Quick Startup Guide for SIMOVERT MASTERDRIVES 6SE70 MC

Motion Control

We reserve the right to modify functions, technical data, standards, drawings and parameters.

We have checked the contents of this document to ensure that they coincide with the described hardware and software. However, deviations cannot be completely ruled-out, so we cannot guarantee complete conformance. However, the information in this document is regularly checked and the necessary corrections will be included in subsequent editions. We are thankful for any recommendations or suggestions.

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NOTE:

These instructions do not purport to cover all details or variations in equipment, nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, please contact your local Siemens office.

Further, the contents of these instructions shall neither become a part of nor modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Siemens Energy & Automation. The warranty contained in the contract between the parties is the sole warranty of Siemens Energy & Automation. Any statements contained herein do not create new warranties nor modify the existing warranty.

Note:

This Quick Startup Guide is not an autonomous document, but is intended to direct users to the section in the **Operating Instructions** which are important for start-up. Thus, these brief instructions can only be completely valid when used in conjunction with the Operating Instructions. It is especially important to observe the warning and information regarding potential hazards in the Operating Instructions.

Warning:

- Electrical equipment has parts an components which are at hazardous voltage levels.
- If the warning information in the **detailed Operating Instructions** is not observed, this can result in severe bodily injury or material damage.
- Only appropriately qualified personnel may work with this equipment.
- These personnel must be knowledgeable with all of the warning information and service/maintenance measures of the **Operating Instruction.**

Perfect and safe operation of this equipment assumes professional transport, storage, erection and installation as well as careful operating control and service.

Parameterization of Base Unit Section 1 Table of Contents:

Note: Refer to Operating Instruction Manual for power and control connections.

1.1 Power Section Definition

Note: Power Section is pre-defined at the factory. Power Section Definition is require if a new board CUMC board is put into the drive or boards are switched between units with different ratings. Drive should be defaulted and re-parameterized after Power Section Definition.

P060 = 8	Select “Power Section Definition” Menu
↓	
P070 = ?	Input Code for unit (MRPD, see List or Rating Plate)
↓	
P060 = 1	Return to Parameter Menu

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Unit List

PWE: Parameter Value
In[A]: Rated Output Current in Amps (P072)

Frequency Converter
Compact PLUS AC-AC type

PWE	Order Number	In[A]
1	6SE7011-5EP50	1.5
3	6SE7013-0EP50	3.0
5	6SE7015-0EP50	5.0
7	6SE7018-0EP50	8.0
9	6SE7021-0EP50	10.0
13	6SE7021-4EP50	14.0
15	6SE7022-1EP50	20.5
17	6SE7022-7EP50	27.0
19	6SE7023-4EP50	34.0

Frequency Inverter
Compact PLUS DC-AC type

PWE	Order Number	In[A]
2	6SE7012-0TP50	2.0
4	6SE7014-0TP50	4.0
6	6SE7016-0TP50	6.1
8	6SE7021-0TP50	10.2
12	6SE7021-3TP50	13.2
14	6SE7021-8TP50	17.5
16	6SE7022-6TP50	25.5
18	6SE7023-4TP50	34.0
20	6SE7023-8TP50	37.5

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Frequency Inverter
Construction Type: Compact DC-AC

PWE	**Order Number**	**In[A]**
4	6SE7016-1TA51	6.1
10	6SE7018-0TA51	8.0
12	6SE7021-0TA51	10.2
19	6SE7021-3TB51	13.2
26	6SE7021-8TB51	17.5
36	6SE7022-6TC51	25.5
43	6SE7023-4TC51	34.0
47	6SE7023-8TD51	37.5
53	6SE7024-7TD51	47.0
57	6SE7026-0TD51	59.0
67	6SE7027-2TD51	72.0

Frequency Converter
Construction Type: Compact AC-AC

PWE	**Order Number**	**In[A]**
3	6SE7016-1EA51	6.1
9	6SE7018-0EA51	8.0
11	6SE7021-0EA51	10.2
18	6SE7021-3EB51	13.2
25	6SE7021-8EB51	17.5
35	6SE7022-6EC51	25.5
42	6SE7023-4EC51	34.0
46	6SE7023-8ED51	37.5
52	6SE7024-7ED51	47.0
56	6SE7026-0ED51	59.0
66	6SE7027-2ED51	72.0

Frequency Inverter
Construction Type: Chassis Unit DC-AC

PWE	Order Number	In[A]
75	6SE7031-0TE50	92.0
83	6SE7031-2TF50	124.0
91	6SE7031-5TF50	146.0
99	6SE7031-8TF50	186.0*1 155.0*2
103	6SE7032-1TG50	210.0*1 175.0*2
109	6SE7032-6TG50	260.0*1 218.0*2
113	6SE7033-2TG50	315.0*1 262.0*2
117	6SE7033-7TH50	370.0*1 308.0*2
120	6SE7035-1TJ50	510.0*1 423.0*2

Frequency Converter
Construction Type: Chassis Unit AC-AC

PWE	Order Number	In[A]
74	6SE7031-0EE50	92.0
82	6SE7031-2EF50	124.0
90	6SE7031-5EF50	146.0
98	6SE7031-8EF50	186.0*1 155.0*2
102	6SE7032-1EG50	210.0*1 175.0*2
108	6SE7032-6EG50	260.0*1 218.0*2
112	6SE7033-2EG50	315.0*1 262.0*2
116	6SE7033-7EH50	370.0*1 308.0*2
147	6SE7035-1EK50	510.0*1 423.0*2

*1 Theoretical rated output current at 3 kHz Pulse Frequency

*2 Rated output current at 5 kHz Pulse Frequency; the permissible rated output current will be reduced further at higher pulse frequencies

Note: P67 (cooling option; 0=air, 1=water). For certain applications, water cooled units can be used without current derating and the parameter P67 can be set to “1” (contact your Application Engineer for further information).

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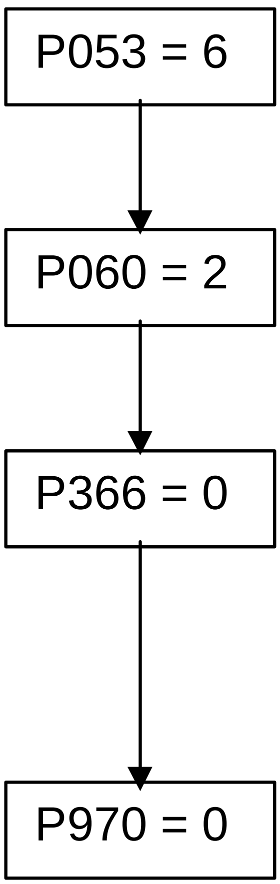
1.2 Factory Reset



6: Parameter Changes permitted via PMU and Serial Interface (OP1 and PC)

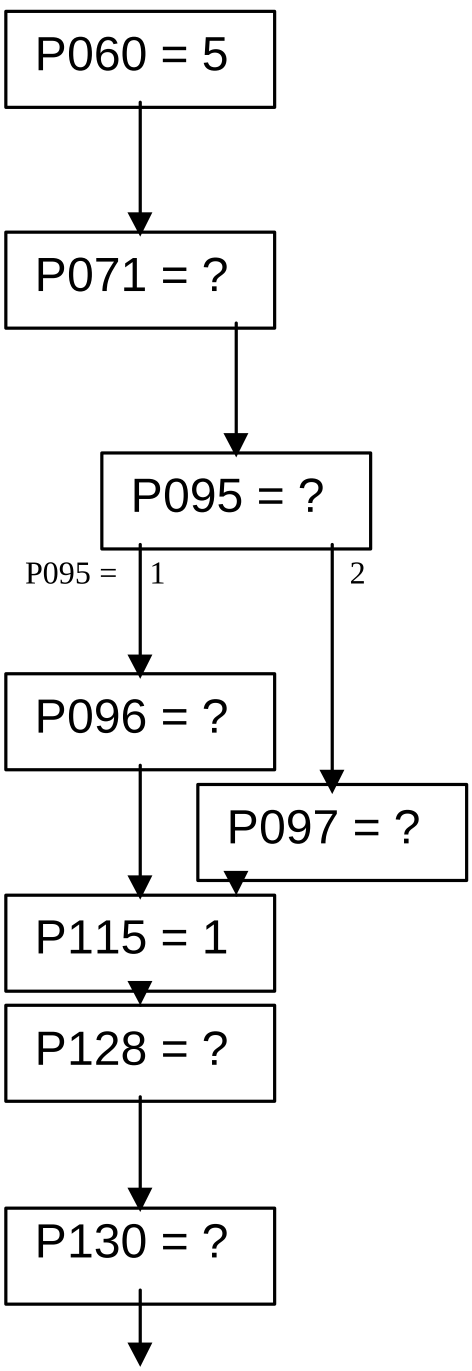
2: Menu Select = Fixed Settings

Select Factory Setting
0: Standard
1: Standard with OP1 Control
2: Cabinet Unit with Terminal Strip Control
3: Cabinet Unit with OP1 Control

Start Parameter Reset
0: Parameter Reset
1: No Parameter Change

Note: After Factory Reset unit will switch to status 5 (P060 = 5) “Drive Setting”

1.3 Drive Setting with Siemens Motor



Select "Drive Settings"

Enter Input Line Voltage (VDC for DC Supply and r.m.s. VAC for AC Supply)

eg. 620 VDC Unit (for 460 VAC Rectifier)

eg. 460 VAC

Select Motor Type
1: 1FT6/1FK6 Servo-Motor
2: 1PA6/1PH7/1PL6 Induction-Motor

Input Code number for 1FT6/1FK6 motor (See List)

Input Code number for 1PA6/1PH7/1PL6 motor (See List)

Load pre-set motor Data

Input Maximum Output Current(A)

Motor Rated Current is listed on Motor Nameplate. Current may be increased if the duty cycle is not continuous to account for required current inrush of dynamic servo motion.

