MITSUBISHI ELECTRIC
Changes for the Better

FATEC

AC Servo School Text
AC Servo Trouble Shooting Course
(MELSERVO-J5)

●SAFETY PRECAUTIONS●

(Always read these instructions before exercise.)

When designing the system, always read the relevant manuals and give sufficient consideration to safety.
During the exercise, pay full attention to the following points and handle the product correctly.

[EXERCISE PRECAUTIONS]

! CAUTION

- Follow the instructor's direction during the exercise.
- Do not remove the module of the demonstration machine or change wirings without permission.
  Doing so may cause failures, malfunctions, personal injuries and/or a fire.
- Turn off the power before mounting or removing the module.
  Failure to do so may result in malfunctions of the module or electric shock.
- When the demonstration machine (such as X/Y table) emits abnormal odor/sound, press the "Power switch" or "Emergency switch" to turn off.
- When a problem occurs, notify the instructor as soon as possible.

! WARNING

- Do not touch the terminals while the power is on to prevent electric shock.
- Do not operate the switches with wet hands. Doing so may cause an electric shock.
- To prevent an electric shock, ground the demonstration machine securely.
- Before opening the safety cover, turn off the power or ensure the safety.

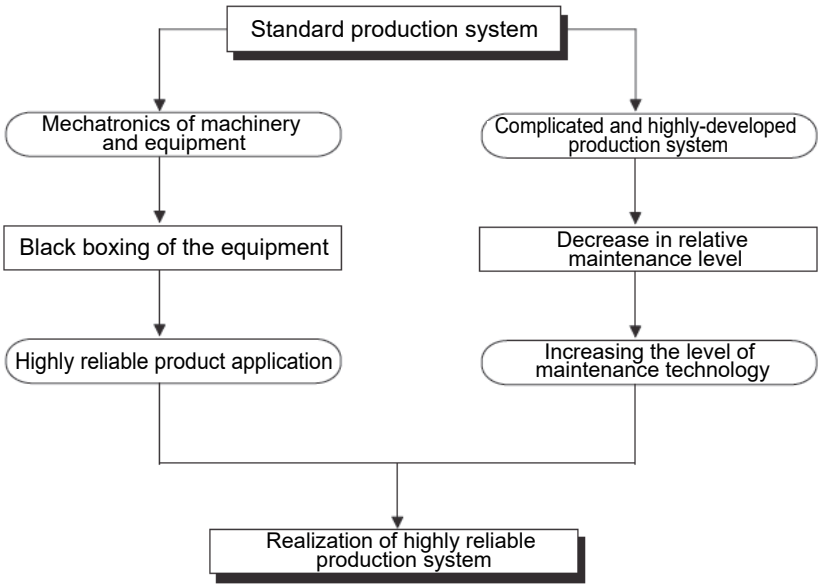
CONTENTS

1 IMPORTANCE OF PRODUCTIVE MAINTENANCE

When a production system stops because of a failure or power failure, loss corresponding to the stop duration occurs.
Therefore, it is necessary to design the equipment system so that stops due to failure and stops due to power failure do not occur.
In the unlikely event that a production system stops, how quickly it can be brought back into operation is an important issue, and each factory has in place an organization of maintenance personnel to improve the operating ratio of production systems.

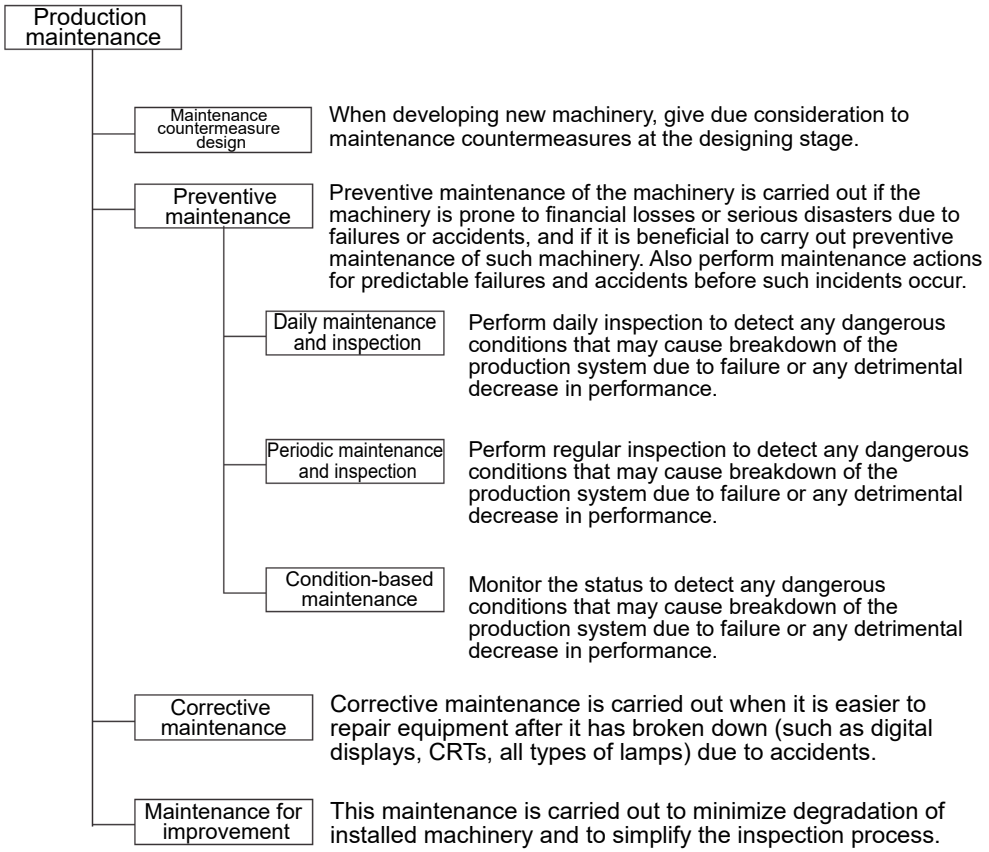
1.1 Importance of Maintenance

With the remarkable shift to mechatronic machinery and equipment and the growing complexity and sophistication of systems, equipment is increasingly becoming like black boxes and relative maintenance levels are declining, making it difficult to improve the operation ratio.
Consequently, highly reliable products and raising the level of maintenance technology are strongly required.



1.2 Maintenance System

To achieve a highly reliable production system, it is important to establish a maintenance system. The following figure outlines a maintenance system.



1.3 Maintenance Plan

In a production system, considering repairs only after failures occur results in longer repair times and makes it difficult to achieve a higher operation ratio.
Therefore, a maintenance plan should be established from the time the production system is introduced, and efficient maintenance should be performed accordingly.
When a failure occurs, maintenance must be performed systematically as detailed below to achieve system recovery within a short time.

Table 1.1 Daily inspection and periodic inspection

Plan item	Description	
Maintenance education	Knowledge about AC servos	• Basic knowledge of AC servos, including principles, functions, and performance • Characteristics of AC servos • Positioning of AC Servos • Introduction status of AC servos (usage status in your department, etc.) • Details of introduced (adopted) model (model, functions, performance, characteristics, and other properties of AC servo used)
	Maintenance scope and maintenance technology	• Knowledge of maintenance related to AC servos (Characteristics of AC servos in terms of maintenance, maintenance items of AC servos) • Precautions for maintenance of AC servos (Handling method, key points for maintenance, etc.)
	Training	• Functions related to AC servo maintenance • Peripheral equipment maintenance related functions (Troubleshooting function, etc.) • Troubleshooting training (Operation of peripheral equipment, replacement of hardware, etc.)
Maintenance time	Clarify the distinction between preventive maintenance and corrective maintenance targets, and set the maintenance timing.	
Maintenance equipment	Spare parts, components, measuring instruments, measurement equipment, etc., for maintenance	
Maintenance procedures	Prepare the manuals, etc., and clearly define the implementation content and methods.	
Maintenance staff	Secure staff, determine staffing and assignment, etc.	
Improvement of maintenance methods	Study of ways to improve maintenance methods, etc.	
Understanding AC servo manufacturer service and support system	After-sales service	• Service base (location, contact information, person in charge, etc.) • Service scope (target models, scope of servicing) • Service time (start/end time, time required for arrival, emergencies, etc.) • Service period (free service period, handling of paid services, etc.) • Spare parts supply period (repair after production discontinuation, supply period) • Measures in case of production discontinuation (content of discontinuation declaration, repair period, etc.) • Time required for repair (standard delivery time, shortest/longest delivery time, etc.)
	Technical support	• Support base (location, contact information, person in charge, etc.) • Scope of support (target models, hardware/software, system) • Support method (telephone, fax, visit, school, actual machine operation) • Manual (manual effective for maintenance)

1.4 Management of Maintenance Documents

To achieve quick recovery after a failure occurs, it is necessary to organize and manage the documents described in the following table.

Table 1.2 Maintenance documents to be managed

Plan item	Document name	Description
System-specific documents	System/control specifications	The functions and operations of the system/control (Operation sequence/timing, operating conditions, operating procedure)
	Electric wiring diagrams	Developed connection diagrams (such as power supply circuit, power circuit, control circuit, operation circuit, and display circuit) Inter-device/inter-board connection diagrams (Cabling diagram and grounding cabling diagram)
	Equipment layout diagrams	In-panel electrical equipment layout diagram, terminal block wire number layout diagram, connector pin connection assignment table (Diagrams that identify various instrument models, wire numbers, and other such items)
	List of hardware used	List of electrical equipment used in the system (Models and specifications of all the electrical equipment such as the modules that comprise the AC servo system, peripheral equipment, electrical parts in the cabinet, I/O devices, and software packages)
	Controlled system installation guides and maintenance and inspection instructions	For handling (operation), maintenance, and inspection of controlled systems
General documents	Catalogs of hardware used	Catalogs providing information such as the configuration and manufacturer of the equipment
	Installation guides and technical data of the hardware used	For troubleshooting of hardware and software

1.5 Maintenance Records

The following maintenance records must also be managed for use as maintenance reference after failure recovery.

Table 1.3 Maintenance records to be managed

Record item	Description
Error/failure occurrence conditions	Apparatus/equipment name, phenomenon, circumstances
System stop time	Occurrence time, stop duration
Impact of occurrence	Monetary value of loss, lost time, other impacts
Cause	Method of cause investigation, cause including presumption
Recovery method	Recovery method such as replacement, repair
Recurrence prevention measure	Method to prevent similar occurrences, lesson learned
Failure records	Records including source of failure and countermeasures
Name of person in charge	

1.6 Failure Stages

Generally, complex systems are known to fail in three stages: Initial failure, random failure, and wear-out failure, as shown in Figure 1.1. Initial failures are considered to be eliminated during the manufacturing and inspection process by the manufacturer. Random failures are unexpected failures that cannot be anticipated and may occur within the service life of the equipment before wear progresses. It is difficult to take technical countermeasures but we can take measures based on statistics.

Wear-out failures occur near the end of service life as a result of degradation or wear, and increase rapidly over time. The number of years until replacement is indicated by point tb in Figure 1.1. At this point, appropriate preventive maintenance is achieved by replacing specific parts with new parts.

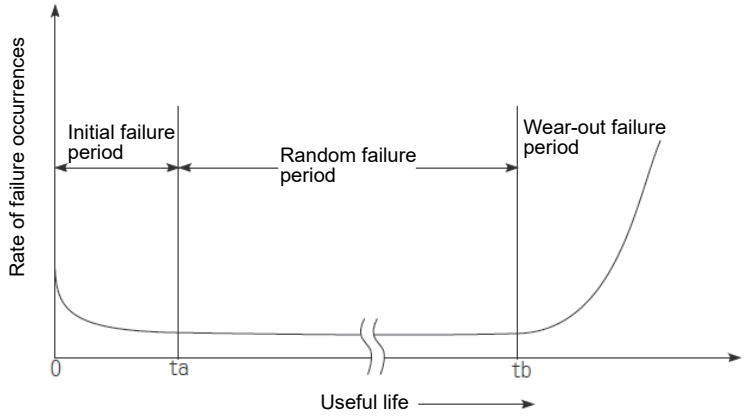
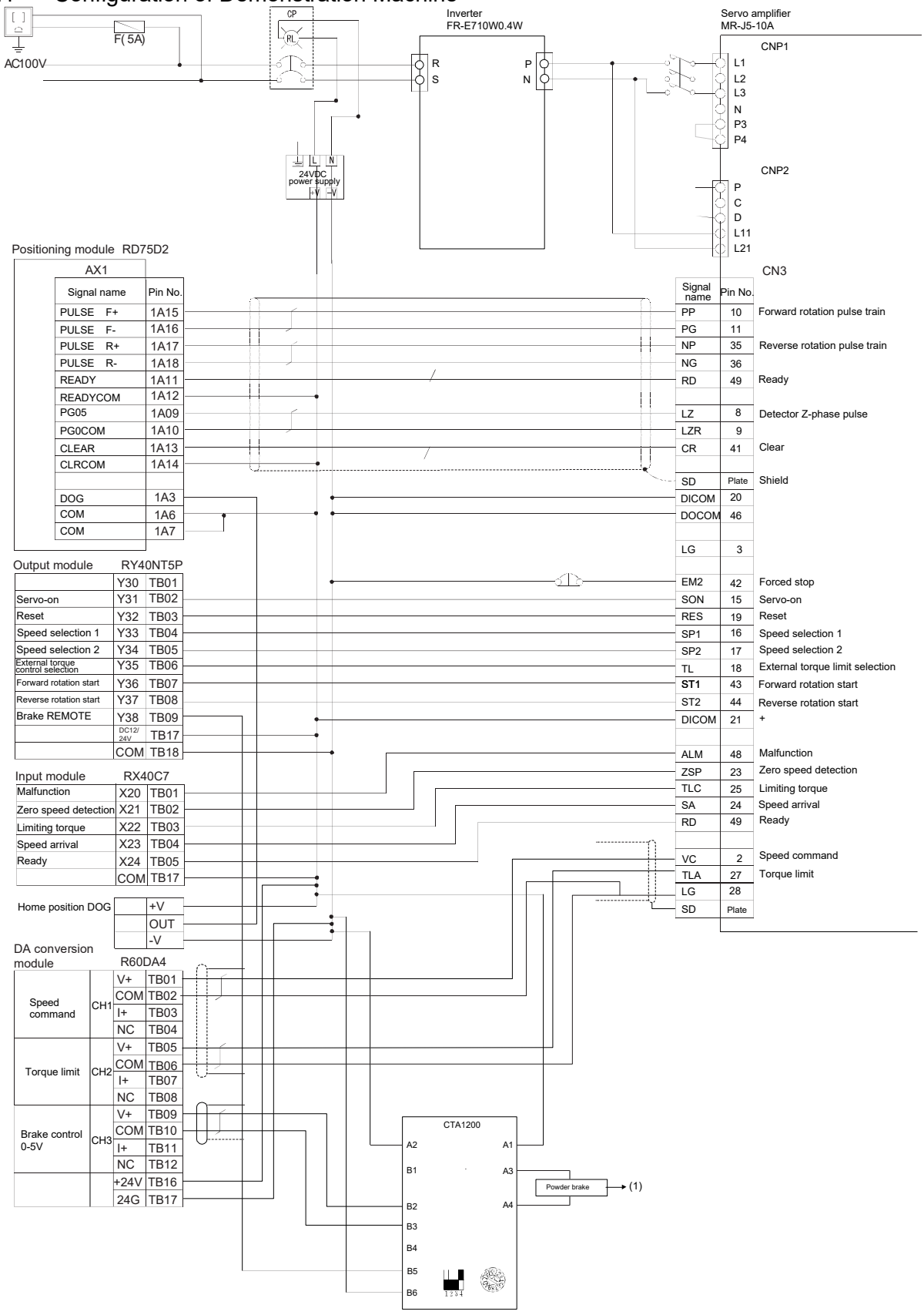


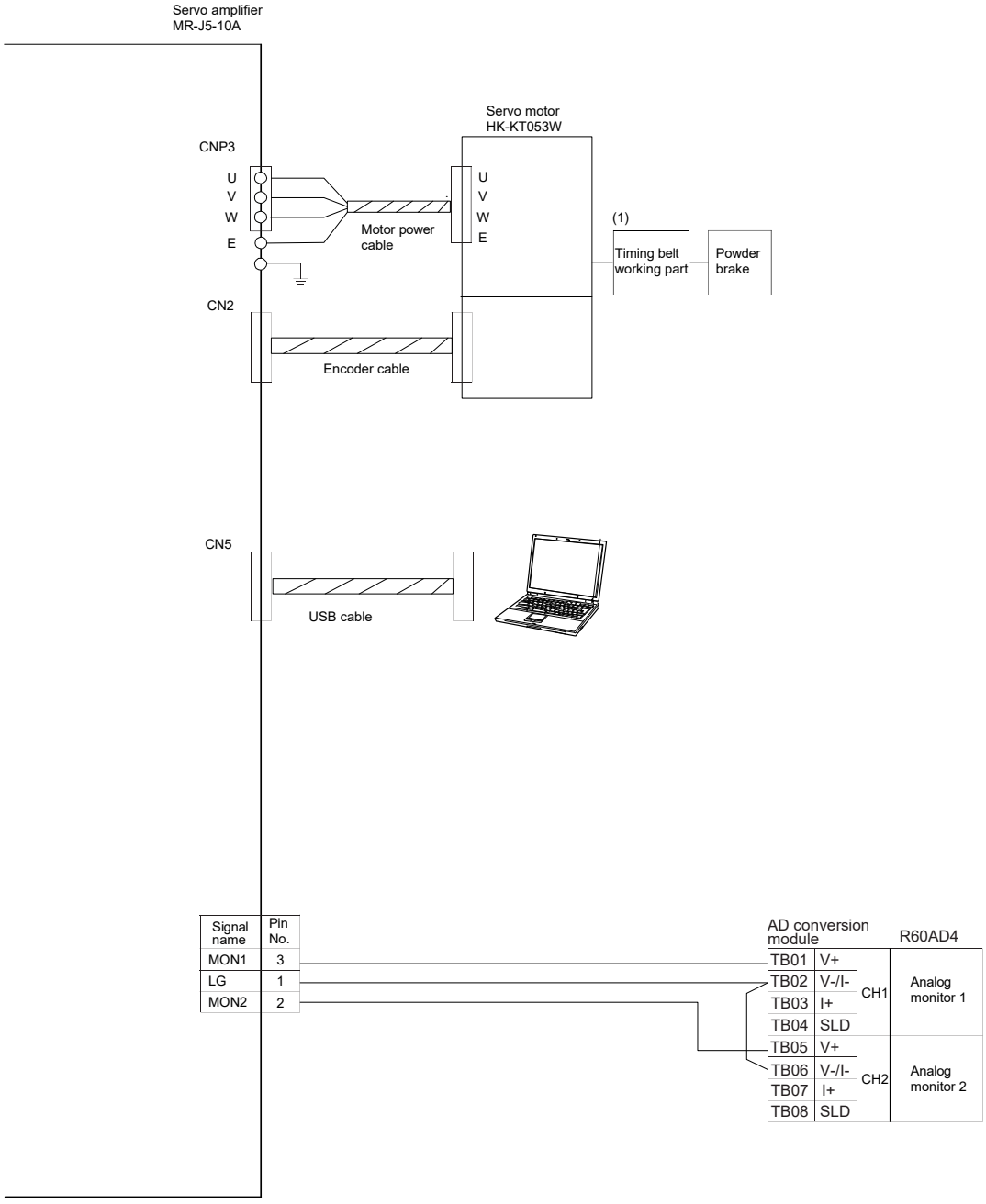
Figure 1.1 Bathtub curve

Memo

2 UNDERSTANDING AC SERVO SYSTEMS

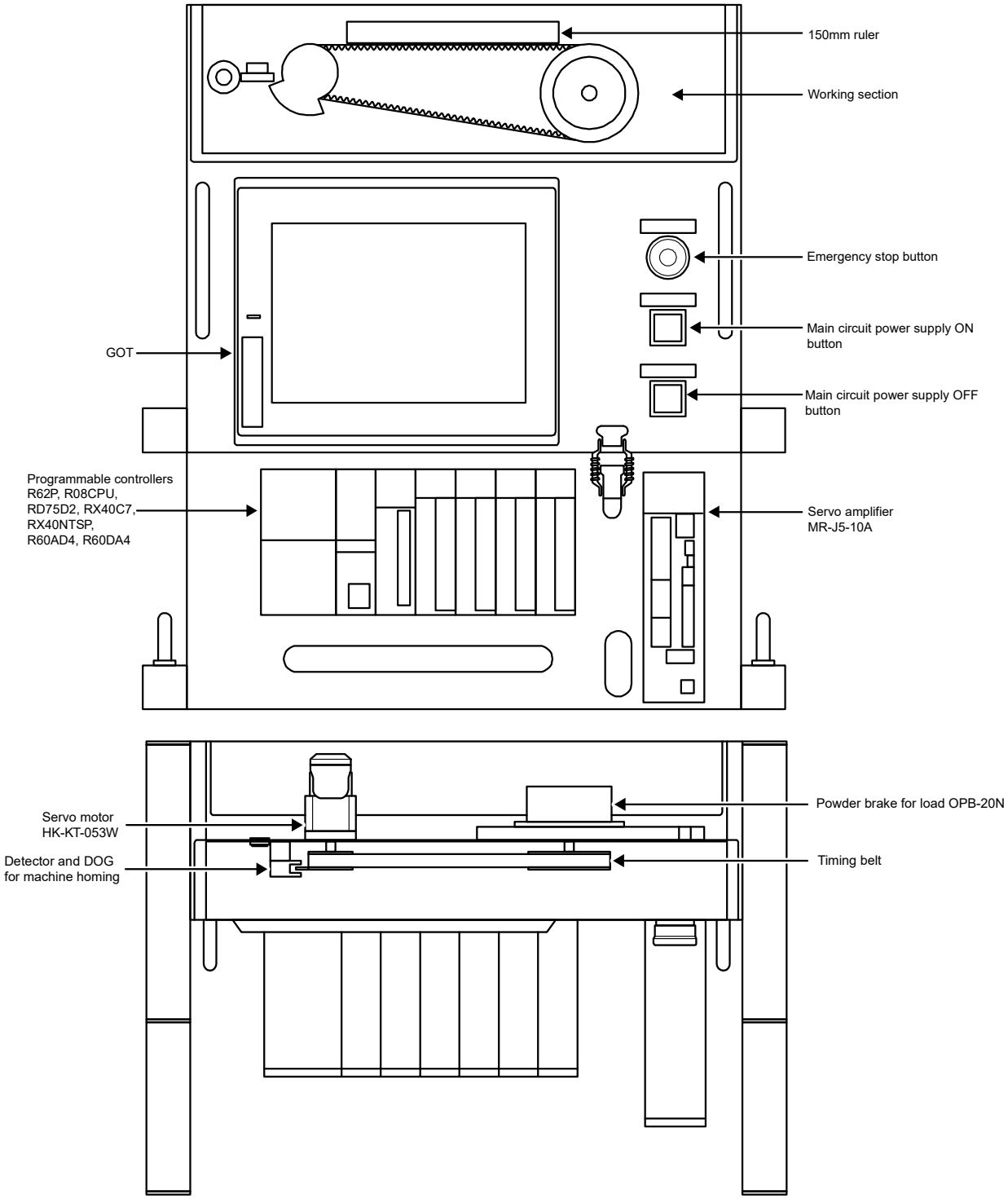
2.1 Configuration of Demonstration Machine

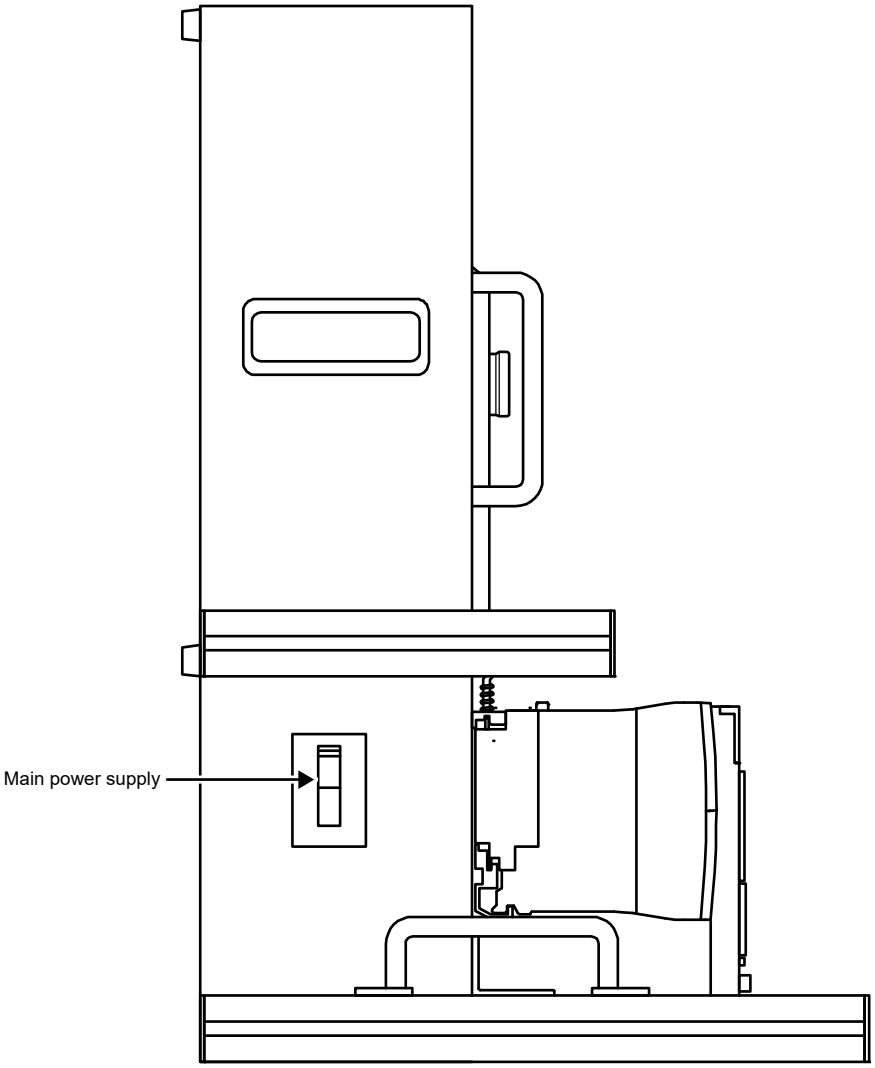



Servo amplifier
MR-J5-10A
Servo motor
HK-KT053W
CNP3
U
V
W
E
Motor power cable
U
V
W
E
(1)
Timing belt working part
Powder brake
CN2
Encoder cable
CN5
USB cable
Signal name
Pin No.
MON1
3
LG
1
MON2
2
AD conversion module
R60AD4
TB01
V+
TB02
V-/I-
TB03
I+
TB04
SLD
CH1
Analog monitor 1
TB05
V+
TB06
V-/I-
TB07
I+
TB08
SLD
CH2
Analog monitor 2

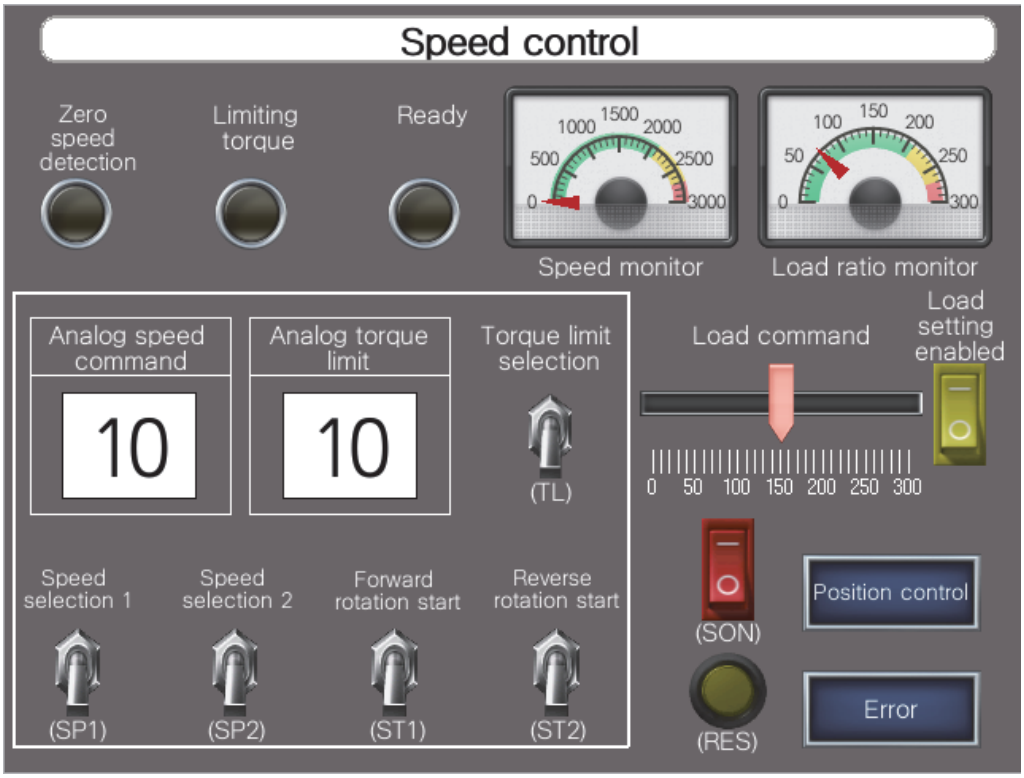
2.2 Demonstration Machine Appearance and Part Names

2.2.1 Demonstration machine appearance and architecture




Main power supply

2.2.2 GOT display



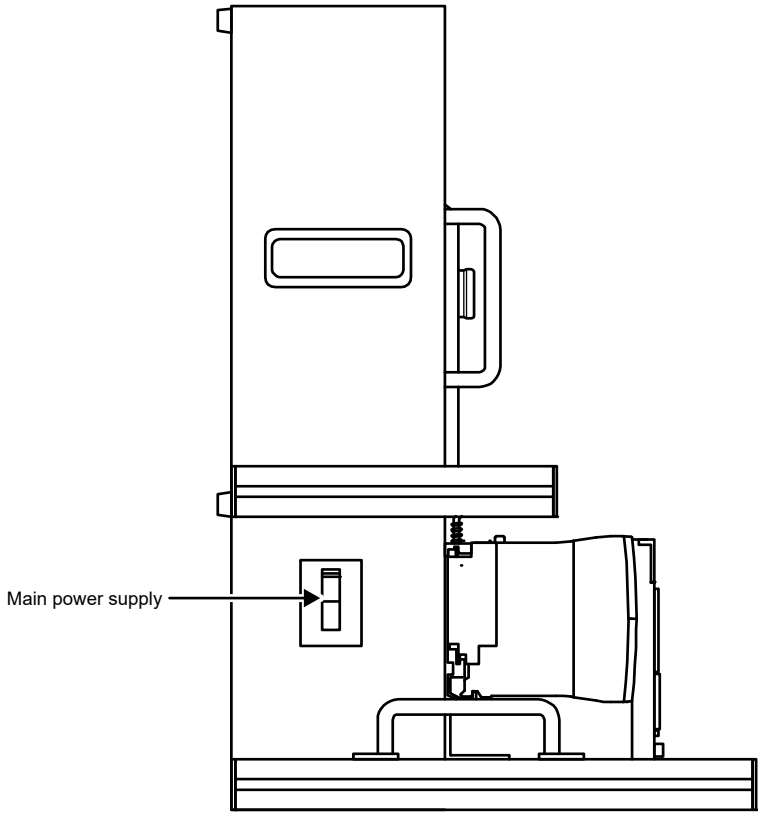
2.3 Exercises on MR-J5 Servo Amplifier

2.3.1 Speed control

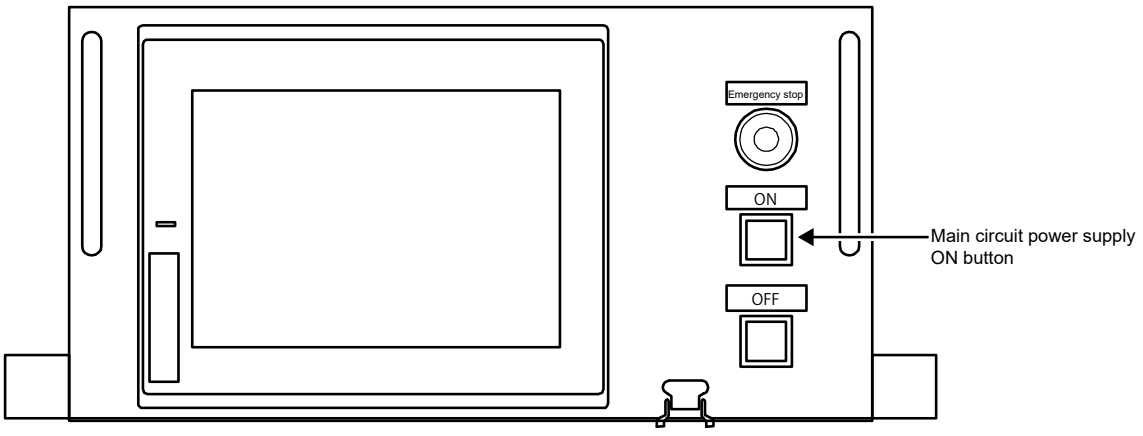
(1) Power-on

1. Connect the supplied 100V AC cable to the socket in accordance with the shape of the socket (two-pole parallel or two-pole parallel with grounding).

2. Turn on the main power.



3. Press the main circuit power supply ON button. Power will be supplied to the main circuit of the servo amplifier.



(2) Parameter settings

Before operating the demonstration machine, set the parameters to the demonstration machine setting values (speed control) shown in the table below.

Refer to section 7.3.7 "Parameter settings" for how to set the parameters.

> POINT
>
> ●Parameters marked with * before their abbreviations become enabled when the power is turned off and then turned on again after the setting.

(a) Basic setting servo parameters group ([Pr.PA_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PA01	**STY	10003000h	-	10003000	10003002
PA02	**REG	00000000h	-	00000000	00000000
PA03	*ABS	00000000h	-	00000000	00000000
PA04	*AOP1	00002000h	-	00002000	00002000
PA05	*FBP	10000	pulse	10000	10000
PA06	CMX	1	-	67108864	67108864
PA07	CDV	1	-	10000	10000
PA08	ATU	00000001h	-	00000004	00000004
PA09	RSP	16	-	32	32
PA10	INP	400	pulse	400	400
PA11	TLP	1000.0	%	1000.0	1000.0
PA12	TLN	1000.0	%	1000.0	1000.0
PA13	*PLSS	00000100h	-	00000100	00000100
PA14	*POL	0	-	0	0
PA15	*ENR	4000	pulse/rev	4000	4000
PA16	*ENR2	1	-	1	1
PA17	**MSR	00000000h	-	00000000	00000000
PA18	**MTY	00000000h	-	00000000	00000000
PA19	*BLK	000000ABh	-	000000AB	000000AB
PA20	*TDS	00000000h	-	00000000	00000000
PA21	*AOP3	00000001h	-	00000001	00000001
PA22	**PCS	00000000h	-	00000000	00000000
PA23	DRAT	00000000h	-	00000000	00000000
PA24	AOP4	00000000h	-	00000000	00000000
PA25	OTHOV	0	%	0	0
PA26	*AOP5	00000000h	-	00000000	00000000
PA27	For manufacturer setting	00000000h	pulse	00000000	00000000
PA28	**AOP6	00000000h	-	00000000	00000000
PA29	For manufacturer setting	0	-	0	0
PA30	For manufacturer setting	0	-	0	0
PA31	For manufacturer setting	0	-	0	0
PA32	For manufacturer setting	00000000h	-	00000000	00000000
PA33	For manufacturer setting	0.0	-	0.0	0.0
PA34	QDIS	0	0.1Rev, mm	0	0
PA35	For manufacturer setting	00000000h	-	00000000	00000000

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PA36	For manufacturer setting	00000000h	-	00000000	00000000
PA37	For manufacturer setting	00000000h	-	00000000	00000000
PA38	For manufacturer setting	00000000h	-	00000000	00000000
PA39	For manufacturer setting	00000000h	-	00000000	00000000
PA40	For manufacturer setting	00000000h	-	00000000	00000000
PA41	For manufacturer setting	00000000h	-	00000000	00000000
PA42	For manufacturer setting	00000000h	-	00000000	00000000
PA43	For manufacturer setting	00000000h	-	00000000	00000000
PA44	For manufacturer setting	00000000h	-	00000000	00000000

(b) Gain/filter setting servo parameters group ([Pr.PB_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
B01	FILT	00000000h	-	00000000	00000000
PB02	VRFT	00000000h	-	00000000	00000000
PB03	PST	0	ms	0	0
PB04	FFC	0	%	0	0
PB05	For manufacturer setting	500	-	500	500
PB06	GD2	7.00	Multiplier	7.43	7.43
PB07	PG1	15.0	rad/s	338.0	338.0
PB08	PG2	37.0	rad/s	249.0	249.0
PB09	VG2	823	rad/s	5397	5397
PB10	VIC	33.7	ms	5.0	5.0
PB11	VDC	980	-	980	980
PB12	OVA	0	%	99	99
PB13	NH1	4500	Hz	4500	4500
PB14	NHQ1	00000000h	-	00000000	00000000
PB15	NH2	4500	Hz	480	480
PB16	NHQ2	00000000h	-	00000011	00000011
PB17	NHF	00000000h	-	0000012B	0000012B
PB18	LPF	3141	rad/s	32000	32000
PB19	VRF11	100.0	Hz	100.0	100.0
PB20	VRF12	100.0	Hz	100.0	100.0
PB21	VRF13	0.00	-	0.00	0.00
PB22	VRF14	0.00	-	0.00	0.00
PB23	VFBF	00001000h	-	00001001	00001001
PB24	*MVS	00000000h	-	00000000	00000000
PB25	*BOP1	00000000h	-	00000000	00000000
PB26	*CDP	00000000h	-	00000000	00000000
PB27	CDL	10	pulse	10	10
PB28	CDT	1	ms	1	1
PB29	GD2B	7.00	Multiplier	7.00	7.00
PB30	PG2B	0.0	rad/s	0.0	0.0
PB31	VG2B	0	rad/s	0	0
PB32	VICB	0.0	ms	0.0	0.0
PB33	VRF11B	0.0	Hz	0.0	0.0
PB34	VRF12B	0.0	Hz	0.0	0.0

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PB35	VRF13B	0.00	-	0.00	0.00
PB36	VRF14B	0.00	-	0.00	0.00
PB37	For manufacturer setting	1600	-	1600	1600
PB38	For manufacturer setting	0.000	-	0.000	0.000
PB39	For manufacturer setting	0.000	-	0.000	0.000
PB40	For manufacturer setting	0.000	-	0.000	0.000
PB41	For manufacturer setting	00000000h	-	00000000	00000000
PB42	For manufacturer setting	00000000h	-	00000000	00000000
PB43	For manufacturer setting	00000000h	-	00000000	00000000
PB44	For manufacturer setting	0.00	-	0.00	0.00
PB45	CNHF	00000000h	-	00000000	00000000
PB46	NH3	4500	Hz	4500	4500
PB47	NHQ3	00000000h	-	00000000	00000000
PB48	NH4	4500	Hz	4500	4500
PB49	NHQ4	00000000h	-	00000000	00000000
PB50	NH5	4500	Hz	4500	4500
PB51	NHQ5	00000000h	-	00000000	00000000
PB52	VRF21	100.0	Hz	100.0	100.0
PB53	VRF22	100.0	Hz	100.0	100.0
PB54	VRF23	0.00	-	0.00	0.00
PB55	VRF24	0.00	-	0.00	0.00
PB56	VRF21B	0.0	Hz	0.0	0.0
PB57	VRF22B	0.0	Hz	0.0	0.0
PB58	VRF23B	0.00	-	0.00	0.00
PB59	VRF24B	0.00	-	0.00	0.00
PB60	PG1B	0.0	rad/s	0.0	0.0
PB61	For manufacturer setting	0.0	-	0.0	0.0
PB62	For manufacturer setting	00000000h	-	00000000	00000000
PB63	For manufacturer setting	00000000h	-	00000000	00000000
PB64	For manufacturer setting	00000000h	-	00000000	00000000
PB65	CDL2	10	pulse	10	10
PB66	CDT2	1	ms	1	1
PB67	GD2C	7.00	Multiplier	7.00	7.00
PB68	PG2C	0.0	rad/s	0.0	0.0
PB69	VG2C	0	rad/s	0	0
PB70	VICC	0.0	ms	0.0	0.0
PB71	VRF11C	0.0	Hz	0.0	0.0
PB72	VRF12C	0.0	Hz	0.0	0.0
PB73	VRF13C	0.00	-	0.00	0.00
PB74	VRF14C	0.00	-	0.00	0.00
PB75	VRF21C	0.0	Hz	0.0	0.0
PB76	VRF22C	0.0	Hz	0.0	0.0
PB77	VRF23C	0.00	-	0.00	0.00
PB78	VRF24C	0.00	-	0.00	0.00
PB79	PG1C	0.0	rad/s	0.0	0.0
PB80	For manufacturer setting	177.0	-	177.0	177.0
PB81	*CFIL	00000001h	-	00000001	00000001
PB82	PFT	0.0	ms	0	0

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PB83	For manufacturer setting	00000000h	-	00000000	00000000
PB84	For manufacturer setting	00000000h	-	00000000	00000000
PB85	For manufacturer setting	00000000h	-	00000000	00000000
PB86	For manufacturer setting	00000000h	-	00000000	00000000
PB87	For manufacturer setting	00000000h	-	00000000	00000000
PB88	For manufacturer setting	00000000h	-	00000000	00000000
PB89	For manufacturer setting	00000000h	-	00000000	00000000
PB90	For manufacturer setting	00000000h	-	00000000	00000000
PB91	For manufacturer setting	00000000h	-	00000000	00000000
PB92	For manufacturer setting	00000000h	-	00000000	00000000

(c) Extension setting servo parameters group ([Pr.PC_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PC01	STA	0	ms	0	0
PC02	STB	0	ms	0	0
PC03	STC	0	ms	0	0
PC04	TQC	0	ms	0	0
PC05	SC1	100.00	r/min, mm/s	100.00	100.00
PC06	SC2	500.00	r/min, mm/s	500.00	500.00
PC07	SC3	1000.00	r/min, mm/s	1000.00	1000.00
PC08	SC4	200.00	r/min, mm/s	200.00	200.00
PC09	SC5	300.00	r/min, mm/s	300.00	300.00
PC10	SC6	500.00	r/min, mm/s	500.00	500.00
PC11	SC7	800.00	r/min, mm/s	800.00	800.00
PC12	VCM	0	r/min, mm/s	0	0
PC13	TLC	100.0	%	100.0	100.0
PC14	MOD1	00000000h	-	00000002	00000002
PC15	MOD2	00000001h	-	00000001	00000001
PC16	MBR	0	ms	0	0
PC17	ZSP	50	r/min, mm/s	50	50
PC18	*BPS	00000000h	-	00000000	00000000
PC19	*ENRS	00000000h	-	00000000	00000000
PC20	For manufacturer setting	0	-	0	0
PC21	For manufacturer setting	00000000h	-	00000000	00000000
PC22	**COP1	00000000h	-	00000000	00000000
PC23	*COP2	00000000h	-	00000000	00000000
PC24	*COP3	00000000h	-	00000000	00000000
PC25	For manufacturer setting	00000000h	-	00000000	00000000
PC26	*COP5	00000000h	-	00000000	00000000
PC27	*COP6	00000000h	-	00000000	00000000
PC28	*COP7	00000000h	-	00000000	00000000
PC29	*COP8	00000120h	-	00000120	00000120
PC30	STA2	0	ms	0	0
PC31	STB2	0	ms	0	0
PC32	CMX2	1	-	1	1
PC33	CMX3	1	-	1	1

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PC34	CMX4	1	-	1	1
PC35	TL2	1000.0	%	1000.0	1000.0
PC36	*DMD	00000000h	-	00000000	00000000
PC37	VCO	0	mV	-4	-4
PC38	TPO	0	mV	0	0
PC39	MO1	0	mV	0	0
PC40	MO2	0	mV	0	0
PC41	For manufacturer setting	0	-	0	0
PC42	For manufacturer setting	0	-	0	0
PC43	ERZ	0	rev, mm	0	0
PC44	**COP9	00000050h	-	00000050	00000050
PC45	**COPA	00000000h	-	00000000	00000000
PC46	For manufacturer setting	0	-	0	0
PC47	For manufacturer setting	0	-	0	0
PC48	For manufacturer setting	0	-	0	0
PC49	For manufacturer setting	0	-	0	0
PC50	**COPB	00000001h	-	00000000	00000000
PC51	RSBR	100	ms	100	100
PC52	For manufacturer setting	0	-	0	0
PC53	For manufacturer setting	0	-	0	0
PC54	RSUP1	0	0.0001rev, 0.01mm	0	0
PC55	For manufacturer setting	0	-	0	0
PC56	For manufacturer setting	100	-	100	100
PC57	For manufacturer setting	00000000h	-	00000000	00000000
PC58	For manufacturer setting	0	-	0	0
PC59	For manufacturer setting	00000000h	-	00000000	00000000
PC60	**COPD	00000000h	-	00000000	00000000
PC61	For manufacturer setting	00000000h	-	00000000	00000000
PC62	For manufacturer setting	00000000h	-	00000000	00000000
PC63	For manufacturer setting	00000000h	-	00000000	00000000
PC64	For manufacturer setting	00000000h	-	00000000	00000000
PC65	For manufacturer setting	00000000h	-	00000000	00000000
PC66	For manufacturer setting	0	-	0	0
PC67	For manufacturer setting	00000000h	-	00000000	00000000
PC68	For manufacturer setting	0	-	0	0
PC69	For manufacturer setting	00000000h	-	00000000	00000000
PC70	For manufacturer setting	0	-	0	0
PC71	For manufacturer setting	00000040h	-	00000040	00000040
PC72	For manufacturer setting	00000000h	-	00000000	00000000
PC73	ERW	0	rev, mm	0	0
PC74	For manufacturer setting	00000000h	-	00000000	00000000
PC75	For manufacturer setting	00C00000h	-	00C00000	00C00000
PC76	For manufacturer setting	00000000h	-	00000000	00000000
PC77	For manufacturer setting	10	-	10	10
PC78	For manufacturer setting	0	-	0	0
PC79	For manufacturer setting	00000000h	-	00000000	00000000
PC80	For manufacturer setting	00000000h	-	00000000	00000000

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PC81	For manufacturer setting	0.0	-	0.0	0.0
PC82	For manufacturer setting	0.0	-	0.0	0.0
PC83	For manufacturer setting	50.00	-	50.00	50.00
PC84	For manufacturer setting	10	-	10	10
PC85	For manufacturer setting	400	-	400	400
PC86	For manufacturer setting	10	-	10	10
PC87	For manufacturer setting	20.00	-	20.00	20.00
PC88	For manufacturer setting	10	-	10	10
PC89	For manufacturer setting	00000000h	-	00000000	00000000
PC90	PLFT	0	pulse/s	00000000	00000000
PC91	For manufacturer setting	00000000h	-	00000000	00000000
PC92	For manufacturer setting	0	-	00000000	00000000
PC93	For manufacturer setting	00000000h	-	00000000	00000000
PC94	For manufacturer setting	00000000h	-	00000000	00000000
PC95	For manufacturer setting	00000000h	-	00000000	00000000
PC96	For manufacturer setting	00000000h	-	00000000	00000000
PC97	For manufacturer setting	00000000h	-	00000000	00000000
PC98	For manufacturer setting	00000000h	-	00000000	00000000
PC99	For manufacturer setting	00000000h	-	00000000	00000000

(d) I/O setting servo parameters group ([Pr.PD_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PD01	*DIA1	00000000h	-	00000C00	00000C00
PD02	For manufacturer setting	00000000h	-	00000000	00000000
PD03	*DI1L	00000202h	-	00000202	00000202
PD04	*DI1H	00000202h	-	00000202	00000202
PD05	*DI2L	00002100h	-	00002000	00002000
PD06	*DI2H	00002021h	-	00002021	00002021
PD07	*DI3L	00000704h	-	00002104	00002104
PD08	*DI3H	00000707h	-	00000707	00000707
PD09	*DI4L	00000805h	-	00000505	00000505
PD10	*DI4H	00000808h	-	00000808	00000808
PD11	*DI5L	00000303h	-	00000303	00000303
PD12	*DI5H	00003803h	-	00003803	00003803
PD13	*DI6L	00002006h	-	00002006	00002006
PD14	*DI6H	00003920h	-	00003920	00003920
PD15	For manufacturer setting	000C0C0Ch	-	000C0C0C	000C0C0C
PD16	For manufacturer setting	00000C0Ch	-	00000C0C	00000C0C
PD17	*DI8L	000A0A0Ah	-	000A0707	000A0707
PD18	*DI8H	00000A00h	-	00000A00	00000A00
PD19	*DI9L	000B0B0Bh	-	000B0808	000B0808
PD20	*DI9H	00000B00h	-	00000B00	00000B00
PD21	*DI10L	002B2323h	-	002B2323	002B2323
PD22	*DI10H	00002B23h	-	00002B23	00002B23
PD23	*DO1	00000004h	-	00000004	00000004
PD24	*DO2	0000000Ch	-	0000000C	0000000C

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PD25	*DO3	00000004h	-	00000004	00000004
PD26	*DO4	00000007h	-	00000007	00000007
PD27	For manufacturer setting	00000003h	-	00000003	00000003
PD28	*DO6	00000002h	-	00000002	00000002
PD29	*DIF	00000007h	-	00000007	00000007
PD30	*DOP1	00000000h	-	00000000	00000000
PD31	*DOP2	00000000h	-	00000000	00000000
PD32	*DOP3	00000000h	-	00000000	00000000
PD33	*DOP4	00000000h	-	00000000	00000000
PD34	*DOP5	00000000h	-	00000000	00000000
PD35	For manufacturer setting	00000000h	-	00000000	00000000
PD36	For manufacturer setting	00000000h	-	00000000	00000000
PD37	For manufacturer setting	00000000h	-	00000000	00000000
PD38	For manufacturer setting	0	-	0	0
PD39	For manufacturer setting	0	-	0	0
PD40	For manufacturer setting	0	-	0	0
PD41	For manufacturer setting	00000000h	-	00000000	00000000
PD42	*DIA4	00000000h	-	00000000	00000000
PD43	*DI11L	00000000h	-	00000000	00000000
PD44	*DI11H	00003A00h	-	00003A00	00003A00
PD45	*DI12L	00000000h	-	00000000	00000000
PD46	*DI12H	00003B00h	-	00003B00	00003B00
PD47	*DO7	00000000h	-	00000000	00000000
PD48	For manufacturer setting	00000000h	-	00000000	00000000
PD49	For manufacturer setting	00000000h	-	00000000	00000000
PD50	For manufacturer setting	00000000h	-	00000000	00000000
PD51	For manufacturer setting	00000000h	-	00000000	00000000
PD52	For manufacturer setting	00110001h	-	00110001	00110001
PD53	For manufacturer setting	0	-	0	0
PD54	For manufacturer setting	0	-	0	0
PD55	For manufacturer setting	0	-	0	0
PD56	For manufacturer setting	00000000h	-	00000000	00000000
PD57	For manufacturer setting	00000000h	-	00000000	00000000
PD58	For manufacturer setting	00000000h	-	00000000	00000000
PD59	For manufacturer setting	00000000h	-	00000000	00000000
PD60	*DIP	00000000h	-	00000000	00000000
PD61	For manufacturer setting	00000000h	-	00000000	00000000
PD62	For manufacturer setting	00000000h	-	00000000	00000000
PD63	For manufacturer setting	00000000h	-	00000000	00000000
PD64	For manufacturer setting	00000000h	-	00000000	00000000
PD65	For manufacturer setting	00000000h	-	00000000	00000000
PD66	For manufacturer setting	00000000h	-	00000000	00000000
PD67	For manufacturer setting	00000000h	-	00000000	00000000
PD68	For manufacturer setting	00000000h	-	00000000	00000000
PD69	For manufacturer setting	00000000h	-	00000000	00000000
PD70	For manufacturer setting	00000000h	-	00000000	00000000
PD71	For manufacturer setting	00000000h	-	00000000	00000000
PD72	For manufacturer setting	00000000h	-	00000000	00000000

(e) Extension setting 2 servo parameters group ([Pr.PE_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PE01	**FCT1	00000000h	-	00000000	00000000
PE02	For manufacturer setting	00000000h	-	00000000	00000000
PE03	*FCT2	00000003h	-	00000003	00000003
PE04	**FBN	1	-	1	1
PE05	**FBD	1	-	1	1
PE06	BC1	400	r/min	400	400
PE07	BC2	100	kpulse	100	100
PE08	DUF	10	rad/s	10	10
PE09	For manufacturer setting	00000000h	-	00000000	00000000
PE10	FCT3	00000000h	-	00000000	00000000
PE11	For manufacturer setting	00000000h	-	00000000	00000000
PE12	For manufacturer setting	00000000h	-	00000000	00000000
PE13	For manufacturer setting	00000000h	-	00000000	00000000
PE14	For manufacturer setting	00000111h	-	00000111	00000111
PE15	For manufacturer setting	20	-	20	20
PE16	For manufacturer setting	00000000h	-	00000000	00000000
PE17	For manufacturer setting	00000100h	-	00000100	00000100
PE18	For manufacturer setting	00000000h	-	00000000	00000000
PE19	For manufacturer setting	00000000h	-	00000000	00000000
PE20	For manufacturer setting	00000000h	-	00000000	00000000
PE21	For manufacturer setting	00000000h	-	00000000	00000000
PE22	For manufacturer setting	00000000h	-	00000000	00000000
PE23	For manufacturer setting	00000000h	-	00000000	00000000
PE24	For manufacturer setting	00000000h	-	00000000	00000000
PE25	For manufacturer setting	00000000h	-	00000000	00000000
PE26	For manufacturer setting	00000000h	-	00000000	00000000
PE27	For manufacturer setting	00000000h	-	00000000	00000000
PE28	For manufacturer setting	00000000h	-	00000000	00000000
PE29	For manufacturer setting	00000000h	-	00000000	00000000
PE30	For manufacturer setting	00000000h	-	00000000	00000000
PE31	For manufacturer setting	00000000h	-	00000000	00000000
PE32	For manufacturer setting	00000000h	-	00000000	00000000
PE33	For manufacturer setting	00000000h	-	00000000	00000000
PE34	For manufacturer setting	1	-	1	1
PE35	For manufacturer setting	1	-	1	1
PE36	For manufacturer setting	0.0	-	0.0	0.0
PE37	For manufacturer setting	0.00	-	0.00	0.00
PE38	For manufacturer setting	0.00	-	0.00	0.00
PE39	For manufacturer setting	20	-	20	20
PE40	For manufacturer setting	00000000h	-	00000000	00000000
PE41	EOP3	00000000h	-	00000001	00000001
PE42	For manufacturer setting	0	-	0	0
PE43	For manufacturer setting	0.0	-	0.0	0.0
PE44	LMCP	0	0.01%	0	0
PE45	LMCN	0	0.01%	0	0
PE46	LMFLT	0	0.1ms	0	0

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PE47	TOF	0	0.01%	0	0
PE48	*LMOP	00000000h	-	00000000	00000000
PE49	LMCD	0	0.1ms	0	0
PE50	LMCT	0	pulse, kpulse	0	0
PE51	For manufacturer setting	00000000h	-	00000000	00000000
PE52	For manufacturer setting	00000000h	-	00000000	00000000
PE53	For manufacturer setting	00000000h	-	00000000	00000000
PE54	For manufacturer setting	00000000h	-	00000000	00000000
PE55	For manufacturer setting	00000000h	-	00000000	00000000
PE56	For manufacturer setting	00000000h	-	00000000	00000000
PE57	For manufacturer setting	00000000h	-	00000000	00000000
PE58	For manufacturer setting	00000000h	-	00000000	00000000
PE59	For manufacturer setting	00000000h	-	00000000	00000000
PE60	For manufacturer setting	00000000h	-	00000000	00000000
PE61	For manufacturer setting	0.000	-	0.000	0.000
PE62	For manufacturer setting	0.000	-	0.000	0.000
PE63	For manufacturer setting	0.000	-	0.000	0.000
PE64	For manufacturer setting	0.000	-	0.000	0.000
PE65	For manufacturer setting	0.0	-	0.0	0.0
PE66	For manufacturer setting	0.0	-	0.0	0.0
PE67	For manufacturer setting	0.0	-	0.0	0.0
PE68	For manufacturer setting	00000000h	-	00000000	00000000
PE69	For manufacturer setting	00000000h	-	00000000	00000000
PE70	For manufacturer setting	00000000h	-	00000000	00000000
PE71	For manufacturer setting	00000000h	-	00000000	00000000
PE72	For manufacturer setting	00000000h	-	00000000	00000000
PE73	For manufacturer setting	00000000h	-	00000000	00000000
PE74	For manufacturer setting	00000000h	-	00000000	00000000
PE75	For manufacturer setting	00000000h	-	00000000	00000000
PE76	For manufacturer setting	00000000h	-	00000000	00000000
PE77	For manufacturer setting	00000000h	-	00000000	00000000
PE78	For manufacturer setting	0	-	0	0
PE79	For manufacturer setting	0	-	0	0
PE80	For manufacturer setting	00000000h	-	00000000	00000000
PE81	For manufacturer setting	00000000h	-	00000000	00000000
PE82	For manufacturer setting	00000000h	-	00000000	00000000
PE83	For manufacturer setting	00000000h	-	00000000	00000000
PE84	For manufacturer setting	00000000h	-	00000000	00000000
PE85	For manufacturer setting	00000000h	-	00000000	00000000
PE86	For manufacturer setting	00000000h	-	00000000	00000000
PE87	For manufacturer setting	00000000h	-	00000000	00000000
PE88	For manufacturer setting	00000000h	-	00000000	00000000

(f) Extension setting 3 servo parameters group ([Pr.PF_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PF01	For manufacturer setting	00000000h	-	00000000	00000000
PF02	*FOP2	00000000h	-	00000000	00000000
PF03	For manufacturer setting	00000000h	-	00000000	00000000
PF04	For manufacturer setting	0	-	0	0
PF05	For manufacturer setting	0	-	0	0
PF06	For manufacturer setting	00000000h	-	00000000	00000000
PF07	For manufacturer setting	1	-	1	1
PF08	For manufacturer setting	1	-	1	1
PF09	*FOP5	00000013h	-	00000013	00000013
PF10	For manufacturer setting	00000000h	-	00000000	00000000
PF11	For manufacturer setting	00000000h	-	00000000	00000000
PF12	For manufacturer setting	65535	-	65535	65535
PF13	For manufacturer setting	100	-	100	100
PF14	For manufacturer setting	100	-	100	100
PF15	DBT	2000	ms	2000	2000
PF16	For manufacturer setting	00000000h	-	00000000	00000000
PF17	For manufacturer setting	10	-	10	10
PF18	**STOD	10	s	10	10
PF19	For manufacturer setting	00000000h	-	00000000	00000000
PF20	For manufacturer setting	00000000h	-	00000000	00000000
PF21	DRT	0	s	0	0
PF22	For manufacturer setting	200	-	200	200
PF23	OSCL1	20	%	20	20
PF24	*FOP9	00000000h	-	00000000	00000000
PF25	CVAT	200	ms	200	200
PF26	For manufacturer setting	0	-	0	0
PF27	For manufacturer setting	0	-	0	0
PF28	For manufacturer setting	0	-	0	0
PF29	For manufacturer setting	00000000h	-	00000000	00000000
PF30	For manufacturer setting	0	-	0	0
PF31	FRIC	0	r/min, mm/s	0	0
PF32	*VIBT	50	100ms	50	50
PF33	For manufacturer setting	00000000h	-	00000000	00000000
PF34	For manufacturer setting	00000000h	-	00000000	00000000
PF35	For manufacturer setting	00000000h	-	00000000	00000000
PF36	For manufacturer setting	00000000h	-	00000000	00000000
PF37	For manufacturer setting	00000000h	-	00000000	00000000
PF38	For manufacturer setting	00000000h	-	00000000	00000000
PF39	For manufacturer setting	00000000h	-	00000000	00000000
PF40	For manufacturer setting	0	-	0	0
PF41	For manufacturer setting	0	-	0	0
PF42	For manufacturer setting	0	-	0	0
PF43	For manufacturer setting	0	-	0	0
PF44	For manufacturer setting	0	-	0	0
PF45	For manufacturer setting	00000000h	-	00000000	00000000
PF46	For manufacturer setting	0	-	0	0

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PF47	For manufacturer setting	00000000h	-	00000000	00000000
PF48	For manufacturer setting	00000000h	-	00000000	00000000
PF49	TSL	0	0.0001%/°C	0	0
PF50	TIC	0	0.1%	0	0
PF51	*MFP	00000000h	-	00000000	00000000
PF52	MFPP	00000000h	-	00000000	00000000
PF53	FPMT	0	10rev, m	0	0
PF54	PAV	0	0.1%	0	0
PF55	PSD	0	0.1	0	0
PF56	VAV	0	0.1%	0	0
PF57	VSD	0	0.1%	0	0
PF58	TMO	0	10rev, m	0	0
PF59	For manufacturer setting	00000000h	-	00000000	00000000
PF60	For manufacturer setting	00000000h	-	00000000	00000000
PF61	For manufacturer setting	00000000h	-	00000000	00000000
PF62	For manufacturer setting	00000000h	-	00000000	00000000
PF63	For manufacturer setting	00000000h	-	00000000	00000000
PF64	For manufacturer setting	00000000h	-	00000000	00000000
PF65	For manufacturer setting	00000000h	-	00000000	00000000
PF66	BLG	00000000h	-	00000000	00000000
PF67	BLN	0	0.01degree	0	0
PF68	BLTT	0	0.1	0	0
PF69	SPAV2	0	0.1%	0	0
PF70	SPSD2	0	0.1%	0	0
PF71	BFP	00000000h	-	00000000h	00000000h
PF72	SBT	0	0.1N	0	0
PF73	ABT	0	0.1N	0	0
PF74	SSF	0	0.1%	0	0
PF75	ASF	0	0.1%	0	0
PF76	BTS	0	0.1%	0	0
PF77	For manufacturer setting	00000000h	-	00000000	00000000
PF78	For manufacturer setting	00000000h	-	00000000	00000000
PF79	For manufacturer setting	00110010h	-	00110010	00110010
PF80	DRMC	00000000h	-	00000000	00000000
PF81	DRMS	00000000h	-	00000000	00000000
PF82	DRTM	00000000h	-	00000000	00000000
PF83	For manufacturer setting	00000000h	-	00000000	00000000
PF84	DRTC	005A8101h	-	005A8101	005A8101
PF85	DRTL1	0	-	0	0
PF86	DRTL2	0	-	0	0
PF87	DRAC1	00020201h	-	00020201	00020201
PF88	DRAC2	02040003h	-	02040003	02040003
PF89	DRAC3	02090205h	-	02090205	02090205
PF90	DRAC4	0000020Ch	-	0000020C	0000020C
PF91	DRDC1	00120000h	-	00120000	00120000
PF92	DRDC2	80058010h	-	80058010	80058010
PF93	DRDC3	8000800Ah	-	8000800A	8000800A

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PF94	DRDC4	801D8015h	-	801D8015	801D8015
PF95	**DRCLR	00000000h	-	00000000	00000000
PF96	For manufacturer setting	00000000h	-	00000000	00000000
PF97	For manufacturer setting	00000000h	-	00000000	00000000
PF98	For manufacturer setting	00000000h	-	00000000	00000000
PF99	For manufacturer setting	00000000h	-	00000000	00000000

(g) Motor extension setting servo parameters group ([Pr.PL_ _])

No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PL01	**LIT1	00000301h	-	00000301	00000301
PL02	**LIM	1000	μm	1000	1000
PL03	**LID	1000	μm	1000	1000
PL04	*LIT2	00000003h	-	00000003	00000003
PL05	LB1	0	mm, 0.01rev	0	0
PL06	LB2	0	mm/s, r/min	0	0
PL07	LB3	100	%	100	100
PL08	*LIT3	00001010h	-	00001010	00001010
PL09	LPWM	30	%	30	30
PL10	For manufacturer setting	5	-	5	5
PL11	For manufacturer setting	100	-	100	100
PL12	For manufacturer setting	500	-	500	500
PL13	For manufacturer setting	00000000h	-	00000000	00000000
PL14	For manufacturer setting	00000000h	-	00000000	00000000
PL15	For manufacturer setting	20	-	20	20
PL16	For manufacturer setting	0	-	0	0
PL17	LTSTS	00000000h	-	00000000	00000000
PL18	IDLV	0	%	0	0
PL19	For manufacturer setting	0	-	0	0
PL20	For manufacturer setting	0	-	0	0
PL21	For manufacturer setting	0	-	0	0
PL22	For manufacturer setting	0	-	0	0
PL23	For manufacturer setting	00000000h	-	00000000	00000000
PL24	For manufacturer setting	0	-	0	0
PL25	For manufacturer setting	0	-	0	0
PL26	For manufacturer setting	00000000h	-	00000000	00000000
PL27	For manufacturer setting	00000000h	-	00000000	00000000
PL28	For manufacturer setting	00000000h	-	00000000	00000000
PL29	For manufacturer setting	00000000h	-	00000000	00000000
PL30	For manufacturer setting	00000000h	-	00000000	00000000
PL31	For manufacturer setting	00000000h	-	00000000	00000000
PL32	For manufacturer setting	00000000h	-	00000000	00000000
PL33	For manufacturer setting	00000000h	-	00000000	00000000
PL34	For manufacturer setting	00000000h	-	00000000	00000000
PL35	For manufacturer setting	00000000h	-	00000000	00000000
PL36	For manufacturer setting	00000000h	-	00000000	00000000
PL37	For manufacturer setting	00000000h	-	00000000	00000000

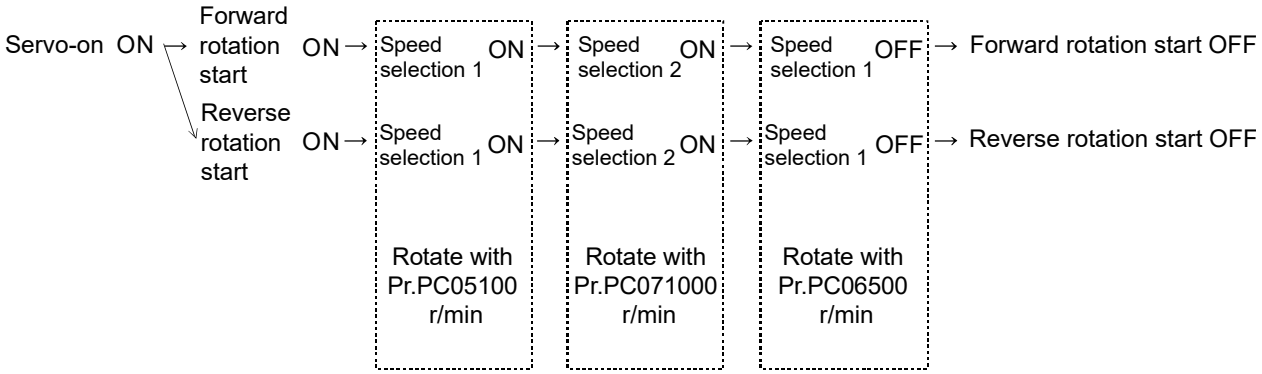
No.	Abbreviation	Initial value	Unit	Demonstration machine setting value	
				Position control	Speed control
PL38	For manufacturer setting	00000000h	-	00000000	00000000
PL39	For manufacturer setting	00000000h	-	00000000	00000000
PL40	For manufacturer setting	00000000h	-	00000000	00000000
PL41	For manufacturer setting	00000000h	-	00000000	00000000
PL42	For manufacturer setting	00000000h	-	00000000	00000000
PL43	For manufacturer setting	00000000h	-	00000000	00000000
PL44	For manufacturer setting	00000000h	-	00000000	00000000
PL45	For manufacturer setting	00000000h	-	00000000	00000000
PL46	For manufacturer setting	00000000h	-	00000000	00000000
PL47	For manufacturer setting	00000000h	-	00000000	00000000
PL48	For manufacturer setting	00000000h	-	00000000	00000000
PL49	For manufacturer setting	00000000h	-	00000000	00000000
PL50	For manufacturer setting	00000000h	-	00000000	00000000
PL51	For manufacturer setting	00000000h	-	00000000	00000000
PL52	For manufacturer setting	00000000h	-	00000000	00000000
PL53	For manufacturer setting	0	-	0	0
PL54	For manufacturer setting	00000000h	-	00000000	00000000
PL55	For manufacturer setting	00000000h	-	00000000	00000000
PL56	For manufacturer setting	00000000h	-	00000000	00000000
PL57	For manufacturer setting	00000000h	-	00000000	00000000
PL58	For manufacturer setting	00000000h	-	00000000	00000000
PL59	For manufacturer setting	00000000h	-	00000000	00000000
PL60	For manufacturer setting	00000000h	-	00000000	00000000
PL61	For manufacturer setting	00000000h	-	00000000	00000000
PL62	For manufacturer setting	00000000h	-	00000000	00000000
PL63	For manufacturer setting	00000000h	-	00000000	00000000
PL64	For manufacturer setting	00000000h	-	00000000	00000000
PL65	For manufacturer setting	00000000h	-	00000000	00000000
PL66	For manufacturer setting	00000000h	-	00000000	00000000
PL67	For manufacturer setting	00000000h	-	00000000	00000000
PL68	For manufacturer setting	00000000h	-	00000000	00000000
PL69	For manufacturer setting	00000000h	-	00000000	00000000
PL70	For manufacturer setting	00000000h	-	00000000	00000000
PL71	For manufacturer setting	00000000h	-	00000000	00000000
PL72	For manufacturer setting	00000000h	-	00000000	00000000

(3) Operation

(a) Internal three-speed operation

1) Operate the servo motor with the procedure below to check if the motor rotates in the forward and reverse directions at the speed specified by Internal speed commands 1 to 3 (Pr.PC05 to Pr.PC07).

The speed can be checked with the display (5-digit, 7-segment display) on the front of the servo amplifier or with the monitor of MR Configurator2 installed on the computer.



2) Change the value in Internal speed commands 1 to 3 (Pr.PC05 to Pr.PC07), then check the operation.

* Set Pr.PC05 and Pr.PC06 to desired values and Pr.PC07 to 3000.

(b) Analog speed command (VC) operation

Turning off the internal three-speed (speed selection 1 and speed selection 2) enables operation using the VC input.

1) Turn on the forward rotation start or reverse rotation start switch, then check if the speed can be changed by the numerical input of the analog speed command as desired.

* If the motor rotates even when the speed command is 0, the rotation is caused by an input offset of the external speed command signal. This does not occur when the motor is operated by the internal speed command.

Such motor rotation can be stopped using the method "4) Adjusting VC offset" in section 2.3.1 (3) (c).

(c) Checking settings of each parameter (refer to section 7.3.6 "Parameter" for details of the parameters.)

1) Checking acceleration/deceleration time constants
Set the speed acceleration time constant (Pr.PC01) and speed deceleration time constant (Pr.PC02), then check the operation.
Setting example ... Pr.PC01: 0 → 3000 (3 seconds)
Pr.PC02: 0 → 5000 (5 seconds)

2) Checking S-pattern acceleration/deceleration time constants
Set the speed acceleration time constant (Pr.PC01), speed deceleration time constant (Pr.PC02), and S-pattern acceleration/deceleration time constants (Pr.PC03), then check the operation.
Setting example … Pr.PC03: 0 → 500 (0.5 seconds)
Refer to "19) [Pr.PC03_S-pattern acceleration/deceleration time constants (STC)]" in section 7.3.6 (3)(b) for details.
* After checking the operation, set all of Pr.PC01 to Pr.PC03 to 0.

3) Checking torque limit value
Set Internal torque limit (Pr.PA11 and Pr.PA12).
Setting example … Forward rotation torque limit (Pr.PA11): 100.0% → 28.5%
(The torque will be limited to one-third of the maximum torque to disable the torque output of the rated torque or more.)
Turning on the torque limit selection switch enables numerical input of the analog torque limit.

4) Adjusting VC offset
Set Analog command input 1 offset (Pr.PC37) so that the motor does not rotate when the command speed voltage is 0V.
Setting example … Analog command input 1 offset (Pr.PC37): 0mV → □□mV
(If the motor rotates in the CCW direction when Forward rotation start is turned on, set the parameter to a negative value.)

5) Adjusting analog monitor offset
Set Analog monitor 1 offset (Pr.PC39) to compensate the monitor output meter.

6) Setting monitor output
The contents of the monitor output can be changed by setting Analog monitor 1 output (Pr.PC14).
Setting example … 00000002: Motor speed (+8V/maximum speed)
00000003: Generated torque (+8V/maximum torque)

7) Setting status display
Set Status display selection (Pr.PC36) to select the status display shown at power-on.
Setting example … 00000100: Cumulative feedback pulses
00000101: Servo motor speed

8) Checking each status display
1) Enable the load settings during motor operation, then move the load command slider to check the displayed contents such as the peak load ratio and effective load ratio.
2) Set Analog speed command - Maximum speed (Pr.PC12) for a 10V command to 0 then to 2000, then check the output of speed command F, rotation speed r, and GOT speed meter (deflection of the indicator).

2.3.2 Position control

(1) Power-on

Turn on the power in accordance with "(1) Power-on" in section 2.3.1.

(2) Parameter settings

Before operating the demonstration machine, set the parameters to the demonstration machine setting values (position control) shown in "(2) Parameter settings" in section 2.3.1.

(3) Operation

(a) Servo-on

Turn on servo-on (SON) to make the servo-on state.

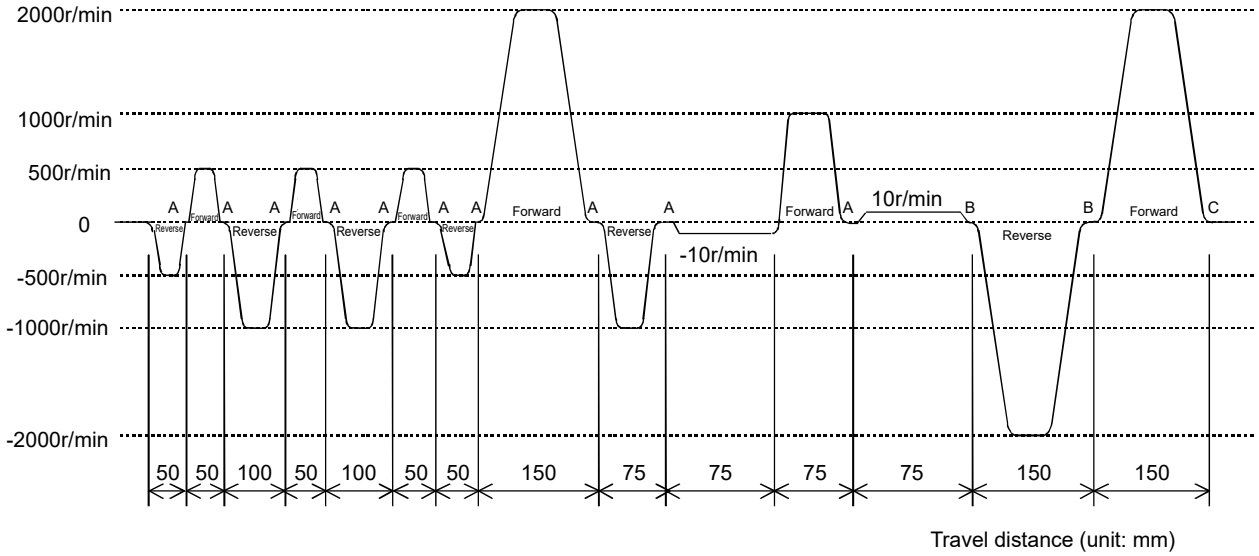
(b) JOG operation

1. Switch the manual/automatic select switch to the manual side.
2. Turn on the forward rotation JOG button to rotate the motor in the forward rotation direction (counterclockwise). (Only when the button is turned on)
3. Turn on the reverse rotation JOG button to rotate the motor in the reverse rotation direction (clockwise). (Only when the button is turned on)

(c) Automatic operation

Perform homing before automatic operation.

1. Switch the manual/automatic select switch to the manual side.
2. Turn on the homing button to make the motor perform homing.
   To perform automatic operation, switch the manual/automatic select switch to the automatic side.
3. Switch the continuous/one-cycle operation switch to one-cycle operation then press the start button to perform operation once in the pattern shown in the figure below.
   Press the stop button to pause the operation.
4. Switch the continuous/one-cycle operation switch to continuous operation then press the start button to perform operation repeatedly in the pattern shown in the figure below.
   Press the stop button to pause the operation.



(Note) A, B, and C indicate the dwell time. A = 500ms, B = 1s, C = 2s

(d) Timing belt working section and home position setting operation

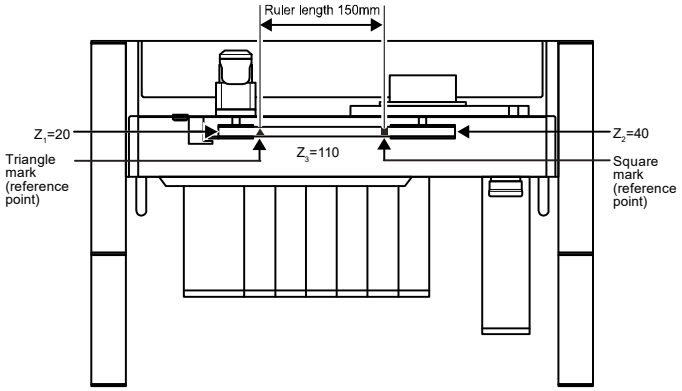
The specifications of the mechanical section (timing working section) of this demonstration machine are as follows.

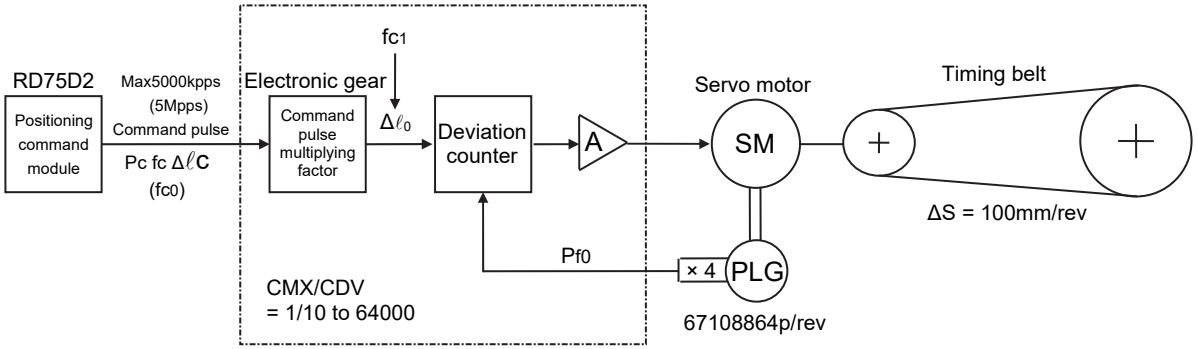
1) Timing belt working part specifications

No.	Item	Specifications
1	Belt length	L = 550mm (one circle)
2	Number of pulley teeth on the servo motor side	Z1 = 20
3	Number of pulley teeth on the powder brake side	Z2 = 40
4	Number of belt teeth	Z3 = 110
5	Inertia moment of the powder brake itself	Ja = 0.358kg·m^2
6	Inertia moment of the servo motor itself	JM = 0.0394 × 10^{-4}kg·m^2
7	Belt travel distance per motor rotation	ΔS = 100mm
8	Motor feedback pulses	Pf0 = 67108864P/rev

2) When the home position is set at the reference position as shown in the figure on the right, if the homing button is turned on for consecutive eleven times, the home position will be set at the reference position again.
In other words, the home position is set at the reference position once in eleven times as shown in the figure on the right.

$$n = \frac{L}{\Delta S} = \frac{550}{100} = \frac{11}{2}$$





(e) Checking operations using each parameter setting (refer to section 7.3.6 "Parameter" for details of the parameters.)

