillation limit is raised. This means that a higher velocity loop gain, necessary for achieving high response and high precision, can be set.

(2) Notes on use

(a) This function can be used only with odd–numbered axes; this function cannot be used with the corresponding even–numbered axes.

[Example of setting parameter No. 1023 (servo axis number)]

Ordinary setting		
X	1	First DSP
Y	2	
Z	3	Second DSP
C	4	

⇨

Setting for using the current loop 125 μsec function		
X	1	First DSP
Y	3	Second DSP
Z	5	Third DSP
C	7	Fourth DSP

(Modify the connection locations of the specified cables and feedback signals according to the parameter setting.)

In the above example, eight CNC axes are required.

(b) A combination of the current loop 125 μsec function (one axis/DSP) and the current loop 250 μsec function (two axes/DSP) is allowed.

In the example below, the current loop 125 μsec function is used for the X– and Y–axes only.

[Example of setting parameter No. 1023 (servo axis number)]

Ordinary setting		
X	1	First DSP
Y	2	
Z	3	Second DSP
C	4	

⇨

Setting for using the current loop 125 μsec function		
X	1	First DSP
Y	3	Second DSP
Z	5	Third DSP
C	6	

(Modify the connection locations of the specified cables and feedback signals according to the parameter setting.)

In the above example, six CNC axes are required.

(c) When the current loop 125 μsec function is used, the velocity loop control period is 500 μsec.

(d) This function can be used with the α series, β series, and C series amplifiers. (The S series amplifier does not allow the user to set a PWM dead zone of 8 μsec, so that this function cannot be used with the S series amplifier.)

(e) This function can be used more effectively by using a serial A or αA1000 pulse coder.

(3) Applicable servo software series and editions

Series 9080/001F and subsequent editions (Series 16–C, 18–C)
Series 9081/001E and subsequent editions (Series 16–C, 18–C)

(4) Parameter setting

(a) Modifications to settings such as the interrupt period

For those axes (odd–numbered) for which the current loop 125 μsec function is to be set, and the corresponding even–numbered axes, set the parameter as described below.

—	—
2004	—

Conventional setting

#7	#6	#5	#4	#3	#2	#1	#0
DLY1	DLY0	TIB1	TIB2	TRW1	TRW0	TIB0	TIA0
0	0	0	0	0	1	1	0

⇩

Setting for using the current loop 125 μsec function

#7	#6	#5	#4	#3	#2	#1	#0
DLY1	DLY0	TIB1	TIB2	TRW1	TRW0	TIB0	TIA0
0	0	1	0	0	0	0	1

With the above setting, a 125–μsec current loop, 500–μsec velocity loop, 250–μsec triangular wave period, and 8–μsec PWM dead zone are set.

(b) Serial pulse coder dummy bit setting

Set the following parameter for the even–numbered axes corresponding to those axes (odd–numbered) for which the current loop 125 μsec function is to be set:

—	—
2009	—

#7	#6	#5	#4	#3	#2	#1	#0
							SERDMY

SERDMY (#0) The serial feedback dummy function is:

0 : Disabled
1 : Enabled ← To be set

(c) Current loop gain (proportional) modification

—	—
2041	—

Current loop gain (PK2)

Set a value double the current setting.

(d) Velocity loop gain (integration term) modification

—	—	Velocity loop gain (PK1V)
2043	—	

Set the value obtained by halving the current setting.

(e) Modification to the 250 μsec acceleration feedback gain

—	—	250 μsec acceleration feedback gain
2066	—	

Set a value double the current setting. This new setting makes the actual feedback gain equivalent.

---

(5) Usage

(a) Set the parameters according to (4) above.

(b) Set the highest value that can be specified for the velocity gain (on the servo screen).

(c) If oscillation occurs at high frequencies, install a torque command filter.

The relationship between the torque command filter coefficient and cut–off frequency is the same as in the case of a conventional velocity loop having a 1–ms period. Typically, set a value of between 150 and 200 Hz.

—	—	Torque command filter (FILTER)
2067	—	

The table below indicates the relationship between the filter cut–off frequencies and parameter settings.

Cut–off frequency (Hz)	Parameter setting	Cut–off frequency (Hz)	Parameter setting
80	2478	170	1408
90	2327	180	1322
100	2185	190	1241
110	2052	200	1166
120	1927	210	1095
130	1810	220	1028
140	1700	230	965
150	1596	240	907
160	1499	250	851

4.19 AUTOMATIC SERVO ADJUSTMENT FUNCTION

(1) Overview

The FANUC automatic adjustment system uses a personal computer to automatically determine servo–related parameter values. Data such as the move commands required for automatic adjustment is sent to the NC from the personal computer via the RS–232C interface (DNC operation). Servo data (such as position and velocity data) generated during operation is fed to the personal computer via an interface board manufactured by FANUC; the optimum parameter values for the system are determined by analyzing the data and comparing with a specified figure. The parameter values determined by the automatic adjustment function are sent to the NC via the RS–232C interface.

(2) Scope

This system allows the adjustments described below to be made.

(a) Velocity loop gain adjustment

The velocity loop gain parameter is automatically adjusted to an optimum value by gradually increasing the gain while monitoring the resonance of the machine system.

(b) Automatic estimation of machine inertia

By repeatedly accelerating/decelerating a machine, the inertia of that machine can be automatically estimated to determine the values of the parameters related to machine inertia. Thus, the acceleration torque of the machine can be separated from the friction torque to facilitate backlash acceleration and abnormal load detection adjustments.

(c) Feed–forward coefficient adjustment

The advanced preview feed–forward coefficient is automatically adjusted to allow the user to eliminate figure errors caused by servo system delay while viewing a circular trace error. (To enable this adjustment, the advanced preview control option is required.)

(d) Quadrant protrusion compensation adjustment

The two–stage backlash acceleration function is adjusted to eliminate quadrant protrusion in circular cutting at both low and high speeds. (To enable this adjustment, the advanced preview control option is not required.)

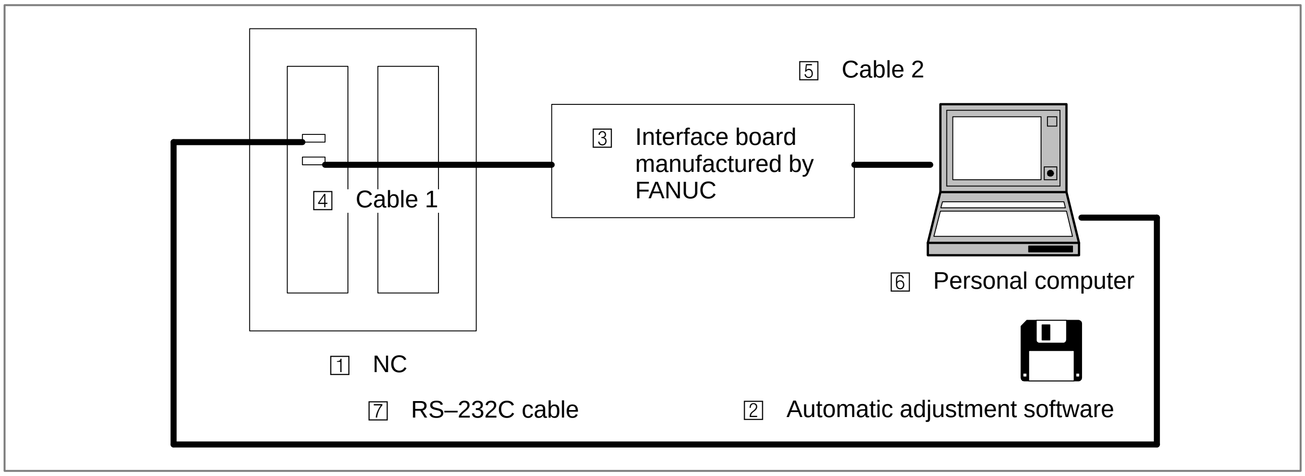
(e) Measurement of machine system velocity loop frequency characteristics

Even without the use of a special measuring instrument, the frequency characteristics (gain diagram) of a velocity loop involving a machine system can be measured easily.

(f) Creation of initial parameter values

Initial digital servo parameter values can be automatically created using the personal computer. The initial parameters include those parameters that are set on the servo setting screen of the NC, which are automatically set by entering data such as the gear reduction ratio, the motor used, and so forth on the personal computer.

(3) System configuration



(a) Items to be purchased from FANUC

$\boxed{1}$ NC

The automatic adjustment function can be used with the following combinations of system software and servo software (as of September, 1996):

NC name	System software	Servo software
Series 15–B	A0C1/N, A0C2/Q and later AAC1/K, AAC2/G and later A1C2/F A2C1/F, A2C2/F and later A6C1/F, A6C2/G and later A0D1/A, A0D2/B and later AAD1/A, AAD2/C and later A1D2/A A2D1/A, A2D2/A and later A6D1/A, A6D2/B and later	Series 9060/001W and later, or Series 9070/001H and later, or Series 9080/001A and later
Series 16–A	B005/24 and later, or B105/18 and later	Series 9060/001W and later
Series 16–B	B0A1/13 and later, or B1A1/12 B7A1/04 and later (16–PB) B8A1/05 and later (16–LB)	Series 9070/001H and later, or Series 9080/001A and later
Series 16–C	All versions can be used.	Series 9080/001A and later
Series 18–A	BD03/20 and later, or BE03/17 and later	Series 9060/001W and later
Series 18–B	BDA1/03 and later, or BEA1/04 and later	Series 9070/001H and later, or Series 9080/001A and later
Series 18–C	All versions can be used.	Series 9080/001A and later
Series 21–TB	DE01/06 and later	Series 9060/001W and later
Series 21–MB	D201/09 and later DDA1/01	Series 9060/001W and later Series 9060/001W and later

The following servo software can also be used:

- Series 9081/001C and later
- Series 9066/001F and later

$\boxed{2}$ Automatic adjustment software produced by FANUC

- For NEC PC9801–series   Specification: A08B–9000–J900
- For IBM PC/AT compatible machines
  Specification: A08B–9001–J900

  (As of September, 1996, the latest edition is Edition 1.4.)

$\boxed{3}$ Interface board manufactured by FANUC
Specification: A06B–6057–H620

$\boxed{4}$ Cable 1 (for connection between the NC and interface board)
Specification: A06B–6050–K872

$\boxed{5}$ Cable 2

NOTE

Only when a NEC PC9801–series PC is used, the cable below (for connection between the interface board and PIO48W manufactured by Contech) is to be purchased from FANUC.
For a desktop personal computer
  Specification: A06B–6050–K870
For a notebook–sized personal computer
  Specification: A06B–6050–K869

(b) Items to be provided by the customer

$\boxed{1}$ Cable 2

NOTE

Only when a IBM PC/AT–compatible machine is used, a commercially available cable (for connection between the interface board and printer port), not shorter than 2 meters, must be provided.

$\boxed{2}$ Personal computer

- A NEC PC9801 series or IBM PC/AT–compatible machine can be used.

NOTE

1 When a NEC PC9801 series PC is used, one of the following I/O expansion boards is required:
For a desktop personal computer:
  PIO–48W (98) manufactured by Contech
For a notebook–sized personal computer:
  PIO–48W (9N) manufactured by Contech

2 When a IBM PC/AT–compatible machine is used, the personal computer must be equipped with a bidirectional printer port.

- The automatic adjustment system requires a 486SX CPU, 33–MHz, or better. For efficient use, a 486DX2 CPU running at 50 MHz, or better, is recommended.

- The automatic adjustment software is compatible with MS–DOS® Version 3.0 and later. Note that the automatic adjustment software is not compatible with Windows®. Use the software in MS–DOS® mode.

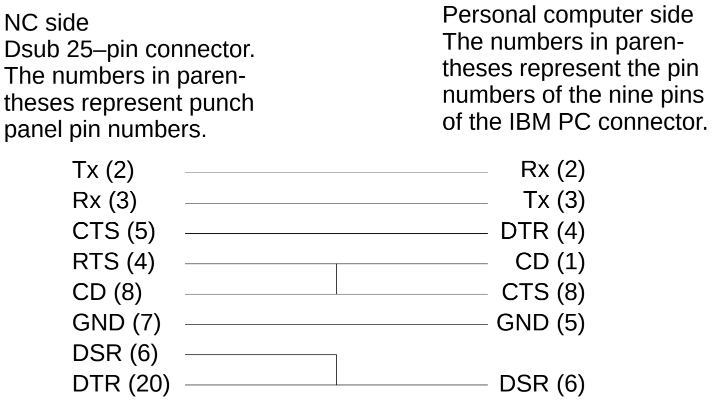
  (When Windows® 95 is used, the software cannot be used in a DOS window. Therefore, when starting up the personal computer, press the F8 key, then select the DOS prompt only mode.)

As of September, 1996, the compatibility of the software with the following machines has been confirmed:

● NEC:	PC9821Ns, PC9821Na
● IBM:	ThinkPad230, 530Cs, 370C, 701, 535 (Windows® 95)
● Fujitsu:	FMV499D3, FMV575D4, FMV BIBLO
● Toshiba:	DynaBook GT–R575 (Windows® 95)
● DEC:	Digital High Note 475

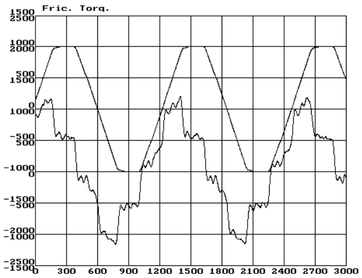
7 RS–232C cable

- When a NEC PC9801–series PC is used, a commercially available reverse cable such as the PC–98HA–16 can be used.
- When a IBM PC/AT–compatible machine is used, manufacture the following cable:

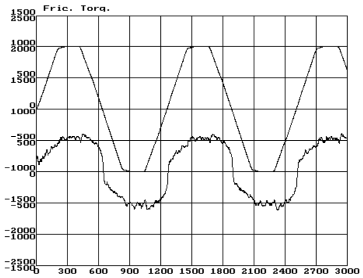


For details of usage, refer to MANUAL.TXT, included on the floppy disk on which the automatic adjustment software is supplied.

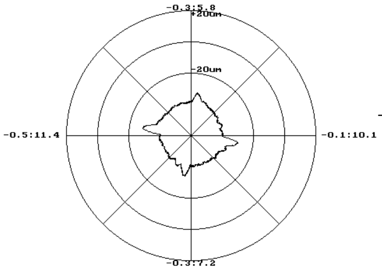
(4) Examples of usage



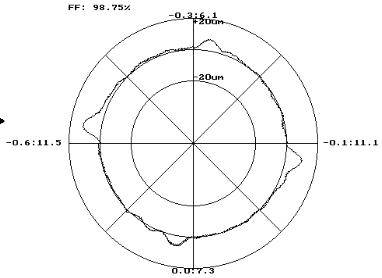
Before inertia estimation
(Up: TSA, Low: Friction torque)



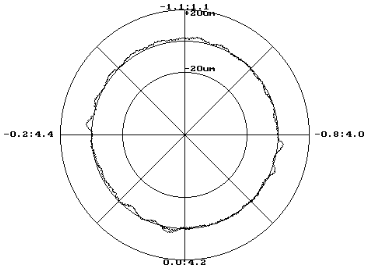
After inertia estimation



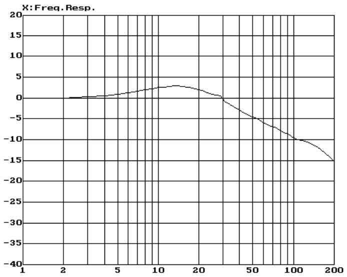
Circle before feed–forward adjustment



Circle after feed–forward adjustment



Circle after backlash acceleration adjustment



Frequency characteristic measurement results

4.20 TANDEM CONTROL FUNCTION

(1) Overview

If a single motor is not capable of producing sufficient torque to drive a large table, for example, tandem control allows two motors to produce movement along one axis.

A motor of the same specification is used for both the main motor and sub–motor.

Only the main motor is responsible for positioning. The sub–motor only produces a torque. In this way, double the torque can be obtained (load sharing mode).

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).

(2) Applicable servo software series and editions

Series 9060/001F and subsequent editions
(Series 15–B, 16–A, 18–A, Power Mate)
Series 9080/001A and subsequent editions (Series 15–B, 16–C, 18–C)

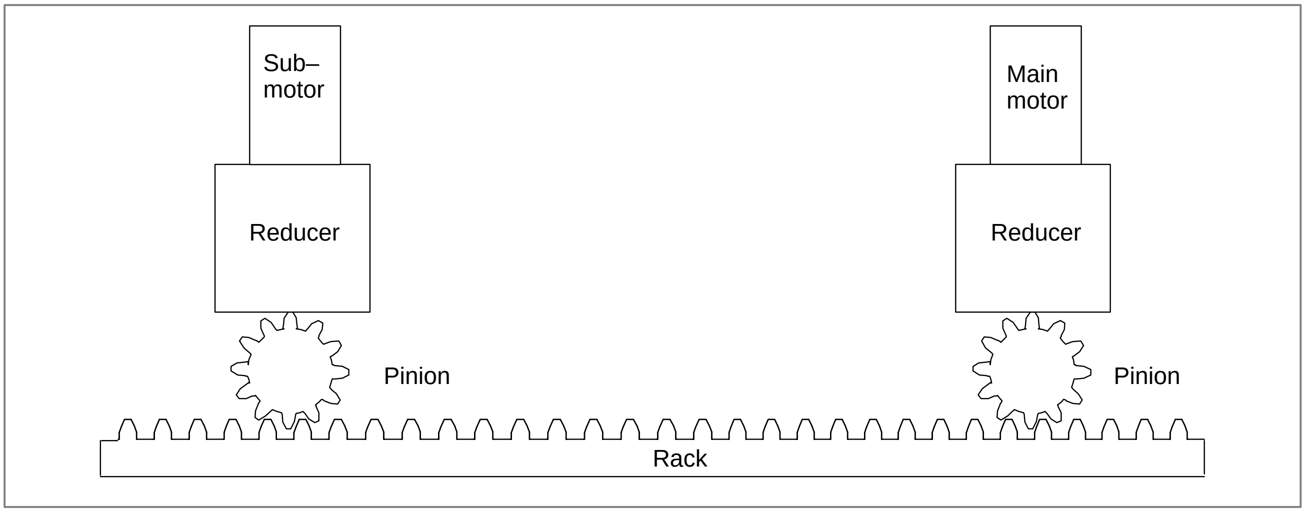


Fig. 4.20 (a) Example of tandem control application (1)

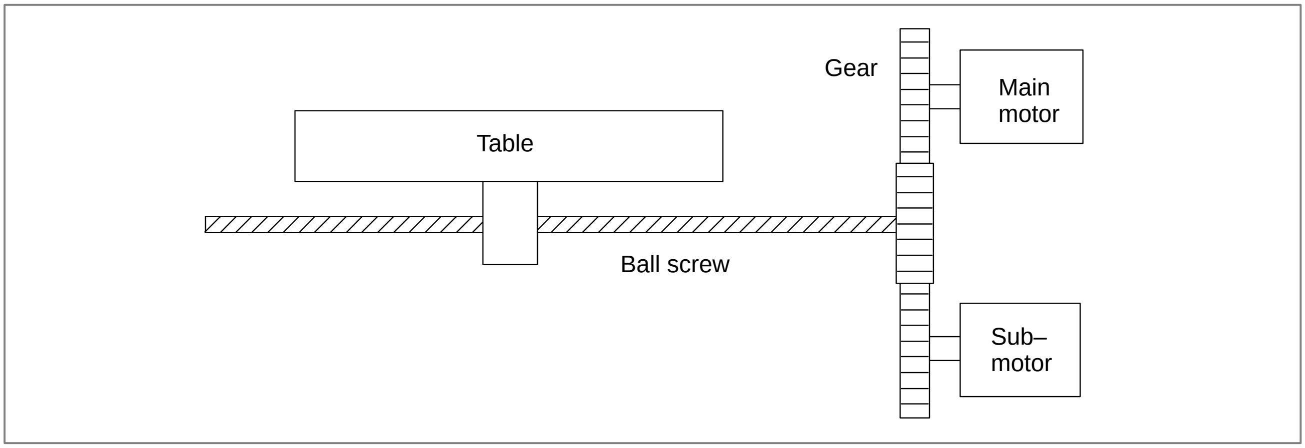


Fig. 4.20 (b) Example of tandem control application (2)

- Notes on stable tandem control operation

To ensure stable tandem control operation, the machine must be capable of performing back–feed.

Back–feed is the moving of the sub–motor from the main motor, or vice versa, through the connected transmission feature. When the back–feed capability is disabled, unstable operation results. In this case, machine adjustment becomes necessary.

The user can check whether the back–feed capability is enabled. To make this check in the case of the example shown in Figs. 4.20 (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.

Table 4.20 Applicable functions for each tandem control type

		Preload function	Velocity feedback averaging function	Dumping compensation function	Position feedback switching function	Motor feedback sharing function
Tandem control	Typical tandem control Fig. 4.20.11 (a)	○	○	○		
	Full preload function Fig. 4.20.11 (b)	○	○	○	○	
Velocity command tandem control	Fig. 4.20.11 (c)					○

○ : Supported as standard

(3) Tandem control parameters

• Tandem axis setting

Because tandem control is an optional function, optional parameters must be set in addition to those shown below.

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

TANDEM (#6) 1 : Enables tandem control. (Set this parameter for the main– and sub–axes)

1023	—	Servo axis arrangement
1023	—	

This parameter specifies servo axis arrangement. Set an odd number for a main axis, and the subsequent even number for the sub–axis. If 3 is set for a main axis, for example, set 4 for the sub–axis.

- **Tandem axis servo parameters**

1875	—	Load inertia ratio (LDINT)
2021	—	

[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

When the full preload function is used, the motor on the driving side is required to bear the total load inertia of the machine and the motor inertia of the other motor. So, calculate the load inertia for the above formula as follows:

(Load inertia) = (Total load inertia of machine) + (Motor inertia)

Example of setting

The example shown in Fig. 4.20 (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

When the full preload function is used:

(Load inertia ratio) = (2 + 1) × 256 = 768

The result obtained from the above formula may cause oscillation due to the mechanical structure. In such a case, set a smaller value.

1879	—	Motor rotation direction (DIRCT)
2022	—	

Main axis:

When a + direction command causes the main axis motor to rotate counterclockwise, as viewed from the motor shaft, set 111. When a + direction command causes the motor to rotate clockwise, set –111.

Sub–axis:

When the sub–axis motor rotates in the same direction as the main axis motor, set the same value as that set for DIRCT for the main axis. When the sub–axis motor rotates in the opposite direction to that of the main axis motor, set a value having a sign opposite to that of the value set for DIRCT for the main axis. (111 or –111)

4.20.1
Preload Function

By applying an offset to the torque controlled by position (velocity) feedback, torques of opposite directions can be applied to the main– (main motor) and sub–axes (sub–motor) to maintain tension at all times. This function can reduce the backlash between the main– and sub–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 are a feature of the machine system.

For example, set preload +Pre for the main axis and preload –Pre for the sub–axis. Then, torques are produced as shown below.

If a torque is required during acceleration/deceleration, 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

For an application which requires only anti–backlash mode, use the full preload function, described in Subsec. 4.20.5.