Select Motor Encoder

Motor Order Code nth Digit:	**1FT6/1FK6** **n = 14th**	**1PL7/1PH7/1PL6/1PH4** **n = 9th**
1: 2-Pole Resolver	T	R
3: Encoder (Sin/Cos)		
ERN 1381		N
ERN 1387	A	M
4.Multiturn Encoder Absolute EQN 1325	E	E
5. Pulse Encoder in Slot C	N/A	H / J

Parameter	Description
P290 = 0	Select Type of Current Control 0: Closed-Loop Current Control
P290 = 0 & 1FT6/1FK6 → P296 P290 = 0 & 1PH7=1PA6/1PL6/1PA4 → P293	
P293 = ?	Input Field Weakening Frequency in Hz (Calculated w/ Self Tune P115)
P294 = ?	Select Flux Control 0: Closed-Loop, Flux Control Active 1: Open-Loop, Flux Control Not Active
P296 = 1	Select Controller Dynamics 0: Highest Dynamics <u>1: Average Dynamics</u> 2: Lowest Dynamics
P353 = ?	Input Reference Value for Speed Variables in rpm. (Normalization Value for Speed) eg: P353 = 6000 rpm
P452.1…4 = ? P453.1…4 = ?	Input Maximum Speed Positive Direction (P452) and Negative Direction (P453) in %. (Referenced to P353) eg. P452 = 100%
P060 = 1	Select “Drive Parameter Menu”

Complete.
For Detailed Parameterization See Compendium Section 6.

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Lists of stored motors - Synchronous Motors

1FK6 / 1FT6

Input in P096	Motor order number (MPRD)	Speed n_n [rpm]	Torque M_n [Nm]	Current I_n [A]
1	1FK6032-6AK7	6000	0.8	1.5
2	1FK6040-6AK7	6000	0.8	1.8
3	1FK6042-6AF7	3000	2.6	2.4
4	1FK6060-6AF7	3000	4.0	3.1
5	1FK6063-6AF7	3000	6.0	4.9
6	1FK6080-6AF7	3000	6.8	5.3
7	1FK6083-6AF7	3000	10.5	7.8
8	1FK6100-8AF7	3000	12.0	9.0
9	1FK6101-8AF7	3000	15.5	10.8
10	1FK6103-8AF7	3000	16.5	11.6
11	1FT6031-4AK7	6000	0.75	1.2
12	1FT6034-1AK7_-3A 1FT6034-4AK7_	6000	1.4	2.1
13	1FT6041-4AF7_	3000	2.15	1.7
14	1FT6041-4AK7	6000	1.7	2.4
15	1FT6044-1AF7_-3A 1FT6044-4AF7_	3000	4.3	2.9
16	1FT6044-4AK7	6000	3.0	4.1
17	1FT6061-6AC7	2000	3.7	1.9
18	1FT6061-1AF7_-3A 1FT6061-6AF7_	3000	3.5	2.6
19	1FT6061-6AH7_	4500	2.9	3.4
20	1FT6061-6AK7	6000	2.1	3.1
21	1FT6062-6AC7	2000	5.2	2.6
22	1FT6062-1AF7_-3A 1FT6062-6AF7_	3000	4.6	3.4
23	1FT6062-6AH7_	4500	3.6	3.9
24	1FT6062-6AK7	6000	2.1	3.2
25	1FT6064-6AC7_	2000	8.0	3.8
26	1FT6064-1AF7_-3A 1FT6064-6AF7_	3000	7.0	4.9
27	1FT6064-6AH7_	4500	4.8	5.5
28	1FT6064-6AK7	6000	2.1	3.5
29	1FT6081-8AC7_	2000	7.5	4.1
30	1FT6081-8AF7_	3000	6.9	5.6
31	1FT6081-8AH7_	4500	5.8	7.3
32	1FT6081-8AK7_	6000	4.6	7.7
33	1FT6082-8AC7_	2000	11.4	6.6
34	1FT6082-1AF7_-1A 1FT6082-8AF7_	3000	10.3	8.7
35	1FT6082-8AH7_	4500	8.5	11.0
36	1FT6082-8AK7_	6000	5.5	9.1
37	1FT6084-8AC7_	2000	16.9	8.3
38	1FT6084-1AF7_-1A 1FT6084-8AF7_	3000	14.7	11.0
39	1FT6084-8AH7_	4500	10.5	12.5
40	1FT6084-8AK7_	6000	6.5	9.2
41	1FT6084-8SC7_	2000	23.5	12.5
42	1FT6084-8SF7_	3000	22.0	17.0
43	1FT6084-8SH7_	4500	20.0	24.5
44	1FT6084-8SK7_	6000	17.0	25.5
45	1FT6086-8AC7_	2000	23.0	10.9
46	1FT6086-1AF7_-1A 1FT6086-8AF7_	3000	18.5	13.0

Input in P096	Motor order number (MPRD)	Speed n_n [rpm]	Torque M_n [Nm]	Current I_n [A]
47	1FT6086-8AH7_	4500	12.0	12.6
48	1FT6086-8SC7_	2000	33.0	17.5
49	1FT6086-8SF7_	3000	31.0	24.5
50	1FT6086-8SH7_	4500	27.0	31.5
51	1FT6086-8SK7	6000	22.0	29.0
52	1FT6102-8AB7	1500	24.5	8.4
53	1FT6102-1AC7_-1A 1FT6102-8AC7	2000	23.0	11.0
54	1FT6102-8AF7_	3000	19.5	13.2
55	1FT6102-8AH7_	4500	12.0	12.0
56	1FT6105-8AB7	1500	42.0	14.5
57	1FT6105-1AC7_-1A 1FT6105-8AC7_	2000	38.0	17.6
58	1FT6105-8AF7_	3000	31.0	22.5
59	1FT6105-8SB7	1500	57.0	21.5
60	1FT6105-8SC7_	2000	55.0	28.0
61	1FT6105-8SF7_	3000	49.0	35.0
62	1FT6108-8AB7	1500	61.0	20.5
63	1FT6108-8AC7	2000	55.0	24.5
64	1FT6108-8SB7	1500	83.0	31.0
65	1FT6108-8SC7	2000	80.0	39.0
66	1FT6132-6AB7	1500	62.0	19.0
67	1FT6132-6AC7	2000	55.0	23.0
68	1FT6132-6AF7_	3000	36.0	23.0
69	1FT6132-6SB7	1500	100.0	36.0
70	1FT6132-6SC7_	2000	98.0	46.0
71	1FT6132-6SF7_	3000	90.0	62.0
72	1FT6134-6AB7	1500	75.0	24.0
73	1FT6134-6AC7	2000	65.0	27.0
74	1FT6134-6SB7	1500	130.0	45.0
75	1FT6134-6SC7	2000	125.0	57.0
76	1FT6134-6SF7_	3000	110.0	72.0
77	1FT6136-6AB7	1500	88.0	27.0
78	1FT6136-6AC7_	2000	74.0	30.0
79	1FT6136-6SB7	1500	160.0	55.0
80	1FT6136-6SC7	2000	150.0	72.0
81	1FT6108-8SF7_	3000	70.0	53.0

Motor list 1FK6 / 1FT6

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Lists of stored motors – Asynchronous Motors 1PA6 / 1PL6

Note 1PA6…- 4 = 1PH7…- 2

Input in P097	Motor order number (MPRD)	Rated speed n_n [rpm]	Pole pair number Z_p	Current I_n [A]	Voltage U_n [V]	Torque M_n [Nm]	Frequency f_n [Hz]
1	1PA6101-4_F	1750	2	9.0	398	24	60.3
2	1PA6103-4_D	1150	2	9.6	390	36	40.6
3	1PA6103-4_F	1750	2	12.7	398	34	60.9
4	1PA6103-4_G	2300	2	15.4	398	31	78.9
5	1PA6105-4_F	1750	2	16.2	398	44	60.3
6	1PA6107-4_D	1150	2	16.0	381	60	40.3
7	1PA6107-4_F	1750	2	20.1	398	57	60.4
8	1PA6131-4_F	1750	2	23.7	398	71	59.7
9	1PA6133-4_D	1150	2	27.5	381	112	39.7
10	1PA6133-4_F	1750	2	33.1	398	96	59.7
11	1PA6133-4_G	2300	2	42.3	398	93	78.0
12	1PA6135-4_F	1750	2	40.0	398	117	59.5
13	1PA6137-4_D	1150	2	40.6	367	162	39.6
14	1PA6137-4_F	1750	2	53.0	357	136	59.5
15	1PA6137-4_G	2300	2	53.9	398	127	77.8
16	1PA6163-4_B	400	2	28.2	274	227	14.3
17	1PA6163-4_D	1150	2	52.1	364	208	39.2
18	1PA6163-4_F	1750	2	69.0	364	185	59.2
19	1PA6163-4_G	2300	2	78.5	398	158	77.3
20	1PA6163-4_B	400	2	35.6	294	310	14.3
21	1PA6167-4_D	1150	2	66.4	357	257	39.1
22	1PA6167-4_F	1750	2	75.2	398	224	59.2
23	1PA6184-4_B	400	2	51.0	271	390	14.2
24	1PA6184-4_D	1150	2	89.0	383	366	39.2
25	1PA6184-4_F	1750	2	122.0	388	325	59.0
26	1PA6184-4_L	2900	2	158.0	395	265	97.4
27	1PA6186-4_B	400	2	68.0	268	506	14.0
28	1PA6186-4_D	1150	2	116.0	390	485	39.1
29	1PA6186-4_F	1750	2	168.0	385	465	59.0
30	1PA6186-4_L	2900	2	205.0	395	333	97.3
31	1PA6224-4_B	400	2	89.0 2	68	725	14.0
32	1PA6224-4_D	1150	2	162.0	385	670	38.9
33	1PA6224-4_F	1750	2	205.0	395	605	58.9
34	1PA6224-4_L	2900	2	275.0	395	490	97.3
35	1PA6226-4_B	400	2	116.0	264	935	14.0
36	1PA6226-4_D	1150	2	200.0	390	870	38.9
37	1PA6226-4_F	1750	2	255.0	395	737	58.9
38	1PA6226-4_L	2900	2	350.0	390	610	97.2
39	1PA6228-4_B	400	2	138.0	272	1145	13.9
40	1PA6228-4_D	1150	2	240.0	390	1070	38.9
41	1PA6228-4_F	1750	2	350.0	395	945	58.8
42	1PA6228-4_L	2900	2	405.0	395	710	97.2
43	1PL6184-4_B	400	2	69.0	300	585	14.4
44	1PL6184-4_D	1150	2	121.0	400	540	39.4
45	1PL6184-4_F	1750	2	166.0	400	486	59.3

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Lists of stored motors – Asynchronous Motors