1) Electronic gear settings and concept (Pr.PA06 and Pr.PA07)
Consider whether the belt travel distance per pulse can be set to $\Delta\ell c$ = 0.001 mm (1μm).

$$\text{Electronic gear ratio } \frac{CMX}{CDV} = \frac{\text{Motor feedback pulse Pf0} \times \text{belt travel distance per pulse } \Delta\ell c}{\text{Belt travel distance per motor rotation } \Delta S}$$

$$= \frac{67108864 \times 0.001}{100} = \frac{8388608}{12500} = \frac{2097152}{3125}$$

2) Find the value of fc for a motor speed of 3000r/min when the electronic gear ratio is 2097152/3125.
Consider whether the belt travel distance per pulse can be set to $\Delta\ell c$ = 0.001 mm (1μm).

$$N = \frac{fc \times 60 \times CMX/CDV}{Pf0} = \frac{fc \times 60 \times 2097152/3125}{67108864} = 3000\text{r/min}$$

$$fc = \frac{67108864 \times 3000}{60 \times 2097152/3125} = 5000\text{kpps} \geq 5000\text{kpps}$$

The maximum command frequency of the positioning module RD75D2 is 5000kpps (5Mpps). This setting is possible because fc matches with the maximum command frequency.

3) Consider if the belt travel distance per pulse can be set to $\Delta\ell c$ = 0.05mm (50μm).

$$\text{Electronic gear ratio} \quad \frac{CMX}{CDV} = \frac{67108864 \times 0.05}{100} = \frac{83886080}{2500} = \frac{4194304}{125}$$

Find the value of fc for a motor speed of 3000r/min when the electronic gear ratio is 4194304/125.

$$fc = \frac{67108864 \times 3000}{60 \times 4194304/125} = 100\text{kpps} < 5000\text{kpps}$$

The maximum command frequency of the positioning module RD75D2 is 5000kpps (5Mpps). The setting is not problematic as the frequency is 200kpps < 5000Kpps even at 6000r/min, which is within the maximum command frequency.

* The feed length per pulse on this demonstration machine has been set to 0.01mm.

$$\frac{CMX}{CDV} = \frac{67108864 \times 0.01}{100} = \frac{67108864}{10000}$$

Perform settings as follows.
Command pulse multiplication numerator (Pr.PA06): 67108864
Command pulse multiplication denominator (Pr.PA07): 10000

4) Set "In-position range" (Pr.PA10).

5) Set "Model control gain" and "Position control gain" (Pr.PB07 and Pr.PB08).

2.4 AC Servo Setup Software

This section describes the operation of setup software "MR Configurator2 (SW1DNC-MRC2-E)" for general-purpose AC servos manufactured by Mitsubishi Electric, for smooth setup operation and graph display by using a computer.

(1) Compatible AC servo model names
MR-J5, MR-JET, MR-J4, MR-JE, MR-J3, MR-JN series

(2) Operating environment

Equipment		Description
Personal computer (Notes 1, 2, 3, 4, 5)	OS	Microsoft® Windows® 10 Education Operating System
		Microsoft® Windows® 10 Enterprise Operating System
		Microsoft® Windows® 10 Pro Operating System
		Microsoft® Windows® 10 Home Operating System
		Microsoft® Windows® 10 IoT Enterprise 2016 LTSB Operating System*1
		Microsoft® Windows® 8.1 Enterprise Operating System
		Microsoft® Windows® 8.1 Pro Operating System
		Microsoft® Windows® 8.1 Operating System
		Microsoft® Windows® 8 Enterprise Operating System
		Microsoft® Windows® 8 Pro Operating System
		Microsoft® Windows® 8 Operating System
		Microsoft® Windows® 7 Enterprise Operating System
		Microsoft® Windows® 7 Ultimate Operating System
		Microsoft® Windows® 7 Professional Operating System
		Microsoft® Windows® 7 Home Premium Operating System
		Microsoft® Windows® 7 Starter Operating System
		Microsoft® Windows Vista® Enterprise Operating System*2
		Microsoft® Windows Vista® Ultimate Operating System*2
		Microsoft® Windows Vista® Business Operating System*2
		Microsoft® Windows Vista® Home Premium Operating System*2
		Microsoft® Windows Vista® Home Basic Operating System*2
		Microsoft® Windows® XP Professional Operating System, Service Pack3*2
		Microsoft® Windows® XP Home Edition Operating System, Service Pack3*2
	CPU	Desktop computer: Intel® Celeron® Processor 2.8GHz or higher recommended Notebook computer: Intel® Pentium® M Processor 1.7GHz or higher recommended
	Memory	512MB or more recommended (32-bit OS) 1GB or more recommended (64-bit OS)
	Hard disk	1GB or more of free space
Browser		Internet Explorer 4.0 or later
Display		Resolution of 1024 × 768 or higher and capable of high color (16-bit) display Connectable with the above personal computers
Keyboard		Connectable with the above personal computers
Mouse		Connectable with the above personal computers
Printer		Connectable with the above personal computers
USB cable		MR-J3USBCBL3M
Ethernet cable		Cable type: Category 5e or higher, (STP) straight cable Standard: IEEE802.3 1000BASE-T or ANSI/TIA/EIA-568-B (Category 5e or higher) Connector: Shielded RJ-45

*1 Only the 64-bit version is supported.
*2 Only the 32-bit version is supported.

Note 1: The 64-bit version of Windows® XP and Windows Vista® is not supported.
2: If .NET Framework 3.5 (including .NET 2.0 and 3.0) is disabled on Windows® 7 or later, it must be enabled.
3: This product may not operate properly if the following functions are used.
• Application startup in Windows® compatibility mode
• User simple switching
• Remote desktop
• Windows XP Mode
• Windows Touch or Touch
• Modern UI
• Client Hyper-V
• Tablet mode
• Virtual Desktop
4: In the following cases, the screen of this product may not operate properly.
• The size of the text and other items on the screen is other than the prescribed values (96DPI, 100%, 9pt, etc.).
• The screen resolution has been changed during operation.
• Multi display has been set.
5: In the case of Windows Vista® or later, use it as a "standard user" or "administrator".

(3) Characteristics

1) Easy setup and easy adjustment
The servo assistance function displays a guide for amplifier settings, test operation, servo adjustment, maintenance, and troubleshooting functions from startup to operation, making setup easy even for first-time users.

2) Array of monitoring and diagnostic functions
The equipment is equipped with various monitor functions, alarm functions, diagnostic functions, and a graph display function that displays the status of the servo motor triggered by input signals such as command pulses, droop pulses, and rotation speed.

3) Easy start-up in various test operations
Various test operations necessary for startup operation, including JOG operation, positioning operation, and motor-less operation, can be performed.

4) More advanced servo adjustment
A full range of tuning and measurement functions required for servos, such as tuning and machine analyzer, are provided for more advanced tuning.

(4) Specifications

With the servo amplifier connected (MR-J5 series)[*6]

Item \ Servo amplifier		MR-J5-A (-RJ)	MR-J5-G (-RJ)[*5]
Communication channel	USB	○	○
	RS-422(RS-232C)	-	-
	Ethernet	-	○
Parameter	Parameter Setting	○	○
	Network Parameter	○	○
	Axis Name Setting	○	-
	Parameter Converter	-	-
Safety	Safety Parameter Setting	-	-
	Change Password	-	-
	Initialize Password	-	-
Positioning Data	Point Table	-	-
	Program	-	-
	Indirect Addressing	-	-
	Cam Data	-	-
Monitor	Display All	○	○
	I/O Monitor	○	○
	Graph	○	○
	ABS Data Display	○	○
Diagnosis	Alarm Display	○	○
	Alarm Occurrence Data	○	○
	Drive recorder	○	○
	No Motor Rotation	○	○
	System Configuration	○	○
	Service life diagnosis	○	○
	Machine Diagnosis	○	○
	Gear Failure Diagnosis	○	○
	Encoder Communication Circuit Diagnosis	○	○

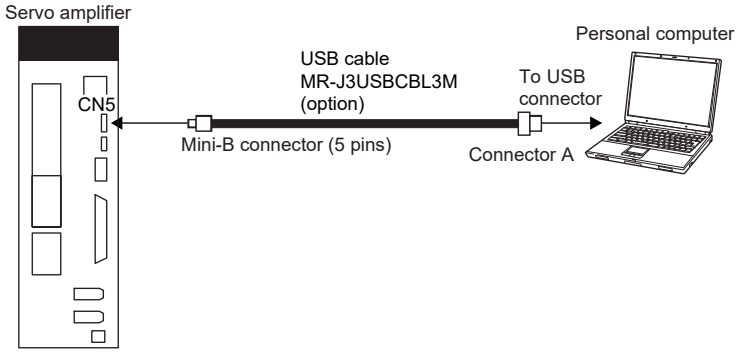
Item \ Servo amplifier		MR-J5-A (-RJ)	MR-J5-G (-RJ)*5
Diagnosis	Fully Closed Loop Diagnosis	○*1	○*1
	Linear Diagnosis	○*2	○*2
Test operation	JOG Mode	○*3	○*3
	Positioning Mode	○	○
	Motor-less Operation	○*4	○*4
	DO Forced Output	○	○
	Program Operation	○	○
	Single-step Feed	○	-
	Test Mode Information	○	○
Adjustment	One-touch tuning	○	○
	Tuning	○	○
	Multi-axis Tuning	-	-
	Machine analyzer	○	○
	Advanced Gain Search	-	-
Tools	Update Parameter Setting Range	○	○
	Machine Unit Conversion Display Setting	-	-

*1: Available only when the operation mode is set to fully closed loop control.
*2: Available only when the operation mode is set to linear servo motor control.
*3: Unavailable when the operation mode is set to linear servo motor control.
*4: Available only when the operation mode is set to standard control.
*5: It is possible to switch to a multi-axis project.
*6: Software reset is supported.

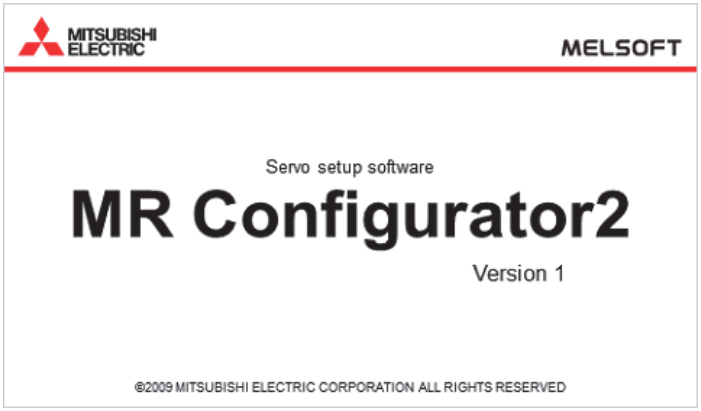
2.4.1 Setup software (SW1DNC-MRC2-E) startup operation

(1) Communication cable connection between personal computer and AC servo amplifier
Data such as parameter contents (including gains), monitor-related data (contents that can be displayed on the LED of the servo amplifier such as currents, speed, and droop pulses), input/output signals of the I/O, and alarm display are available via communication.
As information related to the protocols and commands required for communication is accessible, the user can create software for communication.

Operate a single-axis servo amplifier.
Use the optional MR-J3USBCBL3M cable as the USB cable.

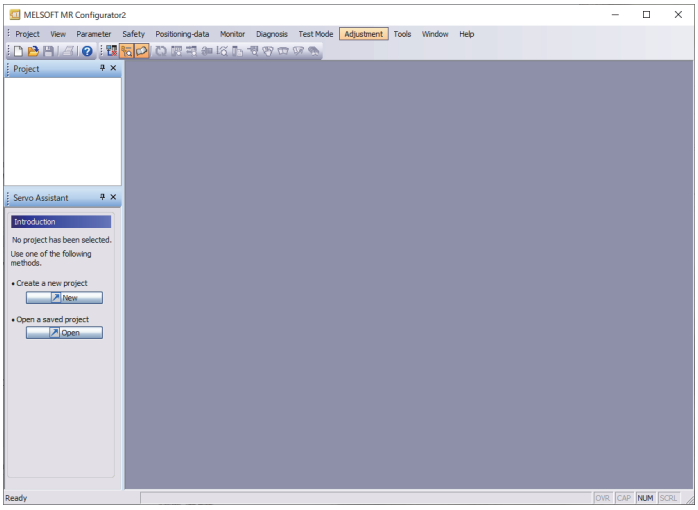


(2) Startup of application software



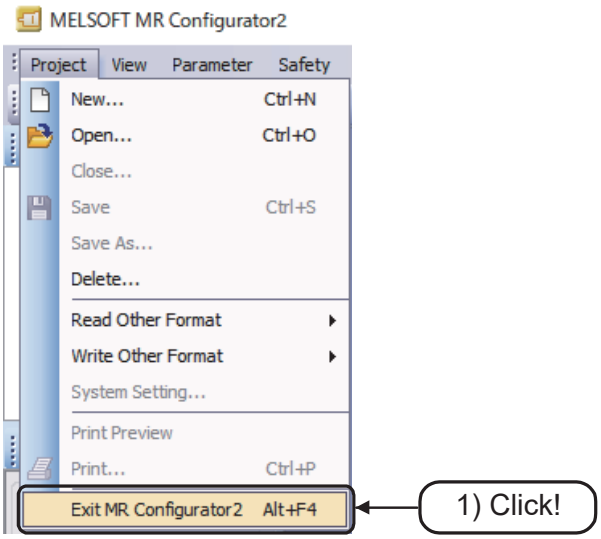
1) Click Windows [Start] - [MELSOFT] - [MR Configurator2].

The startup screen shown on the left is displayed.



2) MR Configurator2 starts.

(3) Termination of application software

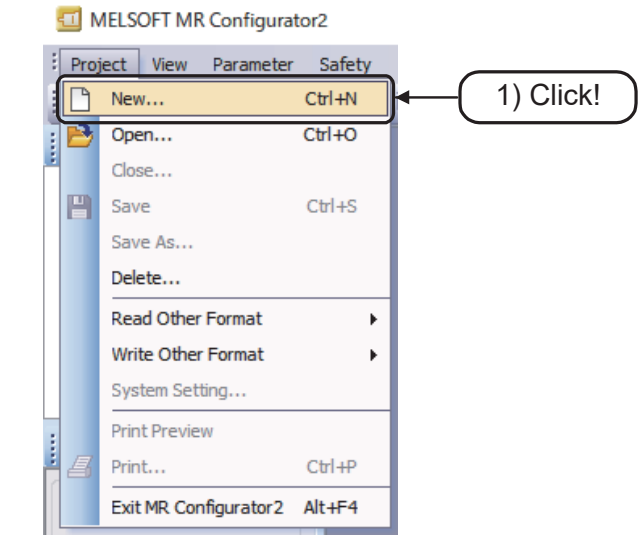


1) In the menu bar, click [Project] → [Exit MR Configurator2].

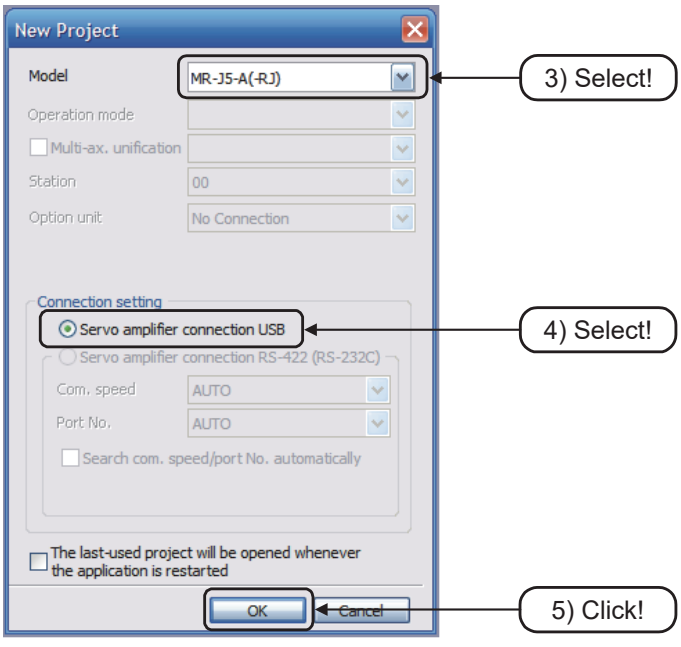
2.4.2 Projects

A project is a collection of files such as system settings and parameter settings, grouped in a common folder.

(1) Creating a new project



1) In the menu bar, click [Project] → [New].



2) The New Project dialog box is displayed.

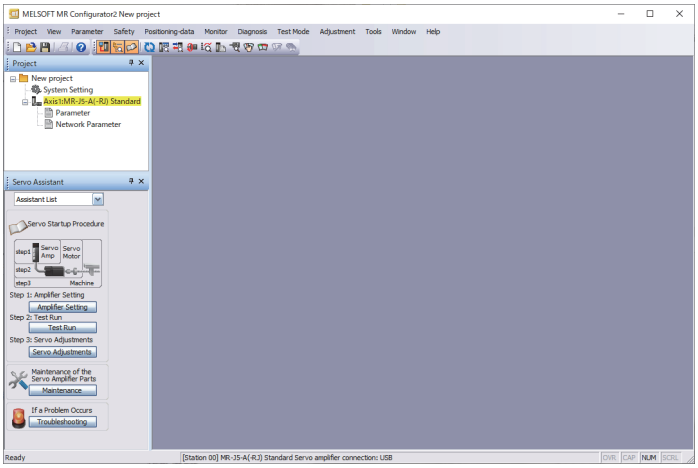
3) Select the model.

4) Configure the connection settings.

5) Click the [OK] button.

(to next page)

(from previous page)



5) The newly created project will open.

(2) Opening a project

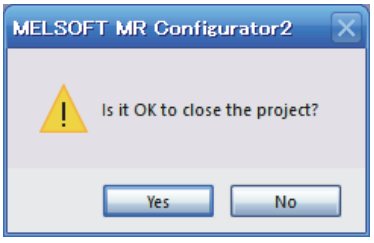
Open an existing MR Configurator2 project.

In the menu bar, click [Project] → [Open] to display the Open Project dialog box. Then select the project to open and click the [Open] button.

(3) Closing a project

Close the currently open MR Configurator2 project.

In the menu bar, click [Project] → [Close] to close the currently open project. The following message is displayed when closing. Click the [Yes] button.



(4) Saving a project

Edit the currently open MR Configurator2 project and save it.

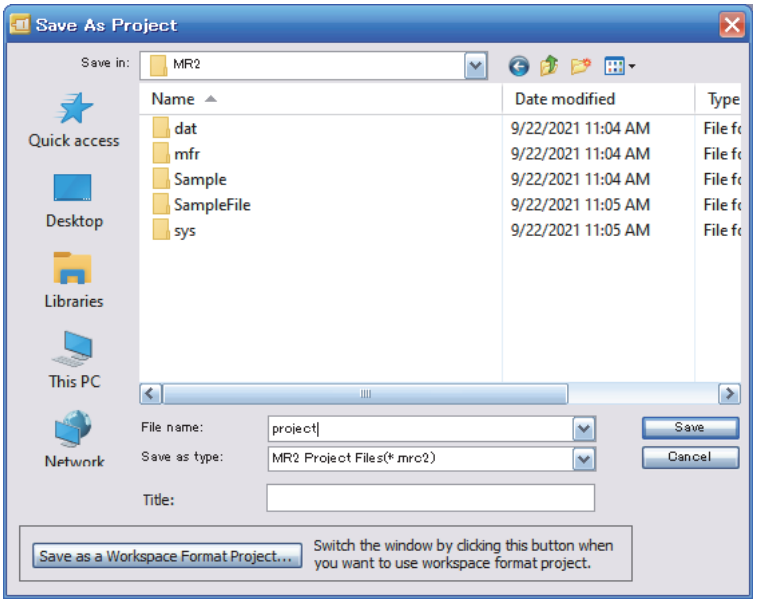
In the menu bar, click [Project] → [Save] to save the project.

POINT
● When saving a new project that has never been saved before, the Save As dialog box is displayed. Refer to "(5) Saving project as" in section 2.4.2.

(5) Saving project as

Save the currently open MR Configurator2 project.

In the menu bar, click [Project] → [Save As]. The following dialog box is displayed.



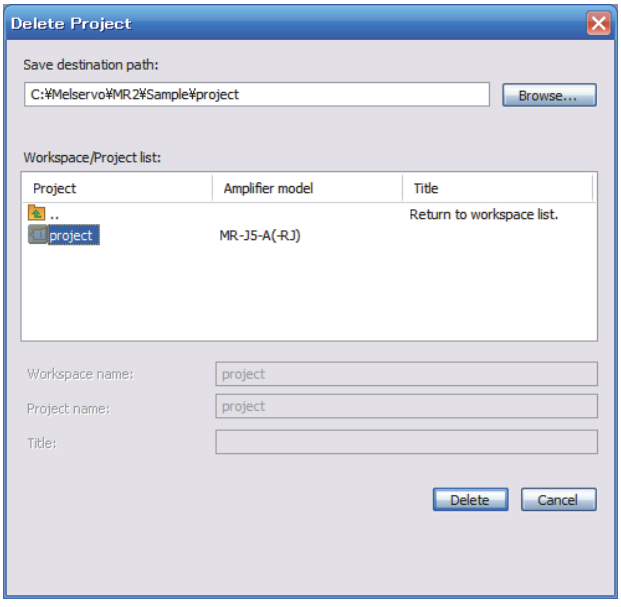
Input the save destination path, the workspace name, and the project name, and click the [Save] button.

Precautions
● To save the MR Configurator2 project in the existing workspace format, click the [Save as a Single File Format Project] button.

(6) Deleting a project

Delete an existing MR Configurator2 project.

In the menu bar, click [Project] → [Delete]. The following dialog box is displayed.

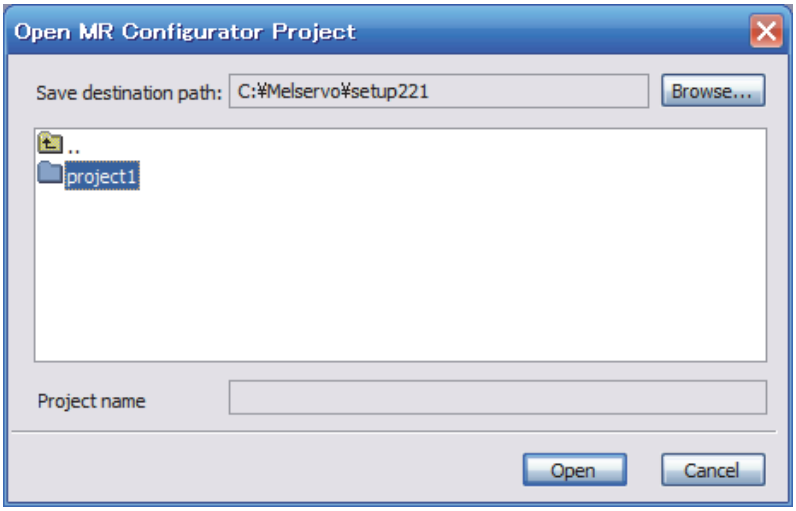


Select the project to be deleted and click the [Delete] button.

(7) Opening an MR Configurator format project

Open an existing MR Configurator project.

In the menu bar, click [Project] → [Read Other Format] → [Open MR Configurator Project]. The following dialog box is displayed.

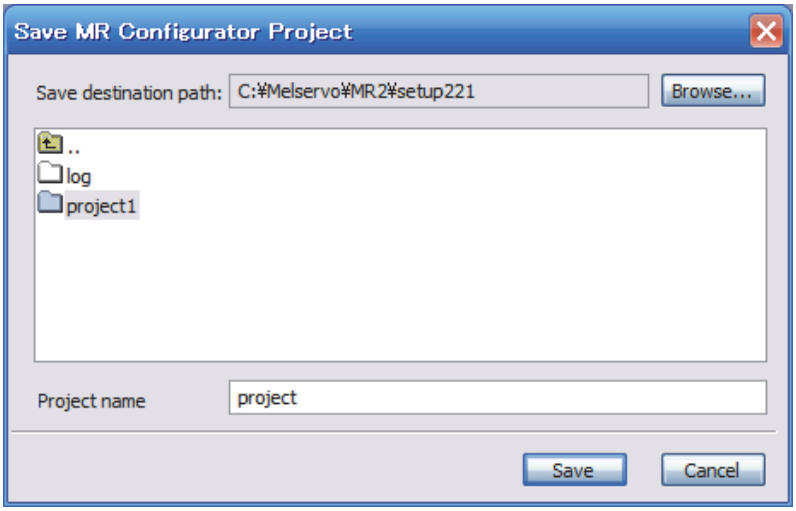


Select the project to be opened and click the [Open] button.

(8) Saving a project in the MR Configurator format

Save a project in the MR Configurator format.

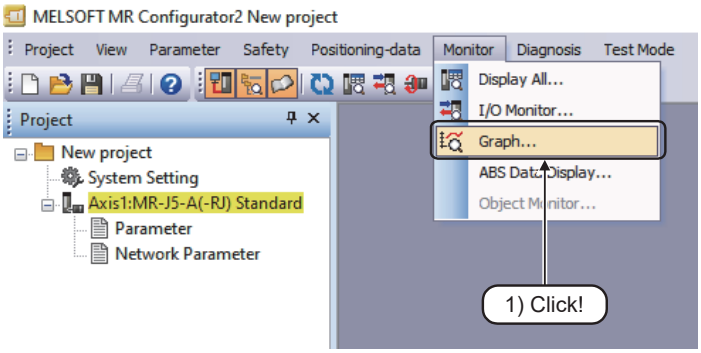
In the menu bar, click [Project] → [Write Other Format] → [Save MR Configurator Project]. The following dialog box is displayed.



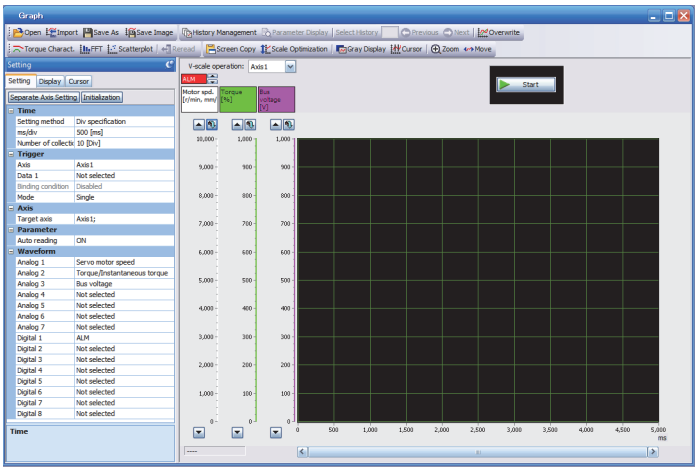
Select the save destination, input the project name, and click the [Save] button.

2.4.3 Graph display

Display the selected monitor graph data in a graph.

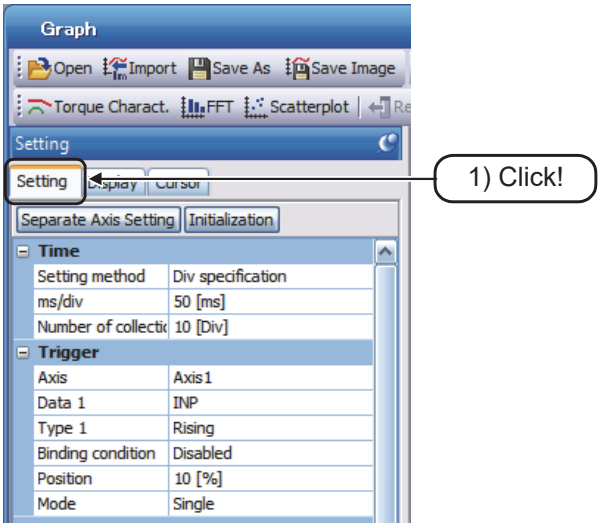


1) In the menu bar, click [Monitor] → [Graph].



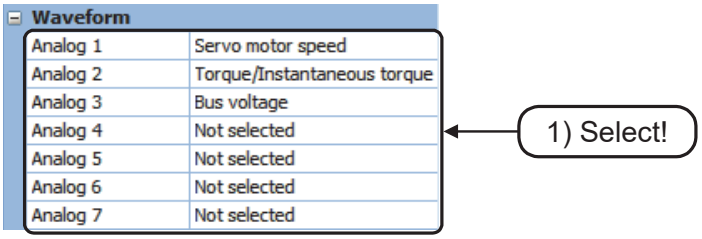
2) The graph display screen is displayed.

(1) Waveform setting



1) Click the [Setting] tab on the graph screen.

(a) Analog CH settings



1) Select the analog CH (1 to 7) data from the drop down list in the "Waveform" field.

* Be sure to select analog CH 1 and CH2.

(List)

Servo motor speed	Settling time	Command pulse frequency+
Torque/Instantaneous torque	Overshoot amount	Command pulse frequency (speed unit)+
Current command	Servo motor speed (0.1r/min unit)	Droop pulse (1 pulse unit)+
Command pulse frequency	Command pulse frequency	Speed command+
Command pulse frequency	(0.1r/min speed unit)	Position within one-revolution+
(unit of speed)	Speed command (0.1r/min unit)	Load-side encoder information 1+
Droop pulse (1 pulse unit)	Torque command	Load-side encoder information 2+
Speed command	Speed limit value	Load-side encoder droop pulse (1 pulse
Bus voltage	Speed limit value (0.1r/min unit)	unit)+
Effective load ratio	Internal temperature of encoder	Position F/B+
Regenerative load ratio	Temperature of servo motor	Excessive error alarm margin (1 pulse unit)+
ABS counter	thermistor	Droop pulse (100 pulse unit)+
Load to motor inertia ratio	Load-side encoder information 1	Excessive error alarm margin (100 pulse
Disturbance torque	Load-side encoder information 2	unit)+
Overload alarm margin	Operation mode	Droop pulse (model position deviation)+
	Servo motor speed+	

(Remark)
By deselecting analog CH3, the measurement time of analog CH1 and CH2 within the same sampling time can be extended to about 1.5 times.

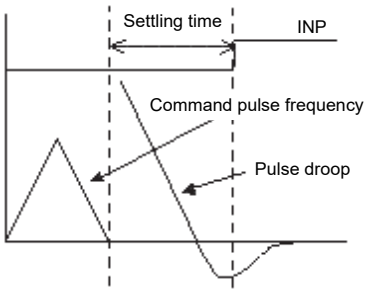
POINT

● When obtaining a graph waveform using the "Test function" from the setup software "MR Configurator2 (SW1DNC-MRC2-E)" (Reference example)

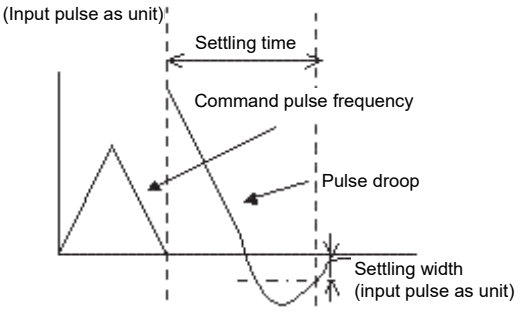
1. With the "JOG operation" function	2. With the "Positioning operation" function
[Measurement selection item]	[Measurement selection item]
CH1: Servo motor speed	CH1: Command pulse frequency
CH2: Torque/Instantaneous torque	CH2: Droop pulse (1 pulse unit)+
CH3: Not set	CH3: Torque/Instantaneous torque

1) When analog settling time is selected:
The settling time settings become effective, and the following settings are configured.

• Time from command termination until INP turns on

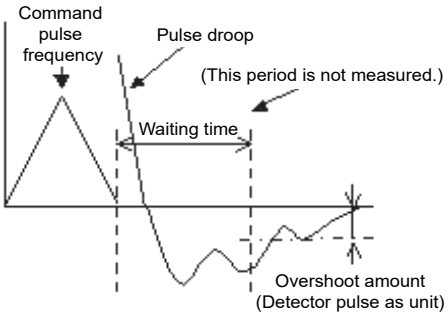


• Time from command termination until droop pulse falls within the settling width
(The settling width is set using the input pulse as the unit.)

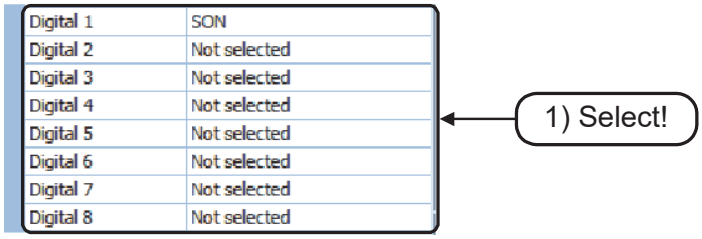


2) When analog overshoot amount is selected:
The overshoot amount (detector pulse unit) settings become effective and the following settings are configured.

• Maximum value of droop pulse [pulse] measured after waiting time has elapsed following command termination (waiting time specified in ms)



(b) Digital CH setting



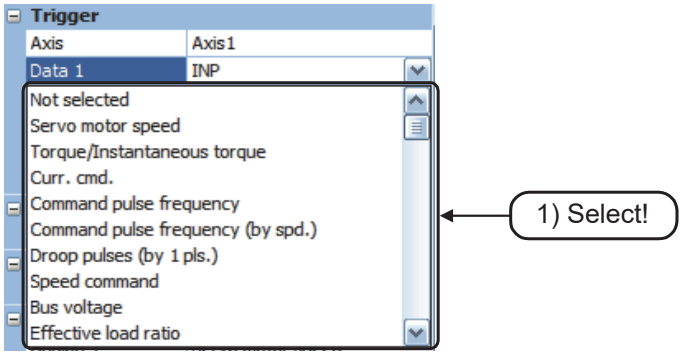
1) Select the digital CH (1 to 8) data from the drop down list in the "Waveform" field.

(List)

SON: Servo-on	EM2/1: Forced stop 2/1	DB: Dynamic brake interlock
LSP: Forward rotation stroke end	STAB2: Second acceleration/deceleration selection	BWNG: Battery warning
LSN: Reverse rotation stroke end		ALM2: (For manufacturer setting)
TL: External torque limit selection		STO: In STO state
TL1: Internal torque limit selection	STO1: STO1	SMPD: Magnetic pole detection completion
PC: Proportional control	STO2: STO2	
RES: Reset	CDP: Gain switching	CDPS2: Variable gain enabled 2
CR: Clear	CDP2: Gain switching 2	CDPS: Variable gain enabled
SP1: Speed selection 1	ABSM: ABS transfer mode	ABSV: Absolute position erased
SP2: Speed selection 2	ABSR: ABS request	IPF: Momentary power failure
SP3: Speed selection 3	RD: Ready	SPC: Proportional control in progress
ST1: Forward rotation start	SA: Speed reached	
ST2: Reverse rotation start	ZSP: Zero speed detection	MTTR: Tough drive in progress
RS1: Forward rotation selection	TLC: Limiting torque	ABSB0: ABS transmission data bit 0
RS2: Reverse rotation selection	VLC: Limiting speed	ABSB1: ABS transmission data bit 1
CM1: Electronic gear selection 1	INP: In-position	ABST: ABS transmission data ready
CM2: Electronic gear selection 2	WNG: Warning	WNGSP: Motor stop warning
LOP: Control switching	ALM: Malfunction	ALMWG: Malfunction/Warning
	OP: Z-phase output	BW9F: AL9F warning
	MBR: Electromagnetic brake interlock	

(2) Trigger settings

(a) Selection of triggered data

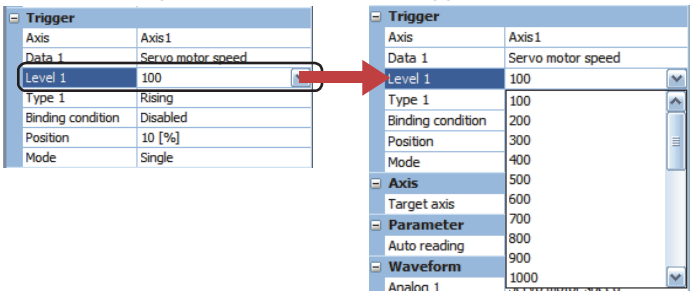


1) Click "Data 1" in the "Trigger" field, and select the data to be specified as trigger from the drop down list.

The selection can be made from analog items and digital items.

(b) Trigger level setting

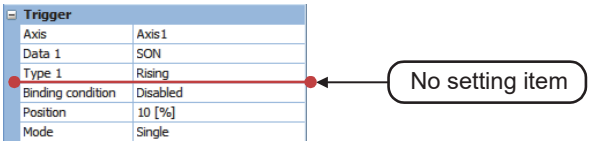
When an analog item is selected in the trigger data column



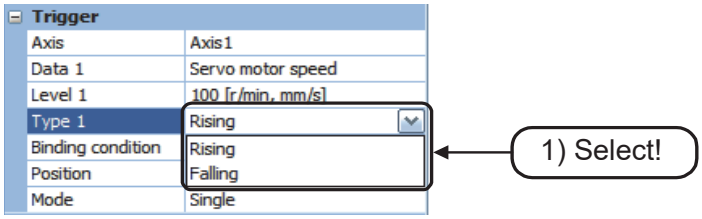
2) Click "Level" in the "Trigger" field to display the drop down list.

If an analog item is selected in "Level 1" is set with the units and numerical values set in "Data 1".

When a digital item is selected in the trigger data column



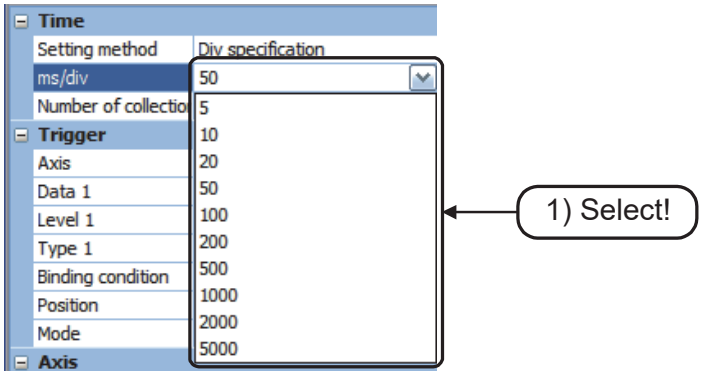
(c) Condition setting



1) Click "Type 1" in the "Trigger" field, and select "Rising" or "Falling" from the drop down list.

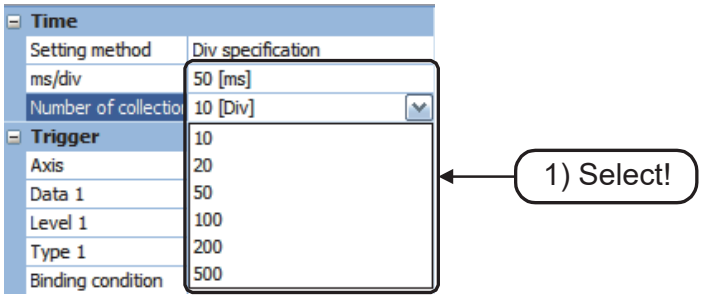
(3) Time setting

(a) Individual Div time setting



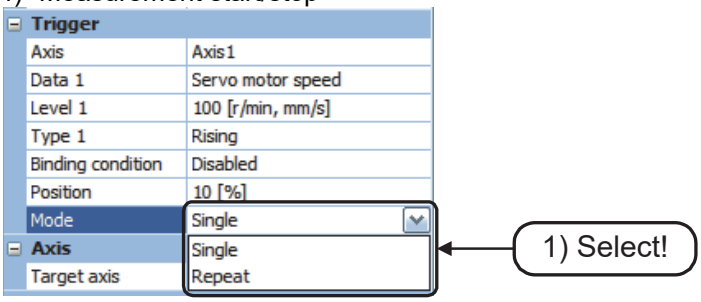
1) Click "ms/div" in the "Time" field and select the time axis scale from the drop down list.

(b) Collective Div setting



1) Click "Number of collection DV" in the "Time" field and select the number of Div to be measured from the drop down list.

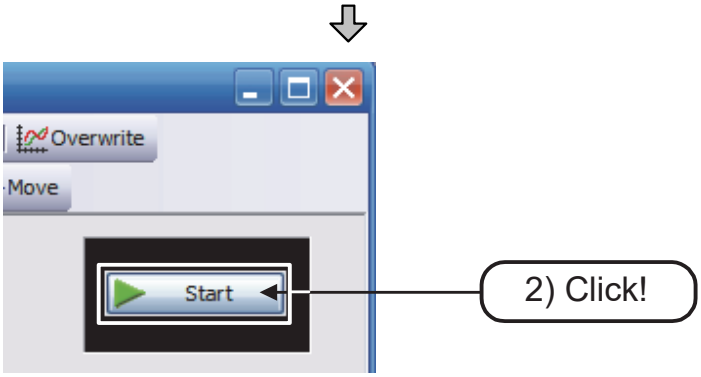
(4) Measurement start/stop



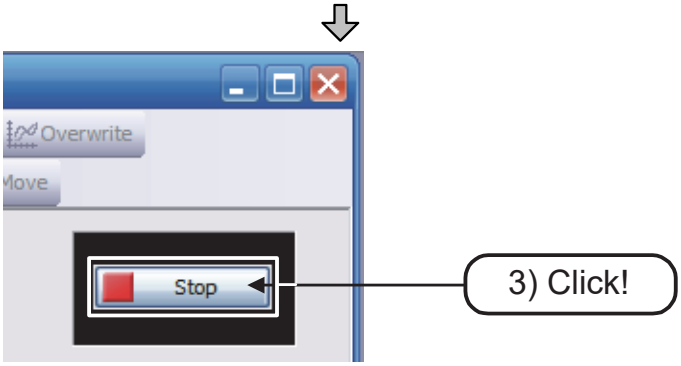
1) Click "Mode" in the "Trigger" field and select "Single" or "Repeat" from the drop down list.

Single: Reads the measurement data when the trigger conditions are first satisfied, and stops the measurement.

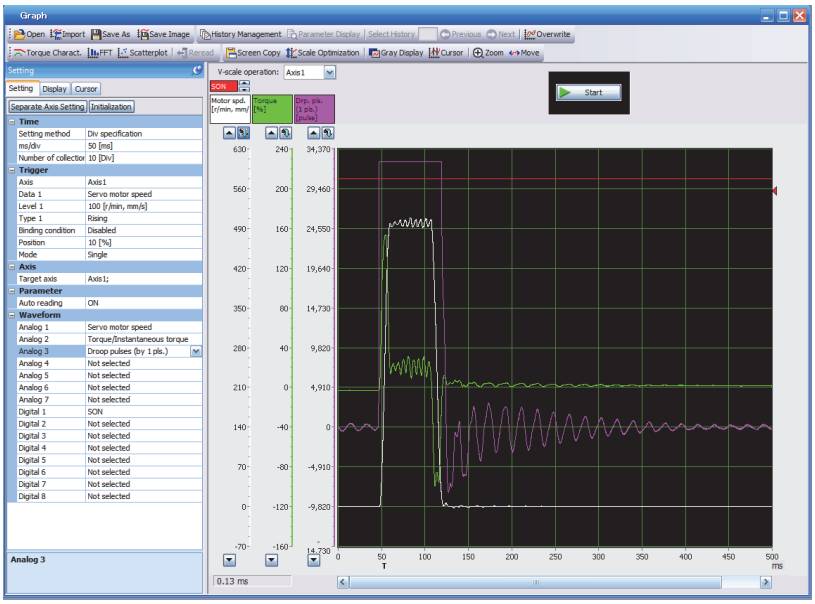
Repeat: Continuously monitors the amplifier and acquires the measurement data whenever the trigger conditions are satisfied.



2) When the Start button is clicked, waveform measurement is started in the currently selected trigger mode.

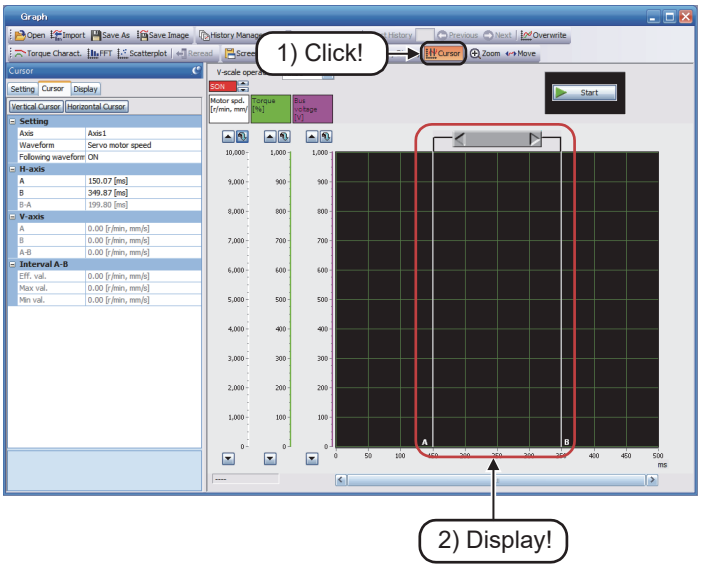


3) To stop measurement, click the Stop button.


Graph
Open
Import
Save As
Save Image
History Management
Parameter Display
Select History
Previous
Next
Overwrite
Torque Charact.
FFT
Scatterplot
Reread
Screen Copy
Scale Optimization
Gray Display
Cursor
Zoom
Move
Setting
Setting
Display
Cursor
Separate Axis Setting
Initialization
Time
Setting method
Div specification
ms/div
50 [ms]
Number of collection
10 [Div]
Trigger
Axis
Axis1
Data 1
Servo motor speed
Level 1
100 [r/min, mm/s]
Type 1
Rising
Binding condition
Disabled
Position
10 [%]
Mode
Single
Axis
Target axis
Axis1;
Parameter
Auto reading
ON
Waveform
Analog 1
Servo motor speed
Analog 2
Torque/Instantaneous torque
Analog 3
Droop pulses (by 1 pls.)
Analog 4
Not selected
Analog 5
Not selected
Analog 6
Not selected
Analog 7
Not selected
Digital 1
SON
Digital 2
Not selected
Digital 3
Not selected
Digital 4
Not selected
Digital 5
Not selected
Digital 6
Not selected
Digital 7
Not selected
Digital 8
Not selected
Analog 3
V-scale operation:
Axis1
SON
Start
0.13 ms
T
ms

(5) Measurement status setting

(a) Cursor

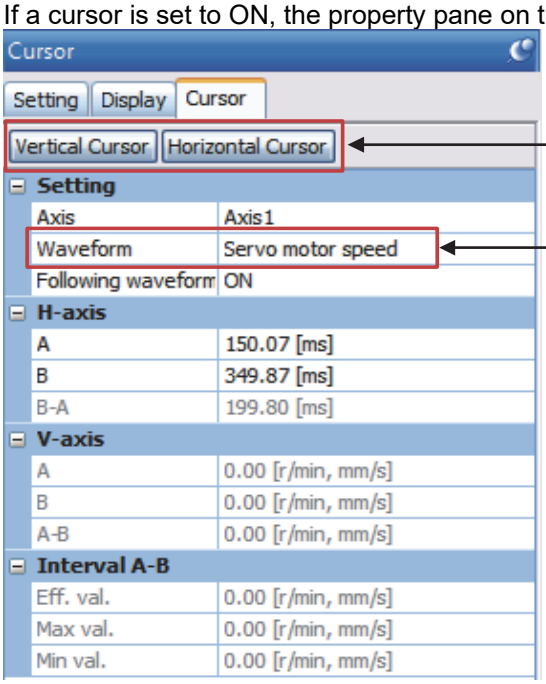


1) Click the Cursor button.

2) The cursor is displayed in the graph display area.

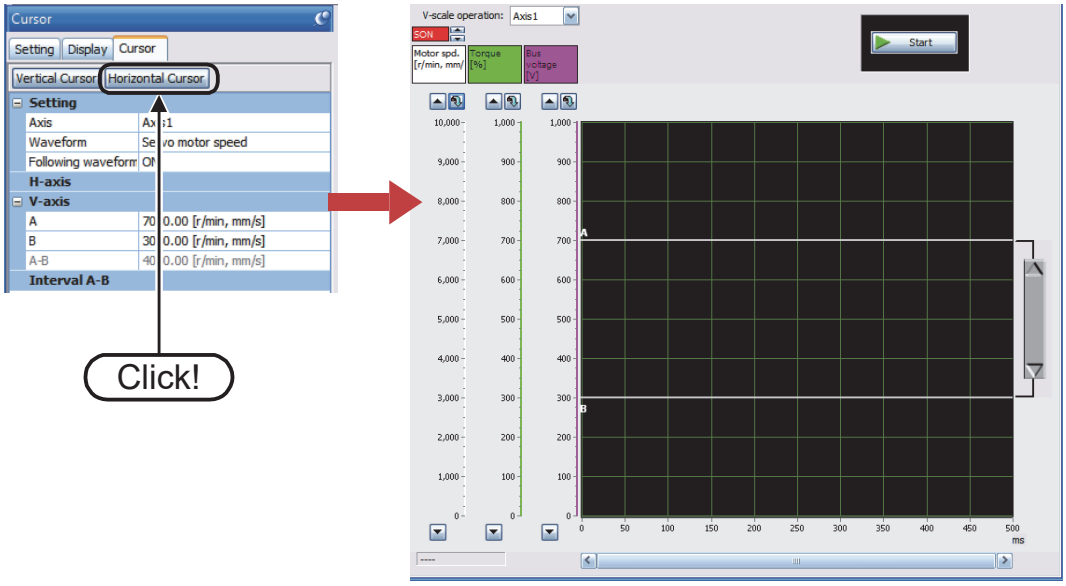
Each cursor can be moved by dragging with the mouse.
When the cursor is dragged, A and B move simultaneously.
If either A or B is dragged, only one will move.

If a cursor is set to ON, the property pane on the left of the screen changes as follows.



Select the cursor type (vertical axis or horizontal axis) and the data type to be measured.

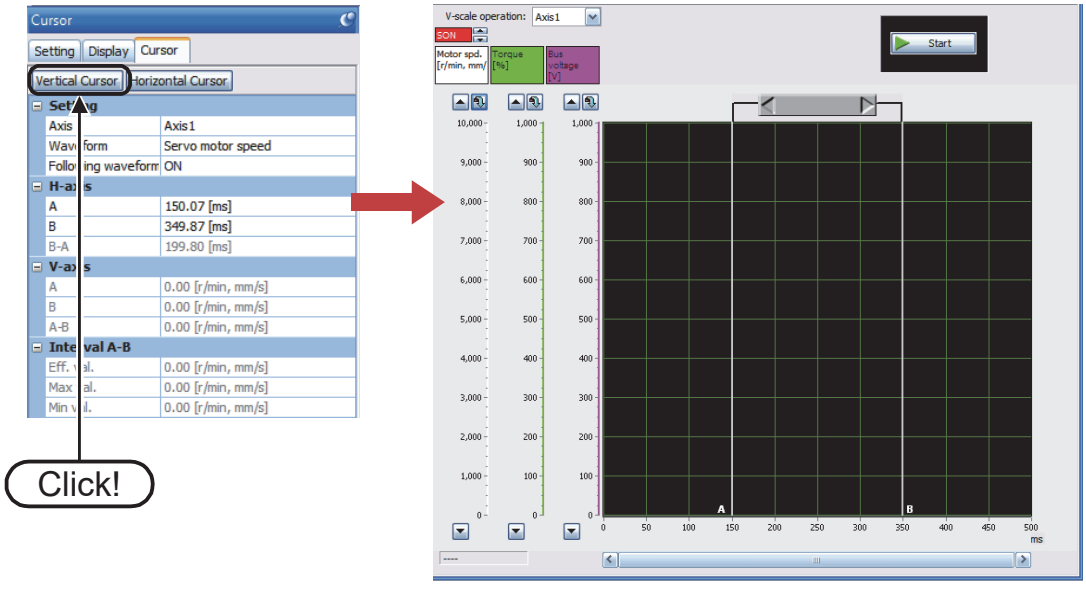
• With a horizontal axis cursor



If a horizontal axis cursor is selected, the following applies:

- Input and indicate the positions (ms) of cursors A and B.
- The cursor in the graph display area moves according to the input values.
- The value also changes in conjunction with the movement of the cursor.
- The time difference is indicated from the input values of cursors A and B.

• With a vertical axis cursor



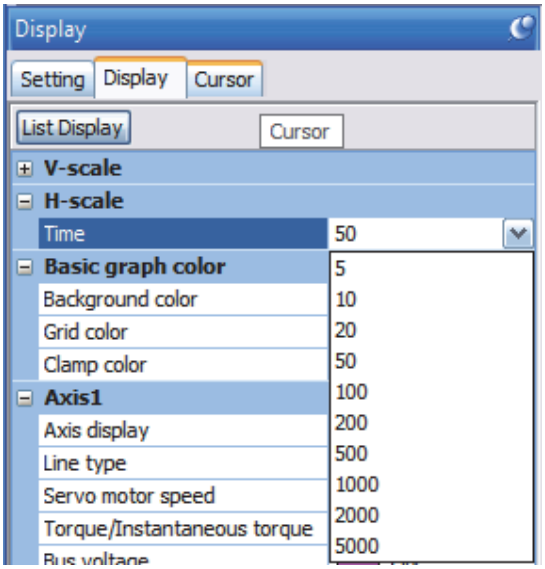
If a vertical axis cursor is selected, the following applies:

- The data type values for cursors A and B are displayed.
- The value difference is indicated from the values of cursors A and B.

• Any numerical values can be input as the cursor values of A and B, and the A-B display and effective values are calculated according to the input values.
• If a value exceeding the waveform display limit is specified, the cursor is displayed outside the waveform and that section is treated as the waveform value on the right edge of the screen.

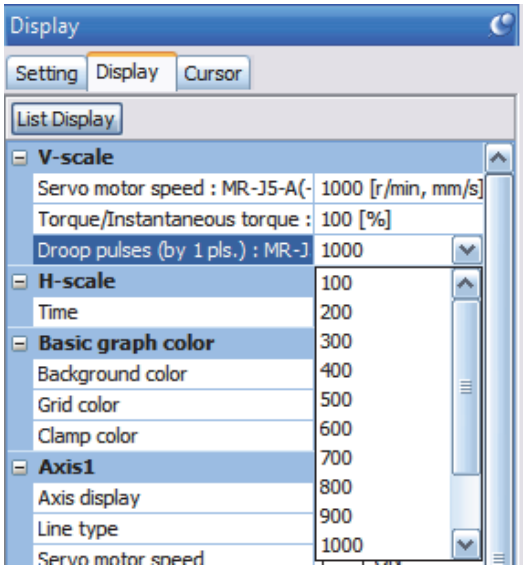
POINT
● Vertical scale optimization When Scale Optimization is clicked, the vertical axis scale and 0-point position of each waveform are automatically adjusted so that all of the waveforms of the selected history fit within the screen.

(b) Horizontal axis scale setting of the displayed waveform



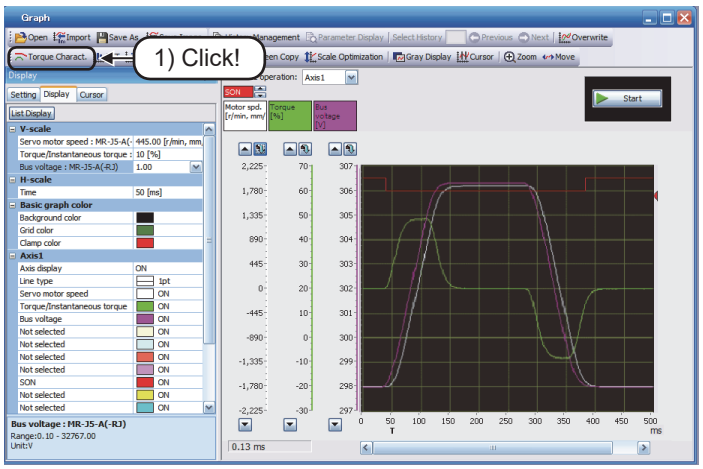
1) Select the "H-scale" field of the display tab, and select the horizontal axis division unit from the drop down list or input a value in the input field.

(c) Vertical axis scale setting of the displayed waveform

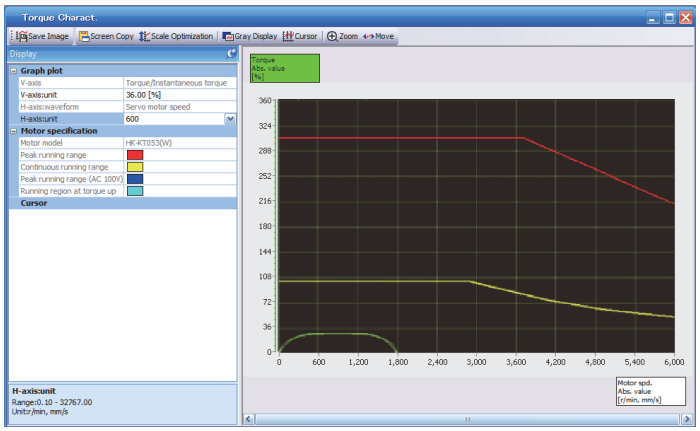


1) Select the "V-scale" field of the display tab, and select the vertical axis division unit from the drop down list or input a value in the input field.

(d) Torque characteristics diagram

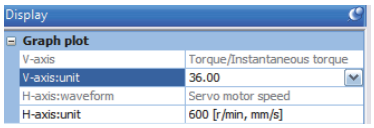


1) Click the Torque Charact. button.



2) The torque characteristics diagram screen is displayed.
The short-duration running range (red) and continuous running range (yellow) of the torque characteristic are displayed simultaneously.
For machines that generate unbalanced torque, such as elevating shafts, it is recommended to use the machine with the unbalanced torque being 70% or less of the rated torque.

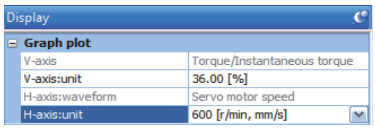
1) Changing torque absolute values



Select "V-axis:unit" from the "Graph plot" field in the property pane, and select the vertical axis division unit from the drop down list or input a value in the input field.

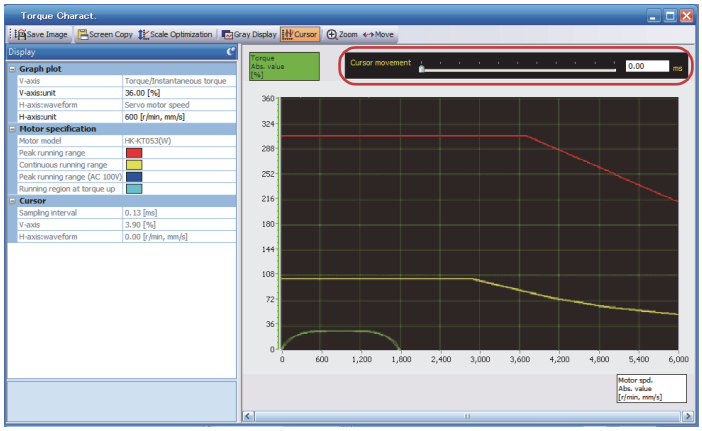
When the Scale Optimization button is clicked, the waveform is automatically converted to a scale value that efficiently fits the waveform.

2) Changing motor speed absolute values



Select "H-axis:unit" from the "Graph plot" field in the property pane, and select the horizontal axis division unit from the drop down list or input a value in the input field.

3) Horizontal scrolling of the displayed waveform



Click the Cursor button to display a cursor travel bar at the top of the torque characteristics diagram screen.

Input the cursor position (ms) using text input or using the slider bar.
The cursor in the graph display area moves according to the input values.

4) Screen copy

Click the Screen Copy button to copy the graph screen to the clipboard.
It can be pasted in other applications. The graph screen can be easily pasted for creating documents.

5) Grayout

Click the Gray Display button to change the graph display to black lines on a white background.
When a screen with a normal black background colored graph is copied to a document and the document is printed, the print may not be clear (the wave data is not clearly visible). Use the grayout function in such cases.

(e) Useful graph functions

This section describes the useful functions of the wave data graph display.

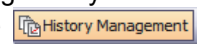
1) Selecting history

Graph data collected since the setup software was started can be displayed for 20 samplings, including the latest sampling.

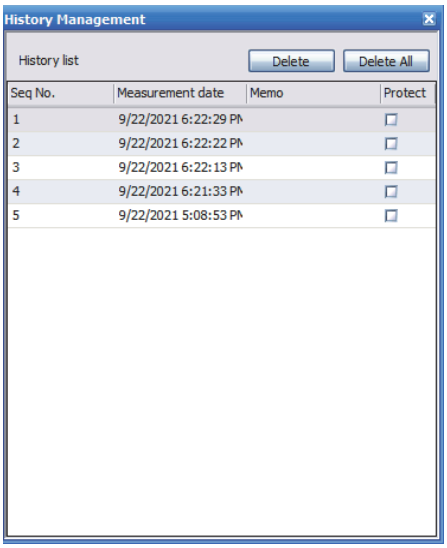
The display can be changed to show the current data or one of the past 19 samplings by specifying a number or by clicking the [Previous] or [Next] button.
Current (1) Past (2 to 20)

If the collection conditions are changed, the history is cleared.

2) Managing history

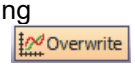
Click the 

button to display the history management screen of the collected graph.

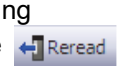


The display can be changed by selecting the row of the history number to be displayed.

3) Overwriting

Click the 

button to enable overwriting. In this case, only the currently selected history is displayed in color, and the waveform of other histories is grayed out.
Using the graph history selection function, the past waveforms can be changed to a specific color.
Changes such as by tuning can be confirmed on the same graph screen.

4) Re-reading
Click the 

button to read the previous graph conditions and data in the servo amplifier. (Single trigger mode only)
It is possible to read the data by starting the graph, disconnecting the personal computer from the servo amplifier, and then connecting it again after the trigger.

5) Saving as CSV file
Graph data can be saved as a CSV file instead of the usual graph format. The graph data can be read by applications that support the CSV format.
CSV files cannot be read by the setup software.

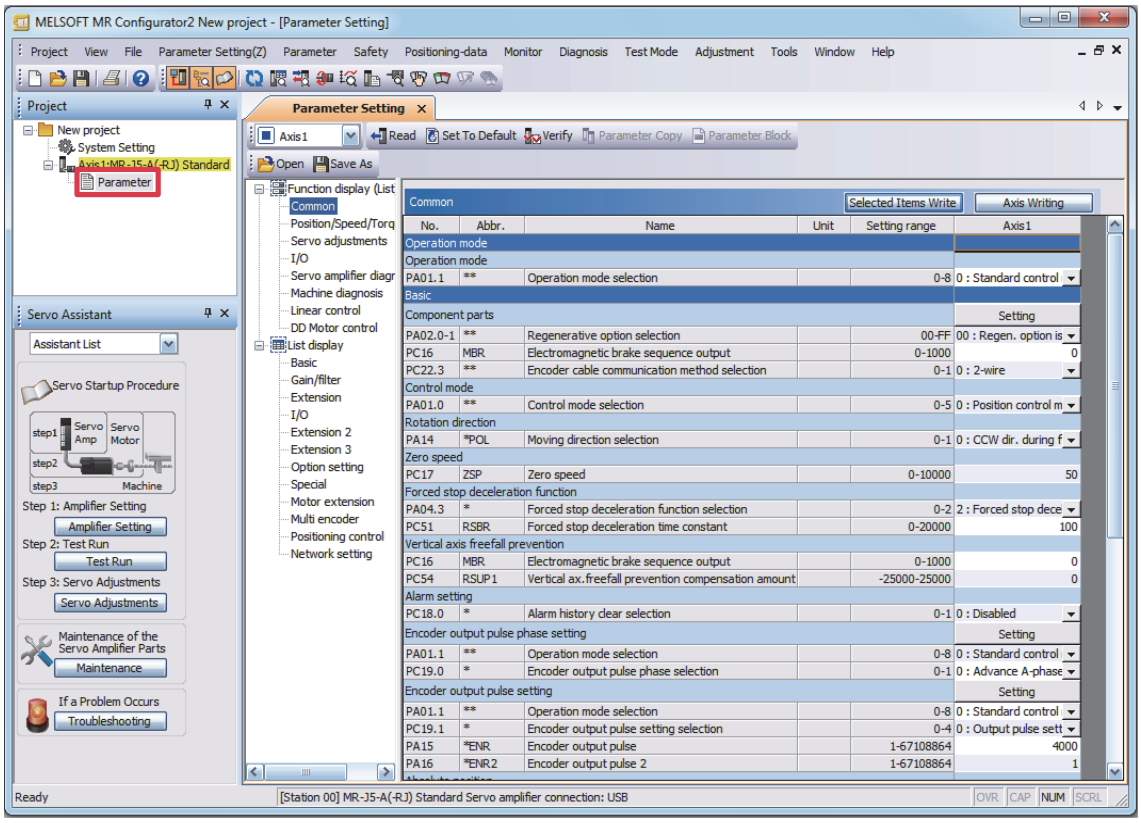
6) Saving as image
Select [File] → [Save Image In File] to save the collected and set screen image as an emf or JPEG file.

2.4.4 Other functions

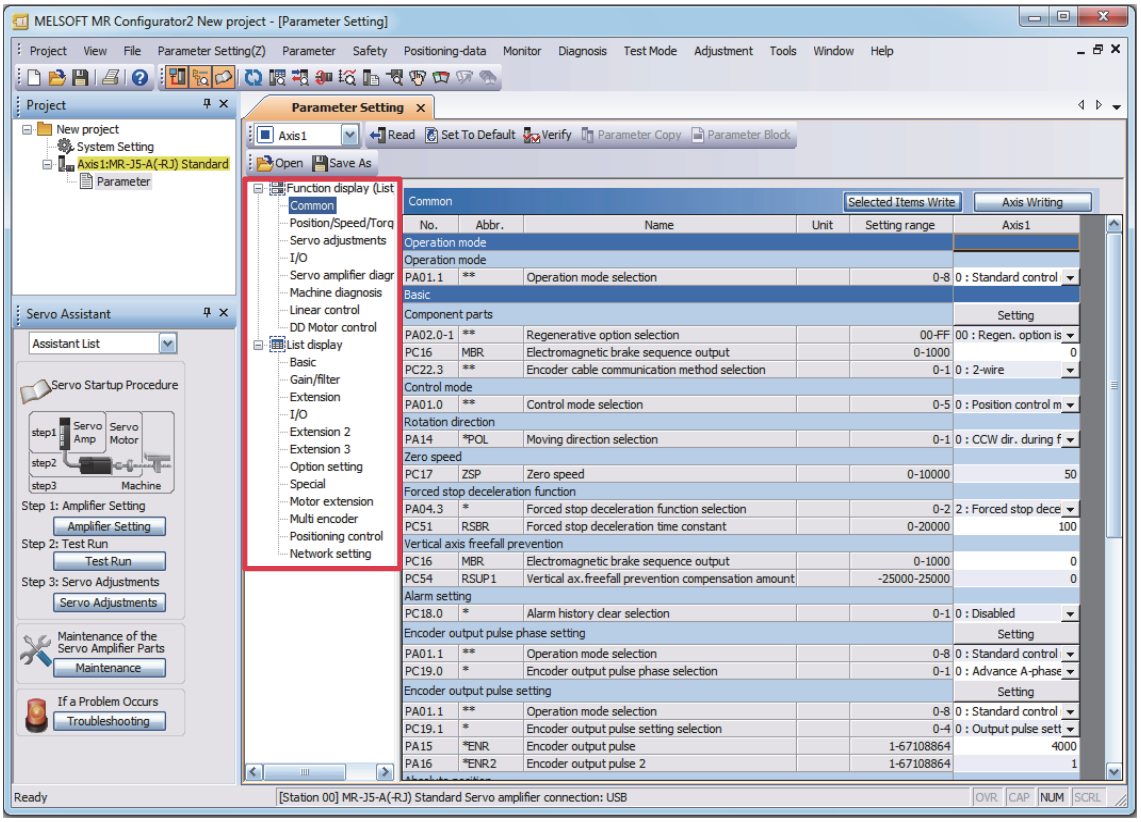
(1) Parameter settings

Parameters can be checked and set easily by connecting the servo amplifier to a computer on which MR Configurator2 (setup software) is already installed.
The method for checking and configuring the settings is shown below.

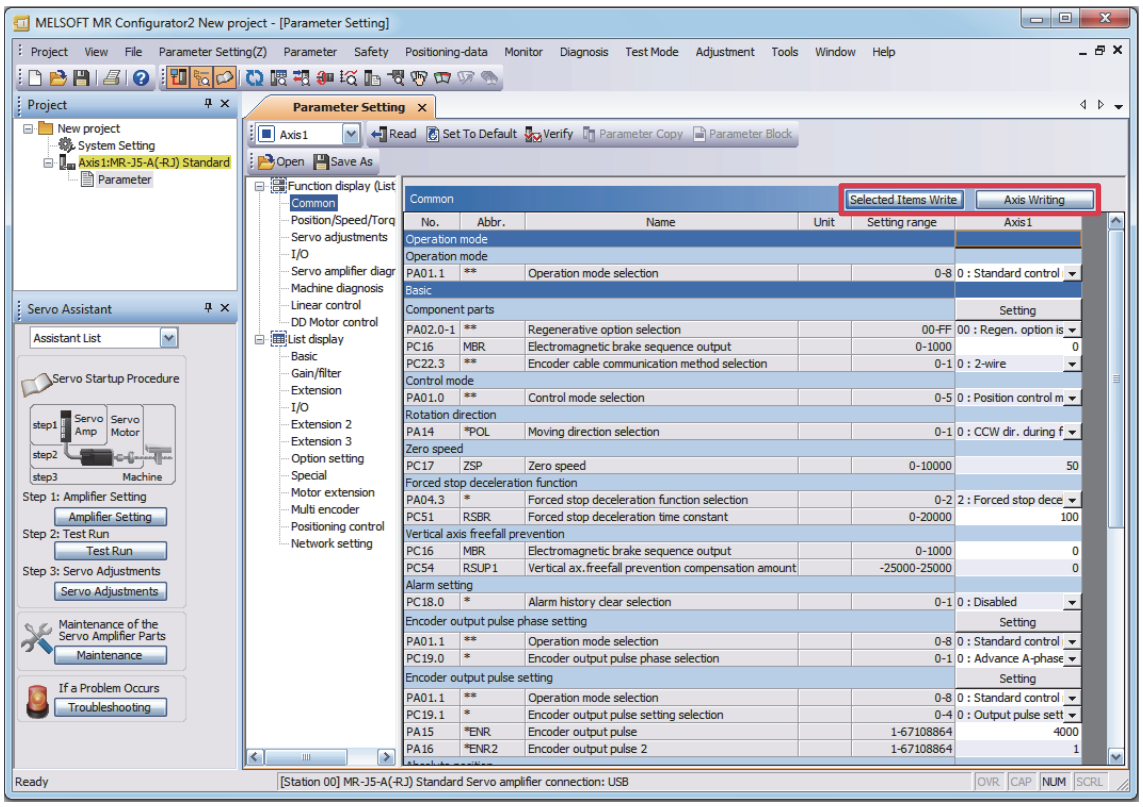
1. Select "Parameter" from the project tree to open the parameter setting screen.



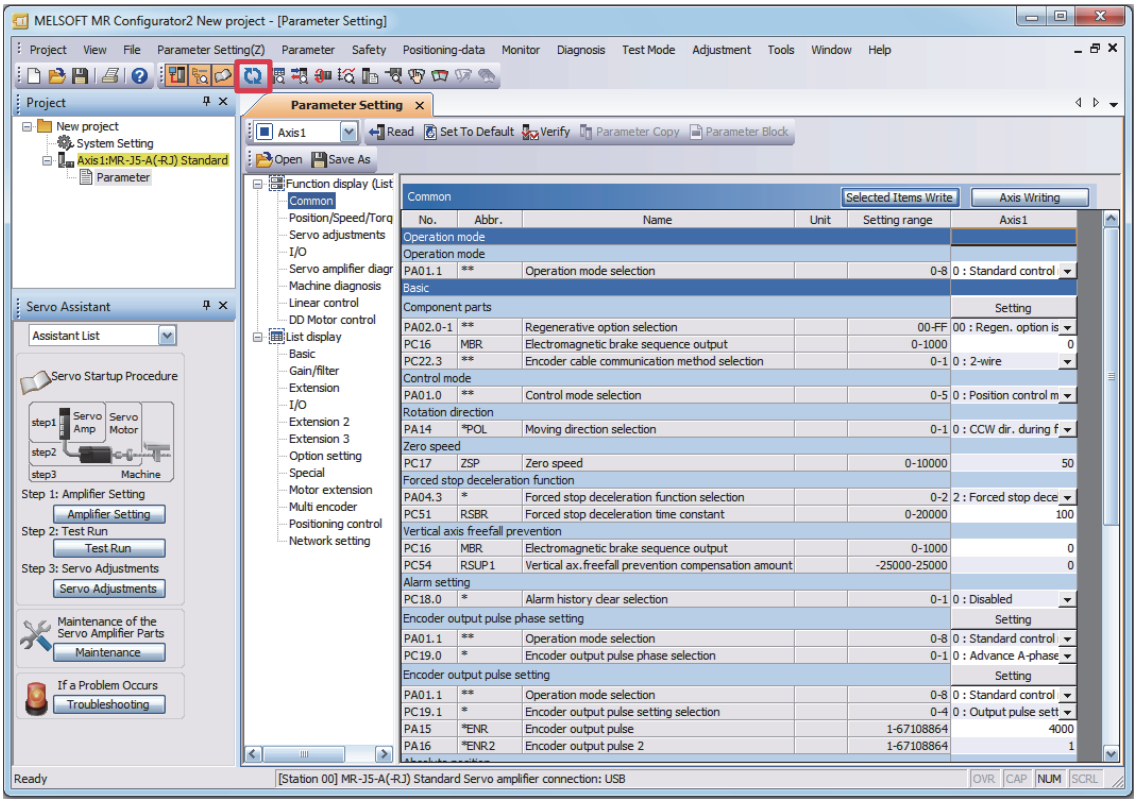
2. Select a group of servo parameters in the selection tree of the parameter setting screen to display and configure the settings.



3. After changing the servo parameter, click "Selected Items Write" or "Axis Writing".



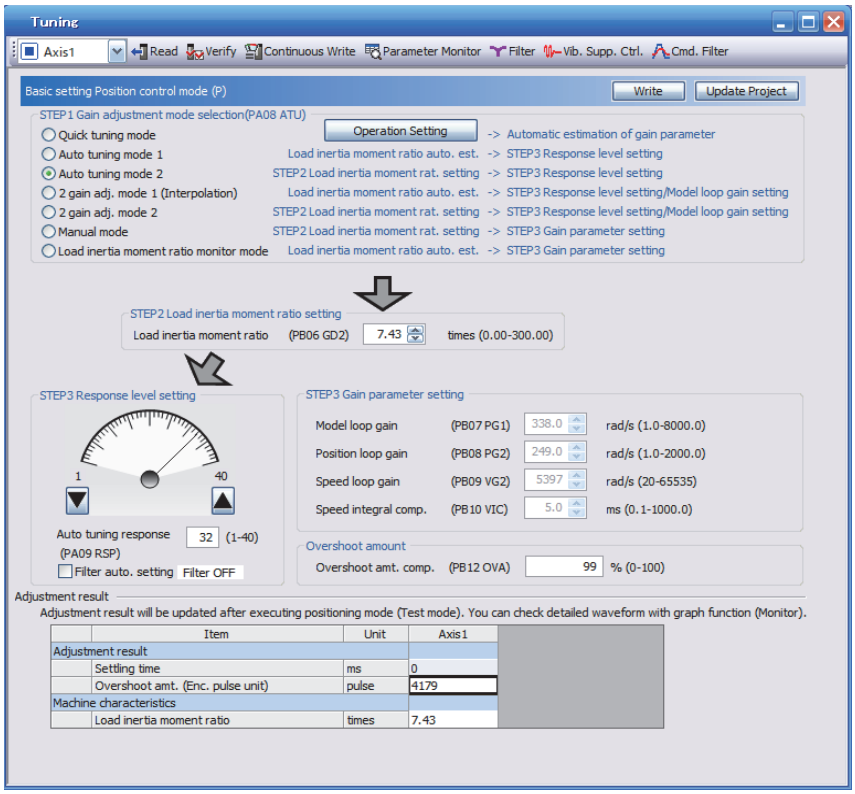
4. Abbreviated servo parameters prefixed with * and servo parameters marked with ** are enabled after the power is cycled or a software reset is performed. Click "Software Reset" for MR Configurator2 to perform the software reset.



(2) Tuning

Display method: In the menu bar, click [Adjustment] → [Tuning].

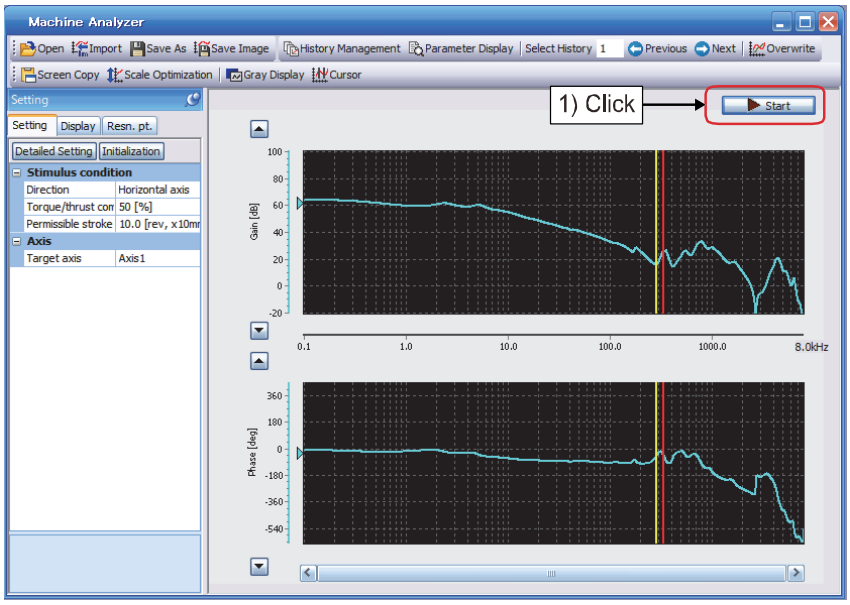
Function: In the tuning dialog box, adjust the gain parameter while viewing the graph to configure the settings so that the desired motion is achieved.



(3) Machine analyzer

Display method: In the menu bar, click [Adjustment] → [Machine Analyzer].

The mechanical frequency characteristics are generally expressed by the diagram indicating the relationship between the frequencies of the gain and phase (bode plot).
The gain indicates the amount of the response of the mechanical system to the torque input. The phase indicates the phase delay of the speed response of the mechanical system to the torque input.
If the mechanical system is rigid and does not have a resonance point, the gain will be linear.
In general, a mechanical system has a resonance point of some kind, and thus the machine analyzer can measure the frequency and amount of the resonance.
The figure below shows a monitoring example of when a mechanical system has a resonance point at 323Hz.
The gain rises and the response of the machine to the input torque increases at the resonance point, thus the machine becomes more likely to vibrate by the resonance frequency as the speed gain rises.



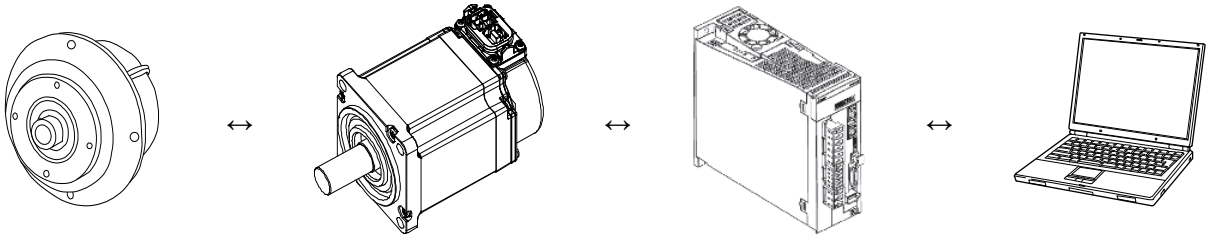
Operation procedure

1) Set Machine Analyzer.
↓ Keep the default settings as is.
2) Execute Machine Analyzer.
↓ Click Start button
3) Monitor wave data.
↓ Check the resonance point and antiresonance point.
4) Set a filter.
↓ Not required if there is no resonance
5) Save the file.
↓ Click the Save As menu.
6) End

* Details can be checked using Help.