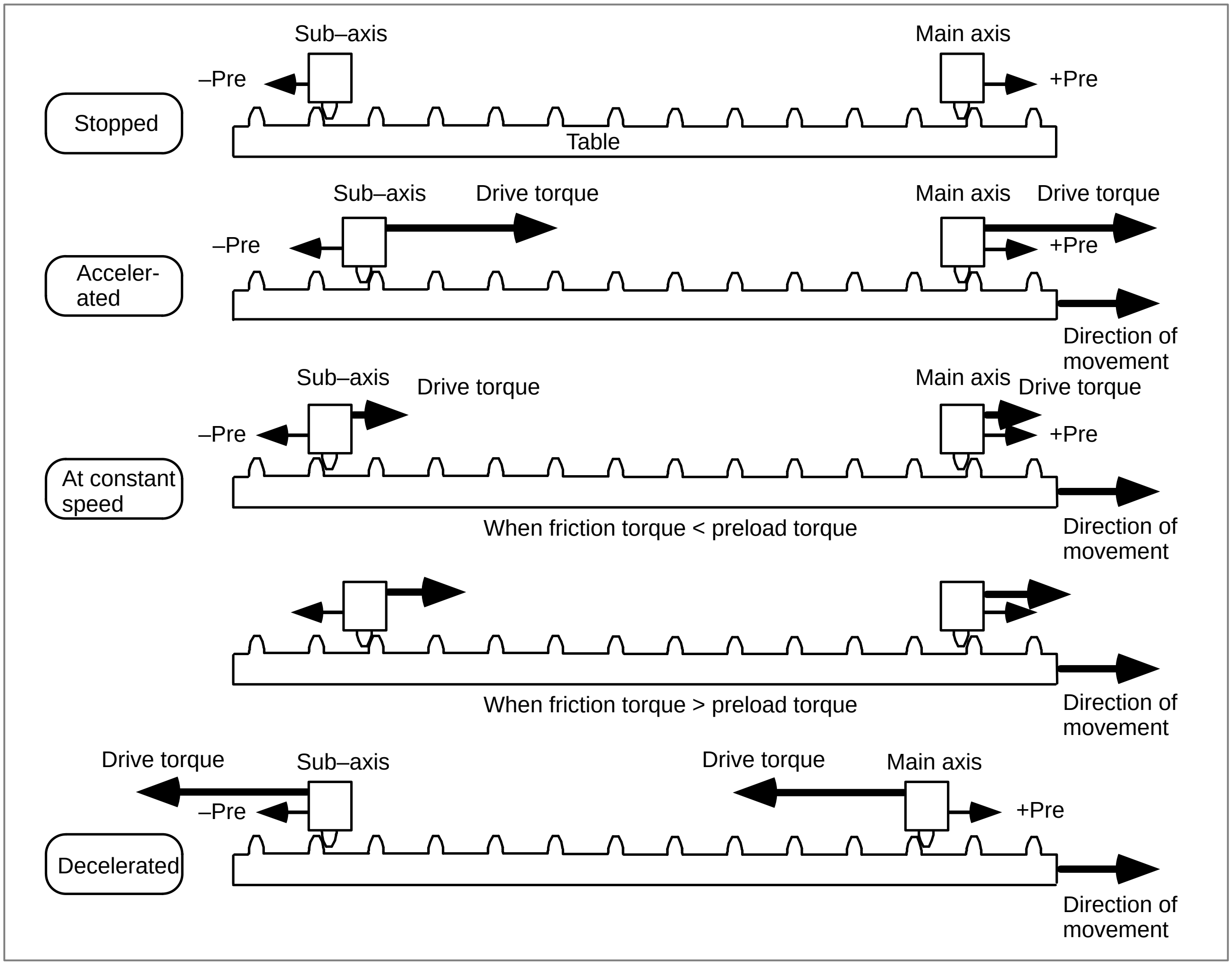


Fig. 4.20.1 (a) Changes of torque during movement

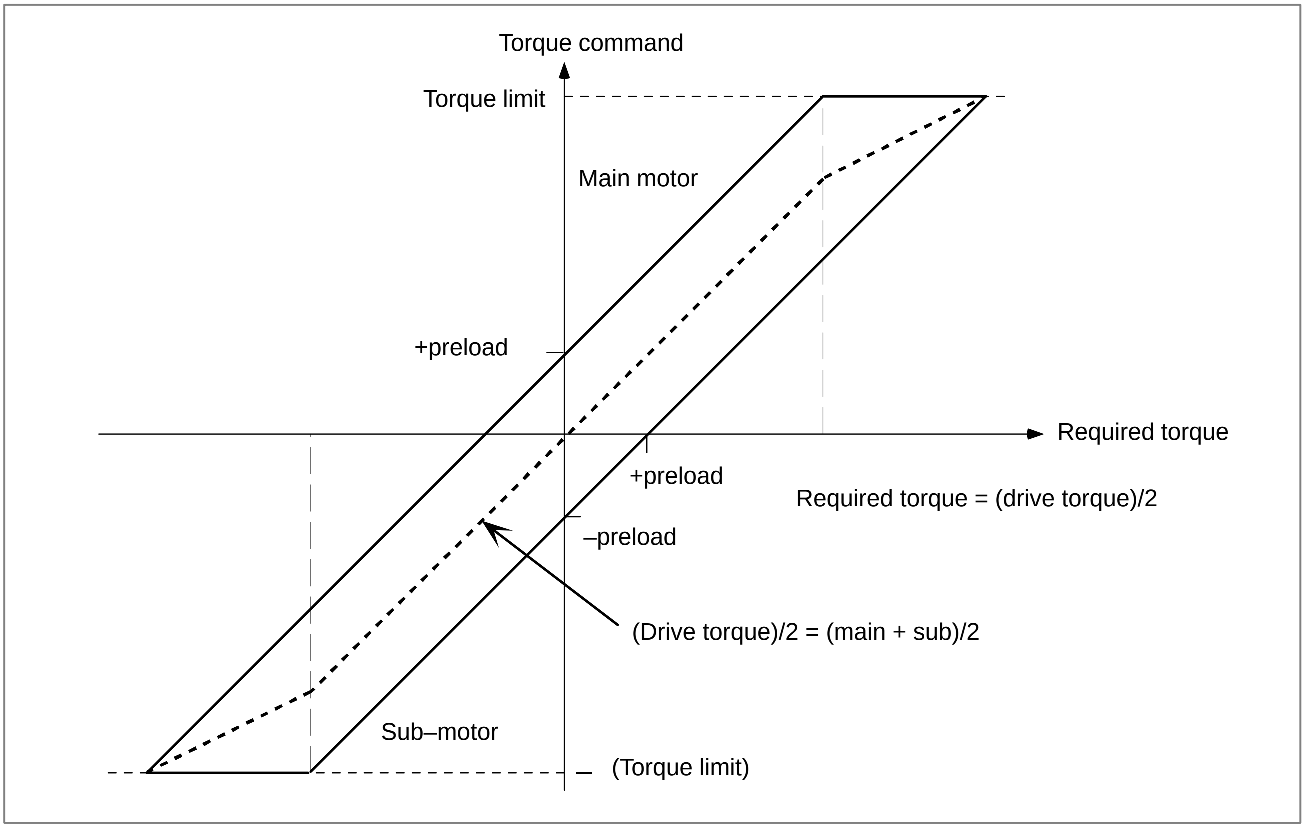


Fig. 4.20.1 (b) Relationship between required torque and torque command for each motor

1980	—	Preload value (PRLOAD)
2087	—	

Set this parameter for the main– and sub–axes.

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 static torque of each motor. As a guideline, specify a value equal to one–third of the rated static torque. As shown in Fig. 4.20.11 (a) in Subsec. 4.20.11, a preload torque is added in any case. So, set the preload torque directions as follows:

- When the rotation directions of the main axis and sub–axis are the same: Different signs
- When the rotation directions of the main axis and sub–axis are different: Same sign

Example of setting

For the α22/3000 (Servo module SVM1–130)

When a preload torque of 50 kgfcm is to be applied, the torque constant is 7.0 kgfcm/Arms according to the specifications of the servo motor. So, the peak value is 4.95 kgfcm/Ap. The torque is converted to a current value as follows: 50/4.95 = 10.1 Ap. The amplifier limit is 130 Ap, so that the value to be set is:

10.1/130 × 7282 = 566

So, set 566 for the main axis, and –566 for the sub–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

When two motors are not connected, always set a preload value of 0.

Otherwise, the sub–axis motor will rotate at extremely high speed, presenting a danger of unexpected machine operation if the motor is connected to the machine.

4.20.2
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 a low spring rigidity.

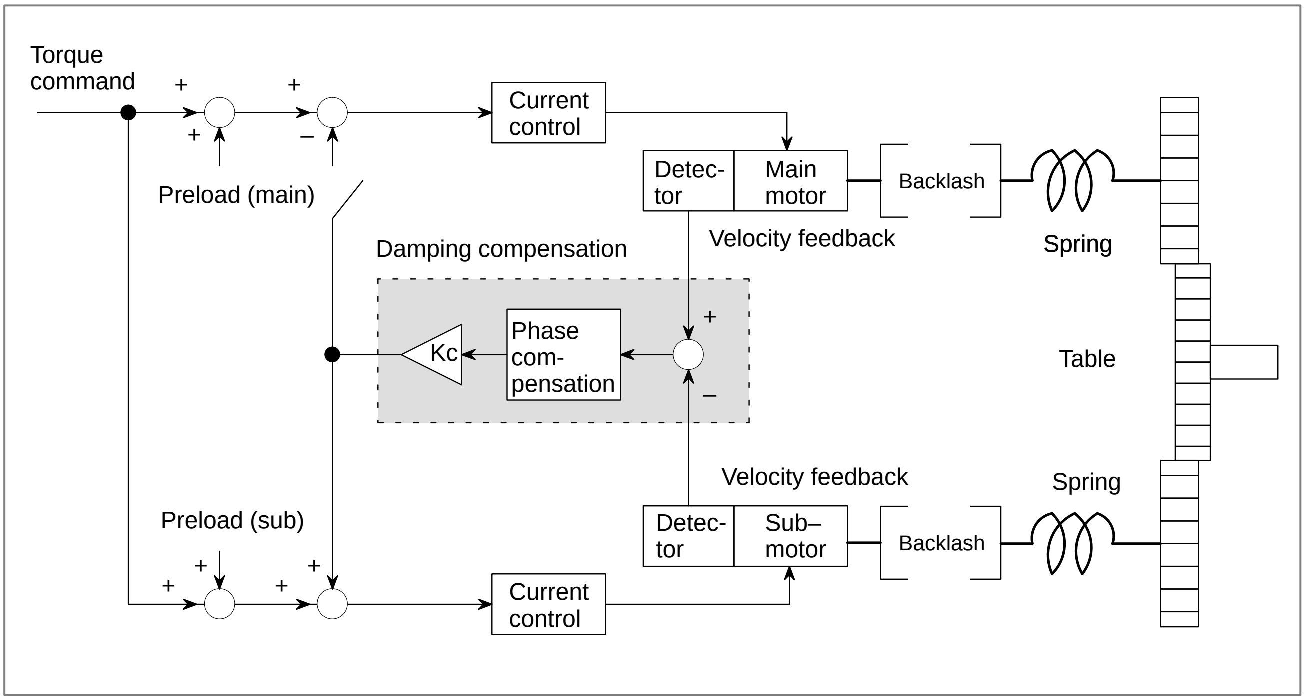


Fig. 4.20.2 (a) Damping compensation function

1952	—
2008	—

#7	#6	#5	#4	#3	#2	#1	#0
LAXDMP							

LAXDMP (#7) 1 : Enables the damping compensation function for the main– and sub–axes. When LAXDMP (#7) = 0, the damping compensation function is enabled for the sub–axis only. Usually, set this bit to 1. (Set this parameter for the **main axis only**.)

(Series 9060/001P and subsequent editions)
(Series 9080/001A and subsequent editions)

1721	—
2036	—

Damping compensation gain Kc (ABPGL)

Set this parameter for the **main axis only**.

[Valid data range] 0 to 32767

[Setting method] $Kc \times 32768\ (0 \leqq Kc < 0.5)$

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.

(Series 9060/001N and subsequent editions)
(Series 9080/001A and subsequent editions)

1721	—	Damping compensation phase coefficient α (ABPHL)
2036	—	

Set this parameter for the **sub–axis only**.

[Valid data range] 51 to 512

[Setting method] $\alpha \times 512$ ($0.1 \leqq \alpha \leqq 1$)

(Series 9060/001P and subsequent editions)
(Series 9080/001A and subsequent editions)

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 check board (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.

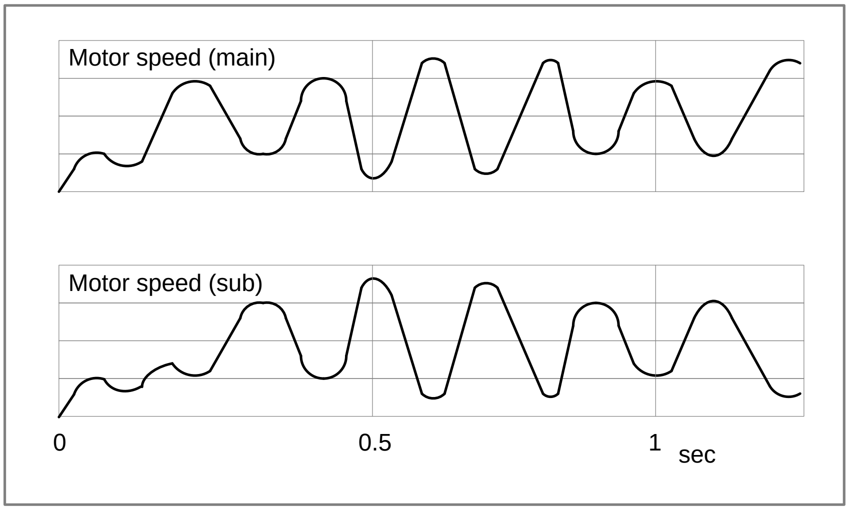


Fig. 4.20.2 (b) Motor speed vibration

Adjustment procedure:

1 Enable the velocity feedback averaging function.
[No. 1952#2 (Series 15–B), No. 2008#2 (Series 16) = 1]

2 Set an adequate preload value.
[No. 1980 (Series 15–B), No. 2087 (Series 16)]

Set a value slightly larger than the load applied during movement.

3 If hybrid control is used, set a time constant of 200
[No. 1932 (Series 15–B)].
Adjust the setting of the parameter to ensure stable axis movement.

4 Set 0 or 512 as phase coefficient α .
[Sub–axis No. 1721 (Series 15–B), No. 2036 (Series 16)]

If 512 is set, the value may have to be reduced when the vibration phase difference between the motors is other than 180°.

5 Set a damping gain of 3277.
[Main axis No. 1721 (Series 15–B), No. 2036 (Series 16)]

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.

6 Repeat steps **2** through **5** until smooth movement is achieved.

4.20.3
Velocity Feedback Averaging Function

As can be seen from the tandem control block diagram shown in Fig. 4.20.11 (a) in Subsec. 4.20.11, 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 averaging function.

		#7	#6	#5	#4	#3	#2	#1	#0
1952	—						VFBAVE		
2008	—								

VFBAVE (#2) 1 : Enables the velocity feedback averaging function. Usually, set this bit to 1. (Set this parameter for the **main axis only**.)

(Series 9060/001F and subsequent editions)
(Series 9080/001A and subsequent editions)

- Functions for improving the stability of a full–closed loop system

  When the tandem control function is used for a full–closed loop system that uses a linear scale, for example, the following three functions may also be used for improved stability and higher position gain:

  1) Dual position feedback function (See Subsec. 4.3.5.)
  2) Machine speed feedback function (See Subsec. 4.3.2.)
  3) Vibration–damping control function (See Subsec. 4.3.6.)

4.20.4
Servo Alarm 2–axis Monitor Function

Tandem control uses the same value, calculated from the main axis velocity loop, for both Tcmd for the main axis and that for the sub–axis, as shown in the tandem control block diagram (Fig. 4.20.11(a)). The current loop, however, operates independently for the main axis and sub–axis, based on the same Tcmd.

If an amplifier alarm is detected (DRDY is turned off) for either axis, therefore, the Mcc for that axis is turned off but the amplifier for the other axis will remain active, possibly causing the motor to operate such that the tandem axis becomes twisted. This can be prevented by monitoring for servo alarms for both axes simultaneously so that, upon the detection of a servo alarm for either axis, the Mcc for the other axis can be turned off immediately. This function is called the servo alarm two–axis monitor function.

		#7	#6	#5	#4	#3	#2	#1	#0
1951	—								ESP2AX
2007	—								

ESP2AX (#0) 1 : Enables the servo alarm two–axis monitor function.
(Set this parameter for the **main axis only**.)

(Series 9080/001K and subsequent editions)

4.20.5
Full Preload Function

(1) Overview

In tandem control, special preload torques of opposite directions, as shown in Fig. 4.20.5 (a), are applied to the main motor and sub–motor to establish tension in the system.

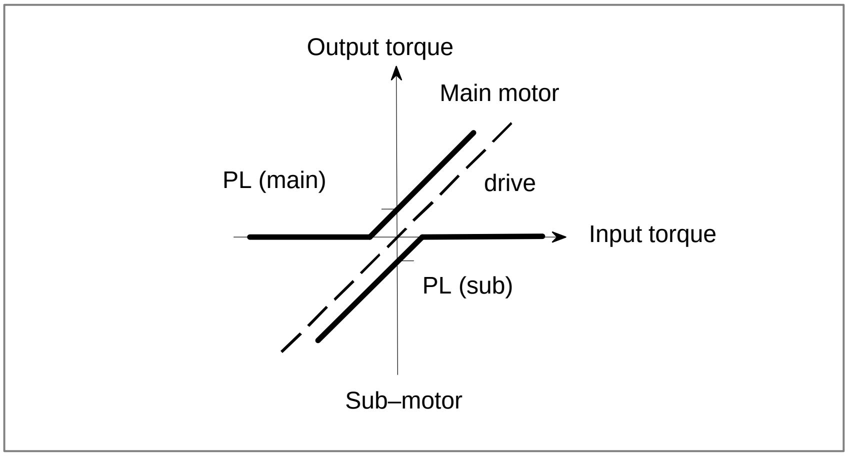


Fig. 4.20.5 (a) Full preload function

With these special torques, the rack and pinions can be kept in tension at all times, as shown in Fig. 4.20.5 (b). This function is referred to as the full preload function.

However, this function must be used together with the position feedback function, such that this function currently can only be used with the Series 15.

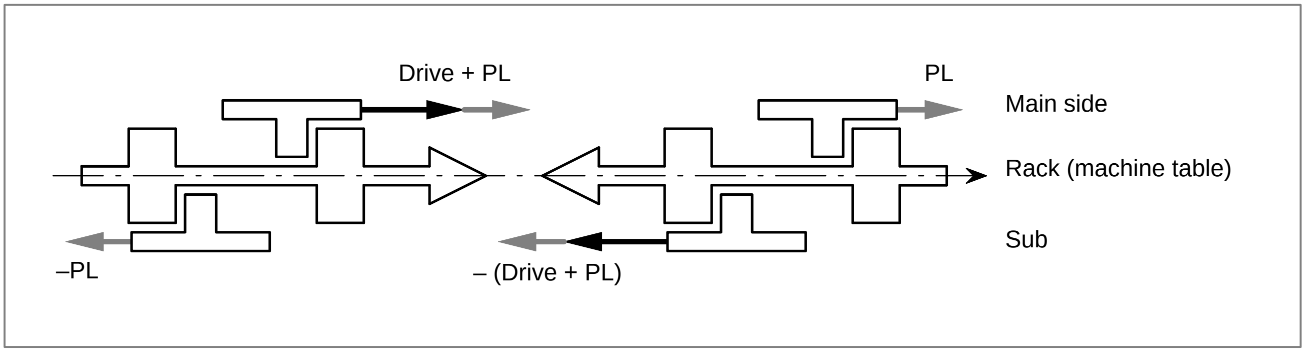


Fig. 4.20.5 (b) Relationship between full preloads and backlash (conceptual)

- **Servo block diagram (full preload function)**

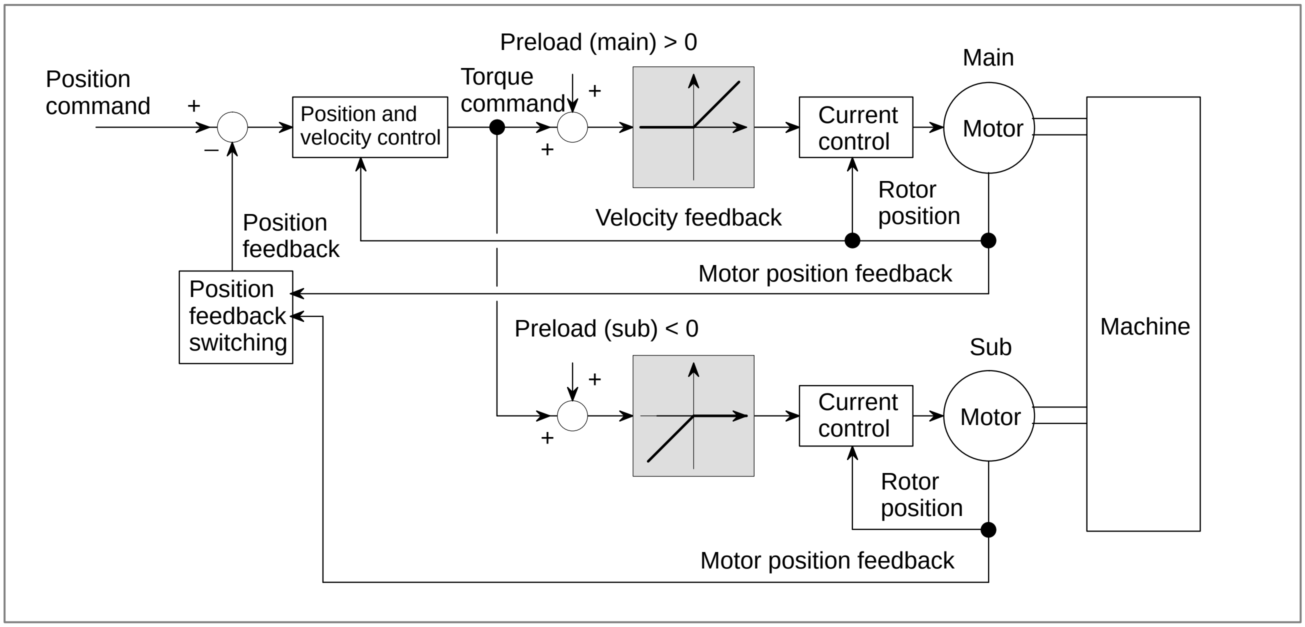


Fig. 4.20.5 (c) Servo block diagram (full preload function)

(2) Parameters for the full preload function

		#7	#6	#5	#4	#3	#2	#1	#0
1952	—					SPPRLD			
2008	—								

SPPRLD (#3) 1 : Enables the full preload function.
(Set this parameter for the **main axis only**.)

(Series 9060/001N and subsequent editions)
(Series 9080/001A and subsequent editions)

CAUTION
Always set this bit while the system is in the emergency stop state. After rewriting this bit, always turn the power to the NC off, then back on.

		#7	#6	#5	#4	#3	#2	#1	#0
1952	—				SPPCHG				
2008	—								

SPPCHG (#4) Specifies the motor output torque polarities:

1 : Outputs only the negative polarity to the main axis, and only the positive polarity to the sub–axis.

0 : Outputs only the positive polarity to the main axis, and only the negative polarity to the sub–axis.

(Set this parameter for the **main axis only**.)

See Fig. 4.20.5 (d).

(Series 9060/001N and subsequent editions)
(Series 9080/001A and subsequent editions)

CAUTION

Always set this bit while the system is in the emergency stop state. After rewriting this bit, always turn the power to the NC off, then back on.

- A motor torque with a positive polarity is a torque that is produced counter clockwise as viewed from the shaft.

- Preload torque signs to be set when the full preload function is used

  The polarity of a preload value must always be the same as that of the output torque. So, set the polarities as follows:

  When SPPCHG = 0 Main–side preload value ≧ 0
  Sub–side preload value ≦ 0

  When SPPCHG = 1 Main–side preload value ≦ 0
  Sub–side preload value ≧ 0

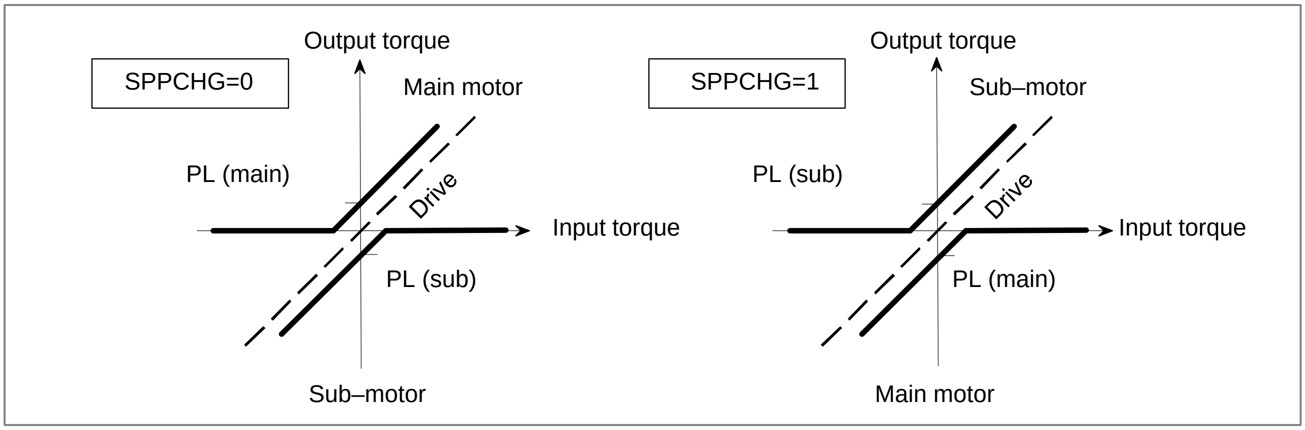


Fig. 4.20.5 (d) Torque output polarity switching and signs of preload values (PL)

(3) Changing the torque output polarity with the full preload function

When the full preload function is used together with synchronous tandem control as shown in Fig. 4.20.5 (e), set the torque output polarity with the parameter bit SPPCHG (No. 1952#4, No. 2008#4) so that the main motor on the master side and that on the slave side produce torques in the same direction.

WARNING

In the example shown in Fig. 4.20.5 (e), the main motor on the master side faces the main motor on the slave side. This means that if the same torque output polarity is set, the two main motors will produce opposing torques, resulting in twisting of the machine. In such a case, set the output polarities so that the output polarity on the master side is opposite to that on the slave side. That is, to prevent the machine from twisting, the output polarities of the motors must be determined according to the structure of the machine.

Table 4.20.5 (a) Example of setting (1)

Synchro-nous axis	Tandem axis	Motor name	SPPCHG	Preload value
Master	Main	X_M	0	+
	Sub	X_2		–
Slave	Main	X_3	1	–
	Sub	X_4		+

Another example is given below.

Table 4.20.5 (b) Example of setting (2)

Synchro-nous axis	Tandem axis	Motor name	SPPCHG	Preload value
Master	Main	X_M	1	–
	Sub	X_2		+
Slave	Main	X_3	0	+
	Sub	X_4		–

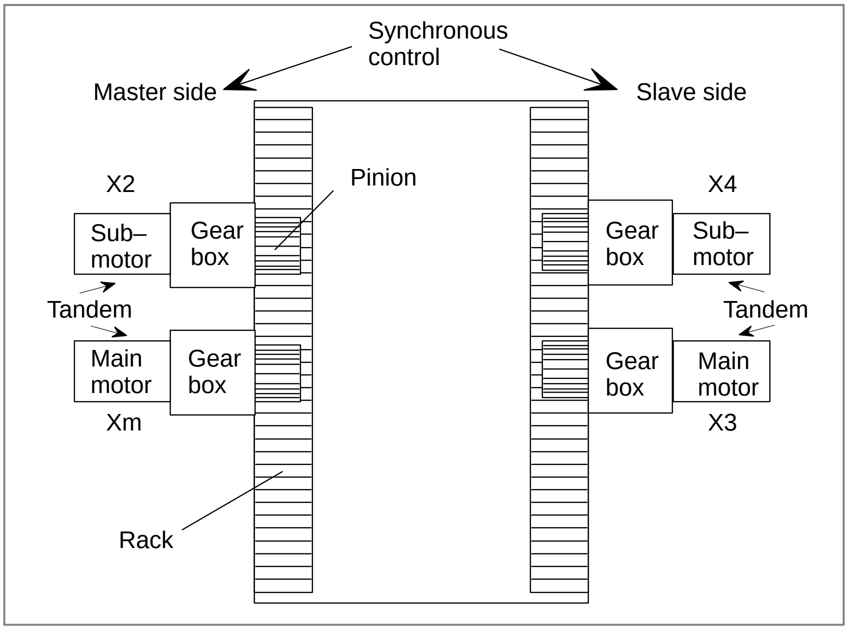


Fig. 4.20.5 (e) Synchronous tandem control

---

(4) Checking whether the full preload function is operating normally

- Observe Tcmd on the main– and sub–axes with the check board.
  The results are output to ch2 (main axis) and ch4 (sub–axis).
- After adjusting the damping compensation gain to 0, apply an acceleration/deceleration command. If the Tcmd value on the main side is positive, and the Tcmd value on the sub–side is negative, the full preload function is operating normally (when SPPCHG = 0).