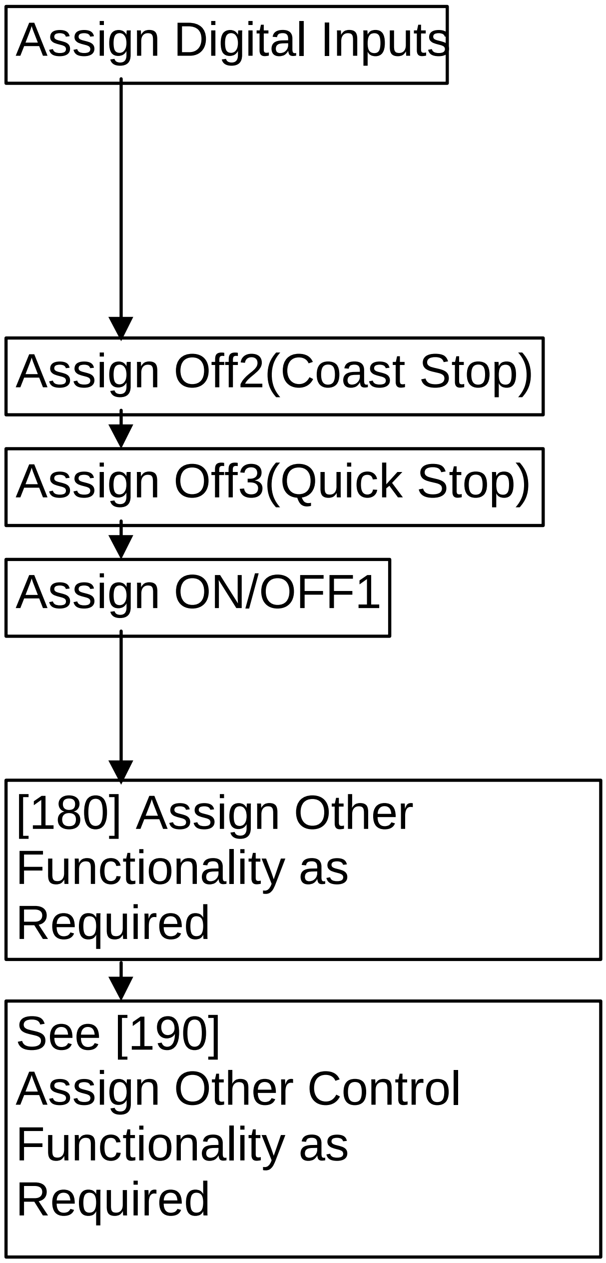
1PA6 / 1PL6

Input in P097	Motor order number (MPRD)	Rated speed n_n [rpm]	Pole pair number Z_p	Current I_n [A]	Voltage U_n [V]	Torque M_n [Nm]	Frequency f_n [Hz]
46	1PL6184-4_L	2900	2	209.0	400	372	97.6
47	1PL6186-4_B	400	2	90.0	290	752	14.3
48	1PL6186-4_D	1150	2	158.0	400	706	39.4
49	1PL6186-4_F	1750	2	231.0	400	682	59.3
50	1PL6186-4_L	2900	2	284.0	390	494	97.5
51	1PL6224-4_B	400	2	117.0	300	1074	14.2
52	1PL6224-4_D	1150	2	218.0	400	997	39.1
53	1PL6224-4_F	1750	2	292.0	400	900	59.2
54	1PL6224-4_L	2900	2	365.0	400	675	97.5
55	1PL6226-4_B	400	2	145.0	305	1361	14.0
56	1PL6226-4_D	1150	2	275.0	400	1287	39.2
57	1PL6226-4_F	1750	2	355.0	400	1091	59.1
58	1PL6226-4_L	2900	2	485.0	395	889	97.4
59	1PL6228-4_B	400	2	181.0	305	1719	14.0
60	1PL6228-4_D	1150	2	334.0	400	1578	39.2
61	1PL6228-4_F	1750	2	473.0	400	1448	59.0
62	1PL6228-4_L	2900	2	534.0	400	988	97.3

Motor list 1PA6 / 1PL6

1.4 Drive Control Word

Function Diagrams will be referred to in brackets with their number. Please refer to function diagrams in the compendium. Example [Diagram Number]



Function Diagram [90]

Digital Inputs/Outputs: Binector Assignments for Control may be made from Digital Inputs

Function Diagram [180]

P555, P556 & P557 can be used to assign Coast to Stop

P558, P559 & P560 can be used to assign Quick Stop

P554 MUST be assigned to activate drive. Note: Acceleration and Deceleration will be based on ramp generator [320]

Function Diagram [190]

Note:	OFF3 is different as compared to the VC drive, it is not a fast ramp, but rather a stop with maximum torque from the inverter (only limited by current limit)!

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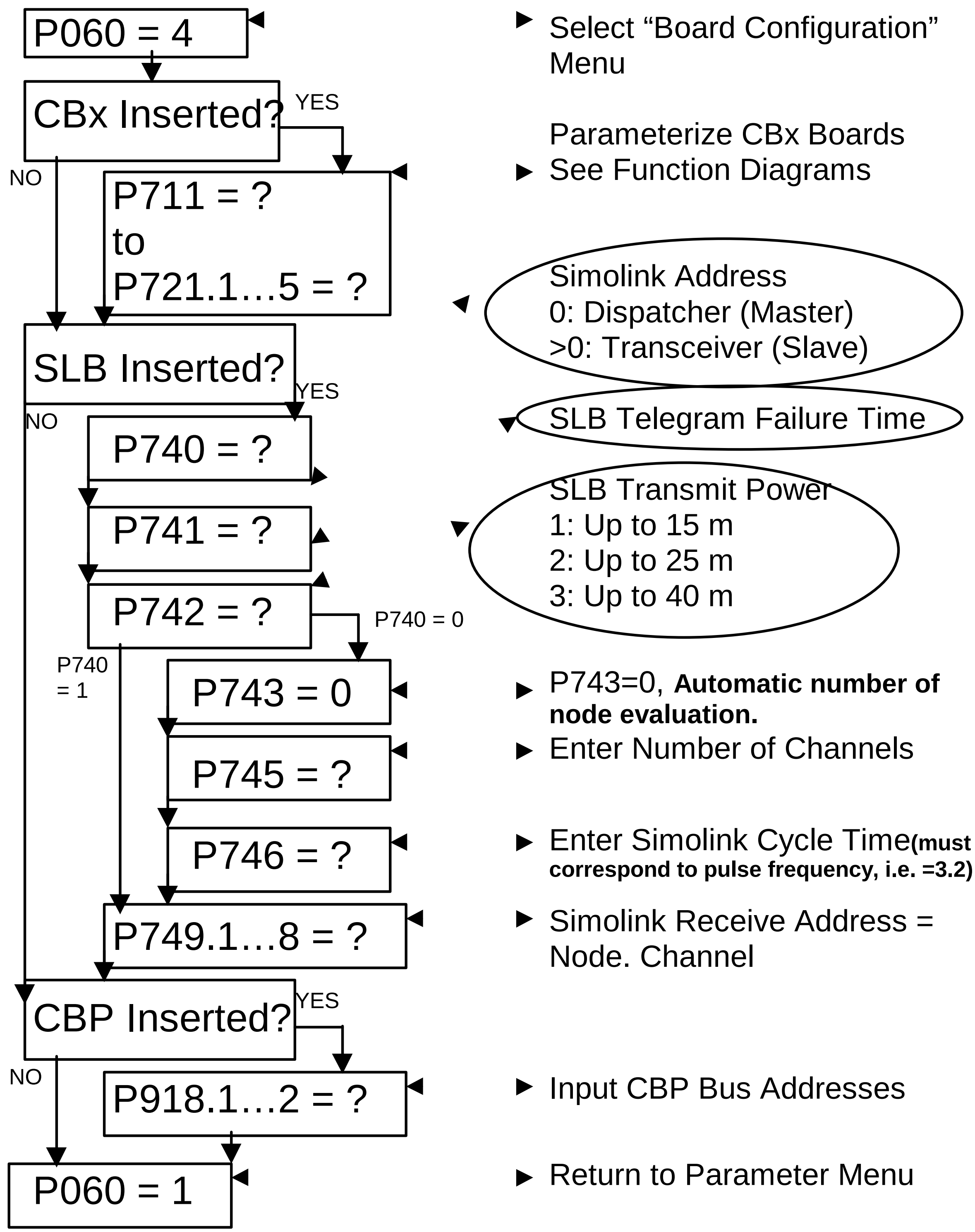
1.5 Tuning Drive and Current Loop

	P060 = 5	Select “Drive Settings”
	P115 = 1	Drive will Calculate Parameters based on Motor selected above and P115 returns to 0.
	P060 = 1	Select “Parameter Menu”
Function Diagram [180]	P554 = Binector	Assign Drive Control Word “On.” A Digital Input can be used. eg: P554 = 20(Digital Input 6)
	P115 = 2	Select Current Loop Tune from PMU. Note: Motor Shaft can move. All OFF commands are valid.
Fault occurs if not turned on within 20s	When PMU displays A078 switch Drive on.	Turn drive on when the PMU displays A078. **Motor will make a sound for approximately 2 -20 seconds.**
	Auto-Tune Complete	When Auto-Tune is complete Drive will be in State “°008.” Turn “On” switch low and Drive will return to State “°009,” Drive Ready.

1.6 Communication Board Configuration



Section 2:
Servo Drive Tuning Procedure

SIMOVERT MASTERDRIVES
6SE70 MC

Motion Control

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Servo Drive Tuning Procedure Section 2 Table of Contents:

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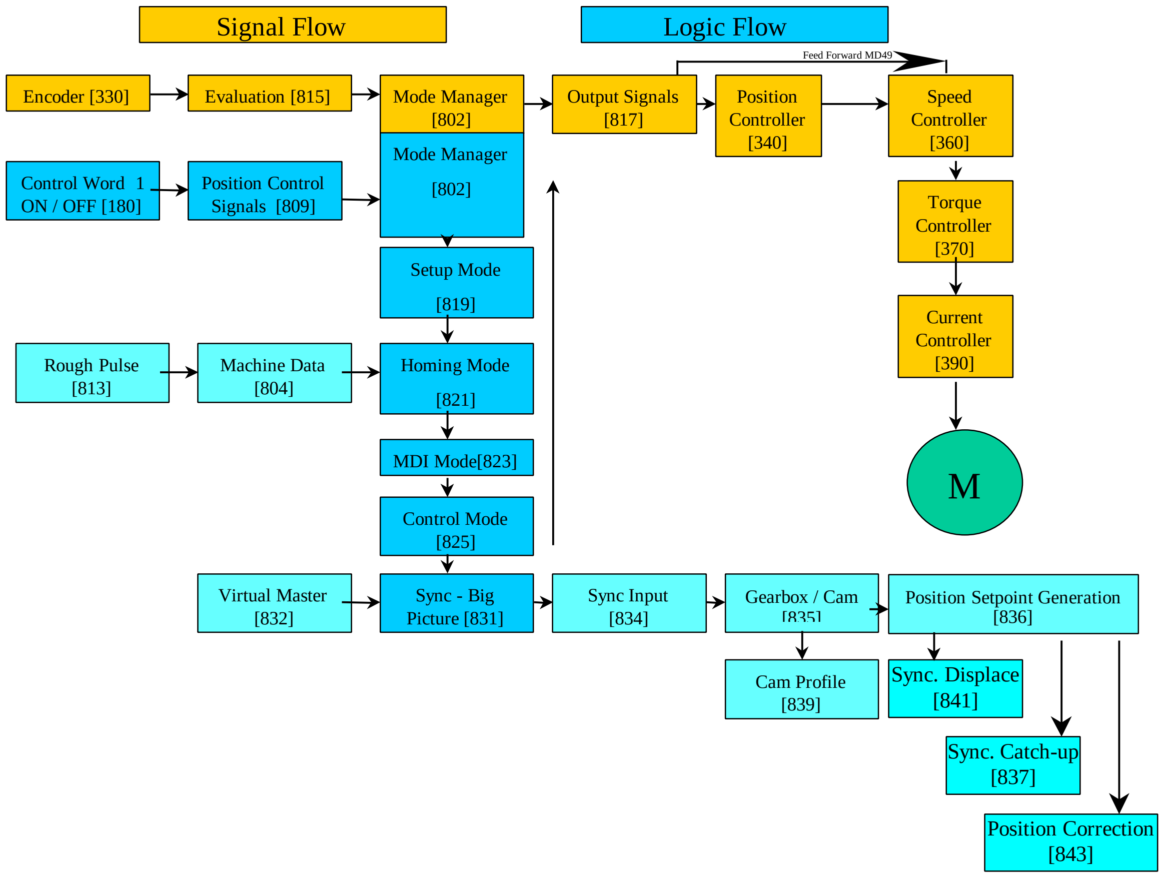
This Diagram illustrates the Signal and Logic Flow in the 6SE70 MC. Refer to section 3.6 for more details.

MC Signal Flow and Logic Flow:



2.1 Drive Tuning Considerations and Overview

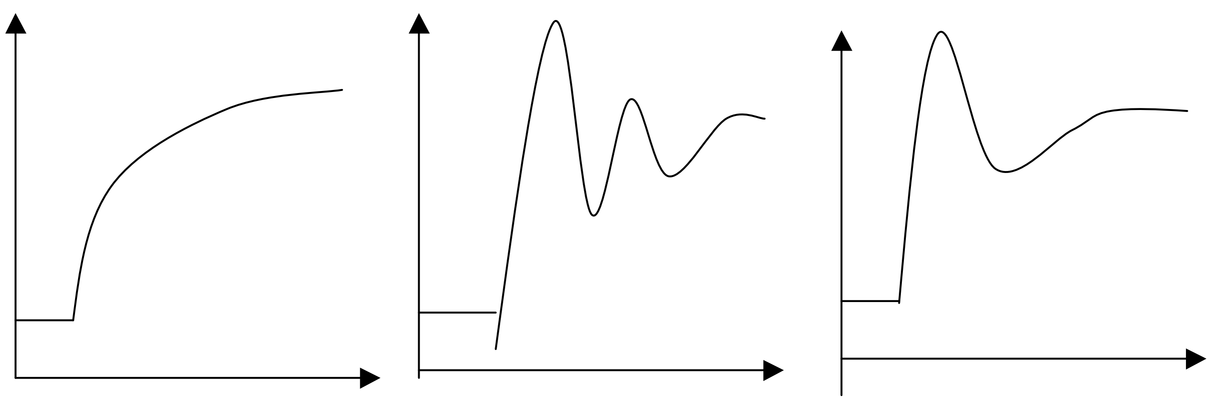
Always tune speed- and position controller with physical system connected to motor.

Speed Loop Tuning
Typically the minimum production speed of the application should be used to start optimization. Observe the torque and the current limit to reduce steps at high gains. e.g. 10% base speed(minimum production speed) with a 0.5% step jump.

Observe the actual speed by setting the analog output P640 to KK151. The analog output is multiplied by a factor of five (P643 = 50) and it is also OFFSET by –5 V (P644 = -5). This is necessary to see the small 0.5% jumps in the system speed.

Step One: Set integration to a large number in order to eliminate it's effects (P240 >= 250ms). Observe jumps while increasing Proportional Gain (P235). (*Proportional Gain will be mostly in the range of 50 to 200)*. The goal is to attain a rapid jump that is still stable.
Note: Observe the current controller to not run into current limits while optimizing.

Step Two: Gradually decrease the integration time (P240) to achieve a 30% to 40% overshoot and a nearly critical damping of the actually speed system.



Speed controller to slow P235 to small	Speed controller to fast P240 to small, P235 to large	Speed controller perfect

Notes:

While tuning the speed controller, make sure the torque step does not reach the limits of torque or current (a step of 0.5% causes a 100% torque step when gain is 200). For high gains the step should be smaller e.g. 0.1%. Check controller setting at minimum speed and maximum speed and watch behavior during ramp up, ramp down and fast stop.

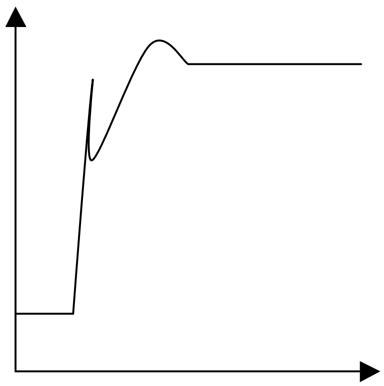
Set the integral part of speed controller (P240 [360]) to maximum(1000) to eliminate the influence of it. Increase the proportional gain for fast response without overshoot. Increase smoothing if necessary to increase proportional gain. Reduce the step if the proportional gain is higher than 100 (step * gain = torque-step).

Decrease the integral part to reach a 43% overshoot in step response. The theoretical value is Tn = 4 * (2ms + Tgl); Tgl is the smoothing time of the actual speed value (if no smoothing is used Tn can be 7 to 8 ms).

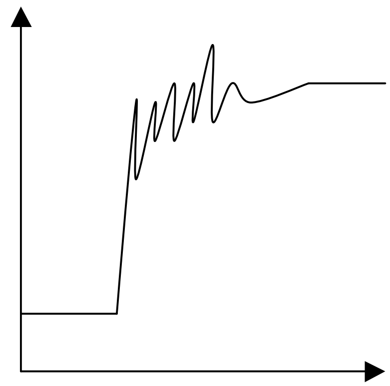
In multi-drive applications the smoothing factor must be equal for all the drives which have to perform together in order to get the same response from every drive. Also, the smoothing of the setpoint must be the same as the smoothing of the actual value.

If no smoothing of the actual value is used(P223 = 0), then the smoothing factor of the speed controller setpoint should be 0.5ms to 0.8ms. Because of different calculation cycles between the position controller and the speed controller, setpoint smoothing is required to produce a smoother torque setpoint.

Because of mechanical instability and thief belts the actual speed may look as follows:



Speed controller acceptable



Speed controller P235 to high

Run the system using a ramp generator up to full system speed and observe the current setpoint. There will be some oscillations in the current and speed while running at full speed. These oscillations may dampen out with a load applied to the system. If the oscillations do not dampen out with a load applied the proportional gain of the speed controller may need to be reduced. Also, spikes in the current at a fixed frequency for a synchronous machine may indicate a mechanical problem in the machine itself.

Note: Optimization should be carried out such that Proportional Gain maintains a proportional relationship with the inertia of the system throughout the load cycle. In other words, if the inertia of the system varies the Proportional Gain should be adapted to this varying inertia so that proportional relationship between the two is maintained (i.e. Adaptive Gain [360]).

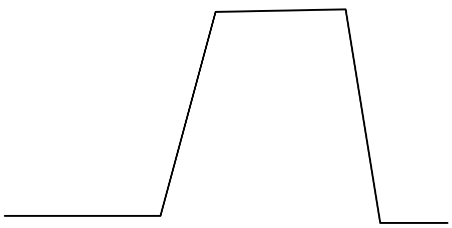
<u>Position Loop Tuning</u>

Setup a LU system and ActWtF (IBF) factor for the drive. Add steps to the actual position to achieve a setpoint step. The step response should be without overshoot. The position controller should work with proportional gains only!

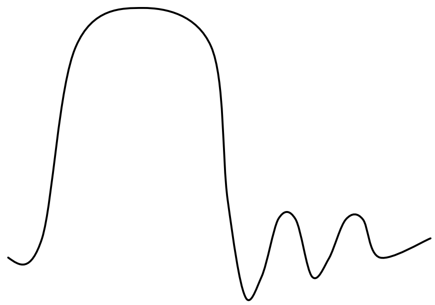
Important:
P205 [340]has to be set up properly according to the LU-system. You can change the LU-system later without changing P204 [340]. Only parameter P205 has to be changed to maintain the same behavior of the position loop. The pre-control/Feed Forward of the speed controller should be 100% for stiff control with rotational applications(not linear) and Synchronization.

The position controller can be limited with P207[340]. It is important to limit the speed controller input signal if it is to be used without ramps. Many Synchronous systems will require the position controller to be limited. (2 – 5%)

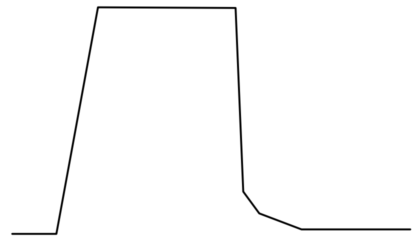
Observe either the actual speed or the actual position. Both of these can be observed while adjusting the position controller gain, P204[340].