Yellow line: Antiresonance point; Red line: Resonance point

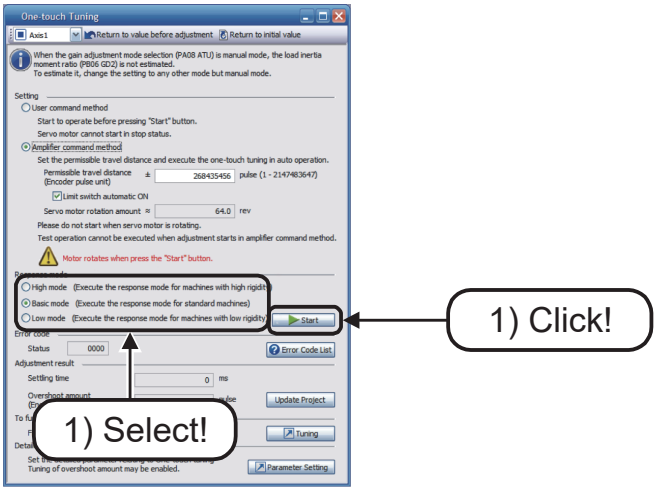
If the resonance frequency of the mechanical system can be measured, the frequencies for machine resonance suppression filter (Pr.PB13 and Pr.PB15) can be determined based on the measured result, suppressing the machine vibration when the gain rises.



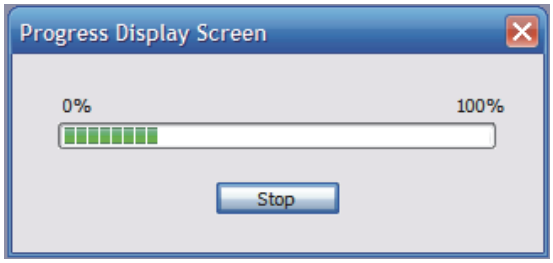
(4) One-touch tuning

Display method: In the menu bar, click [Adjustment] → [One-touch Tuning].

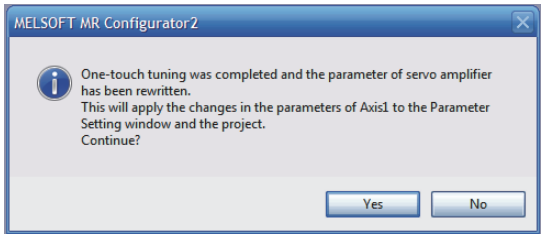
The gain parameter is adjusted automatically.
The automatically adjusted parameters are automatically written to the servo amplifier after one-touch tuning is completed.



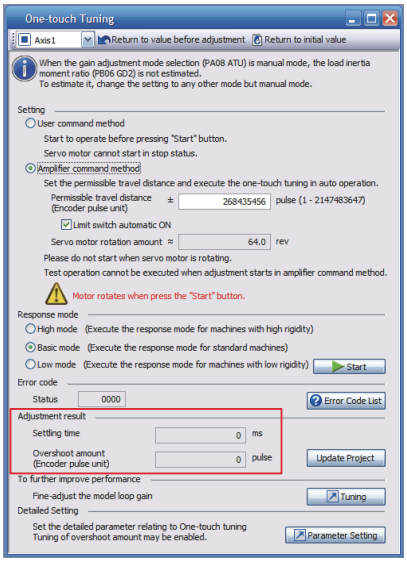
1) Select the response mode on the [One-touch Tuning] screen and click the Start button.
For one-touch tuning in the user command method, clicking "Start" during a servo motor stop causes "C_02" or "C_04" to appear in the error code status.



2) During one-touch tuning, the progress status is displayed in the progress window as shown on the left. One-touch tuning completes when the progress reaches 100%.



3) Completing one-touch tuning starts the writing of servo parameters to the servo amplifier. In addition, the dialog shown on the left is displayed upon one-touch tuning completion. Select whether or not to reflect the tuning result in the project.



4) After one-touch tuning is completed, "0000" is displayed in the error code status. The settling time and overshoot amount are displayed in "Adjustment result" as shown on the left.
* Details can be checked using Help.

(5) Test operation (positioning operation)

Display method: In the menu bar, click [Test Mode] → [Positioning Mode].

POINT
●MR Configurator2 is required to perform the positioning operation. ●When performing positioning operation, set EM2 to ON.

Each positioning operation can be performed without commands from an external command module.

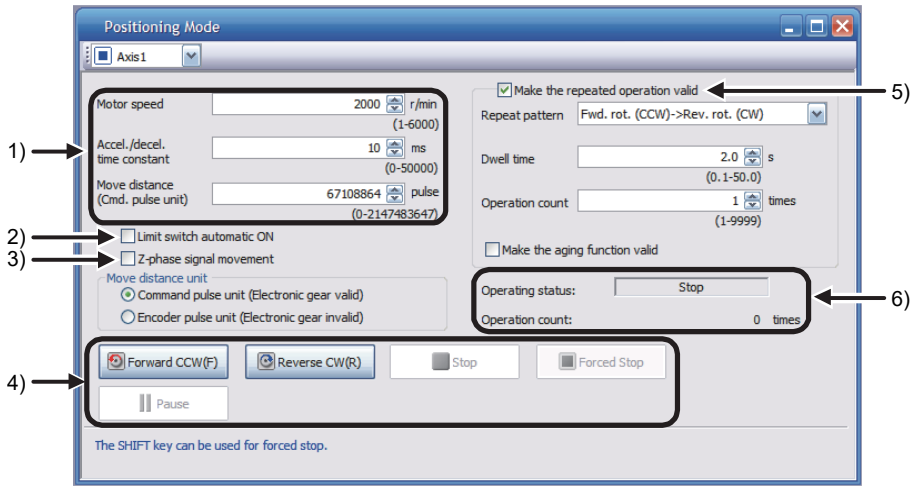
(a) Operation

Clicking the "Forward CCW" or "Reverse CW" button on MR Configurator2 rotates the servo motor, then the motor stops after traveling the set travel distance. The operation conditions can be changed on MR Configurator2. The following table shows the initial conditions and setting ranges of the operation.

Item	Initial setting value	Setting range
Motor speed [r/min]	2000	1 to 6000
Acceleration/deceleration time constants [ms]	10	0 to 50000
Travel distance [pulse]	67108864	0 to 2147483647

(b) Positioning operation screen

Positioning operation can be performed when there is no command from the controller. Operate the motor using the positioning operation screen of MR Configurator2.



1) Motor operation setting

Set the motor speed, acceleration/deceleration time constants, and travel distance for the positioning operation. When changing the speed to the permissible speed, set the speed in [Pr.PA28.4 Speed range limit selection].

2) Limit switch

Select "Limit switch automatic ON" to perform the positioning operation when the limit switch is not connected. Be sure to avoid causing a collision while performing the operation.

3) Z-phase signal movement

When "Z-phase signal movement" is selected, the servo motor moves until the first Z-phase signal is received after positioning operation.

4) Operation

The servo motor can be started (CCW/CW), paused, stopped, or forcibly stopped. Clicking "Operation Start" starts the operation in the specified operation condition.

5) Repeated operation

Selecting "Make the repeated operation valid" enables the repeated operation. Selecting "Make the aging function valid" enables the continuous operation until "Stop" or "Forced Stop" is clicked. Set the repeat pattern, the dwell time, and the number of operations.

6) Operation status

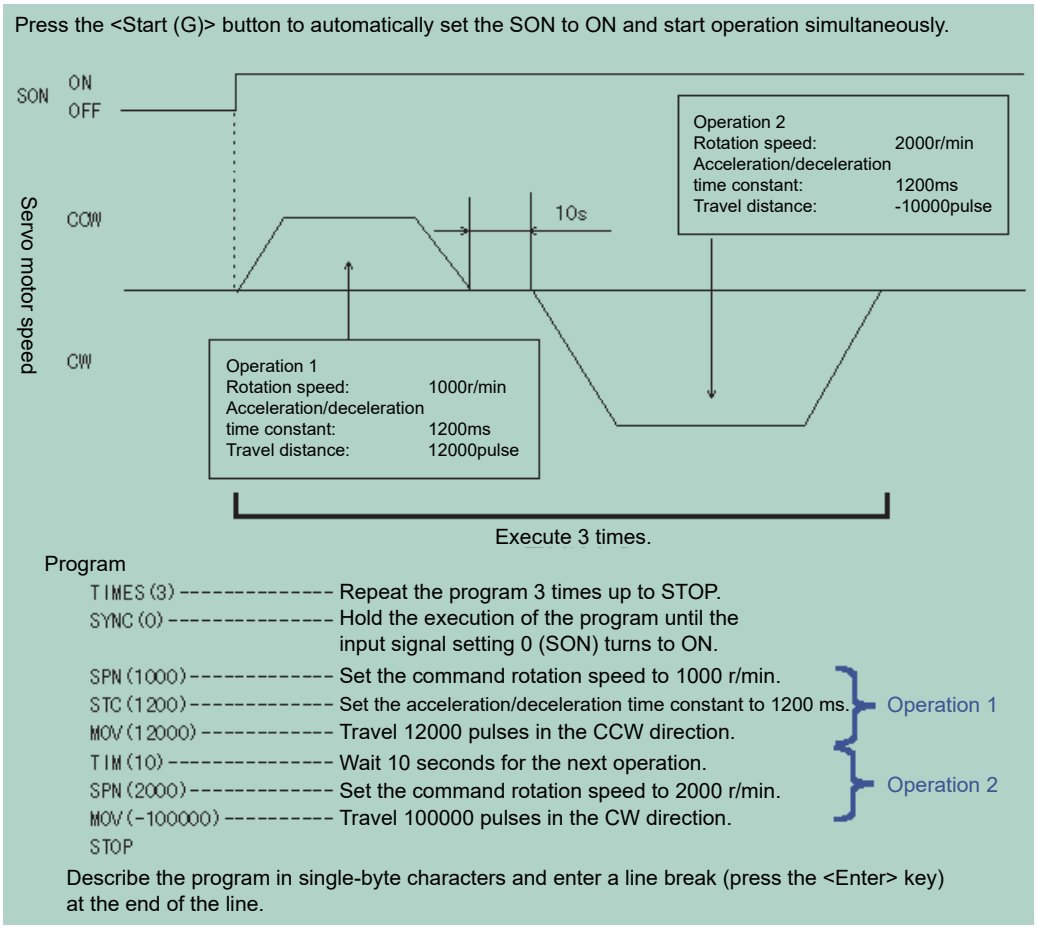
The operation status during the repeat operation and the number of operations are displayed.

The status display can be checked in the display section during positioning operation. Press "MODE" in the positioning operation-ready status to call the status display screen.

(6) Test operation (program operation)

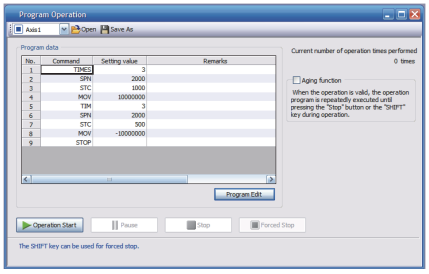
Display method: In the menu bar, click [Test Mode] → [Program Operation].

(a) Program example



The acceleration/deceleration time constants are the same in Operation 1 and 2. In this case, Operation 2 does not need settings of the acceleration/deceleration time constants. Thus, write only the operation program of the setting values that are to be changed from the previous operation.

(Note) If a program operation is performed while the program operation screen and other screens (such as the monitor batch display) are displayed at the same time, the progress of the program may be slow causing the dwell command time to exceed the setting value.

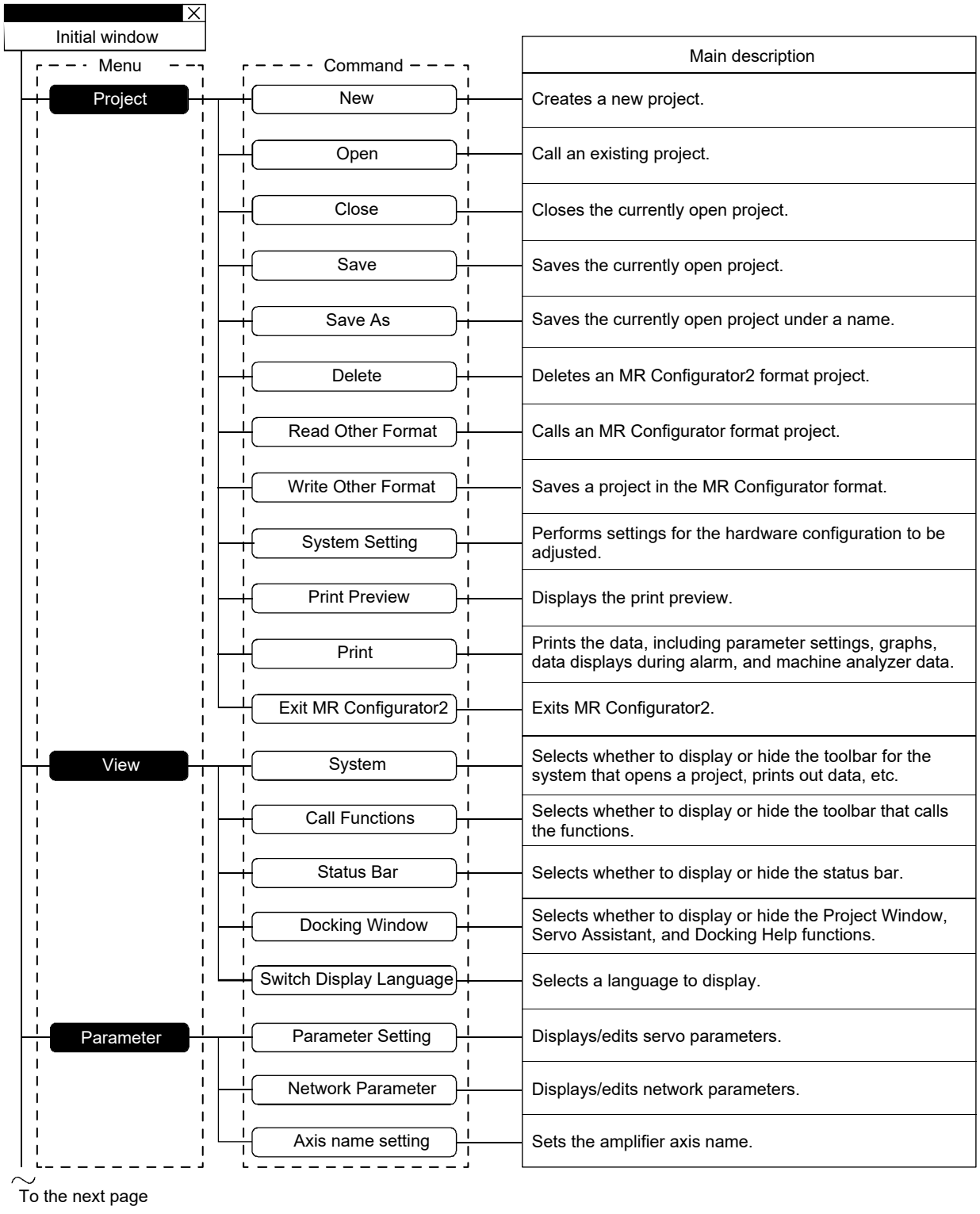


Details of the simplified language for the program operation can be checked on Help.

(7) List of MR Configurator2 functions

This section shows the MR Configurator2 menus and commands.

A detailed description of the usage method for each command is given in the help function of the main software.



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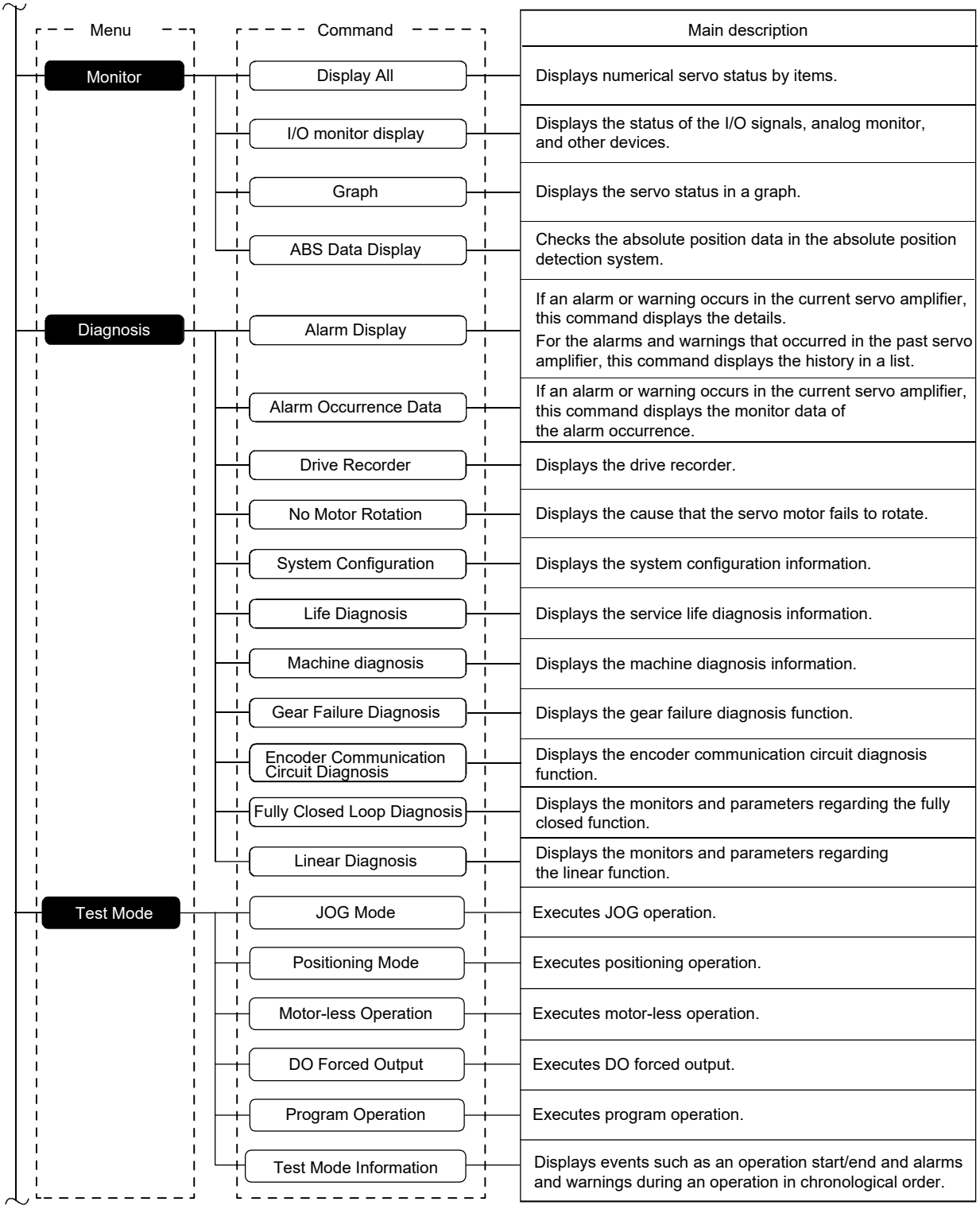

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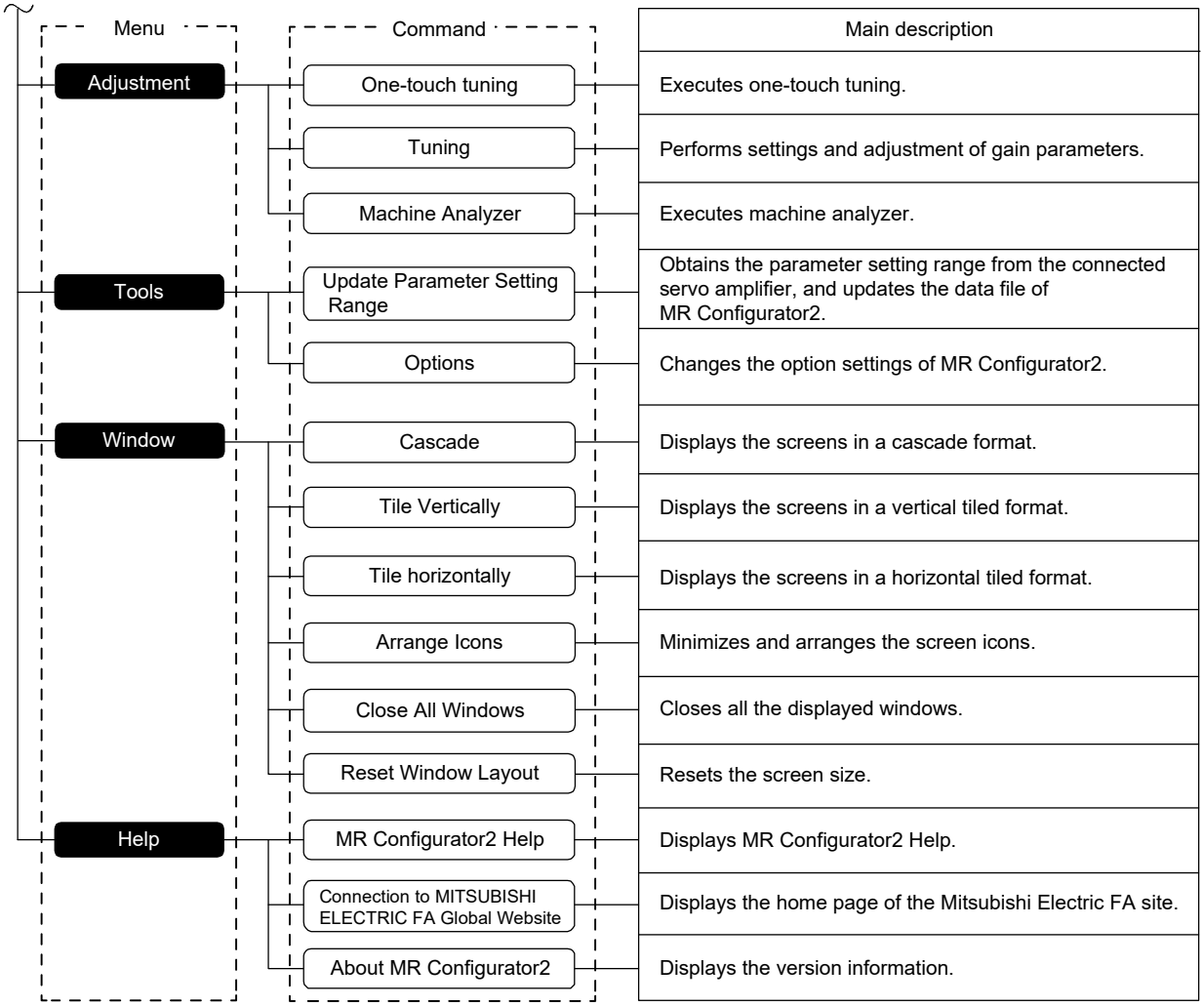


Memo

3 MAINTENANCE COUNTERMEASURES DESIGN

To make the design less susceptible to malfunctions and accidents and to facilitate maintenance, it is necessary to consider maintenance at the design stage.

3.1 Preliminary Actions for Implementing Maintenance Countermeasures

(1) Using products with a low malfunction rate
Simply put, high-reliability products should be used, and the following points should be considered.
1) Is the manufacturer reliable?
2) Is the manufacturer accredited under various national and international standards?
3) Is the design simple?
4) Does the product have a low malfunction rate based on actual results?
5) Does the product have a good reputation in the industry?

(2) System design with good maintainability
To design a system that can be easily maintained, consider the following points.
1) Use an AC servo for which parts and products are easily available.
2) Use an AC servo with high maintainability, such as one with self-diagnosis functions.
3) Use an AC servo whose parameters can be easily read, changed, and saved.
4) Design the system so that malfunctions are automatically displayed.
5) Design the system with consideration to providing sufficient space for easy maintenance, inspection, and repair work.
6) Design the system to allow easy work such as parts replacement, product replacement, and wiring changes.

Memo

4 PREVENTIVE MAINTENANCE

Preventive maintenance consists of daily maintenance/inspection and periodic maintenance/inspection.

4.1 Necessity of Preventive Maintenance

High operating ratio of equipment cannot be secured if repairs are performed after the occurrence of a production system malfunction.
Preventing malfunctions and equipment downtime is the top priority. Carrying out preventive maintenance reliably makes serious malfunctions less likely to occur, and even if they do occur, recovery can be carried out quickly.

4.2 Precautions for Maintenance, Inspection and Parts Replacement

The voltage of the smoothing capacitor remains high for a while even after the power supply has been shut off. Before inspecting the inside of an AC servo amplifier, wait until the charge light turns off, and check that the voltage between the main circuit terminals P and N is 0V using a tester or by other means.

4.3 Inspection items

(1) Daily inspection

• Basically, the following items are to be checked during operation:
(1) Whether the motor operates in accordance with the settings
(2) Whether there is any problem in the environment of the area where the servo is installed in
(3) Whether the cooling system has a problem
(4) Whether there is abnormal vibration or noise
(5) Whether there is abnormal heating or discoloration
• Normally, the input voltage of the AC servo is to be checked using a tester during operation.

(2) Periodic inspection

• Areas where an inspection cannot be performed unless the operation is at a stop and areas requiring periodic inspections are to be checked.
(1) Whether the cooling system has a problem …… Cleaning conditions of the areas such as air filters
(2) Fastening check and tightening the parts again …… Perform inspection by thoroughly checking the screws and bolts as vibrations, temperature changes and other factors may loosen the fastened parts.
(3) Whether the wire and insulator are decayed or damaged
(4) Checks and replacements of the cooling fans, smoothing capacitors, and relays

Table 4.1 Daily and periodic inspections

Area of inspection	Inspection items	What to inspect	Inspection frequency		Inspection method	Determination criteria	Instruments
			Daily	Periodic			
General	Surrounding environment	Check ambient temperature, humidity, dust, dirt, etc.	○				Thermometers, hygrometers, recorders
	Storage environment	Check the ambient temperature, humidity, dust, dirt, and other factors	○		By thermometers, hygrometers, and other instruments	(1) Motor: -15 to 70°C (non-freezing) 90%RH or less (non-condensing) Amplifier: -25 to 70°C (non-freezing) 95%RH or less (non-condensing)	Thermometers, hygrometers, recorders
	Whole system	Check if there is abnormal vibration or noise	○		By visual and aural check	No abnormalities	-
	Power supply voltage	Check if the main circuit voltage is at a normal level	○		By measuring voltage of each phase between L1, L2, and L3 of the servo amplifier terminal block	Refer to the standard specifications	Testers and digital multimeters
Main circuit	General	(1) Check if there is looseness in the fastened parts (2) Check if there is any evidence of overheating on each part (3) Cleaning		○ ○	(1) By tightening the parts again (2) By visual check	(1) (2) No abnormalities	
	Bus bar/wire	(1) Whether the bus bar is distorted (2) Whether the wire sheath is damaged		○	(1) (2) By visual check	(1) (2) No abnormalities	
	Terminal block	Check if there is any damage		○	By visual check	No abnormalities	
Main circuit	Smoothing capacitor	(1) Check if there is liquid leakage (2) Check if the safety valve comes out or swells out (3) Measurement of the static capacity		○ ○	(1) (2) By visual check (3) Measured by a capacity measuring instrument	(1) (2) No abnormalities (3) 85% or more of the rated capacity	Farad meter
	Relay	(1) Check if there is chattering sound during operation (2) Check the timer operation time (3) Check if the contact surface is rough		○ ○ ○	(1) By aural check (2) By measuring the time from power-on to relay attraction (3) By visual check	(1) No abnormalities (2) Within 0.1 to 0.15 seconds (3) No abnormalities	Universal counter
	Resistor	(1) Check if there is breakage on the insulator of the resistor (2) Check if there is disconnection		○ ○	(1) By visual check Wire-wound resistors such as a cement resistor (2) By measuring the resistance using a tester after removing the connection on one side	(1) No abnormalities (2) Errors within ±10% of the displayed resistance value	Testers and digital multimeters

Area of inspection	Inspection items	What to inspect	Inspection frequency		Inspection method	Determination criteria	Instruments
			Daily	Periodic			
Control circuit, protection circuit	Operation check	(1) Check the balance of output voltage between each phase during operation by the servo alone (without any load) (2) Perform sequence protection operation, then check if there is abnormality in the protective and display circuit		○ ○	(1) By measuring the voltage between each U, V, and W-phase of the servo amplifier output terminal (2) By simulating a short in the servo amplifier protective circuit output	(1) The voltage balance between each phase is 4V or less (2) Error occurrence in the sequence	Digital multimeters Rectifier type voltmeters
Cooling system	Cooling fan	(1) Check if there is abnormal vibration or noise (2) Check if there is looseness in the connected parts	○	○	(1) By rotating the fan by hand with the equipment power off (2) By tightening the parts again	(1) Smooth rotation (2) No abnormalities	
Display	Display	Check if the charge light or 7-segment LED has blown	○		By turning on the light and display on the servo amplifier	The charge light and display are confirmed to turn on properly	
Servo motor	General	(1) Check if there is abnormal vibration or noise (2) Check if there is an unusual odor	○ ○		(1) By aural and visual check and by bodily sensations (2) By abnormal odor check based on factors such as overheating and damage	(1) (2) No abnormalities	
	Detector	Check if there is abnormal vibration or noise	○		By aural check and bodily sensations	No abnormalities	
	Cooling fan	(1) Check if there is abnormal vibration or noise (2) Check if mist, foreign matter, or other substances adhere	○		(1) By rotating the fan by hand with the equipment power off (2) By visual check	(1) Smooth rotation (2) No abnormalities	
	Bearing	Check if there is abnormal vibration or noise	○		By aural check and bodily sensations	No abnormalities	

Memo

5 CORRECTIVE MAINTENANCE

5.1 Troubleshooting

For details regarding troubleshooting, refer to the MR-J5 User's Manual (Troubleshooting).
The MR-J5 User's Manual (Troubleshooting) is supplied for this AC Servo Troubleshooting Course.

5.2 Troubleshooting Using Demonstration Machine

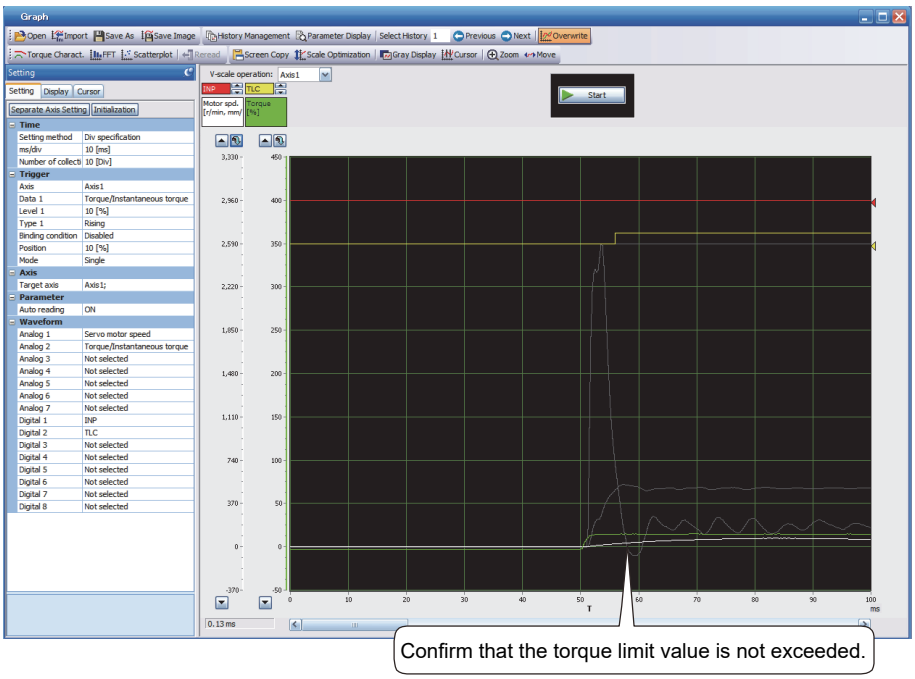
Troubleshooting is carried out using the demonstration machine.
Follow one of the procedures below to check the phenomenon and take corrective action.

5.2.1 Motor does not rotate <Torque limit>

Set Pr.PA01_Operation mode to 10003002h (after making this setting, enable it by turning off and on the main power supply of the demonstration machine or by clicking "Software Reset" in MR Configurator2), and after selecting forward or reverse rotation, check whether the belt rotates correctly with speed selection 2.
Next, change the initial value of Pr.PA11 or Pr.PA12 (forward or reverse rotation torque limit) from 1000% to around 4%.
After forward or reverse rotation is selected, with speed selection 2 or analog speed specification (VC), the zero speed detection or limiting torque LED may turn on and off, and the belt may move choppily, moving and stopping alternately.

(1) Action

Increase the speed/torque limit values.
Trigger torque start-up using MR Configurator2, and compare using the graph overlay when the torque limit is applied and when the torque limit is not applied.



Supplement

- Return Pr.PA11 or Pr.PA12 (forward or reverse rotation torque limit) to the default value (1000%), turn the torque limit selection switch of the demonstration machine to ON, and check that the torque limit can be applied even by numerical input of the analog torque limit.
  Also, in the monitor batch display of MR Configurator2, check the level value where the torque limit is applied (TLC ON timing).
  * After completing the training, turn the torque limit selection switch back to OFF.

Point

- Torque limits may be used in presses, screw tighteners, stroke limiters, and other such stop-on-contact devices.

(2) Cause

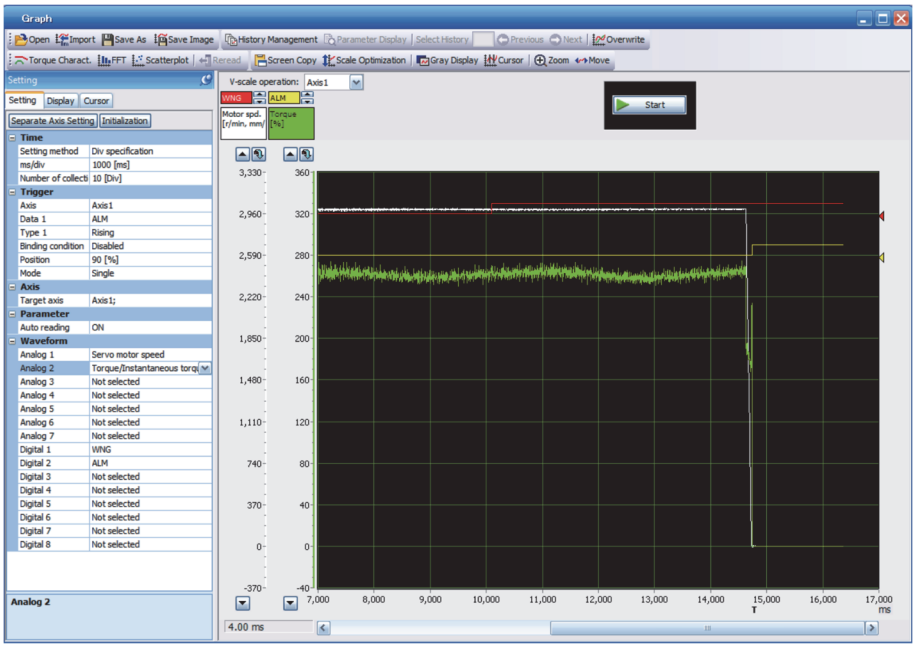
Due to the torque limit, it is not possible to generate the torque required for acceleration.

5.2.2 AL.0E1 and AL.050 display <Overload 1 from Overload warning 1>

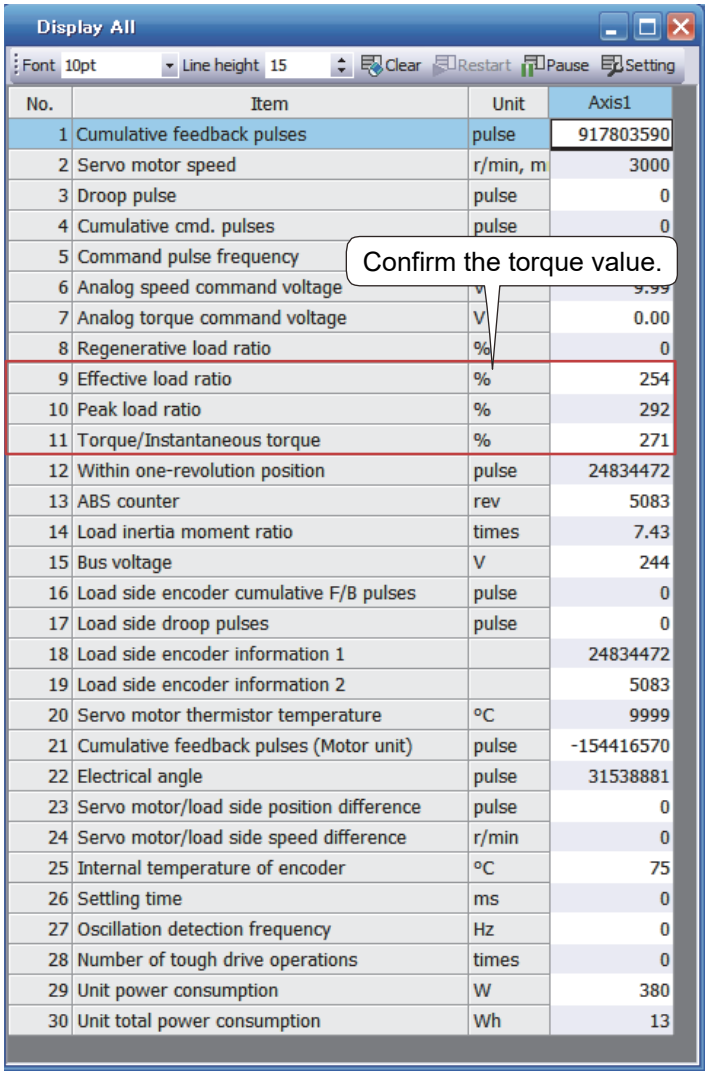
In speed control mode, turn on the load at 3000r/min and slide the load command slider to the right to apply a load of approximately 150 to 159%.
After a while, the servo amplifier display flashes and changes from "AL.0E1" to "AL.050", and then the main circuit power supply turns off.

(1) Action

Check according to the table of [AL. 050_Overload 1] in the MR-J5 User's Manual (Troubleshooting).
Since overload has occurred due to mechanical factors, reduce the load.
Using MR Configurator2, check the torque values when each of the WNG signal displaying AL.0E1 and the ALM signal displaying AL.050 are output, by triggering the rising edge of the ALM signal.



Check the load ratio and the torque value in the monitor batch display of MR Configurator2.



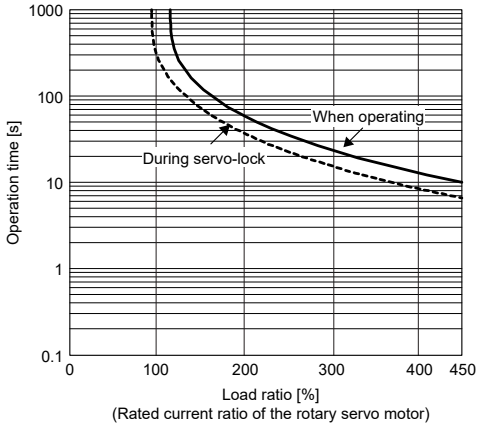
No.	Item	Unit	Axis1
1	Cumulative feedback pulses	pulse	917803590
2	Servo motor speed	r/min, m	3000
3	Droop pulse	pulse	0
4	Cumulative cmd. pulses	pulse	0
5	Command pulse frequency		
6	Analog speed command voltage	V	9.99
7	Analog torque command voltage	V	0.00
8	Regenerative load ratio	%	0
9	Effective load ratio	%	254
10	Peak load ratio	%	292
11	Torque/Instantaneous torque	%	271
12	Within one-revolution position	pulse	24834472
13	ABS counter	rev	5083
14	Load inertia moment ratio	times	7.43
15	Bus voltage	V	244
16	Load side encoder cumulative F/B pulses	pulse	0
17	Load side droop pulses	pulse	0
18	Load side encoder information 1		24834472
19	Load side encoder information 2		5083
20	Servo motor thermistor temperature	°C	9999
21	Cumulative feedback pulses (Motor unit)	pulse	-154416570
22	Electrical angle	pulse	31538881
23	Servo motor/load side position difference	pulse	0
24	Servo motor/load side speed difference	r/min	0
25	Internal temperature of encoder	°C	75
26	Settling time	ms	0
27	Oscillation detection frequency	Hz	0
28	Number of tough drive operations	times	0
29	Unit power consumption	W	380
30	Unit total power consumption	Wh	13

(2) Cause

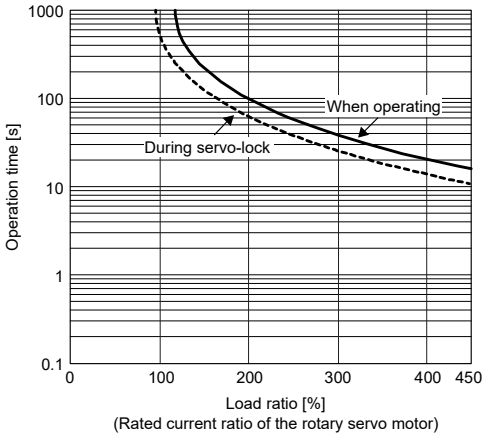
Continuous operation was carried out at a torque exceeding the rated torque.

Point

● The servo amplifier is equipped with an electronic thermal for protecting the servo motor, the servo amplifier, and the servo motor power cable from overload.
The actual overload protection level is lower than the electronic thermal protection curve of the servo amplifier and servo motor used.
[AL. 050 Overload 1] occurs if overload operation is performed above the electronic thermal protection curve shown below. [AL. 051 Overload 2] occurs if the maximum current flows continuously for several seconds due to machine collision or some other cause. Use the equipment within the overload protection level indicated on the left side of the continuous or dotted lines in the following graphs.
For machines where unbalanced torque occurs, such as a vertical axis system, the unbalanced torque should be kept at 70% or lower of the rated torque. This servo amplifier has a built-in servo motor overload protection function. (The servo motor overload current is set on the basis of 115% rated current (full load current) of the servo amplifier.)
The servo amplifier may malfunction regardless of the electronic thermal protection if torque exceeding 100% of the rated torque is generated too frequently while the servo motor is stopped (servo-lock status) or being operated at low speeds of 50r/min or less.



HK-KT053W, HK-KT13W, HK-KT13UW



HK-KT1M3W, HK-KT23W, HK-KT23UW,
HK-KT43W, HK-KT43UW, HK-KT63W
HK-KT7M3W, HK-KT7M3UW, HK-KT103W
HK-KT103UW, HK-KT153W, HK-KT203W
HK-KT202W, HK-KT434W, HK-KT634W,
HK-KT7M34W, HK-KT1034W,
HK-KT1534W, HK-KT2034W, HK-KT2024W

5.2.3 AL.051 display <Overload 2>

Set Pr.PA01_Operation mode to 10003000h (after making this setting, enable it by turning off and on the main power supply of the demonstration machine or by clicking "Software Reset" in MR Configurator2), then turn on the load and apply a load of approximately 150 to 170 by sliding the load command slider to the right.

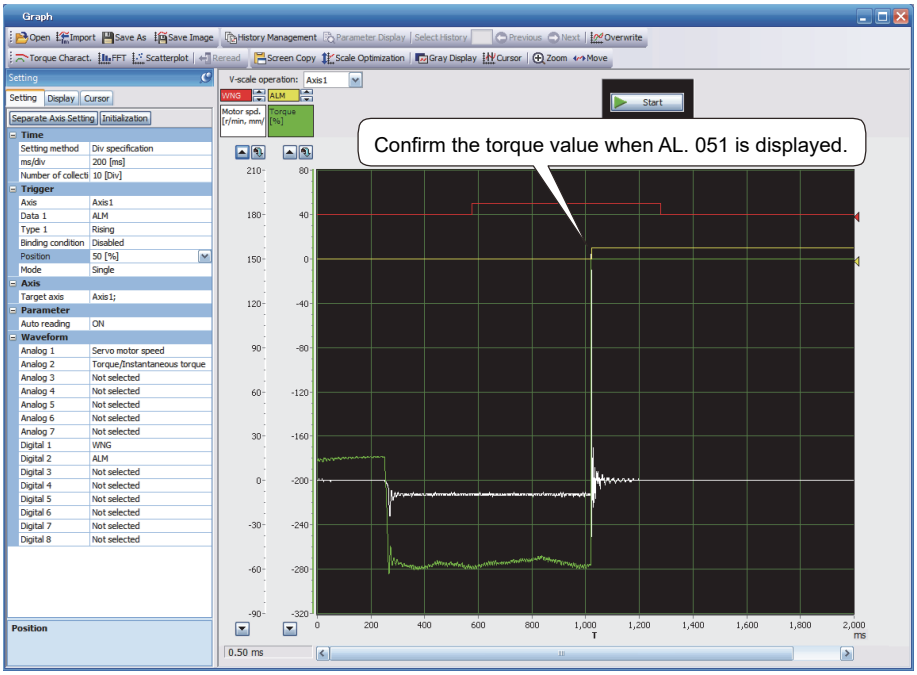
After starting in auto mode and operating several times, the servo amplifier display flashes and changes from "AL.0E1" to "AL.051", and then the main circuit power supply turns off.

(1) Action

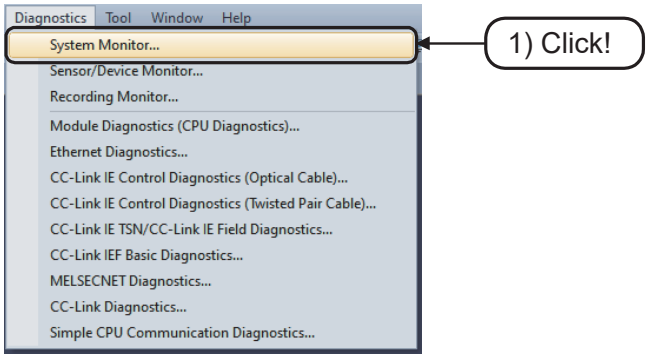
Check according to the table of [AL. 051_Overload 2] in the MR-J5 User's Manual (Troubleshooting).

Since overload has occurred due to mechanical factors, reduce the load.

Using MR Configurator2, check the torque value when the ALM signal displaying AL.051 is output, by triggering the rising edge of the ALM signal.

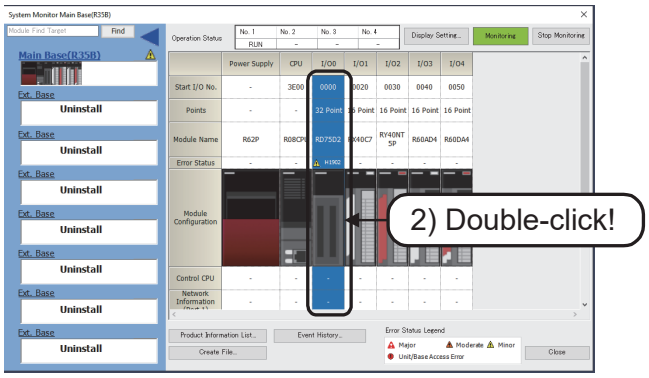


In addition, because AX1 and ERR are flashing on the display of programmable controller positioning module RD75D2, verify that the Ready signal from the drive unit is OFF from the error history of GX Works3 via USB.



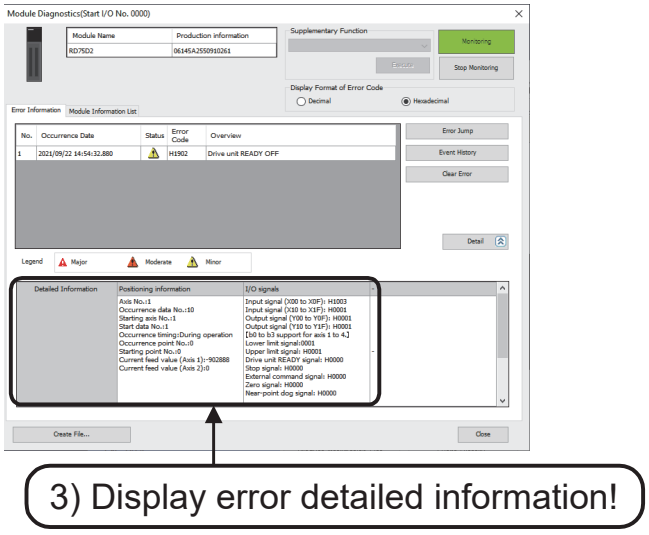
1) Click [Diagnostics] - [System Monitor] on GX Works3.

The system monitor dialog box is displayed.



2) Double click positioning module RD75D2 on the screen.

The module diagnostics dialog box is displayed.



3) The detailed error information is displayed.

(2) Cause

The maximum current continued to flow for a few seconds.

5.2.4 AL.052 display <Excessive error>

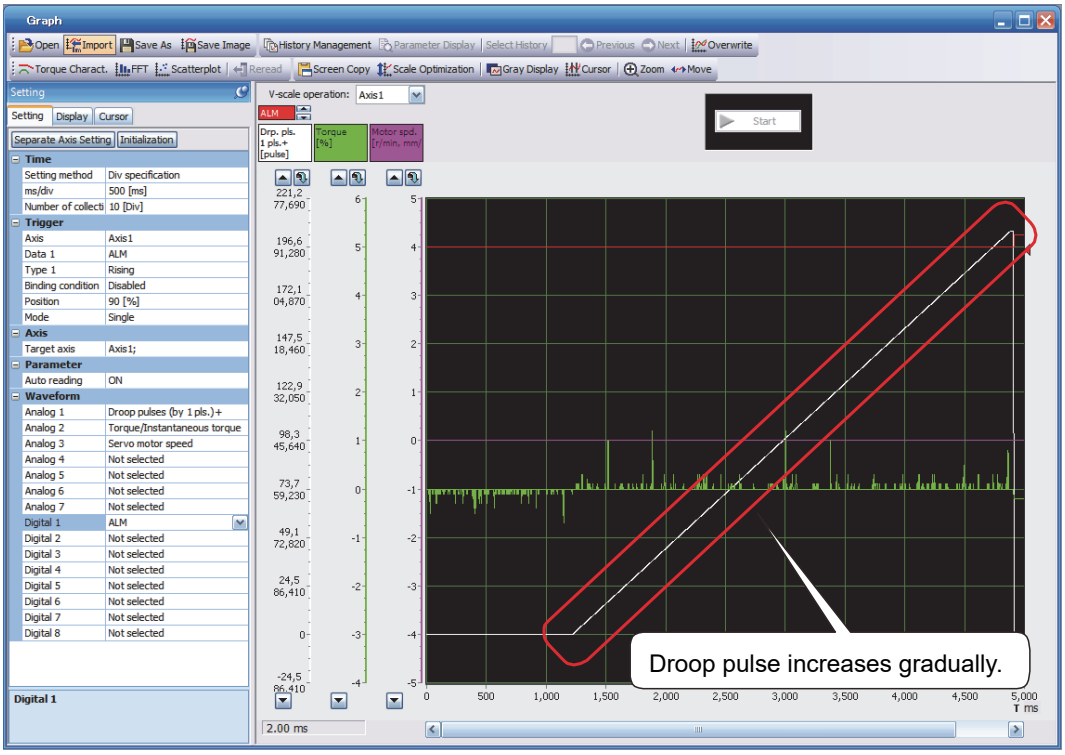
Turn on the torque limit selection switch in the positioning control mode, and check that the AL.052 display flashes by performing manual forward or reverse JOG operation when the torque limit is applied by numerical input of the analog torque limit.

(1) Action

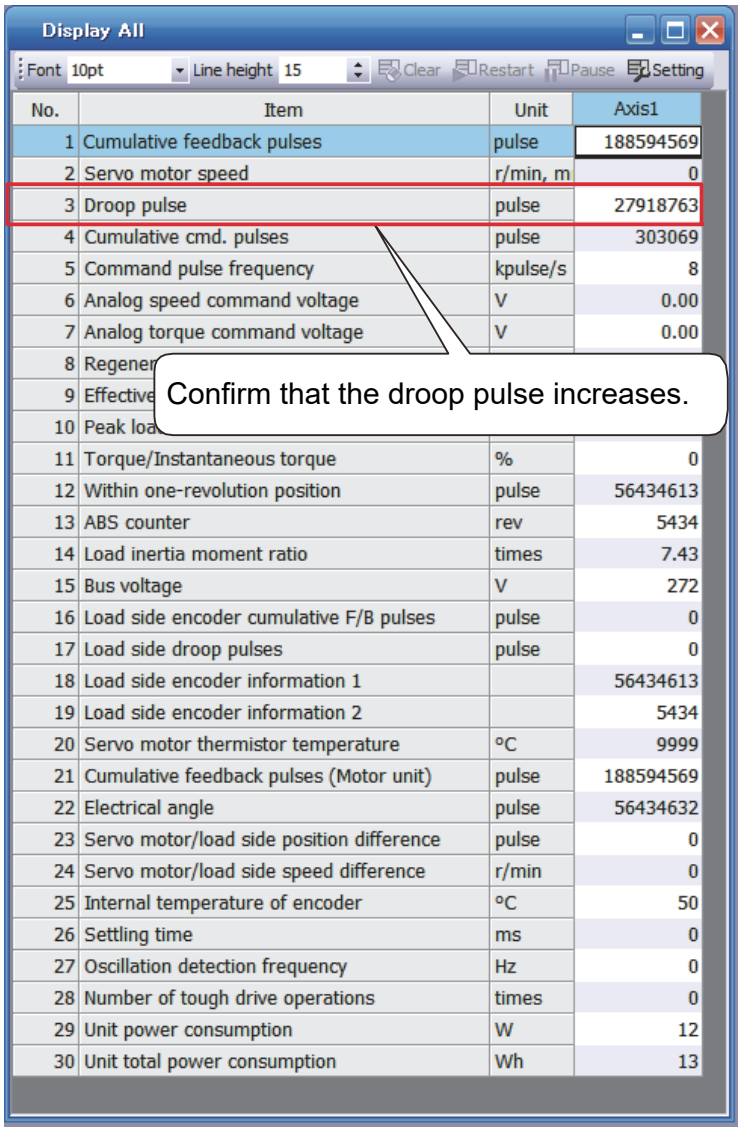
Check according to the table of [AL. 052_Excessive error] in the MR-J5 User's Manual (Troubleshooting).

Since the torque is insufficient during acceleration, increase the torque limit value by numerical input of the analog torque limit.

Using MR Configurator2, check the amount of droop pulse when the ALM signal displaying AL.052 is output, by triggering the rising edge of the ALM signal.



Also, in the MR Configurator2 monitor batch display, verify that the droop pulse value gradually increases.



No.	Item	Unit	Axis1
1	Cumulative feedback pulses	pulse	188594569
2	Servo motor speed	r/min, m	0
3	Droop pulse	pulse	27918763
4	Cumulative cmd. pulses	pulse	303069
5	Command pulse frequency	kpulse/s	8
6	Analog speed command voltage	V	0.00
7	Analog torque command voltage	V	0.00
8	Regener		
9	Effective		
10	Peak loa		
11	Torque/Instantaneous torque	%	0
12	Within one-revolution position	pulse	56434613
13	ABS counter	rev	5434
14	Load inertia moment ratio	times	7.43
15	Bus voltage	V	272
16	Load side encoder cumulative F/B pulses	pulse	0
17	Load side droop pulses	pulse	0
18	Load side encoder information 1		56434613
19	Load side encoder information 2		5434
20	Servo motor thermistor temperature	°C	9999
21	Cumulative feedback pulses (Motor unit)	pulse	188594569
22	Electrical angle	pulse	56434632
23	Servo motor/load side position difference	pulse	0
24	Servo motor/load side speed difference	r/min	0
25	Internal temperature of encoder	°C	50
26	Settling time	ms	0
27	Oscillation detection frequency	Hz	0
28	Number of tough drive operations	times	0
29	Unit power consumption	W	12
30	Unit total power consumption	Wh	13

(2) Cause

Deviation between the model position and the actual servo motor position exceeded the reference value.

* After completing the training, turn the torque limit selection switch back to OFF.

5.2.5 AL.010 display <Undervoltage>

In the main circuit power supply ON and servo ON state, turn the main circuit power supply OFF. After a while, check that AL.010 is displayed.

(1) Action

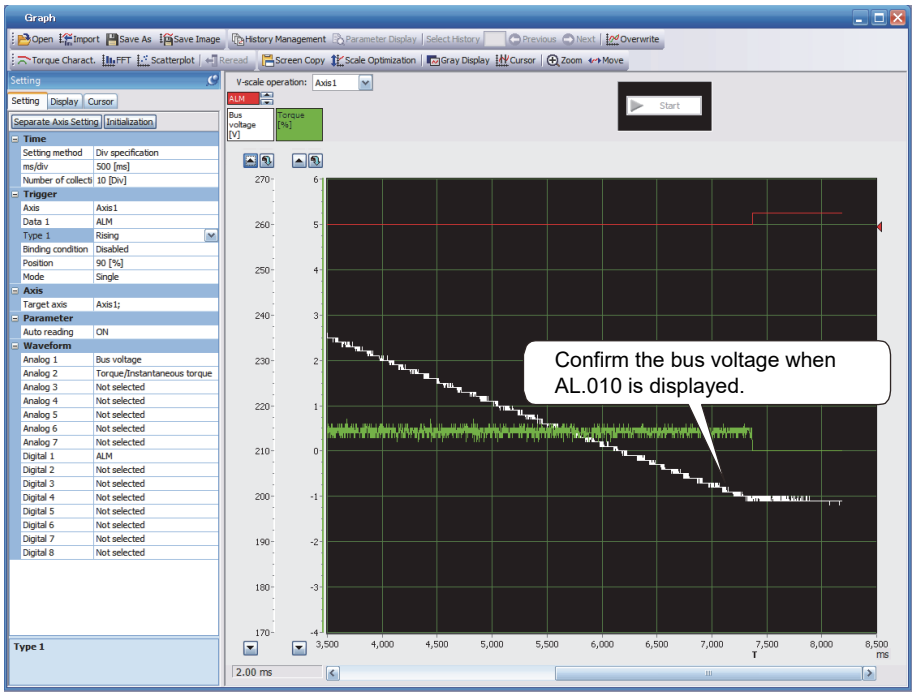
Check according to the table of AL.010 in the MR-J5 User's Manual (Troubleshooting).

Check the bus voltage in MR Configurator2. If it is 200V or less, the main circuit voltage has dropped.

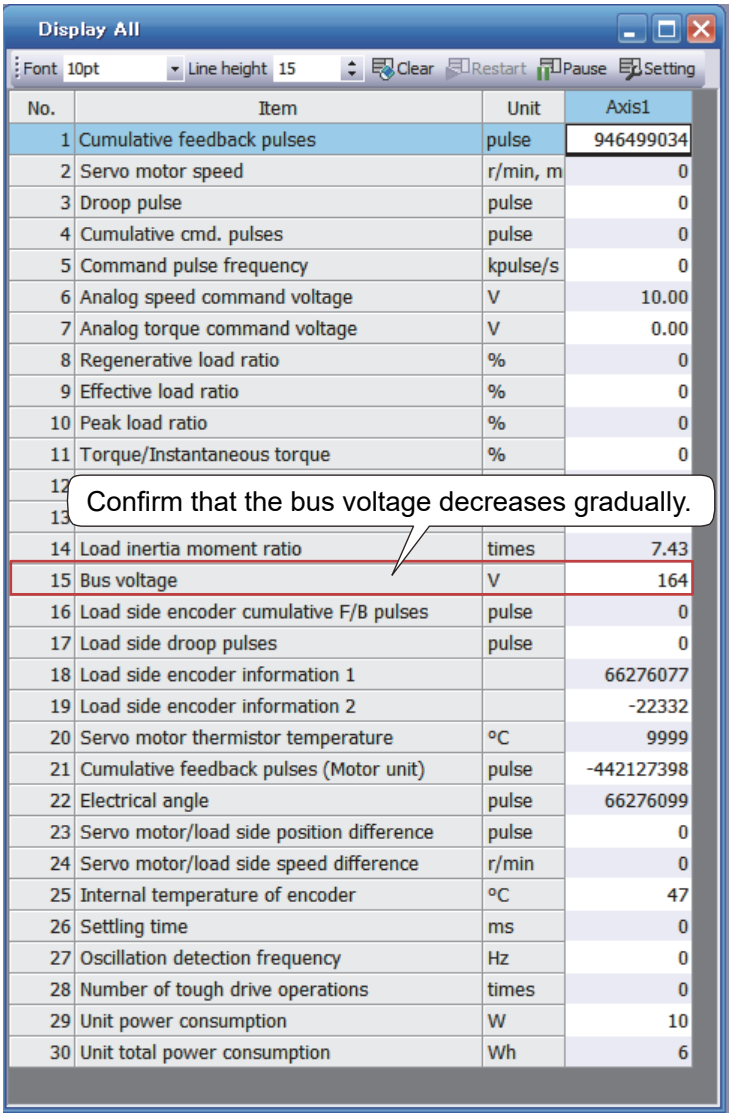
Turn off the servo, and after resetting, turn on the main circuit power supply and then the servo.

When the main circuit power supply is turned off in the main circuit power supply ON and servo ON state, the bus voltage decreases gradually over time.

Trigger the rising edge of ALM using MR Configurator2, and check that the bus voltage level at the timing when AL.010 is displayed is 200V.



Also, in the MR Configurator2 monitor batch display, verify that the bus voltage value gradually decreases.



No.	Item	Unit	Axis1
1	Cumulative feedback pulses	pulse	946499034
2	Servo motor speed	r/min, m	0
3	Droop pulse	pulse	0
4	Cumulative cmd. pulses	pulse	0
5	Command pulse frequency	kpulse/s	0
6	Analog speed command voltage	V	10.00
7	Analog torque command voltage	V	0.00
8	Regenerative load ratio	%	0
9	Effective load ratio	%	0
10	Peak load ratio	%	0
11	Torque/Instantaneous torque	%	0
14	Load inertia moment ratio	times	7.43
15	Bus voltage	V	164
16	Load side encoder cumulative F/B pulses	pulse	0
17	Load side droop pulses	pulse	0
18	Load side encoder information 1		66276077
19	Load side encoder information 2		-22332
20	Servo motor thermistor temperature	°C	9999
21	Cumulative feedback pulses (Motor unit)	pulse	-442127398
22	Electrical angle	pulse	66276099
23	Servo motor/load side position difference	pulse	0
24	Servo motor/load side speed difference	r/min	0
25	Internal temperature of encoder	°C	47
26	Settling time	ms	0
27	Oscillation detection frequency	Hz	0
28	Number of tough drive operations	times	0
29	Unit power consumption	W	10
30	Unit total power consumption	Wh	6

(2) Cause

When the servo is ON, power was restored after the bus voltage (between P and N) dropped to 200V.

Point

- This time, the main circuit power supply is turned off for the demonstration machine. However, AL.010 frequently occurs when the power situation is poor, and thus countermeasures for stable power supply are desirable.

5.2.6 AL.0E9 display <Main circuit off warning>

Turn on the main power supply of the demonstration machine and in the main circuit power supply OFF state, turn on the servo. Confirm that AL.0E9 is displayed because there is no bus voltage.

(1) Action

According to the table of AL.0E9 in the MR-J5 User's Manual (Troubleshooting), turn on the main circuit power supply.

Point
● "AL.0E9" often occurs when the servo is turned on by mistake in the main circuit power supply OFF state, so this warning is displayed.

6 IMPROVEMENT FOR EASY MAINTENANCE

To improve the maintainability of the production system, it is necessary to reduce the deterioration of the equipment and make improvements to facilitate maintenance work.

6.1 Equipment Maintainability Improvement

(1) Making improvements to reduce equipment deterioration
   1) Review the environment and make improvements, such as installing ventilation or air-conditioning equipment, so that the equipment does not deteriorate abnormally.
   2) Apply dust-proofing, moisture-proofing, and vibration-proofing measures to prevent abnormal deterioration of the equipment.
   3) Replace any equipment presumed to be deteriorating at a faster rate with more durable equipment.

(2) Performing improvements so as to enable easy repairs
   1) Improve the structure of the equipment.
   2) Make improvements to secure space for repair.
   3) Change to products that are easy to repair.

(3) Changing to products with a low malfunction rate
   1) Change to products with a low malfunction rate and high reliability.

Memo

7 REVIEW OF EQUIPMENT ENVIRONMENT

7.1 Noise Reduction Techniques

Noises are classified into external noises, which enter the servo amplifier to cause it to malfunction, and those radiated by the servo amplifier to cause peripheral equipment to malfunction. Because the servo amplifier is an electronic device that handles weak signals, the following general noise reduction techniques are required.

The servo amplifier can also be a source of noise as its outputs are chopped by high carrier frequencies. If peripheral equipment malfunctions due to noise produced by the servo amplifier, take measures to reduce the noise. The reduction techniques will vary slightly with the routes of noise transmission.

7.1.1 Noise reduction techniques

(1) General reduction techniques

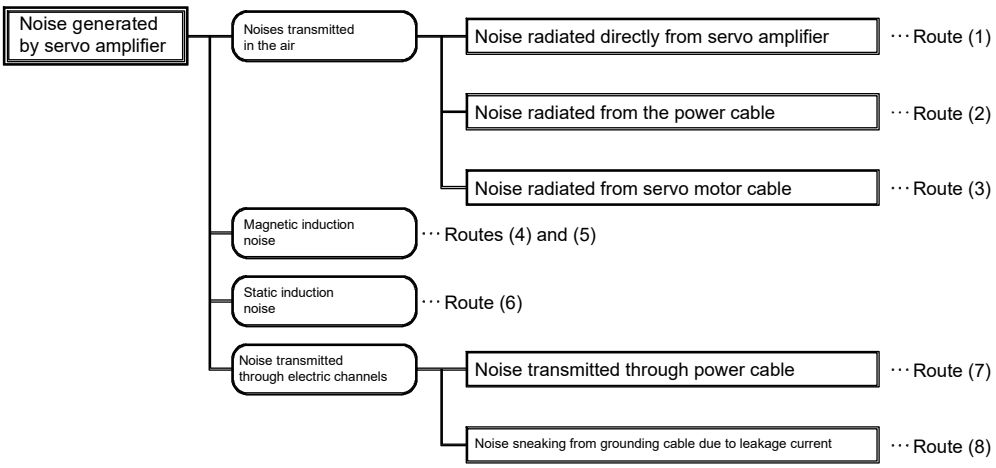
- Avoid bundling power lines (input/output) and signal cables together or running them in parallel to each other. Separate the power lines from the signal cables.
- Use a shielded twisted pair cable for connection with the encoder and for control signal transmission, and connect the external conductor of the cable to the SD terminal.
- Ground the servo amplifier, servo motor, or other devices together at one point. For details, refer to "Grounding" in the MR-J5 User's Manual (Hardware).

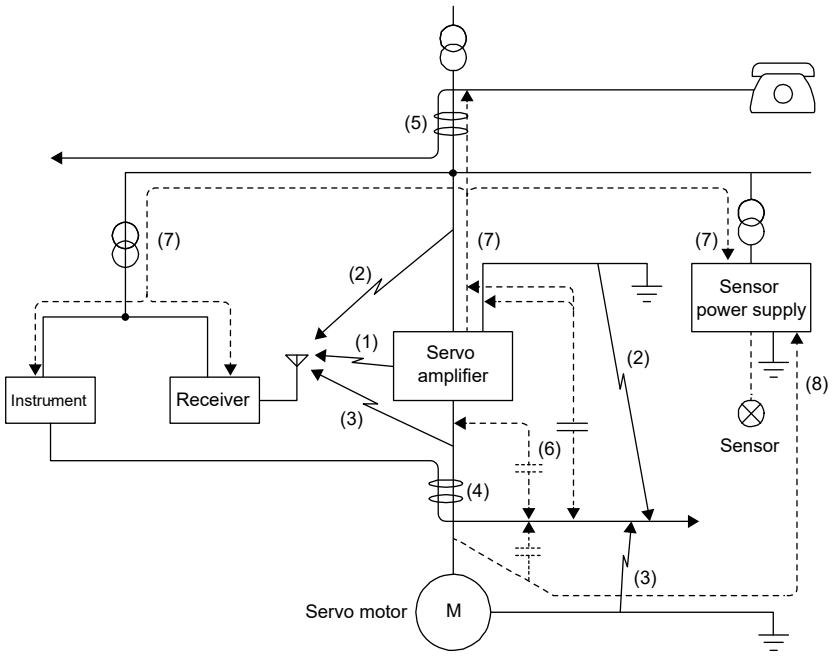
(2) Reduction techniques for external noises that cause the servo amplifier to malfunction

If there are noise sources (such as a magnetic contactor, an electromagnetic brake, and many relays) that make a large amount of noise near the servo amplifier and the servo amplifier may malfunction, the following countermeasures are required.

- Provide surge killers on the noise sources to suppress noise.
- Attach data line filters to the signal cables.
- Ground the shields of the encoder connecting cable and the control signal cables with cable clamp fittings.
- Although a surge absorber is built into the servo amplifier, to protect the servo amplifier and other equipment against large exogenous noise and lightning surge, attaching a varistor to the power input section of the equipment is recommended.

(3) Techniques for noises radiated by the servo amplifier that cause peripheral equipment to malfunction
Noises produced by the servo amplifier are classified into those radiated from the cables connected to the servo amplifier and its main circuits (input/output), those induced electromagnetically or statically by the signal cables of the peripheral equipment located near the main circuit cables, and those transmitted through the power supply cables.

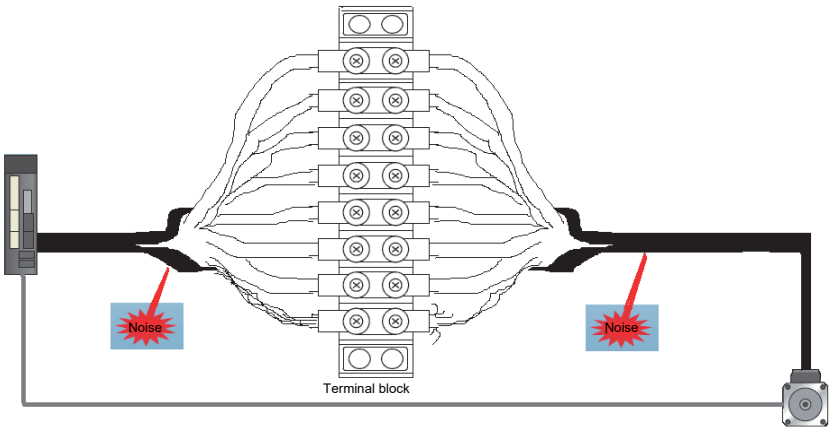




Noise transmission route	Suppression techniques
(1), (2), (3)	A malfunction due to noise transmitted through the air may occur in devices which handle weak signals and are susceptible to noise, such as measuring instruments, receivers and sensors. In addition, a malfunction may also occur when their signal cables are stored in a cabinet together with the servo amplifier or when the signal cables run near the servo amplifier. Take the following measures to prevent a malfunction: • Provide maximum clearance between easily affected devices and the servo amplifier. • Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. • Avoid wiring the power lines (input/output lines of the servo amplifier) and signal lines side by side or bundling them together. • Insert a line noise filter to the I/O cables or a radio noise filter on the input line to reduce radiated noise from the cables. • Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.
(4), (5), (6)	When power cables and signal cables are laid side by side or bundled together, electromagnetic and static induction noise is transmitted to the signal cables, causing malfunctions. Take the following precautions to protect the signal cables against noise. • Provide maximum clearance between easily affected devices and the servo amplifier. • Provide maximum clearance between easily affected signal cables and the I/O cables of the servo amplifier. • Avoid wiring the power lines (input/output lines of the servo amplifier) and signal lines side by side or bundling them together. • Use shielded wires for the signal and power lines, or put the lines in separate metal conduits.
(7)	When the power supply of peripheral equipment is connected to the power supply of the servo amplifier system, noise produced by the servo amplifier may be transmitted back through the power supply cable, and the equipment may malfunction. The following techniques are required. • Install the radio noise filter (FR-BIF(-H)) on the power lines (input lines) of the servo amplifier. • Install the line noise filter (FR-BSF01/FR-BLF) on the power lines of the servo amplifier.
(8)	If the grounding wires of the peripheral equipment and the servo amplifier make a closed loop circuit, leakage current may flow through, causing the equipment to malfunction. In this case, the malfunction may be prevented by disconnecting the grounding wires from the equipment.

Fault example: Extension of the encoder cable
[Fault description]
For equipment requiring an encoder cable length of 30m, MR-AENSCBL20M-H was newly purchased in addition to MR-J3ENSCBL10M-H, which had already been purchased, and a terminal block was used to join the two cables.
Although there was no problem at first after installation, Excessive error AL.052 sometimes occurred.

[Cause of fault]
The wiring of the shielded portion of the junction terminal block was about to break.



[Fault countermeasure]
The encoder cable was changed to MR-AENSCBL30M-H.

Precaution
● If an encoder cable length greater than 50m is required, standard cables cannot be used. Because there are differences in the wiring and parameter setting values, consult with the closest dealer.

7.2 Earth-Leakage Current Breaker

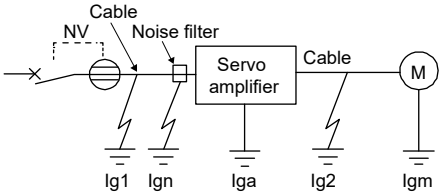
(1) Selection method

High-frequency chopper currents controlled by pulse width modulation flow in the AC servo circuits. Leakage currents containing harmonic contents are larger than those of the servo motor, which runs on AC power.

Select an earth-leakage current breaker according to the following formula, and ground the servo amplifier, servo motor, etc. securely.

To minimize leakage currents, make the input and output wires as short as possible, and keep a distance of 30cm or longer between the wires and ground.

$$\text{Rated sensitivity current} \geq 10 \times \{Ig1 + Ign + Iga + K \times (Ig2 + Igm)\}\ [mA] \ldots (7\text{-}1)$$



Earth-leakage current breaker		K*1
Type	Mitsubishi Electric products	
Models provided with harmonic and surge reduction techniques	NV-SP NV-SW NV-CP NV-CW NV-HW	1
General models	BV-C1 NFB NV-L	3

*1: K: Constant with the harmonics taken into account

Ig1: Leakage current on the electric channel from the earth-leakage current breaker to the input terminals of the servo amplifier (obtained from (a) Leakage current example per 1km with CV cableas with metal wiring (Ig1, Ig2))

Ig2: Leakage current on the electric channel from the output terminals of the servo amplifier to the servo motor (obtained from (a) Leakage current example per 1km with CV cables with metal wiring (Ig1, Ig2))

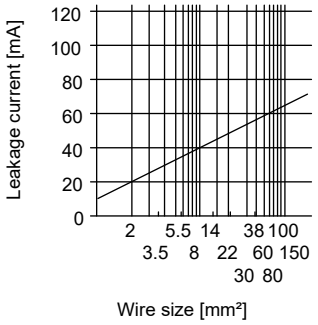
Ign: Leakage current when a filter is connected to the input side (4.4mA per FR-BIF(-H))

Iga: Servo amplifier leakage current (obtained from (c) Servo amplifier leakage current example (Iga))

Igm: Servo motor leakage current (obtained from (b) Servo motor leakage current example (Igm))

(a) Example of leakage current (Ig1, Ig2) per km of CV cable run in metal conduit

• 200V class



(b) Servo motor leakage current example (Igm)

Servo motor output [kW]	Leakage current [mA]
0.05 to 1	0.1
1.2 to 2	0.2
3 to 3.5	0.3

(c) Servo amplifier leakage current example (Iga)

Servo amplifier	Leakage current [mA]
MR-J5-10_ MR-J5-20_ MR-J5-40_ MR-J5-60_ MR-J5-70_ MR-J5-100_	0.16
MR-J5-200_ MR-J5-350_	0.22

(d) Earth-leakage current breaker selection example

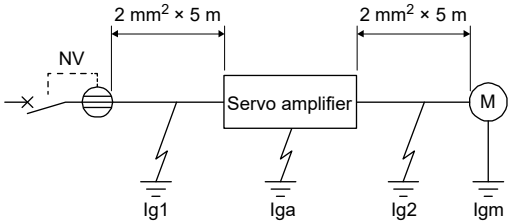
Servo amplifier	Rated sensitivity current of earth-leakage current breaker [mA]
MR-J5-10_ to MR-J5-350_	15

Precautions

● Filters in EN standards may be inapplicable in some regions due to their large leakage currents.

(2) Selection example

The following shows a selection example of the earth-leakage current breaker under the following conditions.



Use a harmonic and surge compatible earth-leakage circuit breaker.

Find each term of formula (7.1) from the diagram.

$$Ig1 = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

$$Ig2 = 20 \cdot \frac{5}{1000} = 0.1 \text{ [mA]}$$

Ign = 0 (Not used)

Iga = 0.1 [mA]

Igm = 0.1 [mA]

Insert these values in formula (7.1).

Ig ≥ 10•{0.1 + 0 + 0.1 + 1•(0.1 + 0.1)}

Ig ≥ 4 [mA]

According to the result of calculation, use an earth-leakage current breaker having the rated sensitivity current (Ig) of 4.0mA or more.

Use an earth-leakage current breaker having Ig of 15mA for the NV-SP/SW/CP/CW/HW series.

7.3 Installation and Operation

Precautions

- Before starting operation, check each parameter. Depending on the machine, an unexpected operation may occur.
- The radiator and regenerative resistor of the servo amplifier, servo motor, and other parts may become hot when the power is on and for a while after the power is turned off. Take safety measures such as using covers to prevent operators' hands or components (such as cables) from accidentally touching the hot area. Not doing so may cause a burn injury and component damages.
- Never touch the rotor of the servo motor during operation. Doing so may cause an injury.

7.3.1 Turning on servo amplifier for the first time

When turning on the servo amplifier for the first time, follow the steps below.

Installation and wiring	Install and wire the servo amplifier and servo motor.
Test operation of the servo motor alone in test operation mode	With the servo motor disconnected from the machine, operate the servo motor at the lowest speed possible, and check whether the servo motor operates correctly.
Equipment configuration settings	Set each servo parameter according to the equipment configuration.
Controller-related settings	Perform necessary settings according to commands from the controller.
Operation by controller command	Operate the servo motor at the lowest speed possible by giving commands to the servo amplifier from the controller, and check whether the servo motor operates correctly.
Actual operation	

7.3.2 Installation

Precautions

- Install the servo amplifier and regenerative resistor on incombustible material. Installing them either directly on or near combustibles may lead to smoke or a fire. In addition, the servo amplifier must be installed in a metal cabinet.
- Provide adequate protection to prevent the following matter from entering the servo amplifier: conductive matter such as screws and metal fragments, and combustible matter such as oil.
- Devices such as the servo amplifier regenerative resistor and servo motor may become hot. Take safety measures such as using covers.
- Do not stack in excess of the specified number of product packages.
- Do not hold the front cover, cables, or connectors when carrying the servo amplifier. Doing so may cause the servo amplifier to drop.
- To prevent a malfunction, do not drop the servo amplifier or servo motor or subject them to impacts.
- Install the servo amplifier and servo motor in a place that can support their weight as stated in the MR-J5 user's manuals.
- Do not get on the equipment or put a heavy load on it.
- Do not install or operate any servo amplifier that is missing parts or is damaged.
- To prevent a malfunction, do not block the intake and exhaust areas of the servo amplifier.
- Do not subject connectors to impacts. Doing so may cause a connection failure, malfunction, or other failures.
- Use the product within the specified environment. For the environment, refer to "Servo amplifier standard specifications" in the MR-J5 User's Manual (Introduction).
- To prevent a fire or injury from occurring in the event of an earthquake or other natural disaster, securely install, mount, and wire the servo amplifier as stated in the MR-J5 user's manuals.
- When the product has been stored for an extended period of time, contact your local sales office.
- When handling the servo amplifier, be careful with the edges of the servo amplifier.
- Fumigants that are used to disinfect and protect wooden packaging from insects contain halogens (such as fluorine, chlorine, bromine, and iodine) cause damage if they enter our products. Please take necessary precautions to ensure that any residual materials from fumigants do not enter our products, or perform disinfection and pest control using a method other than fumigation, such as heat treatment. Perform disinfection and pest control on the wooden packaging materials before packing the products.
- Provide an external emergency stop circuit to stop the operation and shut-off the power immediately.
- For equipment in which the moving part of the machine may collide against the load side, install a limit switch or stopper to the end of the moving part.