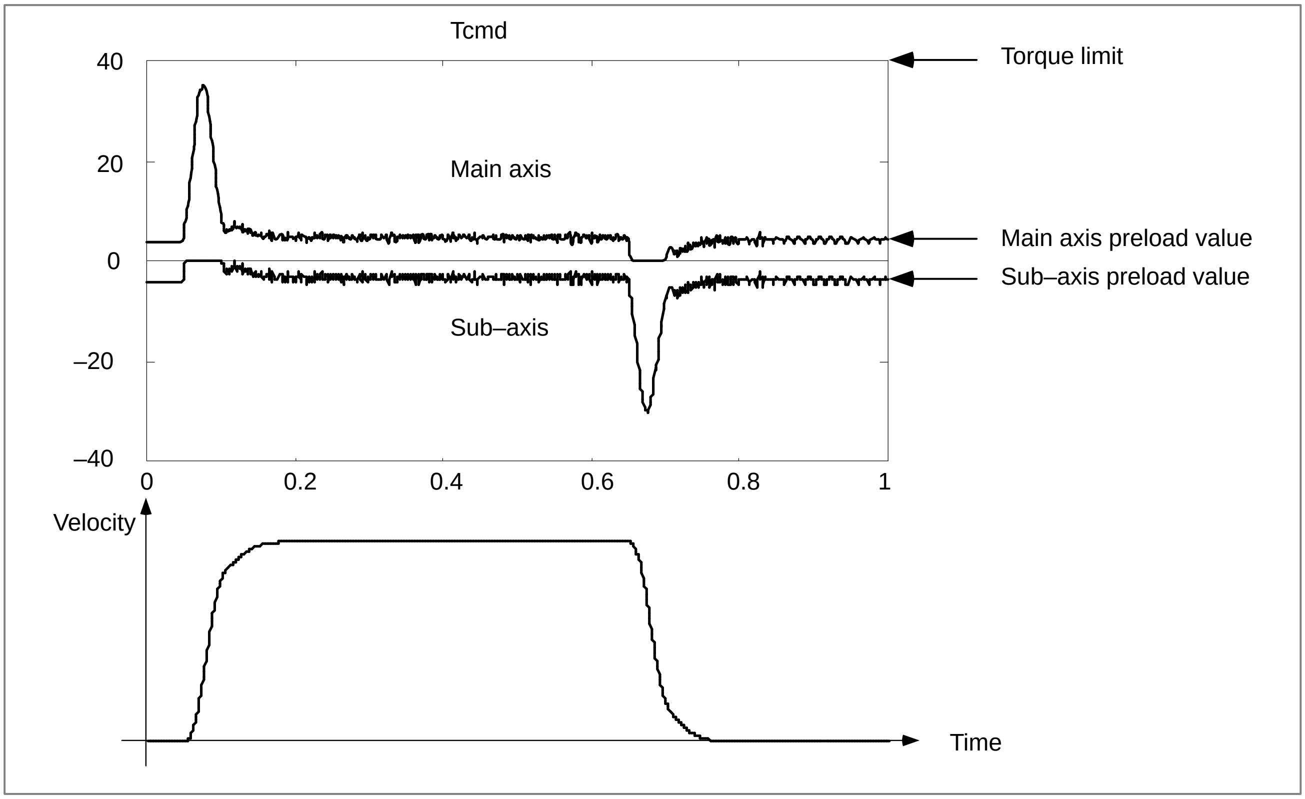


Fig. 4.20.5 (f) Tcmd at acceleration/deceleration time (when the full preload function is used)

4.20.6
Position Feedback Switching Function

When the full preload function is enabled, low servo rigidity can result in vibration, as shown in Fig. 4.20.6 (a), only in the case of driving by the sub–axis. In such a case, stable operation can be achieved by using the position feedback switching function.

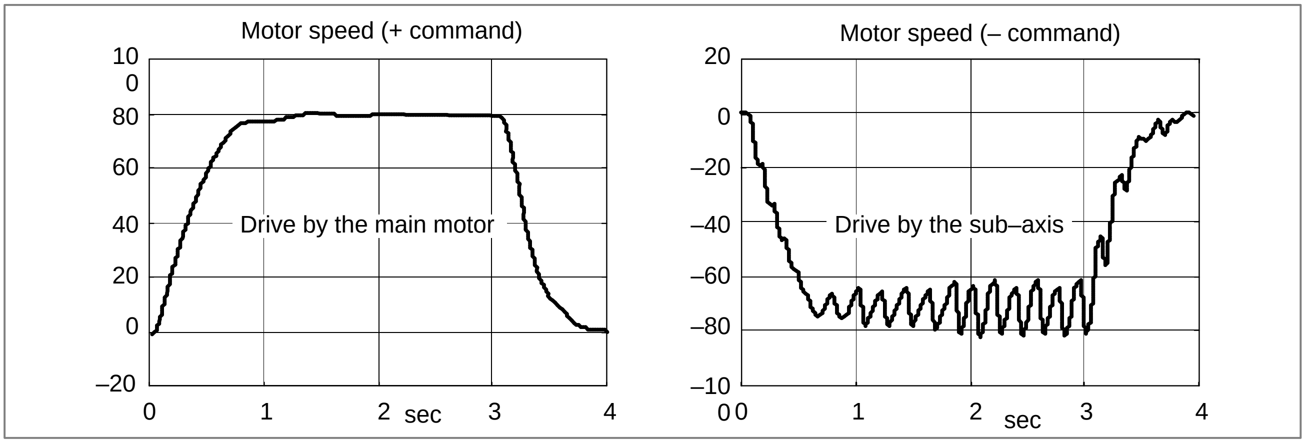


Fig. 4.20.6 (a) Motor speeds with plus–direction and minus–direction commands

1952	—
2008	—

#7	#6	#5	#4	#3	#2	#1	#0
	PFBSWC						

PFBSWC (#6) 1 : Switches position feedback according to the direction of a torque command.

0 : Always uses main axis position feedback.

(Set this parameter for the **main axis only**.)

(Series 9060/001P and subsequent editions)
(Series 9080/001A and subsequent editions)

CAUTION

Always set this bit while the system is in the emergency stop state. After rewriting this bit, always turn the power to the NC off, then back on.

1737	—
2126	—

Position feedback switching time constant τ (JITEI)

[Valid data range] 0 to 4096

[Method of setting] $\{1 - \exp(-1\ \mathrm{ms}/\tau)\} \times 4096$

[Standard setting] 0

When $\tau = \infty$: Parameter = 0
When τ = 50 ms: Parameter = 81
When $\tau = 0$: Parameter = 4096

(Set this parameter for the **main axis only**. Set 0 for this parameter for the sub–axis.)

NOTE

This parameter is valid only when PFBSWC = 1.

- **Notes on the position feedback switching function**

- Reference position return operation and positioning are performed with the main axis only. Note, however, that during movement (command$\neq$0), position feedback on the driving side is used for position control. (A switching time constant is to be specified with the parameter.)
- Adjust the switching time constant if a shock is observed at the time of position feedback switching.
- Basically, the position feedback switching function assumes setting of semi–closed loop mode. When the position feedback switching function is to be used with full–closed loop mode, divide the scale signal into two to apply the same signal to both the main and sub–sides.
  (When a serial separate pulse coder is being used, do not connect the REQ signal for the sub–axis.)
  Moreover, set full–closed loop mode for the main and sub–sides as well.

  At present, this function can be used only with the Series 15.

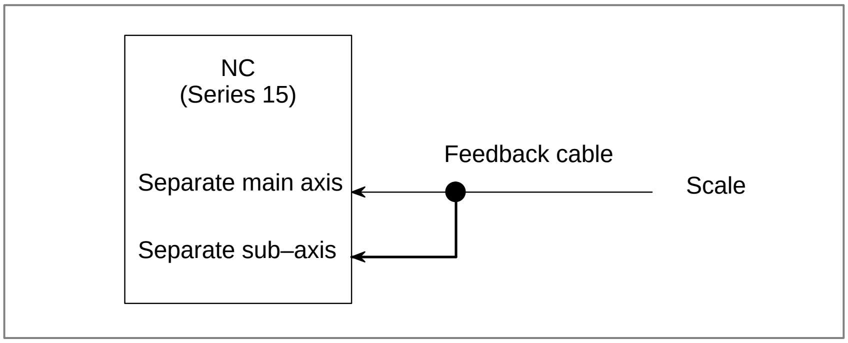


Fig. 4.20.6 (b) Cable on the scale side when the position feedback switching function is used (full–closed loop)

4.20.7
Velocity Command Tandem Control

Subsec. 4.20.10 (tandem control and synchronous control selection criteria) suggests that synchronous control is to be used when back–feed is impossible. When synchronous control cannot be used, velocity command tandem control can be used. The same velocity command is output, to the main and sub–sides, to enable velocity control on each side. Position control is exercised on the main side only. Only velocity control is exercised on the sub–side.

NOTE

The name of the control depends on the common command for tandem control. When the same position command is used, the name is synchronous control. When the same velocity command is used, the name is velocity command tandem control. When the same torque command is used, the name is (torque command) tandem control.

		#7	#6	#5	#4	#3	#2	#1	#0
1952	—			VCMDTM					
2008	—								

VCMDTM (#5) 1 : Enables velocity command tandem control.
(Set this parameter for the **main axis only**.)

(Series 9060/001N and subsequent editions)
(Series 9080/001A and subsequent editions)

NOTE

Usually, set this bit to 0. This function cannot be used together with tandem control. Moreover, set a preload value of 0.

For velocity command tandem control, usually set the same values for the servo parameters for the main axis and sub–axis.

4.20.8

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 (α300, α400) with the wire tandem specification is used.

The motor feedback sharing function is usually used in combination with the velocity command tandem control function.

		#7	#6	#5	#4	#3	#2	#1	#0
1960	—	PFBCPY							
2018	—								

PFBCPY (#7) 1 : The motor feedback signal for the main axis is shared by the sub–axis motor.
(Set this parameter for the **sub–axis only**.)

(Series 9080/001A and subsequent editions)

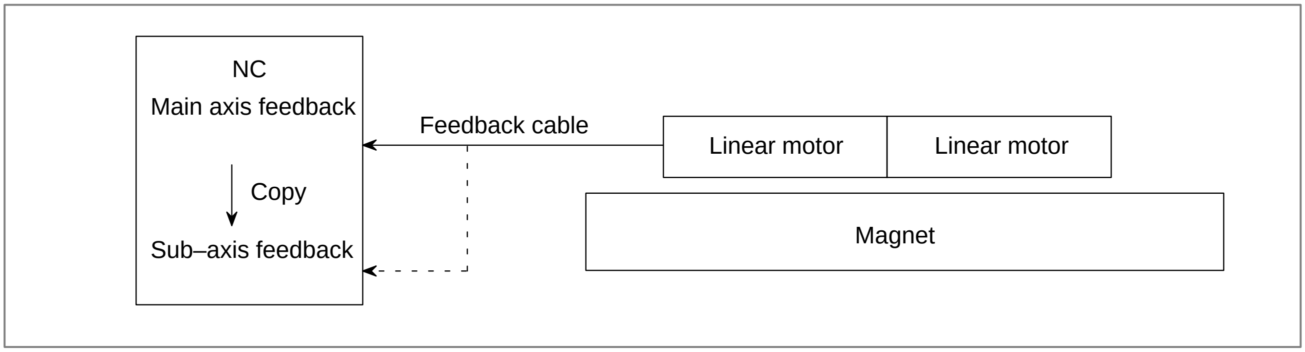


Fig. 4.20.8 Motor feedback sharing function

4.20.9
Adjustment

(1) Preparation prior to start–up

(a) Check the command cables and feedback cables.

(b) Set the tandem axis parameters.

	Series 16	Series 15
☐ The main and sub–axes are set as tandem axes.	No.1817#6	No.1817#6
☐ Odd–numbers are assigned to the main axes, and even–numbers are assigned to the sub–axes.	No.1023	No.1023

(c) Set position feedback (for the main and sub–axes).
Set the parameters, assuming that position feedback is also available for the sub–axis as shown in Fig. 4.20.9.

☐ Setting semi–closed loop mode or full–closed loop mode.	No.1815#1	No.1815#1 No.1807#1
☐ DMR setting	No.1816	No.1816
☐ CMR setting	No.1820	No.1820
☐ Setting the reference counter capacity	No.1821	No.1896
☐ Setting the high–resolution pulse coder	No.2000#0	No.1804#0
☐ Setting the number of velocity detection pulses	No.2023	No.1876
☐ Setting the number of position detection pulses	No.2024	No.1891
☐ Flexible feed gear (numerator) setting	No.2084	No.1977
☐ Flexible feed gear (denominator) setting	No.2085	No.1978

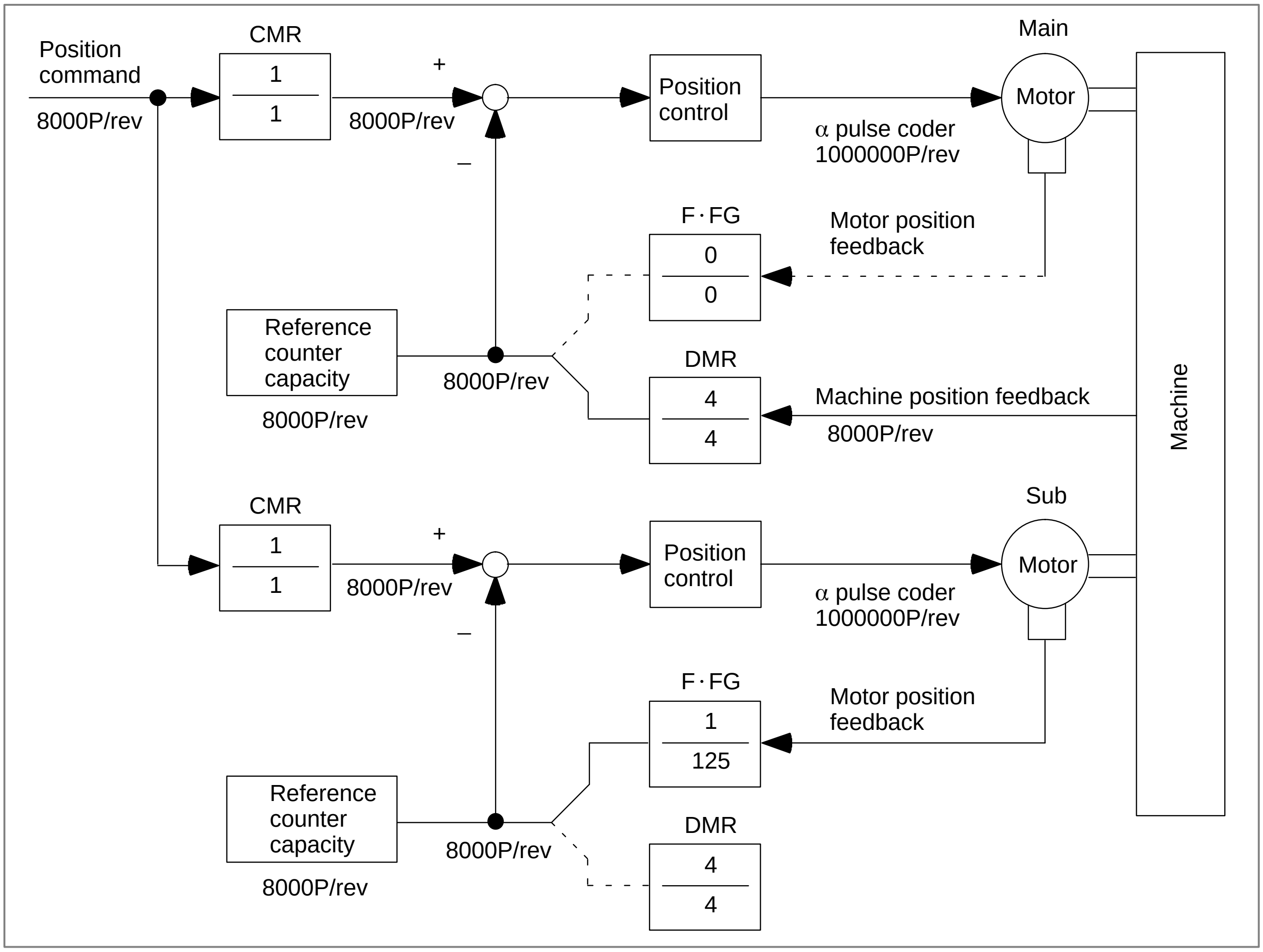


Fig. 4.20.9 Example of position feedback setting

(d) Example of position feedback setting

(i) Full–closed loop system using a 1–μm increment system, 8080 P/motor revolution for scale feedback, a scale detection unit of 0.5 μm/P, and an α 64 pulse coder

	Series 16	Series 15	Main	Sub
• Full–closed loop	No. 1815	No. 1815	00000010	00000000
		No.1807	00001000	00000000
• DMR	No.1816	No.1816	01110000	01110000
• CMR	No.1820	No.1820	4	4
• Reference counter capacity	No.1821	No.1896	8080	8080
• High–resolution pulse coder	No.2000	No.1804	00000000	00000000
• Number of velocity detection pulses	No.2023	No.1876	8192	8192
• Number of position detection pulses	No.2024	No.1891	8080	12500
• Flexible feed gear	No.2084	No.1977	0	101
• Flexible feed gear	No.2085	No.1978	0	12500

(ii) Semi–closed loop system using a 1–μ° increment system, rotary axis with a gear reduction ratio of 1/984, and an α 64 pulse coder

	Series 16	Series 15	Main	Sub
• Semi–closed loop	No. 1815	No. 1815	00000000	00000000
		No.1807	00000000	00000000
• DMR	No.1816	No.1816	01110000	01110000
• CMR	No.1820	No.1820	2	2
• Reference counter capacity	No.1821	No.1896	15000	15000
• High–resolution pulse coder	No.2000	No.1804	00000000	00000000
• Number of velocity detection pulses	No.2023	No.1876	8192	8192
• Number of position detection pulses	No.2024	No.1891	12500	12500
• Flexible feed gear	No.2084	No.1977	3	3
• Flexible feed gear	No.2085	No.1978	8200	8200

$$\frac{360000/984}{1000000} = \frac{36}{98400} = \frac{3}{8200}$$

(2) Start–up procedure

(a) Always set the emergency stop state before setting the motor rotation direction parameter. Based on the machine configuration, set the direction of rotation when the machine moves in the positive (+) direction (+ direction of the NC command) as described below. After setting, the power to the NC must be turned off, then back on.

Direction of rotation = 111 (counterclockwise as viewed from the motor shaft)
Direction of rotation = –111 (clockwise as viewed from the motor shaft)

(b) 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.

(i) 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.

(ii) Making a check using NC commands

After checking (c) and (d) 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.

(c) 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.

(d) Check the operation by entering a plus (+) command and minus (–) command.

If the error persists due to friction load, increase the torque limit.

(e) If the operation is normal, return the torque limit to its original value, then set a preload value.

---

(3) Adjustment items

If vibration occurs:

- Check the position feedback setting (Art. (1) in Subsec. 4.20.9).
- Check Vcmd (CH1), Tcmd (CH2 and CH4), and the speeds (CH5 and CH6) using the check board.

(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 averaging function.

(No. 1952#2 = 1) Series 15
(No. 2008#2 = 1) Series 16

(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. 4.20.2.)

(No. 1721) Series 15
(No. 2036) Series 16

(c) The operation of a full–closed–loop system is unstable.

→ Check the position feedback setting (Item (c) and (d) in Art. (1).) 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. 1980) Series 15
(No. 2087) Series 16

(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.

4.20.10
Notes on Tandem Control

(1) Tandem control and synchronous control selection criteria

Two control methods are supported to enable the control of one axis using two motors: tandem control and synchronous control. The synchronous control method controls the position of the master axis and slave axis by using the same command. If a position feedback difference occurs between the two motors, control is applied by correcting the slave axis. The servo system applies position control separately to the master and slave axes.

The tandem control method exercises position control over the main axis only; this method exercises torque control over the sub–axis only. (For clarity, the terms master and slave are used for synchronous control, while main and sub are used for tandem control.) When building a machine system, select a suitable control method, paying careful attention to the differences between the control methods.

In general, apply the following guideline:

- When the machine system is rigid or supports back–feed, select tandem control.
- When the machine system exhibits effects such as twisting, or does not support back–feed, select synchronous control (for example, when a gantry type machine or worm wheel is used.)

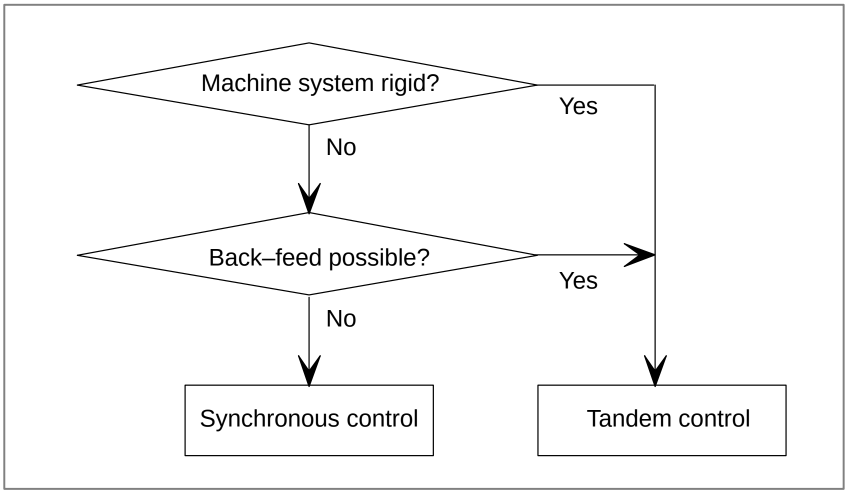


Fig. 4.20.10 (a) Flow of selection

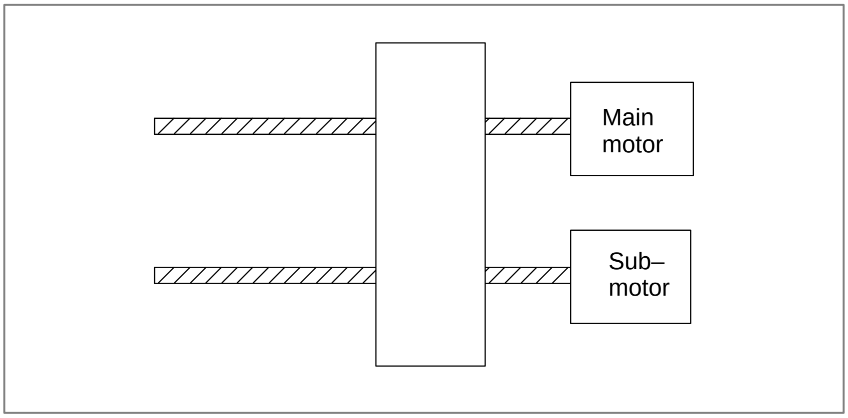


Fig. 4.20.10 (b) Example of synchronous control (machine system not supporting back–feed)

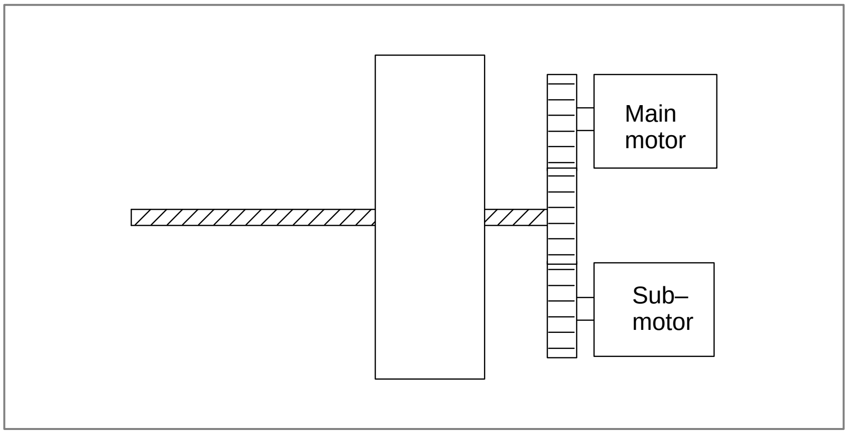


Fig. 4.20.10 (c) Example of tandem control (rigid machine system)

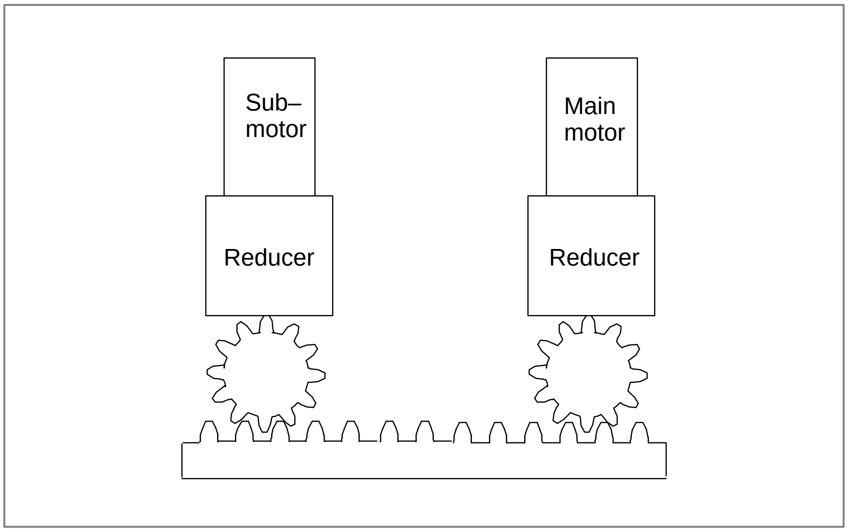


Fig. 4.20.10 (d) Example of tandem control (machine system supporting back–feed)