Ideal Speed Ramp Response

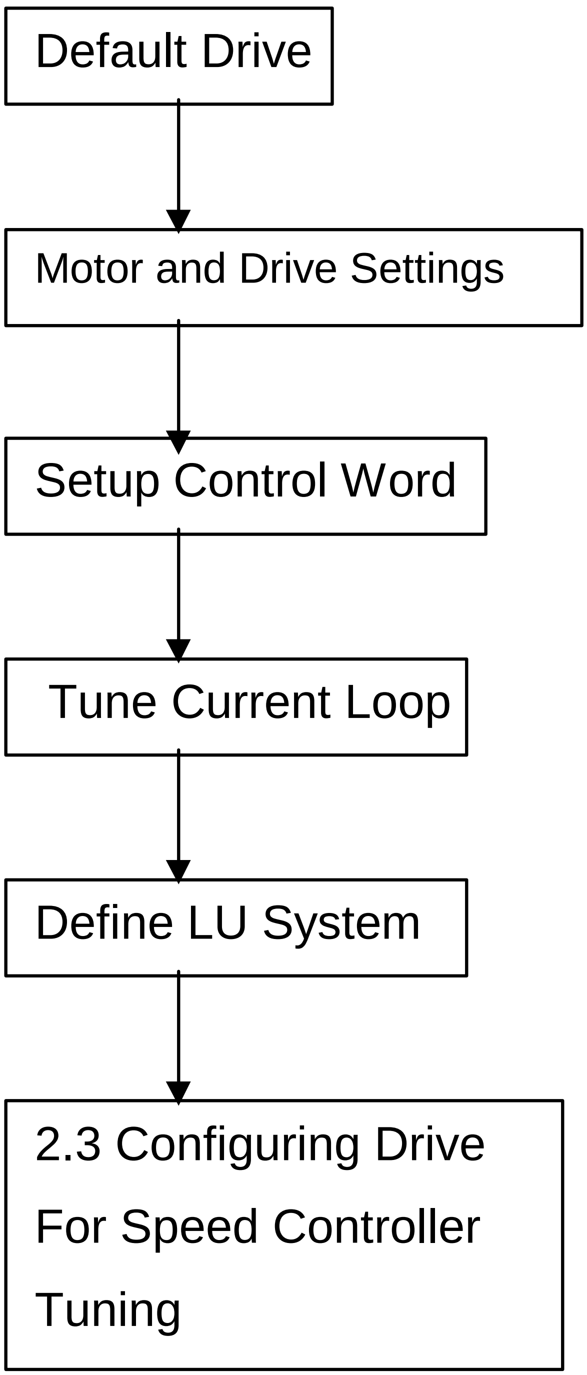


Speed Ramp with Overshoot



Realistic Speed

2.2 Configuring Drive



Quick Parameterization:
Default Procedure (Section 1.2, page 7)

Quick Parameterization:
Drive Settings with Siemens Motor (Section 1.3, page 8)

Quick Parameterization:
Drive Control Word
(Section 1.4, page 14)

Quick Parameterization Guide:
Tuning Drive and Current Loop
(Section 1.5, page 15)

Technology Options Quick Setup Method:
Establishing LU System
(Section 3.5, page 39)

Proceed to next section

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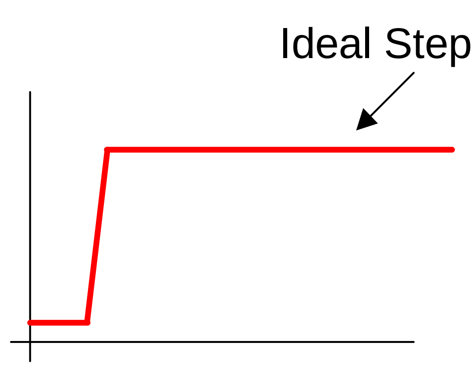
2.3 Configuring Drive For Speed Controller Tuning

Function Diagram	Setting	Description
Function Diagram [290]	P401 = 10%	Main Setpoint = 10%
	P402 = .5%	Jump = .5% (Set Main Ref Ramp times as needed [320] P462, P464)
Function Diagram [750]	U177.02 = KK0042	Select Analog Switch to Jump with.
	U176 = 18(DIN5)	Assign Switch to Input
	U950.86 = 4	Activate Switch
Function Diagram [360]	P224 = KK0526	Assign Switch Output to Jump Speed after ramp
Function Diagram [310]	P443 = KK0041	Assign Main Setpoint
Function Diagram [80]	P640 = KK0151	Set Analog Output to Actual Speed Setpoint
	P643 = 150	Scale Output X15 to show small jump
	P644 = -10	Shift Output down

2.4 Set Speed Controller Proportional Gain (Kp)

Function Diagram [360]

Step	Notes
Attach Oscilloscope	Analog Output Terminals X101 11 &12
Scale Scope	Typically 5mV, 100ms and DC Offset
Observe Step Response	Start with On command assigned previously
Set P240 = 1000	This eliminates the effects of Controller Integration.
Adjust P235 Proportional Gain	Attain highest possible values (50 to 200) and ideal speed jump. There should be NO overshoot when using proportional gain only!
Smooth Feedback P223 Only if Necessary!	This will reduce Motor Noise, however it will slow system reponse down. (Typical value: 1 to 5)



2.5 Set Speed Controller Integral Gain (Tn)

Function Diagram [80]

P640 = KK168 — Observe Current Setpoint at analog output

↓

P643 = 10 — No Scaling

↓

P644 = 0 — No Offset

↓

Scale Scope

↓

Function Diagram [360]

Observe Step Response of Current Setpoint — Start with On command assigned previously

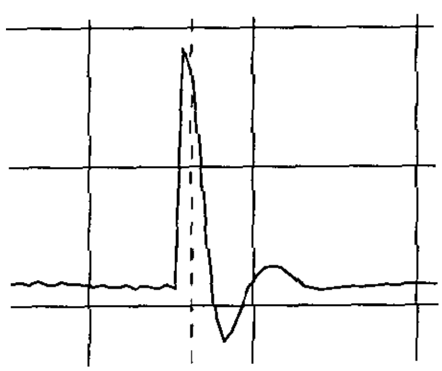
↓

Adjust Kp (P235) and smoothing (P223) to limit excessive oscillation — Only for Excessive Oscillation! You are looking for a sharp current spike and stable settling.

↓

Adjust P240 (Tn) — Look for signal to jump then settle, ignore normal current oscilation. Set at the point where you see no effect if you increase P240.

↓



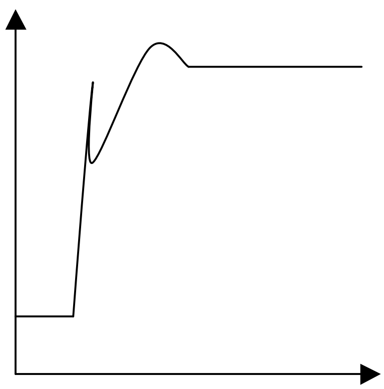
Ideal Current Step Response

Theoretical:
Tn= 4 *(2ms + Tgl) = P240
Tgl = P223 Actual speed smoothing
with no smoothing, Tn can be as small as 7 to 8 ms.

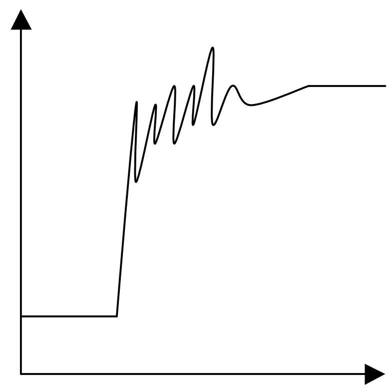
Observe Step Response of Speed Controller

Observe the speed controller step response as above. Theoretically an Ideal overshoot should be 43%. P240 [360] should be reduced to acheive the desired overshoot.

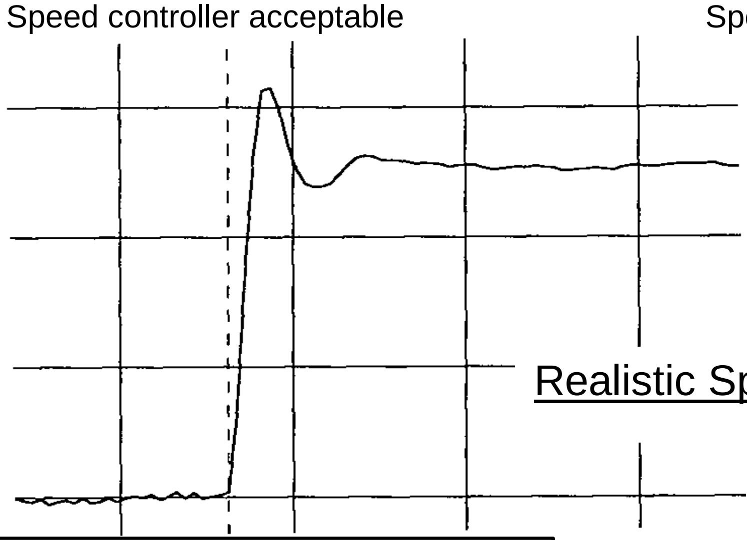
Observe at 0%, 10%, 50% & 100% and look for oscilations. Reduce P235 to fix this as needed.



Speed controller acceptable

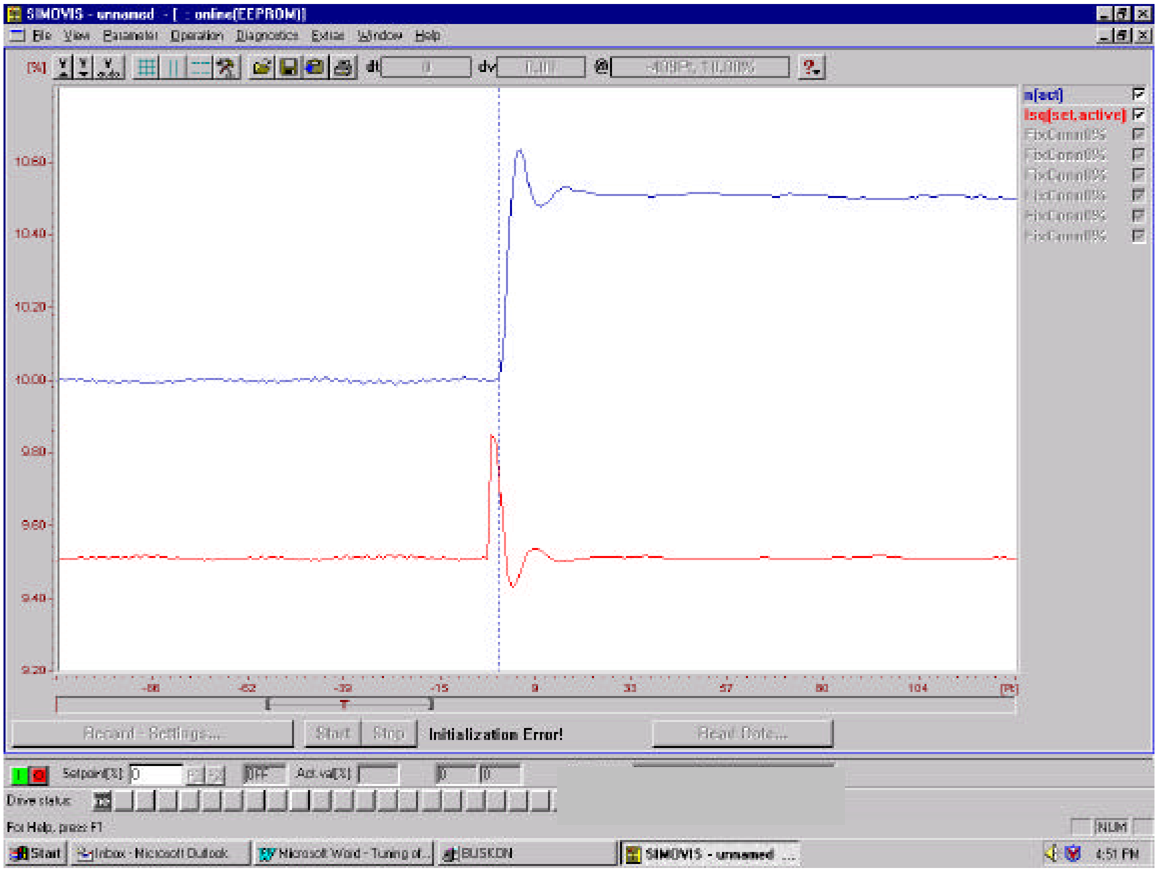


Speed controller P235 to high



Realistic Speed Controller Step Response

Proceed to Position Controller Tuning in Section 2.6



Ideal Speed Controller Step Response and Current Step Response Plotted with SIMOVIS Trace Function.