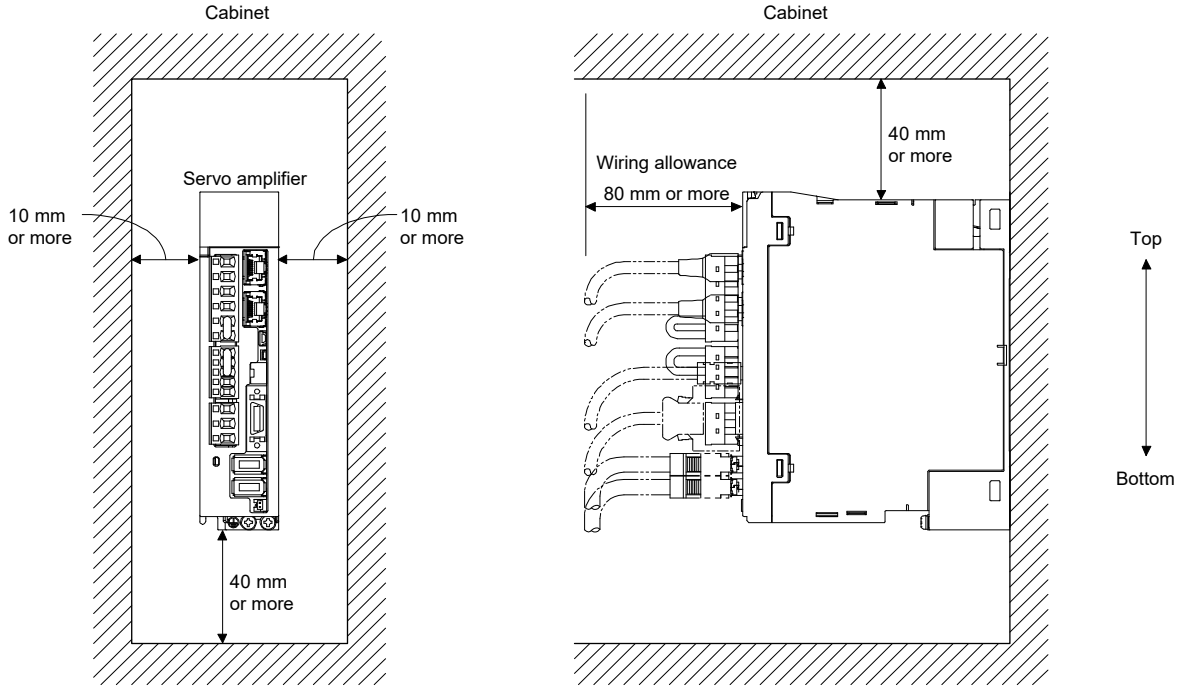
(1) Mounting direction and clearances

Precautions

- The servo amplifier must be installed in the specified direction.
- To prevent a malfunction, maintain the specified clearances between the servo amplifier and cabinet walls or other equipment.
- When using the servo amplifier at an ambient temperature exceeding 55°C and up to 60°C, circulate air so that the air at the top and bottom of the servo amplifier does not stagnate.

(a) Installation clearances for the servo amplifier

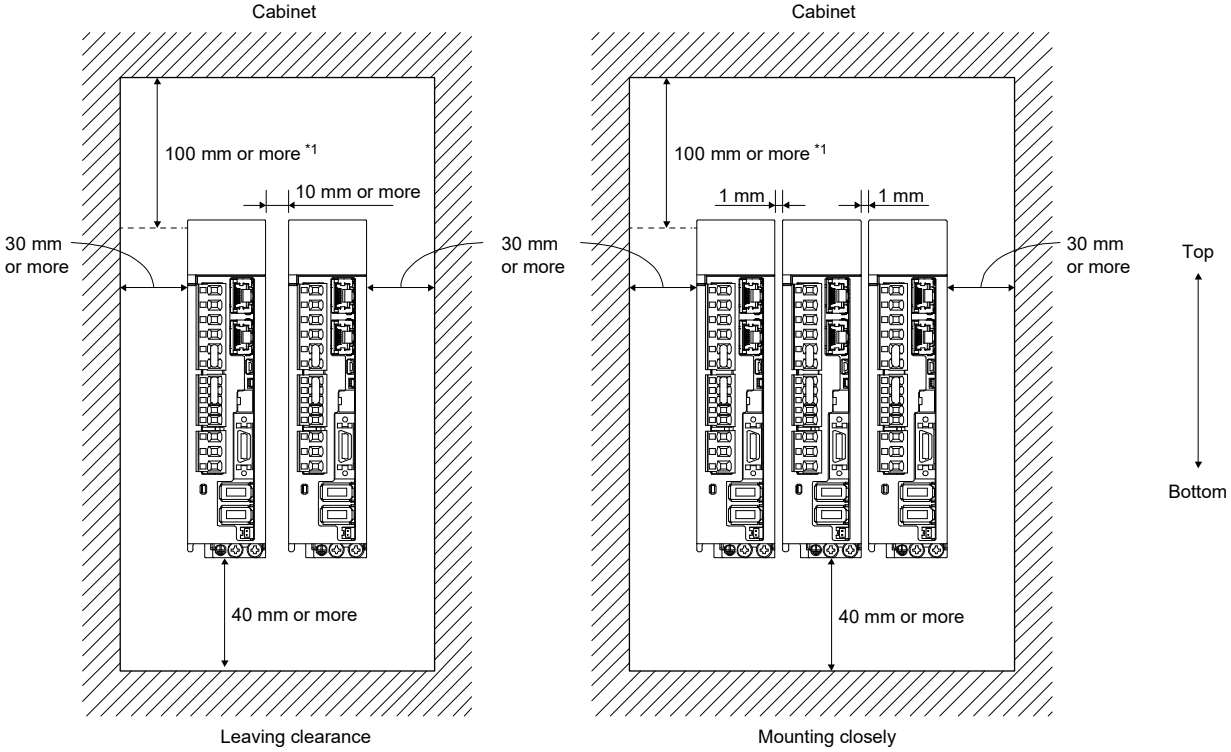
1) Installation of one servo amplifier



2) Installation of two or more servo amplifiers

Precautions
● For the availability of close mounting, refer to "Servo amplifier standard specifications" in the MR-J5 User's Manual (Introduction). ● When closely mounting multiple servo amplifiers, the servo amplifier on the right must have a larger depth than that on the left. Otherwise, the CNP1, CNP2, and CNP3 connectors cannot be removed.

Maintain a large clearance above the servo amplifiers and install a cooling fan to prevent the temperature inside the cabinet from exceeding the temperature specified in the environmental conditions.
When closely mounting the servo amplifiers, leave a clearance of 1mm between the adjacent servo amplifiers in consideration of mounting tolerances.
When mounting servo amplifiers in this manner, keep the ambient temperature within 0 to 45°C, or use the servo amplifiers with 75% or less of the effective load ratio.



*1: Leave a clearance of 100mm or more above the fan units.

(b) Other precautions

When using heat generating equipment such as the regenerative option, install it with full consideration of heat generation so that the servo amplifier is not affected.
Mount the servo amplifier on a perpendicular wall in the correct vertical direction.

(2) Keeping out foreign materials

- When drilling the cabinet for assembly, prevent drill chips and wire fragments from entering the servo amplifier.
- Prevent foreign matter such as oil, water, and metallic dust from entering the servo amplifier through openings in the cabinet or through a cooling fan installed on the ceiling.
- When installing the cabinet in a place where toxic gas, dirt, and dust exist, conduct an air purge (force clean air into the cabinet from outside to make the internal pressure higher than the external pressure) to prevent such materials from entering the cabinet.

Fault example: Communication error 2

[Fault description]

When a servo amplifier that was stored for some time in a warehouse was used after a long time, there was a communication error.

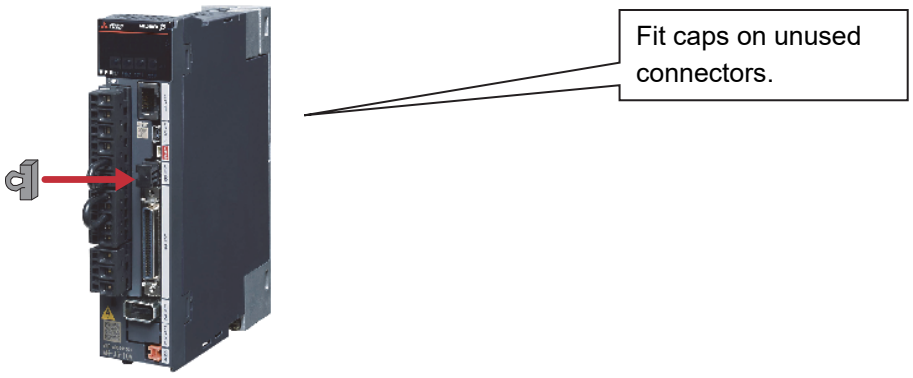
When replaced with a new one, the new servo amplifier worked without any problems.

[Cause of fault]

There was dust stuck to the optical fiber cable connector of the servo amplifier.

[Fault countermeasure]

Fit caps on unused connectors before storing the servo amplifier.



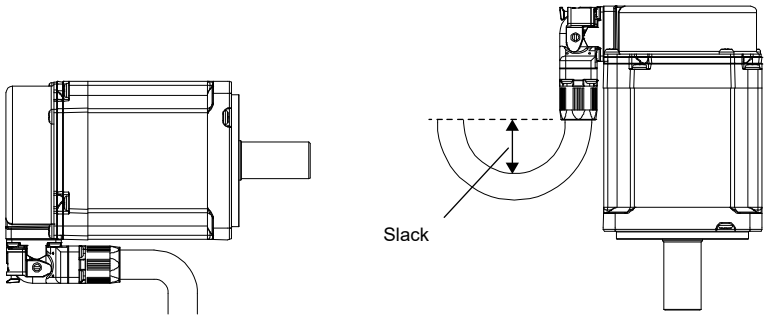
(3) Mounting direction

(a) Rotary servo motor

The mounting direction of the rotary servo motor is shown in the table below.

Rotary servo motor series	Mounting direction
HK-KT, HK-ST	Any direction

It is recommended to set the connector section downward if the rotary servo motor is mounted horizontally. Examine the cable clamping method, and give a gentle slack to the connection cable, to prevent excessive load from being applied to the connector and cable connection part.



(b) Rotary servo motor with an electromagnetic brake

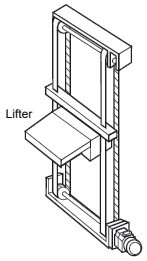
The rotary servo motor with an electromagnetic brake can also be mounted in the same directions as the one without an electromagnetic brake. When the servo motor with an electromagnetic brake is mounted with the shaft end upward, the brake plate may generate sliding sound but it is not a fault.

Fault example: Electromagnetic brake

<Example of use>

Conveyor (vertical)

Performs transport positioning of lifters. This type of machines use servo motors with electromagnetic brakes to prevent a drop at a power failure. (This application is also used in multistory parking garages.)

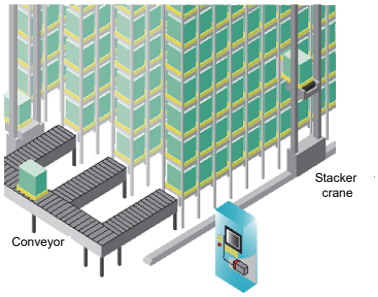


Automatic warehouses/picking systems

More automatic warehouses introduce AC servos into their picking parts and running parts to meet the needs of speeding up.

Smooth acceleration at a high speed can be achieved by adopting AC servo motors.

Automatic warehouses and picking systems connected with supply chain management (SCM) significantly improves the storage management efficiency of logistics from obtaining materials to product delivery.



The lifting device uses a servo motor with an electromagnetic brake.

[Fault description]

It was informed by the site that a strange smell comes from the motor, so the motor was replaced with a spare one as a temporary measure. When the faulty motor was examined, the brake lining was found to be worn.

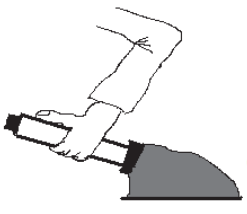
[Cause of fault]

From the motor analysis results, the motor might have been rotated with the brake locked.

Point

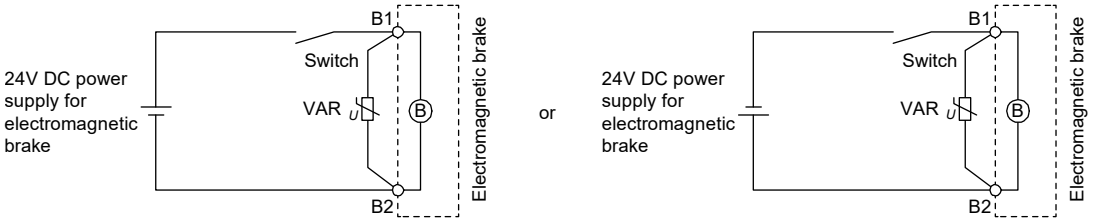
- The electromagnetic brake is designed to hold the motor shaft. Do not use it for normal braking.
  Even when the electromagnetic brake is accidentally locked as in this case, it is possible for the motor to rotate because the maximum torque of the motor is greater than the static friction torque.

  (Similar example)
  The electromagnetic brake works like the hand brake in a vehicle.
  Even when the hand brake is applied, the vehicle can be forced to move by pressing the accelerator.



Power supply for electromagnetic brake

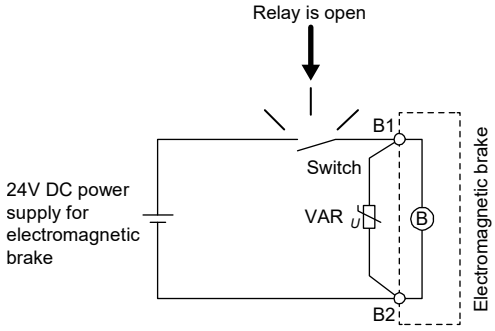
Prepare a dedicated power supply for the electromagnetic brake as described below. The electromagnetic brake terminals (B1 and B2) have no polarity.



Be sure to install a surge absorber between B1 and B2.

The following 5 points were examined, and the main cause was identified as 4).

1) Is 24V DC for interface internal power supply output (VDD) used? Table below (Note 4)
2) Is the capacity of 24V DC sufficient?
3) Has a voltage drop caused the voltage in the electromagnetic brake to drop to 21.6V or less (24V DC -10%)?
4) Has the relay between 24V DC and the electromagnetic brake failed to switch on and is it open? (Is the wiring of the relay disconnected?)



5) Is the electromagnetic brake power cable disconnected?

The characteristics of a rotary servo motor electromagnetic brake designed to hold the motor shaft are as follows.

• HK-KT series

Item		HK-KT053WB HK-KT13WB HK-KT1M3WB HK-KT13UWB	HK-KT23WB HK-KT43(4)WB HK-KT63(4)WB	HK-KT23UWB HK-KT43UWB	HK-KT7M3(4)WB HK-KT103(4)WB	HK-KT7M3UWB HK-KT103UWB	HK-KT153(4)WB HK-KT203(4)WB HK-KT202(4)WB
Type*1		Spring actuated type safety brake					
Rated voltage*4		24V DC (-10 - 0%)					
Power consumption at 20°C [W]		6.4	7.9	8.2	10	9.0	13.8
Coil resistance*6 [Ω]		91	73	70	57	64	42
Inductance*6 [H]		0.14	0.20	0.19	0.16	0.23	0.15
Brake static friction torque*7 [N•m]		0.48 or more	1.9 or more	1.3 or more	3.2 or more	3.2 or more	9.5 or more
Release delay time*2 [s]		0.03	0.03	0.03	0.04	0.03	0.09
Braking delay time [s]	DC off*2	0.01	0.02	0.02	0.02	0.03	0.03
Permissible braking work [J]	Per braking	5.6	22	22	64	66	64
	Per hour	56	220	220	640	660	640
Brake looseness at servo motor shaft*5 [degree]		2.5	1.2	0.9	0.9	0.9	0.9
Brake life*3	Number of braking times	20000	20000	20000	20000	20000	20000
	Work per braking [J]	5.6	22	22	64	33	64
Selection example of surge absorbers to be used*6	For the suppressed voltage 125V	TND20V-680KB (Manufactured by Nippon Chemi-Con Corporation)					
	For the suppressed voltage 350V	TND10V-221KB (Manufactured by Nippon Chemi-Con Corporation)					

*1: There is no manual release mechanism. Supply 24V DC to release the electromagnetic brake electrically.

*2: This is the value for the initial suction gap at 20°C.

*3: The brake gap widens due to the wear of the brake lining caused by braking, but the gap cannot be adjusted. Therefore, the period until adjustment is required is defined as the brake life.

*4: Provide a dedicated power supply for the electromagnetic brake.

*5: This value is a design value. It is not a guaranteed value.

*6: Select the relay for electromagnetic brake control appropriately, taking into consideration the characteristics of the electromagnetic brake and the surge absorber. If a diode is used for the surge absorber, the operating time of the electromagnetic brake will be longer.

*7: The brake static friction torque is the lower limit value in the initial state at 20°C.

• HK-ST series

Item		HK-ST52(4)WB HK-ST102(4)WB HK-ST172(4)WB	HK-ST202(4)AWB HK-ST302(4)WB	HK-ST202(4)WB HK-ST352(4)WB HK-ST5024WB
Type*1		Spring actuated type safety brake		
Rated voltage*4		24V DC (-10 - 0%)		
Power consumption at 20°C [W]		20	23	34
Coil resistance*5 [Ω]		29	25	17
Inductance*5 [H]		0.05	0.25	0.06
Brake static friction torque*7 [N•m]		8.5 or more	16 or more	44 or more
Release delay time*2 [s]		0.04	0.12	0.1
Braking delay time [s]	DC off*2	0.03	0.03	0.03
Permissible braking work	Per braking [J]	400	400	4500
	Per hour [J]	4000	4000	45000
Brake looseness at servo motor shaft*5 [degree]		0.2 to 0.6	0.01 to 0.6	0.2 to 0.6
Brake life*3	Number of braking times	20000	5000	20000
	Work per braking [J]	200	400	1000
Selection example of surge absorbers to be used*6	For the suppressed voltage 125V	TND20V-680KB (Manufactured by Nippon Chemi-Con Corporation)		
	For the suppressed voltage 350V	TND10V-221KB (Manufactured by Nippon Chemi-Con Corporation)		

*1: There is no manual release mechanism. Supply 24V DC to release the electromagnetic brake electrically.

*2: This is the value for the initial suction gap at 20°C.

*3: The brake gap widens due to the wear of the brake lining caused by braking, but the gap cannot be adjusted. Therefore, the period until adjustment is required is defined as the brake life.

*4: Provide a dedicated power supply for the electromagnetic brake.

*5: This value is a design value. It is not a guaranteed value.

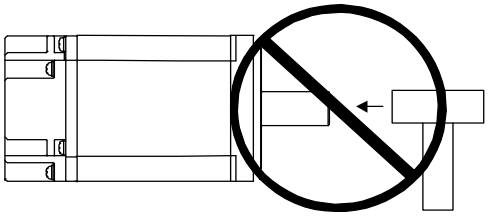
*6: Select the relay for electromagnetic brake control appropriately, taking into consideration the characteristics of the electromagnetic brake and the surge absorber. If a diode is used for the surge absorber, the operating time of the electromagnetic brake will be longer.

*7: The brake static friction torque is the lower limit value in the initial state at 20˚C.

(4) Load mounting/dismounting precautions

Precautions

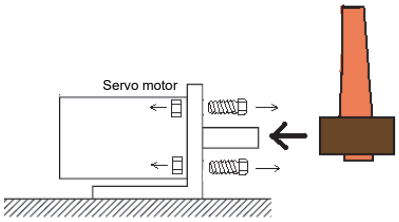
- To prevent a malfunction on the encoder, the shaft end must not be hammered during assembly.



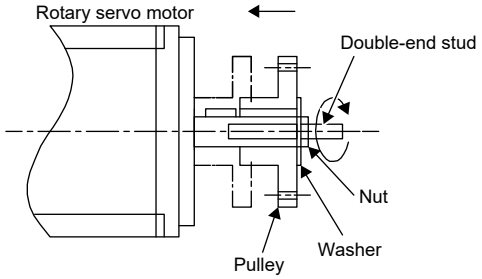
- Do not process the shaft to avoid damage to the encoder and bearing.

Fault example: Handling of servo motor
[Fault description]
When assembling the test device, a servo motor from a device that was not in use was installed, but this caused a detector error at power-on.

[Cause of fault]
Upon examination of the faulty motor, a crack was found in the glass disk of the encoder.
The servo motor taken from a device that was not in use was removed with a wooden hammer.
(Use of that hammer was thought to be OK because it was made of wood.)



• When mounting a pulley to the rotary servo motor with a keyed shaft, use the screw hole in the shaft end. To fit the pulley, first insert a double-end bolt into the screw hole of the shaft, put a washer against the end face of the coupling, and insert and tighten a nut to force the pulley in.

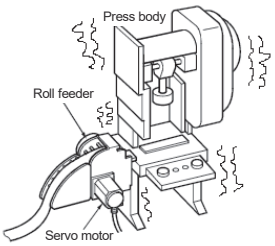


• For the shaft without a keyway, use a friction coupling or the like.
• When removing the pulley, use a pulley remover to protect the shaft from excessive load and impact.
• To ensure safety, fit a protective cover or the like on the rotary area, such as the pulley, mounted to the shaft.
• When a threaded shaft end part is needed to mount a pulley on the shaft, please contact your local sales office.
• The direction of the encoder on the rotary servo motor cannot be changed.
• When mounting the rotary servo motor, use spring washers or similar parts and fully tighten the bolts so that they do not become loose due to vibration.

Fault example: Vibration

[Fault description]

A press device was converted to a servo system and delivered to the customer. However, after about three months, detector errors occurred occasionally, and finally these errors became constant.



[Cause of fault]

Upon examination of the faulty motor, the glass disk of the encoder was found to have come unfastened.

Because vibration was thought to be the cause, the vibration was measured and found to exceed the permissible value.

The environment conditions for use of the servo motor are as follows.

Conditions	Operation	Transport/Storage
Ambient temperature	0 to 60˚C (non-freezing)*2	-15 to 70˚C (non-freezing)
Ambient humidity	10 to 90%RH (non-condensing)	10 to 90%RH (non-condensing)
Ambience*1	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist, dust, nor high magnetic field	
Altitude	2000m or less above sea level*3	
Vibration resistance	HK-KT053W, HK-HT13W, HK-KT1M3W, HK-KT13UW, HK-KT23W/HK-KT43W/HK-KT63W, HK-KT23UW, HK-KT43UW, HK-KT7M3W, HK-KT103W, HK-KT434W, HK-KT634W, HK-KT7M34W, HK-KT1034W	X, Y: 49m/s2
	HK-KT7M3UW, HK-KT103UW	X: 24.5m/s2 Y: 49m/s2
	HK-KT153W, HK-KT203W, HK-KT202W, HK-KT1534W, HK-KT2034W, HK-KT2024W	X, Y: 24.5m/s2
	HK-ST52W, HK-ST102W, HK-ST172W, HK-ST202AW, HK-ST302W, HK-ST202W, HK-ST352W, HK-ST524W, HK-ST1024W, HK-ST1724W, HK-ST2024AW, HK-ST3024W, HK-ST2024W, HK-ST3524W, HK-ST5024W	X: 24.5m/s2 Y: 49m/s2
External magnetic field	10mT or less	

*1: Do not use the device in an environment where it will be constantly exposed to oil mist, oil, or water.

*2: For restrictions on ambient temperature, refer to "Derating" in the Rotary Servo Motor User's Manual (HK Series).

*3: For restrictions when using the motor at an altitude exceeding 1000m above sea level, refer to "Derating" in the Rotary Servo Motor User's Manual (HK Series).

[Fault countermeasure]

The housing has been separated from the press unit so that the vibration is not transmitted to the servo motor.

Also, a spare motor is kept in reserve.

(5) Permissible load for the shaft

For the permissible load for the shaft specific to the rotary servo motor, refer to the Rotary Servo Motor User's Manual (HK series).

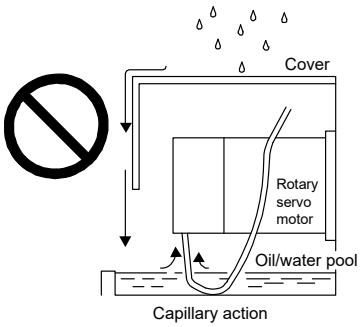
- Use a flexible coupling and adjust the misalignment of the shaft to less than the permissible radial load.
- When using a pulley, sprocket, or timing belt, keep the radial load within the permissible value.
- Exceeding the permissible load can cause deterioration of the bearing and damage to the shaft.
- The load indicated as the permissible load for the shaft is a static load in a single direction and does not include eccentric loads. To prevent the rotary servo motor being damaged, make eccentric loads as small as possible.

Precautions
● Do not use a rigid coupling as it may apply excessive bending load to the shaft of the rotary servo motor, leading the shaft to break and the bearing to wear out.

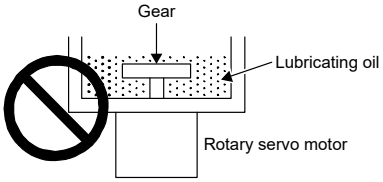
(6) Protection from oil and water

Provide adequate protection to prevent foreign matter, such as oil from entering the rotary servo motor shaft. When installing the rotary servo motor, consider the following items:

• Do not use the rotary servo motor with its cable soaked in oil or water.



• When the servo motor is to be installed with the shaft end upward, provide measures so that it is not exposed to oil and water entering from the machine side, gear box, etc.



• If oil such as cutting oil splashes on the servo motor, the sealant, packing, cable, and other parts may be affected depending on the oil type.

• In the environment where the rotary servo motor is exposed to oil mist, oil, or water, the rotary servo motor of the standard specifications may not be usable. Please contact your local sales office.

Fault example: Load on the servo motor shaft

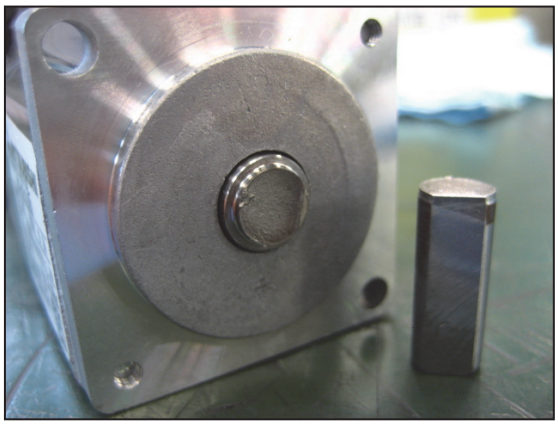
[Fault description]

It was informed by a customer that the shaft of the servo motor of a device supplied more than five years ago had broken.

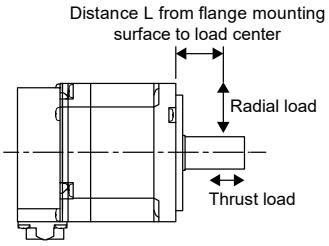
[Cause of fault]

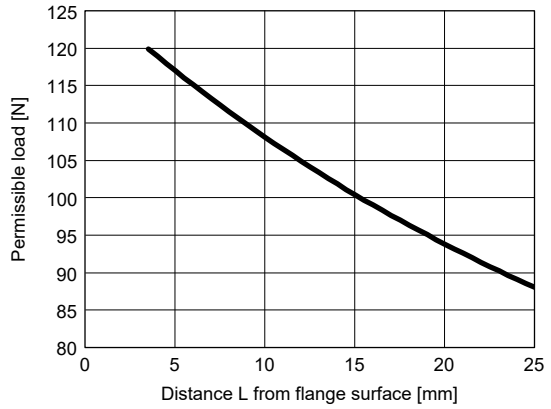
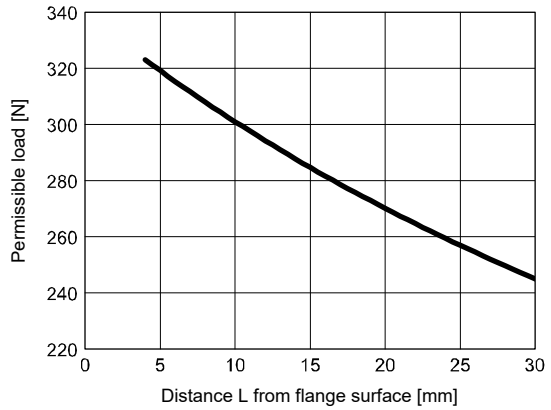
A cross-section of the faulty motor revealed a fatigue fracture.

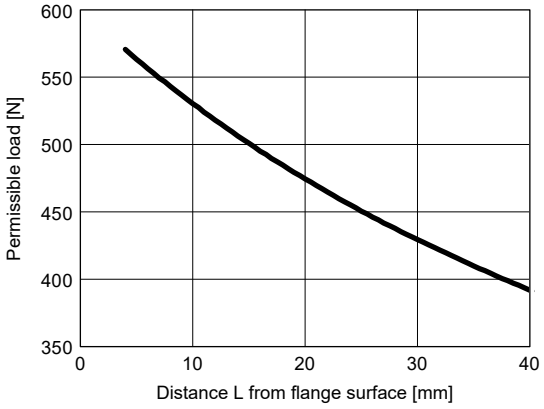
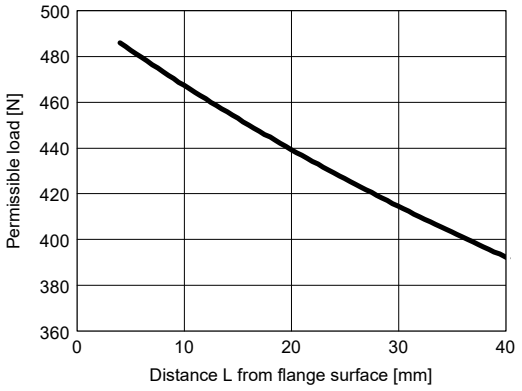
When the radial load was measured, it was found to exceed the permissible value.



The permissible loads for shafts are listed below. Ensure that the shaft is not subjected to loads exceeding the permissible value. These values are the maximum permissible values when these loads are acting independently of each other.



Model	Radial load		Thrust load	Graph of relationship between load and load position
	Load position L [mm]	Load [N]	Load [N]	
HK-KT053W HK-KT13W HK-KT1M3W HK-KT13UW	25	88	59	
HK-KT23W HK-KT43(4)W HK-KT63(4)W HK-KT23UW HK-KT43UW	30	245	98	

Model	Radial load		Thrust load	Graph of relationship between load and load position
	Load position L [mm]	Load [N]	Load [N]	
HK-KT7M3(4)W HK-KT103(4)W HK-KT7M3UW HK-KT103UW	40	392	147	
HK-KT153(4)W HK-KT203(4)W HK-KT202(4)W	40	392	147	

(7) Cables

The power supply and encoder cables routed from the rotary servo motor should be fixed to the rotary servo motor to keep them unmovable. Otherwise, the cable may be disconnected. In addition, do not modify the connectors, terminals, and other areas at the ends of the cables.

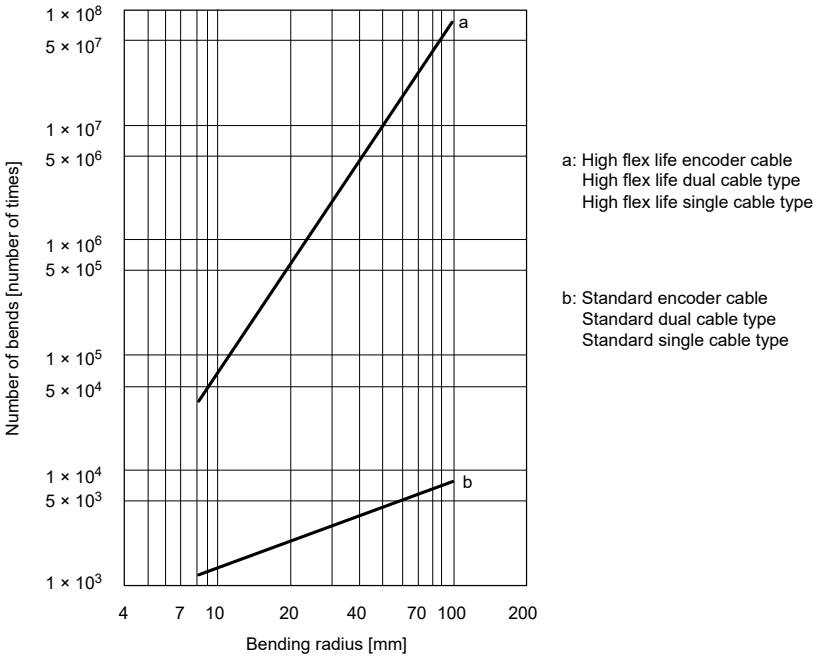
Precautions
● The cables should not be damaged, stressed, loaded, or pinched.

(8) Cable stress

- The method used to clamp the cable must be fully examined so that bending stress and cable's own weight stress are not applied to the cable connection.
- When used for applications where the servo motor moves, fix the cables (encoder, power supply, brake) with gentle slack from the connecting part of each connector to prevent stress from being applied to the connecting part of each servo motor connector. Use the optional motor cable/encoder cable within the flex life range.
- Prevent the cable insulator from being cut by sharp chips or from touching and rubbing against the machine corners.
- Prevent the cables from getting stepped on by workers or run over by vehicles.
- If installing the servo motor that moves on a machine, make the bend radius as large as possible. Refer to "(9) Cable flex life" for the flex life.

(9) Cable flex life

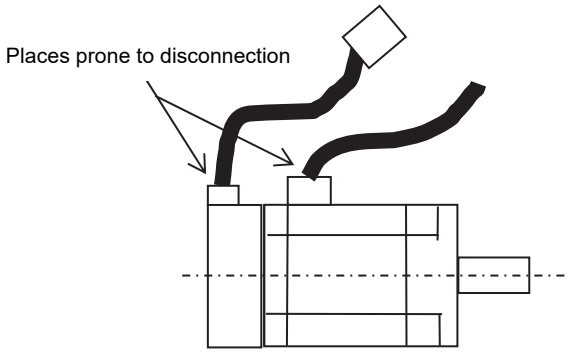
The flex life of the cables is shown below. This graph shows calculated values. Since they are not guaranteed values, provide a slight allowance for these values.

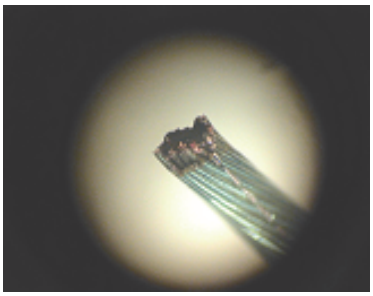


Fault example: Bending of encoder cable
[Fault description]
The servo had an encoder communication error and this error was corrected by replacing the encoder cable.

[Cause of fault]
The encoder cable was disconnected.

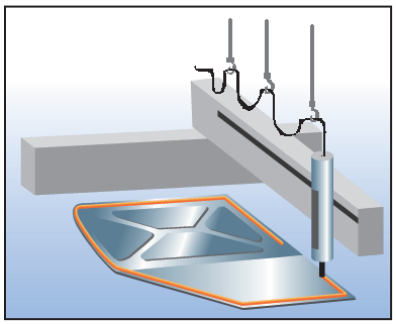
[Fault countermeasure]
The encoder cable from the motor has been fixed in place.





Magnified image of the disconnected portion (15×)

• Similar faults
[Fault description]
The servo used for the main shaft of a sealing device had an encoder communication error, and this was corrected by replacing the relay encoder cable.



The main shaft of the
sealing device moves along the processing path, causing repeated bending of the relay encoder cable.

[Fault countermeasure]
Use a high flex relay cables and also keep spare cable on hand.

7.3.3 Wiring system and sequence

(1) Power-on procedure

Point
● The voltage of analog monitor output, the output signal, or other conditions may be unstable at power-on.

1) Wire the power supply using a magnetic contactor between the power supply and the main circuit power supply (L1/L2/L3) of a servo amplifier by referring to "(2) Connection example" in section 7.3.3. Switch off the magnetic contactor as soon as an alarm occurs.

2) Switch on the control circuit power supply (L11 and L21) simultaneously with the main circuit power supply or before switching on the main circuit power supply. If the main circuit power supply is not on, the display shows the corresponding warning. However, the warning will disappear and the servo amplifier will operate properly if the main circuit is powered on.

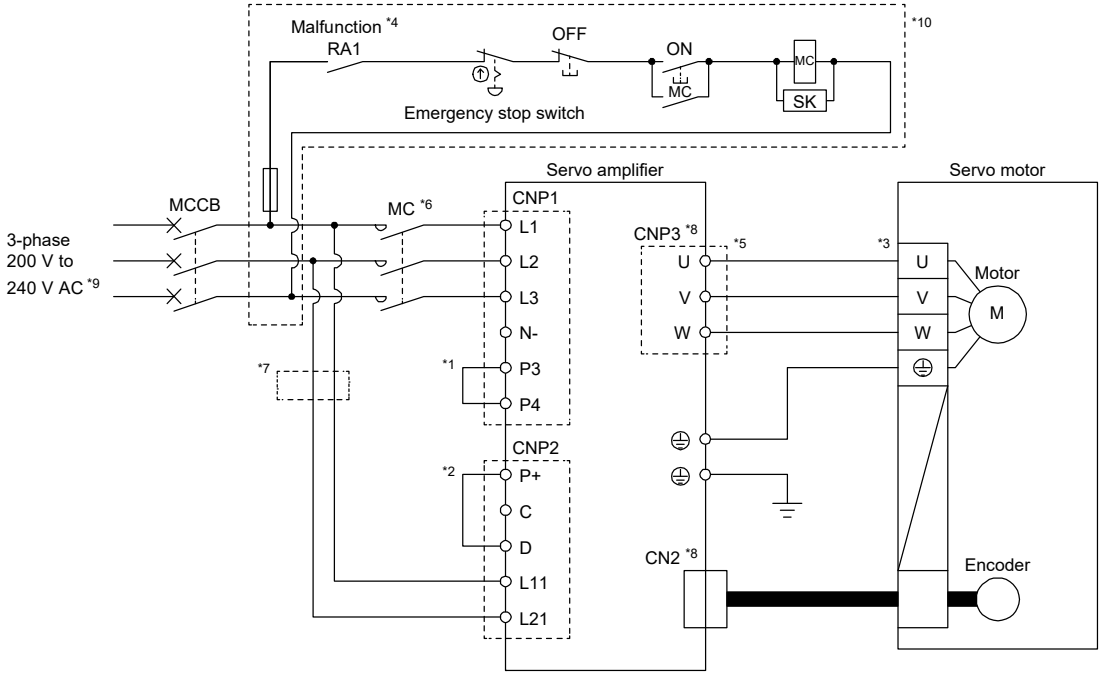
3) The servo amplifier receives SON (Servo-on) 2.5s to 3.5s after the main circuit power supply is powered on.

4) Once RES (Reset) is turned on, the base circuit is shut off and the servo motor shaft coasts.

(2) Connection example

Wire the power supply and main circuit so that the power shuts off when an alarm is detected and SON (Servo-on) turns off at the same time. For the wiring details, refer to Standard connection diagram in section 7.3.4.

Always connect a magnetic contactor between the power supply and the main circuit power supply (L1/L2/L3) of a servo amplifier to configure a circuit that shuts off the power supply on the servo amplifier side.



Wiring of the power supply and the main circuit
(for the MR-J5-10A to MR-J5-350A with 3-phase 200 to 240V AC)

*1: P3 and P4 are connected from the factory. Remove the short-circuit bar between P3 and P4 before connecting a power factor improving DC reactor. Additionally, the power factor improving DC reactor and a power factor improving AC reactor cannot be used together.

*2: Connect the P+ and D terminals. P+ and D are connected from the factory. Refer to "Regenerative option" in the MR-J5 User's Manual (Hardware) when using a regenerative option.

*3: Using optional cables is recommended for servo motor power cables and encoder cables. Refer to the Rotary Servo Motor User's Manual (HK series) for selecting cables.

*4: If ALM (Malfunction) output is disabled with a servo parameter, configure a power circuit which switches off a magnetic contactor after detection of an alarm occurrence on the controller side.

*5: Refer to the Rotary Servo Motor User's Manual (HK series) for connecting servo motor power cables.

*6: Use the magnetic contactor with an operation delay time (interval from current being applied to the coil until closure of contacts) of 80ms or less. The bus voltage may drop depending on the main circuit voltage and operation pattern, causing a dynamic brake deceleration during a forced stop deceleration. If dynamic brake deceleration is not required, delay the time to turn off the magnetic contactor.

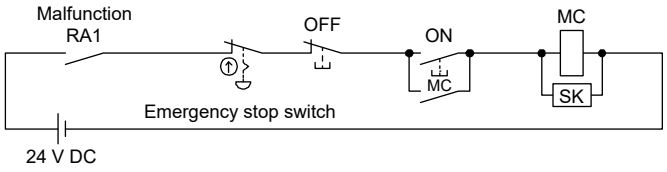
*7: If wires used for L11 and L21 are thinner than wires used for L1, L2, and L3, use a molded-case circuit breaker. Refer to "Molded-case circuit breakers, fuses, magnetic contactors" in the MR-J5 User's Manual (Hardware) for details.

*8: Connecting the servo motor for an incorrect axis to U, V, W, or CN2 of the servo amplifier may cause a malfunction.

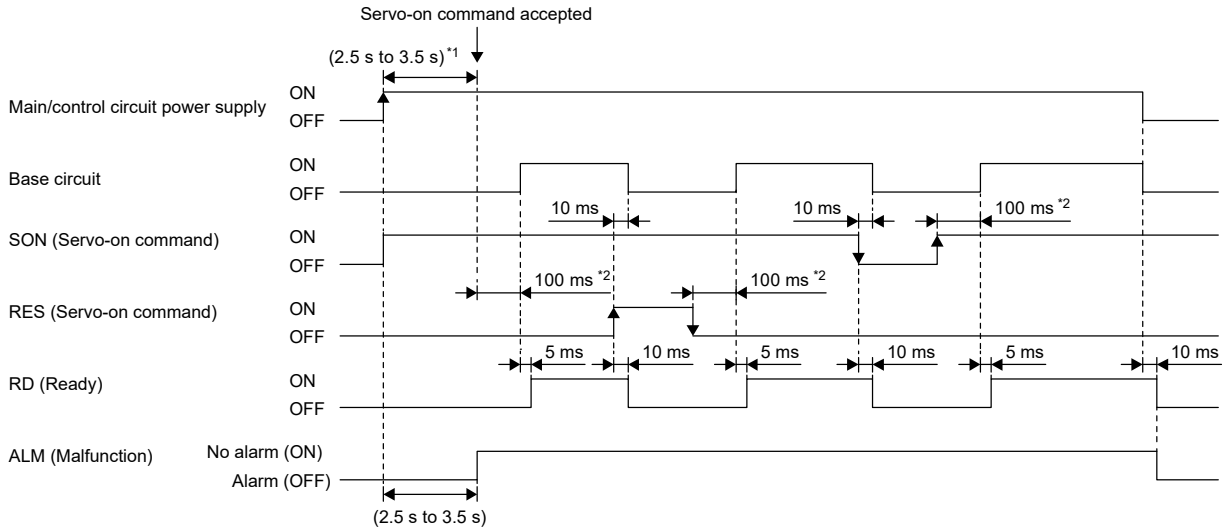
*9: For 1-phase 200 to 240V AC power supply, connect the power supply to L1 and L3. Leave L2 open.

*10: If operating the on switch and off switch of the main circuit power supply with a DC power supply, do not share the 24V DC power supply for interface with the magnetic contactor. Use the power supply designed exclusively for the magnetic contactor. Refer to "Driving on/off of main circuit power supply with DC power supply [G] [A]" in the MR-J5 User's Manual (Hardware) for the available magnetic contactors.

Operating the on switch and off switch with the DC power supply meets IEC/EN 60204-1 requirements. Also, change the configuration of the part inside the dotted line as follows.



(3) Timing chart



Timing chart at power-on

*1: For a linear servo system, this is "4.5 to 5.5s".

*2: The time will be longer in the magnetic pole detection of a linear servo motor and direct drive motor.

(4) Timing chart at alarm occurrence

This function displays an alarm or warning when an error occurs during operation. When an alarm occurs, ALM (Malfunction) turns off and the servo motor stops. When a warning occurs, the servo motor may not stop for each warning number.

The stop method changes depending on whether the forced stop deceleration function is enabled or disabled. However, even if the forced stop deceleration function is enabled, the forced stop deceleration may not be effective and the servo motor may stop with the dynamic brake or other methods, depending on the alarm that has occurred.

After deactivating the alarm or warning, resume the operation. Refer to the MR-J5 User's Manual (Troubleshooting) for the details of alarms and warnings.

Point

- When an alarm occurs, remove its cause, check that the operation signal is not being inputted, ensure safety, and deactivate the alarm before restarting the operation.
- In the torque control mode, the forced stop deceleration function cannot be used.

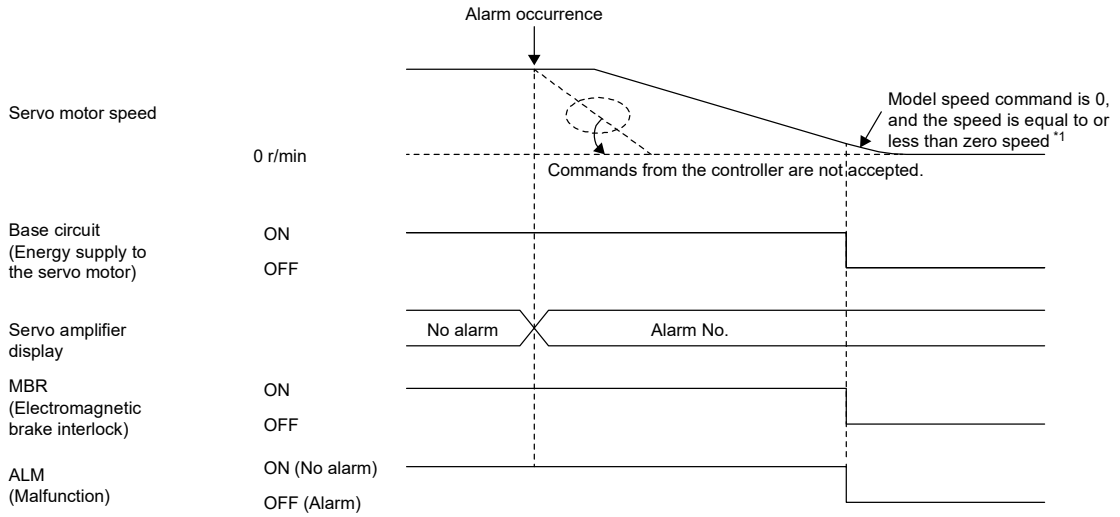
The following table shows how to deactivate the alarm.

Alarm deactivation	Explanation
Alarm reset	• The controller sends an error reset command. • Click "Occurred Alarm Reset" in the "Alarm Display" window of MR Configurator2. • Turn on RES (Reset) with an input device. • Push the "SET" button while the display of the servo amplifier is in the current alarm display mode.
Power cycling	• Cycle the power. • Perform the software reset with commands from the controller and MR Configurator2. Refer to step 4 of"(1) Parameter settings" in section 2.4.4 for how to reset the software.

(a) When using the forced stop deceleration function

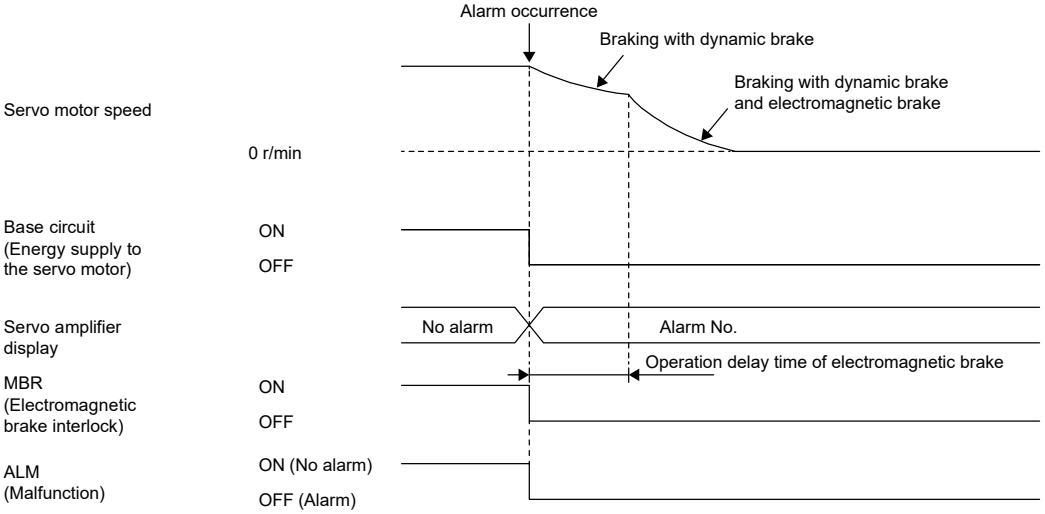
Point
● When [Pr.PA04.3 Forced stop deceleration function selection] is set to "2" (Forced stop deceleration function enabled)

1) Stopping with the forced stop deceleration function
When an alarm is detected, the servo motor stops using forced stop deceleration and MBR and ALM are turned off.



*1: The model speed command is a speed command generated in the servo amplifier for forced stop deceleration of the servo motor.

2) Stopping with dynamic brake
When an alarm is detected, MBR and ALM are turned off, and the servo motor stops using the dynamic brake and electromagnetic brake.



(b) When the forced stop deceleration function is not used

Point

● When [Pr.PA04.3 Forced stop deceleration function selection] is set to "0" (Forced stop deceleration function disabled)

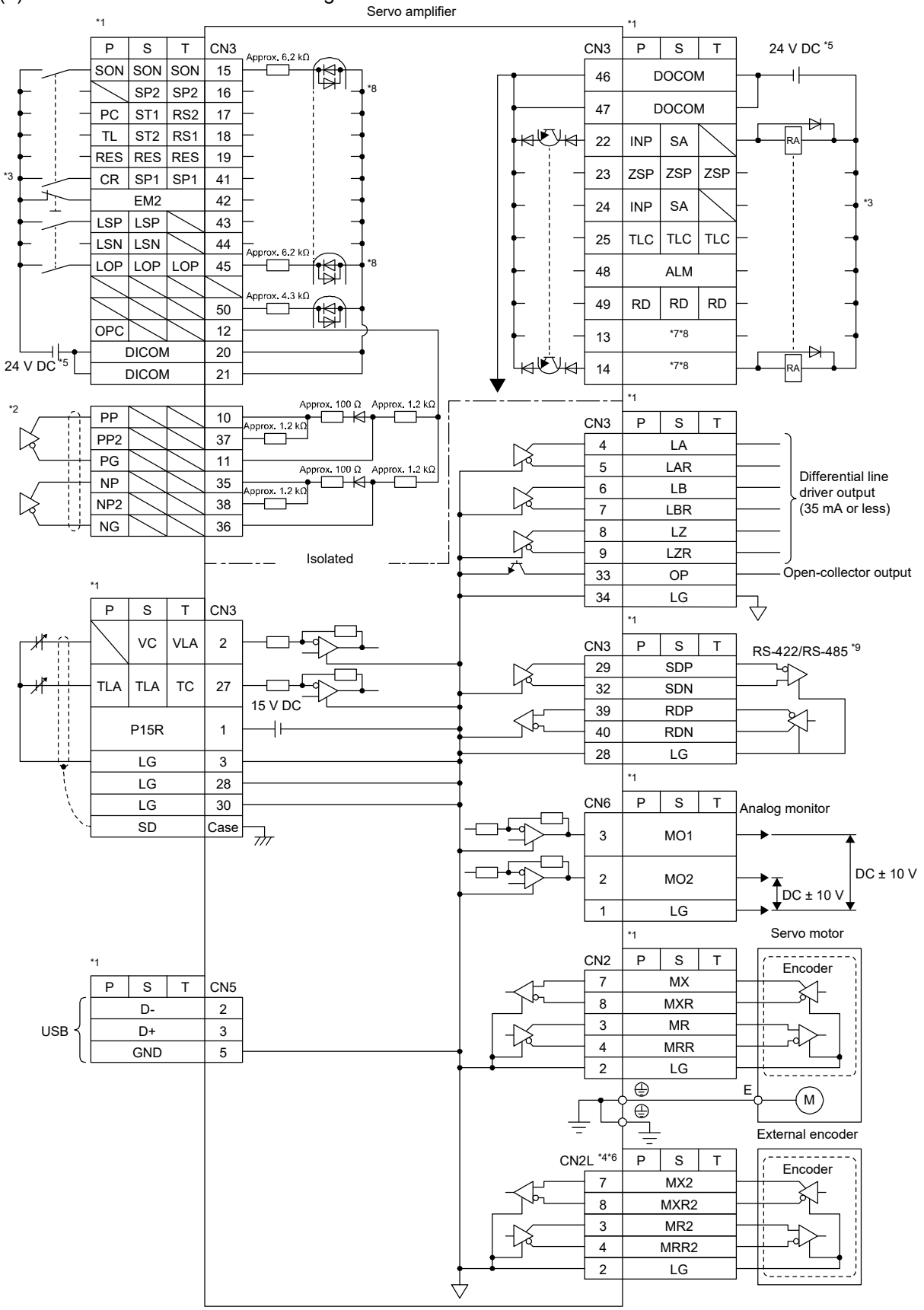
The operation status during an alarm occurrence or network communication shut-off is the same as "2) Stopping with dynamic brake" in section 7.3.3 (4) (a).

1) Regenerative error
When a regenerative error (AL.030) occurs, repeatedly canceling the alarm by turning off and on the control circuit power supply to continue the operation may cause accidents due to the heat generated by the external regenerative resistor.

2) Momentary power failure of the power supply
Undervoltage (AL.010) occurs when the input power supply is in the following states.
• The power failure of the control circuit power supply continues for 60ms or more, and the control circuit is not completely turned off.
• The bus voltage drops to 200V DC or less for MR-J5-□A.

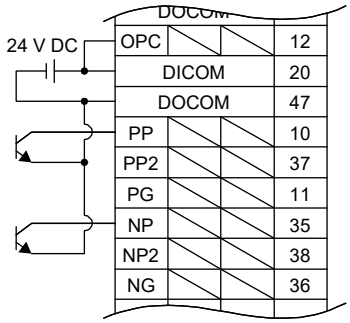
3) With position control mode (incremental)
When an alarm occurs, the home position is erased. When operation is restarted after clearing the alarm, execute home position return.

(5) Interface internal connection diagram

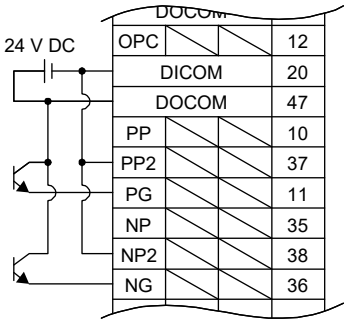


*1: P: Position control mode, S: Speed control mode, T: Torque control mode

*2: This is for the differential line driver pulse train input. For the open-collector pulse train input, connect as follows.



For sink input interface



For source input interface

*3: This diagram shows a sink I/O interface. Refer to "Source I/O interface" in the MR-J5 User's Manual (Hardware) for source I/O interfaces.

*4: This is for the MR-J5-_A_-RJ_ servo amplifier. The MR-J5-_A_ servo amplifier does not have the CN2L connector.

*5: Although the diagram shows the input signal and the output signal each using a separate 24V DC power supply for illustrative purposes, the system can be configured to use a single 24V DC power supply.

*6: Refer to "Parts identification" in the MR-J5 User's Manual (Introduction) for connecting an external encoder.

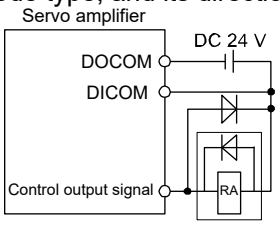
*7: Output devices are not assigned by default. Assign the output devices with [Pr.PD47] as necessary.

*8: If the MR-J5-_A_-RJ_ is used, the values in the CN3-16 pin and the CN3-45 pin are approximately 4.3kΩ.

*9: RS-422 and RS-485 are not supported.

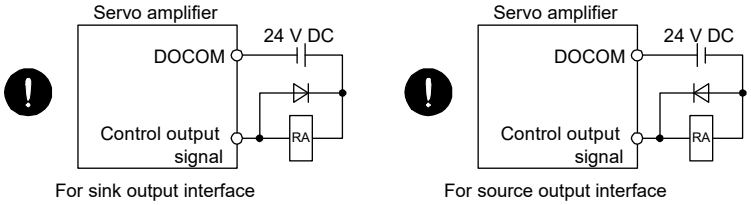
Fault example: No control output
[Fault description]
Control output signals ALM, ZSP, TLC, and INP are not output.

[Cause of fault]
The internal components for servo amplifier control output were burnt out.
Even though the direction of the surge absorbing diode was correct, the relay mounted was a built-in diode type, and its direction was incorrect.



Point

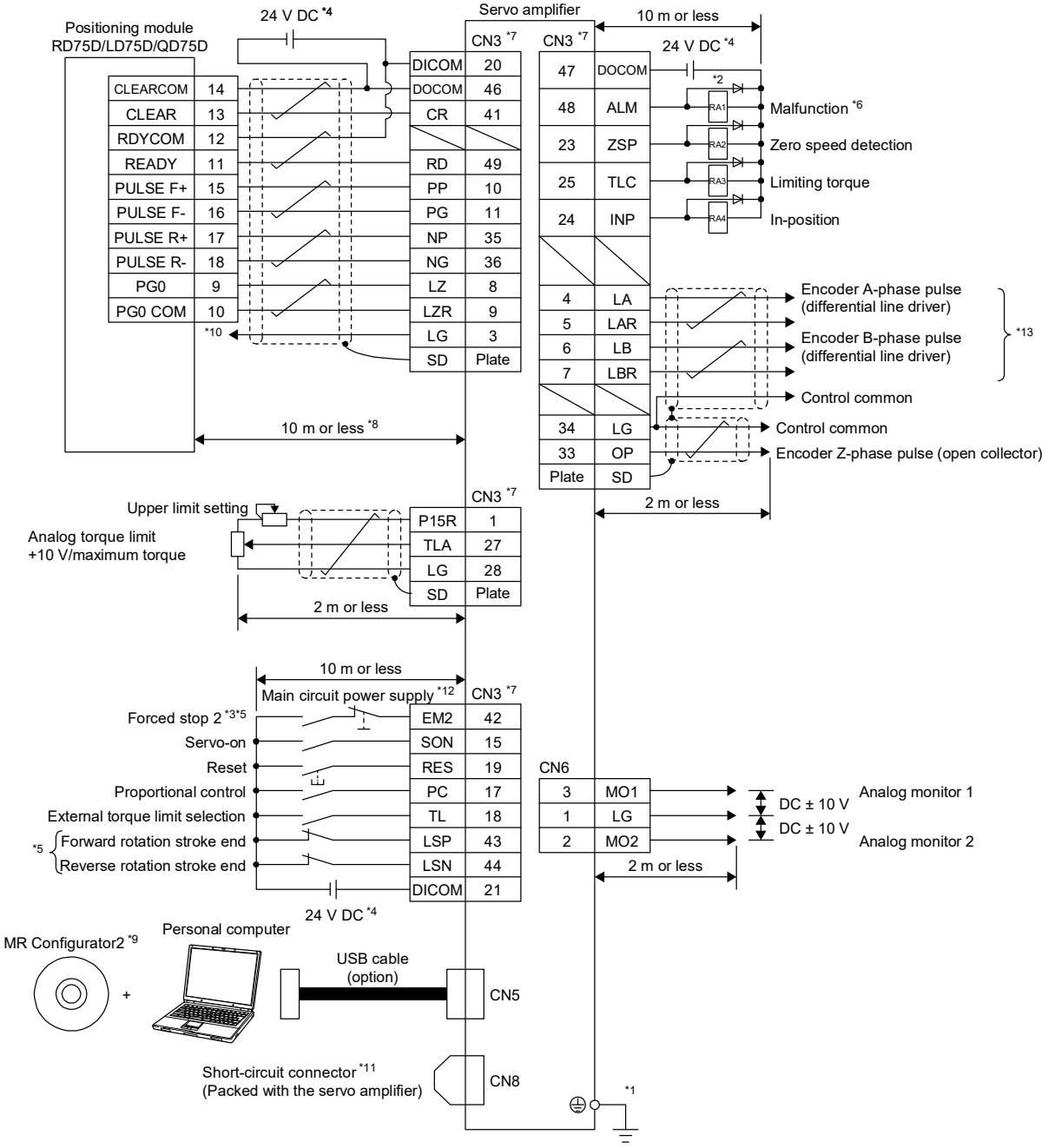
- Connect the surge absorbing diode in the correct direction. Failing to do so may cause the amplifier to malfunction and not to output signals, disabling protective circuits such as the emergency stop.



7.3.4 Standard connection diagram

(1) Position control

(a) Sink I/O interface



Connection I in position control

*1: To prevent an electric shock, connect the protective earth (PE) terminal (the terminal marked with the ⏚ symbol) of the servo amplifier to the protective earth (PE) of the cabinet.
*2: Connect the diode in the correct direction. If it is connected reversely, the servo amplifier may malfunction and not output signals, disabling protective circuits such as EM2 (Forced stop 2).
*3: Install a forced stop switch (normally closed contact).
*4: Supply 24V DC ± 10% to interfaces from an external source. The total current capacity of these power supplies is 500mA maximum. The amperage will not exceed 500mA when all the I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to "Digital input interface DI-1" in the MR-J5 User's Manual (Hardware) for the current required for the interfaces.
Although the diagram shows the input signal and the output signal each using a separate 24V DC power supply for illustrative purposes, the system can be configured to use a single 24V DC power supply.
*5: When starting operation, turn on EM2 (Forced stop 2), LSP (Forward rotation stroke end), and LSN (Reverse rotation stroke end) (normally closed contact).
*6: If no alarm is occurring, ALM (Malfunction) is on (normally closed contact). If an alarm occurs, stop programmable controller's signals with a sequence program.
*7: The pins with the same signal name are connected in the servo amplifier.
*8: This length applies when the command pulse train input is the differential line driver type. For the open-collector type, connect them within 2m.
*9: Use the SW1DNC-MRC2-_.
*10: This connection is not required when the positioning module is RD75D, LD75D, or QD75D. However, to enhance noise tolerance, it is recommended to connect LG of the servo amplifier and control common.
*11: If not using the STO function, attach the short-circuit connector that came with the servo amplifier.
*12: To prevent an unexpected restart of the servo amplifier, configure a circuit that turns off EM2 when the main circuit power supply is turned off.
*13: Noise or disconnection of the command cable connected to the controller may cause a position mismatch. To avoid the position mismatch, check the encoder A-phase pulse and encoder B-phase pulse on the controller side.
*14: For source interfaces, the polarity (positive or negative) of the power supply is reversed as compared with sink interfaces.
*15: For source interfaces, CLEAR and CLEARCOM are reversed as compared with sink interfaces.

(b) Connecting minimum necessary I/O signals

Motor operation requires at least the following signals. The output signal does not need to be connected with the motor.

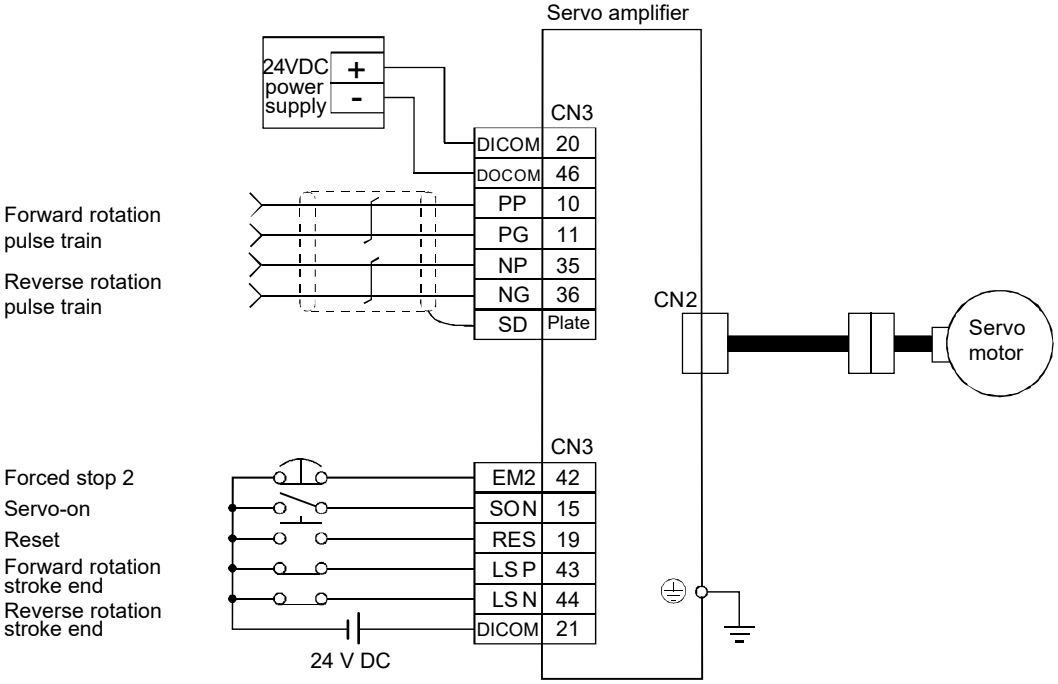
1) Servo-on ····· Needs to be turned on before operation as this is a signal to activate the main circuit. Turning on this signal makes a servo-lock state.

2) Forward/reverse rotation stroke end ··· Connect with limit switches that are normally installed on the load side. Turning off either of these signals disables the motor to rotate in the corresponding direction. The motor can be rotated in the opposite direction. For devices which do not have load-side limit switches such as a roll feed, always short between DOCOM and terminals of the forward/reverse rotation stroke ends.

3) Forward/reverse rotation pulse train ··· When the pulse train is input, the motor rotates in accordance with the number of pulses and pulse frequency. When no pulse trains are input, the motor stops and becomes a servo-lock state.

4) Reset ····· Cancels alarms. This is not an indispensable signal as alarms can also be canceled by turning off the control circuit power supply.
In addition, turning on the reset signal releases the servo-lock state, and the servo motor coasts.

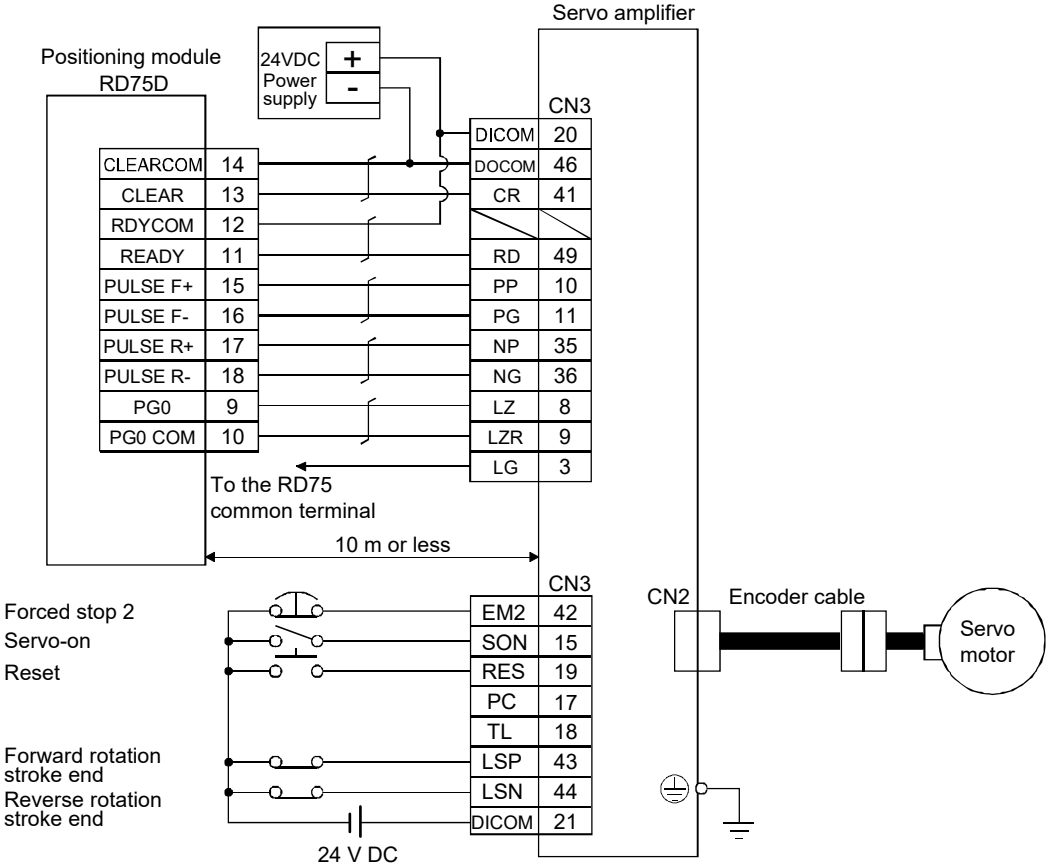
5) Forced stop 2 ····· When EM2 is turned off (open between commons), the servo motor decelerates to a stop with commands. The forced stop will be deactivated if EM2 is turned on (short between commons) while in the forced stop state.



Connection II in position control

(c) Connecting minimum necessary I/O signals for operation with the RD75D

1) Servo-on
2) Forward/reverse rotation stroke end
3) Forward/reverse rotation pulse train ··· Connect with the terminal of the RD75D as shown in the diagram below.
4) Reset
5) Clear ····· Clears the counter at homing.
6) Zero pulse ····· Used as the home position signal at homing.
7) Ready ····· Outputs the servo-on state to the RD75D to use this signal as the interlock signal.
8) Forced stop 2 ····· When EM2 is turned off (open between commons), the servo motor decelerates to a stop with commands. The forced stop will be deactivated if EM2 is turned on (short between commons) while in the forced stop state.



* Refer to the RD75 manual for details of connections relating to the RD75.

Connection III in position control

[Supplementary explanation]

1) Types of pulse train input

The command pulses are generally input using forward/reverse rotation pulse trains in either of the open-collector type or differential type, and the RD75P and RD75D also use this method.

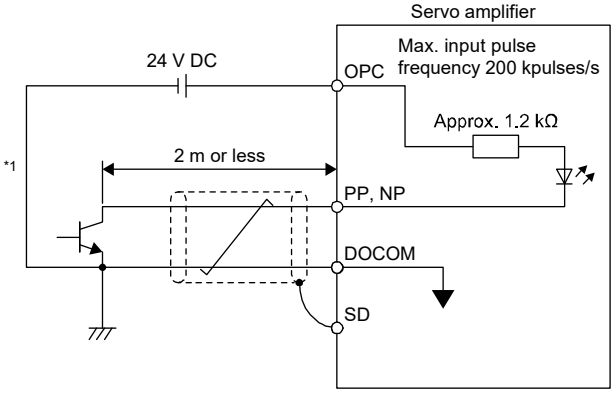
To support pulse trains of the various command modules besides the RD75P and RD75D, the MR-J5 series servo amplifiers are also compatible with the pulse trains shown below by switching the parameter settings.

1) Types of pulse train form

Refer to 13) [Pr.PA13_Command pulse input form (*PLSS)] in section 7.3.6 (3)(b) for command pulse input form.

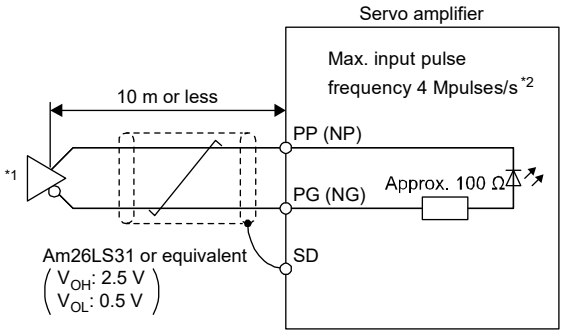
2) Types of hardware

Applicable configuration can be selected from the following in accordance with the hardware of the command module.



*1: A photocoupler is used as the pulse train input interface. Therefore, this circuit does not operate properly due to reduction in current if a resistor is connected to the pulse train signal line.

Open-collector type



*1: A photocoupler is used as the pulse train input interface. Therefore, this circuit does not operate properly due to reduction in current if a resistor is connected to the pulse train signal line.

*2: Set [Pr.PA13.2] to "0" to use the input pulse frequency of 4Mpulses/s.

Differential line driver type

2) Torque limit

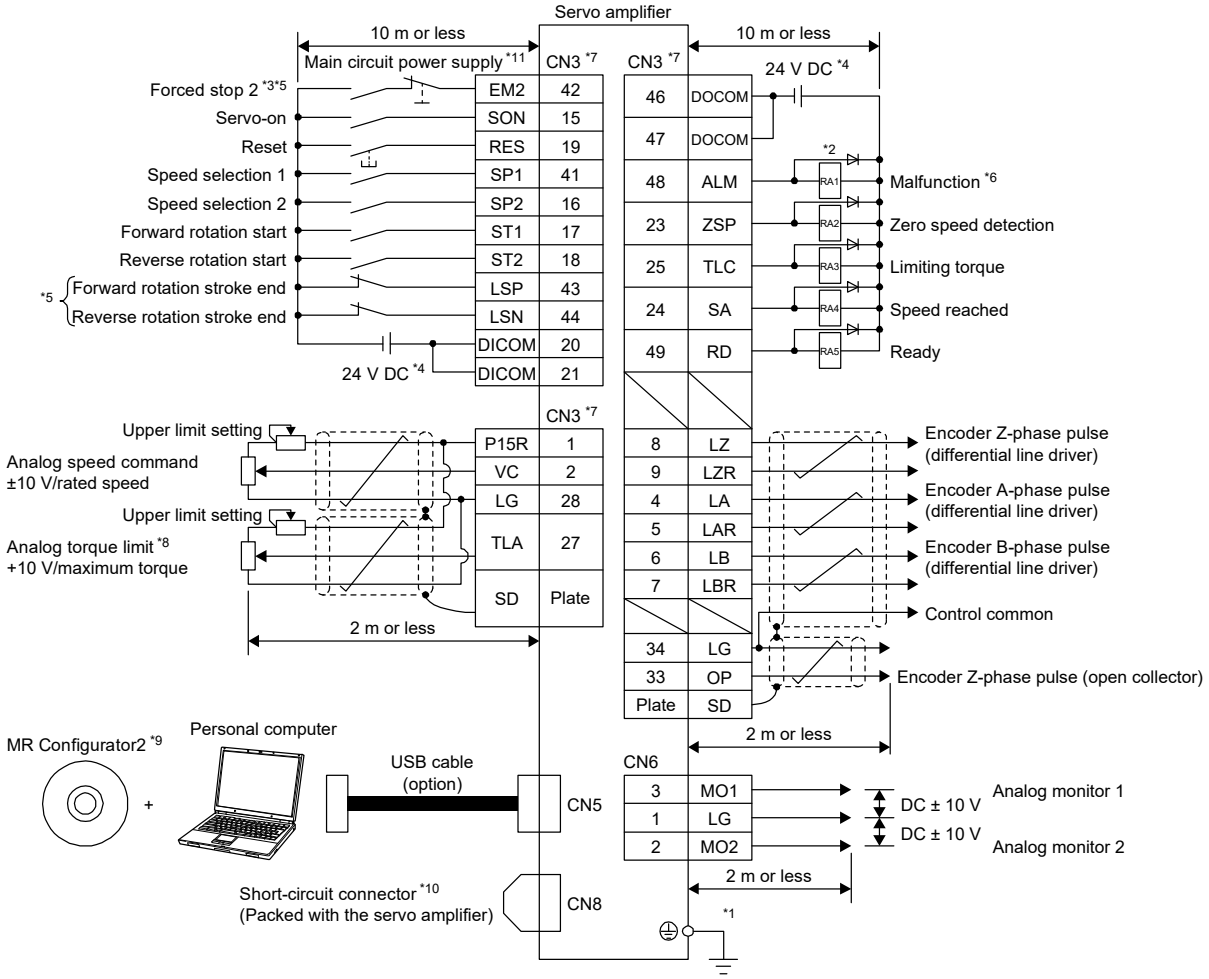
The torque limit function limits the torque generated by the servo motor.

The following torque limit can be set. The torque limit function can be used by switching the following limit values.

Item	Outline
Internal torque limit	The maximum torque is limited by the values of [Pr.PA11 Forward rotation torque limit] and [Pr.PA12 Reverse rotation torque limit].
Internal torque limit 2	The generated torque is limited by the value of [Pr.PC35 Internal torque limit 2].
External analog torque limit	The maximum torque is limited by the value input to the TLA (analog torque limit).

(2) Speed control

(a) Sink I/O interface



Connection I in speed control

*1: To prevent an electric shock, connect the protective earth (PE) terminal (the terminal marked with the ⏚ symbol) of the servo amplifier to the protective earth (PE) of the cabinet.
*2: Connect the diode in the correct direction. If it is connected reversely, the servo amplifier may malfunction and not output signals, disabling protective circuits such as EM2 (Forced stop 2).
*3: Install a forced stop switch (normally closed contact).
*4: Supply 24V DC ± 10% to interfaces from an external source. The total current capacity of these power supplies is 500mA maximum. The amperage will not exceed 500mA when all the I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to "Digital input interface DI-1" in the MR-J5 User's Manual (Hardware) for the current required for the interfaces.
Although the diagram shows the input signal and the output signal each using a separate 24V DC power supply for illustrative purposes, the system can be configured to use a single 24V DC power supply.
*5: When starting operation, turn on EM2 (Forced stop 2), LSP (Forward rotation stroke end), and LSN (Reverse rotation stroke end) (normally closed contact).
*6: If no alarm is occurring, ALM (Malfunction) is on (normally closed contact).
*7: The pins with the same signal name are connected in the servo amplifier.
*8: TLA will be available when TL (External torque limit selection) is enabled with servo parameters ([Pr.PD03] to [Pr.PD22]). For details, refer to the MR-J5 User's Manual (Function).
*9: Use the SW1DNC-MRC2-_.
*10: If not using the STO function, attach the short-circuit connector that came with the servo amplifier.
*11: To prevent an unexpected restart of the servo amplifier, configure a circuit that turns off EM2 when the main circuit power supply is turned off.
*12: For source interfaces, the polarity (positive or negative) of the power supply is reversed as compared with sink interfaces.

(b) Connecting minimum necessary I/O signals

Motor operation requires at least the following signals. The output signal does not need to be connected with the motor.