4.20.11 Block Diagrams

(1) Tandem control

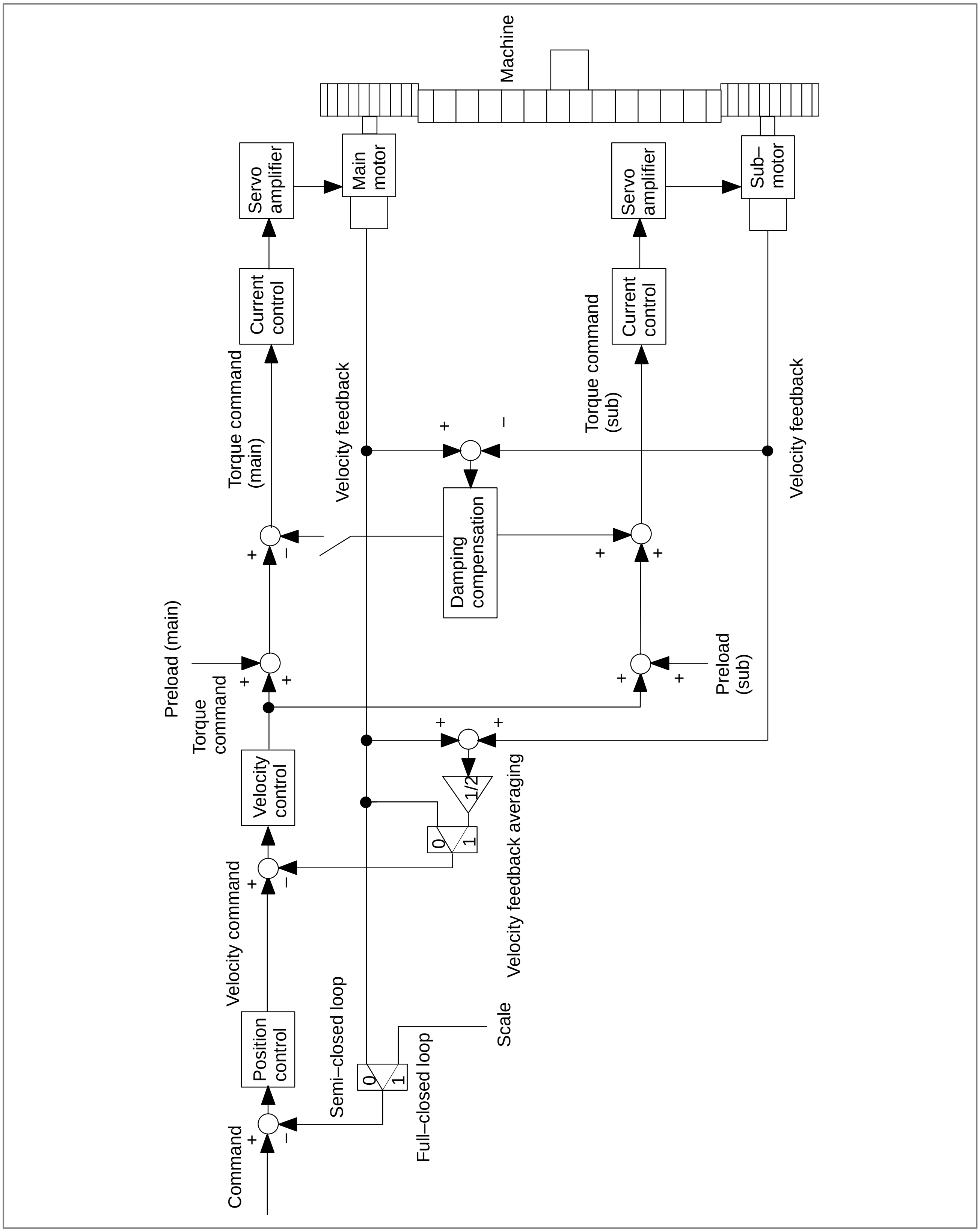


Fig. 4.20.11 (a) Tandem control (typical)

(2) Tandem control (with full preload function)

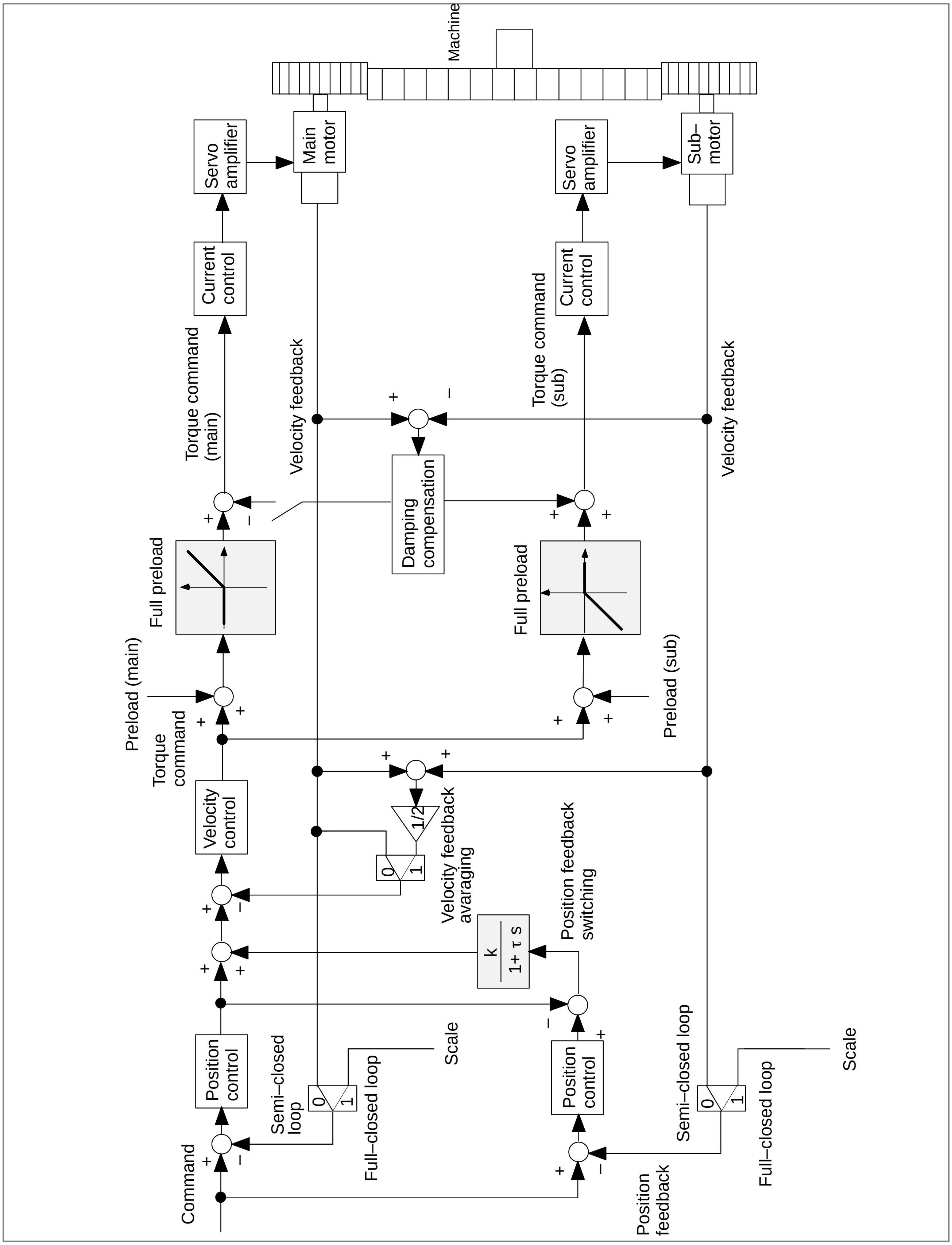


Fig. 4.20.11 (b) Tandem control (with full preload function)

(3) Velocity command tandem control

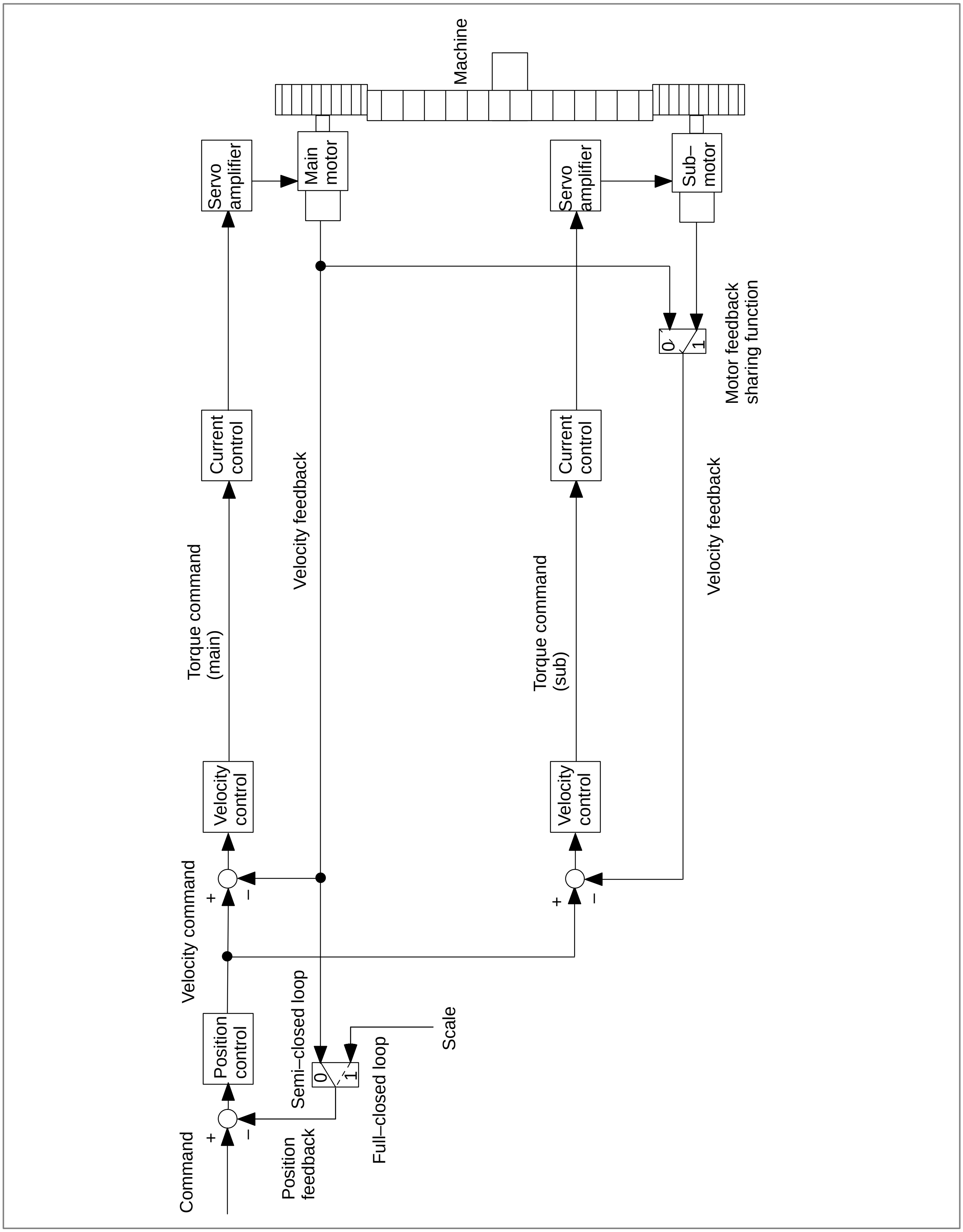


Fig. 4.20.11 (c) Velocity command tandem control

5 DIFFERENCES BETWEEN THE PARAMETERS FOR THE FANUC Series 15–A AND 15–B

(1) Overview

The Series 15–A and 15–B incorporate servo software of different series. For some servo functions, they use different parameter numbers and setting methods.

The Series 15–A and 15–B are applicable to the following servo ROMs that support the α servo–mechanism:

NC model	Series of servo ROM applicable to the α servo–mechanism
Series 15–A	Series 9041 (supporting dual position feedback) Series 9046 (supporting standard and high–speed positioning)
Series 15–B	Series 9060 (supporting the 320C25 servo module) Series 9070 (supporting the 320C51 servo module) Series 9080 (supporting the 320C52 servo module) Series 9081 (supporting the 320C52 servo module)

The parameter numbers and setting methods differ for the following servo functions:

1	Dual position feedback function	2	High–speed positioning function
3	Feed–forward function	4	Machine velocity feedback function
5	Functions for α motor	6	Function for extending position gain setting range

(2) Details

(a) Dual position feedback function (See Subsec. 4.3.5.)

The Series 15–A and 15–B use different numbers for the parameter that enables this function. For other parameters related to this function, however, the two systems use the same numbers.

Function	Series 15–A (Series 9041)	Series 15–B
Enable bit	No. 1955#7	No. 1709#7
Maximum amplitude Conversion coefficient (numerator/denominator) Primary delay time constant Zero width	No. 1861 No. 1971 / No.1972 No.1973 No. 1974	

(b) High–speed positioning function (See Sec. 4.9.)

The Series 15–A and 15–B use different parameter numbers for this function.

<table>
<tr><th colspan="3">Low–speed integration</th></tr>
<tr><th></th><th>Series 15–A
(Series 9046)</th><th>Series 15–B</th></tr>
<tr><td>Enable bit
Disable speed
Enable speed</td><td>No. 1954#6
No. 1972
No. 1973</td><td>No. 1957#1
No. 1714
No. 1715</td></tr>
<tr><th colspan="3">Position gain switch function</th></tr>
<tr><td>Enable bit
Switching speed</td><td>No.1954#5
No. 1974</td><td>No.1957#0
No. 1713</td></tr>
</table>

(c) Feed–forward function (See Subsec. 4.5.1.)

(d) Machine speed feedback function (See Subsec. 4.3.2.)

For the functions indicated above, the Series 15–A and 15–B use identical parameter numbers and different setting methods.

NC model	Position feed–forward coefficient (Parameter 1961) Machine speed feedback coefficient (Parameter 1981)
Series 15–A	$\text{Set value} = \alpha \times 4096 \times \dfrac{8192}{\text{Number of position feedback pulses per motor revolution}}$
Series 15–B	$\text{Set value} = \alpha \times 100 \quad (\alpha : 0 \text{ to } 1)$

NC model	Velocity feed–forward coefficient (Parameter 1985)
Series 15–A	$\text{Set value} = \alpha \times 4096 \times \dfrac{8192}{\text{Number of position feedback pulses per motor revolution}}$
Series 15–B	$\text{Set value} = \alpha \times 10000 \quad (\alpha : 0 \text{ to } 1)$

NC model	Velocity feed–forward coefficient (Parameter 1962)
Series 15–A	$\text{Set value} = (-\text{PK2V}) \times \dfrac{\text{Rotor inertia + load inertia}}{\text{Rotor inertia}} \times \dfrac{0.04 \times 8000}{\text{Number of position feedback pulses per motor revolution}}$
Series 15–B	$\text{Set value} = \dfrac{\text{Rotor inertia + load inertia}}{\text{Rotor inertia}} \times 100$

(e) α motor functions

The Series 15–A and 15–B use different parameter numbers and setting methods for these functions.

Function	Series 15–A (Series 9046)	Series 15–B
TCMD–dependent current loop gain change function	No. 1864 (Low–byte)	No. 1967
TCMD–dependent phase–advance compensation function	No. 1991 (common)	
Actual current limit function		
Enable bit	No. 1954#1	No. 1955#5
Set value	No. 1864 (High–byte)	No. 1995

(f) Function for extending the position gain setting range

The Series 15–A and 15–B use different parameter numbers and setting methods for this function.

Function for extending the position gain setting range		
Function	**Series 15–A**	**Series 15–B**
Enable bit	No.1955#5	No.1804#4
Setting method	The number of position pulses (parameter 1891) is multiplied by 8.	Above bit only

6

DETAILS OF PARAMETERS

6.1 DETAILS OF Series 0–C AND 15–A SERVO PARAMETERS (9041, 9046 SERIES)

The descriptions of parameters follow.
For parameters for which a specification method is not described, do not change the parameters from the values set up automatically during servo parameter initialization.
The parameters in the upper row apply to Series 0–C, and those in the lower row, to Series 15–A.

	#7	#6	#5	#4	#3	#2	#1	#0
8X00							DGPR	HRPC
1804							DGPR	PLCO

Series 15–A

PLCO (#0) 0.1 μm control is:

0 : Not performed
1 : Performed

Series 0–C

HRPC (#0) 0.1 μm control is:

0 : Not performed
1 : Performed

For Series 0–C, setting bit 0 (HRPC) of parameter No. 8X00 to 1 increases the weight of the following parameters by 10 times.

No.8X23	Number of velocity feedback pulses	Set value	× 10
No.8X24	Number of position feedback pulses	Set value	× 10
No.0004	Capacity of reference counter	Set value	× 10
No.0504	Move position deviation	Set value	× 10
No.0508	Grid Shift	Set value	× 10

DGPR (#1) When power is switched on, the motor–specific digital servo parameter is:

0 : Not performed
1 : Specified

After a motor ID No. is set in parameter Nos. 8X20 and 1874 (motor type), if DGPR is set to 0, the motor–specific parameter is set to a standard value when power is switched on. DGPR is also set to 1 simultaneously.

8X01	#7	#6	#5	#4	#3	#2	#1	#0
1806	AMR7	AMR6	AMR5	AMR4	AMR3	AMR2	AMR1	AMR0

ARM0 to ARM7 (#0 – #7)

Set AMR values according to the number of pulses output from the pulse coder of the motor.

ARM								
7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	α pulse coder, and serial pulse coder A other than the following models
0	0	0	0	0	0	1	1	AC3–0S, 4–0S
1	0	0	0	0	0	1	0	AC5–0

8X02	#7	#6	#5	#4	#3	#2	#1	#0
1807					PFSE			

PFSE (#3) The separate detector is:

1 : Used

0 : Not used

This parameter must be set only for Series 15–A. For Series 0–C, specifying parameter No. 0037 specifies this parameter automatically.

8X03	#7	#6	#5	#4	#3	#2	#1	#0
1808	VOFS	OVSC	BLEN	NPSP	PIEN	OBEN	TGAL	

TGAL (#1) Software disconnection alarm detection level is:

0 : Set to a standard value

1 : Lowered to a value specified separately

Related parameter:

8X64 (Series 0–C) and 1892 (Series 15–A)

OBEN (#2) The velocity control observer is:

0 : Not used

1 : Used

(For details of this function, see Subsec. 4.3.3)

Related parameters:

8X47 (Series 0–C) and 1859 (Series 15–A)
8X50 (Series 0–C) and 1862 (Series 15–A)
8X51 (Series 0–C) and 1863 (Series 15–A)

PIEN (#3) Velocity control is :

0 : Set to IP

1 : Set to PI

NPSP (#4) The N-pulse suppress function is :

0 : Not used

1 : Used

(For details of this function, see Subsec. 4.2.1)

BLEN (#5) The backlash acceleration function is :
0 : Not used
1 : Used
(For details of this function, see Subsec. 4.5.4)
Related parameters :
8X48 (Series 0–C) and 1860 (Series 15–A)

OVSC (#6) The overshoot compensation function is :
0 : Disabled
1 : Enabled
(For details, see Sec. 4.4)
Related parameters :
8X45 (Series 0–C) and 1857 (Series 15–A)

VOFS (#7) The VCMD offset function is :
0 : Not used
1 : Used

	#7	#6	#5	#4	#3	#2	#1	#0
8X04 1809		DLY0						

DLY0 (#6) The PWM dead zone is set to:
0 : 8 μs
1 : 16 μs

This parameter must always be 1 for S Series servo amplifiers.

	#7	#6	#5	#4	#3	#2	#1	#0
8X05 1883	SFCM	BLKC					FEED	

FEED (#1) The feed forward function is :
0 : Disabled
1 : Enabled
(For details, see Subsec. 4.5.1)
Related parameters :
8X68 (Series 0–C) and 1961 (Series 15–A)

BLKC (#6) The vertical axis brake control function is :
0 : Disabled
1 : Enabled
(For details, see Sec. 4.8)
Related parameters :
8X83 (Series 0–C) and 1976 (Series 15–A)

SFCM (#7) The static friction compensation function is:
0 : Disabled
1 : Enabled
(For details, see Subsec. 4.5.7.)
Related parameters:
8X03 (Series 0–C) and 1808 (Series 15–A)
8X72 (Series 0–C) and 1965 (Series 15–A)
8X73 (Series 0–C) and 1966 (Series 15–A)

8X06
1884

#7	#6	#5	#4	#3	#2	#1	#0
	DCBE		ACCF		PKVE	DBST	FCBL

FCBL (#0) In closed loop feedback :

0 : Backlash compensation pulses are set into error counter as compensation.
1 : Backlash compensation pulses are not used for position compensation.

(For details, see Subsec. 4.5.4)

Related parameter:
8X48 (Series 0–C) and 1860 (Series 15–A)

If this parameter is set to 1, quadrant protrusions caused by backlash can be reduced even in a closed loop system.
Generally, in a closed loop system, backlash compensation is not set. If FCBL is set to 1, however, protrusions can be reduced without position deviation.

DBST (#1) The stop distance reduction function is:

0 : Disabled.
1 : Enabled.

(For details, see Sec. 4.7)

Related parameters
8X05 (Series 0–C) and 1883 (Series 15–A)
8X83 (Series 0–C) and 1976 (Series 15–A)

PKVE (#2) The velocity dependent current loop gain variable function is :

0 : Disabled
1 : Enabled

Related parameters :
8X74 (Series 0–C) and 1967 (Series 15–A)

ACCF (#4) The 1-ms acceleration feedback function is :

0 : Disabled
1 : Enabled

Related parameters :
8X67 (Series 0–C) and 1895 (Series 15–A)
8X76 (Series 0–C) and 1969 (Series 15–A)

DCBE (#6) During deceleration, back electromotive force compensation is:

0 : Disabled
1 : Enabled

8X09
1953

#7	#6	#5	#4	#3	#2	#1	#0
BLST	BLCU		K2VC		ADBL		SERD

SERD (#0) The dummy serial feedback function is:

0 : Disabled
1 : Enabled

If this parameter is specified for axes to which a servo amplifier or motor is not connected, alarms related to pulse coders and amplifiers are ignored.
(For details, see Sec. 4.6).

ADBL (#2) The new backlash acceleration function is :

0 : Disabled
1 : Enabled

(For details, see Subsec. 4.5.5)

Related parameters :

8X48 (Series 0–C) and 1860 (Series 15–A)
8X87 (Series 0–C) and 1980 (Series 15–A)

K2VC (#4) The function for changing the proportional gain in the stop state is:

0 : Disabled.
1 : Enabled.

(For details, see Subsec. 4.2.2.)

Related parameters

8X89 (Series 0–C) and 1982 (Series 15–A)

BLCU (#6) The function for enabling the backlash acceleration function only during cuttingis :

0 : Disabled
1 : Enabled

(For details, see Subsec. 4.5.4)

BLST (#7) The backlash acceleration stop function is :

0 : Disabled
1 : Enabled

(For details, see Subsec. 4.5.4)

Related parameters :

8X82 (Series 0–C) and 1975 (Series 15–A)

	#7	#6	#5	#4	#3	#2	#1	#0
8X10	POLE	SSG1	PGTW		BLTE		RCCL	
1954	—	MVFB	—		BLTE		RCCL	

The upper row is for the Series 9046.
The lower row is for the Series 9041.

RCCL (#1) The actual–current limit function is:

0 : Disabled
1 : Enabled

Related parameter:

8X52 (Series 0–C) and 1864 (Series 15–A)

BLTE (#3) Multiplication of the backlash acceleration amount by 10 (For high-resolution pulse coders) is :

0 : Disabled
1 : Enabled

PGTW (#5) The position gain switch function is:

0 : Disabled.
1 : Enabled.

(For details, see Subsec. 4.9.1)

SSG1 (#6) The low–speed integration function is:

0 : Disabled.
1 : Enabled.

(For details, see Subsec. 4.9.2.)

This bit functions with the Series 9046 only.

MVFB (#6) The machine speed feedback function is:

0 : Disabled
1 : Enabled

(For details, see Subsec. 4.3.2.)
This bit functions with the Series 9041 only.

POLE (#7) The punch laser function is:

0 : Disabled.
1 : Enabled.

This bit is supported by the Series 9046 only.

	#7	#6	#5	#4	#3	#2	#1	#0
8X11 1954	DPFB		PGEX					

PGEX (#5) The position gain range

0 : Not expanded
1 : Expanded by 8 times
(For details, see Subsec. 2.1.4)

DPFB (#7) The dual position feedback function is :

0 : Invalidated.
1 : Validated.
(For details, see Subsec. 4.3.5.)

	#7	#6	#5	#4	#3	#2	#1	#0
8X12 1956			VCMD2	VCMD1			MSFE	
Standard : Setting	0	0	0	0	0	0	1	0

MSFE (#1) The machine speed feedback function is :

0 : Disabled
1 : Enabled

(For details, see Subsec. 4.3.2)

Related parameter:

8X88 (Series 0–C) and 1981 (Series 15–A)

VCMD1 (#4), VCMD2 (#5)

The VCMD waveform is converted according to the table below.
(For details, see Sec. 4.11.)

VCMD2	VCMD1	Number of velocity commnd revolution/ 5V
0	0	0.9155 rpm
0	1	14 rpm
1	0	234 rpm
1	1	3750 rpm

★ : Do not change.