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2.6 Set Position Controller Proportional Gain

Function Diagram	Step	Description
	Cycle Control Power	
Function Diagram [340]	P206 = 0	Set Position Loop Integral Gain
	P210 = 1	Release Position Controller
	P207 = 5%	Limit Output of Position Controller
	If P223 = 0, Then P221 = 0.5 to 0.8ms	Because of different calculation cycles between the position controller and the speed controller, setpoint smoothing is required to produce a smoother torque setpoint.
Function Diagram [340]	P190 = KK415	Position Controller Setpoint will come from U2015
	U015 = r201 + (10 degree step in LU)	Set Position Controller Setpoint to current position plus a 10 degree step. (eg: U015 = 100)
Function Diagram [80]	P640 = KK151	Set Analog output to Speed Controller Output
	P643/P644 = 150/0	Scale Analog output / No Offset

Scale Scope

↓

Function Diagram [340]

Step the Axis by ten degrees (Turn drive on)

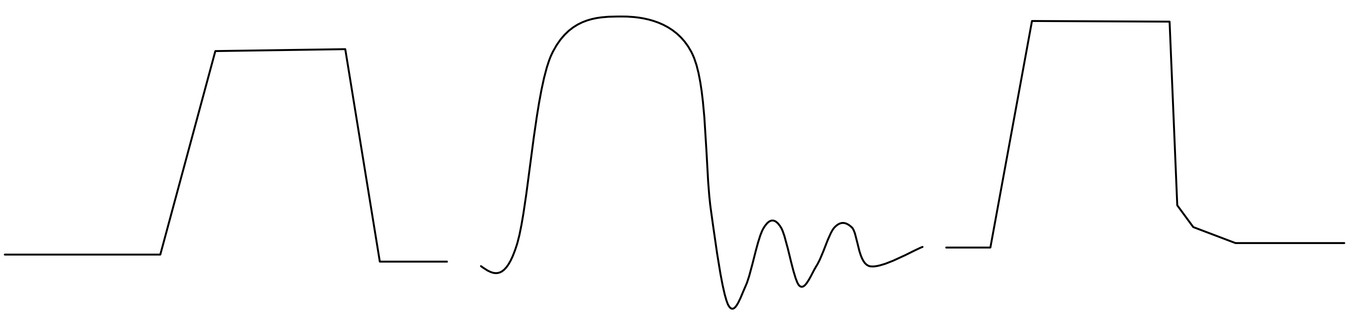
Set U015 to add an additional 10 degree step. Observe the step on the oscilloscope.

↓

Function Diagram [340]

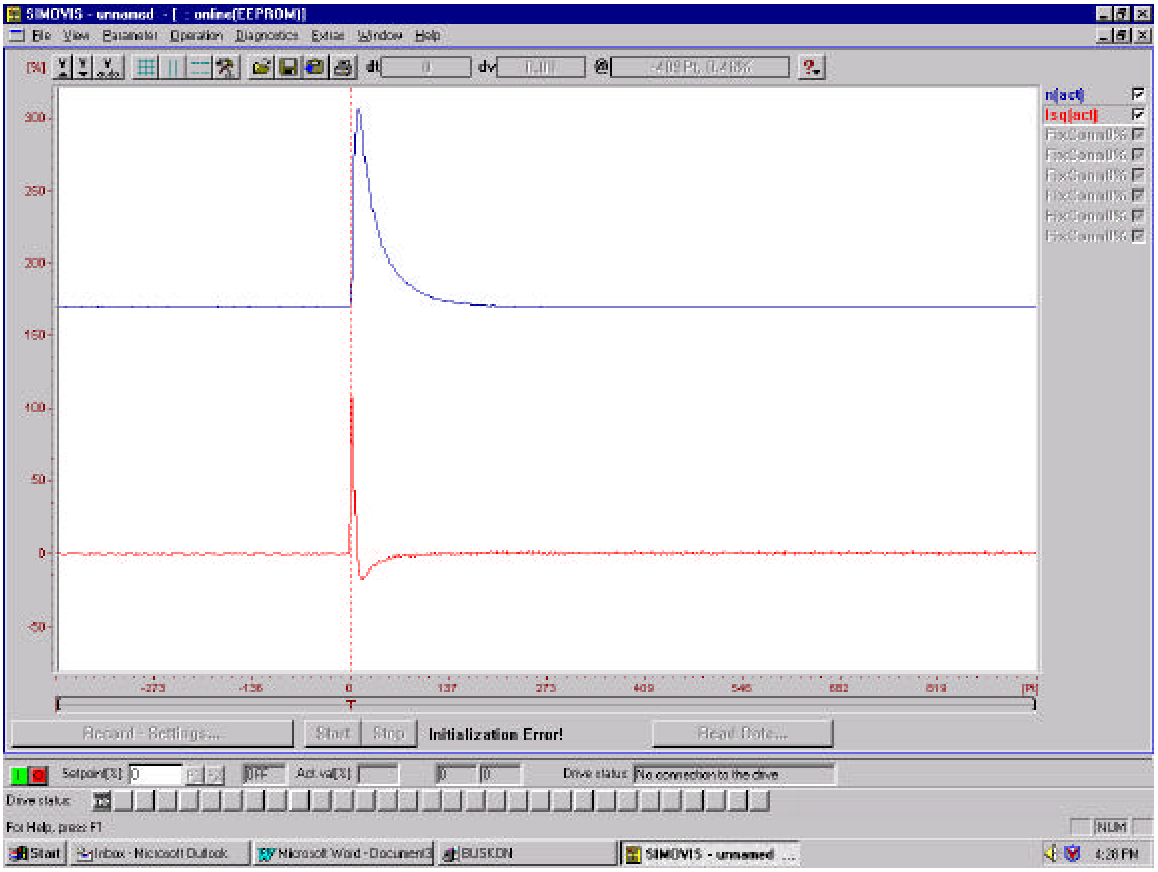
Adjust P204
Range .1 to 1+
For a Good Step

Position loop proportional gain. If values of P204 are too great the system will oscillate and become unstable.



Ideal Speed Ramp Response | Speed Ramp with Overshoot | Realistic Speed

SIEMENS



Realistic Speed Controller Step Response and Current Controller Response

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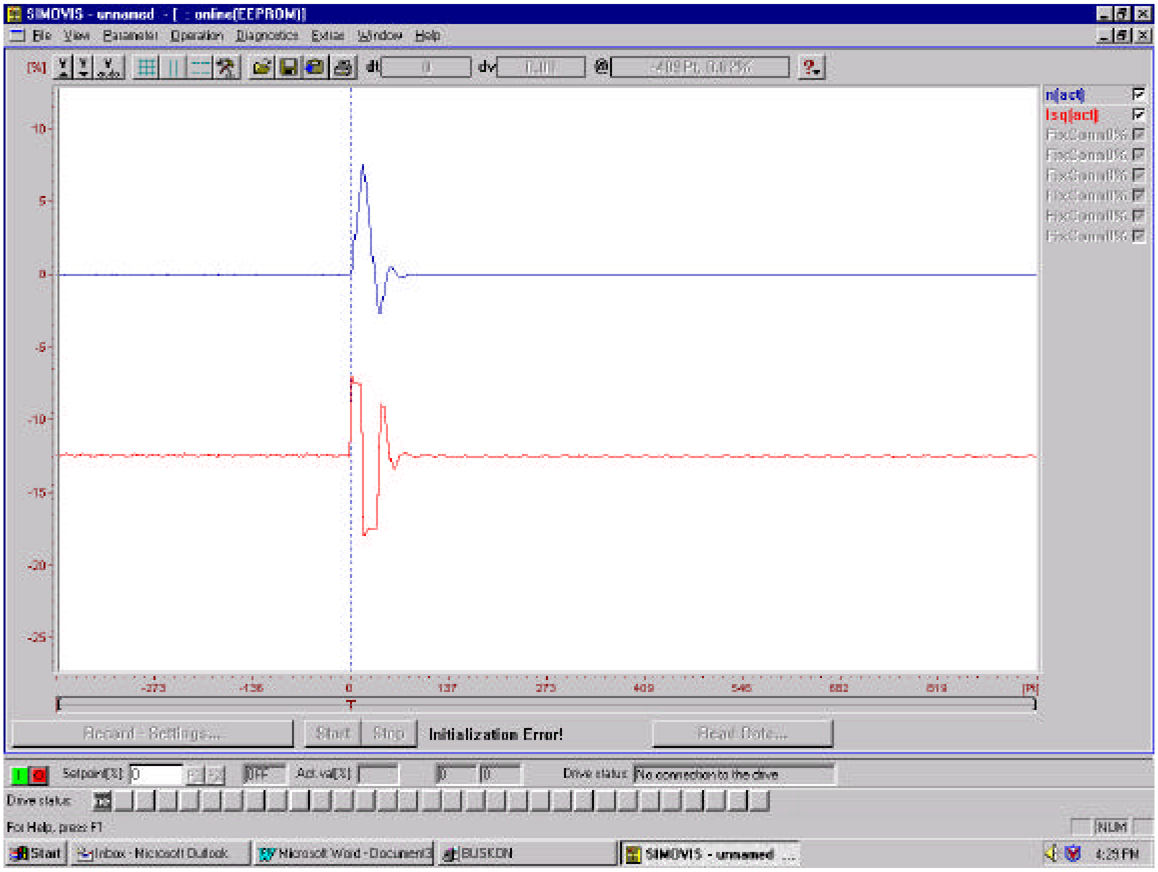

Unstable Speed Controller Step Response and Current Controller Response

After P204 is Optimized
Set P206 = 250

Set a very long integration time to cancel out residual error which may occur over time.