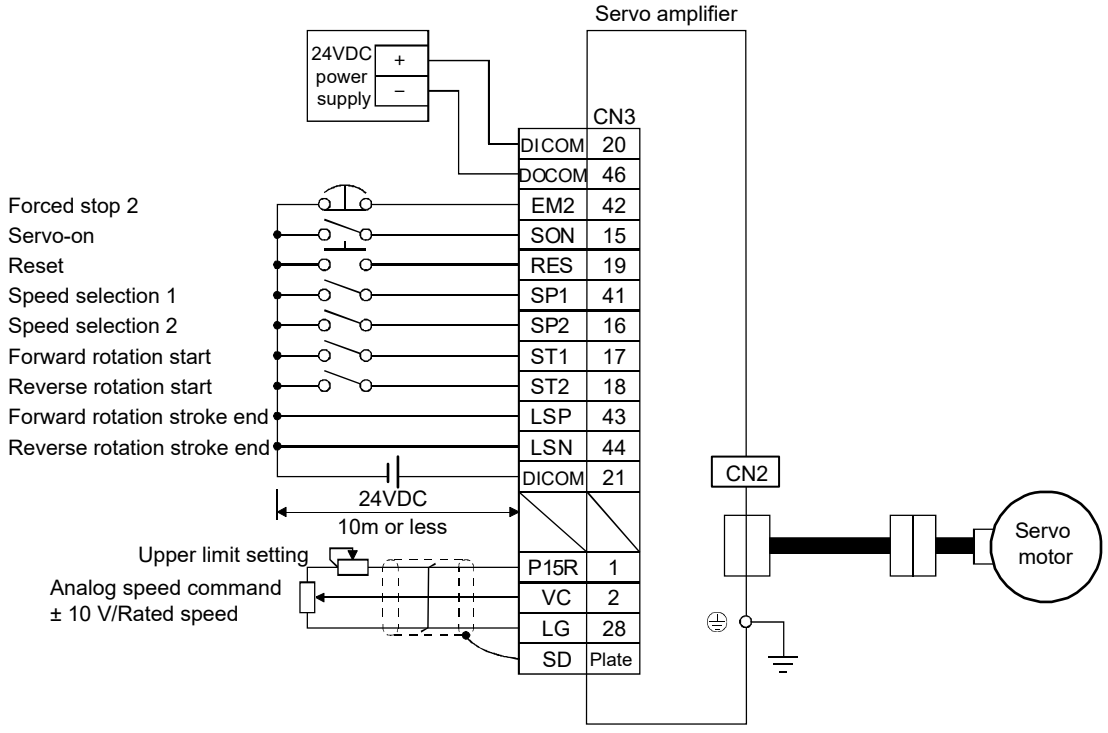
1) Servo-on ····· Needs to be turned on before operation as this is a signal to activate the main circuit.
Turning on this signal makes a servo-lock state.

2) Speed selection 1 and 2 ····· Select whether to set the speed command to the parameter setting value or the external analog setting value.
The figure below is for the external analog speed command.

3) Forward/reverse rotation start ··· Used as the start signals.

4) Reset ····· Cancels alarms. This is not an indispensable signal as alarms can also be canceled by turning off the control circuit power supply.
In addition, turning on the reset signal releases the servo-lock state, and the servo motor coasts.

5) Forced stop 2 ····· When EM2 is turned off (open between commons), the servo motor decelerates to a stop with commands. The forced stop will be deactivated if EM2 is turned on (short between commons) while in the forced stop state.



Connection II in speed control

[Supplementary explanation] Speed command circuit configuration

1) SP1 (Speed selection 1)/SP2 (Speed selection 2) and speed command value
The speed command can be selected with SP1 (Speed selection 1) and SP2 (Speed selection 2).

Input devices*1		Speed command value
SP2	SP1	
0	0	VC (Analog speed command)
0	1	[Pr.PC05 Internal speed 1]
1	0	[Pr.PC06 Internal speed 2]
1	1	[Pr.PC07 Internal speed 3]

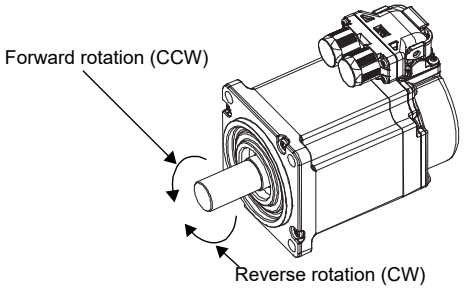
*1: 0: OFF
1: On

When SP3 (Speed selection 3) is enabled with the settings of [Pr.PD03 Input device selection 1] to [Pr.PD22 Input device selection 10], internal speed 4 to 7 can be selected.

Input devices*1			Speed command value
SP3	SP2	SP1	
0	0	0	VC (Analog speed command)
0	0	1	[Pr.PC05 Internal speed 1]
0	1	0	[Pr.PC06 Internal speed 2]
0	1	1	[Pr.PC07 Internal speed 3]
1	0	0	[Pr.PC08 Internal speed 4]
1	0	1	[Pr.PC09 Internal speed 5]
1	1	0	[Pr.PC10 Internal speed 6]
1	1	1	[Pr.PC11 Internal speed 7]

*1: 0: OFF
1: ON

2) ST1 (Forward rotation start)/ST2 (Reverse rotation start)
The motor starts and stops by ST1 (Forward rotation start) and ST2 (Reverse rotation start). Turning off or on both ST1 and ST2 decelerates the motor to a stop, then makes a servo-lock state.
When the speed setting is configured using an external analog voltage, the relations between the motor rotation direction and the current polarity or start signal are as shown in the following table.



Input devices*1		Rotation direction*2			
ST2	ST1	VC (Analog speed command)			Internal speed
		Polarity: +	0V	Polarity: -	
0	0	Stop (Servo-lock)	Stop (Servo-lock)	Stop (Servo-lock)	Stop (Servo-lock)
0	1	CCW	Stop (No servo-lock)	CW	CCW
1	0	CW		CCW	CW
1	1	Stop (Servo-lock)	Stop (Servo-lock)	Stop (Servo-lock)	Stop (Servo-lock)

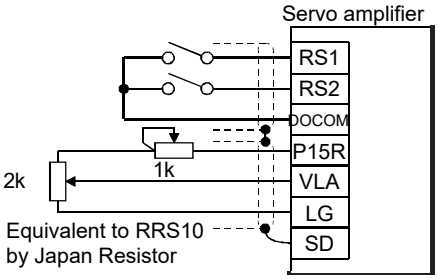
*1: 0: OFF
1: ON

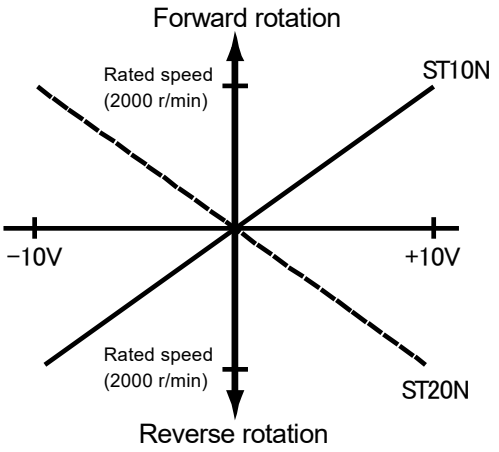
*2: If the torque limit is canceled during servo-lock, the servo motor may suddenly rotate, depending on the amount of the position deviation from the command position.

3) External wiring example

The following shows a configuration of a speed command circuit using an external analog voltage.

1) When operating the motor in forward/reverse directions using only ⊕ of the analog voltage polarity





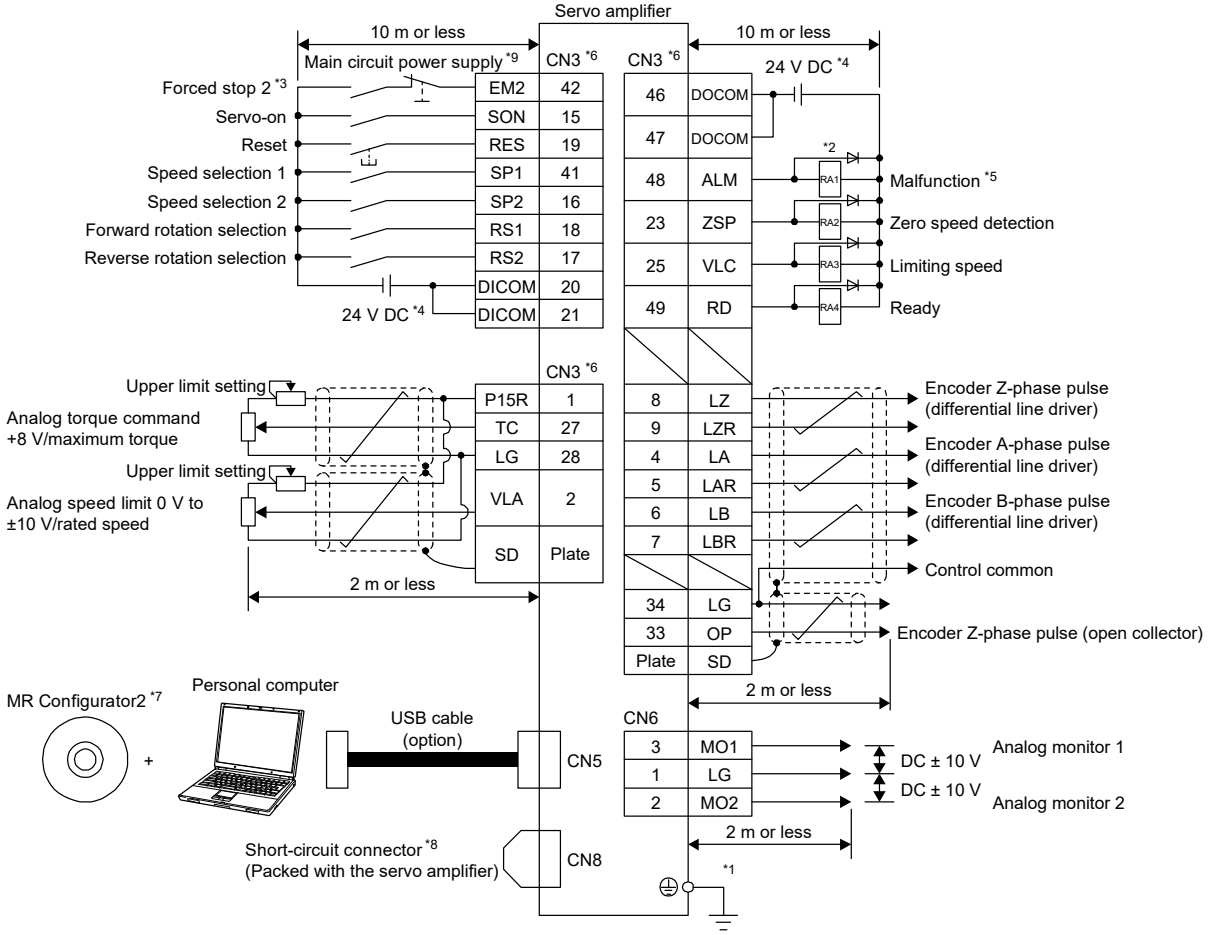
Speed command circuit configuration I

4) Torque limit

For the torque limit, refer to the supplementary explanation in "2) Torque limit" in section 7.3.4 (1)(c).

(3) Torque control

1) Sink I/O interface



Torque control connection

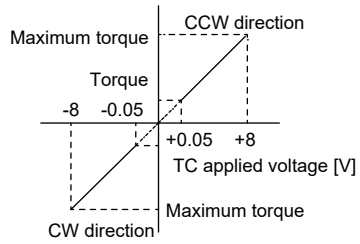
*1: To prevent an electric shock, connect the protective earth (PE) terminal (the terminal marked with the ⏚ symbol) of the servo amplifier to the protective earth (PE) of the cabinet.
*2: Connect the diode in the correct direction. If it is connected reversely, the servo amplifier may malfunction and not output signals, disabling protective circuits such as EM2 (Forced stop 2).
*3: Install a forced stop switch (normally closed contact).
*4: Supply 24V DC ± 10% to interfaces from an external source. The total current capacity of these power supplies is 500mA maximum. The amperage will not exceed 500mA when all the I/O signals are used. Reducing the number of I/O points decreases the current capacity. Refer to "Digital input interface DI-1" in the MR-J5 User's Manual (Hardware) for the current required for the interfaces.
Although the diagram shows the input signal and the output signal each using a separate 24V DC power supply for illustrative purposes, the system can be configured to use a single 24V DC power supply.
*5: If no alarm is occurring, ALM (Malfunction) is on (normally closed contact).
*6: The pins with the same signal name are connected in the servo amplifier.
*7: Use the SW1DNC-MRC2-_.
*8: If not using the STO function, attach the short-circuit connector that came with the servo amplifier.
*9: To prevent an unexpected restart of the servo amplifier, configure a circuit that turns off EM2 when the main circuit power supply is turned off.
*10: For source interfaces, the polarity (positive or negative) of the power supply is reversed as compared with sink interfaces.

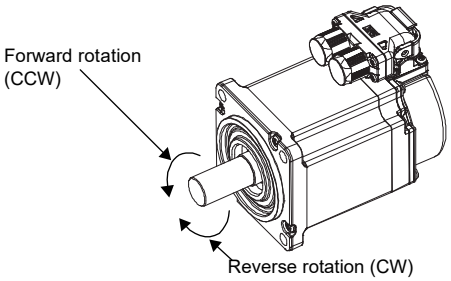
[Supplementary explanation]

1) Torque control

a) Torque command and torque

The relationship between the applied voltage of the analog torque command (TC) and the torque of the servo motor is shown below.± The maximum torque is generated at 8V. The torque at ±8V input can be changed with [Pr.PC13 Analog torque command maximum output].





Torque control level (when RS1 is ON)

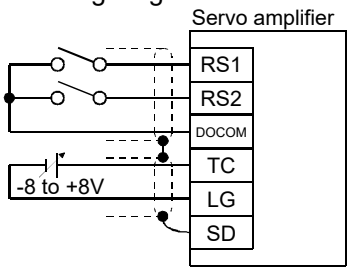
The output torque command value with respect to the voltage varies by about 5% from product to product. Moreover, if the voltage is low (-0.05 to 0.05V) and the actual speed is close to the limit value, the torque may fluctuate. In such a case, increase the speed limit value.

The torque generation direction can be selected by using RS1 (forward rotation selection), RS2 (reverse rotation selection), and TC (analog torque command).

Input devices*1		Rotation direction		
RS2	RS1	TC (Analog torque command)		
		Polarity: +	0V	Polarity: -
0	0	No torque	No torque	No torque
0	1	CCW (forward rotation power running/reverse rotation regeneration)		CW (reverse rotation power running/forward rotation regeneration)
1	0	CW (reverse rotation power running/forward rotation regeneration)		CCW (forward rotation power running/reverse rotation regeneration)
1	1	No torque		No torque

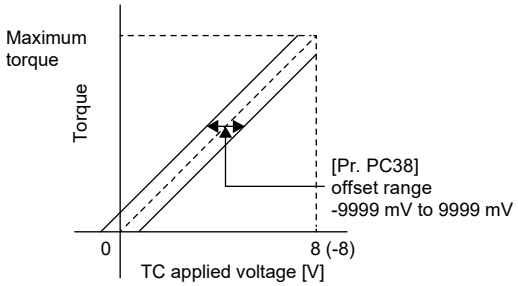
*1: 0: OFF
1: ON

b) Connection diagram
Perform connection according to the following diagram.



Connection example

c) Analog torque command offset
An offset voltage of -9999 to 9999mV can be added to the TC applied voltage with [Pr.PC38 Analog command input 2 offset], as follows.



Analog torque command offset range

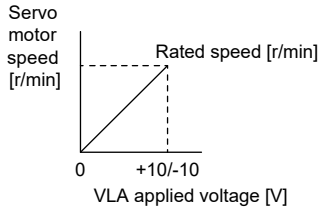
2) Torque limit
When [Pr.PA11 Forward rotation torque limit] and [Pr.PA12 Reverse rotation torque limit] are set, the maximum torque is always limited during operation. The relationship between the limit value and servo motor torque is the same as in the description of the position control mode. However, an analog torque limit (TLA) cannot be used.

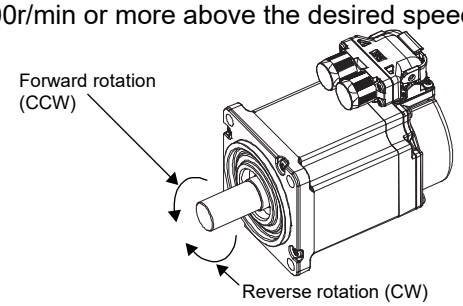
3) Speed limit

a) Speed limit value and rotation speed

The speed is limited to the speed set in [Pr.PC05 Internal speed 1] to [Pr.PC11 Internal speed 7] or the speed set by the applied voltage of the analog speed limit (VLA). The relationship between the applied voltage of the analog speed limit (VLA) and the speed of the servo motor is shown below.

When the servo motor speed reaches the speed limit value, torque control may become unstable. Increase the set value by 100r/min or more above the desired speed limit.





VLA applied voltage and rotation speed (When RS1 is ON)

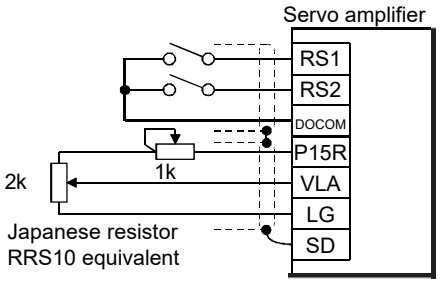
The limit direction according to RS1 (Forward rotation selection) and RS2 (Reverse rotation selection) is shown below.

Input devices*1		TC (Analog torque command)		Speed limit direction		
RS1	RS2			Analog speed limit (VLA)		Internal speed limit
		Voltage polarity	Torque command direction	Polarity: +	Polarity: -	
1	0	Polarity: +	CCW	CCW	CCW	CCW
		Polarity: -	CW	CW	CW	CW
0	1	Polarity: +	CW	CW	CW	CW
		Polarity: -	CCW	CCW	CCW	CCW

*1: 0: OFF
1: ON

b) Connection diagram

Normally, perform connection according to the following diagram.



Connection example 1

Torque limit and torque control

Because the torque generated by the motor is proportional to the current, the torque generated by the motor can be freely controlled by controlling the current of the AC servo motor.

Usually, an AC servo motor (synchronous type) has a maximum torque of 300% or more. When controlling the position and speed, control to keep the torque from exceeding a certain value is called "torque limiting".

On the other hand, control to maintain the generated torque of the motor at a certain value is known as "torque control".

Torque limiting is used for example to protect the gear reducer and to limit the force during pressing operation, controlling the load and preventing the application of greater force than necessary to the machine.

Torque control is used for example in winding devices to keep the force (tension) applied to the material constant even when the speed changes. The speed depends on the generated torque and the load torque.

c) Speed limit value selection

The speed limit can be selected with SP1 (Speed selection 1), SP2 (Speed selection 2), and SP3 (Speed selection 3).

Input devices*1			Speed limit
SP3	SP2	SP1	
0	0	0	Analog speed limit (VLA)
0	0	1	[Pr.PC05 Internal speed 1]
0	1	c	[Pr.PC06 Internal speed 2]
0	1	1	[Pr.PC07 Internal speed 3]
1	0	0	[Pr.PC08 Internal speed 4]
1	0	1	[Pr.PC09 Internal speed 5]
1	1	0	[Pr.PC10 Internal speed 6]
1	1	1	[Pr.PC11 Internal speed 7]

*1: 0: OFF
1: ON

When the speed is limited by internal speed 1 to 7, speed variation caused by ambient temperature does not occur.

d) Limiting speed (VLC)

VLC changes to ON when the servo motor speed reaches the speed limited by internal speed 1 to 7 or the analog speed limit.

7.3.5 Power-on

(1) Checking

Check the installation and wiring performed in sections 7.3.2 "Installation" and 7.3.3 "Wiring system and sequence" thoroughly again before turning on the power.

(a) Installation ····· Check the installation condition in accordance with section 7.3.2 "Installation". Specifically, check the influence of the heating element inside the cabinet upon the servo amplifier ambient temperature, whether the heating element is contacting the cables, and the waterproof/oil prevention measures of the servo motor.

(b) Wiring ····· Check the wiring in accordance with "Wiring system and sequence" in section 7.3.3. The wiring must be carefully checked because an incorrect wiring of the main circuit may damage the module.

The items to be checked are shown below. Refer to each installation guide or instruction manual for model-specific details that are not mentioned here.

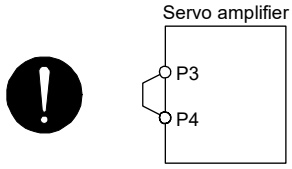
(2) Wiring

Before switching on the main circuit and control circuit power supplies, check the following items.

(a) Power supply system wiring

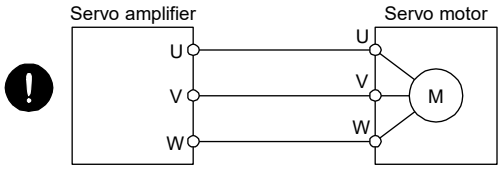
1) Power supply system wiring

- Check that the power supplied to the power input terminals (L1/L2/L3/L11/L21) of the servo amplifier satisfies the defined specifications. For the power supply specifications, refer to "Servo amplifier standard specifications" in the MR-J5 User's Manual (Introduction).
- If the power factor improving DC reactor is not used, check that P3 and P4 are connected.

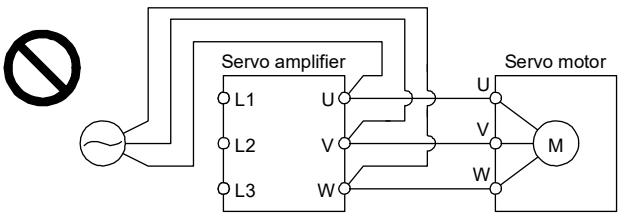


2) Connecting the servo amplifier and the servo motor

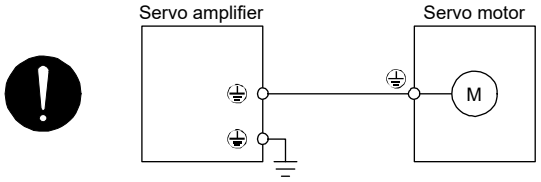
- Check that the phases (U/V/W) of the servo amplifier power outputs and the phases (U/V/W) of the servo motor power inputs match with each other.



- Check that the power to be supplied to the servo amplifier is not connected to the power outputs (U/V/W). This would cause the servo amplifier and servo motor to malfunction.



• Check that the grounding terminal of the servo motor is connected to the PE terminal of the servo amplifier.

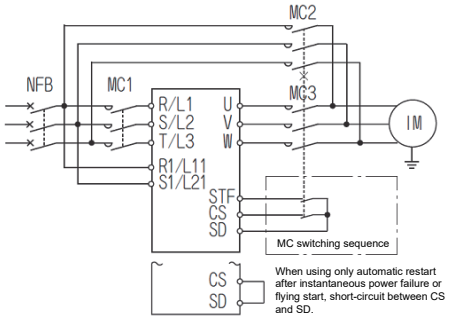


• Check that the CN2 connector of the servo amplifier is securely connected to the encoder of the servo motor using a motor cable or encoder cable.

Fault example: Motor connection
[Fault description]
For the first time, we hired an external company to assemble a device.
During the meeting, the external company told us they were experienced in the use of inverters, so no need to worry. However, the fact that this would be their first time using servos was a little bit of a concern.
Not too long after that, we were informed that the motor had overheated and burned at startup.

[Cause of fault]
The servo motor was directly connected to AC power.
The following inverter connection diagram was referred to and AC power was directly supplied via the MC.
The motor did not rotate, and while this was being investigated, the motor rapidly heated up and emitted an abnormal smell.

<Inverter connection example>



3) Using options or peripheral equipment

1) Regenerative option

• Check that the lead wire between terminal P+ and terminal D has been removed.
• Check that the wire of the regenerative option is connected to terminal P+ and terminal C.
• Check that twisted wires have been used for connecting the regenerative option to the servo amplifier.

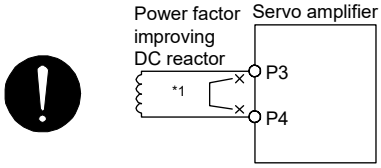
Refer to "Connection of regenerative option" in the MR-J5 User's Manual (Hardware) for details.

2) Simple converter

Refer to "Example of configuration including peripheral equipment" in the MR-J5 User's Manual (Hardware) for details.

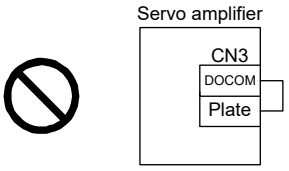
3) Power factor improving DC reactor

• Check that a power factor improving DC reactor is connected between P3 and P4.



(b) I/O signal wiring

• Check that I/O signals are connected correctly.
If the DO forced output mode is used, the pins of the CN3 connector can be forcibly switched on/off. This mode is used to check the wiring. In this case, switch on the control circuit power supply only. Refer to "Example I/O signal connections" in the MR-J5 User's Manual (Hardware) for details of the I/O signal connections.
• Check that a voltage exceeding 24V DC has not been applied to the pins of the CN3 connector.
• Check that the plate and DOCOM of the CN3 connector have not been shorted.



(3) Surrounding environment

Check the following items about the environment surrounding the servo amplifier and servo motor.

(a) Handling cables

• Check that the wiring cables have not been stressed.
• Check that the encoder cable has been used within its flex life.
Refer to "(9) Cable flex life" in section 7.3.2 for details.
• Check that the connector of the servo motor has not been stressed.

(b) Environment

Check that signal cables and power cables have not been shorted primarily by wire offcuts and metallic dust.

7.3.6 Parameter

Digital servos use parameters to perform settings required for analog servos such as gain adjustment and offset adjustment of the analog I/O signals. In addition, the digital servos select a control mode from the position/speed/torque modes and switch the functions. The parameter lists of MR-J5 model servo amplifier are shown in the following.

(1) Lists of servo parameter supported modes

When using this servo in the position control mode, setting mainly the basic setting parameters allows the basic parameters to be set at installation.

(a) Explanation of servo parameters

The following shows the meaning of each abbreviation used in the lists. "○" indicates the modes that can be used, and "-" indicates the modes that cannot be used or modes that are not used even if set.

Mode	Abbreviation	Meaning
Operation mode	Standard	Standard control mode
	Linear	Linear servo motor control mode
	DD	Direct drive motor control mode
	Semi closed	Semi closed loop control mode
	Fully closed	Fully closed loop control mode
Control mode	P	Position control mode
	S	Speed control mode
	T	Torque control mode

(b) Lists of supported control modes

1) Basic setting servo parameters group ([Pr.PA_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PA01	PA01.0	○	○	○	○	○	○	○	○
	PA01.1	○	○	○	○	○	○	○	○
	PA01.4	○	–	○	○	○	○	–	–
PA02	PA02.0-1	○	○	○	○	○	○	○	○
	PA02.4	○	○	○	○	○	○	○	○
	PA02.5	○	○	○	○	○	○	○	○
PA03	PA03.0	○	○	○	○	○	○	–	–
	PA03.1	○	–	–	○	–	–	–	–
PA04	PA04.3	○	○	○	○	○	○	○	–
PA05	–	○	–	○	–	–	○	–	–
PA06	–	○	○	○	○	○	○	–	–
PA07	–	○	○	○	○	○	○	–	–
PA08	PA08.0	○	○	○	○	○	○	○	–
	PA08.4	○	○	○	○	○	○	○	–
	PA08.5	○	○	○	○	○	○	○	–
	PA08.6	○	○	○	○	○	○	○	–
PA09	–	○	○	○	○	○	○	○	–
PA10	–	○	○	○	○	○	○	–	–
PA11	–	○	○	○	○	○	○	○	○
PA12	–	○	○	○	○	○	○	○	○
PA13	PA13.0	○	○	○	○	○	○	–	–
	PA13.1	○	○	○	○	○	○	–	–
	PA13.2	○	○	○	○	○	○	–	–
PA14	–	○	○	○	○	○	○	–	–
PA15	–	○	○	○	○	○	○	○	○
PA16	–	○	○	○	○	○	○	○	○
PA17	–	–	○	○	–	○	○	○	○
PA18	PA18.0-3	–	○	○	–	○	○	○	○
PA19	–	○	○	○	○	○	○	○	○
PA20	PA20.1	○	○	○	○	○	○	○	–
	PA20.2	○	○	○	○	○	○	○	○
PA21	PA21.0	○	○	○	○	○	○	○	–
	PA21.3	○	○	○	○	○	○	–	–
PA22	PA22.1	○	○	○	○	○	○	–	–
PA23	PA23.0-1	○	○	○	○	○	○	○	○
	PA23.2-4	○	○	○	○	○	○	○	○
PA24	PA24.0	○	○	○	○	○	○	○	–
PA25	–	○	○	○	○	○	○	–	–
PA26	PA26.0	○	○	○	○	○	○	○	–
PA28	PA28.4	○	○	○	○	○	○	○	○
PA34	–	○	○	○	○	○	○	○	○

2) Gain/filter setting servo parameters group ([Pr.PB_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PB01	PB01.0	○	○	○	○	○	○	○	○
	PB01.3	○	○	○	○	○	○	○	–
PB02	PB02.0	○	○	○	○	○	○	–	–
	PB02.1	○	○	○	○	○	○	–	–
PB03	–	○	○	○	○	○	○	–	–
PB04	–	○	○	○	○	○	○	–	–
PB06	–	○	○	○	○	○	○	○	–
PB07	–	○	○	○	○	○	○	○	–
PB08	–	○	○	○	○	○	○	–	–
PB09	–	○	○	○	○	○	○	○	–
PB10	–	○	○	○	○	○	○	○	–
PB11	–	○	○	○	○	○	○	○	–
PB12	–	○	○	○	○	○	○	–	–
PB13	–	○	○	○	○	○	○	○	○
PB14	PB14.1	○	○	○	○	○	○	○	○
	PB14.2	○	○	○	○	○	○	○	○
PB15	–	○	○	○	○	○	○	○	○
PB16	PB16.0	○	○	○	○	○	○	○	○
	PB16.1	○	○	○	○	○	○	○	○
	PB16.2	○	○	○	○	○	○	○	○
PB17	PB17.0-1	○	○	○	○	○	○	○	○
	PB17.2	○	○	○	○	○	○	○	○
PB18	–	○	○	○	○	○	○	○	–
PB19	–	○	○	○	○	○	○	–	–
PB20	–	○	○	○	○	○	○	–	–
PB21	–	○	○	○	○	○	○	–	–
PB22	–	○	○	○	○	○	○	–	–
PB23	PB23.0	○	○	○	○	○	○	○	○
	PB23.1	○	○	○	○	○	○	○	–
	PB23.3	○	○	○	○	○	○	○	○
PB24	PB24.0	○	○	○	○	○	○	–	–
PB25	PB25.0	○	○	○	○	○	○	○	–
	PB25.1	○	○	○	○	○	○	–	–
PB26	PB26.0	○	○	○	○	○	○	○	–
	PB26.1	○	○	○	○	○	○	○	–
	PB26.2	○	○	○	○	○	○	○	–
	PB26.4	○	○	○	○	○	○	○	–
	PB26.5	○	○	○	○	○	○	–	–
PB27	–	○	○	○	○	○	○	○	–
PB28	–	○	○	○	○	○	○	○	–
PB29	–	○	○	○	○	○	○	○	–
PB30	–	○	○	○	○	○	○	–	–
PB31	–	○	○	○	○	○	○	○	–
PB32	–	○	○	○	○	○	○	○	–

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PB33	–	○	○	○	○	○	○	–	–
PB34	–	○	○	○	○	○	○	–	–
PB35	–	○	○	○	○	○	○	–	–
PB36	–	○	○	○	○	○	○	–	–
PB45	PB45.0-1	○	○	○	○	○	○	–	–
	PB45.2	○	○	○	○	○	○	–	–
PB46	–	○	○	○	○	○	○	○	○
PB47	PB47.0	○	○	○	○	○	○	○	○
	PB47.1	○	○	○	○	○	○	○	○
	PB47.2	○	○	○	○	○	○	○	○
PB48	–	○	○	○	○	○	○	○	○
PB49	PB49.0	○	○	○	○	○	○	○	○
	PB49.1	○	○	○	○	○	○	○	○
	PB49.2	○	○	○	○	○	○	○	○
PB50	–	○	○	○	○	○	○	○	○
PB51	PB51.0	○	○	○	○	○	○	○	○
	PB51.1	○	○	○	○	○	○	○	○
	PB51.2	○	○	○	○	○	○	○	○
PB52	–	○	○	○	○	○	○	–	–
PB53	–	○	○	○	○	○	○	–	–
PB54	–	○	○	○	○	○	○	–	–
PB55	–	○	○	○	○	○	○	–	–
PB56	–	○	○	○	○	○	○	–	–
PB57	–	○	○	○	○	○	○	–	–
PB58	–	○	○	○	○	○	○	–	–
PB59	–	○	○	○	○	○	○	–	–
PB60	–	○	○	○	○	○	○	○	–
PB65	–	○	○	○	○	○	○	○	–
PB66	–	○	○	○	○	○	○	○	–
PB67	–	○	○	○	○	○	○	○	–
PB68	–	○	○	○	○	○	○	–	–
PB69	–	○	○	○	○	○	○	○	–
PB70	–	○	○	○	○	○	○	○	–
PB71	–	○	○	○	○	○	○	–	–
PB72	–	○	○	○	○	○	○	–	–
PB73	–	○	○	○	○	○	○	–	–
PB74	–	○	○	○	○	○	○	–	–
PB75	–	○	○	○	○	○	○	–	–
PB76	–	○	○	○	○	○	○	–	–
PB77	–	○	○	○	○	○	○	–	–
PB78	–	○	○	○	○	○	○	–	–
PB79	–	○	○	○	○	○	○	○	–
PB81	PB81.4	○	○	○	○	○	○	–	–
PB82	–	○	○	○	○	○	○	–	–

3) Extension setting servo parameters group ([Pr.PC_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PC01	–	○	○	○	–	–	–	○	○
PC02	–	○	○	○	–	–	–	○	○
PC03	–	○	○	○	–	–	–	○	○
PC04	–	○	○	○	–	–	–	–	○
PC05	–	○	○	○	–	–	–	○	○
PC06	–	○	○	○	–	–	–	○	○
PC07	–	○	○	○	–	–	–	○	○
PC08	–	○	○	○	–	–	–	○	○
PC09	–	○	○	○	–	–	–	○	○
PC10	–	○	○	○	–	–	–	○	○
PC11	–	○	○	○	–	–	–	○	○
PC12	–	○	○	○	–	–	–	○	○
PC13	–	○	○	○	–	–	–	–	○
PC14	PC14.0-1	○	○	○	○	○	○	○	○
PC15	PC15.0-1	○	○	○	○	○	○	○	○
PC16	–	○	○	○	○	○	○	○	○
PC17	–	○	○	○	○	○	○	○	○
PC18	PC18.0	○	○	○	○	○	○	○	○
PC19	PC19.0	○	○	○	○	○	○	○	○
	PC19.1	○	○	○	○	○	○	○	○
	PC19.2	○	○	○	○	○	○	–	–
PC22	PC22.3	○	○	○	○	○	○	○	○
PC23	PC23.0	○	○	○	–	–	–	○	–
	PC23.2	○	○	○	–	–	–	○	○
	PC23.3	○	○	○	–	–	–	–	○
PC24	PC24.0	○	○	○	○	○	○	–	–
	PC24.3	○	○	○	○	○	○	–	–
PC26	PC26.0	○	○	○	○	○	○	○	–
	PC26.4	○	○	○	○	○	○	○	○
	PC26.6	○	○	○	○	○	○	○	○
PC27	PC27.2	○	○	○	○	○	○	○	○
	PC27.4	○	○	○	○	○	○	○	○
PC28	PC28.3	–	○	–	–	–	○	○	○
PC29	PC29.0	○	–	–	○	–	○	○	○
	PC29.3	○	○	○	○	○	○	○	○
	PC29.4	○	○	○	○	○	○	○	○
PC30	–	○	○	○	–	–	–	○	○
PC31	–	○	○	○	–	–	–	○	○
PC32	–	○	○	○	○	○	○	–	–
PC33	–	○	○	○	○	○	○	–	–
PC34	–	○	○	○	○	○	○	–	–
PC35	–	○	○	○	○	○	○	○	○
PC36	PC36.0-1	○	○	○	○	○	○	○	○
	PC36.2	○	○	○	○	○	○	○	○

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PC37	–	○	○	○	○	○	○	○	○
PC38	–	○	○	○	○	○	○	○	○
PC39	–	○	○	○	○	○	○	○	○
PC40	–	○	○	○	○	○	○	○	○
PC43	–	○	○	○	○	○	○	–	–
PC44	PC44.3	○	○	○	○	○	○	–	–
PC45	PC45.0	○	○	○	○	○	○	○	○
	PC45.2	○	○	○	○	○	○	○	○
PC50	PC50.0	○	○	○	○	○	○	○	○
	PC50.1	○	○	○	–	–	–	–	○
PC51	–	○	○	○	○	○	○	○	–
PC54	–	○	○	○	○	○	○	–	–
PC60	PC60.0	○	–	–	–	–	○	○	○
	PC60.1	○	○	○	○	○	○	○	○
	PC60.4	○	○	○	○	○	○	○	○
PC73	–	○	○	○	○	○	○	–	–
PC90	–	○	○	○	○	○	○	–	–

4) I/O setting servo parameters group ([Pr.PD_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PD01	PD01.0-7	○	○	○	○	○	○	○	○
PD03	PD03.0-1	○	○	○	○	○	○	–	–
	PD03.2-3	○	○	○	–	–	–	○	–
PD04	PD04.0-1	○	○	○	–	–	–	–	○
PD05	PD05.0-1	○	○	○	○	○	○	–	–
	PD05.2-3	○	○	○	–	–	–	○	–
PD06	PD06.0-1	○	○	○	–	–	–	–	○
PD07	PD07.0-1	○	○	○	○	○	○	–	–
	PD07.2-3	○	○	○	–	–	–	○	–
PD08	PD08.0-1	○	○	○	–	–	–	–	○
PD09	PD09.0-1	○	○	○	○	○	○	–	–
	PD09.2-3	○	○	○	–	–	–	○	–
PD10	PD10.0-1	○	○	○	–	–	–	–	○
PD11	PD11.0-1	○	○	○	○	○	○	–	–
	PD11.2-3	○	○	○	–	–	–	○	–
PD12	PD12.0-1	○	○	○	–	–	–	–	○
PD13	PD13.0-1	○	○	○	○	○	○	–	–
	PD13.2-3	○	○	○	–	–	–	○	–
PD14	PD14.0-1	○	○	○	–	–	–	–	○
PD17	PD17.0-1	○	○	○	○	○	○	–	–
	PD17.2-3	○	○	○	–	–	–	○	–
PD18	PD18.0-1	○	○	○	–	–	–	–	○
PD19	PD19.0-1	○	○	○	○	○	○	–	–

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
	PD19.2-3	○	○	○	–	–	–	○	–
PD20	PD20.0-1	○	○	○	–	–	–	–	○
PD21	PD21.0-1	○	○	○	○	○	○	–	–
	PD21.2-3	○	○	○	–	–	–	○	–
PD22	PD22.0-1	○	○	○	–	–	–	–	○
PD23	PD23.0-1	○	○	○	○	○	○	○	○
PD24	PD24.0-1	○	○	○	○	○	○	○	○
PD25	PD25.0-1	○	○	○	○	○	○	○	○
PD26	PD26.0-1	○	○	○	○	○	○	○	○
PD28	PD28.0-1	○	○	○	○	○	○	○	○
PD29	PD29.0	○	○	○	○	○	○	○	○
	PD29.1	○	○	○	○	○	○	○	○
	PD29.2	○	○	○	○	○	○	–	–
PD30	PD30.0	○	○	○	○	○	○	○	–
	PD30.1	○	○	○	○	○	○	○	○
	PD30.3	○	○	○	○	○	○	○	○
PD31	PD31.2	○	○	○	○	○	○	–	–
PD32	PD32.0	○	○	○	○	○	○	–	–
PD33	PD33.2	○	○	○	○	○	○	○	○
PD34	PD34.1	○	○	○	○	○	○	○	○
PD43	PD43.0-1	○	○	○	○	○	○	–	–
	PD43.2-3	○	○	○	–	–	–	○	–
PD44	PD44.0-1	○	○	○	–	–	–	–	○
PD45	PD45.0-1	○	○	○	○	○	○	–	–
	PD45.2-3	○	○	○	–	–	–	○	–
PD46	PD46.0-1	○	○	○	–	–	–	–	○
PD47	PD47.0-1	○	○	○	○	○	○	○	○
	PD47.2-3	○	○	○	○	○	○	○	○
PD60	PD60.0-7	○	○	○	○	○	○	○	○

5) Extension setting 2 servo parameters group ([Pr.PE_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PE01	PE01.0	○	–	○	○	○	○	–	–
PE03	PE03.0	○	–	○	○	○	○	–	–
	PE03.1	○	–	○	○	○	○	–	–
	PE03.3	○	–	○	○	○	○	–	–
PE04	–	○	–	○	○	○	○	–	–
PE05	–	○	–	○	○	○	○	–	–
PE06	–	○	–	○	○	○	○	–	–
PE07	–	○	–	○	○	○	○	–	–
PE08	–	○	–	○	○	○	○	–	–
PE10	PE10.1	○	–	○	○	○	○	–	–
PE41	PE41.0	○	○	○	○	○	○	○	○
	PE41.6	○	○	○	○	○	○	○	○

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PE44	–	○	○	○	○	○	○	–	–
PE45	–	○	○	○	○	○	○	–	–
PE46	–	○	○	○	○	○	○	–	–
PE47	–	○	○	○	○	○	○	○	○
PE48	PE48.0	○	○	○	○	○	○	–	–
	PE48.1	○	○	○	○	○	○	–	–
PE49	–	○	○	○	○	○	○	–	–
PE50	–	○	○	○	○	○	○	–	–

6) Extension setting 3 servo parameters group ([Pr.PF_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PF02	PF02.4	○	○	○	○	○	–	–	–
	PF02.5	○	○	○	○	○	–	–	–
PF09	PF09.0	○	–	–	○	–	○	○	○
	PF09.1	○	○	○	○	○	○	○	○
PF15	–	○	–	–	○	–	○	○	○
PF18	–	○	○	○	○	○	○	○	○
PF21	–	○	○	○	○	○	○	○	○
PF23	–	○	○	○	○	○	○	○	–
PF24	PF24.0	○	○	○	○	○	○	○	○
PF25	–	○	○	○	○	○	○	○	○
PF31	–	○	○	○	○	○	○	○	○
PF32	–	○	○	○	○	○	○	○	–
PF49	–	○	○	○	○	○	○	○	○
PF50	–	○	○	○	○	○	○	○	○
PF51	PF51.0	○	○	○	○	○	○	○	○
	PF51.1	○	○	○	○	○	○	○	○
	PF51.2	○	○	○	○	○	○	○	○
	PF51.5	○	○	○	○	○	○	○	○
	PF51.6	○	○	○	○	○	○	○	○
PF52	PF52.0	○	○	○	○	○	○	○	○
	PF52.1	○	○	○	○	○	○	○	○
	PF52.2	○	○	○	○	○	○	○	○
	PF52.4	○	○	○	○	○	○	○	○
	PF52.5	○	○	○	○	○	○	○	○
PF53	–	○	○	○	○	○	○	○	○
PF54	–	○	○	○	○	○	○	○	○
PF55	–	○	○	○	○	○	○	○	○
PF56	–	○	○	○	○	○	○	○	○
PF57	–	○	○	○	○	○	○	○	○
PF58	–	○	○	○	○	○	○	○	○
PF66	PF66.0-3	○	–	○	○	○	○	○	–
	PF66.4-7	○	–	○	○	○	○	○	–
PF67	–	○	–	○	○	○	○	○	–

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PF68	–	○	–	○	○	○	○	○	–
PF69	–	○	○	○	○	○	○	○	○
PF70	–	○	○	○	○	○	○	○	○
PF71	PF71.0	○	○	○	○	○	○	○	○
	PF71.1	○	○	○	○	○	○	○	○
PF72	–	○	–	○	○	○	○	○	○
PF73	–	○	–	○	○	○	○	○	○
PF74	–	○	–	○	○	○	○	○	○
PF75	–	○	–	○	○	○	○	○	○
PF76	–	○	–	○	○	○	○	○	○
PF80	PF80.0	○	○	○	○	○	○	○	○
	PF80.2-3	○	○	○	○	○	○	○	○
PF81	PF81.0	○	○	○	○	○	○	○	○
PF82	PF82.0	○	○	○	○	○	○	○	○
	PF82.1	○	○	○	○	○	○	○	○
	PF82.2	○	○	○	○	○	○	○	○
	PF82.3	○	○	○	○	○	○	○	○
PF84	PF84.0-1	○	○	○	○	○	○	○	○
	PF84.2-3	○	○	○	○	○	○	○	○
	PF84.4-5	○	○	○	○	○	○	○	○
PF85	–	○	○	○	○	○	○	○	○
PF86	–	○	○	○	○	○	○	○	○
PF87	PF87.0-2	○	○	○	○	○	○	○	○
	PF87.4-6	○	○	○	○	○	○	○	○
PF88	PF88.0-2	○	○	○	○	○	○	○	○
	PF88.4-6	○	○	○	○	○	○	○	○
PF89	PF89.0-2	○	○	○	○	○	○	○	○
	PF89.4-6	○	○	○	○	○	○	○	○
PF90	PF90.0-2	○	○	○	○	○	○	○	○
PF91	PF91.0-3	○	○	○	○	○	○	○	○
	PF91.4-7	○	○	○	○	○	○	○	○
PF92	PF92.0-3	○	○	○	○	○	○	○	○
	PF92.4-7	○	○	○	○	○	○	○	○
PF93	PF93.0-3	○	○	○	○	○	○	○	○
	PF93.4-7	○	○	○	○	○	○	○	○
PF94	PF94.0-3	○	○	○	○	○	○	○	○
	PF94.4-7	○	○	○	○	○	○	○	○
PF95	PF95.0	○	○	○	○	○	○	○	○

7) Motor extension setting servo parameters group ([Pr.PL_ _])

No.	Detail No.	Operation mode					Control mode		
		Semi closed			Fully closed				
		Standard	Linear	DD	Standard	DD	P	S	T
PL01	PL01.0	–	○	○	–	○	○	○	○
	PL01.2	–	○	–	–	–	○	○	○
PL02	–	–	○	–	–	–	○	○	○
PL03	–	–	○	–	–	–	○	○	○
PL04	PL04.0	–	○	○	–	○	○	○	○
	PL04.3	–	○	○	–	○	○	○	○
PL05	–	–	○	○	–	○	○	–	–
PL06	–	–	○	○	–	○	○	○	–
PL07	–	–	○	○	–	○	○	○	○
PL08	PL08.0	–	○	○	–	○	○	○	○
	PL08.2	–	○	○	–	○	○	○	○
PL09	–	–	○	○	–	○	○	○	○
PL17	PL17.0	–	○	○	–	○	○	○	○
	PL17.1	–	○	○	–	○	○	○	○
PL18	–	–	○	○	–	○	○	○	○

(2) Lists of servo parameter initial values

Abbreviated parameters prefixed with * or ** are enabled after the power is cycled or a software reset is performed.

(a) Basic setting servo parameters group ([Pr.PA_ _])

No.	Abbreviation	Initial value	Unit
PA01	**STY	10003000h	–
PA02	**REG	00000000h	–
PA03	*ABS	00000000h	–
PA04	*AOP1	00002000h	–
PA05	*FBP	10000	pulse
PA06	CMX	1	–
PA07	CDV	1	–
PA08	ATU	00000001h	–
PA09	RSP	16	–
PA10	INP	400	*1
PA11	TLP	1000.0	%
PA12	TLN	1000.0	%
PA13	*PLSS	00000100h	–
PA14	*POL	0	–
PA15	*ENR	4000	pulse/rev
PA16	*ENR2	1	–
PA17	**MSR	00000000h	–
PA18	**MTY	00000000h	–
PA19	*BLK	000000ABh	–
PA20	*TDS	00000000h	–
PA21	*AOP3	00000001h	–
PA22	**PCS	00000000h	–
PA23	DRAT	00000000h	–
PA24	AOP4	00000000h	–
PA25	OTHOV	0	%
PA26	*AOP5	00000000h	–
PA27	For manufacturer setting	00000000h	–
PA28	**AOP6	00000000h	–
PA29	For manufacturer setting	0	–
PA30	For manufacturer setting	0	–
PA31	For manufacturer setting	0	–
PA32	For manufacturer setting	00000000h	–
PA33	For manufacturer setting	0.0	–
PA34	QDIS	0	0.1rev, mm
PA35	For manufacturer setting	00000000h	–
PA36	For manufacturer setting	00000000h	–
PA37	For manufacturer setting	00000000h	–
PA38	For manufacturer setting	00000000h	–
PA39	For manufacturer setting	00000000h	–
PA40	For manufacturer setting	00000000h	–
PA41	For manufacturer setting	00000000h	–
PA42	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PA43	For manufacturer setting	00000000h	–
PA44	For manufacturer setting	00000000h	–

*1: Refer to "10) [Pr.PA10_In-position range (INP)]" in section 7.3.6 (3) (b).

(b) Gain/filter setting servo parameters group ([Pr.PB_ _])

No.	Abbreviation	Initial value	Unit
PB01	FILT	00000000h	–
PB02	VRFT	00000000h	–
PB03	PST	0	ms
PB04	FFC	0	%
PB05	For manufacturer setting	500	–
PB06	GD2	7.00	Multiplier
PB07	PG1	15.0	rad/s
PB08	PG2	37.0	rad/s
PB09	VG2	823	rad/s
PB10	VIC	33.7	ms
PB11	VDC	980	–
PB12	OVA	0	%
PB13	NH1	4500	Hz
PB14	NHQ1	00000000h	–
PB15	NH2	4500	Hz
PB16	NHQ2	00000000h	–
PB17	NHF	00000000h	–
PB18	LPF	3141	rad/s
PB19	VRF11	100.0	Hz
PB20	VRF12	100.0	Hz
PB21	VRF13	0.00	–
PB22	VRF14	0.00	–
PB23	VFBF	00001000h	–
PB24	*MVS	00000000h	–
PB25	*BOP1	00000000h	–
PB26	*CDP	00000000h	–
PB27	CDL	10	*1
PB28	CDT	1	ms
PB29	GD2B	7.00	Multiplier
PB30	PG2B	0.0	rad/s
PB31	VG2B	0	rad/s
PB32	VICB	0.0	ms
PB33	VRF11B	0.0	Hz
PB34	VRF12B	0.0	Hz
PB35	VRF13B	0.00	–
PB36	VRF14B	0.00	–
PB37	For manufacturer setting	1600	–
PB38	For manufacturer setting	0.000	–
PB39	For manufacturer setting	0.000	–
PB40	For manufacturer setting	0.000	–
PB41	For manufacturer setting	00000000h	–
PB42	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PB43	For manufacturer setting	00000000h	–
PB44	For manufacturer setting	0.00	–
PB45	CNHF	00000000h	–
PB46	NH3	4500	Hz
PB47	NHQ3	00000000h	–
PB48	NH4	4500	Hz
PB49	NHQ4	00000000h	–
PB50	NH5	4500	Hz
PB51	NHQ5	00000000h	–
PB52	VRF21	100.0	Hz
PB53	VRF22	100.0	Hz
PB54	VRF23	0.00	–
PB55	VRF24	0.00	–
PB56	VRF21B	0.0	Hz
PB57	VRF22B	0.0	Hz
PB58	VRF23B	0.00	–
PB59	VRF24B	0.00	–
PB60	PG1B	0.0	rad/s
PB61	For manufacturer setting	0.0	–
PB62	For manufacturer setting	00000000h	–
PB63	For manufacturer setting	00000000h	–
PB64	For manufacturer setting	00000000h	–
PB65	CDL2	10	*1
PB66	CDT2	1	ms
PB67	GD2C	7.00	Multiplier
PB68	PG2C	0.0	rad/s
PB69	VG2C	0	rad/s
PB70	VICC	0.0	ms
PB71	VRF11C	0.0	Hz
PB72	VRF12C	0.0	Hz
PB73	VRF13C	0.00	–
PB74	VRF14C	0.00	–
PB75	VRF21C	0.0	Hz
PB76	VRF22C	0.0	Hz
PB77	VRF23C	0.00	–
PB78	VRF24C	0.00	–
PB79	PG1C	0.0	rad/s
PB80	For manufacturer setting	177.0	–
PB81	*CFIL	00000001h	–
PB82	PFT	0.0	ms
PB83	For manufacturer setting	00000000h	–
PB84	For manufacturer setting	00000000h	–
PB85	For manufacturer setting	00000000h	–
PB86	For manufacturer setting	00000000h	–
PB87	For manufacturer setting	00000000h	–
PB88	For manufacturer setting	00000000h	–
PB89	For manufacturer setting	00000000h	–
PB90	For manufacturer setting	00000000h	–
PB91	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PB92	For manufacturer setting	00000000h	–

*1: Refer to the MR-J5 User's Manual (Parameters).

(c) Extension setting servo parameters group ([Pr.PC_ _])

No.	Abbreviation	Initial value	Unit
PC01	STA	0	ms
PC02	STB	0	ms
PC03	STC	0	ms
PC04	TQC	0	ms
PC05	SC1	100.00	r/min, mm/s
PC06	SC2	500.00	r/min, mm/s
PC07	SC3	1000.00	r/min, mm/s
PC08	SC4	200.00	r/min, mm/s
PC09	SC5	300.00	r/min, mm/s
PC10	SC6	500.00	r/min, mm/s
PC11	SC7	800.00	r/min, mm/s
PC12	VCM	0	r/min, mm/s
PC13	TLC	100.0	%
PC14	MOD1	00000000h	–
PC15	MOD2	00000001h	–
PC16	MBR	0	ms
PC17	ZSP	50	r/min, mm/s
PC18	*BPS	00000000h	–
PC19	*ENRS	00000000h	–
PC20	For manufacturer setting	0	–
PC21	For manufacturer setting	00000000h	–
PC22	**COP1	00000000h	–
PC23	*COP2	00000000h	–
PC24	*COP3	00000000h	–
PC25	For manufacturer setting	00000000h	–
PC26	*COP5	00000000h	–
PC27	*COP6	00000000h	–
PC28	*COP7	00000000h	–
PC29	*COP8	00000120h	–
PC30	STA2	0	ms
PC31	STB2	0	ms
PC32	CMX2	1	–
PC33	CMX3	1	–
PC34	CMX4	1	–
PC35	TL2	1000.0	%
PC36	*DMD	00000000h	–
PC37	VCO	0	mV
PC38	TPO	0	mV
PC39	MO1	0	mV
PC40	MO2	0	mV
PC41	For manufacturer setting	0	–
PC42	For manufacturer setting	0	–
PC43	ERZ	0	rev, mm

No.	Abbreviation	Initial value	Unit
PC44	**COP9	00000050h	–
PC45	**COPA	00000000h	–
PC46	For manufacturer setting	0	–
PC47	For manufacturer setting	0	–
PC48	For manufacturer setting	0	–
PC49	For manufacturer setting	0	–
PC50	**COPB	00000001h	–
PC51	RSBR	100	ms
PC52	For manufacturer setting	0	–
PC53	For manufacturer setting	0	–
PC54	RSUP1	0	0.0001rev, 0.01mm
PC55	For manufacturer setting	0	–
PC56	For manufacturer setting	100	–
PC57	For manufacturer setting	00000000h	–
PC58	For manufacturer setting	0	–
PC59	For manufacturer setting	00000000h	–
PC60	**COPD	00000000h	–
PC61	For manufacturer setting	00000000h	–
PC62	For manufacturer setting	00000000h	–
PC63	For manufacturer setting	00000000h	–
PC64	For manufacturer setting	00000000h	–
PC65	For manufacturer setting	00000000h	–
PC66	For manufacturer setting	0	–
PC67	For manufacturer setting	00000000h	–
PC68	For manufacturer setting	0	–
PC69	For manufacturer setting	00000000h	–
PC70	For manufacturer setting	0	–
PC71	For manufacturer setting	00000040h	–
PC72	For manufacturer setting	00000000h	–
PC73	ERW	0	rev, mm
PC74	For manufacturer setting	00000000h	–
PC75	For manufacturer setting	00C00000h	–
PC76	For manufacturer setting	00000000h	–
PC77	For manufacturer setting	10	–
PC78	For manufacturer setting	0	–
PC79	For manufacturer setting	00000000h	–
PC80	For manufacturer setting	00000000h	–
PC81	For manufacturer setting	0.0	–
PC82	For manufacturer setting	0.0	–
PC83	For manufacturer setting	50.00	–
PC84	For manufacturer setting	10	–
PC85	For manufacturer setting	400	–
PC86	For manufacturer setting	10	–
PC87	For manufacturer setting	20.00	–
PC88	For manufacturer setting	10	–
PC89	For manufacturer setting	00000000h	–
PC90	PLFT	0	pulse/s
PC91	For manufacturer setting	00000000h	–
PC92	For manufacturer setting	0	–

No.	Abbreviation	Initial value	Unit
PC93	For manufacturer setting	00000000h	–
PC94	For manufacturer setting	00000000h	–
PC95	For manufacturer setting	00000000h	–
PC96	For manufacturer setting	00000000h	–
PC97	For manufacturer setting	00000000h	–
PC98	For manufacturer setting	00000000h	–
PC99	For manufacturer setting	00000000h	–

(d) I/O setting servo parameters group ([Pr.PD_ _])

No.	Abbreviation	Initial value	Unit[*1]
PD01	*DIA1	00000000h	–
PD02	For manufacturer setting	00000000h	–
PD03	*DI1L	00000202h	–
PD04	*DI1H	00000202h	–
PD05	*DI2L	00002100h	–
PD06	*DI2H	00002021h	–
PD07	*DI3L	00000704h	–
PD08	*DI3H	00000707h	–
PD09	*DI4L	00000805h	–
PD10	*DI4H	00000808h	–
PD11	*DI5L	00000303h	–
PD12	*DI5H	00003803h	–
PD13	*DI6L	00002006h	–
PD14	*DI6H	00003920h	–
PD15	For manufacturer setting	000C0C0Ch	–
PD16	For manufacturer setting	00000C0Ch	–
PD17	*DI8L	000A0A0Ah	–
PD18	*DI8H	00000A00h	–
PD19	*DI9L	000B0B0Bh	–
PD20	*DI9H	00000B00h	–
PD21	*DI10L	002B2323h	–
PD22	*DI10H	00002B23h	–
PD23	*DO1	00000004h	–
PD24	*DO2	0000000Ch	–
PD25	*DO3	00000004h	–
PD26	*DO4	00000007h	–
PD27	For manufacturer setting	00000003h	–
PD28	*DO6	00000002h	–
PD29	*DIF	00000007h	–
PD30	*DOP1	00000000h	–
PD31	*DOP2	00000000h	–
PD32	*DOP3	00000000h	–
PD33	*DOP4	00000000h	–
PD34	*DOP5	00000000h	–
PD35	For manufacturer setting	00000000h	–
PD36	For manufacturer setting	00000000h	–
PD37	For manufacturer setting	00000000h	–
PD38	For manufacturer setting	0	–

No.	Abbreviation	Initial value	Unit*1
PD39	For manufacturer setting	0	–
PD40	For manufacturer setting	0	–
PD41	For manufacturer setting	00000000h	–
PD42	*DIA4	00000000h	–
PD43	*DI11L	00000000h	–
PD44	*DI11H	00003A00h	–
PD45	*DI12L	00000000h	–
PD46	*DI12H	00003B00h	–
PD47	*DO7	00000000h	–
PD48	For manufacturer setting	00000000h	–
PD49	For manufacturer setting	00000000h	–
PD50	For manufacturer setting	00000000h	–
PD51	For manufacturer setting	00000000h	–
PD52	For manufacturer setting	00110001h	–
PD53	For manufacturer setting	0	–
PD54	For manufacturer setting	0	–
PD55	For manufacturer setting	0	–
PD56	For manufacturer setting	00000000h	–
PD57	For manufacturer setting	00000000h	–
PD58	For manufacturer setting	00000000h	–
PD59	For manufacturer setting	00000000h	–
PD60	*DIP	00000000h	–
PD61	For manufacturer setting	00000000h	–
PD62	For manufacturer setting	00000000h	–
PD63	For manufacturer setting	00000000h	–
PD64	For manufacturer setting	00000000h	–
PD65	For manufacturer setting	00000000h	–
PD66	For manufacturer setting	00000000h	–
PD67	For manufacturer setting	00000000h	–
PD68	For manufacturer setting	00000000h	–
PD69	For manufacturer setting	00000000h	–
PD70	For manufacturer setting	00000000h	–
PD71	For manufacturer setting	00000000h	–
PD72	For manufacturer setting	00000000h	–

(e) Extension setting 2 servo parameters group ([Pr.PE_ _])

No.	Abbreviation	Initial value	Unit
PE01	**FCT1	00000000h	–
PE02	For manufacturer setting	00000000h	–
PE03	*FCT2	00000003h	–
PE04	**FBN	1	–
PE05	**FBD	1	–
PE06	BC1	400	r/min
PE07	BC2	100	kpulse
PE08	DUF	10	rad/s
PE09	For manufacturer setting	00000000h	–
PE10	FCT3	00000000h	–
PE11	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PE12	For manufacturer setting	00000000h	–
PE13	For manufacturer setting	00000000h	–
PE14	For manufacturer setting	00000111h	–
PE15	For manufacturer setting	20	–
PE16	For manufacturer setting	00000000h	–
PE17	For manufacturer setting	00000100h	–
PE18	For manufacturer setting	00000000h	–
PE19	For manufacturer setting	00000000h	–
PE20	For manufacturer setting	00000000h	–
PE21	For manufacturer setting	00000000h	–
PE22	For manufacturer setting	00000000h	–
PE23	For manufacturer setting	00000000h	–
PE24	For manufacturer setting	00000000h	–
PE25	For manufacturer setting	00000000h	–
PE26	For manufacturer setting	00000000h	–
PE27	For manufacturer setting	00000000h	–
PE28	For manufacturer setting	00000000h	–
PE29	For manufacturer setting	00000000h	–
PE30	For manufacturer setting	00000000h	–
PE31	For manufacturer setting	00000000h	–
PE32	For manufacturer setting	00000000h	–
PE33	For manufacturer setting	00000000h	–
PE34	For manufacturer setting	1	–
PE35	For manufacturer setting	1	–
PE36	For manufacturer setting	0.0	–
PE37	For manufacturer setting	0.00	–
PE38	For manufacturer setting	0.00	–
PE39	For manufacturer setting	20	–
PE40	For manufacturer setting	00000000h	–
PE41	EOP3	00000000h	–
PE42	For manufacturer setting	0	–
PE43	For manufacturer setting	0.0	–
PE44	LMCP	0	0.01%
PE45	LMCN	0	0.01%
PE46	LMFLT	0	0.1ms
PE47	TOF	0	0.01%
PE48	*LMOP	00000000h	–
PE49	LMCD	0	0.1ms
PE50	LMCT	0	pulse, kpulse
PE51	For manufacturer setting	00000000h	_
PE52	For manufacturer setting	00000000h	_
PE53	For manufacturer setting	00000000h	_
PE54	For manufacturer setting	00000000h	_
PE55	For manufacturer setting	00000000h	_
PE56	For manufacturer setting	00000000h	_
PE57	For manufacturer setting	00000000h	_
PE58	For manufacturer setting	00000000h	_
PE59	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PE60	For manufacturer setting	00000000h	–
PE61	For manufacturer setting	0.000	–
PE62	For manufacturer setting	0.000	–
PE63	For manufacturer setting	0.000	–
PE64	For manufacturer setting	0.000	–
PE65	For manufacturer setting	0.0	–
PE66	For manufacturer setting	0.0	–
PE67	For manufacturer setting	0.0	–
PE68	For manufacturer setting	00000000h	–
PE69	For manufacturer setting	00000000h	–
PE70	For manufacturer setting	00000000h	–
PE71	For manufacturer setting	00000000h	–
PE72	For manufacturer setting	00000000h	–
PE73	For manufacturer setting	00000000h	–
PE74	For manufacturer setting	00000000h	–
PE75	For manufacturer setting	00000000h	–
PE76	For manufacturer setting	00000000h	–
PE77	For manufacturer setting	00000000h	–
PE78	For manufacturer setting	0	–
PE79	For manufacturer setting	0	–
PE80	For manufacturer setting	00000000h	–
PE81	For manufacturer setting	00000000h	–
PE82	For manufacturer setting	00000000h	–
PE83	For manufacturer setting	00000000h	–
PE84	For manufacturer setting	00000000h	–
PE85	For manufacturer setting	00000000h	–
PE86	For manufacturer setting	00000000h	–
PE87	For manufacturer setting	00000000h	–
PE88	For manufacturer setting	00000000h	–

(f) Extension setting 3 servo parameters group ([Pr.PF_ _])

No.	Abbreviation	Initial value	Unit
PF01	For manufacturer setting	00000000h	–
PF02	*FOP2	00000000h	–
PF03	For manufacturer setting	00000000h	–
PF04	For manufacturer setting	0	–
PF05	For manufacturer setting	0	–
PF06	For manufacturer setting	00000000h	–
PF07	For manufacturer setting	1	–
PF08	For manufacturer setting	1	–
PF09	*FOP5	00000013h	–
PF10	For manufacturer setting	00000000h	–
PF11	For manufacturer setting	00000000h	–
PF12	For manufacturer setting	65535	–
PF13	For manufacturer setting	100	–
PF14	For manufacturer setting	100	–
PF15	DBT	2000	ms
PF16	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PF17	For manufacturer setting	10	–
PF18	**STOD	10	s
PF19	For manufacturer setting	00000000h	–
PF20	For manufacturer setting	00000000h	–
PF21	DRT	0	s
PF22	For manufacturer setting	200	–
PF23	OSCL1	20	%
PF24	*FOP9	00000000h	–
PF25	CVAT	200	ms
PF26	For manufacturer setting	0	–
PF27	For manufacturer setting	0	–
PF28	For manufacturer setting	0	–
PF29	For manufacturer setting	00000000h	–
PF30	For manufacturer setting	0	–
PF31	FRIC	0	r/min, mm/s
PF32	*VIBT	50	100ms
PF33	For manufacturer setting	00000000h	–
PF34	For manufacturer setting	00000000h	–
PF35	For manufacturer setting	00000000h	–
PF36	For manufacturer setting	00000000h	–
PF37	For manufacturer setting	00000000h	–
PF38	For manufacturer setting	00000000h	–
PF39	For manufacturer setting	00000000h	–
PF40	For manufacturer setting	0	–
PF41	For manufacturer setting	0	–
PF42	For manufacturer setting	0	–
PF43	For manufacturer setting	0	–
PF44	For manufacturer setting	0	–
PF45	For manufacturer setting	00000000h	–
PF46	For manufacturer setting	0	–
PF47	For manufacturer setting	00000000h	–
PF48	For manufacturer setting	00000000h	–
PF49	TSL	0	0.0001%/°C
PF50	TIC	0	0.1%
PF51	*MFP	00000000h	–
PF52	MFPP	00000000h	–
PF53	FPMT	0	10rev, m
PF54	PAV	0	0.1%
PF55	PSD	0	0.1
PF56	VAV	0	0.1%
PF57	VSD	0	0.1%
PF58	TMO	0	10rev, m
PF59	For manufacturer setting	00000000h	–
PF60	For manufacturer setting	00000000h	–
PF61	For manufacturer setting	00000000h	–
PF62	For manufacturer setting	00000000h	–
PF63	For manufacturer setting	00000000h	–
PF64	For manufacturer setting	00000000h	–
PF65	For manufacturer setting	00000000h	–

No.	Abbreviation	Initial value	Unit
PF66	BLG	00000000h	–
PF67	BLN	0	0.01degree
PF68	BLTT	0	0.1
PF69	SPAV2	0	0.1%
PF70	SPSD2	0	0.1%
PF71	BFP	00000000h	–
PF72	SBT	0	0.1N
PF73	ABT	0	0.1N
PF74	SSF	0	0.1%
PF75	ASF	0	0.1%
PF76	BTS	0	0.1%
PF77	For manufacturer setting	00000000h	–
PF78	For manufacturer setting	00000000h	–
PF79	For manufacturer setting	00110010h	–
PF80	DRMC	00000000h	–
PF81	DRMS	00000000h	–
PF82	DRTM	00000000h	–
PF83	For manufacturer setting	00000000h	–
PF84	DRTC	005A8101h	–
PF85	DRTL1	0	–
PF86	DRTL2	0	–
PF87	DRAC1	00020201h	–
PF88	DRAC2	02040003h	–
PF89	DRAC3	02090205h	–
PF90	DRAC4	0000020Ch	–
PF91	DRDC1	00120000h	–
PF92	DRDC2	80058010h	–
PF93	DRDC3	8000800Ah	–
PF94	DRDC4	801D8015h	–
PF95	**DRCLR	00000000h	–
PF96	For manufacturer setting	00000000h	–
PF97	For manufacturer setting	00000000h	–
PF98	For manufacturer setting	00000000h	–
PF99	For manufacturer setting	00000000h	–

(g) Motor extension setting servo parameters group ([Pr.PL_ _])

No.	Abbreviation	Initial value	Unit
PL01	**LIT1	00000301h	–
PL02	**LIM	1000	μm
PL03	**LID	1000	μm
PL04	*LIT2	00000003h	–
PL05	LB1	0	mm, 0.01rev
PL06	LB2	0	mm/s, r/min
PL07	LB3	100	%
PL08	*LIT3	00001010h	–
PL09	LPWM	30	%
PL10	For manufacturer setting	5	_
PL11	For manufacturer setting	100	_

No.	Abbreviation	Initial value	Unit
PL12	For manufacturer setting	500	_
PL13	For manufacturer setting	00000000h	_
PL14	For manufacturer setting	00000000h	_
PL15	For manufacturer setting	20	_
PL16	For manufacturer setting	0	_
PL17	LTSTS	00000000h	_
PL18	IDLV	0	%
PL19	For manufacturer setting	0	_
PL20	For manufacturer setting	0	_
PL21	For manufacturer setting	0	_
PL22	For manufacturer setting	0	_
PL23	For manufacturer setting	00000000h	_
PL24	For manufacturer setting	0	_
PL25	For manufacturer setting	0	_
PL26	For manufacturer setting	00000000h	_
PL27	For manufacturer setting	00000000h	_
PL28	For manufacturer setting	00000000h	_
PL29	For manufacturer setting	00000000h	_
PL30	For manufacturer setting	00000000h	_
PL31	For manufacturer setting	00000000h	_
PL32	For manufacturer setting	00000000h	_
PL33	For manufacturer setting	00000000h	_
PL34	For manufacturer setting	00000000h	_
PL35	For manufacturer setting	00000000h	_
PL36	For manufacturer setting	00000000h	_
PL37	For manufacturer setting	00000000h	_
PL38	For manufacturer setting	00000000h	_
PL39	For manufacturer setting	00000000h	_
PL40	For manufacturer setting	00000000h	_
PL41	For manufacturer setting	00000000h	_
PL42	For manufacturer setting	00000000h	_
PL43	For manufacturer setting	00000000h	_
PL44	For manufacturer setting	00000000h	_
PL45	For manufacturer setting	00000000h	_
PL46	For manufacturer setting	00000000h	_
PL47	For manufacturer setting	00000000h	_
PL48	For manufacturer setting	00000000h	_
PL49	For manufacturer setting	00000000h	_
PL50	For manufacturer setting	00000000h	_
PL51	For manufacturer setting	00000000h	_
PL52	For manufacturer setting	00000000h	_
PL53	For manufacturer setting	0	_
PL54	For manufacturer setting	00000000h	_
PL55	For manufacturer setting	00000000h	–
PL56	For manufacturer setting	00000000h	_

No.	Abbreviation	Initial value	Unit
PL57	For manufacturer setting	00000000h	_
PL58	For manufacturer setting	00000000h	_
PL59	For manufacturer setting	00000000h	_
PL60	For manufacturer setting	00000000h	_
PL61	For manufacturer setting	00000000h	_
PL62	For manufacturer setting	00000000h	_
PL63	For manufacturer setting	00000000h	_
PL64	For manufacturer setting	00000000h	_
PL65	For manufacturer setting	00000000h	_
PL66	For manufacturer setting	00000000h	_
PL67	For manufacturer setting	00000000h	_
PL68	For manufacturer setting	00000000h	_
PL69	For manufacturer setting	00000000h	_
PL70	For manufacturer setting	00000000h	_
PL71	For manufacturer setting	00000000h	_
PL72	For manufacturer setting	00000000h	_

(3) Servo parameter details

Restrictions

- Settable servo parameters and values differ depending on the controller model, servo amplifier software version, and MR Configurator2 software version. For details, refer to the MR-J5 User's Manual. Refer to the Mitsubishi Electric FA site for the latest software version of MR Configurator2. In addition, the software version of the servo amplifier can be checked with MR Configurator2 or by other means.

Precautions

- Never make a drastic adjustment or change to the servo parameter values as doing so will make the operation unstable.
- Do not change the servo parameter settings as described below. Doing so may cause an unexpected condition, such as failing to start up the servo amplifier.
  - Changing the values of the servo parameters for manufacturer setting
  - Setting a value outside the range
  - Changing the fixed value in each servo parameter
- When writing servo parameters with the controller, make sure that the control axis No. of the servo amplifier is set correctly. Failure to do so may cause the servo parameter settings of another axis to be written and result in the servo amplifier being in an unexpected condition.
- Some servo parameters are adjusted automatically. For example, auto tuning automatically adjusts gain servo parameters.

(a) Explanation of servo parameters

For how to interpret the servo parameter numbers, refer to "Interpreting servo parameter numbers" in the MR-J5 User's Manual (Introduction).

The following explains how to read the details of servo parameters.

Item	Explanation	
No.	Indicates the servo parameter No., which can be identified by the servo parameter group and number.	Servo parameter No., abbreviations, and names are indicated as follows. **[Pr. PA01_Operation mode (**STY)]** Symbol Name No./Detail No.
Abbreviation	Indicates the abbreviation of the servo parameter. "*" added to abbreviations means the following. * or **: After setting, cycle the power or reset the software.	
Name	Indicates the name of the servo parameter.	
Initial value	Indicates the servo parameter initial value at factory setting. When there is a unit in the servo parameter, the unit is shown with [ ].	
Setting range	Indicates the setting range of the servo parameter.	
Supported software version	Indicates the supported software version of the servo amplifier. The servo parameter is available on servo amplifiers with the software version or later.	

(b) Parameters necessary to be set or checked before operation

If the settings of the parameters introduced in this section are incorrectly configured, the motor will not operate or an alarm will occur. Be sure to check the parameters before operation and change the settings as necessary. Refer to the MR-J5 User's Manual (Parameters) for details of other parameters.

1) [Pr.PA01_Operation mode (**STY)]

Initial value	Setting range	Supported software version
10003000h	10003000h to 10013085h	Refer to the relevant detail No.

• [Pr.PA01.0_Control mode selection]

Initial value	Setting range	Supported software version
0h	0h to 5h	A0

Select a control mode.
0: Position control mode (P)
1: Position control mode and speed control mode (P/S)
2: Speed control mode (S)
3: Speed control mode and torque control mode (S/T)
4: Torque control mode (T)
5: Torque control mode and position control mode (T/P)

• [Pr.PA01.1_Operation mode selection]

Initial value	Setting range	Supported software version
0h	0h to 8h	A0

0: Standard control mode
4: Linear servo motor control mode
6: Direct drive motor control mode

• [Pr.PA01.4_Fully closed loop operation mode selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A5

Select whether to enable or disable the fully closed loop control mode.
The external encoder communication method of four-wire type cannot be used in the fully closed loop control mode on the MR-J5-_A_. In that case, use the MR-J5-_A_-RJ.
When this servo parameter is set to "1" in the linear servo motor control mode, [AL.037 Parameter error] occurs.
0: Disabled (semi closed loop control mode)
1: Enabled (fully closed loop control mode)

2) [Pr.PA02_Regenerative option (**REG)]

Initial value	Setting range	Supported software version
00000000h	00000000h to 001100FFh	Refer to the relevant detail No.

• [Pr.PA02.0-1_Regenerative option selection]

Initial value	Setting range	Supported software version
00h	00h to FFh	A0

Select a regenerative option.
Incorrect setting may cause the regenerative option to burn.
If a selected regenerative option is not for use with the servo amplifier, [AL.037 Parameter error] occurs.
00: Regenerative option is not used.
- No regenerative resistors are used on servo amplifiers with a capacity of 100W.
- Built-in regenerative resistors are used on servo amplifiers with a capacity of 0.2 to 3.5kW.

02: MR-RB032
03: MR-RB12
04: MR-RB32
05: MR-RB30
06: MR-RB50 (A cooling fan is required.)
0B: MR-RB3N
0C: MR-RB5N (A cooling fan is required.)

• [Pr.PA02.4_Simple converter selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

When using the simple converter, set this servo parameter.
The simple converter and external regenerative option can be used together. When using an external regenerative option, set the regenerative option to be used with [Pr.PA02.0-1].
0: Simple converter is not used.
1: MR-CM3K

• [Pr.PA02.5_Excessive regeneration warning enabled/disabled selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

When the simple converter is used, whether to enable or disable the detection of [AL.0E0.1 Excessive regeneration warning] is selectable with this servo parameter.
When [Pr.PA02.4] is set to "0" (simple converter is not used.), setting this servo parameter to "1" (disabled) triggers [AL.037 Parameter error].
0: Enabled
1: Disabled

3) [Pr.PA03_Absolute position detection system (*ABS)]

Initial value	Setting range	Supported software version
00000000h	00000000h to 00000011h	Refer to the relevant detail No.

• [Pr.PA03.0_Absolute position detection system selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

Set this servo parameter when using the absolute position detection system in the position control mode. If the absolute position detection system is switched to the incremental system, the home position is erased. Execute homing again when the absolute position detection system is enabled.
0: Disabled (incremental system)
1: Enabled (absolute position detection system by DIO)
The absolute position detection system cannot be used when an incremental type encoder is used or when the semi closed/fully closed loop control switching is enabled. At this time, enabling the absolute position detection system triggers [AL.037 Parameter error].

• [Pr.PA03.1_Servo motor replacement preparation]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

To replace an in-use batteryless absolute position encoder equipped servo motor while the absolute position detection system is in enabled status, set this servo parameter to "enabled". Selecting "1" (enabled) enables servo motor replacement. After completing the servo motor replacement preparation, the value automatically changes to "0" (disabled).
After replacing the servo motor, the home position is erased. Execute homing again.
After setting this servo parameter to "1" (enabled), cycle the power and deactivate [AL.01A.5 Servo motor combination error 3].
0: Disabled
1: Enabled

4) [Pr.PA04_Function selection A-1 (*AOP1)]

Initial value	Setting range	Supported software version
00002000h	00000000h to 00002000h	Refer to the relevant detail No.

• [Pr.PA04.3_Forced stop deceleration function selection]

Initial value	Setting range	Supported software version
2h	0h to 2h	A0

0: Forced stop deceleration function disabled (EM1 is used.)

2: Forced stop deceleration function enabled (EM2 is used.)

Setting value		Selecting EM2 or EM1	Deceleration method	
[Pr.PA04.3]	[Pr.PA04.2]*1		EM2 or EM1 is off.	Alarm occurrence
0	0	EM1	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.
2	0	EM2	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.
0	1	Neither EM2 nor EM1 is used.	–	MBR (Electromagnetic brake interlock) turns off without the forced stop deceleration.
2	1	Neither EM2 nor EM1 is used.	–	MBR (Electromagnetic brake interlock) turns off after the forced stop deceleration.

*1: For the MR-J5-_A_ servo amplifier, the setting value of this servo parameter is fixed to "0". To disable forced stop, change the setting value of [Pr.PD01.3].

5) [Pr.PA05_Number of command input pulses per revolution (*FBP)]

Initial value	Setting range	Supported software version
10000 [pulse]	1000 to 1000000	A0

The servo motor rotates once as per command input pulse that has been set.

The setting value of this servo parameter is enabled when [Pr.PA21.3 Electronic gear compatibility selection] is set to "1" (number of command input pulses per revolution). In the linear servo motor control mode or fully closed loop control mode, [Pr.PA21.3] cannot be set to "1".

6) [Pr.PA06_Electronic gear numerator (CMX)]

Initial value	Setting range	Supported software version
1	1 to 2147483647	A0

Set the electronic gear numerator.
This servo parameter is enabled in the following condition: [Pr.PA21.3 Electronic gear compatibility selection] is "0" (electronic gear), "2" (J3 electronic gear setting value compatibility mode), "3" (J2S electronic gear setting value compatibility mode), or "4" (J4 electronic gear setting value compatibility mode).
The condition range of the electronic gear is shown in the table below. If the set value is outside this range, noise may be generated during acceleration/deceleration, or operation may not be performed at the preset speed and/or acceleration/deceleration time constants. In addition, if the electric gear numerator exceeds "2147483647" by combining this servo parameter and [Pr.PA21.3], the electric gear numerator is limited to "2147483647".