Series		**Details**	
0–C	**15–A**		
8X20	1874	Motor No. The data range varies with the edition. Series 9046/Edition 001A: 3 to 89 Series 9046/Edition 001B: 3 to 89	⇒ 2.1.2
8X21	1875	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.
8X22	1879	Motor rotation direction	⇒ 2.1.2
8X23	1876	Number of velocity pulses	⇒ 2.1.2
8X24	1891	Number of position pulses	⇒ 2.1.2
8X40	1852	Current loop gain (PK1)	★
8X41	1853	Current loop gain (PK2)	★
8X42	1854	Current loop gain (PK3)	★
8X43	1855	Velocity loop integral gain (PK1V)	Adjust for individual machines separately.
8X44	1856	Velocity loop proportional gain (PK2V)	
8X45	1857	Velocity loop incomplete integral gain (PK3V)	⇒ 4.4
8X46	1858	Velocity loop gain (PK4V)	★
8X47	1859	Observer parameter (POA1)	★
8X48	1860	Backlash acceleration amount	⇒ 4.5.4
8X49	1861	Maximum dual position feedback amplitude (Series 9041)	⇒ 4.3.5
8X50	1862	Observer gain (POK1)	★
8X51	1863	Observer gain (POK2)	★
8X52	1864	Final clamp value for the actual–current limit	★
8X53	1865	Current dead–zone compensation (PPMAX)	★
8X54	1866	Current dead–zone compensation (PDDP) The standard setting for α motors is 1894. To drive the α motor with an S Series amplifier, change it to 3787.	★
8X55	1867	Current dead–zone compensation (PHYST)	★
8X56	1868	Backelectromotive force compensation (EMFCMP)	★
8X57	1869	Current–phase control (PVPA)	★
8X58	1870	Current–phase control (PALPH)	★
8X59	1871	Backelectromotive force compensation (EMFBAS)	★
8X60	1872	Torque limit Standard setting, which specifies the torque applied when the maximum current limited by the amplifier flows.	★

★ : Do not change.

Series		Details	
0–C	15–A		
8X61 8X62 8X63	1873 1877 1878	Backelectomotive force compensation (EMFLMT) Overload protection coefficient (OVC1) Overload protection coefficient (OVC2)	★ ★ ★
8X64	1892	Software disconnection alarm level ⇒ Refer to the Maintenance Manual (B–65165E) for the CONTROL MOTOR α series	
8X65	1893	Overload protection coefficient (OVCLMT)	★
8X66	1894	250 μsec acceleration feedback	⇒ 4.3.1
8X67	1895	Torque command filter	⇒ 4.3.4

Suppress high–frequency vibration in the machine system.
Specify 50% of the vibration frequency as a cutoff frequency.

Cutoff frequency (Hz)	60	75	100	120	150	200
Setting value	2810	2557	2185	2052	1700	1166

8X68	1961	Feed–forward coefficient	⇒ 4.5.1
8X69	1962	Velocity feed–forward coefficient	⇒ 4.5.1
8X70	1963	Backlash acceleration timing The timing for acceleration is determined according to a position error.	
8X71	1964	Time during which backlash acceleration is effective Acceleration is performed for (setting value x 2 + 1) ms.	⇒ 4.5.4
8X72	1965	Static friction compensation amount	⇒ 4.5.7
8X73	1966	Stop time determination parameter	⇒ 4.5.7
8X74	1967	Velocity–dependent current–loop gain	
8X76	1969	1–ms acceleration feedback gain	
8X77	1970	Overshoot prevention counter	⇒ 4.4
8X79 8X80 8X81	1972 1973 1974	Limit speed for enabling low–speed integration during acceleration Limit speed for enabling low–speed integration during deceleration Position gain switching speed (Series 9046)	⇒ 4.9
 8X78 8X79 8X80 8X81	 1971 1972 1973 1974	Dual position feedback (Series 9041) Conversion coefficient (numerator) Conversion coefficient (denominator) Primary delay time constant Zero width	⇒ 4.3.5
8X82	1975	Backlash acceleration stop	⇒ 4.5.4
8X83	1976	Brake control timer (msec)	⇒ 4.10

★ : Do not change.

Series		**Details**	
0–C	**15–A**		
8X84 8X85	1977 1978	Flexible feed gear (numerator) Flexible feed gear (denominator)	⇒ 2.1.2
8X86	1979	Rated current parameter Used to display the actual current on the servo adjustment screen.	★
8X87	1980	Torque offset	⇒ 4.5.3
8X88	1981	Machine speed feedback gain	⇒ 4.3.2
8X89	1982	Base pulse for backlash acceleration Function for changing the proportional gain in the stop state: Stop level	⇒ 4.2.2
8X91	1984	Nonlinear control parameter	
8X97	1990	Static friction compensation stop parameter	⇒ 4.5.7
8X98	1991	Current–phase compensation coefficient	★
8X99	1992	N–pulse suppression level	★ ⇒ 4.2.1

6.2

DETAILS OF THE SERVO PARAMETERS FOR Series 15–B, 16, 18, 20, 21, Power Mate, Power Mate–E (SERIES 9060, 9064, 9065, 9066, 9070, 9080, AND 9081)

The descriptions of parameters follow.

For parameters for which a specification method is not described, do not change the parameters from the values set up automatically during servo parameter initialization.

The parameter in the top left cell applies to Series 15–B; the one in the bottom left cell, to Series 16, 18, 20, 21, Power Mate; and the one in the bottom right cell, to Power Mate–E.

★ : Do not change.

1804	—
2000	1000

#7	#6	#5	#4	#3	#2	#1	#0
			PGEX	PRMC		DGPR	PLC0

PLC0 (#0) The detection unit is:

0 : 1 μm or semi–closed
1 : 0.1 μm and full–closed ⇒ 2.1.3

Serial pulse coder C is:

0 : Not used
1 : Used

DGPR (#1) When power is switched on, the motor–specific standard servo parameter is:

0 : Specified
1 : Not specified ⇒ 2.1.3

PRMC (#3) ★ : Do not change.

PGEX (#4) The position gain range is:

0 : Not expanded
1 : Expanded by 8 times ⇒ 2.1.4

1806	—
2001	1001

#7	#6	#5	#4	#3	#2	#1	#0
AMR7	AMR6	AMR5	AMR4	AMR3	AMR2	AMR1	AMR0

AMR0 to AMR 7 (#0 – #7)

Specify the AMR value according to the pulse coder model for the motor.

AMR								
7	6	5	4	3	2	1	0	
0	0	0	0	0	0	0	0	α pulse coder, and serial pulse coder A other than the following models
0	0	0	0	0	0	1	1	AC3–0S, 4–0S
1	0	0	0	0	0	1	0	AC5–0

		#7	#6	#5	#4	#3	#2	#1	#0
1807	—	VFSE				PFSE			
2002	1002								

		#7	#6	#5	#4	#3	#2	#1	#0
1815	—							OPT	
1815	—								

OPT (#1) A separate position detector is:
0 : Not used
1 : Used ⇒ 2.1.4
This bit is not supported by the Power Mate–E.

PFSE (#3) A separate position detector is:
0 : Not used
1 : Used
Set this parameter with the Series 15–B only.
With the Series 16, 18, 20, and 21, this parameter is automatically set by setting OPT = 1.

VFSE (#3) A separate position detector is:
0 : Not used
1 : Used
This parameter is automatically set by setting OPT = 1.

When a separate position detector is used with the Power Mate–E:
Set PFSE = VFSE = 1.
When no separate position detector is used with the Power Mate–E:
Set PFSE = VFSE = 0.

		#7	#6	#5	#4	#3	#2	#1	#0
1808	—	VOFS	OVSC	BLEN	NPSP	PIEN	OBEN	TGAL	
2003	1003								

TGAL (#1) The software disconnection alarm detection level is
0 : Not changed
1 : Changed ⇒ Refer to the Maintenance Manual for the CONTROL MOTOR α series (B–65165E).

OBEN (#2) The observer function is:
0 : Not used
1 : Used ⇒ 4.3.3

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 ⇒ 4.2.1

BLEN (#5) The backlash acceleration function is:
0 : Not used
1 : Used ⇒ 4.5.4

OVSC (#6) The overshoot compensation function is:
0 : Not used
1 : Used ⇒ 4.4

VOFS (#7) The VCMD offset function is:

0 : Not used
1 : Used

1809	—
2004	1004

#7	#6	#5	#4	#3	#2	#1	#0
	DLY0						
0	0	0	0	0	1	1	0

DLY0 (#6) The PWM dead zone is:

0 : Set to 8 μs
1 : Set to 16 μs

This parameter must always be 1 for S Series servo amplifiers.

1883	—
2005	1005

#7	#6	#5	#4	#3	#2	#1	#0
SFCM	BRKC					FEED	

FEED (#1) The feed forward function is:

0 : Invalidated
1 : Validated ⇒ 4.5.1

BRKC (#6) The vertical–axis brake control function is:

0 : Invalidated
1 : Validated ⇒ 4.8

SFCM (#7) The static friction compensation function is:

0: Not used
1: Used ⇒ 4.5.7

1884	—
2006	1006

#7	#6	#5	#4	#3	#2	#1	#0
	DCBE		ACCF	SPVE	PKVE	SBSM	FCBL

FCBL (#0) During full–closed mode, backlash compensation is:

0 : Applied to the position
1 : Not applied to the position ⇒ 4.5.4

SBSM (#1) An amplifier whose input voltage is 200 V (standard) or 60 V is used:

0 : Uses an amplifier whose input voltage is 200 V (standard).
1 : Uses an amplifier whose input voltage is 60 V. ⇒ 4.13

PKVE (#2) Speed–dependent current loop gain variable function is:

0 : Not used
1 : Used ⇐ ★ : Do not change

SPVE (#3) A separate position detector is:

0 : Not used
1 : Used ⇒ 4.13

ACCF (#4) The 1–ms acceleration feed back function is:

0 : Invalidated
1 : Validated ⇒ No. 1969 (2076)

DCBE (#6) At deceleration, back electromotive force compensation is:

0 : Invalidated
1 : Validated ⇐ ★ : Do not change

1951	—
2007	—

#7	#6	#5	#4	#3	#2	#1	#0
FRCA	FAD						

FAD (#6) The fine acceleration/deceleration function is:

0 : Not used
1 : Used ⇒ 4.9.3

NOTE
After this bit is set, the power must be turned off, then back on.

FRCA (#7) Torque control is:

0 : Not exercised
1 : Exercised ⇒ 4.14

1952	—
2008	—

#7	#6	#5	#4	#3	#2	#1	#0
LAXD	PFBS	VCTM	SPPC	SPPR	VFBA	TNOM	

TNOM (#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.

VFBA (#2) 1 : Enables the velocity feedback averaging function.
(Usually, set this bit to 1. Set this parameter for the **main axis only**.)
⇒ 4.20.3

SPPR (#3) 1 : Enables the full preload function.
(Set this parameter for the **main axis only**.)

CAUTION
Always set this bit while the system is in the emergency stop state. After rewriting this bit, the power to the NC must be turned off, then back on. ⇒ 4.20.5

SPPC (#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**.)

CAUTION
Always set this bit while the system is in the emergency stop state. After rewriting this bit, the power to the NC must be turned off, then back on. ⇒ 4.20.5

VCTM (#5) 1 : Enables velocity command tandem control.
(Set this parameter for the **main axis only**.)

> **NOTE**
> Usually, set this bit to 0. This function cannot be used together with tandem control. Moreover, set a preload value of 0. ⇒ 4.20.7

PFBS (#6) 1 : Switches position feedback according to the direction of a torque command.
(Set this parameter for the **main axis only**.)

> **CAUTION**
> Always set this bit while the system is in the emergency stop state. After rewriting this bit, the power to the NC must be turned off, then back on. ⇒ 4.20.6

LAXD (#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**.)
⇒ 4.20.2

		#7	#6	#5	#4	#3	#2	#1	#0
1953	—	BLST	BLCU				ADBL	IQOB	SERD
2009	1009								

SERD (#0) The dummy serial feedback function is:

0 : Not used
1 : Used ⇒ 4.6

IQOB (#1) 1 : Eliminates the effect of voltage saturation in abnormal load detection.

This bit functions with the Series 9066 only. With other series, setting bit 2 of parameter No. 2200 has the same effect. With the Series 9066, set either bit. ⇒ 4.10.1

ADBL (#2) The new backlash acceleration function is:

0 : Invalidated
1 : Validated ⇒ 4.5.5

BLCU (#6) The function that validates the backlash acceleration function only at cutting is:

0 : Invalidated
1 : Validated ⇒ 4.5.4

BLST (#7) The backlash acceleration stop function is:

0 : Invalidated
1 : Validated ⇒ 4.5.4

		#7	#6	#5	#4	#3	#2	#1	#0
1954	—								
2010	1010	POLE		HBBL	HBPE	BLTE	LINE		

LINE (#2) 1 : Controls a linear motor.

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. This bit is not supported by the Power Mate–E. ⇒ 4.12.1

BLTE (#3) The function to multiply the backlash acceleration amount by 10 is:

0 : Invalidated
1 : Validated ⇒ 4.5.4

HBPE (#4) A pitch error compensation is added to the error counter of:

0 : Full–closed loop ⇐ Standard setting
1 : Semi–closed loop ⇒ 4.3.5

HBBL (#5) A backlash compensation amount is added to the error counter of:

0 : Semi–closed loop ⇐ Standard setting
1 : Full–closed loop ⇒ 4.3.5

POLE (#7) the punch / laser switching function is:

0 : Invalidated
1 : Validated

		#7	#6	#5	#4	#3	#2	#1	#0
1955	—								
2011	1011			RCCL					

RCCL (#5) The actual current torque limit variable function is:

0 : Not used
1 : Used ⇐ ★ : Do not change

		#7	#6	#5	#4	#3	#2	#1	#0
1956	—								
2012	1012	STNG		VCM2	VCM1			MSFE	

MSFE (#1) The machine speed feedback function is:

0 : Invalidated
1 : Validated ⇒ 4.3.2

VCM1 (#4) The VCMD waveform signal conversion on the check board is switched.

VCM2 (#5)

VCMD2	VCMD1	Number of velocity commnd revolution/ 5V
0	0	0.9155 rpm
0	1	14 rpm
1	0	234 rpm
1	1	3750 rpm

⇒ 4.11

STNG (#7) In velocity command mode, a software disconnection alarm is:

0 : Detected
1 : Ignored

1957	—	#7	#6	#5	#4	#3	#2	#1	#0
2015	1015		BLAT	TDOU				SSG1	PGTW

PGTW (#0) The position gain switching function is:

0 : Invalidated
1 : Validated ⇒ 4.9.1

SSG1 (#1) The integration function for low speed is:

0 : Invalidated
1 : Validated ⇒ 4.9.2

TDOU (#5) Between channels 2 and 4 on the check board:

0 : TCMD is output.
1 : Estimated load torque is output. ⇒ 4.10

BLAT (#6) The two–stage backlash acceleration function is:

0 : Not used
1 : Used ⇒ 4.5.6

1958	—	#7	#6	#5	#4	#3	#2	#1	#0
2016	1016	NFL8	NFL7	NFL5		K2VC			ABNT

ABNT (#0) The abnormal load detection function (option) is:

0 : Not used
1 : Used ⇒ 4.10

K2VC (#3) The function for changing the proportional gain in the stop state is:

0 : Not used.
1 : Used. ⇒ 4.2.2

NFL5 (#5) 1 : Cut–off area = 0.8 × (center frequency) to 1.25 × (center frequency)

NFL7 (#6) 1 : Cut–off area = 0.7 × (center frequency) to 1.4 × (center frequency)

NFL8 (#7) 1 : Cut–off area = 0.5 × (center frequency) to 2.0 × (center frequency)
⇒ 4.3.7

1959	—	#7	#6	#5	#4	#3	#2	#1	#0
2017	1017	PK25	OVCR	RISC	HTNG				DBST

DBST (#0) The stop distance reduction function is:

0 : Not used.
1 : Used.

This bit is not supported by the Power Mate–E. ⇒ 4.7

HTNG (#4) In velocity command mode, the hardware disconnection alarm of a separate detector is:

0 : Detected
1 : Ignored

RISC (#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.
This bit is not supported by the Power Mate–E. ⇒ 4.5.3

OVCR (#6) 0 : The OVC alarm remains as is.

1 : The OVC alarm is improved. ⇒ 4.17

PK25 (#7) High–speed velocity loop proportional processing is:

0 : Not used
1 : Used

This bit is not supported by the Power Mate–E. ⇒ 4.2.3

1960	—
2018	—

#7	#6	#5	#4	#3	#2	#1	#0
PFBC						MOVO	

MOVO (#1) The observer stop time disable function is:

0 : Not used
1 : Used ⇒ 4.3.3

PFBC (#7) 1 : The motor feedback signal for the main axis is shared by the sub–axis. (Set this parameter for the **main axis only**.) ⇒ 4.20.8

1709	—
2019	1019

#7	#6	#5	#4	#3	#2	#1	#0
DPFB			SPSY				

SPSY (#4) A separate velocity detector is:

0 : Not used
1 : Used ⇒ 4.13

DPFB (#7) The dual position feedback function (option) is:

0 : Not used
1 : Used ⇒ 4.3.5

1740	—
2200	1200

#7	#6	#5	#4	#3	#2	#1	#0
				ABGO	IQOB		

IQOB (#2) 1 : Eliminates the effect of voltage saturation on abnormal load detection.
When the Series 9066 is used, setting bit 1 of parameter No. 2009 has the same effect. Set either bit. ⇒ 4.10.1

ABGO (#3) 1 : When an abnormal load is detected, a threshold is set separately for cutting and rapid traverse.
This bit is not supported by the Power Mate–E. ⇒ 4.10.1

1741	—
2201	—

#7	#6	#5	#4	#3	#2	#1	#0
	CPEE		SPVC				CROF

CROF (#0) The function for obtaining current offsets upon an emergency stop is:

0 : Not used
1 : Used ⇒ 4.15

SPVC (#4) Without using the conversion coefficient (SBPDNL), the number of velocity pulses is:

0 : Not set
1 : Set ⇒ 4.13

CPEE (#6) The actual current display peak hold function is:

0 : Not used
1 : Used ⇒ 4.16

1742	—
2202	—

#7	#6	#5	#4	#3	#2	#1	#0
			DUAL	OVS1			FAGO

FAGO (#0) The fine acceleration/deceleration function, used separately for cutting and rapid traverse, is:

0 : Not used
1 : Used ⇒ 4.9.3

NOTE
After this bit is set, the power must be turned off, then back on.

OVS1 (#3) 1 : Overshoot compensation is valid only once after the termination of a move command. ⇒ 4.4

DUAL (#4) Zero width is determined:

0 : Only by setting = 0
1 : By setting ⇒ 4.3.5

1743	—
2203	—

#7	#6	#5	#4	#3	#2	#1	#0
			FRC2				

FRC2 (#4) Torque control type 2 is:

0 : Not exercised
1 : Exercised ⇒ 4.14

1749	—
2209	—

#7	#6	#5	#4	#3	#2	#1	#0
					FADL		

FADL (#2) 0 : FAD bell–shaped type
1 : FAD linear type ⇒ 4.9.3

NOTE
After this bit is set, the power must be turned off, then back on.

★ : Do not change.

Series 15–B	Series 16, 18 20, 21, Power Mate	Power Mate–E	Details	
1874	2020	1020	Motor No. The data range varies with the edition. Series 9060/Edition 001L: 3 to 89 Series 9064/Edition 001C: 31 to 36 Series 9070/Edition 001C: 3 to 89	⇒ 2.1.2
1875	2021	1021	Load inertia ratio $\frac{\text{Load inertia}}{\text{Rotor inertia}} \times 256$ Increase velocity loop gain parameters PK1V and PK2V by (1 + LDINT/256) times.	Adjust for individual machines separately.
1879 1876 1891	2022 2023 2024	1022 1023 1024	Rotation direction of the motor Number of velocity pulse Number of position pulse	⇒ 2.1.2 ⇒ 2.1.2 ⇒ 2.1.2
1713	2028	1028	Velocity enabling position gain switching	⇒ 4.9
1714	2029	1029	Acceleration–time velocity enabling integration function for low speed.	
1715	2030	1030	Deceleration–time velocity enabling integration function for low speed	
1718 1719	2033 2034	—— ——	Number of position feedback pulses Vibration–damping control gain	⇒ 4.3.6
1724	2039	——	Stage 2 acceleration amount for two–stage backlash acceleration	⇒ 4.5.6
1852 1853 1854	2040 2041 2042	1040 1041 1042	Current loop integral gain (PK1) Current loop proportional gain (PK2) Current loop gain (PK3)	★ ★ ★
1855	2043	1043	Velocity loop integral gain (PK1V)	Adjust for individual machines separately.
1856	2044	1044	Velocity loop proportional gain (PK2V)	
1857	2045	1045	Velocity loop incomplete integral gain (PK3V)	⇒ 4.4
1858	2046	1046	Velocity loop gain (PK4V)	★
1859	2047	1047	Observer parameter (POA1) This parameter is adjusted when the abnormal load detection and two–stage backlash functions are used. If a negative value is specified, its absolute value is multiplied by ten internally (for Series 9060/001L, Series 9070/001C and subsequent editions)	★ ⇒ 4.3.3
1860	2048	1048	Backlash acceleration amount	⇒ 4.5.6
1861	2049	1049	Maximum dual position feedback amplitude	⇒ 4.3.5

★ : Do not change.

Series 15–B	Series 16, 18 20, 21, Power Mate	Power Mate–E	Details	
1862 1863	2050 2051	1050 1051	Observer gain (POK1) Observer gain (POK2) When only the abnormal load detection function is used, these parameters must be changed. POK1 ⇒ 3559, POK2 ⇒ 3329.	★ ★ ⇒ 4.10
1864	2052	1052	Not used	★
1865	2053	1053	Current dead–zone compensation (PPMAX)	★
1866	2054	1054	Current dead–zone compensation (PDDP) The standard setting for α motors is 1894. To drive the α motor with an S Series amplifier, change it to 3787.	★
1867 1868 1869 1870 1871	2055 2056 2057 2058 2059	1055 1056 1057 1058 1059	Current dead–zone compensation (PHYST) Back electromotive force compensation (EMFCMP) Current phase compensation (PVPA) Current phase compensation (PALPH) Back electromotive force compensation (EMFBAS)	★ ★ ★ ★ ★
1872	2060	1060	Torque limit Standard setting ⇒ specifies the torque applied when the maximum current limited by the amplifier flows.	★
1873 1877 1878	2061 2062 2063	1061 1062 1063	Back electromotive force compensation (EMFLMT) Overload protection coefficient (OVC1) Overload protection coefficient (OVC2)	★ ★ ★
1892	2064	1064	Software disconnection alarm level ⇒ Refer to the Maintenance Manual (B–65165E) for the CONTROL MOTOR α series	
1893	2065	1065	Overload protection coefficient (OVCLMT)	★
1894	2066	1066	250 μsec acceleration feedback	⇒ 4.3.1
1895	2067	1067	Torque command filter	⇒ 4.3.4

Suppress high–frequency vibration in the machine system.
Specify 50% of the vibration frequency as a cutoff frequency.

Cutoff frequency (Hz)	60	75	100	120	150	200
Setting value	2810	2557	2185	2052	1700	1166

Series 15–B	Series 16, 18 20, 21, Power Mate	Power Mate–E	Details	
1961	2068	1068	Feed–forward coefficient Typical setting = α × 100 (0<α<1)	⇒ 4.5.1
1962	2069	1069	Velocity feed–forward coefficient	⇒ 4.5.1

Setting value < 0 ⇒ valid only for advance control

$$\text{Setting value} = \frac{\text{Machine load inertia + motor rotor inertia}}{\text{Motor rotor inertia } (\beta = 50 \text{ to } 100)} \times \beta$$

★ : Do not change.

Series 15–B	Series 16, 18 20, 21, Power Mate	Power Mate–E	Details	
1963	2070	1070	Backlash acceleration timing The timing for acceleration is determined according to a position error.	
1964	2071	1071	Time during which backlash acceleration is effective Acceleration is performed for (setting value × 2 + 1) ms.	⇒ 4.5.4
1965	2072	1072	Static friction compensation amount	⇒ 4.5.7
1966	2073	1073	Stop time determination parameter	
1967	2074	1074	Current loop gain variable with velocity	★
1969	2076	1076	1–ms acceleration feedback gain	
1970	2077	1077	Overshoot prevention counter	⇒ 4.4
1971	2078	1078	Dual position feedback conversion coefficient (numerator)	⇒ 4.3.5
1972	2079	1079	Dual position feedback conversion coefficient (denominator)	
1973	2080	1080	Dual position feedback primary delay time constant	
1974	2081	1081	Dual position feedback zero width	
1975	2082	1082	Backlash acceleration stop amount	⇒ 4.5.4
1976	2083	1083	Brake control timer (msec)	⇒ 4.8
1977	2084	1084	Flexible feed gear (numerator)	⇒ 2.1.2
1978	2085	1085	Flexible feed gear (denominator)	
1979	2086	1086	Rated current parameter Used to display the actual current on the servo adjustment screen.	⇒ ★
1980	2087	1087	Torque offset	
1981	2088	1088	Machine speed feedback gain	⇒ 4.3.2
1982	2089	1089	Base pulse for backlash acceleration	
1984	2091	1091	Nonlinear control parameter	
1985	2092	——	Advanced control feed–forward coefficient Typical setting = $\alpha \times 10000$ ($0<\alpha<1$)	⇒ 4.5.2
1990	2097	1097	Static friction compensation stop parameter	⇒ 4.5.7
1991	2098	1098	Current phase compensation coefficient	★
1992	2099	1099	N–pulse suppression level	★ ⇒ 4.2.1
1994	2101	——	Overshoot compensation valid level	⇒ 4.4
1995	2102	1102	Final clamp value for the actual–current limit	★
1996	2103	1103	Track back amount applied when an abnormal load is detected	⇒ 4.10

★ : Do not change.