Record values:
P120-P125,235, 240, 223, 204, 207, 206

Basic Speed Controller and Position Controller Tuning Complete.

Proceed to Technology Tuning

Note: When integration time is enabled, check to make sure that no overshoot occurs. If speed controller pre-control is properly adjusted the integration time can actually be left off (P206=0 [340]).

Technology Additional Tuning

Set MD49

Run the drive through technology to find the ideal Feed Forward value (MD49). Remember that Machine Data values must be activated at U502. Rotary systems should have a pre-control/ Feed Foward of 100%. For Linear systems start with at least 50% pre-control/ Feed Forward.

↓

Run the system up to 100% speed

↓

Verify speed controller and position controller gain

If the system will not operate at 100% speed these parameters may need to be re-optimized or decreased.

↓

Tuning Procedure completed

Remember that the Feed Forward will provide the setpoint for the Speed Controller velocity and the Position Controller can have a relatively small gain because it is only closing the loop to eliminate error. Individual systems will require different values for Feed Forward.

Note: U502 is not needed if Synchronization is used like a free function block.

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Section 3:
Technology Options Quick Setup Method

SIMOVERT MASTERDRIVES 6SE70 MC

Motion Control

SIEMENS

MASTERDRIVE MOTION CONTROL: TECHNOLOGY OPTIONS QUICK SETUP METHOD

Typical changes to Parameters needed for using Technology Options.
Intended to be used with function diagrams listed in [ ] .

Purpose:

The purpose of this document is to lead the user through a typical setup of the Technology options for a MASTERDRIVE Motion Controller. Follow through each of the steps, with the stated function diagrams, and apply them to your individual setup. These steps will lead you through general technology activation without the use of a download file. The “Control flow sequence” and the “Activation & Setting” sections illustrate the setup required for use with the “Operating Mode Manager.” The individual setup of the drive control and IO is left to the user. This should be used as a checklist for connecting drive functions and performing required definitions.

SIEMENS

Technology Options Quick Setup Method
Section 3 Table of Contents:

3.1 Default Drive – Quick Startup Guide Section 1.2

3.2 Set Motor Data – Quick Startup Guide Section 1.3

3.3 Verify F01 Technology Activation [850]

If n978 = 1 technology is activated.
If n978 = 0 see [850].

3.4 Choosing Operating Mode Manager [802]

Operating Mode Manager U953.32 = 4 activate Manager U953.33 = 20 inactive sync free function	Operating Mode Manager allows the user to change between modes of operation including: 0: No Operation 1: Set Up 2: Homing 3: MDI 4: Control 5: Automatic Positioning 6: Automatic Single Block 11: Synchronous Operation
B. Sync. Mode Operation As Free Function U953.32 = 20 inactive Manager U953.33 = 4 activate Sync	As an alternative the Synchronous Mode of operation may be exclusively selected. The Operating Mode Manager takes up processor time when activated. If only the Sync Mode is going to be used then this section may be activated on it's own.

3.5 Establish Length Unit System

Rotary System
Define LU/Revolution Equivalent

Example:
If: 1LU = .1 degree

Then: 3,600 LU/rev

LU represents Length Unit. The terminology of Length Units is used to define units of measurement that the drive will count when turning the motor.

The user will define distances that the drive moves in the measure of Length Units. Length Units provide flexibility because the user can define Linear or Rotary Axis systems to their needs.

↓

Encoder Type	Resolution (inc/rev)	Achievable Positioning Accuracy (Pulse/rev)
Resolver	4096 (2^{12})	1024
Pulse Encoder	4096	1024 with a 1024 PPR encoder
Sin/Cos Encoder ERN1381/1387	16777216 (2^{24})	10^5 to 10^6
Multiturn/Absolute Value Encoder EQN1325	16777216 (2^{24})	10^5 to 10^6

Note: For any systems, which are vibration/position critical, a better feedback device should be used, such as a Sine/Cosine Encoder.

In practice, the resolution of the encoder must be higher than the requested positioning accuracy by a factor of 4 to 10. The levels of achievable accuracy given above are only rough guidelines.

↓

Determine Encoder Resolution:

Set parameter P171 according to the encoder resolution.

If resolution is 4096 ticks/rev:
4096 = 2šž→ P171 = 12

[330.3]
Depending on the type of feedback device which is used varying bit values of resolution are available for the drive to operate with.
The number of bits that the drive will use as feedback is entered into P171.

↓

Set Actual Weighting Factor (ActWtF, or IBF)

IBF = (LU/rev) / (Encoder resolution ticks/ rev)

IBF = (P169).(P170___eight digits)

P169 equals the integer value
P170 must equal an eight digit decimal number

ie:	Good Example
If:	3600 LU/rev and 4096 counts/rev
then:	ActWtf or IBF = .87890625
	P169 = 0
	P170 = 87890625

ie:	Bad Example
If:	36,000 LU/rev and 4096 counts/rev
then:	ActWtf or IBF = 8.7890625
	P169 = 8
	P170 = 7890625

The ActWtF (IBF) factor represents a weighting factor between the LU/revolution and the encoder resolution. The user defines both of these values.

Calculation and Parameter limits may be reached if the user attempt to have values that are too large in both the LU/revolution and Encoder Resolution that is utilized.

The IBF Factor should be less than or equal to 1 if possible. If the IBF factor is greater than 1 the drive will be attempting to count LU's to accuracy greater than the feedback device is generating.

Set the Rated Speed for Position Control (1000 LU/min)

$$P205 = \frac{(P353, rpm) \times (LU/rev)}{1000}$$

ie:	Good Example
If:	Max Speed = 6000 rpm and 3,600 LU/rev
Then:	P205 = 21,600

[340.3]

P205 is used to define the speed for position control resulting at 100% speed (actual value).

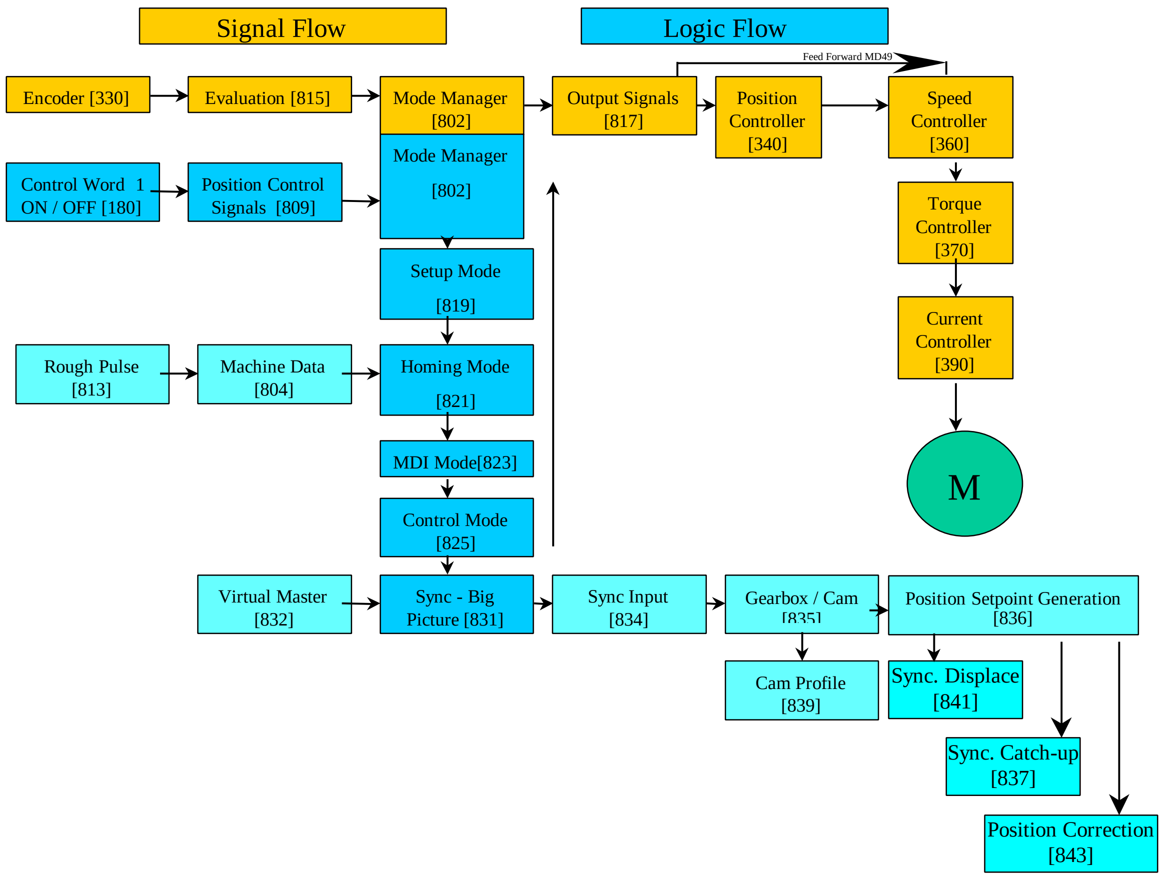
Note: P205 is limited to 10,000,000 with version 1.3 software. Parameter limits may effect the user's ability to utilize the full resolution of the encoder and quantity of Length Units.

SIEMENS

3.6 Control Flow Sequence

Follow the Signal and Logic Flow through these function diagrams.

MC Signal Flow and Logic Flow:



Function Diagram:	**Description:**
[809] Position Control Signals	This block is used as a control word for the Technology (F01). Modes of operation and control signals are assigned at this point.
[802] Operating Mode Manager	Operating Mode Manager allows the user to change between modes of operation including: 0: No Operation 1: Set Up 2: Homing 3: MDI 4: Control 5: Automatic Positioning 6: Automatic Single Block 11: Synchronous Operation
[819] Setup Mode	Set-up Mode is used for position controlled inching. Set-up Mode takes into account software limits for position.
[821] Homing Mode	Homing Mode is used to approach a predefined position. This position is used to define the reference system for the Axis. An external signal (BERO signal), such as a proximity switch, will indicate when the Axis is in place.
[823] MDI Positioning Mode	MDI mode is used for point to point positioning. MDI defines the acceleration, speed and position for a movement of the axis.
[825] Control Mode	Control Mode is used for position controlled inching. Control Mode is similar to Set-up Mode but it does NOT take into account software limits for position.