Encoder resolution [pulse]	Setting range (CMX/CDV)
67108864	1/10 < CMX/CDV < 64000

7) [Pr.PA07_Electronic gear denominator (CDV)]

Initial value	Setting range	Supported software version
1	1 to 2147483647	A0

Set the electronic gear denominator.
This servo parameter is enabled in the following condition: [Pr.PA21.3 Electronic gear compatibility selection] is "0" (electronic gear), "2" (J3 electronic gear setting value compatibility mode), "3" (J2S electronic gear setting value compatibility mode), or "4" (J4 electronic gear setting value compatibility mode).
Refer to Appendix 3.5.1 "Electronic gear function" for details.

8) [Pr.PA08_Auto tuning mode (ATU)]

Initial value	Setting range	Supported software version
00000001h	00000000h to 01110006h	Refer to the relevant detail No.

• [Pr.PA08.0_Gain adjustment mode selection]

Initial value	Setting range	Supported software version
1h	0h to 6h	A0

Select the gain adjustment mode.

0: 2 gain adjustment mode 1 (interpolation mode)

1: Auto tuning mode 1

2: Auto tuning mode 2

3: Manual mode

4: 2 gain adjustment mode 2

5: Quick tuning mode

6: Load to motor inertia ratio monitor mode

Refer to the following table for details.

Setting value of [Pr.PA08.0]	Gain adjustment mode	Servo parameter adjusted automatically
0	2 gain adjustment mode 1 (interpolation mode)	[Pr.PB06 Load to motor inertia ratio/load to motor mass ratio] [Pr.PB08 Position control gain] [Pr.PB09 Speed control gain] [Pr.PB10 Speed integral compensation]
1	Auto tuning mode 1	[Pr.PB06 Load to motor inertia ratio/load to motor mass ratio] [Pr.PB07 Model control gain] [Pr.PB08 Position control gain] [Pr.PB09 Speed control gain] [Pr.PB10 Speed integral compensation]
2	Auto tuning mode 2	[Pr.PB07 Model control gain] [Pr.PB08 Position control gain] [Pr.PB09 Speed control gain] [Pr.PB10 Speed integral compensation]
3	Manual mode	–
4	2 gain adjustment mode 2	[Pr.PB08 Position control gain] [Pr.PB09 Speed control gain] [Pr.PB10 Speed integral compensation]
5	Quick tuning mode	[Pr.PB07 Model control gain] [Pr.PB08 Position control gain] [Pr.PB09 Speed control gain] [Pr.PB10 Speed integral compensation] [Pr.PB13 Machine resonance suppression filter 1] [Pr.PB14 Notch shape selection 1] [Pr.PB15 Machine resonance suppression filter 2] [Pr.PB16 Notch shape selection 2] [Pr.PB18 Low-pass filter setting] [Pr.PB23 Low-pass filter selection] [Pr.PB50 Machine resonance suppression filter 5] [Pr.PB51 Notch shape selection 5] [Pr.PE41 Function selection E-3]
6	Load to motor inertia ratio monitor mode	[Pr.PB06 Load to motor inertia ratio/load to motor mass ratio]

• [Pr.PA08.4_Quick tuning - Load to motor inertia ratio setting]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

Set the load to motor inertia ratio at quick tuning. If the load connected to the servo motor is equal to or larger than the load to motor inertia ratio set in the servo parameter, an overshoot may occur in positioning operation after quick tuning.
0: Load to motor inertia ratio of 30 times or less
1: Load to motor inertia ratio of 100 times or less

• [Pr.PA08.5_Quick tuning - Execution selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

Set when to execute quick tuning.
0: At initial servo-on after cycling the power
1: At every servo-on

• [Pr.PA08.6_Quick tuning - Restore selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

Set whether to return servo parameters to the values they had set before quick tuning was executed.
0: Disabled
1: Enabled
By setting "1" (enabled), the following servo parameters return to the values they had set before quick tuning was executed. If quick tuning has never been performed after power on or software reset, setting "1" (enabled) only keeps the current servo parameter values.

No.	Abbreviation	Name
PB01	FILT	Adaptive tuning mode (adaptive filter II)
PB07	PG1	Model control gain
PB08	PG2	Position control gain
PB09	VG2	Speed control gain
PB10	VIC	Speed integral compensation
PB11	VDC	Speed differential compensation
PB13	NH1	Machine resonance suppression filter 1
PB14	NHQ1	Notch shape selection 1
PB15	NH2	Machine resonance suppression filter 2
PB16	NHQ2	Notch shape selection 2
PB18	LPF	Low-pass filter setting
PB23	VFBF	Low-pass filter selection
PB50	NH5	Machine resonance suppression filter 5
PB51	NHQ5	Notch shape selection 5
PE41	EOP3	Function selection E-3 (Robust filter)

9) [Pr.PA09_Auto tuning response (RSP)]

Initial value	Setting range	Supported software version
16	1 to 40	A0

Set the auto tuning response.

Setting value	Machine characteristic	
	Responsiveness	Guideline for machine resonance frequency [Hz]
1	Low response ↑	2.7
2		3.6
3		4.9
4		6.6
5		10.0
6		11.3
7		12.7
8		14.3
9		16.1
10		18.1
11		20.4
12		23.0
13		25.9
14		29.2
15		32.9
16		37.0
17		41.7
18		47.0
19	↓	52.9
20	Middle response	59.6
21	↑	67.1
22		75.6
23		85.2
24		95.9
25		108.0
26		121.7
27		137.1
28		154.4
29		173.9
30		195.9
31		220.6
32		248.5
33		279.9
34		315.3
35		355.1
36		400.0
37		446.6
38	↓	501.2
39	High response	571.5
40		642.7

10) [Pr.PA10_In-position range (INP)]

Initial value	Setting range	Supported software version
400 [Refer to the text below for the unit.]	0 to 16777215	A0

Set the in-position range in the command pulse unit.
With the setting of [Pr.PC24.0 In-position range unit selection], the unit can be changed to the servo motor encoder pulse unit.

In-position range setting

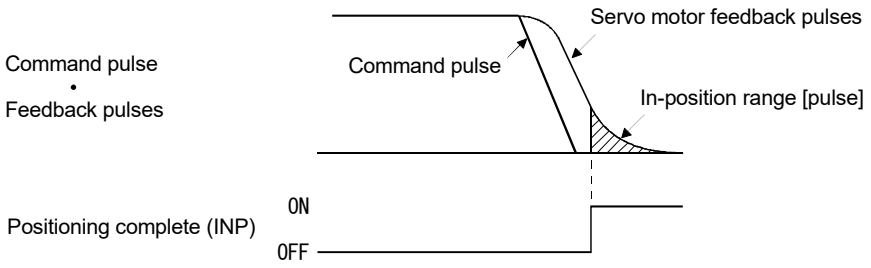
Control mode [Pr.PA01]	In-position setting range
Position, speed, and torque control modes	Range where positioning completion (INP) is output

Selecting a control side for the in-position range

[Pr.PA01.4 Fully closed loop operation mode selection]	In-position range unit
"0" (semi closed loop system)	Command resolution unit (motor-side encoder)
"1" (fully closed loop system)	Command resolution unit (load-side encoder)

In-position range unit

[Pr.PA01.0 Control mode selection]	[Pr.PC24.0 In-position range unit selection]	Unit
Position, speed, and torque control modes	0 (command unit)	pulse
"1" (fully closed loop system)	1 (servo motor encoder pulse unit)	pulse



11) [Pr.PA11_Forward rotation torque limit (TLP)]

Initial value	Setting range	Supported software version
1000.0 [%]	0.0 to 1000.0	A0

The torque or thrust generated by the servo motor can be limited.
Set servo parameters in relation to the rated torque or continuous thrust as 100.0 [%]. Set the servo parameter when limiting the torque of the servo motor for CCW power running or CW regeneration, or when limiting the thrust of the linear servo motor for positive direction power running or negative direction regeneration. If this servo parameter is set to "0.0", the servo motor does not generate torque or thrust.
When [Pr.PC50.0 Torque limit unit change] is set to "0" (maximum torque unit), set the servo parameter in relation to the maximum torque or maximum thrust (= 100.0%).
If a value larger than the maximum torque or maximum thrust of the servo motor is set, the value will be limited to the maximum torque or maximum thrust of the servo motor.
When torque (thrust) is output with the analog monitor output, the larger value of either [Pr.PA11 Forward rotation torque limit] or [Pr.PA12 Reverse rotation torque limit] is applied to the torque (thrust) at the maximum output voltage.

12) [Pr.PA12_Reverse rotation torque limit (TLN)]

Initial value	Setting range	Supported software version
1000.0 [%]	0.0 to 1000.0	A0

The torque or thrust generated by the servo motor can be limited.
Set servo parameters in relation to the rated torque or continuous thrust as 100.0 [%]. Set the servo parameter to limit the torque of the servo motor for CW power running or CCW regeneration, or to limit the thrust of the linear servo motor for negative direction power running or positive direction regeneration. If this servo parameter is set to "0.0", the servo motor does not generate torque or thrust.
When [Pr.PC50.0 Torque limit unit change] is set to "0" (maximum torque unit), set the servo parameter in relation to the maximum torque or maximum thrust (= 100.0%).
If a value larger than the maximum torque or maximum thrust of the servo motor is set, the value will be limited to the maximum torque or maximum thrust of the servo motor.
When torque (thrust) is output with the analog monitor output, the larger value of either [Pr.PA11 Forward rotation torque limit] or [Pr.PA12 Reverse rotation torque limit] is applied to the torque (thrust) at the maximum output voltage.

13) [Pr.PA13_Command pulse input form (*PLSS)]

Initial value	Setting range	Supported software version
00000100h	00000000h to 00000412h	Refer to the relevant detail No.

• [Pr.PA13.0_Command input pulse train form selection]

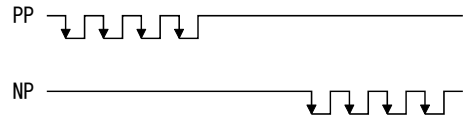
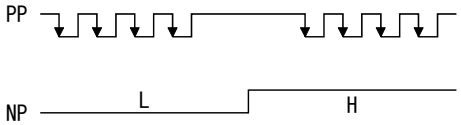
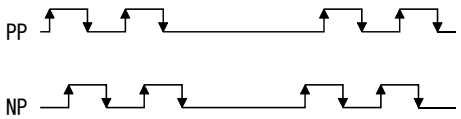
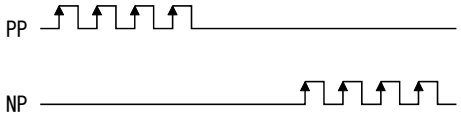
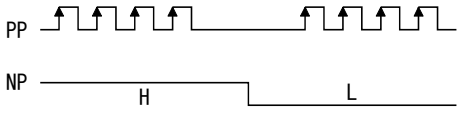
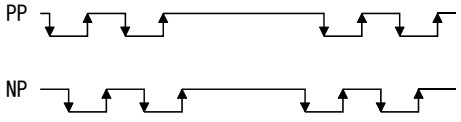
Initial value	Setting range	Supported software version
0h	0h to 2h	A0

0: Forward/reverse rotation pulse train

1: Signed pulse train

2: A-phase/B-phase pulse train (the servo amplifier multiplies the input pulse by 4, and imports the multiplied input pulses.)

Refer to the following table for setting values.

[Pr.PA13.1]	[Pr.PA13.0]	Pulse train form		Forward rotation (positive direction) command	Reverse rotation (negative direction) command
1	0	Negative logic	Forward rotation pulse train (positive direction pulse train) Reverse rotation pulse train (negative direction pulse train)		
1	1		Pulse train + sign		
1	2		A-phase pulse train B-phase pulse train		
0	0	Positive logic	Forward rotation pulse train (positive direction pulse train) Reverse rotation pulse train (negative direction pulse train)		
0	1		Pulse train + sign		
0	2		A-phase pulse train B-phase pulse train		

Arrows in the table indicate the timing of importing pulse trains. A-phase/B-phase pulse trains are imported after they have been multiplied by 4.

• [Pr.PA13.1_Pulse train logic selection]

Initial value	Setting range	Supported software version
0h	0h to 1h	A0

0: Positive logic
1: Negative logic
Match the logic of the command pulse train received from the connected controller.
Refer to [Pr.PA13.0_Command input pulse train form selection] for setting values.

• [Pr.PA13.2_Command input pulse train filter selection]

Initial value	Setting range	Supported software version
1h	0h to 3h	A0

Selecting the appropriate filter for the command pulse frequency can increase noise tolerance.
0: Command input pulse train is 4Mpulses/s or less
1: Command input pulse train is 1Mpulse/s or less
2: Command input pulse train is 500kpulses/s or less
3: Command input pulse train is 200kpulses/s or less
"1" can be set for commands up to 1Mpulse/s. When inputting commands exceeding 1Mpulse/s and up to 4Mpulses/s, set "0".
To prevent the following malfunctions, set a correct value in accordance with the command pulse frequency.
Setting a value higher than the actual command value will decrease noise tolerance.
Setting a value lower than the actual command will cause a position mismatch.

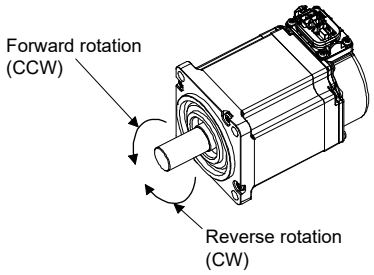
14) [Pr.PA14_Travel direction selection (*POL)]

Initial value	Setting range	Supported software version
0	0 to 1	A0

Select the servo motor rotation direction or linear servo motor travel direction for the command input pulse.

• For position control mode
With the setting value of [Pr.PA14 Travel direction selection], the rotation and travel direction can be changed without reversing the forward/reverse rotation pulse inputs for the input pulse train.

• For speed and torque control modes
The rotation and travel direction cannot be changed with the servo parameter.
The servo motor rotation direction is as follows.



15) [Pr.PA15_Encoder output pulses (*ENR)]

Initial value	Setting range	Supported software version
4000 [pulse/rev]	1 to 67108864	A0

Set the encoder output pulses that are output from the servo amplifier, by using the number of output pulses per revolution, dividing ratio, or electronic gear ratio. (after multiplication by 4)
Selecting "1" (dividing ratio setting) in [Pr.PC19.1 Encoder output pulse setting selection] will divide the travel distance [pulse] by the setting value.
Set a numerator for the electronic gear for the A/B-phase pulse output when "3" (A-phase/B-phase pulse electronic gear setting) is selected in [Pr.PC19.1].
The maximum output frequency is 4.6Mpulses/s. Set the value within the range.
For details of the relation to PC19, refer to the MR-J5 User's Manual (Function).

16) [Pr.PA19_Servo parameter writing prohibited (*BLK)]

Initial value	Setting range	Supported software version
000000ABh	00000000h to 0000FFFFh	A0

Settings of all the parameters can be changed on this servo amplifier in the factory setting.
The settings of [Pr.PA19] can prohibit writing to prevent unnecessary changes.
The following table shows the parameters that can be referred to and written to by the settings of [Pr.PA19]. Parameters with "○" in their columns are to be modified by [Pr.PA19].

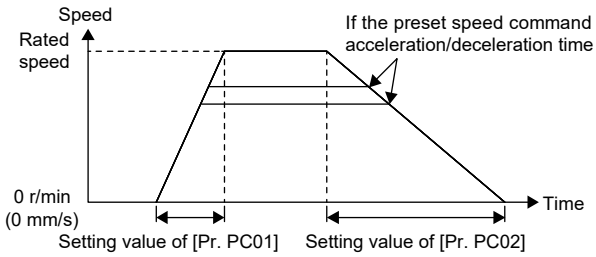
[Pr.PA19]	Setting value operation	PA	PB	PC	PD	PE	PF	PO	PS	PL, PU	PT, PV	PN
Setting values not listed below	Readable	○	×	×	×	×	×	×	×	×	×	×
	Writable	○	×	×	×	×	×	×	×	×	×	×
0000000A	Readable	19 only	×	×	×	×	×	×	×	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
0000000B	Readable	○	○	○	×	×	×	×	×	×	×	×
	Writable	○	○	○	×	×	×	×	×	×	×	×
0000000C	Readable	○	○	○	○	×	×	×	×	×	×	×
	Writable	○	○	○	○	×	×	×	×	×	×	×
0000000D	Readable	○	○	○	○	×	×	×	○	×	×	×
	Writable	○	○	○	○	×	×	×	○	×	×	×
0000000E	Readable	○	○	○	○	×	×	○	○	×	×	×
	Writable	○	○	○	○	×	×	○	○	×	×	×
0000000F	Readable	○	○	○	○	○	×	○	○	○	×	×
	Writable	○	○	○	○	○	×	○	○	○	×	×
000000AA	Readable	○	○	○	○	○	○	×	×	×	×	×
	Writable	○	○	○	○	○	○	×	×	×	×	×
000000AB (Initial value)	Readable	○	○	○	○	○	○	○	○	○	○	○
	Writable	○	○	○	○	○	○	○	○	○	○	○
0000100B	Readable	○	×	×	×	×	×	×	×	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
0000100C	Readable	○	○	○	○	×	×	×	×	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
0000100D	Readable	○	○	○	○	×	×	×	○	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
0000100E	Readable	○	○	○	○	×	×	○	○	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×

[Pr.PA19]	Setting value operation	PA	PB	PC	PD	PE	PF	PO	PS	PL, PU	PT, PV	PN
0000100F	Readable	○	○	○	○	○	×	○	○	○	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
000010AA	Readable	○	○	○	○	○	○	×	×	×	×	×
	Writable	19 only	×	×	×	×	×	×	×	×	×	×
000010AB	Readable	○	○	○	○	○	○	○	○	○	○	○
	Writable	19 only	×	×	×	×	×	×	×	×	×	×

17) [Pr.PC01_Speed acceleration time constant (STA)]

Initial value	Setting range	Supported software version
0 [ms]	0 to 50000	A0

In the speed control mode or torque control mode, set the acceleration time required to reach the rated speed from 0r/min for VC (Analog speed command) and [Pr.PC05 Internal speed 1] to [Pr.PC11 Internal speed 7].
For example for the servo motor of 3000r/min rated speed, set 3000 (3s) to increase speed from 0r/min to 1000r/min in 1s.



18) [Pr.PC02_Speed deceleration time constant (STB)]

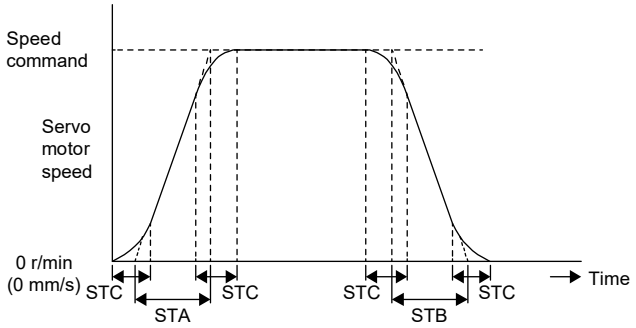
Initial value	Setting range	Supported software version
0 [ms]	0 to 50000	A0

When using the servo amplifier in the speed control mode or torque control mode, set the deceleration time for the servo motor to stop from the rated speed or the rated speed for VC (Analog speed command) and [Pr.PC05 Internal speed 1] to [Pr.PC11 Internal speed 7].
This function is enabled in the speed control mode and torque control mode.

19) [Pr.PC03_S-pattern acceleration/deceleration time constants (STC)]

Initial value	Setting range	Supported software version
0 [ms]	0 to 5000	A0

Set the time of the arc part for S-pattern acceleration/deceleration.
By setting "0", linear acceleration/deceleration is performed.



STA: Speed acceleration time constant ([Pr.PC01])
STB: Speed deceleration time constant ([Pr.PC02])
STC: S-pattern acceleration/deceleration time constant ([Pr.PC03])
If a large value is set to STA (speed acceleration time constant) or STB (speed deceleration time constant), the actual operation time for the arc part may differ from the setting value of the S-pattern acceleration/deceleration time constant.

The upper limit of the actual time for the arc part is limited to $\frac{2000000}{STA}$ during acceleration and $\frac{2000000}{STB}$ during deceleration.

(Example) At the setting of STA = 20000, STB = 5000, and STC = 200, the actual time for the arc part is as follows:

Acceleration time: 100 [ms]

$$\left(\begin{array}{l} \text{The time is limited to 100[ms]} \\ \text{because there is a limitation} \\ \frac{2000000}{20000} = 100[\text{ms}] < 200[\text{ms}] \end{array} \right)$$

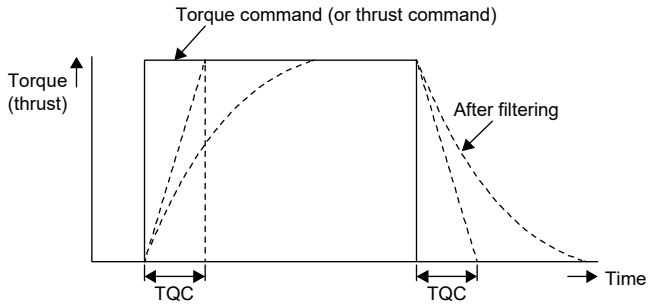
At deceleration: 200 [ms]

$$\left(\begin{array}{l} \text{The time is limited to 200[ms]} \\ \text{because there is a limitation} \\ \frac{2000000}{5000} = 400[\text{ms}] > 200[\text{ms}] \end{array} \right)$$

20) [Pr.PC04_Torque command time constant (TQC)]

Initial value	Setting range	Supported software version
0 [ms]	0 to 5000	A0

Set the time constant of a primary delay filter for the torque command (or thrust command).



TQC: Torque command time constant

21) [Pr.PC05_Internal speed 1 (SC1)]

Initial value	Setting range	Supported software version
100.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing the speed to the permissible speed, set the speed in [Pr.PA28.4 Speed range limit selection].

• When using the speed control mode, set the speed 1 of internal speed commands.

• When using the torque control mode, set the speed 1 of internal speed limit.

22) [Pr.PC06_Internal speed 2 (SC2)]

Initial value	Setting range	Supported software version
500.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 2 of internal speed commands.

• When using the torque control mode, set the speed 2 of internal speed limit.

23) [Pr.PC07_Internal speed 3 (SC3)]

Initial value	Setting range	Supported software version
1000.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 3 of internal speed commands.

• When using the torque control mode, set the speed 3 of internal speed limit.

24) [Pr.PC08_Internal speed 4 (SC4)]

Initial value	Setting range	Supported software version
200.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 4 of internal speed commands.

• When using the torque control mode, set the speed 4 of internal speed limit.

25) [Pr.PC09_Internal speed 5 (SC5)]

Initial value	Setting range	Supported software version
300.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 5 of internal speed commands.

• When using the torque control mode, set the speed 5 of internal speed limit.

26) [Pr.PC10_Internal speed 6 (SC6)]

Initial value	Setting range	Supported software version
500.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 6 of internal speed commands.

• When using the torque control mode, set the speed 6 of internal speed limit.

27) [Pr.PC11_Internal speed 7 (SC7)]

Initial value	Setting range	Supported software version
800.00 [r/min], [mm/s]	0.00 to 65535.00	A0

Set a value within the range between 0 and the maximum speed. When changing to the permissible speed, set the speed in [Pr.PA28.4].

• When using the speed control mode, set the speed 7 of internal speed commands.

• When using the torque control mode, set the speed 7 of internal speed limit.

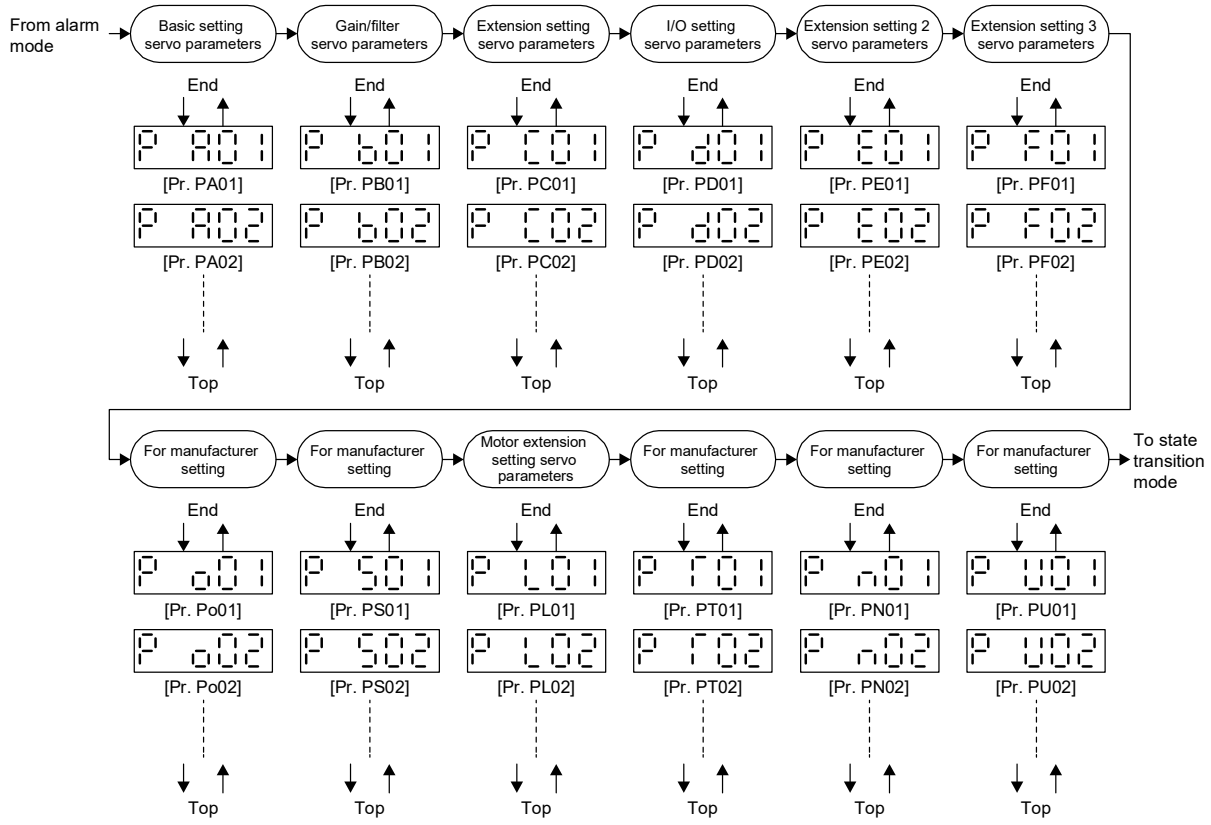
7.3.7 Parameter settings

After turning on the power, configure initial settings of the parameter values as necessary for the operation conditions. Set the parameters mentioned in section 7.3.6 "Parameters" in accordance with the design specifications.

In particular, be sure to confirm the parameters mentioned in "(b) Parameters necessary to be set or checked before operation" in section 7.3.6 (3).

[Parameter mode transition]

After selecting the corresponding parameter mode with the "MODE" button, pressing the "UP" or "DOWN" button changes the display as follows.

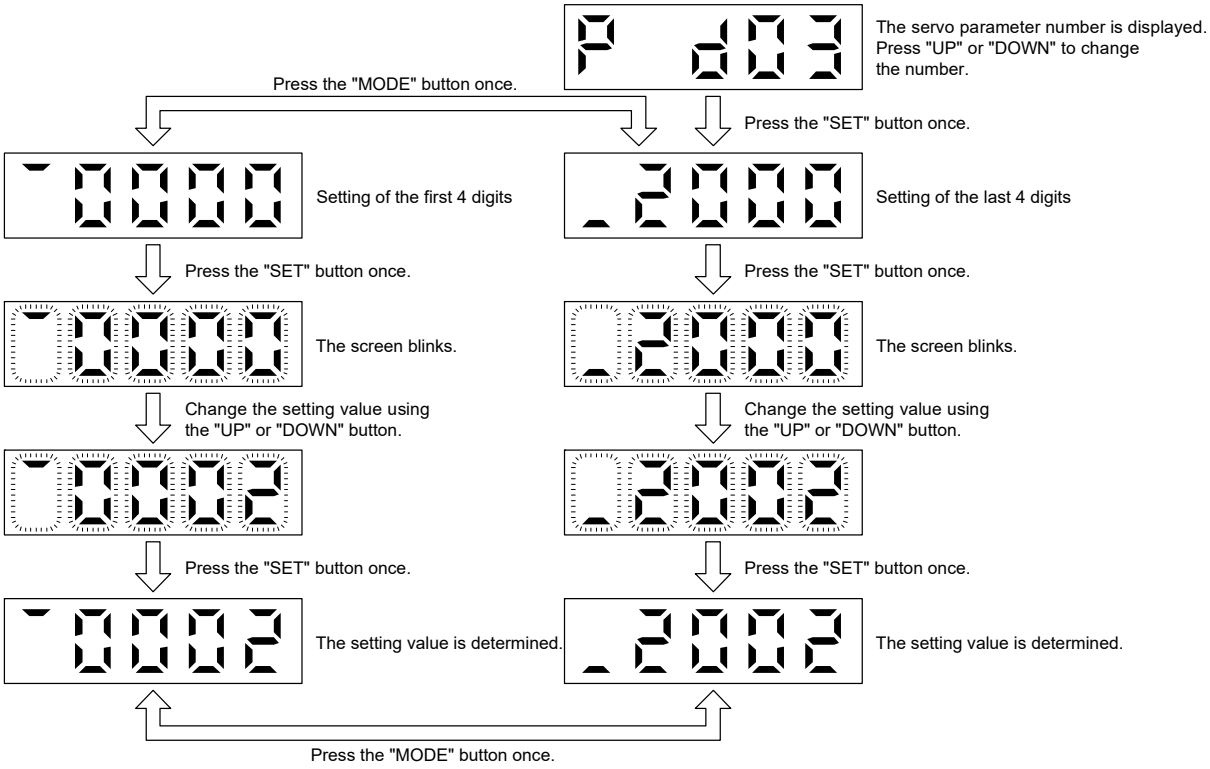


Demonstration machine operation

[Operation method]

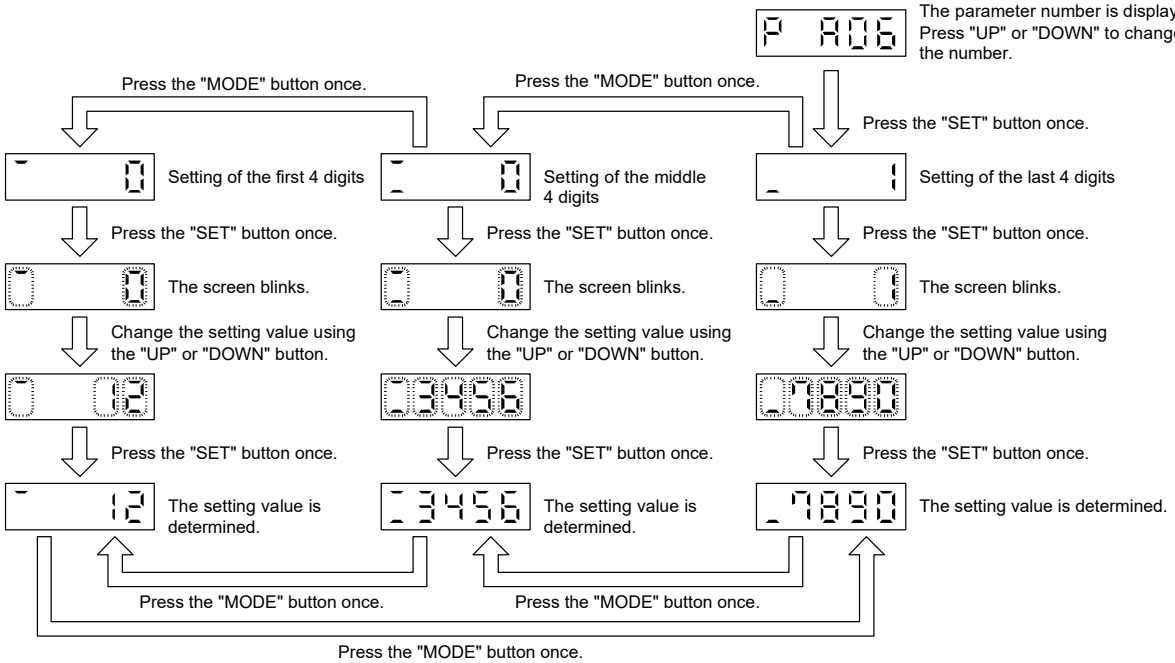
• Servo parameter in hexadecimal

The operation method example is shown below when [Pr.PD03 Input device selection 1L] is set to "00022002". Press "MODE" to switch to the basic setting servo parameter screen.



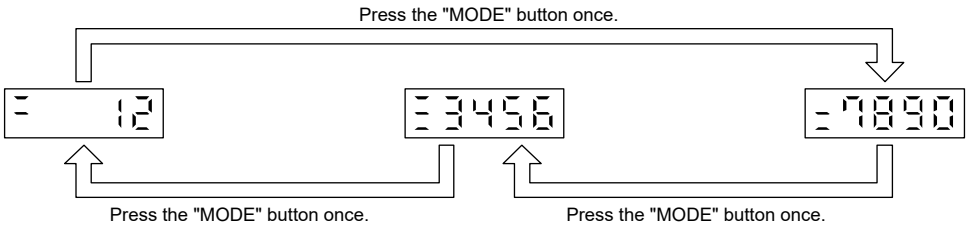
• Servo parameter in decimal

The following example gives the operation procedure to change [Pr.PA06 Electronic gear numerator] to "1234567890".



Demonstration machine operation

When the value of the servo parameter is negative, a minus is displayed in the first digit. The example in the case of "-1234567890" is displayed.



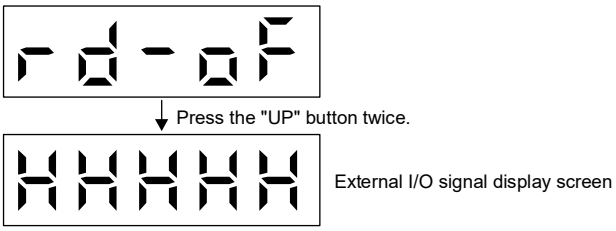
Demonstration machine operation

7.3.8 Checking external I/O signal

Before starting operation, check if the operation panel, peripheral relays, etc. are connected with the servo amplifier I/O signal in accordance with the connection diagram.
This section explains how to diagnose the ON/OFF of the servo amplifier I/O signal which can be checked with the servo amplifier display.

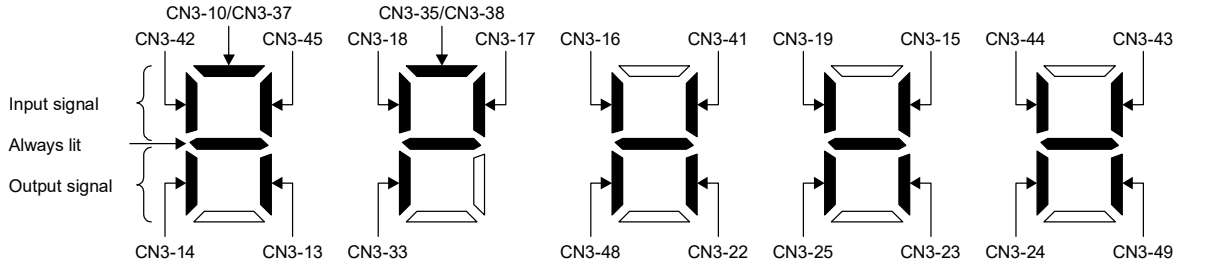
(1) Operation

The display screen after power-on is shown. Press "MODE" to display the diagnostic screen.



(2) Display content

The 7 LED segments and CN3 connector pins correspond as shown below. The CN3-13 pin and CN3-14 pin can be used on the MR-J5-_A-RJ servo amplifiers.



Light on: on
Light off: off

The LED segments corresponding to the pins are lit to indicate on, and are extinguished to indicate off. For pin signals in each control mode, refer to "Connectors and pin assignments" in the MR-J5 User's Manual (Hardware).

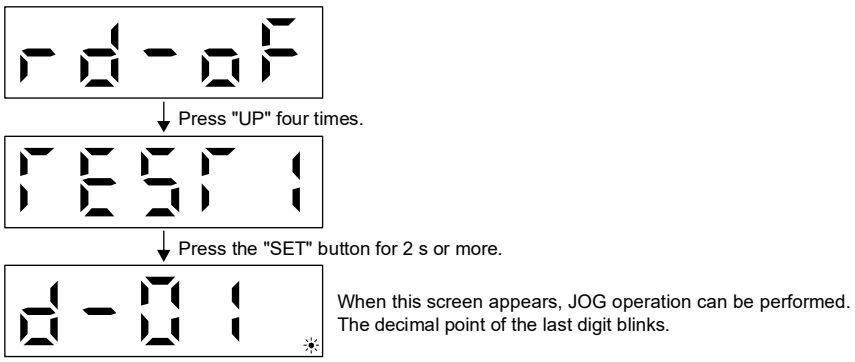
7.3.9 Test operation mode

Precautions

- The test operation mode is designed for checking servo operation. Do not use it for an actual operation.
- If the servo motor operates abnormally, stop the servo motor with EM2 (Forced stop 2).
- The test operation mode cannot be used in the absolute position detection system by DIO ([Pr.PA03.0 Absolute position detection system selection] set to "1" (enabled (absolute position detection system by DIO))). To perform the test operation, select the incremental system in [Pr.PA03].
- MR Configurator2 is required to perform the positioning operation.
- The test operation cannot be performed unless SON (servo-on) is turned off.

(1) Mode switching

The display screen after power-on is shown. Select JOG operation or motor-less operation in the following procedure. Press "MODE" to display the diagnostic screen.



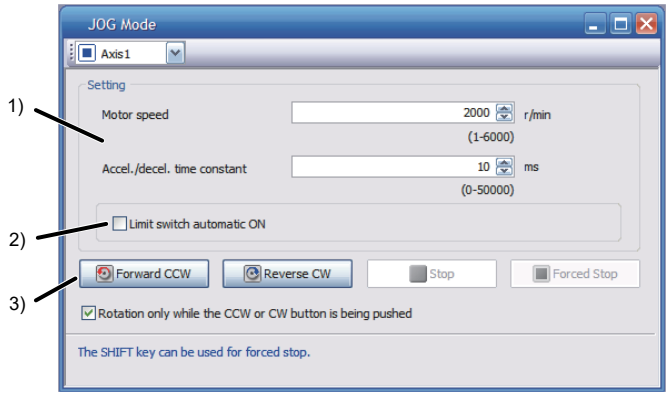
(2) JOG operation

The JOG operation can be performed when there is no command from the controller. The motor can be operated at the specified speed. Operate the motor using the JOG operation screen of MR Configurator2.

Precautions
● When performing the JOG operation, turn on EM2, LSP, and LSN. LSP and LSN can be set to automatic on by setting [Pr.PD01.2] to "C".

(a) Operation

A servo motor operates while holding down "UP" or "DOWN". The servo motor stops operating by releasing the button. Operation conditions can be changed by using MR Configurator2. Use the JOG operation screen of MR Configurator2.



1) Motor operation setting

Set the motor speed and acceleration/deceleration time constants for JOG operation. When changing the speed to the permissible speed, set the speed in [Pr.PA28.4 Speed range limit selection].

2) Limit switch automatic ON

JOG operation can be performed without connecting the limit switch. Be sure to avoid causing a collision while performing the operation.

3) Operation

The servo motor can be started (CCW/CW), paused, stopped, or forcibly stopped. Clicking "Start" starts the operation. When "Rotation only while the CCW or CW button is being pushed" is selected, clicking "Forward CCW" or "Reverse CW" will perform operation until "Stop" or "Forced Stop" is clicked.

If operating conditions are not changed in MR Configurator2, operate the servo motor under the following conditions.

Item	Setting range
Servo motor speed [r/min]	200
Acceleration/deceleration time constants [ms]	1000

Starting operation and stop of a servo motor can be done by the buttons. Operate it as follows.

Button	Description
UP	Press to start CCW rotation. Release to stop.
DOWN	Press to start CW rotation. Release to stop.

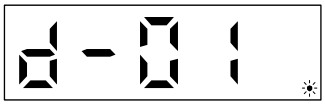
(b) Status display

Press "MODE" in the JOG operation-ready status to call the status display screen. When the JOG operation is performed by pressing "UP" or "DOWN", the servo status during the JOG operation is displayed. Every time "MODE" is pressed, the next status display screen appears. When one cycle of the screen display is complete, it returns to the JOG operation-ready status screen. For details of the status display, refer to "Switch setting and display of the servo amplifier" in the MR-J5 User's Manual (Introduction).

Note that the status display screen cannot be changed by "UP" or "DOWN" during the JOG operation.

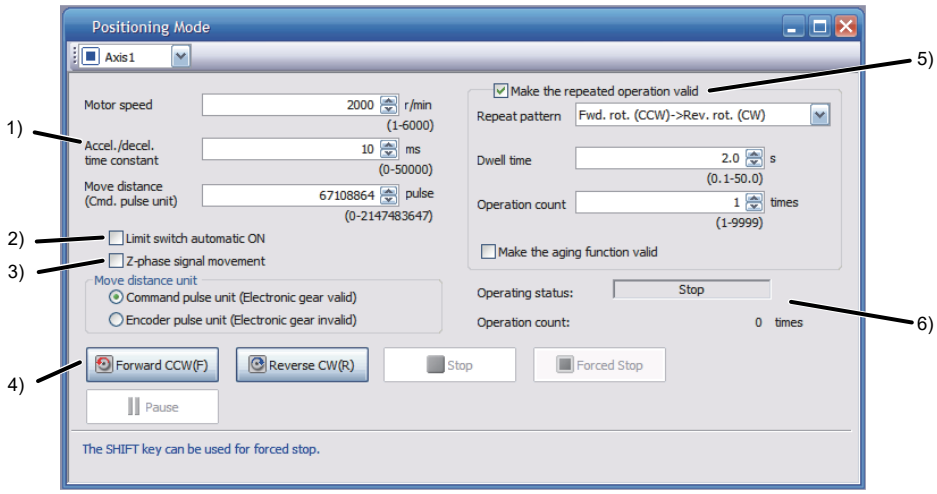
(c) Termination of JOG operation

To end the JOG operation, shut the power off once, or press "MODE" to switch to the next screen, and then hold down "SET" for 2s or longer.



(3) Positioning operation

Positioning operation can be performed when there is no command from the controller. Operate the motor using the positioning operation screen of MR Configurator2.



1) Motor operation setting

Set the motor speed, acceleration/deceleration time constants, and travel distance in the positioning operation mode. When changing the speed to the permissible speed, set the speed in [Pr.PA28.4 Speed range limit selection].

2) Limit switch

Select "Limit switch automatic ON" to perform the positioning operation when the limit switch is not connected. Be sure to avoid causing a collision while performing the operation.

3) Z-phase signal movement

When "Z-phase signal movement" is selected, the servo motor moves until the first Z-phase signal after positioning operation.

4) Operation

The servo motor can be started (CCW/CW), paused, stopped, or forcibly stopped. Clicking "Operation Start" starts the operation in the specified operation condition.

5) Repeated operation

Selecting "Make the repeated operation valid" enables the repeated operation. Selecting "Make the aging function valid" enables the continuous operation until clicking "Stop" or "Forced Stop". Set the repeat pattern, the dwell time, and the number of operations.

6) Operation status

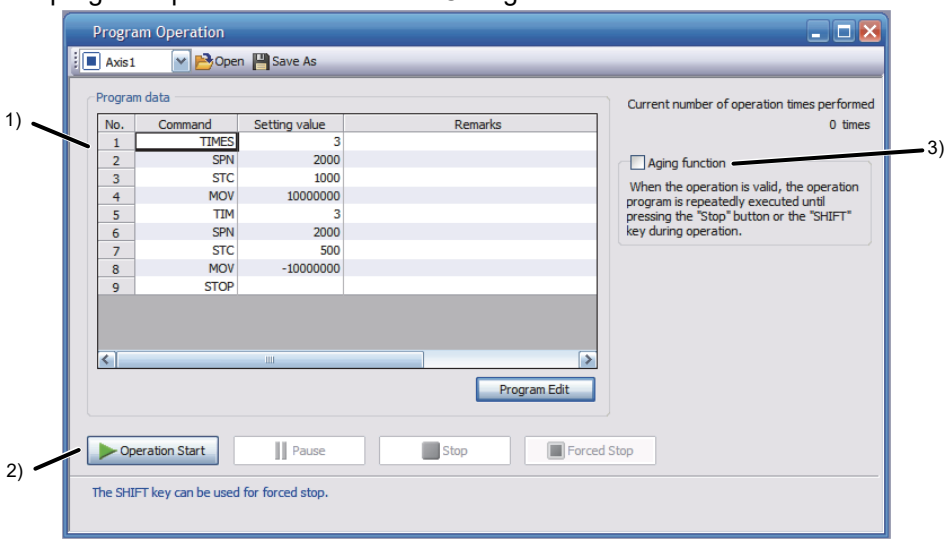
The operation status during the repeat operation and the number of operations are displayed.

The status display can be checked in the display section during positioning operation. Press "MODE" in the positioning operation-ready status to call the status display screen.

(4) Program operation

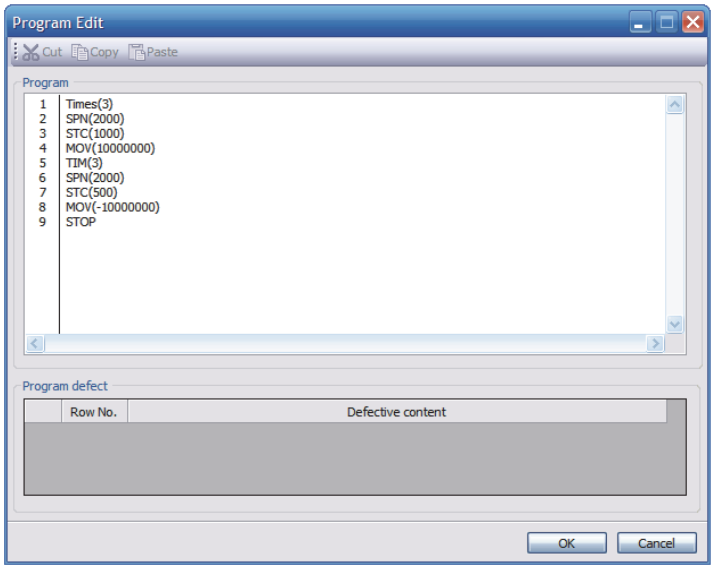
Positioning operation using multiple operation patterns can be performed without a controller. Operate the motor using the program operation screen of MR Configurator2. For details, refer to Help of MR Configurator2.

1. Open the program operation screen of MR Configurator2.



No.	Item	Screen operation
1)	Program display	Displays the program. To edit the display item, click "Program Edit".
2)	Operation	The servo motor can be started (CCW/CW), paused, stopped, or forcibly stopped. Clicking "Operation Start" starts the operation according to the program.
3)	Repeat execution	Displays the number of execution times. Selecting "Aging function" enables the repeated operation of the operation program.

2. Clicking "Program Edit" on the program operation screen opens the program edit screen. Input the program and click "OK". For program commands, refer to Help of MR Configurator2.



(5) Motor-less operation

Point
● The motor-less operation cannot be used in the linear servo motor control mode or direct drive motor control mode.

Without a servo motor connected to the servo amplifier, signal output and status display can be performed in response to the controller commands as if the servo motor is actually running. This operation can be used to check the sequence of a controller. Use this operation after the forced stop has been released. Use this operation with the servo amplifier connected to the controller.
To perform the motor-less operation, set [Pr.PC60.0 Motor-less operation selection] to "1" (enabled). To terminate the motor-less operation, set [Pr.PC60.0] to "0" (disabled).

(a) Load conditions

The operation is performed in the following conditions. Note that the conditions may differ from those of actual machines.

Load item	Conditions
Load torque	0
Load to motor inertia ratio	[Pr.PB06 Load to motor inertia ratio/load to motor mass ratio]

(b) Alarm

In the motor-less operation, some alarms and warnings are not generated. The following are examples of alarms which do not occur.

- [AL.016 Encoder initial communication error 1]
- [AL.01E Encoder initial communication error 2]
- [AL.01F Encoder initial communication error 3]
- [AL.020 Encoder normal communication error 1]
- [AL.021 Encoder normal communication error 2]
- [AL.025 Absolute position erased]
- [AL.092 Battery cable disconnection warning]
- [AL.09F Battery warning]

8 LIFE OF AC SERVO PARTS

8.1 Parts Replacement

The service life of the following parts is listed below. In addition, the service life varies depending on the operating methods and environment. If any fault is found in a part, it is necessary to replace it immediately regardless of its service life. For parts replacement, please contact your local sales office.

Part name	Recommended service life
Smoothing capacitor	10 years
Relay	Total number of times of power-on, forced stop by EM1 (Forced stop 1), and sudden stop command from controller: 100,000
Cooling fan*1	50,000 hours to 70,000 hours (7 to 8 years)
Absolute position battery	Refer to "ABSOLUTE POSITION DETECTION SYSTEM" in the MR-J5 User's Manual (Hardware).
Bearing	20,000 hours to 30,000 hours
Encoder	20,000 hours to 30,000 hours
Oil seal	5,000 hours
Battery*2	5 years from date of manufacture

*1: For J5 servo amplifiers, the cooling fan can be replaced by the user with a "fan unit".

*2: The battery can be replaced by the user.

(1) Smoothing capacitor

The characteristic of the smoothing capacitor is deteriorated due to ripple currents or other factors. The service life of the capacitor greatly varies depending on ambient temperature and operating conditions. The service life of the capacitor is 10 years under continuous operation in air-conditioned environments (ambient temperatures of 40°C or less at altitudes of up to 1000m and 30°C or less at altitudes of over 1000m and up to 2000m).

(2) Relays

Contact faults occur due to contact wear arisen from switching currents. A relay will reach the end of its service life if the following actions are performed a total of 100,000 times: powering on the servo amplifier, inputting the EM1 command (Forced stop 1), and inputting the quick stop command from the servo controller. In addition, the service life of a relay may vary depending on the power supply capacity.

(3) Servo amplifier cooling fan

The cooling fan bearings will reach the end of their service life in 50,000 hours to 70,000 hours. Therefore, the cooling fan must be replaced after seven to eight years of continuous operation as a guideline. If unusual noise or vibration is found during inspection, the cooling fan must also be replaced. The service life has been calculated in an environment which contains no corrosive gas, flammable gas, oil mist, or dust. The average annual ambient temperature was 40°C.

(4) Bearings

When the motor is run at rated speed and at rated load, bearings should be changed every 20000 to 30000 hours as a guideline. As this differs depending on the operating conditions, the bearings must also be changed if unusual noise or vibration occurs during inspection.

(5) Oil seal

Oil seals must be changed in 5000 hours of operation at rated speed as a guideline. This differs depending on the operating conditions. The oil seals must also be changed if oil leakage a similar problem is found during inspection.

Even if the oil seal on the rotary servo motor makes noises during operation, it does not indicate a problem with the functions.

(6) Battery

Quality of the batteries degrades by the storage condition. The battery life is 5 years from the production date regardless of the connection status.

8.1.1 Battery replacement procedure

Precautions

- It is recommended to check the voltage between P+ and N- with a tester or some other instrument after turning off the power and waiting for 15 minutes or more until the charge lamp turns off.
- Servo amplifiers may be damaged by static electricity. Always take the following precautions.
  - Ground your body and the workbench.
  - Do not touch the conductive parts, such as connector pins and electrical parts, directly.
- Check that the replacement battery is still within its useful life.

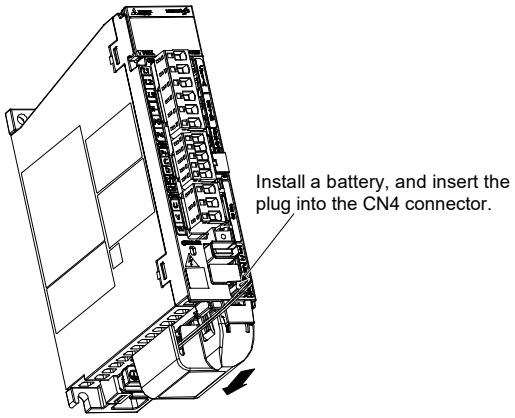
Point

- Replacing a battery with the control circuit power supply turned off will erase the absolute position data.

Replace the battery with only the control circuit power supply turned on. If the battery is replaced with the control circuit power supply turned on, [AL.09F.1 Battery voltage drop] will occur, but the absolute position data will not be lost.
For the procedure for mounting the battery to the servo amplifier, refer to "Battery mounting procedure" in section 8.1.2.

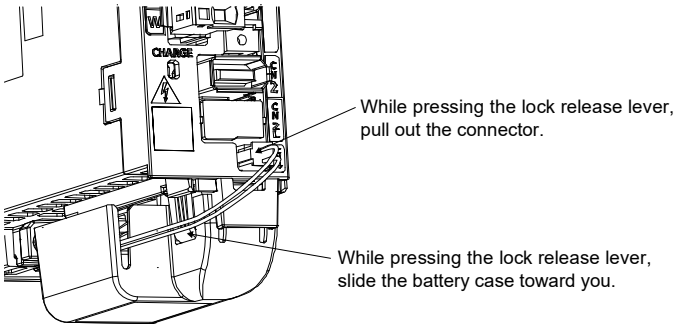
8.1.2 Battery mounting procedure

(1) Mounting method



(2) Removal method

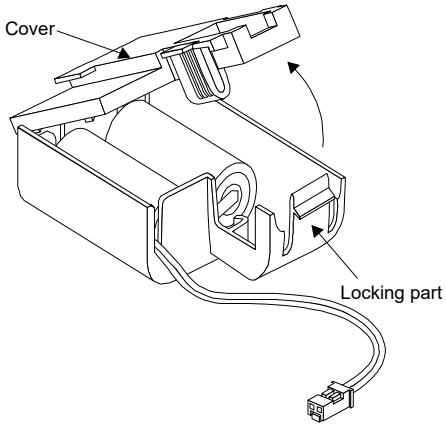
Precautions
● If the battery connector is pulled out without pressing the lock release lever, the servo amplifier CN4 connector or the battery connector may become damaged.



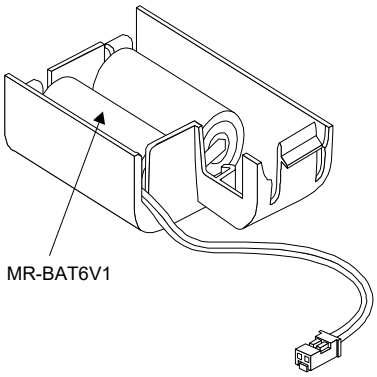
8.1.3 Built-in battery replacement procedure

If the MR-BAT6V1SET has reached the end of its useful life, replace the built-in MR-BAT6V1 battery.

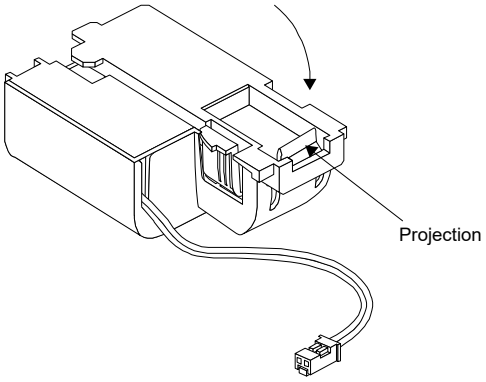
1. Open the lid by pressing the lock part.



2. Replace the built-in battery with a new MR-BAT6V1 battery.



3. Close the lid by pressing on it until it is secured by the claw of the lock.

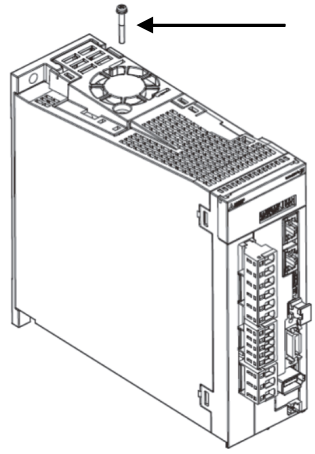


8.1.4 Fan unit replacement procedure

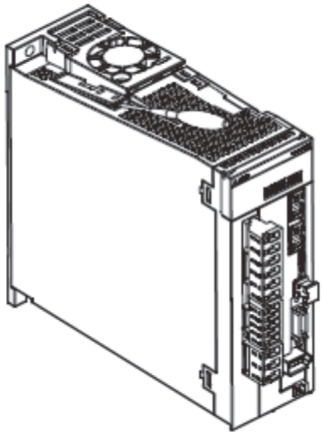
The fan unit is an integrated structure that consists of the cooling fan and a cover. When replacing the cooling fan, replace the entire fan unit. Before replacing the fan unit, turn off the power supply.

(1) Removal method

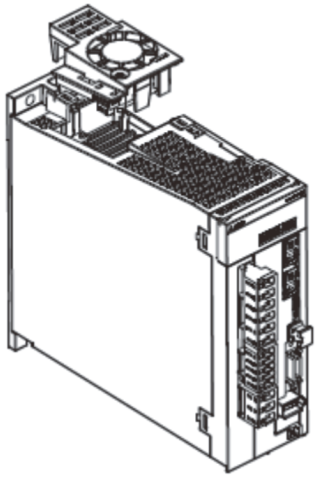
1. Remove the screws securing the fan unit. The removed screws will be used to install the fan unit.



2. Lift the cover of the fan unit with a precision screwdriver or similar tool.

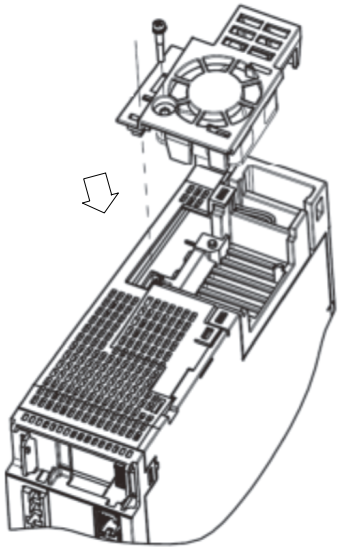


3. Pull out the fan unit vertically.



(2) Mounting method

Align the positioning guide of the fan unit with the positioning guide of the main unit case, insert the fan unit vertically, and fix it with the screws. Use the screws that were used for the fan unit before replacement.



Memo

App. 1 Specification Symbols

Appendix Table 1.1 List of specification symbols

Ta	: Acceleration torque	[N•m]
Td	: Deceleration torque	[N•m]
T_{Ma}	: Motor torque required at acceleration	[N•m]
T_{Md}	: Motor torque required at deceleration	[N•m]
T_L	: Load torque converted into equivalent value on motor shaft	[N•m]
T_u	: Unbalanced torque	[N•m]
T_F	: Load friction torque	[N•m]
T_{LO}	: Load torque on load shaft	[N•m]
Trms	: Continuous effective load torque converted into equivalent value on motor shaft	[N•m]
T_M	: Motor rated torque	[N•m]
T_{mmax}	: Motor maximum torque	[N•m]
J_L	: Load moment of inertia converted into equivalent value on motor shaft	[kg/cm^2]
J_{LO}	: Load moment of inertia on load shaft	[kg/cm^2]
J_M	: Rotor inertia moment of motor itself	[kg/cm^2]
Nr	: Motor rated speed	[r/min]
No	: Motor speed at maximum machine speed	[r/min]
N	: Motor speed	[r/min]
Vo	: Maximum machine speed	[mm/min]
V	: Machine speed	[mm/min]
P_B	: Ball screw lead	[mm]
Z_1	: Number of gear teeth on motor shaft side	
Z_2	: Number of gear teeth on load shaft side	

$$\text{Reduction ratio } 1/n = \frac{Z1}{Z2}$$

Decelerates for 1/n < 1, and accelerates for 1/n > 1

P_f	: Number of feedback pulses	[pulse/rev]
f_{c1}	: Electronic gear output pulse frequency	[pps]
f_c	: Electronic gear input pulse frequency	[pps]
f_0	: Input pulse frequency at maximum machine speed	[pps]
Tpsa	: Acceleration time of command pulse frequency	[s]
Tpsd	: Deceleration time of command pulse frequency	[s]
K_p	: Position loop gain	[s^{-1}]
T_p	: Position loop time constant (Tp = 1/Kp)	[s]
$\Delta\ell_0$	: Feed length per electronic gear output pulse	[mm/pulse]
$\Delta\ell_c$	: Feed length per electronic gear input pulse	[mm/pulse]
ℓ	: Length per feed	[mm]
P	: Number of command input pulses	[pulse]
t_f	: One operation cycle	[s]
t_o	: Positioning time	[s]
t_{st}	: Stopping time	[s]
t_c	: Rated operation time	[s]
t_s	: Stop settling time	[s]
m	: Inertia ratio (m = JL/JM)	[pulse]
ε	: Number of droop pulses	[mm]
Δε	: Positioning accuracy	[mm]
ΔS	: Feed length per motor revolution	[mm]

Example on the ball screw

When directly coupled ΔS = PB

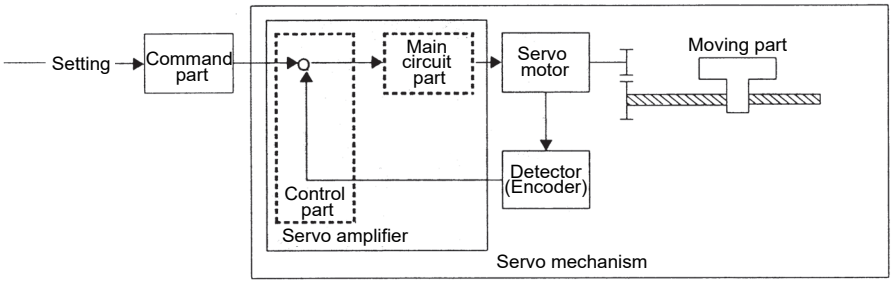
When reduction ratio is 1/n ΔS = PB•1/n

Note 1. When using GD^2 for the unit of the moment of inertia, the expression is GD^2 = 4 × J.
2. 1kg•m^2 = 10000kg•cm^2 in the system of measurement
3. These specification symbols are described assuming inputs and outputs of a servo amplifier.
When assuming the positioning command module to be the main part, substitute the terms as follows.
Examples: Electronic gear input pulse frequency fc → Command output pulse frequency
Feed length per electronic gear input pulse $\Delta\ell_c$ → Feed length per command output pulse (command minimum feed unit)

App. 2 AC SERVO BASICS

App. 2.1 About AC Servos

In JIS, a servomechanism is defined as "a control system configured to follow the desired change of the target using an object's conditions such as position, direction, and posture as the control amount". When a target value (of position, speed, etc.) is input from a command section, its current value (of position, speed, etc.) is detected and control is performed to keep the difference between the current value and the target value as small as possible at all times.
The elements composing a servomechanism are called the servo elements, which are a drive amplifier (AC servo amplifier), drive motor (AC servo motor), and detector. Appendix Figure 2.1 shows the configuration example.



Appendix Figure 2.1 Configuration diagram of a servomechanism

App. 2.2 Placement and Performance of AC Servos

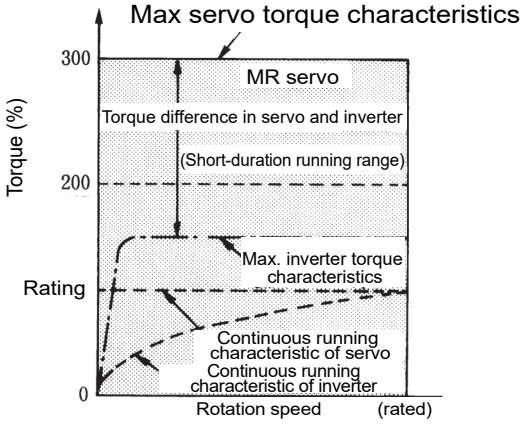
Compared with general motors, a servo motor is designed considering especially about the moment of inertia of its rotor (termed J or GD2) and electrical response performance. Thus, a servo motor can respond to a sudden change of the voltage and current from a servo amplifier. In addition, the servo amplifier that drives the servo motor is configured so that the speed/position control commands can be correctly and quickly transmitted.
Based on the above perspective, this section explains the typical characteristics of the servo motor (its total characteristics in combination with a servo amplifier) by showing the comparisons with a motor driven by a general-purpose inverter which is a general variable speed device.

(1) Features of general-purpose servos and comparison with control devices

The speed - torque characteristics are generally used to indicate the motor characteristics.Appendix Figure 2.2 shows the characteristics comparison between a servo motor and a general-purpose motor with a general-purpose inverter.
This figure indicates that the servo motors have the following three features:

1) Wide speed control range
2) Torque characteristics stable both at high-speed and low-speed operations
3) Large maximum torque

Note) The large maximum torque and small motor moment of inertia enable rapid acceleration and deceleration.



Appendix Figure 2.2 Torque characteristics comparison between servos and inverters

Appendix Table 2.1 Main performance of servo motors

Item	Specifications	Description
Speed control range	1: 1000 to 5000 (1: 10)	Enables operation without worrying about rotation stability or torque decrease until the speed becomes 1/1000 of the rated speed.
Torque characteristics	At low-speed operation	Allows both the continuous operation torque and maximum torque to be output at a constant level within the speed control range. Thus, the servo motor can be operated securely in any speed range even with the rated torque load.
Maximum torque	Approximately 300% (150%)	Allows the instantaneous maximum torque to be output at approximately 300% of the rated torque. Thus, as the servo motor supports a sudden acceleration/deceleration, it can be used for high-frequency positioning.

Note) Values in the parentheses in the specification column are the general specifications of general-purpose inverters.

(2) Applications of AC servos

In addition to the features mentioned in the previous section, the servo motor in combination with the servo amplifier has the positioning function that is distinctive from other variable speed devices. This section explains the positioning function that is distinctive of servos and the representative applications of the servo motor based on the features described in the previous section (1). Details of the positioning function are described in Chapter 2.

(a) Machines that require positioning

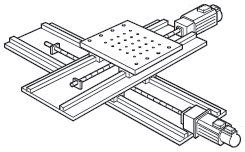
AC servos enable high-precision positioning in combination with dedicated positioning command modules.

General Mitsubishi AC servos can perform positioning with 4000 to 67108864 resolutions, which is sufficient for positioning with 1μm accuracy on machines that feed 24 to 8m per minute.

Application examples: Machine tool devices, woodworking machines, transportation machines, packaging machines, inserter machines/mounter machines, feeder machines, cutter machines, and special working machines

1) X-Y table

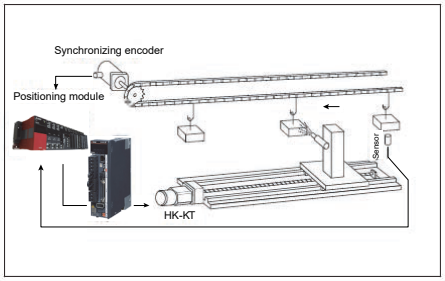
Performs high-speed and high-precision positioning by using two axes of AC servos with loads of ball screws connected to each X and Y axis.



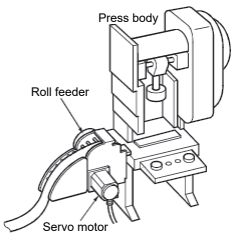
2) Transportation machine (vertical)

Refer to "Fault example: Electromagnetic brake" in section 7.3.2 "Installation" for details.

3) Synchronized feeding (for coating lines)
Detects the positions of products by using the sensor to perform synchronized feeding with encoder signals.
The motor returns the position to the home position after feeding a specified length, then waits for the next product.



4) Press/roll feeder
Operates a feed roller using an AC servo motor to supply a material by a specified length.
The material is to be supplied by the press while the press head is ascending, then punched once in position.

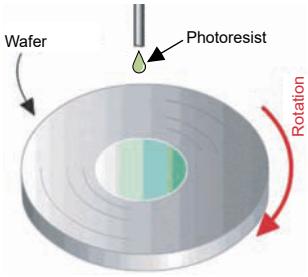


(b) Machines that require wide variable speed range
An AC servo has a high-accuracy speed control performance with a speed control range of 1: 2000 to 5000 and speed fluctuation ratio of 0.01% or less, besides the constant output torque which is a characteristic distinctive from other variable speed equipment. Thus, an AC servo is used for high-accuracy variable speed controls such as line controls.

Application examples: Printing machines, paper converting machines, film production lines, wire drawing machines, winding machines, feeding of various special working machines, various material handling systems, winding and unwinding, main shafts of woodworking machines

1) Spin coating

Produces semiconductor circuits using the principle as described below.
Spin coaters apply photosensitizer (photoresist) to semiconductor wafers.
The resist liquid is dropped on the wafer, then the centrifugal force spreads the liquid.
If the rotation speed of the wafer is too fast, the resist will splash off the wafer. If the rotation speed is too slow, the resist will be applied to the wafer unevenly.

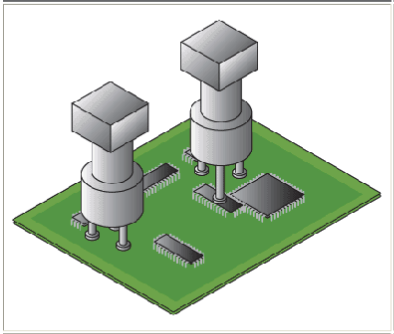
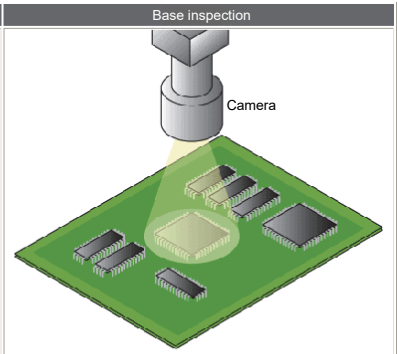


(c) High-frequency positioning

As explained in (a) "Machines that require positioning", the maximum torque of an AC servo is approximately 300% of the rated torque. This allows a motor as a single unit to follow a sudden acceleration/deceleration which takes approximately several tens of milliseconds from stop to the rated speed. Thus, the motor can support a high-frequency positioning of 100 times or more per minute. In addition, as its great features, an AC servo is maintenance-free because it has less mechanical contacting parts in comparison to other positioning methods (clutch brake, DC motor, etc.) and is less susceptible to the ambient temperature.

Application examples: Press feeders, bag making machines, sheet cutters, loaders/unloaders, filling machines, packing machines, various material handling systems, mounters, bonders

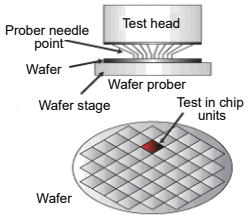
1) Mounter and board inspection

Mounter	Base inspection
	
Check whether the electronic components (LSI, resistor, capacitor, etc.) are mounted on the printed-circuit board. Positioning accuracy and high speed performance are requested.	Check whether the electronic components (LSI, resistor, capacitor, etc.) are mounted correctly on the printed-circuit board. In some cases, the board itself is also checked.

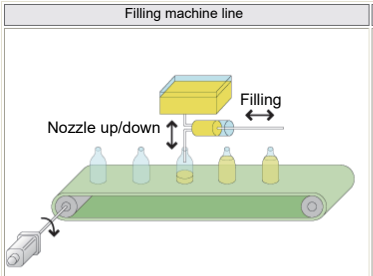
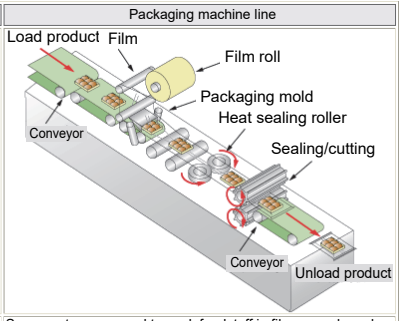
2) Wafer prober

Since many LSI chips are to be produced per wafer, each chip is to be inspected before assembly with a wafer prober and tester.

Precise positioning is required because this device sticks a needle into a chip. In addition, high speed is also required.



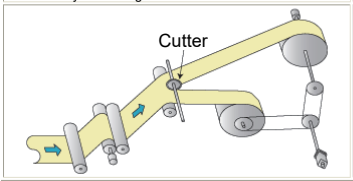
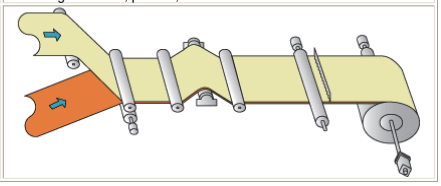
3) Filling machine line/packing machine line

Filling machine line	Packaging machine line
	
Filling machine line Bottles capable of large amounts are filled with different volumes of liquid at fast speeds. The filling speed can be controlled according to the shape of the bottles so that the liquid does not bubble over the specified value.	Servo motors are used to pack foodstuff in film properly and hygienically. The point is to cut and separate the rolled film into precise sizes after the packaging is done according to the size of food products.

(d) Torque control

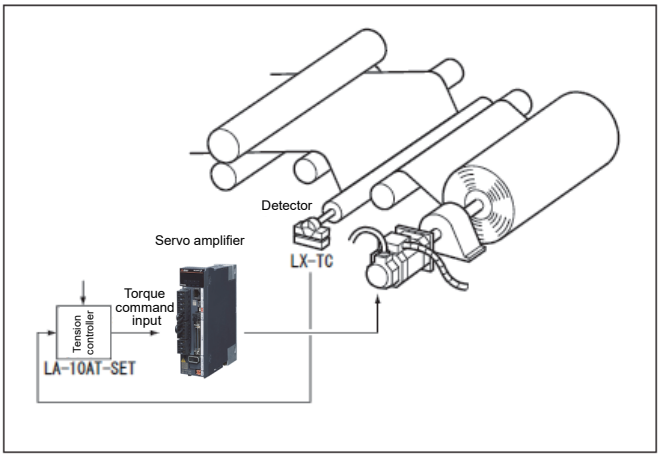
As torque control is available with specific models in addition to speed control and position control functions, an AC servo is applicable to various winding/unwinding devices and other devices in the field of tension control.

1) Slitter/laminator

Slitter	Laminator
A slitting machine is used for slitting at the winded part as the final process after processing has been performed in the processing part. The point is to slit successfully using the slitter by controlling the tension.	The laminator is used to superimpose and fuse several films. It is important to control the tension and adjust the right amount of pressure so that superimposing is done well. The same mechanism is also used in coating machines, printers, etc.
	

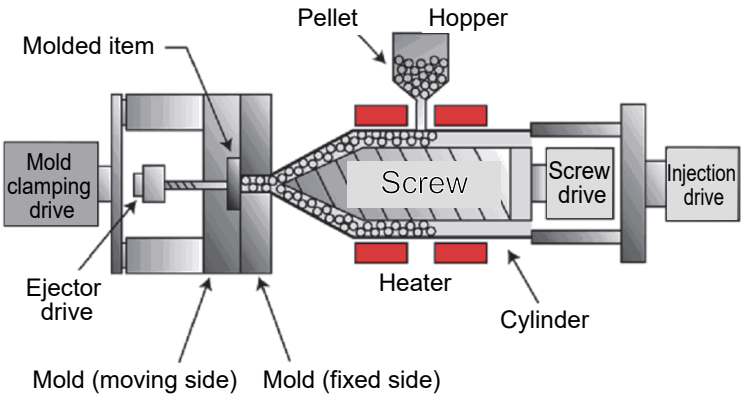
2) Winding device

Performs winding tension control for sheet materials using an AC servo in combination with a tension detector and tension control device.



3) Injection molding machines

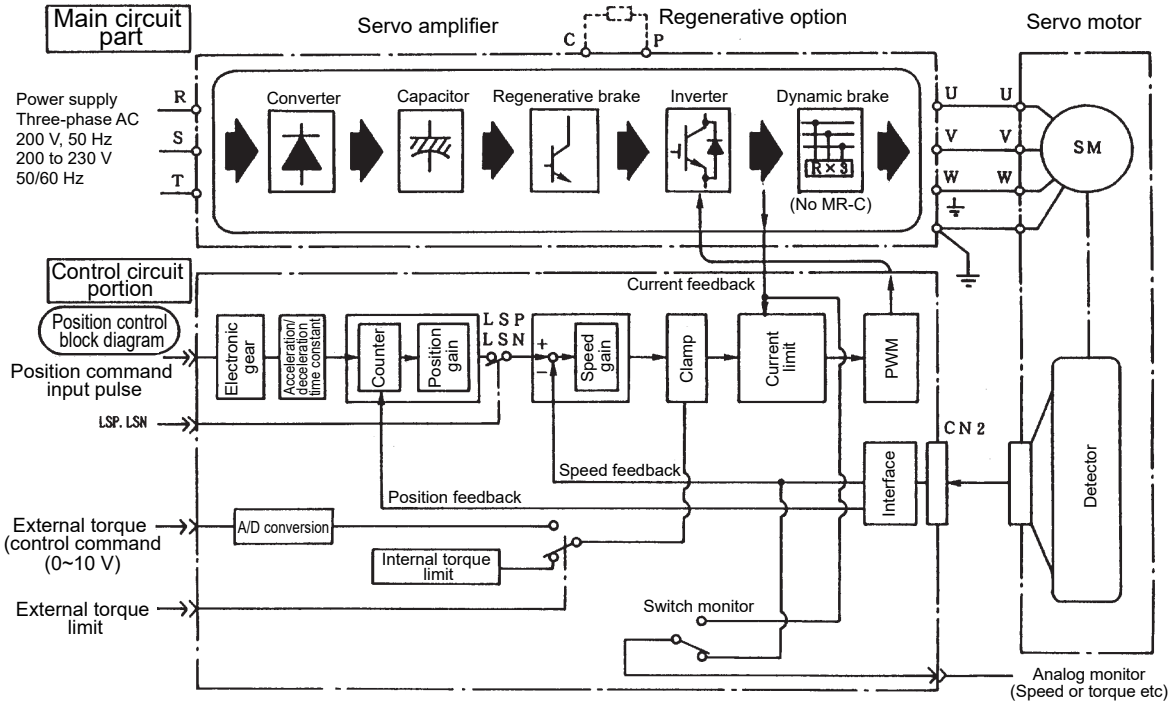
Injects plastic pellets to the mold. The plastic pellets are the material of the molded product and are melted by the heater at the area composed of the cylinder and screw shaft.
Then, the mold opens after cooling, and the ejector pin pushes out the molded product.
The mold clamping force is so large that it exceeds 3000t in some applications for large-sized components.



App. 2.3 AC Servo Mechanisms

App. 2.3.1 Servo amplifier block diagram and operating principle

The basic functions and operating principle of the servo amplifier are shown in the block diagram below.



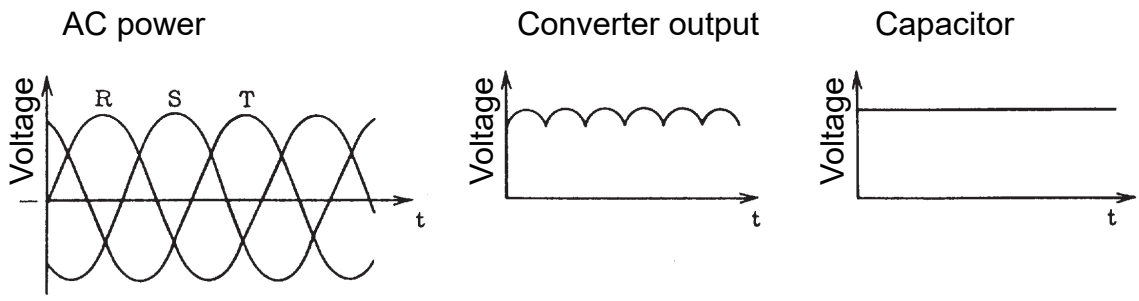
Appendix Figure 2.3 AC servo (pulse train method) block diagram

(1) Main circuit

As the basic functions, the main circuit rectifies and smooths AC power (3-phase 200 to 230VAC, 50/60Hz) by using converters (diode bridges and capacitors). Then, it performs sine-wave PWM control using the inverter (IGBT) and supplies the 3-phase current which has a desired voltage and frequency to the motor to control the motor speed and torque.