Series 15–B	Series 16, 18 20, 21, Power Mate	Power Mate–E	Details	
1997	2104	1104	Abnormal load detection threshold in cutting	⇒ 4.10.1
1998	2105	——	Torque constant	⇒ 4.14
1702	2109	——	Fine acceleration/deceleration time constant (in ms)	⇒ 4.9.3
1705	2112	——	AMR conversion coefficient 1	⇒ 4.12.1
1706	2113	——	Notch filter center frequency (Hz)	⇒ 4.3.7
1727	2116	1116	Abnormal load detection dynamic friction cancel	⇒ 4.10
1729	2118	——	Dual position feedback Semi–closed/full–closed error overestimation level	⇒ 4.3.5
1730	2119	——	Function for changing the proportional gain in the stop state: Stop level	⇒ 4.2.2
1732	2121	——	Conversion coefficient for number of feedback pulses	⇒ 4.13
1733	2122	——	Detection resistance conversion coefficient	
1737	2126	——	Position feedback switching time constant τ	⇒ 4.20.6
1753	2130	——	Correction of two thrust ripples per magnetic pole pair	⇒ 4.12.2
1754	2131	——	Correction of four thrust ripples per magnetic pole pair	⇒ 4.12.2
1755	2132	——	Correction of six thrust ripples per magnetic pole pair	⇒ 4.12.2
1761	2138	——	AMR conversion coefficient 2	⇒ 4.12.1
1765	2142	——	Abnormal load detection threshold in rapid traverse	⇒ 4.10.1
1766	2143	——	Fine acceleration/deceleration time constant 2 (in ms)	⇒ 4.9.3
1767	2144	——	Position feed–forward coefficient for cutting (in 0.01%)	⇒ 4.9.3
1768	2145	——	Velocity feed–forward coefficient for cutting (in %)	⇒ 4.9.3

7 PARAMETER LIST

7.1
FOR SERIES 0–C, 15–A

Series 9046 (compatible with standard and high–speed positioning)
Series 9041 (compatible with dual position feedback)

		Motor model	α3HV	α6HV	α12HV	α22HV	α30HV	αC3	αC6	αC12	αC22	αC30	αC40
		Motor specification	0171	0172	0176	0177	0178	0121	0126	0141	0145	0155	0156
		Motor model											
		Motor specification											
		Motor type No.	1	2	3	4	5	7	8	9	10	11	12
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8□03	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	8□04	01000110	01000110	01000110	01000110	01000110	00000110	00000110	00000110	00000110	00000110	00000110
	1883	8□05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8□06	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000000	01000000	01000000	01000000
	1954	8□10	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010
PK1	1852	8□40	687	828	730	800	1100	1600	1800	3000	2330	1662	2267
PK2	1853	8□41	–2510	–3129	–3038	–3190	–3886	–5059	–6105	–9750	–6831	–6215	–7414
PK3	1854	8□42	–2617	–2638	–2638	–2694	–2663	–2608	–2641	–2687	–2694	–2697	–2695
PK1V	1855	8□43	107	127	188	271	293	107	127	251	271	293	227
PK2V	1856	8□44	–955	–1141	–1683	–2426	–2625	–955	–1140	–2245	–2426	–2625	–2030
PK3V	1857	8□45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8□47	3972	3326	2254	1564	1446	3974	3329	1690	1564	1446	1870
BLCMP	1860	8□48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8□49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8□50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8□51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8□52	3843	3842	3843	3843	3842	3843	3844	3842	3842	3844	3843
PPMAX	1865	8□53	21	21	21	21	21	21	21	21	21	21	21
PDDP	1866	8□54	3787	3787	3787	3787	3787	1894	1894	1894	1894	3787	3787
PHYST	1867	8□55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8□56	2500	4000	3500	3500	4000	3046	4381	4000	4000	11261	7740
PVPA	1869	8□57	2200	2500	2400	2000	1700	2100	1800	2400	2400	3000	3000
PALPH	1870	8□58	70	70	70	60	52	42	48	42	43	42	36
PPBAS	1871	8□59	5	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	8□60	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	8□61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8□62	32686	32637	32568	32370	32359	32686	32637	32412	32370	32343	32528
POVC2	1878	8□63	1031	1639	2505	4981	5110	1030	1636	4446	4981	5313	2997
TGALMLV	1892	8□64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8□65	3059	4866	7445	14847	15235	3056	4858	13245	14847	15850	8911
PK2VAUX	1894	8□66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8□67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8□68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8□69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8□70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8□71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8□72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8□73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8□74	0	0	4000	4000	4000	4000	4000	0	0	4000	0
MODEL	1968	8□75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8□76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8□78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8□79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8□80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8□81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8□82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8□84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8□85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8□86	1287	1623	2008	2836	2872	1286	1622	2678	2836	2930	2197
TDPLD	1980	8□87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8□88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8□89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8□90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8□92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8□93	0	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8□94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8□96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8□97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8□98	5145	5145	5170	10250	15370	12800	17920	17920	12800	12800	12800
ONEPSL	1992	8□99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

Motor model			α0.5	α3/3	α6/2	α6/3	α12/2	α12/3	α22/2	α22/3	α30/2	α30/3	αM3
Motor specification			0113	0123	0127	0128	0142	0143	0147	0148	0152	0153	0161
Motor model			β0.5										
Motor specification			0113										
Motor type No.			13	15	16	17	18	19	20	21	22	23	24
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8□03	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00001000
	1809	8□04	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
	1883	8□05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8□06	01000100	01000100	01000000	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100
	1954	8□10	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010
PK1	1852	8□40	220	1314	2282	943	3121	1324	2195	881	3173	1305	672
PK2	1853	8□41	–540	–3268	–4660	–2956	–4953	–3671	–4490	–2759	–5522	–3431	–2065
PK3	1854	8□42	–2556	–3052	–3052	–2633	–3052	–3052	–3052	–3052	–3052	–3052	–3052
PK1V	1855	8□43	9	87	99	91	188	165	203	214	144	240	53
PK2V	1856	8□44	–79	–781	–887	–818	–1683	–1474	–1821	–1921	–1293	–2153	–471
PK3V	1857	8□45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8□47	–4789	4858	4279	4639	2254	2574	2084	1976	2935	1763	–806
BLCMP	1860	8□48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8□49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8□50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8□51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8□52	3844	3843	3843	3843	3844	3844	3843	3843	3843	3842	3847
PPMAX	1865	8□53	21	21	21	21	21	21	21	21	21	21	21
PDDP	1866	8□54	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
PHYST	1867	8□55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8□56	1200	2000	3500	3000	4000	2500	4000	3000	5000	4500	2500
PVPA	1869	8□57	2000	2200	2000	2800	2000	2200	2000	2200	2600	2000	2400
PALPH	1870	8□58	77	64	41	80	38	64	40	64	46	59	70
PPBAS	1871	8□59	5	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	8□60	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	8□61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8□62	32585	32713	32689	32698	32568	32614	32543	32518	32668	32493	32697
POVC2	1878	8□63	2288	690	991	877	2505	1922	2811	3128	1245	3443	886
TGALMLV	1892	8□64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8□65	6797	2045	2940	2601	7445	5709	8358	9305	3695	10245	2627
PK2VAUX	1894	8□66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8□67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8□68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8□69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8□70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8□71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8□72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8□73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8□74	1000	3000	0	0	2000	2000	2000	2000	2000	1000	3000
MODEL	1968	8□75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8□76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8□78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8□79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8□80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8□81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8□82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8□84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8□85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8□86	1918	1052	1261	1187	2008	1758	2127	2245	1414	2355	1193
TDPLD	1980	8□87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8□88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8□89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8□90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8□92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8□93	0	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8□94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8□96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8□97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8□98	5160	0	10265	30	12800	5145	7680	2585	10240	5145	25
ONEPSL	1992	8□99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

		Motor model	αM6	αM9	α22/1.5	α30/1.2	α40/FAN	α40/2	2–0E	1–0E	0E	5E	E1/3
		Motor specification	0162	0163	0146	0151	0158	0157	0103	0104	0105	0106	0101
		Motor model									αE3/2	αE6/2	αE1/3
		Motor specification									0105	0106	0101
		Motor model									β3/3	β6/2	β1/3
		Motor specification									0033	0034	0031
		Motor type No.	25	26	27	28	29	30	31	32	33	34	35
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8☐03	00001000	00001000	00000000	00000000	00000000	00000000	00001100	00001100	00001100	00001100	00001100
	1809	8☐04	00000110	00000110	00000110	00000110	00000110	00000110	01000110	01000110	00000110	01000110	00000110
	1883	8☐05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000100	00000100	00000100
	1884	8☐06	01000100	01000100	01000000	01000000	01000100	01000100	01000000	01000000	01000000	01000000	01000000
	1954	8☐10	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000010	00000000
PK1	1852	8☐40	950	748	2330	5060	1832	1832	550	715	275	990	359
PK2	1853	8☐41	–2582	–2402	–6381	–9923	–5994	–5994	–1749	–2196	–1006	–3544	–1129
PK3	1854	8☐42	–3052	–2632	–2694	–2705	–2700	–2700	–2564	–2596	–2622	–2632	–2564
PK1V	1855	8☐43	38	61	271	147	201	201	76	93	144	144	102
PK2V	1856	8☐44	–328	–550	–2426	–1313	–1801	–1801	–1374	–1667	–2587	–2587	–916
PK3V	1857	8☐45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8☐46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8☐47	–1156	–690	1564	2891	2107	2107	2761	2277	1467	1467	4141
BLCMP	1860	8☐48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8☐49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8☐50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8☐51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8☐52	3847	3844	3843	3843	3842	3842	2560	3072	3840	3072	0
PPMAX	1865	8☐53	21	21	21	21	21	21	21	21	21	21	21
PDDP	1866	8☐54	1894	1894	1894	1894	1894	1894	3787	3787	1894	3787	1894
PHYST	1867	8☐55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8☐56	3500	3000	4000	8000	6637	6637	2600	3700	3000	3200	2500
PVPA	1869	8☐57	2400	2700	2400	3600	2200	2200	2844	2582	3200	2000	2100
PALPH	1870	8☐58	70	83	43	38	48	48	70	64	80	57	71
PPBAS	1871	8☐59	5	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	8☐60	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	8☐61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8☐62	32727	32692	32370	32665	32361	32579	32430	32257	32456	32456	32617
POVC2	1878	8☐63	516	955	4981	1283	5090	2358	4226	6385	3897	3897	1884
TGALMLV	1892	8☐64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8☐65	1529	2832	14847	3809	15175	7007	12587	19067	11600	11600	5594
PK2VAUX	1894	8☐66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8☐67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8☐68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8☐69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8☐70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8☐71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8☐72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8☐73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8☐74	3000	0	0	0	2000	2000	0	0	0	0	0
MODEL	1968	8☐75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8☐76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8☐77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8☐78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8☐79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8☐80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8☐81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8☐82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8☐83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8☐84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8☐85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8☐86	910	1238	2836	1436	2867	1948	2611	3213	2506	2506	1740
TDPLD	1980	8☐87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8☐88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8☐89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8☐90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8☐91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8☐92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8☐93	0	0	0	0	0	0	0	0	12923	12923	12923
BLCMP2	1987	8☐94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8☐95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8☐96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8☐97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8☐98	5145	0	5120	12800	12800	12800	–2008	–2786	–1476	30	80
ONEPSL	1992	8☐99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

		Motor model	E2/3	50S	60S	70S	5–0	4–0S	3–0S	2–0SP	1–0SP	5S	6S
		Motor specification	0102	0331	0332	0333	0531	0532	0533	0371	0372	0314	0316
		Motor model	αE2/3	α65/2	α100/2	α150/2					α2/2		
		Motor specification	0102	0331	0332	0333					0372		
		Motor model	β2/3										
		Motor specification	0032										
		Motor type No.	36	39	40	41	42	43	44	45	46	48	49
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8☐03	00001100	00001000	00001000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1809	8☐04	00000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	8☐05	00000100	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8☐06	01000000	01010100	01010100	01010100	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1954	8☐10	00000010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	8☐40	704	999	1451	1334	457	460	736	390	1170	1500	750
PK2	1853	8☐41	–2401	–3600	–6000	–5297	–999	–730	–1500	–1053	–2289	–2781	–2000
PK3	1854	8☐42	–2596	–1957	–2259	–2723	–1873	–2373	–2374	–2480	–2485	–3052	–2596
PK1V	1855	8☐43	62	168	130	145	30	58	53	111	91	151	216
PK2V	1856	8☐44	–1111	–1502	–1165	–1295	–300	–517	–477	–997	–812	–1355	–1932
PK3V	1857	8☐45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8☐46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8☐47	3415	2526	3259	2931	0	–733	–795	3806	4674	2801	1964
BLCMP	1860	8☐48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8☐49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8☐50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8☐51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8☐52	3072	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	8☐53	21	21	21	21	21	21	21	21	21	21	21
PDDP	1866	8☐54	1894	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	8☐55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8☐56	3300	4444	4884	6668	0	629	1129	1589	2147	2403	5000
PVPA	1869	8☐57	2700	2800	2800	3040	2330	1861	2330	2330	1864	2330	3750
PALPH	1870	8☐58	78	57	57	57	57	46	57	57	46	57	64
PPBAS	1871	8☐59	5	20	20	20	0	0	0	0	0	0	0
TQLIM	1872	8☐60	7282	6560	6560	6560	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	8☐61	120	120	120	120	0	120	120	120	120	120	120
POVC1	1877	8☐62	32540	32419	32499	32281	32514	32543	32576	32623	32627	32677	32485
POVC2	1878	8☐63	2850	4365	3358	6086	3173	2817	2401	1811	1766	1142	3536
TGALMLV	1892	8☐64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8☐65	8474	13002	9990	18168	9437	8375	7136	5377	5245	3388	10522
PK2VAUX	1894	8☐66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8☐67	0	1100	1100	1100	0	0	0	0	0	0	0
FALPH	1961	8☐68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8☐69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8☐70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8☐71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8☐72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8☐73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8☐74	0	400	400	400	0	0	0	0	0	0	0
MODEL	1968	8☐75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8☐76	0	15	15	15	0	0	0	0	0	0	0
OSCTPL	1970	8☐77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8☐78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8☐79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8☐80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8☐81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8☐82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8☐83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8☐84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8☐85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8☐86	2142	2653	2326	3137	2261	2129	1966	1706	1685	1354	1966
TDPLD	1980	8☐87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8☐88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8☐89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8☐90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8☐91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8☐92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8☐93	14203	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8☐94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8☐95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8☐96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8☐97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8☐98	–2786	0	0	0	0	0	0	0	0	0	0
ONEPSL	1992	8☐99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

Motor model			10S	20S/1.5	20S	30S	30/2	40	0L(C)	5L(C)	6L(C)	7L(C)	10L(C)
Motor specification			0315	0505	0502	0590	0506	0581	0561	0562	0564	0571	0572
Motor model									αL3	αL6	αL9	αL25	αL50
Motor specification									0561	0562	0564	0571	0572
Motor type No.			50	51	52	53	54	55	56	57	58	59	60
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8□03	00000000	00000000	00000000	00000000	00000000	00000000	00001000	00001000	00001000	00001000	00001000
	1809	8□04	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	8□05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8□06	00000000	00000000	00000000	00000000	00000000	00000000	01000100	01000100	01000100	01000100	01000100
	1954	8□10	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	8□40	2591	1131	1261	3414	705	1511	1600	1360	850	590	700
PK2	1853	8□41	–5540	–2477	–2577	–7650	–2716	–5829	–4508	–4000	–2300	–1600	–2000
PK3	1854	8□42	–2623	–2649	–2646	–2663	–2669	–2672	–2614	–2647	–2652	–2685	–2701
PK1V	1855	8□43	260	458	298	201	375	282	18	17	34	92	116
PK2V	1856	8□44	–2328	–4103	–2666	–1797	–3356	–2526	–159	–156	–309	–823	–1035
PK3V	1857	8□45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8□47	1630	925	1424	2112	1131	1502	–2382	–2429	–1229	4611	3666
BLCMP	1860	8□48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8□49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8□50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8□51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8□52	0	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	8□53	21	21	21	21	21	21	21	21	21	21	21
PDDP	1866	8□54	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	8□55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8□56	5520	3549	2731	5456	1961	3478	2000	2000	1240	4500	4800
PVPA	1869	8□57	3500	2797	2600	7200	2330	2800	2330	2330	2330	3000	3200
PALPH	1870	8□58	64	52	57	50	57	43	57	57	57	64	64
PPBAS	1871	8□59	0	0	0	0	0	0	5	5	5	5	5
TQLIM	1872	8□60	7282	7282	6918	6918	6554	7282	5462	5462	7282	7282	7282
EMFLMT	1873	8□61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8□62	32539	32155	32386	32530	32254	32340	32695	32698	32614	32489	32237
POVC2	1878	8□63	2864	7659	4771	2971	6421	5355	912	877	1928	3482	6640
TGALMLV	1892	8□64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8□65	8515	22907	14219	8834	19176	15972	2706	2602	5727	10360	19834
PK2VAUX	1894	8□66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8□67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8□68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8□69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8□70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8□71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8□72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8□73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8□74	0	0	0	0	0	0	3000	3000	4000	4000	4000
MODEL	1968	8□75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8□76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8□78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8□79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8□80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8□81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8□82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8□84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8□85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8□86	1768	3801	2285	1801	2654	2941	1210	1187	1761	2369	3277
TDPLD	1980	8□87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8□88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8□89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8□90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8□92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8□93	0	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8□94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8□96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8□97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8□98	0	0	0	0	0	0	0	0	0	50	0
ONEPSL	1992	8□99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

		Motor model	2–0SP/3	1–0SP/3	0S	5S/3	10S/3	20S/3	30S/3	0L(L)	5L(L)	6L(L)	7L(L)
		Motor specification	0371	0373	0313	0514	0317	0318	0319	0561	0562	0564	0571
		Motor model	α1/3	α2/3									
		Motor specification	0371	0373									
		Motor type No.	61	62	63	64	65	66	67	68	69	70	71
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8□03	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	8□04	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	8□05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8□06	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100
	1954	8□10	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	8□40	390	450	600	672	1090	542	708	1600	1360	850	590
PK2	1853	8□41	–1053	–900	–1600	–1574	–2360	–1377	–1811	–4508	–4000	–2300	–1600
PK3	1854	8□42	–2480	–2503	–2517	–2526	–2625	–2654	–2664	–2614	–2647	–2652	–2685
PK1V	1855	8□43	111	128	126	136	287	305	346	18	17	34	119
PK2V	1856	8□44	–997	–1146	–1127	–1215	–2571	–2734	–3097	–159	–156	–309	–1070
PK3V	1857	8□45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8□47	3806	3311	3366	3124	1476	1388	1226	–2382	–2429	–1229	3547
BLCMP	1860	8□48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8□49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8□50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8□51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8□52	0	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	8□53	21	21	21	21	21	50	50	21	21	21	21
PDDP	1866	8□54	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	8□55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8□56	2800	2520	2520	2520	3780	5400	6000	2000	2000	1240	4500
PVPA	1869	8□57	2330	2330	2330	2330	2330	2330	2200	2330	2330	2330	3000
PALPH	1870	8□58	57	57	57	57	57	57	57	57	57	57	64
PPBAS	1871	8□59	5	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	8□60	7282	7282	7282	7282	7282	7282	7282	5462	5462	7282	7282
EMFLMT	1873	8□61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8□62	32623	32519	32712	32694	32578	32495	32470	32695	32698	32614	32299
POVC2	1878	8□63	1811	3112	706	924	2381	3410	3723	912	877	1928	5867
TGALMLV	1892	8□64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8□65	5377	9256	2094	2740	7075	10144	11081	2706	2602	5727	17509
PK2VAUX	1894	8□66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8□67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8□68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8□69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8□70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8□71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8□72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8□73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8□74	1680	2940	4000	2100	2520	4000	0	3000	3000	4000	4000
MODEL	1968	8□75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8□76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8□78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8□79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8□80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8□81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8□82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8□84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8□85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8□86	1706	2239	1064	1218	1814	2344	2450	1210	1187	1761	3079
TDPLD	1980	8□87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8□88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8□89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8□90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8□92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8□93	0	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8□94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8□96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8□97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8□98	50	0	0	0	0	15	0	0	0	0	50
ONEPSL	1992	8□99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

		Motor model	10L(L)	6S/3	40S/2	0T/3	5T	5T/3	10T	10T/3	0–0SP/3	0S/1.5	5S/1.5
		Motor specification	0572		0583	0381	0382	0383	0384	0385	0374	0515	0516
		Motor model									α2.5/3		
		Motor specification									0374		
		Motor type No.	72	73	78	79	80	81	82	83	84	85	86
Symbol	Parameter No.												
	FS15–A	FS0–C											
	1808	8□03	00001000	00001000	00001000	00001000	00000000	00001000	00000000	00001000	00001000	00000000	00000000
	1809	8□04	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	8□05	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	8□06	01000100	01000100	01000100	01000100	00000000	01000100	00000000	01000100	01000100	01000100	01000100
	1954	8□10	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	8□40	700	1000	892	701	670	456	600	409	294	1275	800
PK2	1853	8□41	–2000	–2400	–2877	–2038	–1600	–1019	–1153	–946	–990	–3600	–2447
PK3	1854	8□42	–2701	–2459	–2666	–2390	–2473	–2498	–2550	–2543	–2455	–2544	–3052
PK1V	1855	8□43	150	135	280	260	287	209	450	349	70	142	212
PK2V	1856	8□44	–1346	–1205	–2511	–2329	–2568	–1877	–4034	–3124	–898	–1268	–1896
PK3V	1857	8□45	0	0	0	0	0	0	0	0	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	8□47	2820	3148	1512	1630	1478	2022	941	1215	4228	2992	2001
BLCMP	1860	8□48	0	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	8□49	0	0	0	0	0	0	0	0	0	0	0
POK1	1862	8□50	956	956	956	956	956	956	956	956	956	956	956
POK2	1863	8□51	510	510	510	510	510	510	510	510	510	510	510
DBLIMI	1864	8□52	0	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	8□53	21	21	50	21	21	21	21	21	21	21	21
PDDP	1866	8□54	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	8□55	319	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	8□56	4800	3200	4800	4008	4400	3684	4590	4008	1971	2000	6000
PVPA	1869	8□57	3200	2300	3200	4200	4000	3000	3335	2330	2330	3500	3650
PALPH	1870	8□58	64	64	60	43	64	64	57	57	57	83	83
PPBAS	1871	8□59	5	5	5	5	0	5	0	5	5	5	5
TQLIM	1872	8□60	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	8□61	120	120	120	120	120	120	120	120	120	120	120
POVC1	1877	8□62	31875	32693	32345	32703	32669	32714	32532	32625	32569	32696	32589
POVC2	1878	8□63	11158	940	5290	819	1235	674	2948	1788	2482	903	2234
TGALMLV	1892	8□64	4	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	8□65	32767	2787	15775	2428	3665	1998	8766	5308	7376	2679	6636
PK2VAUX	1894	8□66	0	0	0	0	0	0	0	0	0	0	0
FILTER	1895	8□67	0	0	0	0	0	0	0	0	0	0	0
FALPH	1961	8□68	0	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	8□69	0	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	8□70	0	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	8□71	0	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	8□72	0	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	8□73	0	0	0	0	0	0	0	0	0	0	0
AALPH	1967	8□74	4000	3200	3333	3158	0	2105	0	3421	2917	1000	3500
MODEL	1968	8□75	0	0	0	0	0	0	0	0	0	0	0
WKAC	1969	8□76	0	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	8□77	0	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	8□78	0	0	0	0	0	0	0	0	0	0	0
INTSP1	1972	8□79	0	0	0	0	0	0	0	0	0	0	0
INTSP2	1973	8□80	0	0	0	0	0	0	0	0	0	0	0
PTWNSP	1974	8□81	0	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	8□82	0	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	8□83	0	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	8□84	0	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	8□85	0	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	8□86	4261	1228	2923	1147	1409	1040	2179	1696	1998	1205	1896
TDPLD	1980	8□87	0	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	8□88	0	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	8□89	0	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	8□90	0	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	8□91	0	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	8□92	0	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	8□93	0	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	8□94	0	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	8□95	0	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	8□96	0	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	8□97	0	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	8□98	0	0	0	0	0	0	0	0	50	0	0
ONEPSL	1992	8□99	400	400	400	400	400	400	400	400	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

		Motor model	6S/1	10S/1	20S/0.5
		Motor specification	0520	0504	0500
		Motor model			
		Motor specification			
		Motor type No.	87	88	89
Symbol	Parameter No.				
	FS15–A	FS0–C			
	1808	8□03	00000000	00000000	00000000
	1809	8□04	01000110	01000110	01000110
	1883	8□05	00000000	00000000	00000000
	1884	8□06	01000000	01000000	00000000
	1954	8□10	00000000	00000000	00000000
PK1	1852	8□40	1008	2420	3500
PK2	1853	8□41	–3840	–6600	–11616
PK3	1854	8□42	–2584	–2640	–2662
PK1V	1855	8□43	215	364	298
PK2V	1856	8□44	–1927	–3261	–2666
PK3V	1857	8□45	0	0	0
PK4V	1858	8□46	–8235	–8235	–8235
POA1	1859	8□47	1970	1164	1424
BLCMP	1860	8□48	0	0	0
DPFMX	1861	8□49	0	0	0
POK1	1862	8□50	956	956	956
POK2	1863	8□51	510	510	510
DBLIMI	1864	8□52	0	0	0
PPMAX	1865	8□53	21	21	21
PDDP	1866	8□54	3787	3787	3787
PHYST	1867	8□55	319	319	319
EMFCMP	1868	8□56	5500	6500	2000
PVPA	1869	8□57	4500	4600	6200
PALPH	1870	8□58	83	83	83
PPBAS	1871	8□59	5	5	5
TQLIM	1872	8□60	7282	7282	7282
EMFLMT	1873	8□61	120	120	120
POVC1	1877	8□62	32487	32320	32384
POVC2	1878	8□63	3517	5601	4805
TGALMLV	1892	8□64	4	4	4
POVCLMT	1893	8□65	10466	16711	14321
PK2VAUX	1894	8□66	0	0	0
FILTER	1895	8□67	0	0	0
FALPH	1961	8□68	0	0	0
VFFLT	1962	8□69	0	0	0
ERBLM	1963	8□70	0	0	0
PBLCT	1964	8□71	0	0	0
SFCCML	1965	8□72	0	0	0
PSPTL	1966	8□73	0	0	0
AALPH	1967	8□74	0	0	0
MODEL	1968	8□75	0	0	0
WKAC	1969	8□76	0	0	0
OSCTPL	1970	8□77	0	0	0
PDPCH	1971	8□78	0	0	0
INTSP1	1972	8□79	0	0	0
INTSP2	1973	8□80	0	0	0
PTWNSP	1974	8□81	0	0	0
BLENDL	1975	8□82	0	0	0
MOFCTL	1976	8□83	0	0	0
SDMR1	1977	8□84	0	0	0
SDMR2	1978	8□85	0	0	0
RTCURR	1979	8□86	1961	2478	2294
TDPLD	1980	8□87	0	0	0
MCNFB	1981	8□88	0	0	0
BLBSL	1982	8□89	0	0	0
ROBSTL	1983	8□90	0	0	0
ACCSPL	1984	8□91	0	0	0
ADFF1	1985	8□92	0	0	0
VMPK3V	1986	8□93	0	0	0
BLCMP2	1987	8□94	0	0	0
AHDRTL	1988	8□95	0	0	0
RADUSL	1989	8□96	0	0	0
SMCNT	1990	8□97	0	0	0
DEPVPL	1991	8□98	0	0	0
ONEPSL	1992	8□99	400	400	400

Note) DPFMX and PDPCH are not used with the Series 9046. With the Series 9041, PDPCL, DPFEX, and DPFZW are used for INTSP1, INTSP2, and PTWNSP. For details, see Sec. 6.1.