Function Diagram:	Description:
[831] Synchronism Mode (overview)	Synchronism Mode is used for the synchronization of several axis's. Functions such as Virtual Master, Engaging/Disengaging, Gear Ratio, Cam Table and Position Correction are incorporated into the synchronization functionality of the Technology (F01).
[832] Synchronism Virtual Master	The Virtual Master is used as a reference for each axis to follow. The advantage of a Virtual Master verses a Real Master is a disturbance free system. The Virtual Master is given speed reference, initial position, reset signals and start/stop signals.
[834] Synchronism Input and Engaging / Disengaging	The Master Axis Signal is assigned here. Engaging and Disengaging represent a clutching function that allows the Axis to match the master and be ramped on and off.
[835] Synchronism Gearbox and Cam Table	The Gearbox can be used to define a ratio between the Master Axis and the following Axis.
[836] Position Setpoint Generation	Position Setpoint and Speed Pre-Control signals are generated after signal has gone passed through Technology Options.
[837] Synchronism Catch-up function	This function can be used to accelerate the drive to the speed of a running machine.

Function Diagram:	Description:
[839] Synchronism Cam Table	The Cam Table can be used as a mapping function between the Master Axis and a following Axis. Profiles are loaded into the table and the following axis can be set to follow irregular motion profiles.
[841] Angular Sync & Displacement	Used to Displace Angle Absolute, Relative or to match Master.
[843] Position Correction	Used to correct for position errors by comparing actual position to a reference position.

3.7 Activation & Settings

This section outlines the drive activation and settings that must be done in order to configure the drive for Technology Control. Refer to the Function Diagrams in [#] while defining the required signals.

Position Control Signals		[809]	Example:
Activate Block	U953.30 = 4		U710.29=10
Mode Selection Address	U710.29	Indexes 29 to 32	U710.30=12
	U710.30	are used to define	U710.32=14
	U710.31	the Mode of	U710.28=18
	U710.32	Operation	U710.3= 18
Jog Forward, DIN select	U710.28	*Can tie Start	Digital Inputs to switch modes
Start, DIN select	U710.03	to Jog	and start functions

↓

Define ON/OFF in Control word	P554 = DIN? [180]	Example: P554 = 20
Make sure OFF123 are enabled		Digital In 6

↓

Link Speed Controller input to Position Controller Output.		[360] [340]
	P220 = KK131	

↓

Link Position Value & Measured parameters		[815.3] [330]
	U535 = 120	
	U539 = 122	

↓

Define Position Sensing Parameters		[330] [815]
	P172 = 302	
	P174 = 301	
	P184 = 303	

↓

Assign Rough Pulse	P178 = DIN	[330]	Example: P178 = 16
	MD45 (U501.45)	[813]	U501.45=7000
See Section 3.8 (below)	U536.1 – 6 = DIN		U502 = 2

↓

Optimize Position Controller	P204.001 = (<2) (adjust when working)		Example: P204 = 1
	P210 = 1		
	P211 = 1	[340]	

3.8 Verify and Define Common Machine Data [821]

U501.0MD#

MD#	Description	Units
MD3	Home Position Coordinate	Post Stop (LU)
MD4	Home Displacement	LU
MD6	Home Reduced Speed	1000 LU/min
MD7	Home Approach Speed	1000 LU/min
MD10	Encoder Offset	LU
MD11	Rotary/Linear Axis	Rotary = # LU/rev & Linear = 0
MD14	Follow Error monitoring @ standstill	LU
MD15	Follow Error monitoring in motion	LU
MD16	In Position Timer monitoring	ms
MD17	In Position Exact Stop Window	LU
MD18	Home Accel displacement search	1000LU/sž
MD19	Home Decel displacement search	1000LU/sž
MD23	Max Speed	1000LU/min
MD41	Home Accel Time-Homing	ms
MD42	Home Decel Time-Homing	ms
MD49	Speed Pre-Controller	0 – 100 %

MD45 [813]

10¢ 10¡ 10 10ž10š 10™
E6 E5 E4 E3 E2 E1

Function:
0 = NO Function
1 = Start and Operate
2 = Start OR Operate
3 = Position Feedback Set on Fly (Automatic Mode)
4 = External Block Change (Automatic Mode)
5 = In Process Measure
6 = Collision (Automatic Mode)
* 7 = Prox Switch for Reference [821.4]
9 = Read in enable

U536.01 (0)	⇒ E1	U536.05 (18)	⇒ E5
.02 (0)	⇒ E2	.06 (20)	⇒ E6
.03 (0)	⇒ E3		
.04 (16)	⇒ E4		

example, U501.45 = 7000, Prox signal set to switch defined in fourth index of U536

Typical Changes to Demo Unit Machine Data - Check Values for your Application
U501.11 = 36,000 LU/rev
U501.14 = 2750
U501.17 = 2200
U501.23 = 216,000
U501.45 = 7000

Guidelines from the MC Manual:
MD23 = Max Traversing Velocity (1000LU / min)

MD14 >= 5 * (Actual Following Error at Standstill (LU))

Note: MD14 & MD17 may have to be higher than suggested values depending on the individual system.

MD15 >= 1.5 * MD23 / Kv (P204)

MD16 ~ 500 to 2000 ms

MD17 < MD14

MD18/MD19 = If unsatisfied with default accel / decel, then calculate based on MD23 max speed and the desired acceleration time.

Changes to Machine Data Must be Manually Activated (U502 = 2)

U502 =	0	⇒	1	⇒	2
	Ok		Change Occurred		Activate Change

3.9 Homing Procedure Checklist

Set & Activate required Machine Data (above)	U502
Set Control Signals / Mode	U710 / [809]
Start Enable / OFF 123 Enable	Control Word [180]
Jog Forward Defined	U710 / [809]
Prox Signal Defined	P178 / U536 / MD45

3.10 Manual Data Input (MDI) Checklist

See [823]

Define MDI Data Sets 0 ⇒ 9 in terms of required motion Acceleration Speed and Position:

G (Accel Function)	Position X	Speed
U55X.001	U55X.002	U55X.003

X = 0 ⇒ 9

↓

Set Control Signals / Mode [809]
n540.14 = Mode In Display
Select MDI Data Set via Bits 8 ⇒ 11 [809]
Example:
If: Data Set 1 (X = 0)
Then: U710.09 = 1

↓

Set G (Acceleration) Functions U55X.001 [823]
90 = Absolute Position 30 = 100%
91 = Relative Position 31 = 10% …
39 = 90%

Example:
If: Relative Motion from current position and 100% Acceleration ramp
Then: U55X.001 = 9130

↓

Set Position Data U55X.002 (LU) [823]

Example:
If: 3600 LU/rev and 90 degree turn required
Then: U55X.002 = 900 LU

↓

Set Speed Data U55X.003 (10 LU/min) [823]

Example:
If: Speed = 100 rpm and 3600 LU/rev
Then: ((100 rev/min) X (3600 LU / rev)) / 10
⇒ U55X.003 = 36,000

SIEMENS

3.11 Synchronism Method

A. Virtual Master Setup
B. Simolink Setup
C. Assign Sync Functions
D. Cam Operations

A. Virtual Master Setup [832]

Activate Function Block U953.34 = 4

Assign Setpoint Input U681 = 11 (Analog Input)

Set rated speed U682
6000 rpm * (36,000 LU/rev) * (1/10)
U682 = 21,600,000

Verify Control Signals	U684.01	Reset
	.02	Start/Stop
	.03	Set to Initial Position

Set Ramp Acceleration U685 (1000LU / sž)

Set the Enable for Virtual Master U689

Set Integrator Axis Cycle Length U687 = LU/rev = 36,000

B. Simolink Setup [140]

Assign SLB Node Address
P740 = 0 (Master) / 1 (Slave)

Define:

Signal Power	P742
# Nodes	P743
# Channels	P745

Assign Transmit on Master [160]
P751.01 = KK817 (Transmit High Word from Virtual Master)
P751.02 = KK817 (Low Word)

Assign Receive on all Drives [150]
P749.01 = Node Channel (e.g. = 0.0)

SIEMENS

C. Assign Sync Functions [834]

Leave U953.33 = 20 unless using explicitly

1. Assign Position Setpoint
   U600.01 = KK7031 (Connector from Simolink Word Channel 0)
   U606 = 0

2. Assign U601 = Rotary Axis Length = (36,000LU/rev)

3. Engaging / Disengaging [834]

   Define Sync Op Mode P602
   Set Accel + Decel Length = U610 (LU)
   Total Cycle Length = U611 (LU)
   Couple Position = U608 (LU)

   Enable Engaging / Disengaging U612
   Define Clutching U656

4. Gear Box Definition [835]
   Numerator: U604.1
   Denominator: U604.2

5. Select Operation: U603 [834]
   1:1
   Gear
   Cam

6. Verify Position Control Reference [340.1]
   P190 = 310 Default

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D. Manual Cam Profile Setup [839]

Note: Should use a download file to configure complex cam operations.

Note: Table Parameters cannot be checked (Loaded) if the table, to be checked, is currently selected (U650).

Table Configuration	U615
	= 1 200 point table
	= 2 Two 100 point tables
Cam Mode	U616
	Y scale, X scale, continuous/stop, absolute/relative
Table Width	U620
# Support Points	U629
X Axis Support Points	U630.1-50 / U631.1-50
Y Axis Support Points	U635.1-50 / U636.1-50

Note: (If operating in a continuous mode, you may wish to have the first coordinate and the last coordinate the same, to avoid jumping motion)

Define Starting Point	U618
Set Table	U619
Select Table	U650
Check Table to Load it.	U617.1 = 2 Check table 1
	U617.2 = 2 Check table 2
	If U617 = 0 then okay to proceed

[836]

Selection of Cam	U603 = 2

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3.12 Operation Signal Assertion

(These signals must be seen by the drive)

Turning System On
OFF1 = OFF2 = OFF3 = ECN = 1
(Profibus must see LB = 1)

Jog Function
Turning System On
Mode = Setup = 1 — Control word bits 31 to 28 [809]

Jog Forward or Jog Backward — Bit 25 or 26

Home Function
Turning System On
Mode = Home = 2 — Control word bits 31 to 28 [809]

Machine Data must be programmed in drive

Jog Forward or Jog Backward — Bit 25 or 26

Rough Pulse must be assigned — P501.45, U536, P178

MDI Function
Turning System On
Mode = MDI = 3 — Control word bits 31 to 28 [809]

MDI Program Select — Bits 15 to 8
MDI program must be in drive

Start — Bit 2

Sync Function
Turning System On
Mode = Sync = 11 — Control word bits 31 to 28 [809]

Virtual Master & Simolink must be setup

Start — Bit 2
Start/Enable Virtual Master