(a) Converter and smoothing capacitor

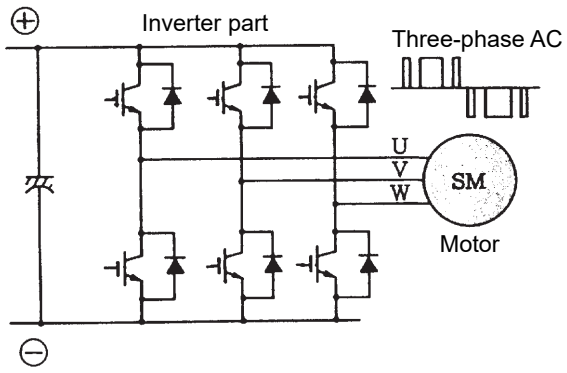
A diode bridge rectifies AC power, then a smoothing capacitor makes DC power with a small ripple.



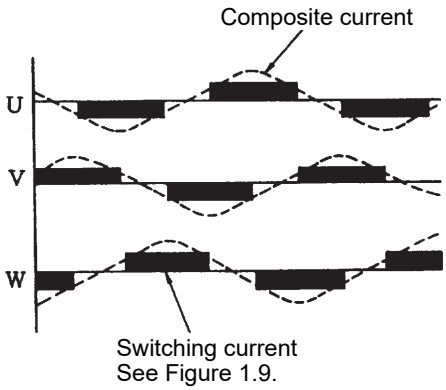
Appendix Figure 2.4 Servo amplifier voltage of each part

(b) Inverter

An inverter generates a current that has a frequency in accordance with the motor speed and appropriate strength for the load torque from the DC power generated by the converter and smoothing capacitor, then supplies the current to the motor.

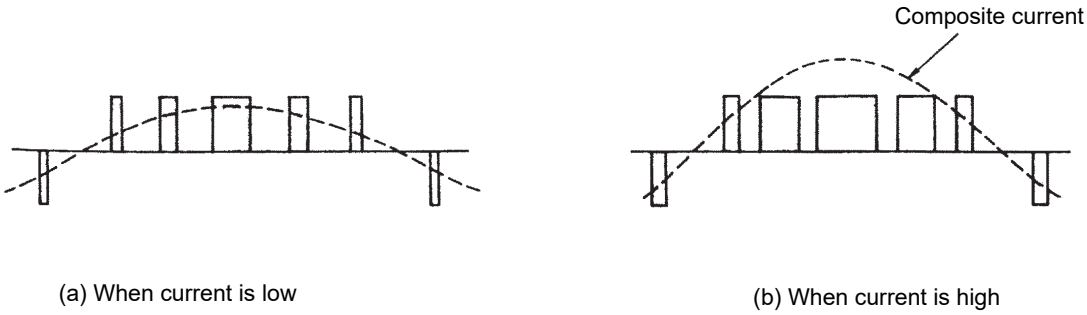


Appendix Figure 2.5 Structure of inverter section



Appendix Figure 2.6 Inverter output current

The motor rotation direction and speed (frequency) are controlled by switching on and off the transistor in the inverter section in accordance with the direction and width of the current, as shown in Appendix Figure 2.7.
The strength of the current is controlled by the width of the current, and this method is called the pulse width modulation (PWM) control.



Appendix Figure 2.7 Current control by PWM

(c) Regenerative brake

1) Regenerative brake circuit

The regenerative brake operates when the actual motor speed exceeds the command speed, specifically when the motor decelerates, moves downward along a vertical axis, or applies a brake on an unwinding axis. The regenerative brake generates braking force by absorbing (consuming) the rotation energy of the motor and load using the built-in regenerative resistor on the servo amplifier side.
This operation status is called regenerative operation, and a servo amplifiers generally has a regenerative circuit. The regenerative circuit behaves as a load for the motor in this case, thus the regenerative braking force varies depending on the energy consumption rate of the circuit. In addition, as the amount of the regenerative energy varies depending on the operation conditions, the energy can be consumed in a circuit provided besides the servo amplifier when a large amount of the regenerative energy needs to be consumed.

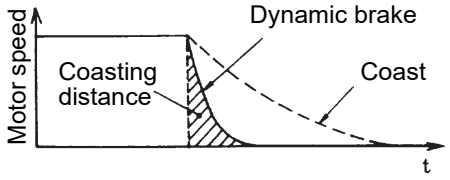
2) Types of regenerative brake circuits

- When a small-capacity model is being used and the regenerative energy is small, regeneration is performed by temporarily charging the smoothing capacitor mentioned above. This is called the capacitor regeneration method, which is to be used for a capacity of approximately 0.4kW or less.
- For a medium-capacity model, current is applied to the resistor so that the energy is consumed as heat. This is called the resistance regeneration method. Note that a larger regenerative energy requires a larger resistor which may affect the peripheral equipment due to the generated heat.
- To make up the above disadvantage of the resistance regeneration method, recently the method that returns the regenerative energy to the power supply has come to be used for a large-capacity model. This is called the power supply regeneration method, which is to be used for a capacity of approximately 11kW or more.

(d) Dynamic brake

If the motor stops by output from the inverter section (base circuit shut-off) at a power failure, alarm occurrence or other occasions, the motor coasts and it takes a long time for the motor to stop completely. This extends the coasting distance, possibly causing malfunctions such as collision with the stroke end.

The dynamic brake is the function that shorts between the servo motor terminals using an appropriate resistor consuming the rotation energy as heat to quickly stop the servo motor at a base circuit shut-off. Although the dynamic brake is normally built in the servo amplifier, it is separated from the servo amplifier of some models such as the MR-C series and the MR-J4 series with a capacity of 11kW or more. In addition, as the dynamic brake does not have power for holding the motor at a stop, mechanical braking at the same time as braking is required to hold the motor when operating a vertical feed.

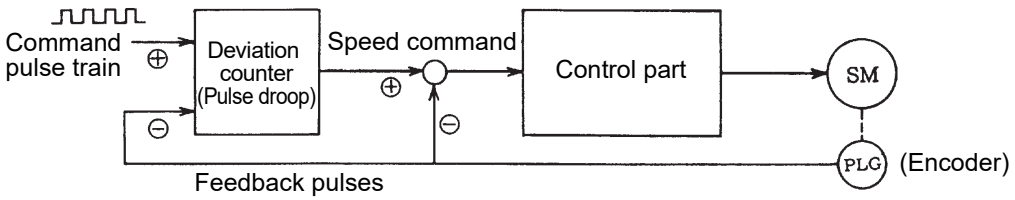


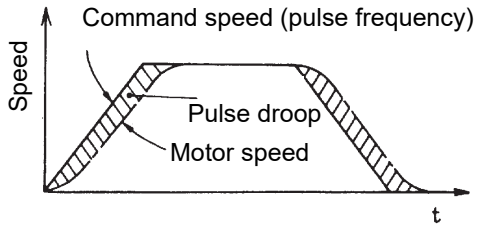
(2) Control circuit section

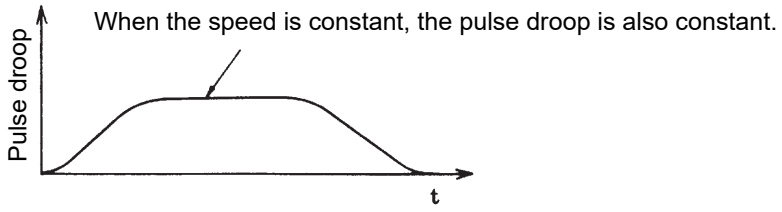
This section calculates the control amount (position, speed, and current) from the command value (target value) and current value very quickly and accurately using a microcomputer, achieving a high-response and accurate servo control. Monitoring of the controlled items and protection of the unit are performed as well. The following explains the brief summary of the controlled items.

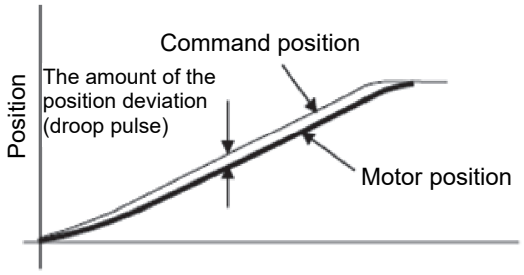
(a) Position control

Pulse trains are used to control the motor speed and rotation direction and to execute high-accuracy positioning.









In the positioning section, the motor moves with a slight delay to the command even when the command pulses are input. The pulses equivalent to the delay are accumulated and retained in the deviation counter, and the said pulses are called the droop pulses. The droop pulses are then output to the speed control section as the speed command.

(b) Speed control

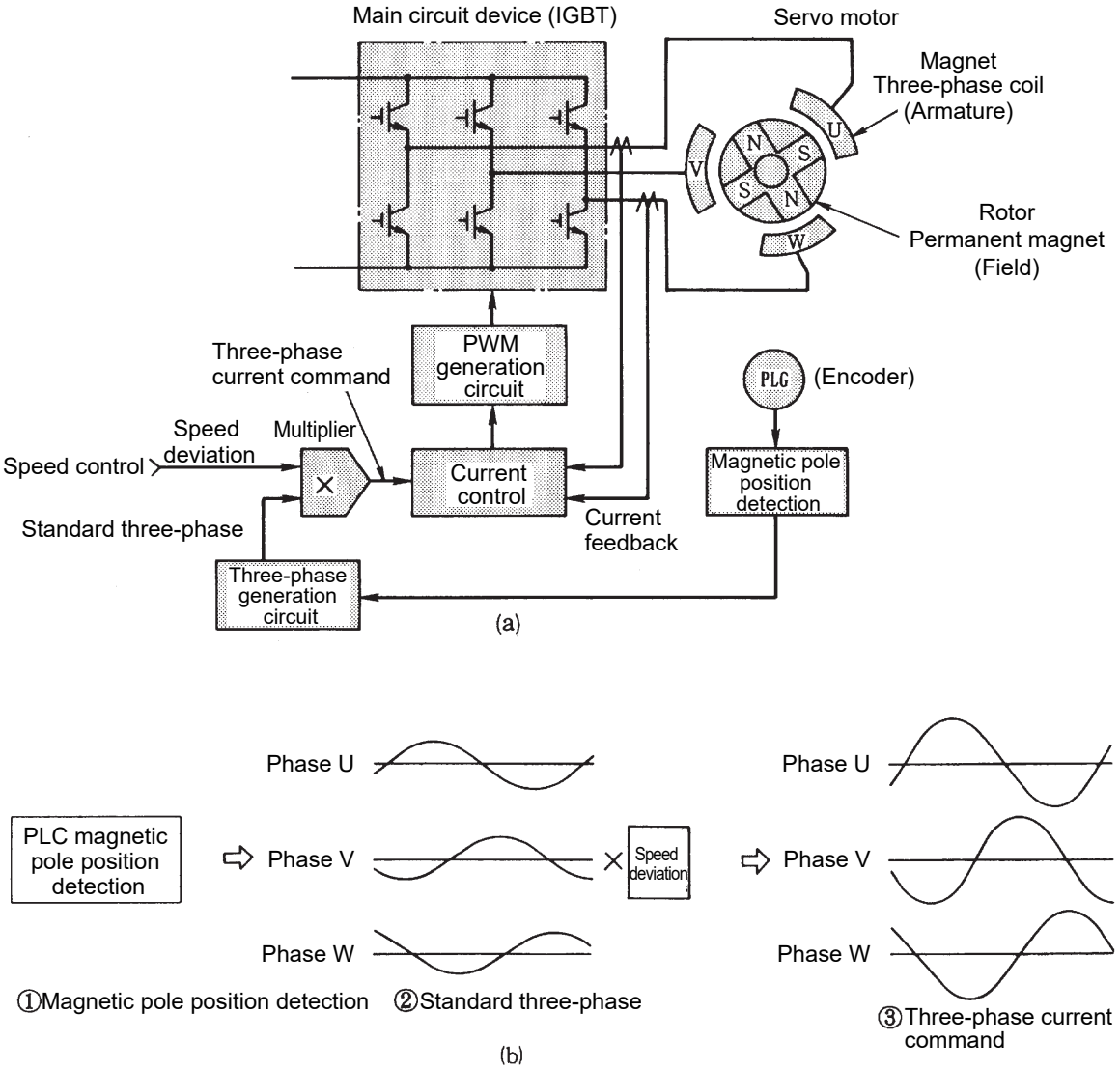
The output from the deviation counter in the position control section is in proportion to the command speed, and thus this output is used as the speed command. The speed command section outputs the deviation between the speed command and motor speed as the current command.

Note that the control signal and analog voltage (0 to ±10V) are input as the speed command from an external device when the motor is operated in the speed control mode.

(c) Current control/3-phase generating circuit

The current control section uses the inverter of the main circuit to control the current of the motor so that the motor operates in accordance with the position command or speed command.

For this current control, the phase of the 3-phase AC is determined in accordance with the motor field (which is determined by the position of the permanent magnet of the rotor), then a current corresponding to the speed deviation is applied.

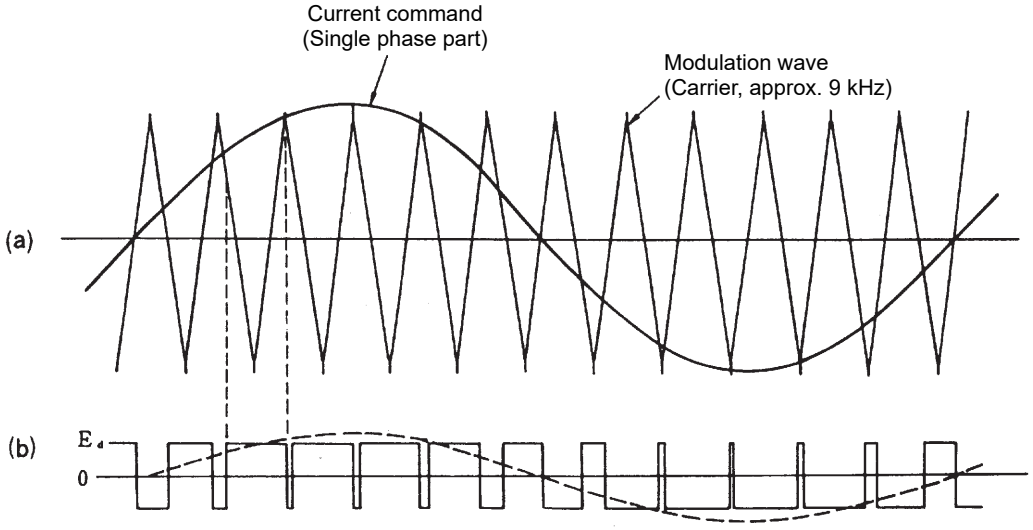


Appendix Figure 2.8 Current control principle

When a synchronous motor is being used, the phase of the motor current needs to match the position of the field system (magnetic pole position).
Therefore, the motor detector has a signal to detect the magnetic pole position, constantly feeding the position data back to the servo amplifier. With this signal, the servo amplifier generates a reference 3-phase current in the 3-phase generating circuit section. The current control section generates a 3-phase current command by multiplying the reference 3-phase current by the speed deviation to control the PWM circuit.

Note) Induction-type servo motors do not have their own field system. Therefore, they do not need magnetic pole position detection.

The PWM method is the method that generates switching pulses several times per cycle, then changes their pulse widths to change the output voltage. The number of the switching pulses generated per second is called the carrier frequency. When the PWM method is being used, motor vibration and noise of the frequency component in proportion to this carrier frequency will occur.



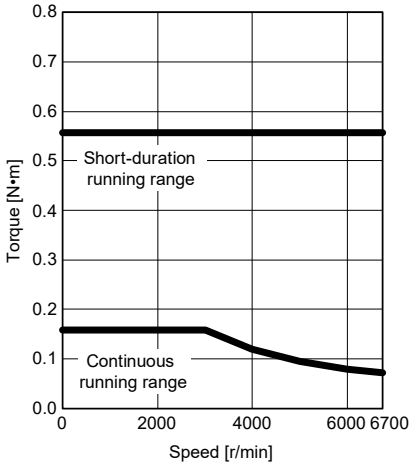
Appendix Figure 2.9 PWM control principle

App. 2.3.2 AC servo motor features and operating principle

(1) Features

The output torque of the servo motor is in proportion to the current applied to the motor.
As the servo amplifier controls the servo motor by constantly detecting the motor speed to apply a current in accordance with the speed deviation, the servo motor can be operated with a constant torque from low speed to high speed.
The torque characteristics vary depending on the servo motor model.
The figure in the right shows the torque characteristics of the HK-KT053W.

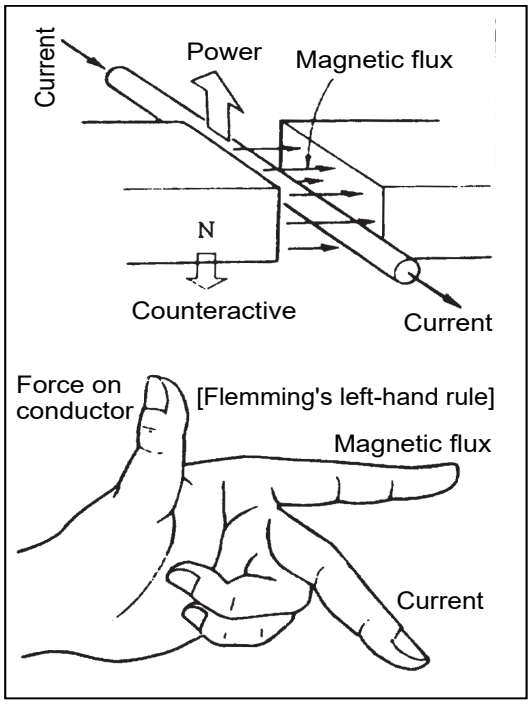
[HK-KT053W]
Standard torque



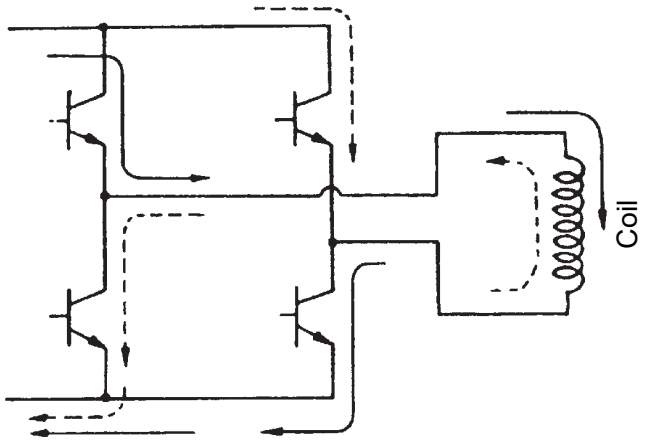
Appendix Figure 2.10 HK-KT053W torque characteristics example

(2) Operating principles

Regardless of the types and sizes, all the motors are operated by the common operating principle which generates torque as indicated by the "Fleming's left hand rule". It simplifies the way of working out the direction of motion where a force acts on a conductor in the magnetic field when a current is applied to the conductor. An SM type (synchronous type) AC servo motor has a permanent magnet in the rotor and windings around the magnet to which a current is applied. It applies a current to the magnet windings in an amount corresponding to the motion of the rotor (rotation speed/direction and output torque).

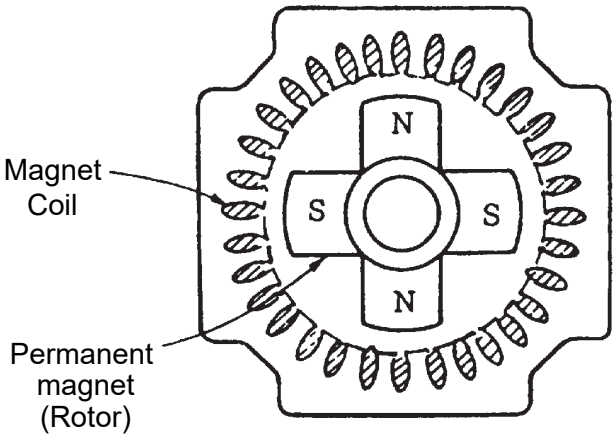


Motor torque generating principle



SM type AC servo motor operating principle

A current is applied to the winding of the motor windings which is orthogonal to the magnetic flux from the rotor magnet by turning on and off the servo amplifier transistor.
The applied voltage is switched at several kHz, and the flowing current is smoothed into a sine wave by the reactance of the winding. The section + and - of the winding voltage are discriminated by the magnetic pole position detection signal output from the detector directly connected to the motor shaft. Moreover, the magnetic flux and current are controlled so that they are always orthogonal to each other. Thus, the SM type AC servo motor does not step out like the general synchronous motors.

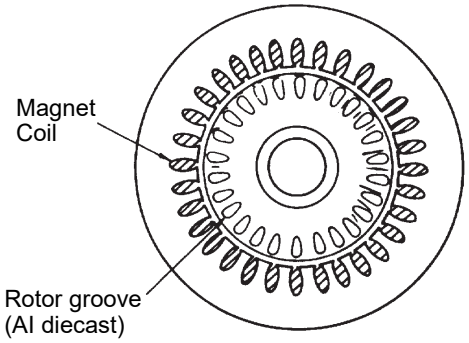


Appendix Figure 2.11 Cross-section of an SM type AC servo motor

(3) IM type (induction type) motor (vector control inverter) principle

An induction motor generates torque under the same principle as the synchronous motor.
However, an induction motor does not have a permanent magnet on the rotor side as shown in the cross-section in the right, thus the current I_a and magnetic flux Φ cannot be supplied separately.
Therefore, a current is applied to the magnet winding, then torque is generated using the current that flows in the rotor slits resulting from magnetic induction and the magnetic flux generated by the magnet winding current.
Thus, both the torque current and magnetic flux current are applied to the magnetic windings, and the relation between the currents is as indicated in expression (2-1).

$I_1 = I_a + I_b$ …… (2-1)



Appendix Figure 2.12 Cross-section of an IM type motor

[I_1: Magnet winding current, I_a: Torque current, I_b: Magnetic flux current
Note) The above expression indicates the vectorial sum, not the arithmetical sum.]

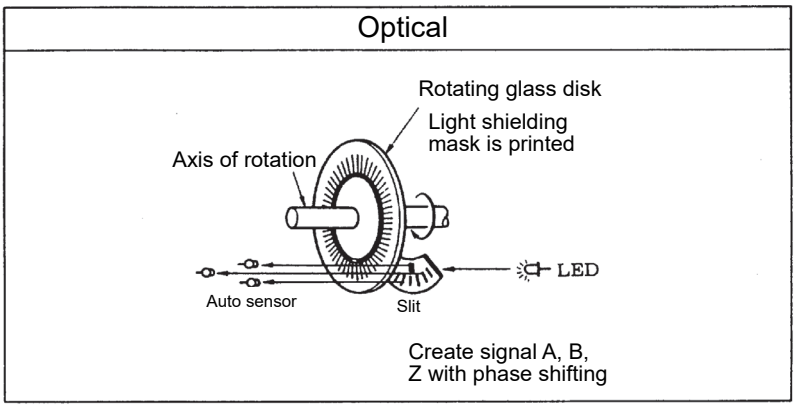
Therefore, an IM motor needs to control the two types of currents separately, and this control is called the vector control.
An IM type motor with the vector control has the same torque characteristics as a servo motor.

App. 2.3.3 Encoder functions and operating principle

As explained above, servo control feeds back the actual value (motor speed and position) relative to the command value to reduce the deviation between these values.
Therefore, a detector is an essential element of a servo system.

(1) Encoder structure

The following shows the structure of an encoder that is mainly used as a detector.



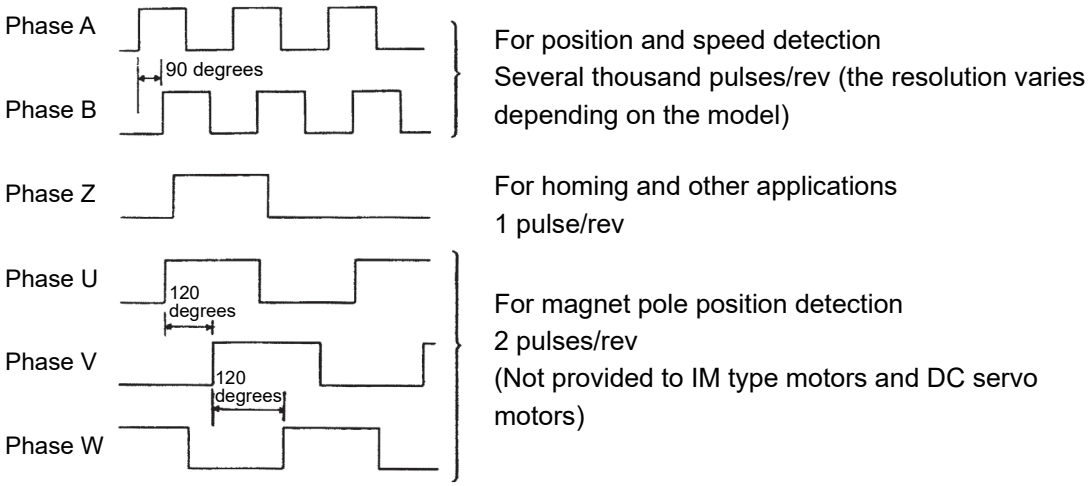
Appendix Figure 2.13 Encoder structure

(2) Encoder functions and signal types

The functions of an encoder installed in a servo motor are roughly classified into three categories as follows:

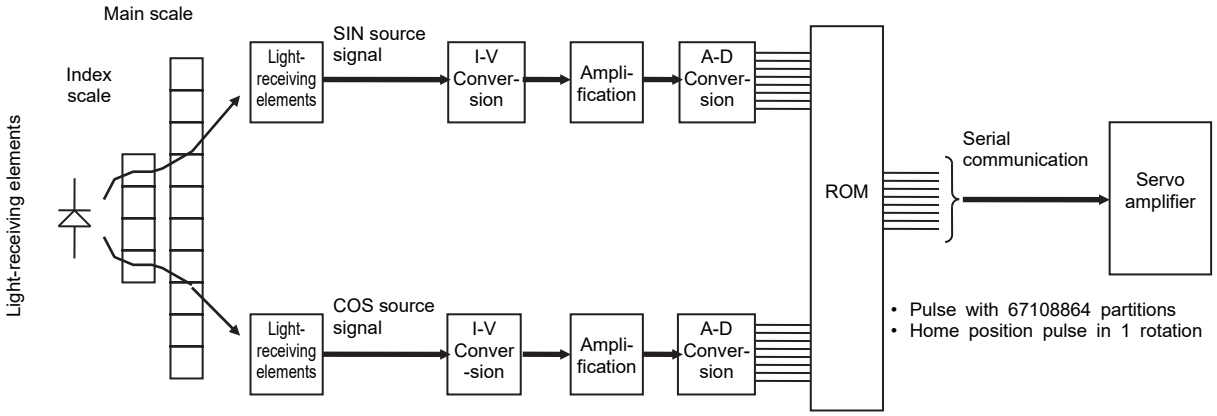
1) Detecting motor position (including rotation direction)
2) Detecting motor speed (including rotation direction)
3) Detecting motor magnetic pole position (unnecessary for an IM type motor and a DC servo motor)

1) and 2) of the above functions use 2-phase pulses which are output incrementally as the motor rotates.



Appendix Figure 2.14 Encoder signal

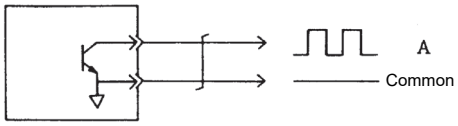
Encoders installed in recent models of AC servo motors generate pulses of 67108864 divisions and home position pulses within one revolution using the SIN original signal and COS original signal as shown below. Then, the data of the generated pulses are transferred using the serial communication method, which transfers data to the servo amplifier via serial communication.



(3) Encoder signal interface

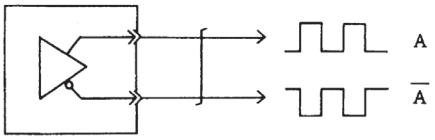
While the encoder signal from the servo motor to the servo amplifier is serialized, the encoder signal from the servo amplifier is pulsed to be output.
There are two types of encoder output signal interfaces as shown below. The recent mainstream is the differential driver output method which performs secure signal transfer.

● Open collector output



At a long-distance transfer, susceptible to noise and the waveform is easy to get rounded.

● Differential driver



Capable of transfer at a high-frequency.
Robust to noise.

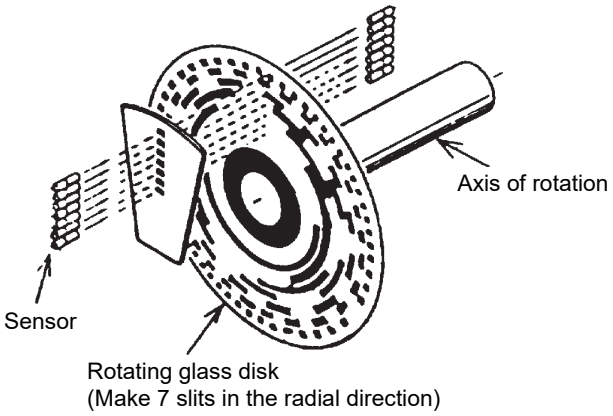
Appendix Figure 2.15 Types of interfaces

(4) Absolute position encoder

An absolute position encoder is often installed in the motor recently to configure an absolute position detection system which does not require homing after a power failure, for purposes such as improving the takt time.

When an absolute position detection system is being used, the rotation position at power-on needs to be found. Thus, as shown in the figure in the right, the absolute position signal (7-bit signal for the case shown in the figure in the right) is output in addition to the incremental signals (A and B) mentioned in section (2).

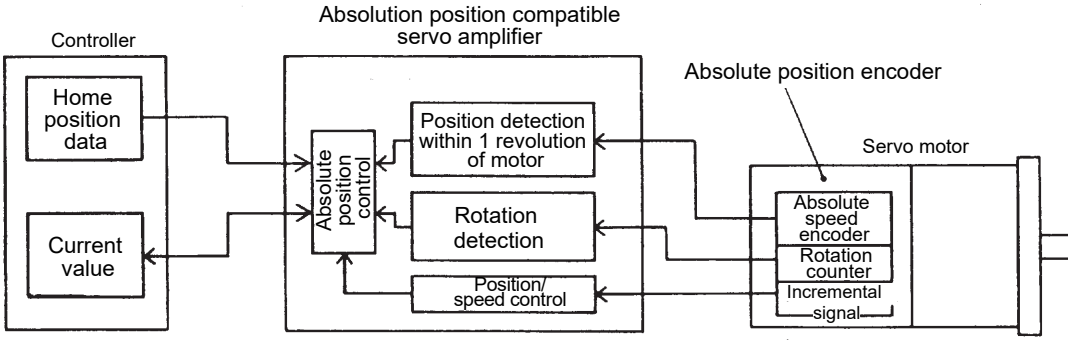
The block diagram of an absolute position detection system is shown below.



Appendix Figure .216 Structure example of an absolute position encoder

Note) Besides the increment signals (A and B) mentioned above, the memory of the absolute position detector backs up the data of an absolute position within one revolution and the counter for the motor rotation amount from the home position. Therefore, once the position is determined by homing, the servo amplifier and controller can always find the motor position even if the power is turned off.

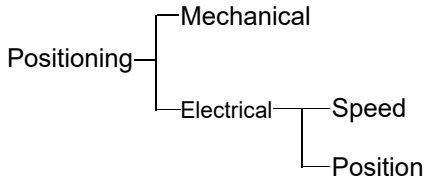
This allows position and speed control to be executed without homing when the power is turned on for the second time or later.



Appendix Figure 2.17 Block diagram of an absolute position detection system

App. 3 POSITIONING CONTROL USING AC SERVOS

App. 3.1 Positioning Method and Stop Accuracy



App. 3.1.1 Positioning types

A moving part can be stopped at a specified position within a specified accuracy either mechanically or electrically. In general, there are two mechanical stopping methods: 1. Pressing the moving part against a stopper (stopper type control of the inverter and torque limit of the AC servo are used until the moving part contacts the stopper). 2. Sandwiching the moving part between objects such as cylinders to forcibly perform positioning, but the stopping position is restricted. On the other hand, the electrical stopping method allows easy positioning at a number of desired positions by providing position sensors.
There are variations in the electrical stopping method in terms of types of position detection and control, which are roughly classified into the speed control method and position control method as follows.

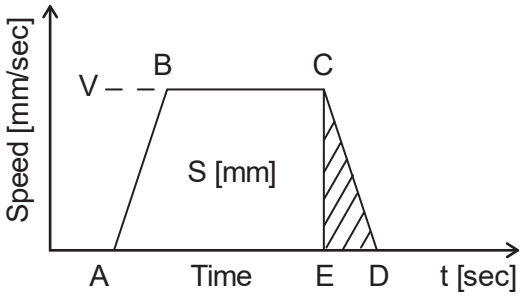
(1) Speed control method: As motors do not have a signal output device required for positioning, the machine side has devices such as limit switches to back up positioning.
(2) Position control method: As the machine side does not have a position detection device, the detector on the servo motor side performs position control with high accuracy.

Appendix Table 3.1 shows the summary of the above description.

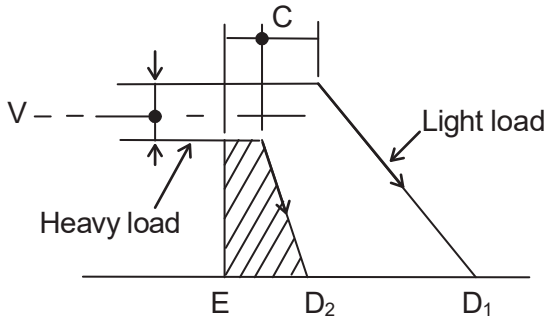
App. 3.1.2 Positioning control and stop precision (for speed control method)

(1) Limit switch method

To automatically stop the moving part operated by the motor, its position is generally detected by devices such as limit switches, then their signals stop the motor (the brake is often activated at the same time).Appendix Figure 3.1 shows the relation between the time and speed of the moving part. As the horizontal axis indicates the time [sec] and the vertical axis indicates the speed [mm/sec], the area within the speed pattern is the travel distance [mm].



Appendix Figure 3.1 Operation (speed) pattern



Appendix Figure 3.2 Coasting distance variation

The coasting distance after activating the limit switch corresponds to the area CDE, indicating the variation of the stop accuracy. The factors that affect the stop accuracy (the factors that may change the area CDE) in this condition are shown in Appendix Figure 3.2, specifically as follows: the variation of the stop time (ED) (variation of the load torque or the brake torque), the speed fluctuation of the moving part at the point C, the variation of the sensor activating position of the point C, and the variation of the delay time from the sensor activates until the motor actually starts decelerating. These variations of the said characters are of course required to be minimized as much as possible, but decreasing the speed V is the most effective to stabilize the stop accuracy. Therefore, when the stop accuracy is not satisfied by stopping from an ordinary speed, generally the motor is first decelerated to a low speed with the limit switch for low-speed switching as shown in Appendix Table 3.1, then the motor is brought to a stop. This method is widely adopted as it is easy and improves the accuracy. However, it also has a disadvantage that the positioning time is long for the following reasons: The speed at passing through the stopping limit switch is unstable due to factors such as load fluctuation if the time at a low speed (which is called a creep speed) is insufficient.
In addition, as the number of stop positions increases, more sensors are required.

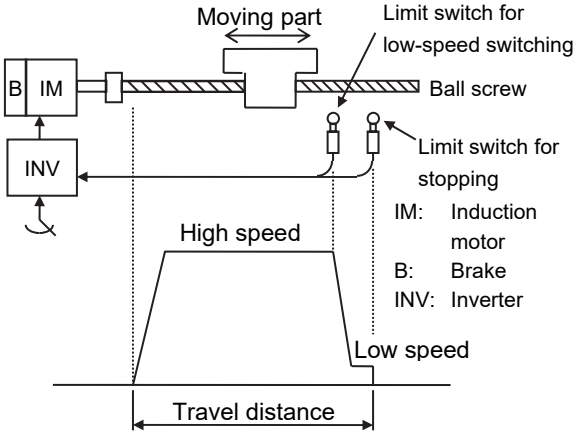
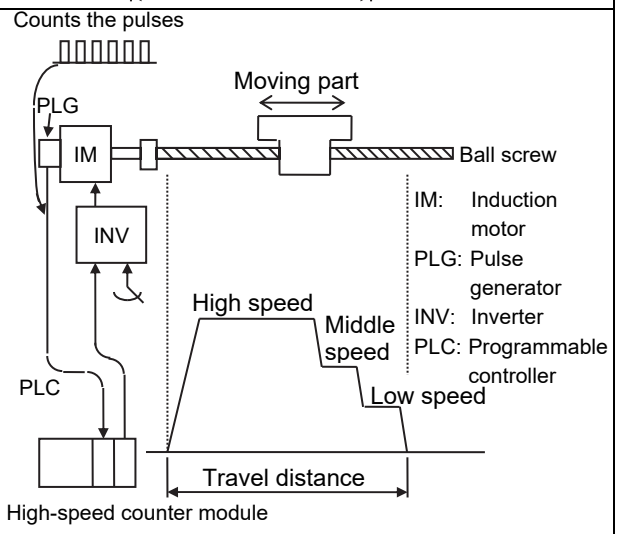
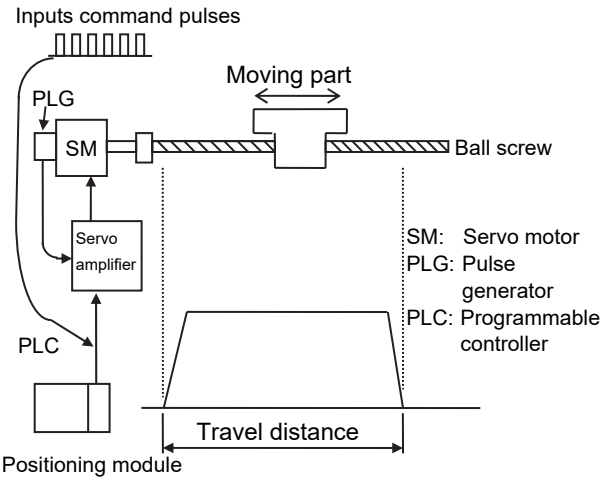
(2) Pulse count method

The pulse count method is the method which is improved from the limit switch method. As stop positions can be selected as desired with this method, decelerating points can also be made as many as desired. Therefore, the time to travel short distance can be reduced. Although the stop accuracies of the limit switch method and pulse count method are equivalent, the pulse count method enables easier position compensation in such conditions as when the moving part goes past the stop position because the current position of the moving part is constantly detected.
However, the stop accuracy itself should not be expected to improve because the same disadvantage as the limit switch method will affect the stop accuracy.

(3) Pulse command method

The positioning method using the servo improves the disadvantages mentioned above. The pulse command method always detects the position of the moving part just as the pulse count method, and continuously decelerates the motor without a creep speed from a high speed directly to the target stop position, then stops the motor within the desired accuracy. This method is called the position control method as opposed to the speed control method.

Appendix Table 3.1 Positioning method comparison table

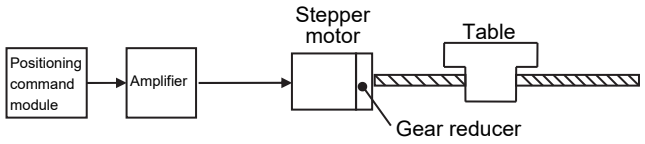
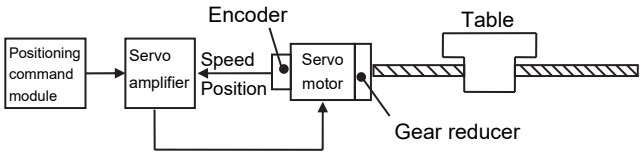
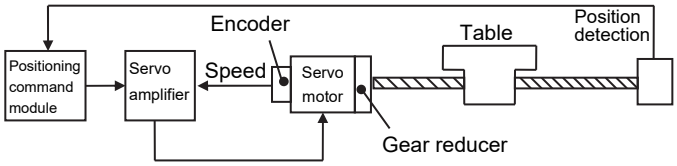
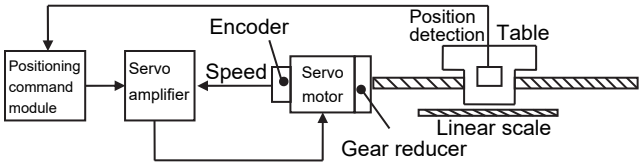
Category	Method	Description	Outline explanation diagram
Speed control method	Limit switch method	Sets limit switches at the points where the moving part passes through. The moving part activates the switches, then their signal stops the servo motor. The method generally uses two switches. The first switch decelerates the motor to a low speed, then the second switch turns off the motor and activates the brake to stop the moving part. An additional positioning device is not required and the system can be configured with a simple control at a reasonable price. (Guideline for stop accuracy……±Approximately 0.5 to 5.0mm)*1	
	Pulse count method	Sets a position detector (such as a pulse encoder) on the motor and the rotation shaft which drives the object, and counts the number of generated pulses with a high-speed counter. This method stops the moving part by outputting the stop signal when the counter reaches the specified value since the pulse is in proportion to the travel distance. Devices such as limit switches can be omitted in this method, and thus changing positions becomes easier. (Devices such as a high-speed counter module can be used.) (Guideline for stop accuracy……±Approximately 0.5 to 5.0mm)*1	
Position control method	Pulse command method	An AC servo motor that rotates in proportion to the number of input pulses is used as the drive motor. High-speed positioning in proportion to the number of pulses can be performed by inputting the number of pulses corresponding to the travel distance to the servo amplifier of the AC servo motor. (Devices such as a positioning module can be used.) (Guideline for stop accuracy……±Approximately 0.001 to 0.05mm)	

*1: The stop accuracy for when the slow speed is 10[mm/sec] to 100[mm/sec] is indicated.

App. 3.1.3 Position control method types

The position control by the servo is a method which constantly feeds back the detected position, and the detecting method has the types as shown in Appendix Table 3.2. (The open loop method, which is not a servo control, is shown as a comparison to the closed loop method.)

Appendix Table 3.2 Position control method types

Loop method		System architecture	Feature
Open loop			• This is not defined as a servo because it does not give a feedback. • The operation stops at overload. • It has small capacity models only.
Semi closed loop	Motor shaft detection		• Easily configured • The fastest response • Stable control system that allows secure operation • Requires backlash compensation of the gear reducer.
	Feed screw-side detection		• Configuration is rather complicated (an additional detector is required). • Control is liable to become unstable under influence of the gear reducer and feed screws. • Backlash compensation of the gear reducer is not required.
Fully closed loop			• An expensive position detector is required. • Control is liable to become unstable under influence of the gears and feed screws, and a response at a high level cannot be obtained. • Backlash compensation of the gear reducer is not required.

The AC servo MELSERVO series has introduced the semi closed loop control using the motor shaft detection method as its control system is stable and is easy for users to handle. In addition, the MELSERVO-J5 supports the fully closed loop control as the standard specification.

App. 3.2 Basics of Positioning Control Using AC Servos

This section explains the positioning control using the pulse command method.

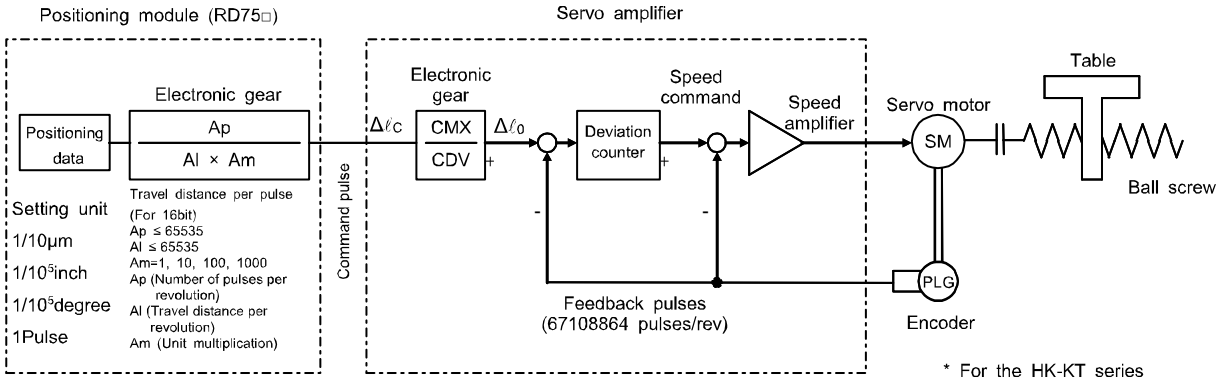
App. 3.2.1 Position detection and number of pulses per motor revolution

As mentioned in "Position control method types" in Appendix 3.1.3, the AC servo MELSERVO series has introduced the semi closed loop control method which detects the motor rotating position, that is the machine position, using the encoder directly connected with the motor shaft. (The MELSERVO-J5 can select the fully closed loop control as the standard specification.)

The encoder outputs a pulse signal corresponding to the motor rotation angle, then the servo amplifier captures the pulse signal to perform positioning control. (Refer to "Encoder functions and operating principle" in Appendix 2.3.3 for details of the encoders.)

The feedback pulses are the reference for the steps of movement of the machine connected with the motor (resolution). Accuracy of the positioning control improves as the number of pulses per motor revolution increases. The resolution of the HK series servo motors is 67108864 pulses (represented as 67108864 pulses/rev).

App. 3.2.2 Idea of positioning servos



Appendix Figure 3.3 Positioning servo configuration

As the positioning command module inputs the command pulses, the servo amplifier captures the command pulses and the feedback pulses corresponding to the number of motor revolutions into its deviation counter. Positioning using servo motors is to control the motor so that there is no difference between the command pulses and the feedback pulses.

Therefore, the servo motors can perform exact positioning using the command pulses.

One of the bases of the positioning control using servos is the movement of a motor shaft (machine) per pulse of the command to the servo amplifier, and the others are as follows:

1) The feed length of the machine is in proportion to the total number of the command pulses
2) The machine speed is in proportion to the speed of the command pulse train (pulse frequency)
3) Positioning completes within the area of the last±1 pulse, and the position is retained in the servo-lock state unless there is a subsequent position command

(1) Deviation counter and motor rotation amount

In the deviation counter, the command pulses from the positioning command module are added together, and at the same time the values of the counter are subtracted as feedback pulses are returned. When the value of the deviation counter (droop pulses) is large, a large speed command is output to rotate the motor at a high speed. The command pulses decrease as the position comes close to the target stop position, decreasing the output of the deviation counter to slow down the motor speed. When the value of the deviation counter (droop pulses) becomes zero, the speed command also becomes zero and the motor stops. In sum, the output of the deviation counter has the function that automatically controls the number of feedback pulses (the motor rotation amount) and command pulses so that both the numbers are the same.
For example, to make a half revolution of the MELSERVO-J5 series servo motor HK-KT which has feedback pulses of 67108864p/rev, an input of 33554432 pulses needs to be given from a positioning command module.

(2) Motor speed

With the control by the deviation counter, the motor rotation speed is in proportion to the command pulse train speed since the motor rotation angle is in proportion to the command pulse amount.
For example, to operate the HK-KT series motor at 3000r/min, command pulses of 3000 revolutions × 67108864 pulses = 201326.592 × 106pulses per minute (201326.592 × 106/60 = 3355443.2 × 103pulses per second) (expressed as 3355443.2 × 103PPS = 3355443.2kpps) are required to be input from the positioning command module.

(3) Positioning completion and servo-lock

When the output of the deviation counter (droop pulses) becomes zero, which means that the number of command pulses and feedback pulses matches, the positioning completes. After the positioning completion, if the servo motor is rotated by an external force, feedback pulses will be input from the encoder to the deviation counter to output a speed command. This command corrects the motor rotation to a direction which constantly makes the droop pulses zero so that the moving part remains at a specified position. This function is called servo-lock.

App. 3.3 Positioning accuracy

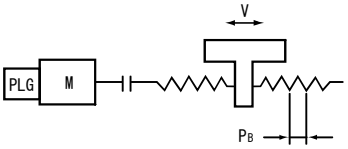
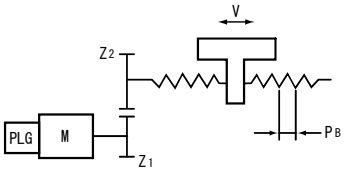
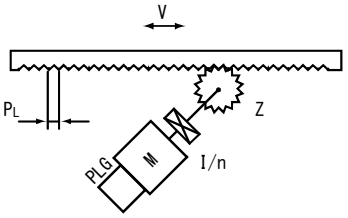
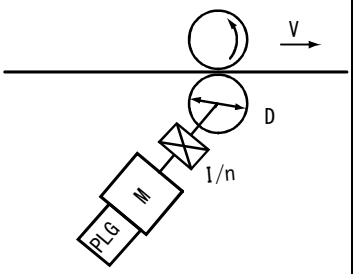
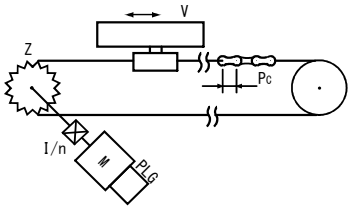
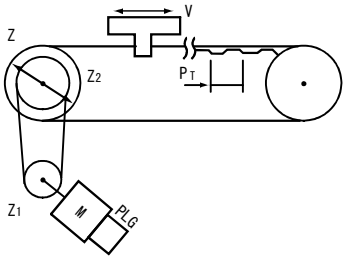
App. 3.3.1 Machine feed length per pulse

The machine feed length per pulse is the minimum unit of the machine movement.Appendix Figure 3.4 Expression (3-1) describes the machine feed length per pulse $\Delta\ell_0$ for when the mechanical system has a ball screw without a gear reducer as shown in section (1). If the mechanical system has a device other than a ball screw or the system has a gear reducer, calculate the machine feed length per pulse based on the machine feed length ΔS per motor revolution. The feed length per pulse $\Delta\ell_0$ can be obtained by substituting the feed length per motor revolution shown in Appendix Figure 3.4 for ΔS in expression (3-1).

$$\Delta\ell_0 = \frac{\Delta S}{P_{fo}} = \frac{\Delta S}{67108864} \text{ [mm/pulse]} \quad \cdots\cdots (3\text{-}1)$$

Note that Pfo is the number of feedback pulses per motor revolution.
The value of Pfo is equal to the encoder resolution, which varies depending on the motor type.
The resolution of each motor type is as follows: the HC-PQ is 4000 [pulses/rev], the HC-SFS is 131072 [pulses/rev], all the MELSERVO-J3 series motors are 262144 [pulses/rev], all the MELSERVO-J4 series motors are 4194304 [pulses/rev], and all the MELSERVO-J5 series motors are 67108864 [pulses/rev].

Appendix Figure 3.4 shows the mechanical system examples and the expression of ΔS.

	(1) Ball screw (directly connected)	(2) Ball screw (connected with gears)	(3) Rack and pinion
Driving method			
Feed length per motor revolution	$\Delta S = P_B$	$\Delta S = P_B \cdot \frac{Z_1}{Z_2} = P_B \cdot \frac{1}{n}$	$\Delta S = P_L \cdot Z \cdot \frac{1}{n}$ Z: Number of pinion teeth
	(4) Roll feed	(5) Driving by chains (directly connected)	(6) Chain, timing belt drive
Driving method			
Feed length per motor revolution	$\Delta S = \pi \cdot D \cdot \frac{1}{n}$	$\Delta S = P_C \cdot Z \cdot \frac{1}{n}$ Z: Number of sprocket teeth	$\Delta S = P_T \cdot Z \cdot \frac{Z_1}{Z_2} = P_T \cdot Z \cdot \frac{1}{n}$ Z: Number of pulley teeth

Appendix Figure 3.4 Feed length per motor revolution of each mechanical system (ΔS)

App. 3.3.2 Machine total accuracy and electrical side accuracy

The machine total accuracy Δε is obtained by adding the machine side accuracy and electrical side accuracy together.

The machine side accuracy is to be considered by the machine manufacturer.

The electrical side accuracy depends on the feed length per pulse on the machine shaft $\Delta\ell_0$ [mm/pulse].

The Mitsubishi MELSERVO series eventually stops the moving part within the area of ±1 pulse of the electronic gear output pulse (±$\Delta\ell_0$ with being converted into the machine axis), then the servo will be set to a servo-lock state. The servo-lock state will be maintained until a subsequent command pulse is sent. Therefore, the electrical side accuracy $\Delta\ell_0$ is generally set to satisfy the following expression so that the machine total accuracy $\Delta\varepsilon$ will not be affected by the electrical side accuracy.

$$\Delta\ell_0 \leq \left(\frac{1}{5} \text{ to } \frac{1}{10}\right) \times \Delta\varepsilon \quad \cdots\cdots (3\text{-}2)$$

<Reference> Machine total accuracy $\Delta\varepsilon$ and feed length per pulse $\Delta\ell_0$
The feed length per pulse ℓ_0 can be obtained with the machine total accuracy $\Delta\varepsilon$ taken into account.

App. 3.4 Motor Speed in Relation to the Maximum Machine Speed

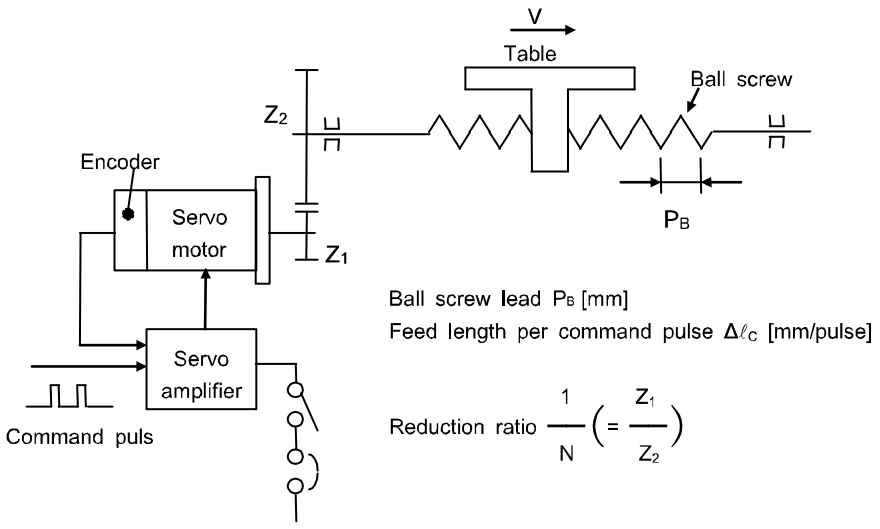
When the mechanical system is operated with gear shift and the ball screw as shown in **エラー! 参照元が見つかりません。**, the motor speed N [r/min] in relation to the machine speed V [mm/min] will be as shown in expression (3-3).

$$\text{Motor speed} = \times \frac{\text{Machine speed}}{\text{Ball screw lead}} \times \frac{1}{\text{Reduction ratio}} \quad \cdots\cdots (3\text{-}3)$$

Therefore, the expression will be as shown in (3-3) for the ball screw lead P_B [mm] and the reduction ratio 1/n.

$$N = \frac{V}{\Delta S} = \frac{V}{P_B} \cdot n \text{ [r/min]} \quad \cdots\cdots (3\text{-}4)$$

If the maximum machine speed V_0 is determined, setting the motor speed to a value that is as close to the rated speed Nr [r/min] as possible without exceeding it enables high accuracy in positioning and thus the power of the motor can be used effectively.



Appendix Figure 3.5 Relation between machine speed and motor speed

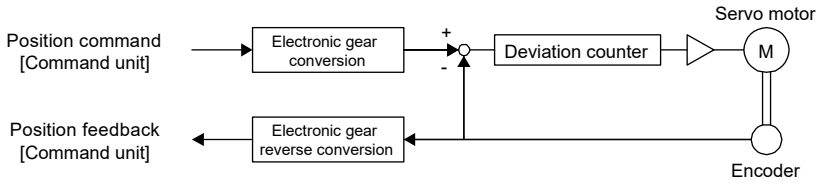
App. 3.5 Command Pulse

In the positioning servo, the machine moves by the number of feedback pulses with the same amount of the number of pulses input from the positioning command module, and the motor is operated at a speed that matches the command pulses with the feedback pulses during a steady operation. Therefore, you need to check if the relation between the minimum command unit for positioning and machine feed length per pulse ("Machine feed length per pulse" in Appendix 3.3.1) is consistent and if the pulse frequency at the maximum machine speed satisfies the operation conditions of both the positioning command module and servo amplifier.

App. 3.5.1 Electronic gear function

Both the positioning command module and the servo amplifier have the electronic gear function. This section explains the electronic gear on the servo amplifier side.

The electronic gear function is a function that multiplies the electronic gear ratio to the position command, and sets the ratio of the rotation amount/travel distance of the servo motor to the rotation amount/travel distance of the command unit as desired. For the position feedback, the inverse number of the electronic gear ratio is multiplied.



Restrictions

- Set the electronic gear within the range of conditions. If a value out of the range is set, [AL.037 Parameter error] occurs.

Precautions

- To prevent unexpected operation, set the electronic gear correctly.
- In the position control mode, ensure that the electronic gear is in servo-off status before setting the gear so as to prevent unexpected operation due to incorrect setting.
- If an excessive command pulse frequency is input from the controller in the position control mode, [AL.031 Overspeed] may occur, depending on the value of the electronic gear ratio.

(1) Setting method

(a) Setting with servo parameters

Set the electronic gear numerator in [Pr.PA06 Electronic gear numerator], and electronic gear denominator in [Pr.PA07 Electronic gear denominator]. When using the electronic gear in the command input pulses per revolution, set [Pr.PA05 Number of command input pulses per revolution]. Set the servo parameter of the electronic gear and the electronic gear setting compatibility mode to be used in "Electronic gear compatibility selection" of [Pr.PA21].

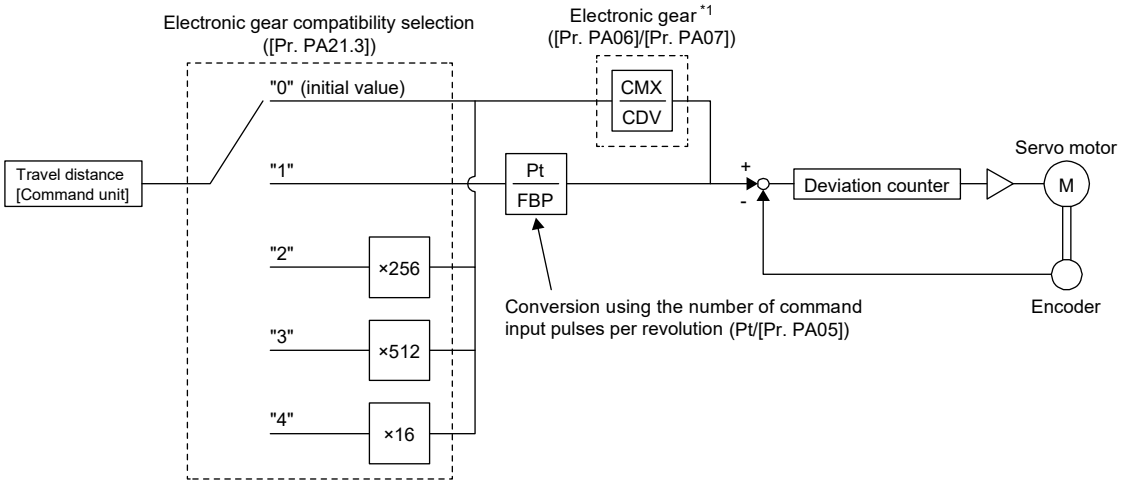
Servo parameter	Symbol	Name	Description
PA05	*FBP	Number of command input pulses per revolution	Set the number of command input pulses per revolution. Initial value: 10000 [pulse]
PA06	CMX	Electronic gear numerator	Set the electronic gear numerator. Initial value: 1
PA07	CDV	Electronic gear denominator	Set the electronic gear denominator. Initial value: 1
PA21.3	*AOP3	Electronic gear compatibility selection	Select the electronic gear, and set the electronic gear setting compatibility mode. 0: Electronic gear (initial value) 1: Number of command input pulses per revolution 2: J3 electronic gear setting value compatibility mode 3: J2S electronic gear setting value compatibility mode 4: J4 electronic gear setting value compatibility mode
PC32	CMX2	Command input pulse multiplication numerator 2	Set the electronic gear numerator at switching with CM1 (Electronic gear selection 1) and CM2 (Electronic gear selection 2) of the input device. Initial value: 1
PC33	CMX3	Command input pulse multiplication numerator 3	
PC34	CMX4	Command input pulse multiplication numerator 4	

(2) Setting example

The electronic gears on the position command side are illustrated in the function block diagrams. The inverse number of the electronic gear ratio is multiplied to the position feedback side.

(a) For position control mode

Adjust [Pr.PA06 Electronic gear numerator] and [Pr.PA07 Electronic gear denominator] so that the travel distance set in the controller matches the travel distance on the machine. When the value is converted with [Pr.PA05 Number of command input pulses per revolution], the numerator of the electronic gear ratio is the encoder resolution, and the denominator is the setting value in [Pr.PA05].



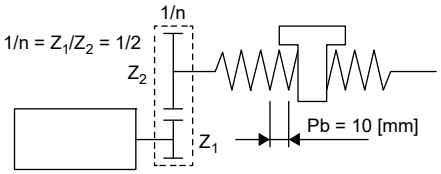
*1: With CM1 (Electric gear selection 1) and CM2 (Electric gear selection 2) of the input device, the setting value of CMX can be selected from [Pr.PA06], [Pr.PC32], [Pr.PC33], or [Pr.PC34].

Pt: Servo motor encoder resolution [pulses/rev]
ΔS: Travel distance per servo motor revolution [command unit/rev]
CMX: Electronic gear numerator
CDV: Electronic gear denominator
CMX/CDV = Pt/ΔS
The following setting example shows how to calculate the electronic gear.

Precautions

● The following specification symbols are necessary for calculation of the electronic gear.
Pb: Ball screw lead [mm]
1/n: Reduction ratio
Pt: Servo motor encoder resolution [pulses/rev]
ΔL0: Travel distance per command pulse [mm/pulse]
ΔS: Travel distance per servo motor revolution [mm/rev]
Δθ°: Angle per pulse [°/pulse]
Δθ: Angle per revolution [°/rev]

1) Setting example for a ball screw
The following shows an example where the ball screw is moved at 10μm per pulse.
Machine specifications



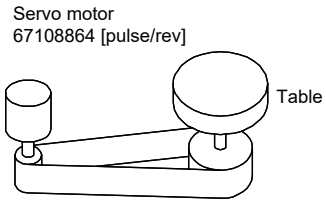
Servo motor encoder resolution
67108864 [pulse/rev]

Ball screw lead Pb = 10 [mm]
Deceleration ratio: 1/n = Z1/Z2 = 1/2
Z_1: Number of gear teeth on servo motor side
Z_2: Number of gear teeth on load gear
Servo motor encoder resolution: P_t = 67108864 [pulses/rev]

$$\frac{CMX}{CDV} = \Delta L_0 \cdot \frac{P_t}{\Delta S} \quad \Delta L_0 \cdot \frac{P_t}{1/n \cdot Pb} = 10 \times 10^{-3} \cdot \frac{67108864}{1/2 \cdot 10} = \frac{67108864}{500} = \frac{16777216}{125}$$

Therefore, set CMX = 16777216 and CDV = 125.

2) Setting example for conveyors
The following shows the example of when the conveyor is rotated at 0.01° per pulse.
Machine specifications



Timing belt: 625/12544

Table: 360˚/rev
Deceleration ratio: 1/n = 625/12544
Servo motor encoder resolution: P_t = 67108864 [pulses/rev]

$$\frac{CMX}{CDV} = \Delta\theta° \cdot \frac{P_t}{\Delta S} = 0.01 \cdot \frac{67108864}{625/12544 \cdot 360} = \frac{841813590016}{22500000} = \frac{26306674688}{703125}$$

At this point, as CMX is outside of the setting range (2147483647 or less), the value needs to be reduced. After reducing CMX to the setting range or less, round off the value to the nearest whole number.

$$\frac{CMX}{CDV} = \frac{26306674688}{703125} = \frac{1753778312.53}{46875} \approx \frac{1753778313}{46875}$$

Therefore, set CMX = 1753778313 and CDV = 46875.

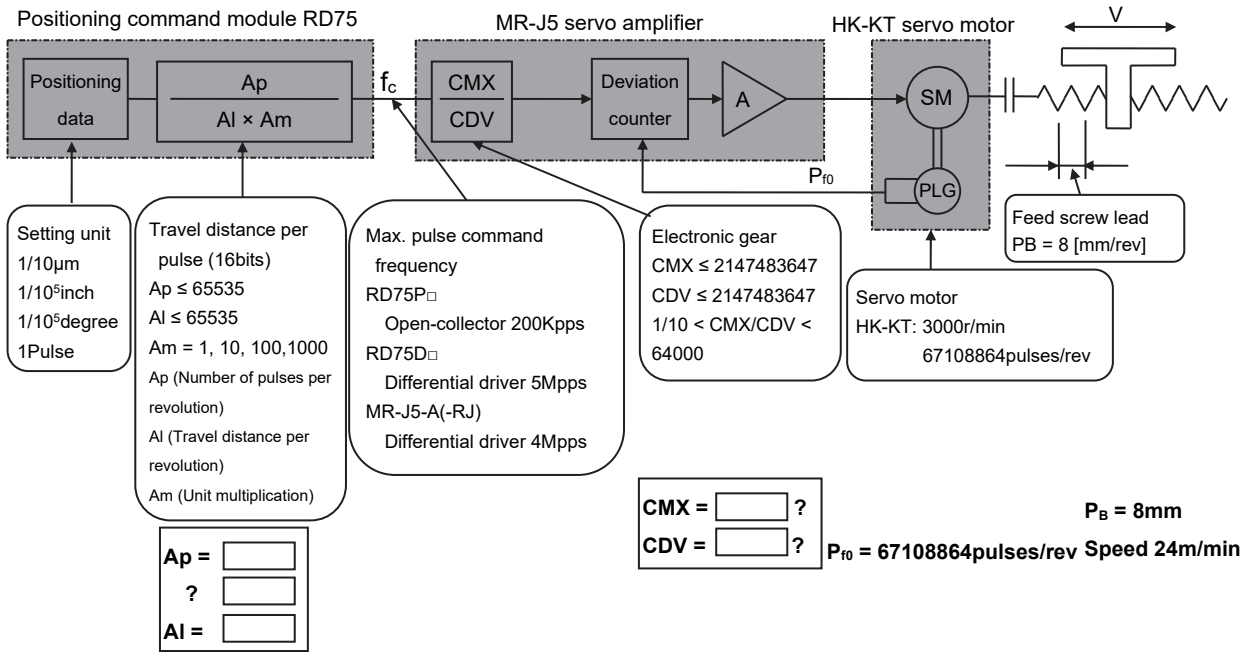
POINT

● If the servo motor rotates in one direction endlessly on systems such as an index table, the error in rounding off accumulates, resulting in the index position mismatch.
For example, even if 36000 pulses are input for the command in the previous example, the following result is obtained for the table. Therefore, a positioning to the same position cannot be performed on the table.

$$36000 \cdot \frac{1753778313}{46875} \cdot \frac{1}{67108864} \cdot \frac{625}{12544} \cdot 360° = 360.0000001°$$

Reduce the value so that the calculated values before and after reduction are as close as possible.

Exercise 3.1



Calculate on the assumption that a differential driver is used.

Q1. Find the machine travel distance per feedback pulse $\Delta\ell 0$.

Q2. Find the electronic gear ratio K on the servo amplifier side. Assume that the electronic gear on the RD75 side is 1/1 and the machine travel distance $\Delta\ell_c$ is 0.05 [μm/pulse].

Q3. Find the command pulse frequency fc assuming the motor speed is 3000 [r/min], using K obtained in the question 2.

Q4. Find the electronic gear ratio K on the servo amplifier side assuming the command pulse frequency is 4Mpps.

Q1.

$$\Delta\ell_0 = \frac{P_B}{P_{fo}} = \frac{8}{67108864} \approx 0.12 \times 10^{-6} \text{ [mm/pulse]}$$

* When positioning for 300 mm, the calculation is as follows: $300 \div 0.12 \times 10^{-6} = 2500000000$ pulses

Q2. Calculate the electronic gear ratio to control the servo motor with travel distance per feedback pulse of the servo motor (0.12×10^{-6} [mm/pulse]) using the machine travel distance of the positioning device (0.05×10^{-3} [mm/pulse]).

$$K = \frac{CMX}{CDV} = \Delta\ell_c \bullet \frac{P_{fo}}{P_B} = 0.05 \times 10^{-3} \times \frac{67108864}{8} = \frac{1}{20000} \times \frac{67108864}{8} = \frac{262144}{625}$$

$\Delta\ell_C$ will be as follows when the electronic gear above is substituted in the expression.

$$\Delta\ell_C = \frac{P_B}{P_{fo}} \times \frac{CMX}{CDV} = \frac{8}{67108864} \times \frac{262144}{625} = 0.00005 \text{ [mm/pulse]}$$

* When positioning for 300 mm, the calculation is as follows, generating no fractions: $300 \div 0.00005 = 6000000$ pulses.
* The electronic gear ratio obtained in the expression above needs to be checked if it does not exceed 4Mpps which is the maximum command frequency for the combination mentioned above.

Q3.

$$f_{c1} = P_{fo} \times \frac{N}{60} = 67108864 \times \frac{3000}{60} = 3355443200 \text{ [pps]}$$

$$f_c = \frac{CDV}{CMX} \bullet f_{c1} = \frac{625}{262144} \times 3355443200 = 8000000 = 8 \text{ [Mpps]}$$

* The control cannot be performed because the command pulse frequency exceeds the RD75D□'s maximum command pulse frequency 5Mpps and the MR-J5-A's maximum command pulse frequency 4Mpps.
(Therefore, find the electronic gear on the servo amplifier side at 4Mpps which is the maximum command pulse frequency that can be used with the combination described above.)

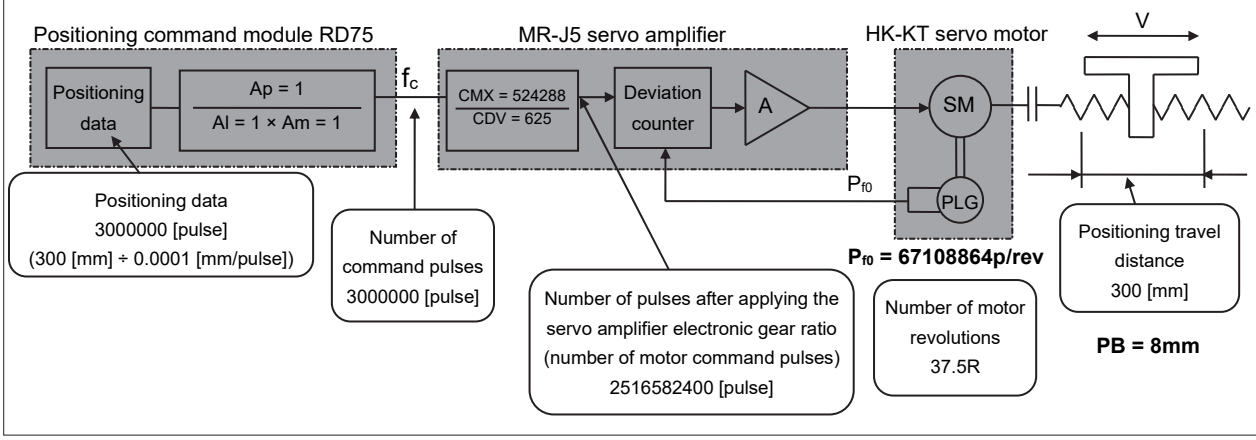
Q4.

$$f_c = \frac{CDV}{CMX} \bullet f_{c1} \Rightarrow \frac{CMX}{CDV} = \frac{f_{c1}}{f_c} = \frac{3355443200}{4 \times 10^6} = \frac{524288}{625}$$

Check the positioning accuracy $\Delta\ell_C$ when the electronic gear above is substituted in the expression.

$$\Delta\ell C = \frac{P_B}{P_{fo}} \times \frac{CMX}{CDV} = \frac{8}{67108864} \times \frac{524288}{625} = 0.0001 \text{ [mm/pulse]}$$

Summary of exercise 3.1
Assume positioning for 300mm.



App. 3.5.2 Maximum input pulse frequency

The maximum servo amplifier input frequency is defined by the following conditions:

(1) The MR-J5 series selects the electronic gear value so that the servo motor can be operated at a speed up to the rated speed with the maximum input pulse frequency (open collector: 200kpps, differential driver: 4Mpps).

The total maximum input pulse frequency including the command device is the maximum frequency that satisfies the operation conditions of both the said servo amplifier and command device.

Exercise 3.2

(1) What is the maximum input pulse frequency of the MR-J5 (3000r/min) series with open collector input in kpps?
(2) Find the range of the electronic gear value K on the MR-J5 when it is operated at the rated speed with the maximum input pulse frequency or less.
(3) What is the maximum input pulse frequency in total for the MR-J5 and RD75 with open collector input in kpps?

(1) It is 200kpps.
(2) The range of the electronic gear value K is as follows:

$$f_{c1} = P_{f0} \times \frac{3000}{60} = 67108864 \times \frac{3000}{60} = 3355443.2 \times 10^3 \text{pps}$$

$$4000 > K \geq \frac{f_{c1}}{f_c} = \frac{3355443.2 \times 10^3}{200 \times 10^6} = \frac{2097152}{125}$$

(3) The frequency that satisfies the operation conditions of both the MR-J5 and RD75 is 200kpps.

Exercise 3.3

(1) What is the maximum input pulse frequency of the MR-J5 (3000r/min) series with differential driver input in kpps?
(2) Find the range of the electronic gear value K on the MR-J5 when it is operated at the rated speed with the maximum input pulse frequency or less.
(3) What is the maximum input pulse frequency in total for the MR-J5 and RD75 with differential driver input in kpps?

(1) It is 4Mpps.
(2) The range of the electronic gear value K is as follows:

$$f_{c1} = P_{f0} \times \frac{3000}{60} = 67108864 \times \frac{3000}{60} = 3355443.2 \times 103\text{pps}$$

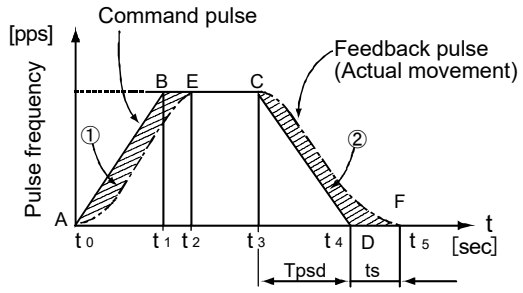
$$64000 > K \geq \frac{f_{c1}}{f_c} = \frac{3355443.2 \times 10^3}{4 \times 10^6} = \frac{8388608}{10000}$$

(3) The frequency that satisfies the operation conditions of both the MR-J5 and RD75 is 4Mpps.

App. 3.6 Speed Patterns and Stop Settling Time

App. 3.6.1 Speed patterns and behavior of droop pulses

Droop pulses are the difference between the command pulses and feedback pulses in the deviation counter of the servo amplifier. Their behavior is shown in Appendix Figure 3.6.



Appendix Figure 3.6 Speed pattern and droop pulses

(1) Behavior from t_0 to t_2

The feedback pulses from the encoder are delayed because of the servo motor acceleration delay to the command pulses, generating the droop pulses ε.

$$\varepsilon = \frac{f_{c1}}{PG1} = \frac{K \bullet f_c}{PG1} \text{ [pulse]}\ldots\ldots(3\text{-}5)$$

PG1: Model control gain

$$K: \frac{CMX}{CDV}$$

(2) Behavior from t_2 to t_3

The motor operates synchronizing the command pulses and servo motor speed while retaining the delay for the droop pulses of the expression in (3-5).

(3) Behavior from t_3 to t_4

The motor operates to catch up the position delay of the expression in (3-5). The motor does not arrive at the command position even at t4 (the point where the command pulses finish), and the motor still rotates even after the command pulses run out.

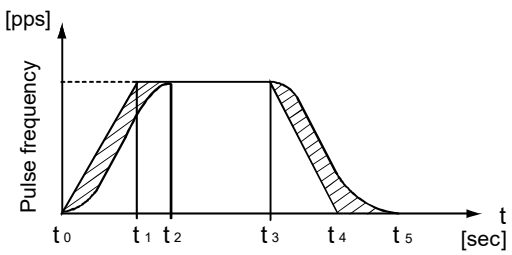
(4) Behavior from t_4 to t5

The motor operates to clear all the remaining droop pulses. The time between t4 and t5 is defined as the stop settling time ts.

(5) Motor behavior

The actual motor speed and droop pulses behave exponentially.
In the end, the motor settles by clearing all the droop pulses, then becomes a servo-lock state.
Therefore, the motor behavior can be described as follows:
The command amount of the command pulses (area ABCD) = the actual feed length (area AECF) and
The amount of pulses accumulated at acceleration 1) (area ABEA) = the amount of pulses that decrease at deceleration 2) (area CFDC)

Exercise 3.4



Assuming PG1 = 36 [sec^{-1}] in the figure on the left, find the droop pulses ε with the deviation counter input indicated below.
f_{c1} = K • f_c = 180k, 18k, 0.9k, 72 [pps]
Moreover, assuming $\Delta\ell_0$ = 0.01 [mm/pulse], convert the obtained droop pulses into a feed length.
Note that an MR-J5 motor is assumed to be used.
(Electronic gear ratio K = 1/16)

Since ε = K • f_c /PG1 [pulse], each result is as follows:

For K • f_c = 180kpps (1318r/min)

$$\varepsilon = \frac{180000}{36} = 5000 \text{ [pulses]}$$, converted into the feed length as 5000 × 0.01 = 50 [mm]

For K • f_c = 18kpps (132r/min)

$$\varepsilon = \frac{18000}{36} = 500 \text{ [pulses]}$$, converted into the feed length as 500 × 0.01 = 5 [mm]

For K • f_c = 0.9kpps (6.6r/min)

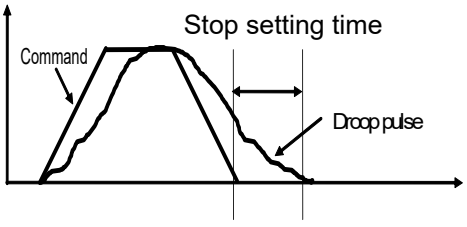
$$\varepsilon = \frac{900}{36} = 25 \text{ [pulses]}$$, converted into the feed length as 25 × 0.01 = 0.25 [mm]

For K • f_c = 72pps (0.53r/min)

$$\varepsilon = \frac{72}{36} = 2 \text{ [pulses]}$$, converted into the feed length as 2 × 0.01 = 0.02 [mm]

App. 3.6.2 Stop settling time ts

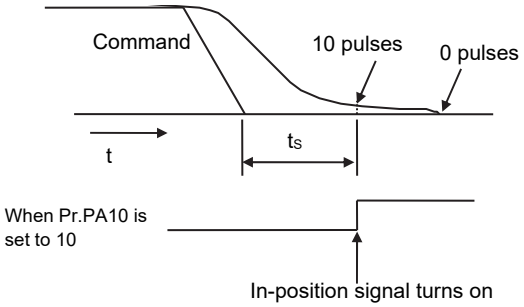
The stop settling time is the time from the end of a command output until the positioning finishes. This settling time determines the takt time for parts mounting machines such as inserters and mounters, thus shortening time is highly important.



The value of the stop settling time can be roughly calculated using Position loop gain 1 (PG1) on the model side in the model adaptive control. However, the value of Position loop gain 1 is highly susceptible to the machine conditions and the value of the load moment of inertia. Therefore, the mechanical system needs to be taken into account when a high-frequency operation feed or high-response stop settling is requested.
The stop settling time until the pulses are reduced to approximately 10 or less is empirically obtained from the following expression.

$$ts \approx \frac{3}{PG1} \text{ (sec)}$$

When the droop pulses are within the accuracy demanded by the machine, the servo motor is regarded as to be at a stop even if it rotates, and an in-position signal is output.
The stop settling time has an influence on the cycle time of high-frequency positioning.