7.2
FOR Series 15–B, 16, 18, 20, 21, Power Mate AND Power Mate–E

Series 9070 (Series 15–B, 16, 18)
Series 9060 (Series 20, 21, Power Mate)
Series 9064 (Power Mate–E)

			Motor model	α3HV	α6HV	α12HV	α22HV	α30HV	αC3	αC6	αC12	αC22	αC30
			Motor specification	0171	0172	0176	0177	0178	0121	0126	0141	0145	0155
			Motor model										
			Motor specification										
			Motor type No.	1	2	3	4	5	7	8	9	10	11
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	00000110	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000000	01000000	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000
PK1	1852	2040	1040	687	828	730	800	1100	1600	1800	3000	2330	1662
PK2	1853	2041	1041	–2510	–3129	–3038	–3190	–3886	–5059	–6105	–9750	–6831	–6215
PK3	1854	2042	1042	–2617	–2638	–2638	–2694	–2663	–2608	–2641	–2687	–2694	–2697
PK1V	1855	2043	1043	107	127	188	271	293	107	127	251	271	293
PK2V	1856	2044	1044	–955	–1141	–1683	–2426	–2625	–955	–1140	–2245	–2426	–2625
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	3972	3326	2254	1564	1446	3974	3329	1690	1564	1446
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	1894	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	2500	4000	3500	3500	4000	3046	4381	4000	4000	11261
PVPA	1869	2057	1057	2200	2500	2400	2000	1700	2100	1800	2400	2400	3000
PALPH	1870	2058	1058	70	70	70	60	52	42	48	42	43	42
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32686	32637	32568	32370	32359	32686	32637	32412	32370	32343
POVC2	1878	2063	1063	1031	1639	2505	4981	5110	1030	1636	4446	4981	5315
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	3059	4866	7445	14847	15235	3056	4858	13245	14847	15850
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	12288	8192	16288	16288	12192	16288	20384	8192	8192	20384
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1287	1623	2008	2836	2872	1286	1622	2678	2836	2930
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	5145	5145	5170	10250	15370	12800	17920	17920	12800	12800
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	15000	15000	15000	15000	15000	15000	15000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	205	325	527	684	921	205	326	395	684	921
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	αC40	α0.5	α3/3	α6/2	α6/3	α12/2	α12/3	α22/2	α22/3	α30/2
			Motor specification	0156	0113	0123	0127	0128	0142	0143	0147	0148	0152
			Motor model		β0.5								
			Motor specification		0113								
			Motor type No.	12	13	15	16	17	18	19	20	21	22
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00001000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000000	01000100	01000100	01000000	01000100	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000
PK1	1852	2040	1040	2267	220	1314	2282	943	3121	1324	2195	881	3173
PK2	1853	2041	1041	–7414	–540	–3268	–4660	–2956	–4953	–3671	–4490	–2759	–5522
PK3	1854	2042	1042	–2695	–2556	–3052	–3052	–2633	–3052	–3052	–3052	–3052	–3052
PK1V	1855	2043	1043	227	9	87	99	91	188	165	203	214	144
PK2V	1856	2044	1044	–2030	–79	–781	–887	–818	–1683	–1474	–1821	–1921	–1293
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1870	–4789	4858	4279	4639	2254	2574	2084	1976	2935
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	7740	1200	2000	3500	3000	4000	2500	4000	3000	5000
PVPA	1869	2057	1057	3000	2000	2200	2000	2800	2000	2200	2000	2200	2600
PALPH	1870	2058	1058	36	77	64	41	80	38	64	40	64	46
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32528	32585	32713	32689	32698	32568	32614	32543	32518	32668
POVC2	1878	2063	1063	2997	2288	690	991	877	2505	1922	2811	3128	1245
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	8911	6797	2045	2940	2601	7445	5709	8358	9305	3695
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	12288	17384	15288	12288	12288	18384	18384	14288	14288	14288
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2197	1918	1052	1261	1187	2008	1758	2127	2245	1414
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	12800	5160	0	10265	30	12800	5145	7680	2585	10240
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	15000	15000	15000	15000	15000	15000	15000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	1557	29	251	419	454	527	601	911	864	1870
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	α30/3	αM3	αM6	αM9	α22/1.5	α30/1.2	α40/FAN	α40/2	2–0E	1–0E
			Motor specification	0153	0161	0162	0163	0146	0151	0158	0157	0103	0104
			Motor model										
			Motor specification										
			Motor type No.	23	24	25	26	27	28	29	30	31	32
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00000000	00001000	00001000	00001000	00000000	00000000	00000000	00000000	00001100	00001100
	1809	2004	1004	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000000	01000000	01000100	01000100	01000000	01000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000	00100000
PK1	1852	2040	1040	1305	672	950	748	2330	5060	1832	1832	550	715
PK2	1853	2041	1041	–3431	–2065	–2582	–2402	–6381	–9923	–5994	–5994	–1749	–2196
PK3	1854	2042	1042	–3052	–3052	–3052	–2632	–2694	–2705	–2700	–2700	–2564	–2596
PK1V	1855	2043	1043	240	53	38	61	271	147	201	201	76	93
PK2V	1856	2044	1044	–2153	–471	–328	–550	–2426	–1313	–1801	–1801	–1374	–1667
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1763	–806	–1156	–690	1564	2891	2107	2107	2761	2277
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	1894	1894	1894	1894	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	4500	2500	3500	3000	4000	8000	6637	6637	2600	3700
PVPA	1869	2057	1057	2000	2400	2400	2700	2400	3600	2200	2200	2844	2582
PALPH	1870	2058	1058	59	70	70	83	43	38	48	48	70	64
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32493	32697	32727	32692	32370	32665	32361	32579	32430	32257
POVC2	1878	2063	1063	3443	886	516	955	4981	1283	5090	2358	4226	6385
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	10245	2627	1529	2832	14847	3809	15175	7007	12587	19067
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	9192	31672	31672	16384	12288	12288	10192	10192	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2355	1193	910	1238	2836	1436	2867	1948	2611	3213
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	5145	25	5145	0	12800	12800	12800	12800	–2008	–2786
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	15000	15000	15000	15000	15000	10000	12000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	1123	221	581	653	684	1842	1756	1756	34	55
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	0E	5E	E1/3	E2/3	50S	60S	70S	5–0	4–0S	3–0S
			Motor specification	0105	0106	0101	0102	0331	0332	0333	0531	0532	0533
			Motor model	αE3/2	αE6/2	αE1/3	αE2/3	α65/2	α100/2	α150/2			
			Motor specification	0105	0106	0101	0102	0331	0332	0333			
			Motor model	β3/3	β6/2	β1/3	β2/3						
			Motor specification	0033	0034	0031	0032						
			Motor type No.	33	34	35	36	39	40	41	42	43	44
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00001100	00001100	00001100	00001100	00001000	00001000	00001000	00000000	00000000	00000000
	1809	2004	1004	00000110	01000110	00000110	00000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000100	00000100	00000100	00000100	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000000	01000000	01000000	01000000	01010100	01010100	01010100	00000000	00000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00000000	00100000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	275	990	359	704	999	1451	1334	457	460	736
PK2	1853	2041	1041	–1006	–3544	–1129	–2401	–3600	–6000	–5297	–999	–730	–1500
PK3	1854	2042	1042	–2622	–2632	–2564	–2596	–1957	–2259	–2723	–1873	–2373	–2374
PK1V	1855	2043	1043	144	144	102	62	168	130	145	30	58	53
PK2V	1856	2044	1044	–2587	–2587	–916	–1111	–1502	–1165	–1295	–300	–517	–477
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1467	1467	4141	3415	2526	3259	2931	0	–733	–795
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	3787	1894	1894	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	3000	3200	2500	3300	4444	4884	6668	0	629	1129
PVPA	1869	2057	1057	3200	2000	2100	2700	2800	2800	3040	2330	1861	2330
PALPH	1870	2058	1058	80	57	71	78	57	57	57	57	46	57
PPBAS	1871	2059	1059	5	5	5	5	20	20	20	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282	6560	6560	6560	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	0	120	120
POVC1	1877	2062	1062	32456	32456	32617	32540	32419	32499	32281	32514	32543	32576
POVC2	1878	2063	1063	3897	3897	1884	2850	4365	3358	6086	3173	2817	2401
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	11600	11600	5594	8474	13002	9990	18168	9437	8375	7136
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	1100	1100	1100	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0	400	400	400	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	15	15	15	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2506	2506	1740	2142	2653	2326	3137	2261	2129	1966
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	–1476	30	80	–2786	0	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	12000	0	12000	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	107	215	51	83	2243	3791	4217	3	10	21
LP24PA	1999	2106	1106	12923	12923	12923	14203	0	0	0	0	0	0

			Motor model	2–0SP	1–0SP	5S	6S	10S	20S/1.5	20S	30S	30/2	40
			Motor specification	0371	0372	0314	0316	0315	0505	0502	0590	0506	0581
			Motor model		α2/2								
			Motor specification		0372								
			Motor type No.	45	46	48	49	50	51	52	53	54	55
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	390	1170	1500	750	2591	1131	1261	3414	705	1511
PK2	1853	2041	1041	–1053	–2289	–2781	–2000	–5540	–2477	–2577	–7650	–2716	–5829
PK3	1854	2042	1042	–2480	–2485	–3052	–2596	–2623	–2649	–2646	–2663	–2669	–2672
PK1V	1855	2043	1043	111	91	151	216	260	458	298	201	375	282
PK2V	1856	2044	1044	–997	–812	–1355	–1932	–2328	–4103	–2666	–1797	–3356	–2526
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	3806	4674	2801	1964	1630	925	1424	2112	1131	1502
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	1589	2147	2403	5000	5520	3549	2731	5456	1961	3478
PVPA	1869	2057	1057	2330	1864	2330	3750	3500	2797	2600	7200	2330	2800
PALPH	1870	2058	1058	57	46	57	64	64	52	57	50	57	43
PPBAS	1871	2059	1059	0	0	0	0	0	0	0	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	6918	6918	6554	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32623	32627	32677	32485	32539	32155	32386	32530	32254	32340
POVC2	1878	2063	1063	1811	1766	1142	3536	2864	7659	4771	2971	6421	5355
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	5377	5245	3388	10522	8515	22907	14219	8834	19176	15972
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0	0	0	0	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1706	1685	1354	1966	1768	3801	2285	1801	2654	2941
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0	0	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	51	104	390	403	598	577	888	1860	995	1709
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

Motor model				0L(C)	5L(C)	6L(C)	7L(C)	10L(C)	2–0SP/3	1–0SP/3	0S/3	5S/3	10S/3
Motor specification				0561	0562	0564	0571	0572	0371	0373	0313	0514	0317
Motor model				αL3	αL6	αL9	αL25	αL50	α1/3	α2/3			
Motor specification				0561	0562	0564	0571	0572	0371	0373			
Motor type No.				56	57	58	59	60	61	62	63	64	65
Symbol	Parameter No.												
	FS15–B	FS16–PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	1600	1360	850	590	700	390	450	600	672	1090
PK2	1853	2041	1041	–4508	–4000	–2300	–1600	–2000	–1053	–900	–1600	–1574	–2360
PK3	1854	2042	1042	–2614	–2647	–2652	–2685	–2701	–2480	–2503	–2517	–2526	–2625
PK1V	1855	2043	1043	18	17	34	92	116	111	128	126	136	287
PK2V	1856	2044	1044	–159	–156	–309	–823	–1035	–997	–1146	–1127	–1215	–2571
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	–2382	–2429	–1229	4611	3666	3806	3311	3366	3124	1476
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	2000	2000	1240	4500	4800	2800	2520	2520	2520	3780
PVPA	1869	2057	1057	2330	2330	2330	3000	3200	2330	2330	2330	2330	2330
PALPH	1870	2058	1058	57	57	57	64	64	57	57	57	57	57
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	5462	5462	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32695	32698	32614	32489	32237	32623	32519	32712	32694	32578
POVC2	1878	2063	1063	912	877	1928	3482	6640	1811	3112	706	924	2381
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	2706	2602	5727	10360	19834	5377	9256	2094	2740	7075
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	3000	3000	4000	4000	4000	1680	2940	4000	2100	2520
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1210	1187	1761	2369	3277	1706	2239	1064	1218	1814
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	50	0	50	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	218	445	451	930	1345	51	74	247	435	541
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	20S/3	30S/3	0L(L)	5L(L)	6L(L)	7L(L)	10L(L)	6S/3	40S/2	0T/3
			Motor specification	0318	0319	0561	0562	0564	0571	0572		0583	0381
			Motor model										
			Motor specification										
			Motor type No.	66	67	68	69	70	71	72	73	78	79
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	542	708	1600	1360	850	590	700	1000	892	701
PK2	1853	2041	1041	–1377	–1811	–4508	–4000	–2300	–1600	–2000	–2400	–2877	–2038
PK3	1854	2042	1042	–2654	–2664	–2614	–2647	–2652	–2685	–2701	–2459	–2666	–2390
PK1V	1855	2043	1043	305	346	18	17	34	119	150	135	280	260
PK2V	1856	2044	1044	–2734	–3097	–159	–156	–309	–1070	–1346	–1205	–2511	–2329
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1388	1226	–2382	–2429	–1229	3547	2820	3148	1512	1630
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	50	50	21	21	21	21	21	21	50	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	5400	6000	2000	2000	1240	4500	4800	3200	4800	4008
PVPA	1869	2057	1057	2330	2200	2330	2330	2330	3000	3200	2300	3200	4200
PALPH	1870	2058	1058	57	57	57	57	57	64	64	64	60	43
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	5462	5462	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32495	32470	32695	32698	32614	32299	31875	32693	32345	32703
POVC2	1878	2063	1063	3410	3723	912	877	1928	5867	11158	940	5290	819
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	10144	11081	2706	2602	5727	17509	32767	2787	15775	2428
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	4000	0	3000	3000	4000	4000	4000	3200	3333	3158
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2344	2450	1210	1187	1761	3079	4261	1228	2923	1147
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	15	0	0	0	0	50	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	866	1079	218	445	451	715	1034	647	1719	269
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	5T	5T/3	10T	10T/3	0–0SP/3	0S/1.5	5S/1.5	6S/1	10S/1	20S/0.5
			Motor specification	0382	0383	0384	0385	0374	0515	0516	0520	0504	0585
			Motor model					α2.5/3					
			Motor specification					0374					
			Motor type No.	80	81	82	83	84	85	86	87	88	89
Symbol	Parameter No.												
	FS15–B	FS16~PM	PM–E										
	1808	2003	1003	00000000	00001000	00000000	00001000	00001000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	01000100	00000000	01000100	01000100	01000100	01000100	01000000	01000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	670	456	600	409	294	1275	800	1008	2420	3500
PK2	1853	2041	1041	–1600	–1019	–1153	–946	–990	–3600	–2447	–3840	–6600	–11616
PK3	1854	2042	1042	–2473	–2498	–2550	–2543	–2455	–2544	–3052	–2584	–2640	–2662
PK1V	1855	2043	1043	287	209	450	349	70	142	212	215	364	298
PK2V	1856	2044	1044	–2568	–1877	–4034	–3124	–898	–1268	–1896	–1927	–3261	–2666
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1478	2022	941	1215	4228	2992	2001	1970	1164	1424
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	4400	3684	4590	4008	1971	2000	6000	5500	6500	2000
PVPA	1869	2057	1057	4000	3000	3335	2330	2330	3500	3650	4500	4600	6200
PALPH	1870	2058	1058	64	64	57	57	57	83	83	83	83	83
PPBAS	1871	2059	1059	0	5	0	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32669	32714	32532	32625	32569	32696	32589	32487	32320	32387
POVC2	1878	2063	1063	1235	674	2948	1788	2482	903	2234	3517	5601	4764
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	3665	1998	8766	5308	7376	2679	6636	10466	16711	14198
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	2105	0	3421	2917	1000	3500	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1409	1040	2179	1696	1998	1205	1896	1961	2478	2284
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0	50	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	433	593	483	624	131	219	279	404	427	888
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0

			Motor model	1500A	3000B	6000B	9000B
			Motor specification	0410	0411	0412	0413
			Motor model				
			Motor specification				
			Motor type No.	90	91	92	93
Symbol	Parameter No.						
	FS15–B	FS16–PM	PM–E				
	1808	2003	1003	00001000	00001000	00001000	00001000
	1809	2004	1004	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	00000000	00000000	00000000
	1954	2010	1010	00000100	00000100	00000100	00000100
	1955	2011	1011	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	1890	4804	4804	5036
PK2	1853	2041	1041	–7180	–14453	–13138	–16000
PK3	1854	2042	1042	–2647	–2660	–2660	–2660
PK1V	1855	2043	1043	19	16	16	14
PK2V	1856	2044	1044	–260	–214	–214	–195
PK3V	1857	2045	1045	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	–4371	–5321	–5321	–5849
BLCMP	1860	2048	1048	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0
POK1	1862	2050	1050	956	956	956	956
POK2	1863	2051	1051	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319
EMFCMP	1868	2056	1056	0	0	0	0
PVPA	1869	2057	1057	0	0	0	0
PALPH	1870	2058	1058	0	0	0	0
PPBAS	1871	2059	1059	0	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120
POVC1	1877	2062	1062	32670	32670	32670	32685
POVC2	1878	2063	1063	1222	1222	1222	1041
TGALMLV	1892	2064	1064	4	4	4	4
POVCLMT	1893	2065	1065	3626	3626	3626	3087
PK2VAUX	1894	2066	1066	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0
MODEL	1968	2075	1075	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0
RTCURR	1979	2086	1086	1402	1402	1402	1293
TDPLD	1980	2087	1087	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0
TRQCST	1998	2105	1105	227	455	911	1481
LP24PA	1999	2106	1106	0	0	0	0

7.3 PARAMETERS FOR HRV CONTROL

Series 9080, 9081 (Series 15–B, 16–C, 18–C)
Series 9066 (Series 20, 21, Power Mate)
Series 9065 (Power Mate–E)

			Motor model	α3HV	α6HV	α12HV	α22HV	α30HV	αC3	αC6	αC12	αC22	αC30
			Motor specification	0171	0172	0176	0177	0178	0121	0126	0141	0145	0155
			Motor model										
			Motor specification										
			Motor type No.	1	2	3	4	5	7	8	9	10	11
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	01000110	01000110	01000110	00000110	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000100	01000100	01000100	01000000	01000000	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00100000	00100000	00100000	00000000	00000000	00000000	00100000
PK1	1852	2040	1040	687	828	730	800	1100	1600	1800	3000	2330	1662
PK2	1853	2041	1041	–2510	–3129	–3038	–3190	–3886	–5059	–6105	–9750	–6831	–6215
PK3	1854	2042	1042	–2617	–2638	–2638	–2694	–2663	–2608	–2641	–2687	–2694	–2697
PK1V	1855	2043	1043	107	127	188	271	293	107	127	251	271	293
PK2V	1856	2044	1044	–955	–1141	–1683	–2426	–2625	–955	–1140	–2245	–2426	–2625
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	3972	3326	2254	1564	1446	3974	3329	1690	1564	1446
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	3787	1894	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	2500	4000	3500	3500	4000	3046	4381	4000	4000	11261
PVPA	1869	2057	1057	2200	–7692	–6922	–6671	–4113	–6405	–3858	–3094	–3872	3000
PALPH	1870	2058	1058	70	–1920	–1700	–3000	–3400	–250	–2500	–4000	–2800	42
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32686	32637	32568	32370	32359	32686	32637	32412	32370	32343
POVC2	1878	2063	1063	1031	1639	2505	4981	5110	1030	1636	4446	4981	5315
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	3059	4866	7445	14847	15235	3056	4858	13245	14847	15850
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	8192	16288	16288	12192	16288	11192	8192	8192	20384
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1287	1623	2008	2836	2872	1286	1622	2678	2836	2930
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	5145	5145	5170	10250	15370	12800	17920	17920	12800	12800
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	15000	15000	15000	0	0	0	15000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	205	325	527	684	921	205	326	395	684	921
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	2568	0	0	2592	2576	16	24	16	24	0
DETQLM	1704	2111	1111	6244	3870	5140	3915	3147	0	5220	0	2660	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	1700	300	3420	700	900	2729	3326	4520	3298	0
MFWKCE	1736	2128	1128	3333	4286	2857	2667	3636	4000	6500	6000	7000	0
MFWKBL	1752	2129	1129	2578	2080	2073	2574	1813	1048	1047	785	1042	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	αC40	α0.5/3	α3/3	α6/2	α6/3	α12/2	α12/3	α22/2	α22/3	α30/2
			Motor specification	0156	0113	0123	0127	0128	0142	0143	0147	0148	0152
			Motor model		β0.5/3								
			Motor specification		0113								
			Motor type No.	12	13	15	16	17	18	19	20	21	22
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000000	01000100	01000100	01000000	01000100	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00100000	00100000	00000000	00100000	00100000	00100000	00000000
PK1	1852	2040	1040	2267	220	1183	2054	754	3121	1324	1975	881	3173
PK2	1853	2041	1041	–7414	–540	–2941	–4194	–2363	–4953	–3671	–4041	–2759	–5522
PK3	1854	2042	1042	–2695	–2556	–3052	–3052	–2633	–3052	–3052	–3052	–3052	–3052
PK1V	1855	2043	1043	227	9	87	99	91	188	165	203	214	144
PK2V	1856	2044	1044	–2030	–79	–781	–887	–818	–1683	–1474	–1821	–1921	–1293
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1870	–4789	4858	4279	4639	2254	2574	2084	1976	2935
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	7740	1200	2000	3500	3000	4000	2500	4000	3000	5000
PVPA	1869	2057	1057	3000	2000	–10250	–6415	–8965	–5135	–7683	–5126	–8965	–3079
PALPH	1870	2058	1058	36	77	–800	–1600	–650	–1500	–540	–600	–650	–700
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32528	32585	32713	32689	32698	32568	32614	32543	32518	32668
POVC2	1878	2063	1063	2997	2288	690	991	877	2505	1922	2811	3128	1245
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	8911	6797	2045	2940	2601	7445	5709	8358	9305	3695
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	12288	17384	3000	8192	0	18384	18384	18384	14288	14288
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2197	1918	1052	1261	1187	2008	1758	2127	2245	1414
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	12800	5160	0	10265	30	12800	5145	7680	2585	10240
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	15000	15000	0	15000	15000	15000	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	1557	29	251	419	454	527	601	911	864	1870
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	32	32	32	0	24	0	24	20
DETQLM	1704	2111	1111	0	7790	6214	3960	5170	5220	0	3920	5170	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	400	2047	2729	1706	4037	2615	2956	1663	4989
MFWKCE	1736	2128	1128	0	0	1500	5000	1000	5000	2500	6000	2000	6000
MFWKBL	1752	2129	1129	0	0	1812	1556	2112	1045	1552	1300	2571	1044
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	α30/3	αM3	αM6	αM9	α22/1.5	α30/1.2	α40/FAN	α40/2	2–0E	1–0E
			Motor specification	0153	0161	0162	0163	0146	0151	0158	0157	0103	0104
			Motor model										
			Motor specification										
			Motor type No.	23	24	25	26	27	28	29	30	31	32
Symbol	Parameter No.												
	FS15–B	FS16–C–PM	PM–E										
	1808	2003	1003	00000000	00001000	00001000	00001000	00000000	00000000	00000000	00000000	00001100	00001100
	1809	2004	1004	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	01000100	01000000	01000000	01000100	01000100	01000000	01000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000	00000000	00000000	00000000	00100000	00100000	00100000	00100000
PK1	1852	2040	1040	1175	538	950	748	2330	5060	1649	1649	550	715
PK2	1853	2041	1041	–3088	–1652	–2582	–2402	–6381	–9923	–5395	–5395	–1749	–2196
PK3	1854	2042	1042	–3052	–3052	–3052	–2632	–2694	–2705	–2700	–2700	–2564	–2596
PK1V	1855	2043	1043	240	53	38	61	271	147	201	201	76	93
PK2V	1856	2044	1044	–2153	–471	–328	–550	–2426	–1313	–1801	–1801	–1374	–1667
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1763	–806	–1156	–690	1564	2891	2107	2107	2761	2277
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	1894	1894	1894	1894	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	4500	2500	3500	3000	4000	8000	6637	6637	2600	3700
PVPA	1869	2057	1057	–5123	2400	–7688	–6407	–3872	–3092	–5150	–5150	2844	2582
PALPH	1870	2058	1058	–504	70	–1440	–1600	–2800	–1200	–3000	–3000	70	64
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32493	32697	32727	32692	32370	32665	32361	32579	32430	32257
POVC2	1878	2063	1063	3443	886	516	955	4981	1283	5090	2358	4226	6385
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	10245	2627	1529	2832	14847	3809	15175	7007	12587	19067
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	9192	3000	31672	12288	12288	12288	14288	14288	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2355	1193	910	1238	2836	1436	2867	1948	2611	3213
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	5145	25	5145	0	12800	12800	12800	12800	–2008	–2786
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000	0	0	0	15000	15000	10000	12000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	1123	221	581	653	684	1842	1756	1756	34	55
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	24	24	32	24	28	20	20	0	0
DETQLM	1704	2111	1111	3890	5220	5220	5220	2660	0	3940	3940	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	2000	1990	2729	853	3298	7846	3326	3326	0	0
MFWKCE	1736	2128	1128	6000	2000	2500	2000	7000	9500	7000	7000	0	0
MFWKBL	1752	2129	1129	2624	2624	1298	2570	1042	788	1300	1300	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	0E	5E	E1/3	E2/3	50S	60S	70S	5–0	4–0S	3–0S
			Motor specification	0105	0106	0101	0102	0331	0332	0333	0531	0532	0533
			Motor model	αE3/2	αE6/2	αE1/3	αE2/3	α65/2	α100/2	α150/2			
			Motor specification	0105	0106	0101	0102	0331	0332	0333			
			Motor model	β3/3	β6/2	β1/3	β2/3						
			Motor specification	0033	0034	0031	0032						
			Motor type No.	33	34	35	36	39	40	41	42	43	44
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00000000	00000000	00000000
	1809	2004	1004	00000110	00000110	00000110	00000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000000	01000000	01000000	01000000	00010000	00010000	00010000	00000000	00000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00000000	00100000	00100000	00100000	00100000	00000000	00000000	00000000
PK1	1852	2040	1040	629	990	359	704	790	1578	1574	457	460	736
PK2	1853	2041	1041	–2093	–3544	–1129	–2401	–3473	–4761	–4809	–999	–730	–1500
PK3	1854	2042	1042	–2622	–2632	–2564	–2596	–2714	–2714	–2718	–1873	–2373	–2374
PK1V	1855	2043	1043	144	144	102	62	121	102	120	30	58	53
PK2V	1856	2044	1044	–2587	–2587	–916	–1111	–1085	–916	–1072	–300	–517	–477
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1467	1467	4141	3415	3498	4141	3541	0	–733	–795
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	3000	3200	2500	3300	4444	4884	6668	0	629	1129
PVPA	1869	2057	1057	–8208	–5136	2100	–9229	–4617	–4617	–3849	2330	1861	2330
PALPH	1870	2058	1058	–2080	–1600	71	–1820	–1620	–1620	–1890	57	46	57
PPBAS	1871	2059	1059	5	5	5	5	20	20	20	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	0	120	120
POVC1	1877	2062	1062	32456	32456	32617	32540	32482	32529	32332	32514	32543	32576
POVC2	1878	2063	1063	3897	3897	1884	2850	3569	2987	5452	3173	2817	2401
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	11600	11600	5594	8474	10622	8881	16262	9437	8375	7136
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	1100	1100	1100	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0	28672	20480	20480	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	15	15	15	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2506	2506	1740	2142	2398	2193	2968	2261	2129	1966
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	–1476	30	80	–2786	0	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	15000	12000	0	12000	15000	15000	15000	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	107	215	51	83	2438	4103	4548	3	10	21
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	3382	0	3867	12	0	0	0	0	0
DETQLM	1704	2111	1111	7799	3120	7784	7868	2148	0	0	0	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	0	0	0	0	0	0	0	0	0
MFWKCE	1736	2128	1128	0	0	0	0	3600	4800	3500	0	0	0
MFWKBL	1752	2129	1129	0	0	0	0	1551	1294	1033	0	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	2–0SP	1–0SP	5S	6S	10S	20S/1.5	20S	30S	30/2	40
			Motor specification	0371	0372	0314	0316	0315	0505	0502	0590	0506	0581
			Motor model		α2/2								
			Motor specification		0372								
			Motor type No.	45	46	48	49	50	51	52	53	54	55
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00000000	00001000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	01000110	00000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	01000100	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00100000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	390	1170	1500	750	2591	1131	1261	3414	705	1511
PK2	1853	2041	1041	–1053	–2289	–2781	–2000	–5540	–2477	–2577	–7650	–2716	–5829
PK3	1854	2042	1042	–2480	–2485	–3052	–2596	–2623	–2649	–2646	–2663	–2669	–2672
PK1V	1855	2043	1043	111	91	151	216	260	458	298	201	375	282
PK2V	1856	2044	1044	–997	–812	–1355	–1932	–2328	–4103	–2666	–1797	–3356	–2526
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	3806	4674	2801	1964	1630	925	1424	2112	1131	1502
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	1894	3787	3787	3787	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	1589	2147	2403	5000	5520	3549	2731	5456	1961	3478
PVPA	1869	2057	1057	2330	–7690	2330	3750	3500	2797	2600	7200	2330	2800
PALPH	1870	2058	1058	57	–1000	57	64	64	52	57	50	57	43
PPBAS	1871	2059	1059	0	0	0	0	0	0	0	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	6918	6918	6554	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32623	32627	32677	32485	32539	32155	32386	32530	32254	32340
POVC2	1878	2063	1063	1811	1766	1142	3536	2864	7659	4771	2971	6421	5355
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	5377	5245	3388	10522	8515	22907	14219	8834	19176	15972
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0	0	0	0	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1706	1685	1354	1966	1768	3801	2285	1801	2654	2941
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0	0	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	15000	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	51	104	390	403	598	577	888	1860	995	1709
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	0	0	0	0	0	0	0	0
DETQLM	1704	2111	1111	0	6194	0	0	0	0	0	0	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	4800	0	0	0	0	0	0	0	0
MFWKCE	1736	2128	1128	0	2500	0	0	0	0	0	0	0	0
MFWKBL	1752	2129	1129	0	1806	0	0	0	0	0	0	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	0L(C)	5L(C)	6L(C)	7L(C)	10L(C)	2–0SP/3	1–0SP/3	0S/3	5S/3	10S/3
			Motor specification	0561	0562	0564	0571	0572	0371	0373	0313	0514	0317
			Motor model	αL3	αL6	αL9	αL25	αL50	α1/3	α2/3			
			Motor specification	0561	0562	0564	0571	0572	0371	0373			
			Motor type No.	56	57	58	59	60	61	62	63	64	65
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	01000110	00000110	00000110	00000110	00000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	01000100	00000000	00000000	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00100000	00100000	00100000	00100000	00000000	00000000	00000000
PK1	1852	2040	1040	1600	1360	850	574	700	390	530	600	672	1090
PK2	1853	2041	1041	–4508	–4000	–2300	–2254	–2000	–1053	–1653	–1600	–1574	–2360
PK3	1854	2042	1042	–2614	–2647	–2652	–2700	–2701	–2480	–2490	–2517	–2526	–2625
PK1V	1855	2043	1043	18	17	34	92	116	111	128	126	136	287
PK2V	1856	2044	1044	–159	–156	–309	–825	–1035	–997	–1146	–1127	–1215	–2571
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	–2382	–2429	–1229	4599	3666	3806	3311	3366	3124	1476
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	1894	1894	1894	1894	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	2000	2000	1240	4500	4800	2800	2520	2520	2520	3780
PVPA	1869	2057	1057	2330	2330	2330	–7692	–6430	2330	–8716	2330	2330	2330
PALPH	1870	2058	1058	57	57	57	–2200	–3300	57	–1200	57	57	57
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	5462	5462	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32695	32698	32614	32476	32214	32623	32519	32712	32694	32578
POVC2	1878	2063	1063	912	877	1928	3644	6929	1811	3112	706	924	2381
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	2706	2602	5727	10844	20705	5377	9256	2094	2740	7075
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	3000	3000	4000	24576	0	1680	8194	4000	2100	2520
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1210	1187	1761	2423	3349	1706	2239	1064	1218	1814
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	50	0	50	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	15000	15000	15000	15000	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	218	445	451	928	1343	51	74	247	435	541
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	0	20	24	0	0	0	0	0
DETQLM	1704	2111	1111	0	0	0	50	0	7715	7780	0	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	0	0	0	2402	785	2300	0	0	0
MFWKCE	1736	2128	1128	0	0	0	2000	4000	0	3000	0	0	0
MFWKBL	1752	2129	1129	0	0	0	2567	2321	0	3088	0	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	20S/3	30S/3	αL3	αL6	αL9	7L(L)	10L(L)	6S/3	40S/2	0T/3
			Motor specification	0318	0319	0561	0562	0564	0571	0572		0583	0381
			Motor model			(HRV)	(HRV)	(HRV)					
			Motor specification										
			Motor type No.	66	67	68	69	70	71	72	73	78	79
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	01000110	01000110	00000110	00000110	00000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	01000100	01000100	00000000	00000000	00000000	01000100	01000100	01000100	01000100	01000100
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00100000	00100000	00100000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	542	708	757	855	737	590	700	1000	892	701
PK2	1853	2041	1041	–1377	–1811	–3394	–3610	–2588	–1600	–2000	–2400	–2877	–2038
PK3	1854	2042	1042	–2654	–2664	–2652	–2676	–2673	–2685	–2701	–2459	–2666	–2390
PK1V	1855	2043	1043	305	346	18	17	35	119	150	135	280	260
PK2V	1856	2044	1044	–2734	–3097	–158	–155	–309	–1070	–1346	–1205	–2511	–2329
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1388	1226	–2395	–2455	–1227	3547	2820	3148	1512	1630
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	50	50	21	21	21	21	21	21	50	21
PDDP	1866	2054	1054	3787	3787	1894	1894	1894	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	5400	6000	2000	2000	1240	4500	4800	3200	4800	4008
PVPA	1869	2057	1057	2330	2200	0	0	–10249	3000	3200	2300	3200	4200
PALPH	1870	2058	1058	57	57	0	0	–800	64	64	64	60	43
PPBAS	1871	2059	1059	5	5	5	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32495	32470	32693	32696	32607	32299	31875	32693	32345	32703
POVC2	1878	2063	1063	3410	3723	940	894	2010	5867	11158	940	5290	819
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	10144	11081	2787	2653	5970	17509	32767	2787	15775	2428
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	4000	0	16384	28672	20480	4000	4000	3200	3333	3158
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	2344	2450	1228	1198	1798	3079	4261	1228	2923	1147
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	15	0	0	0	0	50	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	15000	15000	15000	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	866	1079	219	450	450	715	1034	647	1719	269
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	64	64	16	0	0	0	0	0
DETQLM	1704	2111	1111	0	0	2650	2620	5160	0	0	0	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	0	2000	2500	2500	0	0	0	0	0
MFWKCE	1736	2128	1128	0	0	0	0	2500	0	0	0	0	0
MFWKBL	1752	2129	1129	0	0	0	0	2586	0	0	0	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	5T	5T/3	10T	10T/3	0–0SP/3	0S/1.5	5S/1.5	6S/1	10S/1	20S/0.5
			Motor specification	0382	0383	0384	0385	0374	0515	0516	0520	0504	0585
			Motor model					α2.5/3					
			Motor specification					0374					
			Motor type No.	80	81	82	83	84	85	86	87	88	89
Symbol	Parameter No.												
	FS15–B	FS16–C–PM	PM–E										
	1808	2003	1003	00000000	00001000	00000000	00001000	00001000	00000000	00000000	00000000	00000000	00000000
	1809	2004	1004	01000110	01000110	01000110	01000110	00000110	01000110	01000110	01000110	01000110	01000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	01000100	00000000	01000100	01000100	01000100	01000100	01000000	01000000	00000000
	1954	2010	1010	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
PK1	1852	2040	1040	670	456	600	409	368	1275	800	1008	2420	3500
PK2	1853	2041	1041	–1600	–1019	–1153	–946	–990	–3600	–2447	–3840	–6600	–11616
PK3	1854	2042	1042	–2473	–2498	–2550	–2543	–2455	–2544	–3052	–2584	–2640	–2662
PK1V	1855	2043	1043	287	209	450	349	70	142	212	215	364	298
PK2V	1856	2044	1044	–2568	–1877	–4034	–3124	–898	–1268	–1896	–1927	–3261	–2666
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	1478	2022	941	1215	4228	2992	2001	1970	1164	1424
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	3787	3787	3787	3787	1894	3787	3787	3787	3787	3787
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	4400	3684	4590	4008	1971	2000	6000	5500	6500	2000
PVPA	1869	2057	1057	4000	3000	3335	2330	2330	3500	3650	4500	4600	6200
PALPH	1870	2058	1058	64	64	57	57	57	83	83	83	83	83
PPBAS	1871	2059	1059	0	5	0	5	5	5	5	5	5	5
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	120	120	120	120	120	120
POVC1	1877	2062	1062	32669	32714	32532	32625	32569	32696	32589	32487	32320	32387
POVC2	1878	2063	1063	1235	674	2948	1788	2482	903	2234	3517	5601	4764
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	3665	1998	8766	5308	7376	2679	6636	10466	16711	14198
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	2105	0	3421	0	1000	3500	0	0	0
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1409	1040	2179	1696	1998	1205	1896	1961	2478	2284
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0	50	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	0	0	0	0	0	0
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	433	593	483	624	131	219	279	404	427	888
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	0	0	0	0	0	0	0	0
DETQLM	1704	2111	1111	0	0	0	0	7730	0	0	0	0	0
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	0	0	0	500	0	0	0	0	0
MFWKCE	1736	2128	1128	0	0	0	0	0	0	0	0	0	0
MFWKBL	1752	2129	1129	0	0	0	0	0	0	0	0	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	1500A	3000B	6000B	9000B	αM2	αM2.5	αM22	αM30	αM6HV	αM9HV
			Motor specification	0410	0411	0412	0413	0376	0377	0165	0166	0182	0183
			Motor model										
			Motor specification										
			Motor type No.	90	91	92	93	98	99	100	101	104	105
Symbol	Parameter No.												
	FS15–B	FS16–C~PM	PM–E										
	1808	2003	1003	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000	00001000
	1809	2004	1004	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1884	2006	1006	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000000
	1954	2010	1010	00000100	00000100	00000100	00000100	00000000	00000000	00000000	00000000	00000000	00000000
	1955	2011	1011	00000000	00000000	00000000	00000000	00100000	00100000	00100000	00100000	00000000	00000000
PK1	1852	2040	1040	1890	4804	4804	5036	600	400	555	736	783	542
PK2	1853	2041	1041	–7180	–14453	–13138	–16000	–1957	–1154	–2698	–2623	–2832	–2277
PK3	1854	2042	1042	–2647	–2660	–2660	–2660	–2476	–2547	–2686	–2696	–2607	–2640
PK1V	1855	2043	1043	19	16	16	14	31	56	97	128	37	66
PK2V	1856	2044	1044	–260	–214	–214	–195	–274	–500	–867	–1142	–329	–595
PK3V	1857	2045	1045	0	0	0	0	0	0	0	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235	–8235
POA1	1859	2047	1047	–4371	–5321	–5321	–5849	–1383	–759	4378	3322	–1154	6373
BLCMP	1860	2048	1048	0	0	0	0	0	0	0	0	0	0
DPFMX	1861	2049	1049	0	0	0	0	0	0	0	0	0	0
POK1	1862	2050	1050	956	956	956	956	956	956	956	956	956	956
POK2	1863	2051	1051	510	510	510	510	510	510	510	510	510	510
RESERV	1864	2052	1052	0	0	0	0	0	0	0	0	0	0
PPMAX	1865	2053	1053	21	21	21	21	21	21	21	21	21	21
PDDP	1866	2054	1054	1894	1894	1894	1894	1894	1894	1894	1894	1894	1894
PHYST	1867	2055	1055	319	319	319	319	319	319	319	319	319	319
EMFCMP	1868	2056	1056	0	0	0	0	0	0	0	0	0	0
PVPA	1869	2057	1057	0	0	0	0	–9230	–8722	–7695	–5135	–7690	–6408
PALPH	1870	2058	1058	0	0	0	0	–1400	–1800	–2700	–2240	–1800	–1800
PPBAS	1871	2059	1059	0	0	0	0	0	0	0	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282	7282	7282	7282	7282	7282	7282	7282
EMFLMT	1873	2061	1061	120	120	120	120	0	0	0	0	0	0
POVC1	1877	2062	1062	32670	32670	32670	32685	32685	32645	32587	32567	32725	32678
POVC2	1878	2063	1063	1222	1222	1222	1041	1041	1535	2260	2514	538	1119
TGALMLV	1892	2064	1064	4	4	4	4	4	4	4	4	4	4
POVCLMT	1893	2065	1065	3626	3626	3626	3087	3089	4556	6714	7473	1596	3321
PK2VAUX	1894	2066	1066	0	0	0	0	0	0	0	0	0	0
FILTER	1895	2067	1067	0	0	0	0	0	0	0	0	0	0
FALPH	1961	2068	1068	0	0	0	0	0	0	0	0	0	0
VFFLT	1962	2069	1069	0	0	0	0	0	0	0	0	0	0
ERBLM	1963	2070	1070	0	0	0	0	0	0	0	0	0	0
PBLCT	1964	2071	1071	0	0	0	0	0	0	0	0	0	0
SFCCML	1965	2072	1072	0	0	0	0	0	0	0	0	0	0
PSPTL	1966	2073	1073	0	0	0	0	0	0	0	0	0	0
AALPH	1967	2074	1074	0	0	0	0	20480	8192	12288	8192	28672	12288
MODEL	1968	2075	1075	0	0	0	0	0	0	0	0	0	0
WKAC	1969	2076	1076	0	0	0	0	0	0	0	0	0	0
OSCTPL	1970	2077	1077	0	0	0	0	0	0	0	0	0	0
PDPCH	1971	2078	1078	0	0	0	0	0	0	0	0	0	0
PDPCL	1972	2079	1079	0	0	0	0	0	0	0	0	0	0
DPFEX	1973	2080	1080	0	0	0	0	0	0	0	0	0	0
DPFZW	1974	2081	1081	0	0	0	0	0	0	0	0	0	0
BLENDL	1975	2082	1082	0	0	0	0	0	0	0	0	0	0
MOFCTL	1976	2083	1083	0	0	0	0	0	0	0	0	0	0
SDMR1	1977	2084	1084	0	0	0	0	0	0	0	0	0	0
SDMR2	1978	2085	1085	0	0	0	0	0	0	0	0	0	0
RTCURR	1979	2086	1086	1402	1402	1402	1293	1293	1570	1907	2012	929	1341
TDPLD	1980	2087	1087	0	0	0	0	0	0	0	0	0	0
MCNFB	1981	2088	1088	0	0	0	0	0	0	0	0	0	0
BLBSL	1982	2089	1089	0	0	0	0	0	0	0	0	0	0
ROBSTL	1983	2090	1090	0	0	0	0	0	0	0	0	0	0
ACCSPL	1984	2091	1091	0	0	0	0	0	0	0	0	0	0
ADFF1	1985	2092	1092	0	0	0	0	0	0	0	0	0	0
VMPK3V	1986	2093	1093	0	0	0	0	0	0	0	0	0	0
BLCMP2	1987	2094	1094	0	0	0	0	0	0	0	0	0	0
AHDRTL	1988	2095	1095	0	0	0	0	0	0	0	0	0	0
RADUSL	1989	2096	1096	0	0	0	0	0	0	0	0	0	0
SMCNT	1990	2097	1097	0	0	0	0	0	0	0	0	0	0
DEPVPL	1991	2098	1098	0	0	0	0	0	0	0	0	0	0
ONEPSL	1992	2099	1099	400	400	400	400	400	400	400	400	400	400
INPA1	1993	2100	1100	0	0	0	0	0	0	0	0	0	0
INPA2	1994	2101	1101	0	0	0	0	0	0	0	0	0	0
DBLIM	1995	2102	1102	0	0	0	0	15000	15000	15000	15000	0	15000
ABVOF	1996	2103	1103	0	0	0	0	0	0	0	0	0	0
ABTSH	1997	2104	1104	0	0	0	0	0	0	0	0	0	0
TRQCST	1998	2105	1105	227	455	911	1481	139	143	943	1341	580	603
LP24PA	1999	2106	1106	0	0	0	0	0	0	0	0	0	0
VLGOVR	1700	2107	1107	0	0	0	0	0	0	0	0	0	0
RESERV	1701	2108	1108	0	0	0	0	0	0	0	0	0	0
BELLTC	1702	2109	1109	0	0	0	0	0	0	0	0	0	0
MGSTCM	1703	2110	1110	0	0	0	0	2600	2584	40	24	40	40
DETQLM	1704	2111	1111	0	0	0	0	6440	7780	5220	5220	0	5220
AMRDML	1705	2112	1112	0	0	0	0	0	0	0	0	0	0
NFILT	1706	2113	1113	0	0	0	0	0	0	0	0	0	0
NINTCT	1735	2127	1127	0	0	0	0	1322	625	1802	1756	5572	853
MFWKCE	1736	2128	1128	0	0	0	0	2000	2500	0	3000	0	0
MFWKBL	1752	2129	1129	0	0	0	0	2578	3847	0	2577	0	0
LP2GP	1753	2130	1130	0	0	0	0	0	0	0	0	0	0
LP4GP	1754	2131	1131	0	0	0	0	0	0	0	0	0	0
LP6GP	1755	2132	1132	0	0	0	0	0	0	0	0	0	0
LP4GA	1756	2133	1133	0	0	0	0	0	0	0	0	0	0
LP4PH	1757	2134	1134	0	0	0	0	0	0	0	0	0	0

			Motor model	αM22HV	αM30HV	αM50
			Motor specification	0185	0186	0169
			Motor model			
			Motor specification			
			Motor type No.	106	107	108
Symbol	Parameter No.					
	FS15–B	FS16–C~PM	PM–E			
	1808	2003	1003	00001000	00001000	00001000
	1809	2004	1004	00000110	00000110	00000110
	1883	2005	1005	00000000	00000000	00000000
	1884	2006	1006	00000000	00000000	00000000
	1954	2010	1010	00000000	00000000	00000000
	1955	2011	1011	00100000	00100000	00100000
PK1	1852	2040	1040	430	648	1046
PK2	1853	2041	1041	–2470	–2532	–4459
PK3	1854	2042	1042	–2682	–2692	–2664
PK1V	1855	2043	1043	94	161	43
PK2V	1856	2044	1044	–845	–1444	–386
PK3V	1857	2045	1045	0	0	0
PK4V	1858	2046	1046	–8235	–8235	–8235
POA1	1859	2047	1047	4490	2628	–983
BLCMP	1860	2048	1048	0	0	0
DPFMX	1861	2049	1049	0	0	0
POK1	1862	2050	1050	956	956	956
POK2	1863	2051	1051	510	510	510
RESERV	1864	2052	1052	0	0	0
PPMAX	1865	2053	1053	21	21	21
PDDP	1866	2054	1054	1894	1894	1894
PHYST	1867	2055	1055	319	319	319
EMFCMP	1868	2056	1056	0	0	0
PVPA	1869	2057	1057	–5135	–5130	–5129
PALPH	1870	2058	1058	–2000	–2800	–1440
PPBAS	1871	2059	1059	0	0	0
TQLIM	1872	2060	1060	7282	7282	7282
EMFLMT	1873	2061	1061	0	0	0
POVC1	1877	2062	1062	32596	32447	32583
POVC2	1878	2063	1063	2149	4009	2310
TGALMLV	1892	2064	1064	4	4	4
POVCLMT	1893	2065	1065	6385	11935	6865
PK2VAUX	1894	2066	1066	0	0	0
FILTER	1895	2067	1067	0	0	0
FALPH	1961	2068	1068	0	0	0
VFFLT	1962	2069	1069	0	0	0
ERBLM	1963	2070	1070	0	0	0
PBLCT	1964	2071	1071	0	0	0
SFCCML	1965	2072	1072	0	0	0
PSPTL	1966	2073	1073	0	0	0
AALPH	1967	2074	1074	24576	0	20480
MODEL	1968	2075	1075	0	0	0
WKAC	1969	2076	1076	0	0	0
OSCTPL	1970	2077	1077	0	0	0
PDPCH	1971	2078	1078	0	0	0
PDPCL	1972	2079	1079	0	0	0
DPFEX	1973	2080	1080	0	0	0
DPFZW	1974	2081	1081	0	0	0
BLENDL	1975	2082	1082	0	0	0
MOFCTL	1976	2083	1083	0	0	0
SDMR1	1977	2084	1084	0	0	0
SDMR2	1978	2085	1085	0	0	0
RTCURR	1979	2086	1086	1859	2542	1349
TDPLD	1980	2087	1087	0	0	0
MCNFB	1981	2088	1088	0	0	0
BLBSL	1982	2089	1089	0	0	0
ROBSTL	1983	2090	1090	0	0	0
ACCSPL	1984	2091	1091	0	0	0
ADFF1	1985	2092	1092	0	0	0
VMPK3V	1986	2093	1093	0	0	0
BLCMP2	1987	2094	1094	0	0	0
AHDRTL	1988	2095	1095	0	0	0
RADUSL	1989	2096	1096	0	0	0
SMCNT	1990	2097	1097	0	0	0
DEPVPL	1991	2098	1098	0	0	0
ONEPSL	1992	2099	1099	400	400	400
INPA1	1993	2100	1100	0	0	0
INPA2	1994	2101	1101	0	0	0
DBLIM	1995	2102	1102	15000	15000	15000
ABVOF	1996	2103	1103	0	0	0
ABTSH	1997	2104	1104	0	0	0
TRQCST	1998	2105	1105	967	1061	4330
LP24PA	1999	2106	1106	0	0	0
VLGOVR	1700	2107	1107	0	0	0
RESERV	1701	2108	1108	0	0	0
BELLTC	1702	2109	1109	0	0	0
MGSTCM	1703	2110	1110	40	24	0
DETQLM	1704	2111	1111	3940	5220	5116
AMRDML	1705	2112	1112	0	0	0
NFILT	1706	2113	1113	0	0	0
NINTCT	1735	2127	1127	4051	2388	5116
MFWKCE	1736	2128	1128	0	2000	2000
MFWKBL	1752	2129	1129	0	2575	1287
LP2GP	1753	2130	1130	0	0	0
LP4GP	1754	2131	1131	0	0	0
LP6GP	1755	2132	1132	0	0	0
LP4GA	1756	2133	1133	0	0	0
LP4PH	1757	2134	1134	0	0	0

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Revision Record

FANUC AC SERVO MOTOR α series PARAMETER MANUAL (B–65150E)

Edition	Date	Contents	Edition	Date	Contents
03	Apr., ’97	1. Correction of errors 2. Addition of new functions 3. Addition of parameter table for HRV control			
02	Mar., ’95	1. Correction of errors 2. Addition of servo functions			
01	Apr., ’94				