App. 3.7 Relation between Mechanical Systems and Responsiveness Settings

App. 3.7.1 Responsiveness settings

The conventional control methods needed to adjust the servo positioning loop gain and speed loop gain in accordance with the conditions of the machine. In particular, the load to motor inertia ratio and rigidity often required a long time for adjustment because these factors had to be understood well about how they related to each loop of the servo system.
As the models such as the MELSERVO-J5 series perform the model adaptive control and real-time auto tuning, both the ideal model section and actual loop section can be adjusted automatically to the optimum gain just by setting the auto tuning response to a value that matches with the machine rigidity.
The auto tuning response can be set using the parameter.
Refer to the following table for the settings on the MR-J5.

Appendix Table 3.3 MR-J5 Pr.PA09

Setting value	Auto tuning response	Guidelines for machinery
1 to 13	Low response	Applicable to low mechanical rigidity. Specifically for machines such as belt-driving machines, chain-driving machines, and machines with large backlash.
14 to 18	Low to middle response	Applicable to the average rigidity level of general-purpose machines. Specifically for machines such as belt-driving machines, chain-driving machines, and rack and pinion-driving machines. It is the setting from the factory.
19 to 23	Middle response	Applicable to a rather high level of mechanical rigidity. Specifically when the responsiveness needs to be improved on devices such as ball screws and timing belts with high rigidity.
24 to 28	Middle to high response	Applicable to high mechanical rigidity and very frequent positioning.
29 to 40	High response	Applicable to very high mechanical rigidity and extremely frequent positioning.

Note) Decrease the setting value if hunting or large gear noise occurs on the machine.
Increase the setting value to shorten the stop settling time or other purposes to improve the performance.

App. 4 Positioning Command Module

App. 4.1 Data for Positioning Command Module Settings

This section explains the data for the positioning command module RD75D□ settings.

App. 4.1.1 Basic setting

Item		Setting range
Basic parameter 1	Unit setting	• 0: mm • 1: inch • 2: degree • 3: pulse (default value)
	Electronic gear selection	• 0: 16bit (default value) • 1: 32bit
	Number of pulses per revolution (16bits)	1 to 65535 pulses (default value: 20000)
	Travel distance per revolution (16bits)	Setting values using engineering tools (default value: 20000) • 0.1 to 6553.5 (μm) • 0.00001 to 0.65535 (inches) • 0.00001 to 0.65535 (degrees) • 1 to 65535 (pulses)
		Setting values using programs*1 (default value: 20000) • 1 to 65535 (× 10^{-1}μm) • 1 to 65535 (× 10^{-5}inches) • 1 to 65535 (× 10^{-5}degrees) • 1 to 65535 (pulses)
	Number of pulses per revolution (32bits)	1 to 200000000 pulses (default value: 20000)
	Travel distance per revolution (32bits)	Setting values using engineering tools (default value: 20000) • 0.1 to 20000000.0 (μm) • 0.00001 to 2000.00000 (inches) • 0.00001 to 2000.00000 (degrees) • 1 to 200000000 (pulses)
		Setting values using programs*1 (default value: 20000) • 1 to 200000000 (× 10^{-1}μm) • 1 to 200000000 (× 10^{-5}inches) • 1 to 200000000 (× 10^{-5}degrees) • 1 to 200000000 (pulses)
	Unit multiplication	• 1 time (default value) • 10: ×10 times • 100: ×100 times • 1000: ×1000 times
	Pulse output mode	• 0: PULSE/SIGN mode • 1: CW/CCW mode (default value) • 2: A-phase/B-phase (4 multiplication) • 3: A-phase/B-phase (1 multiplication)
	Rotation direction settings	• 0: Increases the current value with forward rotation pulse output (default value) • 1: Increases the current value with reverse rotation pulse output

Item		Setting range
Basic parameter 1	Offset speed at starting	Setting values using engineering tools (default value: 0) • 0 to 20000000.00 (mm/min) • 0 to 2000000.000 (inches/min) • 0 to 3000000.000 (degrees/min) • 0 to 5000000 (pulses/s)
		Setting values using programs*1 (default value: 0) • 0 to 2000000000 (× 10^{-2}mm/min) • 0 to 2000000000 (× 10^{-3}inches/min) • 0 to 3000000000 (× 10^{-3}degrees/min) • 0 to 5000000 (pulses/s)
Basic parameter 2	Speed limit value	Setting values using engineering tools (default value: 200000) • 0.01 to 20000000.00 (mm/min) • 0.001 to 2000000.000 (inches/min) • 0.001 to 3000000.000 (degrees/min) • 1 to 5000000 (pulses/s)
		Setting values using programs*1 (default value: 200000) • 1 to 2000000000 (× 10^{-2}mm/min) • 1 to 2000000000 (× 10^{-3}inches/min) • 1 to 3000000000 (× 10^{-3}degrees/min) • 1 to 5000000 (pulses/s)
	Acceleration time 0	1 to 8388608ms (default value: 1000)
	Deceleration time 0	
Detail parameter 1	Backlash compensation amount	Setting values using engineering tools (default value: 0) • 0 to 6553.5 (μm) • 0 to 0.65535 (inches) • 0 to 0.65535 (degrees) • 0 to 65535 (pulses)
		Setting values using programs*1 (default value: 0) • 0 to 65535 (× 10^{-1}μm) • 0 to 65535 (× 10^{-5}inches) • 0 to 65535 (× 10^{-5}degrees) • 0 to 65535 (pulses)
	Software stroke limit upper limit value	Setting values using engineering tools (default value: 2147483647) • -214748364.8 to 214748364.7 (μm) • -21474.83648 to 21474.83647 (inches) • 0 to 359.99999 (degrees) • -2147483648 to 2147483647 (pulses)
	Software stroke limit upper limit value	Setting values using programs*1 (default value: 2147483647) • -2147483648 to 2147483647 (× 10^{-1}μm) • -2147483648 to 2147483647 (× 10^{-5}inches) • 0 to 35999999 (× 10^{-5}degrees) • -2147483648 to 2147483647 (pulses)
	Software stroke limit lower limit value	Setting values using engineering tools (default value: 2147483647) • -214748364.8 to 214748364.7 (μm) • -21474.83648 to 21474.83647 (inches) • 0 to 359.99999 (degrees) • -2147483648 to 2147483647 (pulses)
		Setting values using programs*1 (default value: 2147483647) • -2147483648 to 2147483647 (× 10^{-1}μm) • -2147483648 to 2147483647 (× 10^{-5}inches) • 0 to 35999999 (× 10^{-5}degrees) • -2147483648 to 2147483647 (pulses)

Item		Setting range
Detail parameter 1	Software stroke limit selection	• 0: Applying software limit to the feed current value (default value) • 1: Applying software limit to the feed machine value
	Software stroke limit enable/disable setting	• 0: Enabled (default value) • 1: Disabled
	Command in-position range	Setting values using engineering tools (default value: 100) • 0.1 to 214748364.7 (μm) • 0.00001 to 21474.83647 (inches) • 0.00001 to 21474.83647 (degrees) • 1 to 2147483647 (pulses)
		Setting values using programs[*1] (default value: 100) • 1 to 2147483647 (× 10^{-1}μm) • 1 to 2147483647 (× 10^{-5}inches) • 1 to 2147483647 (× 10^{-5}degrees) • 1 to 2147483647 (pulses)
	Torque limit setting value	1 to 5000 (default value: 300)
	M-code ON signal output timing	• 0: WITH mode (default value) • 1: AFTER mode
	Speed switching mode	• 0: Standard speed switching mode (default value) • 1: Front-load speed switching mode
	Interpolation speed specifying method	• 0: Composite speed (default value) • 1: Reference axis speed
	Feed current value at speed control	• 0: The feed current value is not updated (default value). • 1: The feed current value is updated. • 2: The feed current value is cleared to 0.
	Input signal logic selection: Lower limit signal	• 0: Negative logic (default value) • 1: Positive logic
	Input signal logic selection: Upper limit signal	
	Input signal logic selection: Drive unit ready signal	
	Input signal logic selection: Stop signal	
	Input signal logic selection: External command signal	
	Input signal logic selection: Zero-point signal	
	Input signal logic selection: Proximity dog signal	
	Input signal logic selection: Manual pulse generator input	
	Output signal logic selection: Command pulse signal	• 0: Negative logic (default value) • 1: Positive logic
	Output signal logic selection: Deviation counter clear	
	Manual pulse generator input selection	• 0: A-phase/B-phase (4 multiplication) (default value) • 1: A-phase/B-phase (2 multiplication) • 2: A-phase/B-phase (1 multiplication) • 3: PULSE/SIGN
	Speed/position function selection	• 0: Speed/position switching control (INC mode) (default value) • 2: Speed/position switching control (ABS mode)

Item		Setting range
Detail parameter 2	Acceleration time 1	1 to 8388608ms (default value: 1000)
	Acceleration time 2	
	Acceleration time 3	
	Deceleration time 1	
	Deceleration time 2	1 to 8388608ms (default value: 1000)
	Deceleration time 3	
	JOG speed limit value	Setting values using engineering tools (default value: 20000) • 0.01 to 20000000.00 (mm/min) • 0.001 to 2000000.000 (inches/min) • 0.001 to 3000000.000 (degrees/min) • 1 to 5000000 (pulses/s)
		Setting values using programs*1 (default value: 20000) • 1 to 2000000000 (× 10^{-2}mm/min) • 1 to 2000000000 (× 10^{-3}inches/min) • 1 to 3000000000 (× 10^{-3}degrees/min) • 1 to 5000000 (pulses/s)
	JOG operation acceleration time selection	• 0: Acceleration time 0 (default value) • 1: Acceleration time 1 • 2: Acceleration time 2 • 3: Acceleration time 3
	JOG operation deceleration time selection	• 0: Deceleration time 0 (default value) • 1: Deceleration time 1 • 2: Deceleration time 2 • 3: Deceleration time 3
	Acceleration/deceleration process selection	• 0: Trapezoid acceleration/deceleration process (default value) • 1: S-pattern acceleration/deceleration process
	S-pattern ratio	1 to 100% (default value: 100)
	Quick stop deceleration time	1 to 8388608ms (default value: 1000)
	Stop group 1 quick stop selection	• 0: Ordinary deceleration stop (default value) • 1: Quick stop
	Stop group 2 quick stop selection	
	Stop group 3 quick stop selection	
	In-position signal outputting time	0 to 65535ms (default value: 300)
	Circular interpolation error permissible range	Setting values using engineering tools (default value: 100) • 0 to 10000.0 (μm) • 0 to 1.00000 (inches) • 0 to 1.00000 (degrees) • 0 to 100000 (pulses)
		Setting values using programs*1 (default value: 100) • 0 to 100000 (× 10^{-1}μm) • 0 to 100000 (× 10^{-5}inches) • 0 to 100000 (× 10^{-5}degrees) • 0 to 100000 (pulses)
	External command function selection	• 0: External positioning start (default value) • 1: External speed change request • 2: Speed ⇔ position control switching request • 3: Skip request
	Start adjusting time	0.00 to 10000.00ms (default value: 0.00)

Item		Setting range
Homing basic parameter	Homing method	• 0: Proximity dog method (default value) • 1: Stopper method 1 • 2: Stopper method 2 • 3: Stopper method 3 • 4: Count method 1 • 5: Count method 2 • 6: Data set method • 7: Limit switch combined method
	Homing direction	• 0: Positive direction (address increasing direction) (default value) • 1: Negative direction (address decreasing direction)
	Home position address	Setting values using engineering tools (default value: 0) • -214748364.8 to 214748364.7 (μm) • -21474.83648 to 21474.83647 (inches) • 0 to 359.99999 (degrees) • -2147483648 to 2147483647 (pulses)
		Setting values using programs*1 (default value: 0) • -2147483648 to 2147483647 ($\times 10^{-1}$μm) • -2147483648 to 2147483647 ($\times 10^{-5}$inches) • 0 to 35999999 ($\times 10^{-5}$degrees) • -2147483648 to 2147483647 (pulses)
	Homing speed	Setting values using engineering tools (default value: 1) • 0.01 to 20000000.00 (mm/min) • 0.001 to 2000000.000 (inches/min) • 0.001 to 3000000.000 (degrees/min) • 1 to 5000000 (pulses/s)
		Setting values using programs*1 (default value: 1) • 1 to 2000000000 ($\times 10^{-2}$mm/min) • 1 to 2000000000 ($\times 10^{-3}$inches/min) • 1 to 3000000000 ($\times 10^{-3}$degrees/min) • 1 to 5000000 (pulses/s)
	Creep speed	Setting values using engineering tools (default value: 1) • 0.01 to 20000000.00 (mm/min) • 0.001 to 2000000.000 (inches/min) • 0.001 to 3000000.000 (degrees/min) • 1 to 5000000 (pulses/s)
		Setting values using programs*1 (default value: 1) • 1 to 2000000000 ($\times 10^{-2}$mm/min) • 1 to 2000000000 ($\times 10^{-3}$inches/min) • 1 to 3000000000 ($\times 10^{-3}$degrees/min) • 1 to 5000000 (pulses/s)
	Homing retry	• 0: Homing retry using the limit switch is not performed (default value). • 1: Homing retry using the limit switch is performed.

Item		Setting range
Homing detail parameter	Homing dwell time	0 to 65535ms (default value: 0)
	Travel distance settings after proximity dog ON	Setting values using engineering tools (default value: 0) • 0 to 214748364.7 (μm) • 0 to 21474.83647 (inches) • 0 to 21474.83647 (degrees) • 0 to 2147483647 (pulses)
		Setting values using programs*1 (default value: 0) • 0 to 2147483647 (× 10^{-1}μm) • 0 to 2147483647 (× 10^{-5}inches) • 0 to 2147483647 (× 10^{-5}degrees) • 0 to 2147483647 (pulses)
	Homing acceleration time selection	• 0: Acceleration time 0 (default value) • 1: Acceleration time 1 • 2: Acceleration time 2 • 3: Acceleration time 3
	Homing deceleration time selection	• 0: Deceleration time 0 (default value) • 1: Deceleration time 1 • 2: Deceleration time 2 • 3: Deceleration time 3
	Home position shift distance	Setting values using engineering tools (default value: 0) • -214748364.8 to 214748364.7 (μm) • -21474.83648 to 21474.83647 (inches) • -21474.83648 to 21474.83647 (degrees) • -2147483648 to 2147483647 (pulses)
		Setting values using programs*1 (default value: 0) • -2147483648 to 2147483647 (× 10^{-1}μm) • -2147483648 to 2147483647 (× 10^{-5}inches) • -21474.83648 to 21474.83647 (× 10^{-5}degrees) • -2147483648 to 2147483647 (pulses)
	Homing torque limit value	1 to 3000 (default value: 300)
	Deviation counter clear signal outputting time	1 to 65535ms (default value: 11)
	Speed specification at home position shift	• 0: Homing speed (default value) • 1: Creep speed
	Dwell time at homing retry	0 to 65535ms (default value: 0)
	Operation settings at homing incomplete	• 0: Positioning control is not performed (default value). • 1: Positioning control is performed.
Basic parameter 3*2	Operation mode	• Q-compatible mode (default value) • High-speed start mode
	Extension parameter storage settings	• CPU (default value) • Positioning module

*1: When the settings are performed using programs, calculations are performed in the RD75 to convert the values into each unit. Take the value after unit conversion into account to perform settings.

*2: Basic parameter 3 can be set only by engineering tools.

App. 4.1.2 Positioning data

(1) Operation pattern

Operation patterns specify whether a positioning corresponding to a data No. is to finish only with the data No. or to continue on the following data No.

Operation pattern	Setting value	Description
Positioning complete	00	Performs positioning to the specified address, then finishes positioning.
Consecutive positioning control	01	Performs positioning consecutively in order of the data No. by one start signal. The motor stops once at each positioning data.
Consecutive tracking control	11	Performs positioning consecutively in order of the data No. by one start signal. The motor does not stop at each positioning data.

(2) Control method

Set "control method" for when positioning control is performed. The control methods that can be set are as follows.

Control method	Setting value
ABS1: Straight-line control of one axis (ABS)	01H
INC1: Straight-line control of one axis (INC)	02H
FEED1: Fixed length feed control of one axis	03H
VF1: Speed control of one axis (forward rotation)	04H
VR1: Speed control of one axis (reverse rotation)	05H
VPF: Speed/position switching control (forward rotation)	06H
VPR: Speed/position switching control (reverse rotation)	07H
PVF: Position/speed switching control (forward rotation)	08H
PVR: Position/speed switching control (reverse rotation)	09H
ABS2: Linear interpolation control of two axes (ABS)	0AH
INC2: Linear interpolation control of two axes (INC)	0BH
FEED2: Fixed length feed control by linear interpolation of two axes	0CH
ABS⌒: Circular interpolation control with specified auxiliary points (ABS)	0DH
INC⌒: Circular interpolation control with specified auxiliary points (INC)	0EH
ABS . : Circular interpolation control with a specified center point (ABS, CW)	0FH
ABS . : Circular interpolation control with a specified center point (ABS, CCW)	10H
INC . : Circular interpolation control with a specified center point (INC, CW)	11H
INC . : Circular interpolation control with a specified center point (INC, CCW)	12H
VF2: Speed control of two axes (forward rotation)	13H
VR2: Speed control of two axes (reverse rotation)	14H
ABS3: Linear interpolation control of three axes (ABS)	15H
INC3: Linear interpolation control of three axes (INC)	16H
FEED3: Fixed length feed control by linear interpolation of three axes	17H
VF3: Speed control of three axes (forward rotation)	18H
VR3: Speed control of three axes (reverse rotation)	19H
ABS4: Linear interpolation control of four axes (ABS)	1AH
INC4: Linear interpolation control of four axes (INC)	1BH
FEED4: Fixed length feed control by linear interpolation of four axes	1CH
VF4: Speed control of four axes (forward rotation)	1DH
VR4: Speed control of four axes (reverse rotation)	1EH
ABSH⌒: Helical interpolation control with specified auxiliary points (ABS)	20H
INCH⌒: Helical interpolation control with specified auxiliary points (INC)	21H
ABSH . : Helical interpolation control with a specified center point (ABS, CW)	22H
ABSH . : Helical interpolation control with a specified center point (ABS, CCW)	23H
INCH . : Helical interpolation control with a specified center point (INC, CW)	24H
INCH . : Helical interpolation control with a specified center point (INC, CCW)	25H

Control method	Setting value
NOP: NOP command	80H
POS: Current value change	81H
JUMP: JUMP command	82H
LOOP: Beginning of LOOP to LEND	83H
LEND: End of LOOP to LEND	84H

Restrictions

- When the control method is set to "JUMP command", the setting contents of "[Da.9] Dwell time" and "[Da.10] M code" are different from the other control methods.
- When the control method is set to "LOOP", the setting contents of "[Da.10] M code" are different from the other control methods.
- When "[Pr.1] Unit setting" is set to "degree", circular interpolation control and helical interpolation control with three axes cannot be performed. If attempted, circular interpolation failed (error code: 199FH) occurs.

(3) Acceleration time No.

Set any of "Acceleration time 0 to 3" as the acceleration time at positioning.

Acceleration time No.	Setting value	Description
Acceleration time 0	00	Uses the value set in "[Pr.9] Acceleration time 0".
Acceleration time 1	01	Uses the value set in "[Pr.25] Acceleration time 1".
Acceleration time 2	10	Uses the value set in "[Pr.26] Acceleration time 2".
Acceleration time 3	11	Uses the value set in "[Pr.27] Acceleration time 3".

(4) Deceleration time No.

Set any of "Deceleration time 0 to 3" as the deceleration time at positioning.

Deceleration time No.	Setting value	Description
Deceleration time 0	00	Uses the value set in "[Pr.10] Deceleration time 0".
Deceleration time 1	01	Uses the value set in "[Pr.28] Deceleration time 1".
Deceleration time 2	10	Uses the value set in "[Pr.29] Deceleration time 2".
Deceleration time 3	11	Uses the value set in "[Pr.30] Deceleration time 3".

(5) Interpolation object axis

Set an "Interpolation object axis" (partner axis) to perform interpolation operation with two axes.

Interpolation object axis	Setting value	Description
Axis 1 specification	00	Specifies Axis 1 as the interpolation object axis (partner axis).
Axis 2 specification	01	Specifies Axis 2 as the interpolation object axis (partner axis).
Axis 3 specification	10	Specifies Axis 3 as the interpolation object axis (partner axis).
Axis 4 specification	11	Specifies Axis 4 as the interpolation object axis (partner axis).

(6) Positioning address/travel distance

Set the address to be the target value of the positioning control. The setting range differs depending on "[Da.2] Control method".

(a) When "[Pr.1] Unit setting" is set to "mm"

Setting of "[Da.2] Control method"*1	Setting values using engineering tools	Setting values using programs
ABS linear 1: 01H ABS linear 2: 0AH ABS linear 3: 15H ABS linear 4: 1AH Current value change: 81H	Sets the address. -214748364.8 to 214748364.7 (μm)	Sets the address. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
INC linear 1: 02H INC linear 2: 0BH INC linear 3: 16H INC linear 4: 1BH Fixed length feed 1: 03H Fixed length feed 2: 0CH Fixed length feed 3: 17H Fixed length feed 4: 1CH	Sets the travel distance. -214748364.8 to 214748364.7 (μm)	Sets the travel distance. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
Forward rotation, speed/position: 06H Reverse rotation, speed/position: 07H Forward rotation, position/speed: 08H Reverse rotation, position/speed: 09H	Sets the travel distance. 0 to 214748364.7 (μm)	Sets the travel distance. 0 to 2147483647 ($\times 10^{-1}$μm)
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -214748364.8 to 214748364.7 (μm)	Sets the address. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -214748364.8 to 214748364.7 (μm)	Sets the travel distance. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -214748364.8 to 214748364.7 (μm)	Sets the address. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
INC helical interpolation control: 21H INC helical interpolation control clockwise: 24H INC helical interpolation control counterclockwise: 25H	Sets the travel distance. -214748364.8 to 214748364.7 (μm)	Sets the travel distance. -2147483648 to 2147483647 ($\times 10^{-1}$μm)

*1: The settings of positioning address/travel distance are not required for the control methods that are not mentioned here.

(b) When "[Pr.1] Unit setting" is set to "degree"

Setting of "[Da.2] Control method"*2	Setting values using engineering tools	Setting values using programs
ABS linear 1: 01H ABS linear 2: 0AH ABS linear 3: 15H ABS linear 4: 1AH Current value change: 81H	Sets the address. 0 to 359.99999 (degree)	Sets the address. 0 to 35999999 (× 10^{-5}degrees)
INC linear 1: 02H INC linear 2: 0BH INC linear 3: 16H INC linear 4: 1BH Fixed length feed 1: 03H Fixed length feed 2: 0CH Fixed length feed 3: 17H Fixed length feed 4: 1CH	Sets the travel distance. -21474.83648 to 21474.83647 (degree)	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}degrees)
Forward rotation, speed/position: 06H Reverse rotation, speed/position: 07H	Sets the travel distance in the INC mode. 0 to 21474.83647 (degree)	Sets the travel distance in the INC mode. 0 to 2147483647 (× 10^{-5}degrees)
	Sets the address in the ABS mode. 0 to 359.99999 (degree)	Sets the address in the ABS mode. 0 to 35999999 (× 10^{-5}degrees)
Forward rotation, position/speed: 08H Reverse rotation, position/speed: 09H	Sets the travel distance. 0 to 21474.83647 (degree)	Sets the travel distance. 0 to 2147483647 (× 10^{-5}degrees)
ABS helical interpolation control: 20H*3 ABS helical interpolation control clockwise: 22H*3 ABS helical interpolation control counterclockwise: 23H*3	Sets the address. 0 to 359.99999 (degree)	Sets the address. 0 to 35999999 (× 10^{-5}degrees)
INC helical interpolation control: 21H*3 INC helical interpolation control clockwise: 24H*3 INC helical interpolation control counterclockwise: 25H*3	Sets the travel distance. -21474.83648 to 21474.83647 (degree)	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}degrees)

*2: The settings of positioning address/travel distance are not required for the control methods that are not mentioned here.

*3: In helical interpolation control with three axes, "degree" can be set only on linear interpolation axes.

(c) When "[Pr.1] Unit setting" is set to "pulse"

Setting of "[Da.2] Control method"*4	Setting values using engineering tools	Setting values using programs
ABS linear 1: 01H ABS linear 2: 0AH ABS linear 3: 15H ABS linear 4: 1AH Current value change: 81H	Sets the address. -2147483648 to 2147483647 (pulse)	Sets the address. -2147483648 to 2147483647 (pulse)
INC linear 1: 02H INC linear 2: 0BH INC linear 3: 16H INC linear 4: 1BH Fixed length feed 1: 03H Fixed length feed 2: 0CH Fixed length feed 3: 17H Fixed length feed 4: 1CH	Sets the travel distance. -2147483648 to 2147483647 (pulse)	Sets the travel distance. -2147483648 to 2147483647 (pulse)
Forward rotation, speed/position: 06H Reverse rotation, speed/position: 07H Forward rotation, position/speed: 08H Reverse rotation, position/speed: 09H	Sets the travel distance. 0 to 2147483647 (pulse)	Sets the travel distance. 0 to 2147483647 (pulse)
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -2147483648 to 2147483647 (pulse)	Sets the address. -2147483648 to 2147483647 (pulse)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -2147483648 to 2147483647 (pulse)	Sets the travel distance. -2147483648 to 2147483647 (pulse)
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -2147483648 to 2147483647 (pulse)	Sets the address. -2147483648 to 2147483647 (pulse)
INC helical interpolation control: 21H INC helical interpolation control clockwise: 24H INC helical interpolation control counterclockwise: 25H	Sets the travel distance. -2147483648 to 2147483647 (pulse)	Sets the travel distance. -2147483648 to 2147483647 (pulse)

*4: The settings of positioning address/travel distance are not required for the control methods that are not mentioned here.

(d) When "[Pr.1] Unit setting" is set to "inch"

Setting of "[Da.2] Control method"*5	Setting values using engineering tools	Setting values using programs
ABS linear 1: 01H ABS linear 2: 0AH ABS linear 3: 15H ABS linear 4: 1AH Current value change: 81H	Sets the address. -21474.83648 to 21474.83647 (inch)	Sets the address. -2147483648 to 2147483647 (× 10^{-5}inches)
INC linear 1: 02H INC linear 2: 0BH INC linear 3: 16H INC linear 4: 1BH Fixed length feed 1: 03H Fixed length feed 2: 0CH Fixed length feed 3: 17H Fixed length feed 4: 1CH	Sets the travel distance. -21474.83648 to 21474.83647 (inch)	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}inches)
Forward rotation, speed/position: 06H Reverse rotation, speed/position: 07H Forward rotation, position/speed: 08H Reverse rotation, position/speed: 09H	Sets the travel distance. 0 to 21474.83647 (inch)	Sets the travel distance. 0 to 2147483647 (× 10^{-5}inches)
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -21474.83648 to 21474.83647 (inch)	Sets the address. -2147483648 to 2147483647 (× 10^{-5}inches)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -21474.83648 to 21474.83647 (inch)	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}inches)
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -21474.83648 to 21474.83647 (inch)	Sets the address. -2147483648 to 2147483647 (× 10^{-5}inches)
INC helical interpolation control: 20H INC helical interpolation control clockwise: 22H INC helical interpolation control counterclockwise: 23H	Sets the travel distance. -21474.83648 to 21474.83647 (inch)	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}inches)

*5: The settings of positioning address/travel distance are not required for the control methods that are not mentioned here.

(7) Circular address

The circular address is data required only when circular interpolation control or helical interpolation control with three axes is performed.

- For circular interpolation with specified auxiliary points, set the addresses of the auxiliary points (points to be passed) as the circular address.
- For circular interpolation with a specified center point, set the address of the center point as the circular address.

The setting range differs depending on the settings of "[Pr.1] Unit setting" and "[Da.2] Control method".

(a) When "[Pr.1] Unit setting" is set to "mm"

Setting of "[Da.2] Control method"	Setting values using engineering tools	Setting values using programs
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -214748364.8 to 214748364.7 (μm)	Sets the address. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -214748364.8 to 214748364.7 (μm)*1	Sets the travel distance. -2147483648 to 2147483647 ($\times 10^{-1}$μm)*1
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -214748364.8 to 214748364.7 (μm)	Sets the address. -2147483648 to 2147483647 ($\times 10^{-1}$μm)
INC helical interpolation control: 21H INC helical interpolation control clockwise: 24H INC helical interpolation control counterclockwise: 25H	Sets the travel distance. -214748364.8 to 214748364.7 (μm)*1	Sets the travel distance. -2147483648 to 2147483647 ($\times 10^{-1}$μm)*1

*1: Although the values can be input within the ranges shown here as the circular addresses, note that the maximum radius for circular interpolation control is 536870912.

(b) When "[Pr.1] Unit setting" is set to "degree"

Circular addresses are not available for any control method when the unit setting is set to "degree".

(c) When "[Pr.1] Unit setting" is set to "pulse"

Setting of "[Da.2] Control method"	Setting values using engineering tools	Setting values using programs
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -2147483648 to 2147483647 (pulse)	Sets the address. -2147483648 to 2147483647 (pulse)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -2147483648 to 2147483647 (pulse)*2	Sets the travel distance. -2147483648 to 2147483647 (pulse)*2
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -2147483648 to 2147483647 (pulse)	Sets the address. -2147483648 to 2147483647 (pulse)
INC helical interpolation control: 21H INC helical interpolation control clockwise: 24H INC helical interpolation control counterclockwise: 25H	Sets the travel distance. -2147483648 to 2147483647 (pulse)*2	Sets the travel distance. -2147483648 to 2147483647 (pulse)*2

*2: Although the values can be input within the ranges shown here as the circular addresses, note that the maximum radius for circular interpolation control is 536870912.

(d) When "[Pr.1] Unit setting" is set to "inch"

Setting of "[Da.2] Control method"	Setting values using engineering tools	Setting values using programs
ABS circular interpolation control: 0DH ABS circular interpolation control clockwise: 0FH ABS circular interpolation control counterclockwise: 10H	Sets the address. -21474.83648 to 21474.83647 (inch)	Sets the address. -2147483648 to 2147483647 (× 10^{-5}inches)
INC circular interpolation control: 0EH INC circular interpolation control clockwise: 11H INC circular interpolation control counterclockwise: 12H	Sets the travel distance. -21474.83648 to 21474.83647 (inch)*3	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}inches)*3
ABS helical interpolation control: 20H ABS helical interpolation control clockwise: 22H ABS helical interpolation control counterclockwise: 23H	Sets the address. -21474.83648 to 21474.83647 (inch)	Sets the address. -2147483648 to 2147483647 (× 10^{-5}inches)
INC helical interpolation control: 21H INC helical interpolation control clockwise: 24H INC helical interpolation control counterclockwise: 25H	Sets the travel distance. -21474.83648 to 21474.83647 (inch)*3	Sets the travel distance. -2147483648 to 2147483647 (× 10^{-5}inches)*3

*3: Although the values can be input within the ranges shown here as the circular addresses, note that the maximum radius for circular interpolation control is 536870912.

(8) Command speed

Set the command speed at positioning.

- When the command speed exceeds "[Pr.8] Speed limit value", perform positioning with the speed limit value.
- When the command speed is set to "-1", perform positioning control using the current speed (the setting speed of the previous positioning data No.).

The current speed is used on occasions such as when consecutive tracking control is performed. By setting the succeeding positioning data to "-1" then changing the speed, the change also applies to the speed of the following consecutive data. Note that if the positioning data for the first positioning control is set to "-1" at a positioning start, "no command speed" (error code: 1A12H) occurs and the positioning does not start.

The setting range differs depending on the setting of "[Pr.1] Unit setting".

Setting of "[Pr.1] Unit setting"	Setting values using engineering tools	Setting values using programs*1
0: mm	0.01 to 20000000.00 (mm/min)	1 to 2000000000 (× 10^{-2}mm/min)
1: inch	0.001 to 2000000.000 (inch/min)	1 to 2000000000 (× 10^{-3}inches/min)
2: degree	0.001 to 3000000.000 (degree/min)	1 to 3000000000 (× 10^{-3}degrees/min)
3: pulse	1 to 5000000 (pulse/s)	1 to 5000000 (pulse/s)

*1: When the settings are performed using programs, calculations are performed in the RD75 to convert the values into each unit. Take the value after unit conversion into account to perform settings.

(9) Dwell time

Set "Dwell time" or "Positioning data No." in accordance with "[Da.2] Control method".

- When "[Da.2] Control method" is set to other than "JUMP command", set "Dwell time" in the unit of ms.
- When "[Da.2] Control method" is set to "JUMP command", set "Positioning data No." of the JUMP destination excepting the current position.

Dwell time is the time from when a command pulse output is complete until when the in-position signal turns on. It is set to absorb the delay of the mechanical system to commands, such as the delay of the servo system (deviation).

Setting of "[Da.2] Control method"	Setting value	Setting details
JUMP command: 82H	1 to 600	Positioning data No.
Other than JUMP command	0 to 65535 (ms)	Dwell time

(10) M code

Set "M code", "number of pitches", "condition data No.", or "number of LOOP to LEND repeats" in accordance with "[Da.2] Control method".

- When "[Da.2] Control method" is set to other than "JUMP command" or "LOOP", set "M code". If not outputting "M code", set "0" (default value).
- When "[Da.2] Control method" is set to "Helical interpolation control with three axes", set the number of pitches for the linear interpolation axis. Set the number of revolutions used in the circular interpolation as the number of pitches.
- When "[Da.2] Control method" is set to other than "JUMP command", set "condition data No." for JUMP. If 0 is set, JUMP is performed to the positioning data set in "[Da.9] Dwell time" under any conditions. If any of 1 to 10 is set, JUMP is performed in accordance with the corresponding condition data No.1 to 10.
- When "[Da.2] Control method" is set to "LOOP", set the "number of repeats" of LOOP to LEND. If 0 is set, "Control method LOOP setting error" (error code: 1A33H) occurs.

The setting range differs depending on the setting of "[Da.2] Control method".

Setting of "[Da.2] Control method"	Setting value	Setting details
JUMP command: 82H	0 to 10	Condition data No.
LOOP: 83H	1 to 65535	Number of repeats
Helical interpolation: 20H to 25H	0 to 999	Number of pitches
Settings not listed above	0 to 65535	M-code

Positioning data setting examples

Data No.	Operation pattern	Control method	Interpolation object axis	Acceleration time No.	Deceleration time No.	Positioning address	Circular address	Command speed	Dwell time	M-code
1	0: Positioning END	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	50000.0 [µm]	-	2000.00 [mm/min]	-	-
2	0: Positioning End	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	75000.0 [µm]	-	2000.00 [mm/min]	-	-
3	0: Positioning End	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	100000.0 [µm]	-	2000.00 [mm/min]	-	-
4	0: Positioning END	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	150000.0 [µm]	-	2000.00 [mm/min]	-	-
5	0: Positioning END	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	200000.0 [µm]	-	2000.00 [mm/min]	-	-
6	0: Positioning END	01H: ABS1 Straight-line control of one axis (ABS)	-	0: Acceleration time 0	0: Deceleration time 0	25000.0 [µm]	-	2000.00 [mm/min]	-	-
7	0: Positioning END	-	-	0: Acceleration time 0	0: Deceleration time 0	0.0 [µm]	-	0.00 [mm/min]	-	-
8	0: Positioning End	-	-	0: Acceleration time 0	0: Deceleration time 0	0.0 [µm]	-	0.00 [mm/min]	-	-
9	0: Positioning End	-	-	0: Acceleration time 0	0: Deceleration time 0	0.0 [µm]	-	0.00 [mm/min]	-	-
10	0: Positioning End	-	-	0: Acceleration time 0	0: Deceleration time 0	0.0 [µm]	-	0.00 [mm/min]	-	-

App. 5 Functions and Operations of MELSERVO-J5

This section describes the MR-J5-A servo amplifier (pulse command/analog voltage command).

App. 5.1 Function List

The following tables list the functions of the MR-J5-A.

(1) Control mode

Subcategory	Function	Description	Supported software version
Pulse/analog/ DI command	Position control mode (P) (Pulse train input)	This function operates the servo motor in the position control mode by the pulse train input.	A0
	Speed control mode (S) (Internal speed/analog speed command)	This function operates the servo motor in the speed control mode by the internal speed command or analog speed command.	A0
	Torque control mode (T) (Analog torque command)	This function operates the servo motor in the torque control mode by the analog torque command.	A0
Test operation	Test operation mode	This function requires MR Configurator2 for JOG operation, positioning operation, motor-less operation, DO forced output, and program operation.	A0

(2) Drive motor

Subcategory	Function	Description	Supported software version
Universal drive	Linear servo motor	Using the linear servo motor and linear encoder enables the linear servo system to be configured.	A0
	Direct drive motor	Using this function enables the direct drive servo system to be configured to drive the direct drive motor.	A0
Encoder	High-resolution encoder	A 67108864 pulses/rev high-resolution encoder is used for the encoder of the rotary servo motor.	A0
	Batteryless absolute position encoder	The rotation position of the servo motor can be backed up without the battery. Using the servo motor with this encoder enables an absolute value detection system to be configured without battery.	A0

(3) Position detection

Subcategory	Function	Description	Supported software version
Control method	Semi closed loop system	This function uses the servo motor encoder to configure semi closed loop systems.	A0
	Fully closed loop system	This function uses the load-side encoder to configure fully closed loop systems.	A5
Absolute position	Absolute position detection system	This function does not require homing at every power-on as long as homing is performed once.	A0

(4) Operation function

Subcategory	Function	Description	Supported software version
Stop function	Stroke limit function	This function uses LSP (Forward rotation stroke end) and LSN (Reverse rotation stroke end) to limit the travel interval of the servo motor.	A0
Command generation	Command pulse selection	The command pulse train input form can be selected from among three different types.	A0
	Rotation/travel direction selection	This function sets the rotation direction of the servo motor without changing the command polarity.	A0
	Electronic gear	This function performs positioning control with the value obtained by multiplying the position command from the upper controller by a set electronic gear ratio.	A0
	Acceleration/deceleration function	This function sets acceleration and deceleration time constants.	A0
	S-pattern acceleration/ deceleration time constants	This function performs smooth acceleration and deceleration.	A0
	Torque limit	This function limits the servo motor torque.	A0
	Speed limit	This function limits the servo motor speed in the torque control mode.	A0

(5) Control function

Subcategory	Function	Description	Supported software version
Vibration suppression	Advanced vibration suppression control II	This function suppresses vibration and residual vibration at an arm end.	A0
	Machine resonance suppression filter	This function decreases the gain of the specific frequency to suppress the resonance of the mechanical system.	A0
	Shaft resonance suppression filter	When driving the servo motor with a load mounted to the servo motor shaft, resonance due to shaft torsion may generate high frequency mechanical vibration. The shaft resonance suppression filter suppresses this vibration.	A0
	Robust filter	This function improves disturbance response when response performance cannot be increased because of a large load to motor inertia ratio, such as a roll feed axis.	A0
	Slight vibration suppression control	This function suppresses vibration of ±1 pulse generated at each servo motor stop.	A0
Tracking control	Lost motion compensation function	This function reduces the response delay generated when the machine moving direction is reversed.	A0
	Super trace control	This function reduces the droop pulses at the rated speed and at the uniform acceleration/deceleration to almost zero.	A5
	Path tracking model adaptive control	This function reduces tracking errors in reciprocation.	A0

(6) Adjustment function

Subcategory	Function	Description	Supported software version
Automatic adjustment	Quick tuning	This function automatically adjusts the gain at servo-on in a short time without acceleration/deceleration operation of the servo motor. Response without overshoot is possible, saving gain adjustment time.	A0
	Auto tuning	This function automatically adjusts the gain to an optimum value even if the load applied to the servo motor shaft varies.	A0
	One-touch tuning	Gain adjustment is performed with this function just by pressing buttons on the servo amplifier or by clicking a button once on MR Configurator2.	A0
Custom adjustment	Model adaptive control	This function enables stable and highly responsive control according to the ideal model. This is a two-degrees-of-freedom model and can adjust responses to commands and disturbances separately. This function can also be disabled.	A0
	Gain switching function	This function switches gains during rotation and during stop, and uses an input device to switch gains during operation. It supports the gain switching by rotation direction and the 3-step gain switching. Therefore, more detailed gain switching is available.	A0
Adjustment support	Machine analyzer	This function analyzes the frequency characteristic of the mechanical system by simply connecting the servo amplifier with an MR Configurator2 installed personal computer.	A0

(7) I/O, monitor

Subcategory	Function	Description	Supported software version
DI/DO	Input signal selection (device selection)	This function assigns input devices such as LSP (Forward rotation stroke end) to certain pins of the connector.	A0
	Output signal selection (device setting)	This function assigns output devices such as MBR (Electromagnetic brake interlock) to certain pins of the connector.	A0
	Output signal (DO) forced output	This function forcibly switches the output signals on and off regardless of the servo status. Use this function for purposes such as checking output signal wiring.	A0
	External I/O signal display	This function shows the on/off status of external I/O signals on the display.	A0
	A/B/Z-phase output	This function outputs the positions of the encoder and linear encoder in the A/B/Z-phase signal.	A0
LED	Status display	This function shows the servo status on the 7-segment LED display.	A0
Analog input/output	Analog command input automatic offset	Voltage is automatically offset to stop the servo motor if it does not come to a stop when an analog input such as VC (Analog speed command) or VLA (Analog speed limit) is 0V.	A0
	High-resolution analog input	When using the MR-J5-A-RJ, the analog input resolution is 16 bits.	A0
	Analog monitor	This function outputs the servo status in voltage in real time.	A0
Monitor	Power monitoring function	This function calculates the running power and the regenerative power from the data in the servo amplifier such as speed and current. The power consumption and other values are displayed on MR Configurator2.	A0

(8) Option

Subcategory	Function	Description	Supported software version
Regenerative capacity enhancement	Simple converter	This function enables servo amplifiers to be used in a common bus connection. Utilizing the regenerative power contributes to energy-conservation. In addition, it decreases the number of circuit breakers and magnetic contactors.	A0
	Regenerative option	Use this function if the built-in regenerative resistor of the servo amplifier does not have sufficient regenerative capacity for the generated regenerative power.	A0

(9) Engineering tool

Subcategory	Function	Description	Supported software version
Setup software	MR Configurator2	This function performs settings (such as servo parameter settings), test operation, and monitoring with a personal computer.	A0

(10) Protective functions

Subcategory	Function	Description	Supported software version
Alarm	Alarm function	This function displays an alarm or warning when an error occurs during operation. If an alarm occurs, ALM (Malfunction) turns off and stops the servo motor. If a warning occurs, WNG (Warning) will turn on. The servo motor may stop or continue operation depending on the warning.	A0
	Alarm history clear	This function clears alarm history.	A0
Power error detection	Disconnection detection function	This function detects a disconnection in the main circuit power supply input and the servo motor power supply output.	A0
Coasting distance reduction	Forced stop deceleration function	This function decelerates the servo motor to a stop at EM2 off or when there is an alarm.	A0
Drop protection	Electromagnetic brake interlock function	This function operates the electromagnetic brake at servo off and error occurrence, and prevents the vertical axis from dropping.	A0
	Vertical axis freefall prevention function	This function moves the axis up by the mechanical backlash amount of the electromagnetic brake to prevent damage to machines.	A0
Braking protection	Dynamic brake	During the power shut-off and alarm occurrence, this function shorts between U, V, and W phases and operates the brake.	A0

(11) Functional safety

Subcategory	Function	Description	Supported software version
Single servo amplifier function	STO function	This servo amplifier supports the STO function for functional safety as per IEC/EN61800-5-2. This allows a safety system to be easily configured for the equipment.	A0

(12) Instantaneous power failure measures

Subcategory	Function	Description	Supported software version
Tough drive	SEMI-F47 function	This function uses the electrical energy charged in the capacitor to avoid triggering [AL.010 Undervoltage] in case that an instantaneous power failure occurs during operation. Use a 3-phase power supply for the input power supply of the servo amplifier. Using a 1-phase 200VAC for the input power supply will not comply with SEMI-F47 standard.	A0
	Tough drive function	This function makes the equipment continue operating even under conditions where an alarm would normally occur. There are two types of tough drive function: the vibration tough drive and the instantaneous power failure tough drive.	A0

(13) Diagnosis

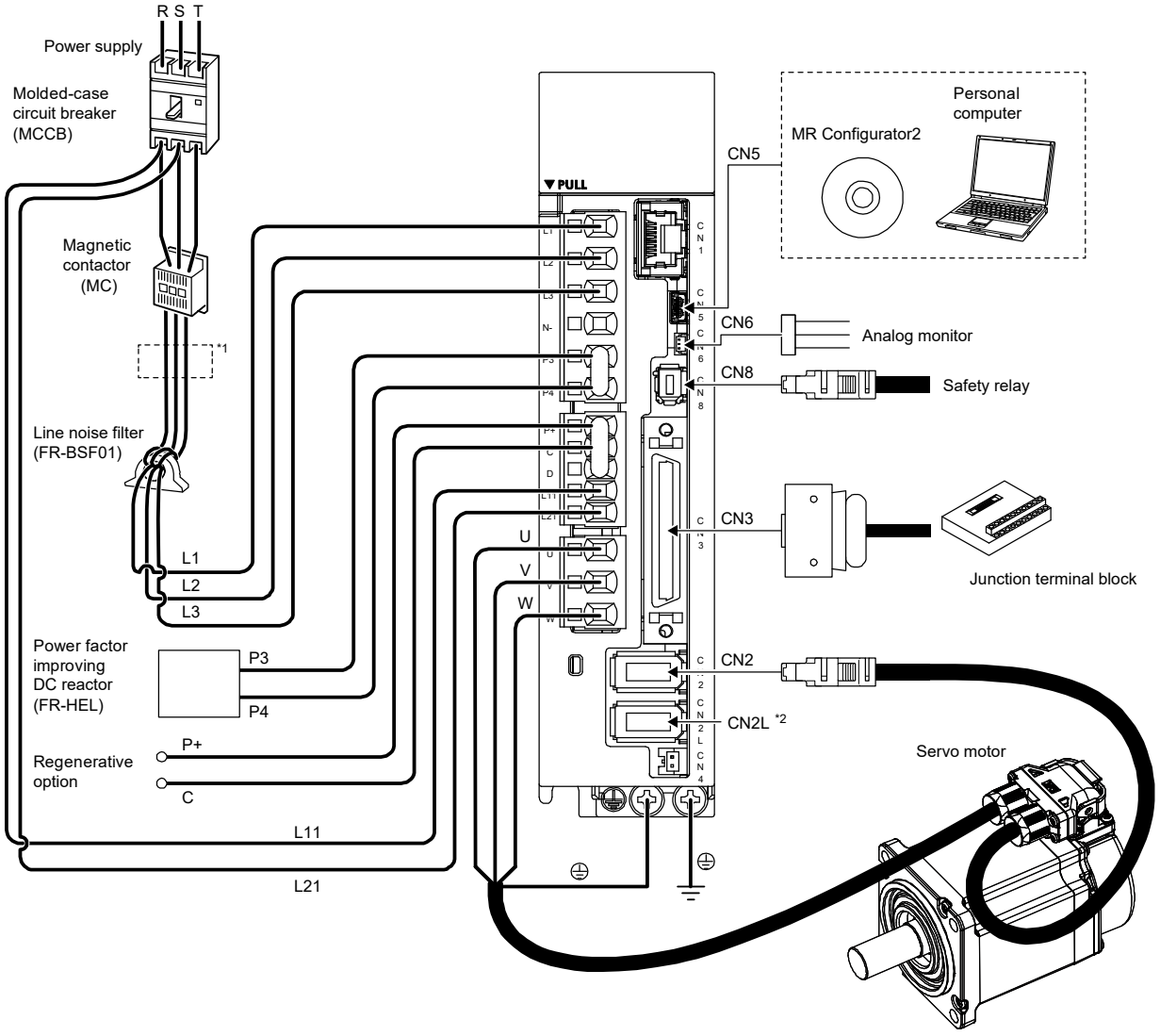
Subcategory	Function	Description	Supported software version
Drive data diagnosis	Drive recorder	This function continuously monitors the servo status and records the state transition before and after an alarm for a fixed period of time. The recorded data can be checked by the Waveform-Display button in the drive recorder window of MR Configurator2 being clicked. However, the drive recorder is not available when: • The graph function of MR Configurator2 is being used. • The machine analyzer function is being used. • [Pr.PF21] is set to "-1". • The controller is not connected (except the test operation mode). • The long-term sampling is supported at an occurrence of a controller-related alarm, and various alarms can be handled.	A0
Drive data diagnosis	Graph function	This function obtains the servo status in the graph.	A0
Failure diagnosis	Encoder communication diagnosis function	This function diagnoses with MR Configurator2 whether the encoder communication error is caused by the circuit malfunction of the servo amplifier or by the malfunction of the cables/encoder.	A0
Life diagnosis	Servo amplifier life diagnosis function	This function enables checking of the cumulative energization time, the number of times the inrush relay has been turned on/off, and the number of times the dynamic brake has been used. It gives an indication of the replacement time for parts on the servo amplifier with a service life (such as the capacitor and the relay) before they malfunction. MR Configurator2 is required for this function.	A0
	Motor life diagnosis function	This function predicts failures of the equipment and the servo motor based on the machine total travel distance. It gives an indication of the replacement time for the servo motor.	A0
	Machine diagnosis function	This function uses the data in the servo amplifier to estimate the friction and vibrational component of the drive system in the equipment and to recognize an error in machine parts such as ball screws and bearings.	A0
		This function automatically sets the threshold used for detecting the error of machine parts such as ball screws and bearings. It outputs the warning when the friction, vibrational component, and total revolution of the servo motor are out of the set threshold. The error in the machine parts such as ball screws and bearings can be detected automatically.	A0
		This function estimates the friction of gear and loosening of belt drive function (decrease in the belt tension), and detects errors in the gear and belt.	A0
System diagnosis	System configuration information	This function uses MR Configurator2 to monitor the servo amplifier model, connected servo motor, encoder, and other information.	A0

(14) History

Subcategory	Function	Description	Supported software version
-	Alarm history	This function saves information of the alarm that occurred in the servo amplifier. The information is saved in chronological order and used for occasions such as identifying the cause of the alarm.	A0

App. 5.2 Configuration Including Peripheral Equipment

The MR-J5 series servo amplifiers are designed so that all the operations such as connection with external devices, monitoring/diagnosis, and parameter settings can be performed at the front of the servo amplifiers. Thus, the said operations are possible even if servo amplifiers are installed in the cabinet. The following is an example using the MR-J5-20A-RJ.



*1: The power factor improving AC reactor can also be used. In this case, the power factor improving DC reactor cannot be used.

*2: This is for the MR-J5-_A-RJ servo amplifier. The MR-J5-_A servo amplifier does not have a CN2L connector. If using the MR-J5-_A-RJ servo amplifier in a linear servo system or a fully closed loop system, connect an external encoder to this connector. Refer to "Parts identification" in the MR-J5 User's Manual (Introduction) for the compatible external encoders.

*3: P3 and P4 are connected from the factory. Remove the short-circuit bar between P3 and P4 before connecting a power factor improving DC reactor. Additionally, the power factor improving DC reactor and a power factor improving AC reactor cannot be used together.

*4: Connect the P+ and D terminals. P+ and D are connected from the factory. Refer to "Regenerative option" in the MR-J5 User's Manual (Hardware) when using a regenerative option.

App. 6 Terms

Adaptive filter II

Adaptive filter II (adaptive tuning) is a function in which the servo amplifier detects machine resonance for a certain period of time and sets the filter characteristics automatically to suppress mechanical system vibration. Since the filter characteristics (frequency and depth) are set automatically, there is no need to be aware of the resonance characteristics of the mechanical system. When the mechanical characteristics are unknown even at mechanical resonance occurrence, the use of the adaptive tuning is recommended.

Analog control <antonym: digital control>

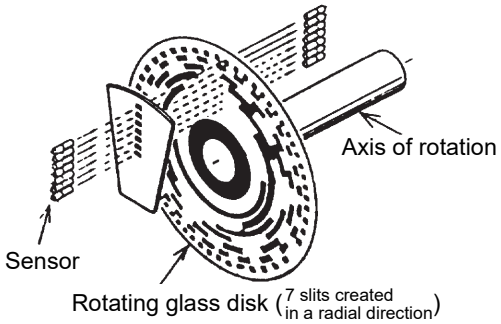
It is a control method which is achieved by a control circuit configured with analog devices such as an operation amplifier.

Absolute position detector <antonym: incremental detector>

It is a detector that enables the angle data within one revolution of the detector to be output to an external device. Models which can take out the angle data of 360 degrees by 8 to 12 bit data are generally used.

The position within one-revolution can be found by using this detector as the servo motor encoder. Thus, it is used to configure an absolute position system combined with a rotation amount counter.

The figure below is the structure of a general absolute position detector. The detector of this example outputs a 7-bit absolute position signal.



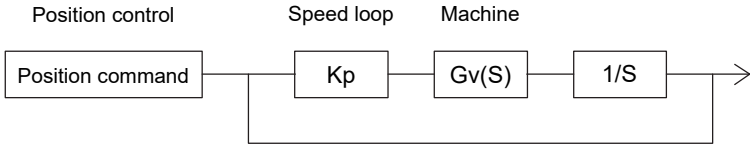
Structure example of an absolute position encoder

Primary delay time constant

It is an exponential time constant, which is the time to reach 63% of the final value. (Refer to the figure in the section "Acceleration time constant".)

Position loop gain

It indicates the responsiveness to commands in a position control. Below is the block diagram of a position control with its speed control system being reduced to "Gv(s)".



The position loop gain here is Kp•Gv (s) = Kp (1/sec)

As the speed loop has feedbacks, the gain is approximately 1.

Then, the position loop gain is expressed as the position responsiveness, resulting in Kp = ωpc (rad/sec).

Inertia (moment of inertia)

Refer to the section of the moment of inertia.

Impact drop

It indicates the fluctuation width of output in relation to the input command in feedback control. The temporal responsiveness characteristics are expressed using the temporary amount of the fluctuation and the duration when the load is changed stepwise.
It is valid especially when an integral action is included.

Responsiveness

The servo systems have position, speed, and current loops. The responsiveness is the trackability to each command, and generally means the speed responsiveness.

Auto tuning (real-time auto tuning)

The performance (especially, responsiveness and stability) of a machine driven by a servo motor varies depending on the characteristics (moment of inertia and rigidity) of the machine. Therefore, adjustment operations are required to bring out the full performance of the machine, and the operations are called tuning.
The auto tuning is the function which automatically performs the said tuning. This function automatically adjusts the speed loop gain and position loop gain which are usually to be set by the servo amplifier.
The real-time auto tuning is the function which automatically performs tuning by constantly following the change of the machine characteristics even during an operation.

All-digital control (digital control)

It is a method that is controlled by a circuit configured with a micro computer and its peripheral LSI and logic IC.

Regenerative brake

When driving a load with a motor, the electricity is usually supplied from the amplifier to the motor. This state is called power running. In contrast, when decreasing the speed of the load, specifically when decelerating the motor or driving a descending load, the rotation energy of the motor and load flows into the servo amplifier. This state is called regeneration.
The servo amplifier obtains regenerative braking torque by consuming the regenerative energy with the capacitor and resistor. The regenerative braking torque is adjusted automatically in accordance with the deceleration pattern. Regenerative options are used for frequent regeneration.

Rotation irregularity

It is a momentary irregularity at a rotation speed change to a command, and generally increases at a low speed and decreases at a high speed.

Angular frequency (ω)

As the unit of the continuous sine wave, the number of cycles per second is expressed in H_z (herz), and the angular frequency is expressed in angles (radian). The value is converted into 2πfrad/sec when the frequency is fH_z.

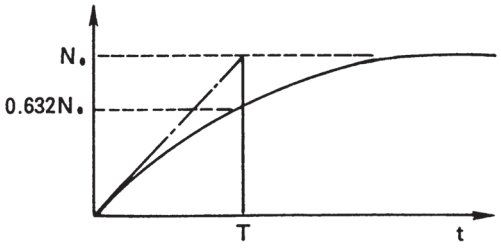
Acceleration time

It is the period of time taken from the current rotation speed to reach the subsequent rotation speed when changing the motor speed.

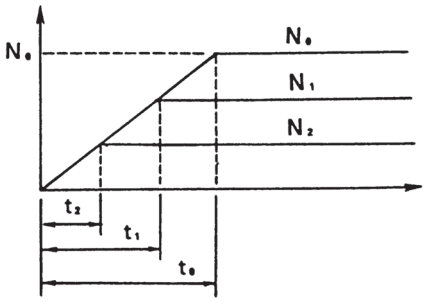
Acceleration/deceleration time constants

It is the period of time taken from 0 [r/min] (0 [mm/s]) to reach the rated speed for the commands or limits, and vice versa.

* It is the period of time taken for the actual speed to reach 63.5% of the target speed for the acceleration pattern in a primary delay function.



Primary delay time constant



Acceleration pattern that has a time constant with the primary delay time

Acceleration time and acceleration time constant

t_0: Acceleration time to the reference speed = constant acceleration time constant

t_1: Acceleration time to the rotation speed N_1

t_2: Acceleration time to the rotation speed N_2

Acceleration

It is the rotation speed change expressed by the ratio relative to the acceleration time, and is the slope against the rotation speed change time. Generally, the term "acceleration" is used for the linear movement in the unit of [m/s^2].

Moment of inertia (inertia)

It is an amount of a rotation weight of a rotating object. It is equivalent to a mass in a linear movement.

Defining equation $J = m \bullet r^2$

In this equation, J: Moment of inertia [$kg \bullet cm^2$]

m: Mass [kg]

r: Rotation radius [cm]

Note that GD2, which is conventionally used to express the amount of the moment of inertia, substitutes "r" (radius) in the above expression with "2r" (diameter). The relation can be expressed as $GD^2 = m \bullet (2r)^2 = 4J$.

Gain search

This function can automatically search for gains that achieve the best settling characteristics. (Enabled only in the position control mode)

It finds the gain that has the shortest settling time and small overshoot while changing the gain automatically.

It is effective when a high-level adjustment is required.

In addition, the preparation before executing the gain search can be performed simply by following the gain search setting wizard.

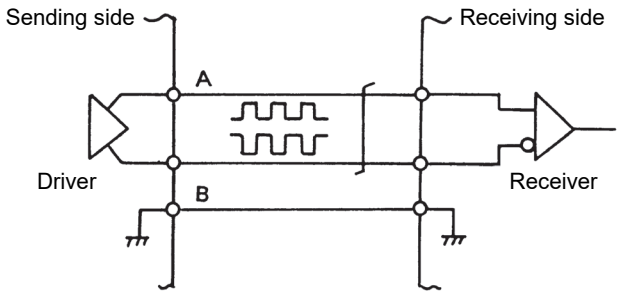
Capacitor regeneration

It is the method which performs regenerative operation by charging regenerative energy to the capacitor of the main circuit.

Since this method does not generate heat, the energy can be used repeatedly as long as the regenerative energy is smaller than the energy charged in the capacitor. Note that only small amount of energy can be charged in the capacitor and thus it is applicable to small-capacity models.

Differential transmission method

It is the method which transmits a signal simultaneously paired with another signal that has the opposite polarity. As the receiving-side device can judge the signal logic as a set, this method has a good noise tolerance, and thus is used for transmitting signals at a high speed such as input/output of pulse trains. In general, devices on the transmission side are called drivers and ones on the receiving side receivers, and dedicated ICs are used in this method.



Frequency response (characteristics)

It expresses the speed responsiveness quantitatively. It indicates up to what frequency the actual motor responds to when a speed command is converted into a form of a sine wave as a minute speed command of approximately 10r/min. It is expressed as ωc [rad/sec] or fc (Hz). This frequency responsiveness can be increased by increasing the speed loop gain, but increasing the gain too much raises the likelihood of vibration and instability depending on the rigidity of the mechanical system or other factors.

Stroke end

The machine has a range (stroke) where it can move within, and position control is to be performed within this range. If the machine exceeds the range by mistake, the machine needs to be stopped forcibly to protect the machine itself. The stroke end is set by either of the following two methods:

1) Provide limit switches on the both sides of the machine, then connect them to the stroke end terminal of the positioning command module or servo amplifier. When these limit switches are activated, the servo motor immediately stops.
2) Set the range defined by the limit switches in the parameter of the positioning command module. The range is called the soft limits, which checks the range at positioning start then generates an error to hold the servo motor.

The moving range of the machine is restricted by both 1) the machine limits and 2) the soft limits as described above, and the machine stops once it overruns a limit. Start the machine towards the opposite direction to pass it over a limit. At an initial operation, the operation of the stroke end limit needs to be checked.

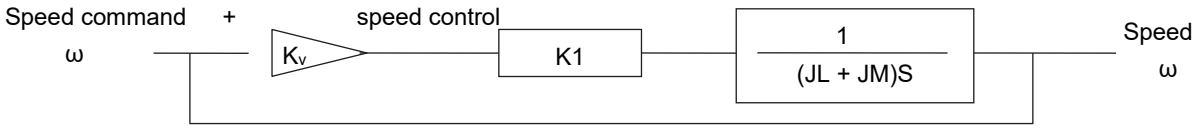
On the other hand, some machines such as rotation tables are disadvantageous if they have stroke ends. In this case, short the stroke end terminals of the positioning command modules or the servo amplifier to operate the machine. In addition, depending on the positioning command module, specific parameters are to be set to "not used" or the current position needs to be changed at appropriate positions.

Speed fluctuation ratio

It expresses the range of fluctuation of the output speed in relation to the input command in speed control. It is a ratio of the fluctuation amount of the rotation speed when the load becomes zero or the rated load value in the reverse direction, generally based on the rotation speed with the rated load.
It was conventionally expressed as an offset in relation to the amplification ratio. However, the other factors often determine the speed fluctuation ratio when an integral action is incorporated. The impact drop characteristics are rather required to be remarked.

Speed loop gain

It indicates the responsiveness to commands in a speed control. The following describes the speed loop gain, assuming the constant determined by the motor to be K1.



The opposite speed loop gain is expressed as follows.

$$\text{Speed loop gain} = \frac{K1 \cdot K_V}{J_M + J_L}$$

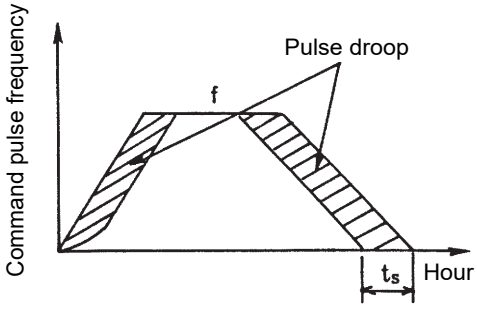
K_V: Speed amplifier gain
J_L: Load inertia
J_M: Motor inertia

Dynamic brake

It is a braking function that is used at a power failure, servo amplifier malfunction, and immediate stop of the machine. Braking torque larger than the electromagnetic brake can be obtained by this function. However, it does not have a holding torque at stop. The MR-J5 servo amplifier has this function. The IM servos, which have induction motors, do not have this function.

Droop pulses

These are the position deviation (number of pulses) accumulated in the servo amplifier at a positioning servo operation. In a low-speed operation, droop pulses are always in proportion to the command pulse frequency. The number of droop pulses becomes within ±1 at positioning completion.



Ground fault

It is a state where either of the cable of the servo amplifier's main power circuit (P and N after rectified by the diode) or the motor power cable (U, V, and W) is short-circuited with the ground.

Resistance regeneration

It is a method which lets the regenerative energy flow in the resistor connected with the servo amplifier bus line to consume the energy as heat, obtaining braking torque.

Stop settling time

Servo motors move with constant deviations against the position command. Therefore, there is a time lag between the stop command completion and the actual servo motor stop.
This time lag is called the stop settling time, and roughly estimated to be $3T_p$ calculated from the time ts shown in the above figure describing the droop pulses.
(T_p: Position loop time constant)
To consider the operation pattern of the servo motor, this stop settling time needs to be taken into account.

Digital control (antonym: analog control)

It is a control method which is achieved by a control circuit configured with digital devices. Recently, it is becoming more common to use microcomputers and microprocessors to process the control with their software to handle the increase of the operation amount.
The advantage of the digital control method is that it is stable in performance without an offset and temperature drifts and thus is highly reproducible.

Power supply regeneration

It is a method which returns the regenerative energy to the power supply via the servo amplifier bus line. Although it requires a dedicated module to return the energy to the power supply, it has less heat generation comparing to the resistance regeneration method, allowing the installation dimensions to be smaller especially when a large regenerative energy is generated. Thus, it is used for operations where regeneration is continuous such as on models with a large capacity and vertical axes.

Electronic gear

It changes the ratio of feedback pulses relative to command pulses. Note that the position resolution does not change as it is defined by the encoder. The ratio can be changed by common fractions using parameter settings.
In contrast to the mechanical gear, the motor torque does not increase even when the reduction ratio is increased.

Electromagnetic brake

The electromagnetic brakes attached to servo motors with electromagnetic brakes are non-excitation brakes, which are to be used for mechanisms such as a vertical axis to prevent the workpiece from sliding down at a power failure or servo amplifier malfunction or to protect the mechanisms at a stop.

Torque linearity

It indicates the relation between the torque command and the torque generated by the motor against the command. Especially in the torque control, the motor has a non-sensitive band when the torque is close to zero. In addition, the magnetic force of the magnet used for the motor changes depending on the temperature, affecting the torque linearity as a result. The magnetic force is affected at -0.2/°C for the ferrite magnet and -0.33/°C for the rare-earth magnet.

Backlash compensation

Most of mechanical systems have non-sensitive bands (gaps). This non-sensitive band is called a backlash. If the mechanical system has a backlash, the machine moves by a travel distance without the amount of the backlash regardless of the servo motor rotation. Therefore, an error in an amount of the backlash is generated between the current position of the positioning command module and the actual machine position. However, the errors are not to be accumulated.
The backlash compensation function compensates the said errors as follows.
Setting the backlash amount in the parameter of the positioning command module outputs an extra pulse train signal in an amount equivalent to the backlash only when the rotation direction of the servo motor changes. At this time, the motor rotates without moving the machine. In addition, the positioning command module does not count this pulse train signal as the current position.

Thus, the machine position matches with the current position of the positioning command module and the error generated by the backlash is compensated.
1) The backlash compensation becomes active after homing is executed.
2) When the backlash settings are changed, homing always needs to be executed.

Power rate

It indicates the acceleration speed of the motor itself when the motor is operated with the output at the rate of its possible output increase on a rated torque motor, and is defined as follows:

$$Q = \frac{T_R^2}{J_M} \times 10 \text{ [kW/s]}$$

TR: Motor output torque [N • m]

JM: Motor moment of inertia [kg • cm^2]

Proportional control

The proportional control is also called the "P control". The manipulated variable Y is in proportion to the deviation value ε, thus expressed as Y = εKp. After positioning completion, if the mechanically-locked motor is forcibly rotated even by one pulse, a large current flows into the motor which then attempts to compensate the position mismatch. To prevent this from happening, setting the control to the proportional control at the same time as the positioning completion can decrease the torque gain, suppressing the current. In addition, the proportional control can suppress the vibration at servo-lock. Note that, although the proportional control introduced here functions to immediately remove the deviation generated by a sudden disturbance, it cannot remove the deviation completely in a continuous disturbance. It is because the control system continues to operate to correct the continuous disturbance, requiring a certain amount of deviation.

Feedback control

It is the control that detects the difference between the command and the actual speed using a closed loop to compensate the command value to reduce this difference.

Feed forward control

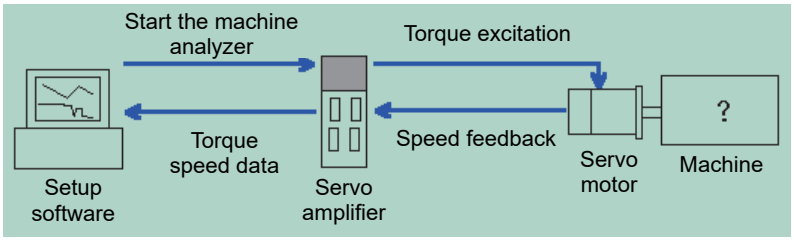
It is the control that outputs a speed command before droop pulses increase when a pulse command is input in the position loop control.

Bus voltage

The voltage is once converted into a DC current by being rectified in the power supply converter area, then converted into an AC current again in the inverter area to drive the AC motor. The voltage of the DC current is called the bus voltage.

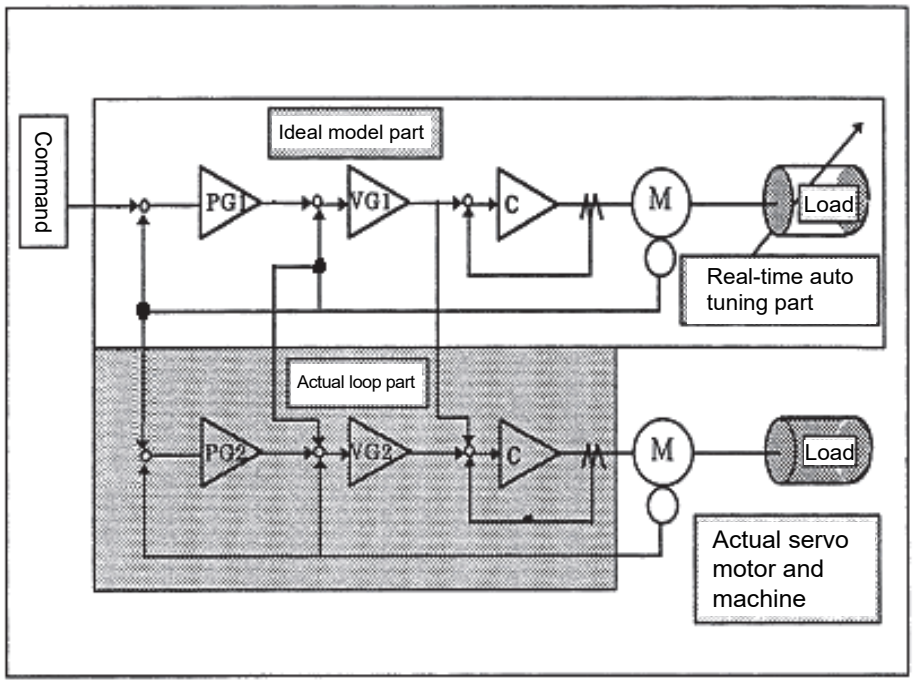
Machine analyzer

The servo amplifier vibrates the servo motor at a random torque for approximately 0.1 to 2 seconds and measures the rotation speed at this time. Then, MR Configurator2 reads the data of the torque and rotation speed out of the servo amplifier to analyze the data.
Thus, the response frequency characteristics of the speed against the motor torque of the machine can be measured.
The frequency characteristics indicate the frequency at which the mechanical system has a resonance point, and thus the settings for functions such as the machine vibration suppression filter can be performed easily.



Model adaptive control and real-time auto tuning

The model adaptive control is the control logic originally developed by Mitsubishi Electric based on the modern control theories. It automatically performs settings of the gains of the model and actual loops in accordance with the load inertia obtained by real-time auto tuning. Thus, this control achieves a high response to the command and stable operation of the machine.



[Explanation]

The control logic of the model adaptive control consists of the three sections as shown in the figure above, namely:

(1) Ideal model section

(2) Real-time auto tuning section

(3) Actual loop section (disturbance-suppression section)

The ideal model section adjusts the gain to an optimum value for the inertia estimated by the real-time auto tuning. Each gain maintains acceptable characteristics even in a high-response control because this section is not affected by machine disturbance, looseness, or the similar factors. The position loop gain (PG1) on the model is used to calculate droop pulses and stop settling time.

The real-time auto tuning calculates the load inertia from the current and time at acceleration and deceleration. It is very effective for machines on which inertia varies greatly such as conveyors. In addition, manual settings are available on machines for which the real-time auto tuning cannot be used (in such cases where a vertical axis has a large unbalance, load inertia exceeding the permissible value, or when the droop pulses need to be constant for interpolation operation or similar occasions).

The actual loop section (disturbance-suppression section) is designed based on the conventional PI control. If an error is generated between the model speed configured by the ideal model section and the actual motor speed due to disturbance torque, a torque command is output from the actual loop section side to follow the model speed.

The disturbance can be suppressed more effectively by setting the gain to a higher level, but increasing the gain too much will cause vibration. This gain value is adjusted to an appropriate level relative to the inertia ratio.

The appropriate values for the model section and actual loop section are set based on the predetermined response setting value for the real-time auto tuning. Therefore, the response setting value needs to be reviewed in order to increase the response.
The model adaptive control is configured as described above, easily enabling adjustment of machines that are too complicated to adjust with the conventional methods, ultra-high frequent application, and other improvements.

RISC

RISC, which stands for "Reduced Instruction Set Computer", is a new type of computer that has a simpler command and command format than the conventional microprocessors (termed CISC as opposed to RISC). Thus, the processing speed can be increased, allowing a huge amount of calculation such as the model adaptive control of a servo in real time.

App. 7 Setting value of the RD75D2 (demonstration machine)

(1) Parameters (axis 1)

Item		Setting value	Remark
Basic parameter 1	Unit setting	0	mm
	Electronic gear selection	0	16bit
	Number of pulses per revolution (16bits)	1 pulse	
	Travel distance per revolution (16bits)	10.0 μm	
	Number of pulses per revolution (32bits)	20000 pulse	
	Travel distance per revolution (32bits)	2000.0 μm	
	Unit multiplication	1	1 time
	Pulse output mode	1	CW/CCW mode
	Rotation direction settings	0	Increases the current value with forward rotation pulse output
	Offset speed at starting	0.00 mm/min	
Basic parameter 2	Speed limit value	600000.00 mm/min	
	Acceleration time 0	100 ms	
	Deceleration time 0	100 ms	
Detail parameter 1	Backlash compensation amount	0.0 μm	
	Software stroke upper limit value	214748364.7 μm	
	Software stroke lower limit value	-214748364.8 μm	
	Software stroke limit selection	0	Applying software limit to the feed current value
	Software stroke limit enable/disable setting	1	Disabled
	Command in-position range	10.0 μm	
	Torque limit setting value	300%	
	M-code ON signal output timing	0	WITH mode
	Speed switching mode	0	Standard speed switching mode
	Interpolation speed specifying method	0	Composite speed
	Feed current value at speed control	0	The feed current value is not updated
	Lower limit signal	1	Positive logic
	Upper limit signal	1	Positive logic
	Drive unit ready signal	0	Negative logic
	Stop signal	0	Negative logic
	External command signal	0	Negative logic
	Zero-point signal	0	Negative logic
	Proximity dog signal	0	Negative logic
	Manual pulse generator input signal	0	Negative logic
	Command pulse signal	0	Negative logic
	Deviation counter clear	0	Negative logic
	Manual pulse generator input selection	0	A-phase/B-phase 4 multiplication
	Speed/position function selection	0	Speed/position switching control (INC mode)

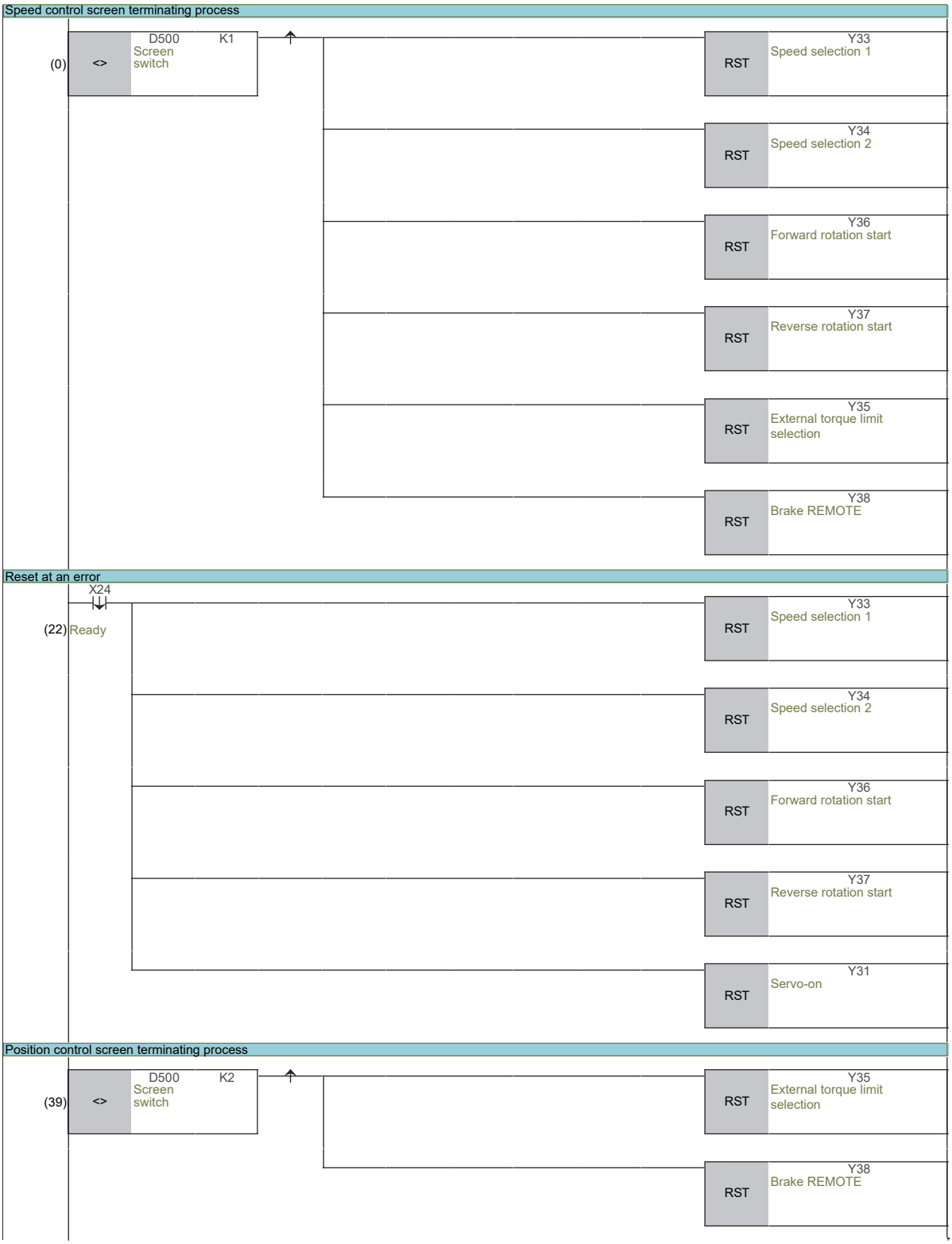
Item		Setting value	Remark
Detail parameter 2	Acceleration time 1	10 ms	
	Acceleration time 2	50 ms	
	Acceleration time 3	1000 ms	
	Deceleration time 1	10 ms	
	Deceleration time 2	50 ms	
	Deceleration time 3	1000 ms	
	JOG speed limit value	600000.00 mm/min	
	JOG operation acceleration time selection	0	Acceleration time 0
	JOG operation deceleration time selection	0	Deceleration time 0
	Acceleration/deceleration process selection	0	Trapezoidal acceleration/deceleration process
	S-pattern ratio	100%	
	Quick stop deceleration time	1000 ms	
	Stop group 1 quick stop selection	0	Ordinary deceleration stop
	Stop group 2 quick stop selection	0	Ordinary deceleration stop
	Stop group 3 quick stop selection	0	Ordinary deceleration stop
	In-position signal outputting time	300 ms	
	Circular interpolation error permissible range	10.0 μm	
	External command function selection	0	External positioning start
	Start adjusting time	0.00 ms	
Homing Basic parameter	Homing method	0	Proximity dog method
	Homing direction	1	Negative direction (address decreasing direction)
	Home position address	0.0 μm	
	Homing speed	5000.00 mm/min	
	Creep speed	1000.00 mm/min	
	Homing retry	1	Homing retry using the limit switch is performed
Homing Detail parameter	Homing dwell time	0 ms	
	Travel distance settings after proximity dog ON	0.0 μm	
	Homing acceleration time selection	3	Acceleration time 3
	Homing deceleration time selection	3	Deceleration time 3
	Home position shift distance	0.0 μm	
	Homing torque limit value	300%	
	Deviation counter clear signal outputting time	11 ms	
	Speed specification at home position shift	0	Homing speed
	Dwell time at homing retry	0 ms	
	Operation settings at homing incomplete	0	Positioning control is not performed
Basic parameter 3	Operation mode	Q-compatible mode	
	Extension parameter storage settings	CPU	

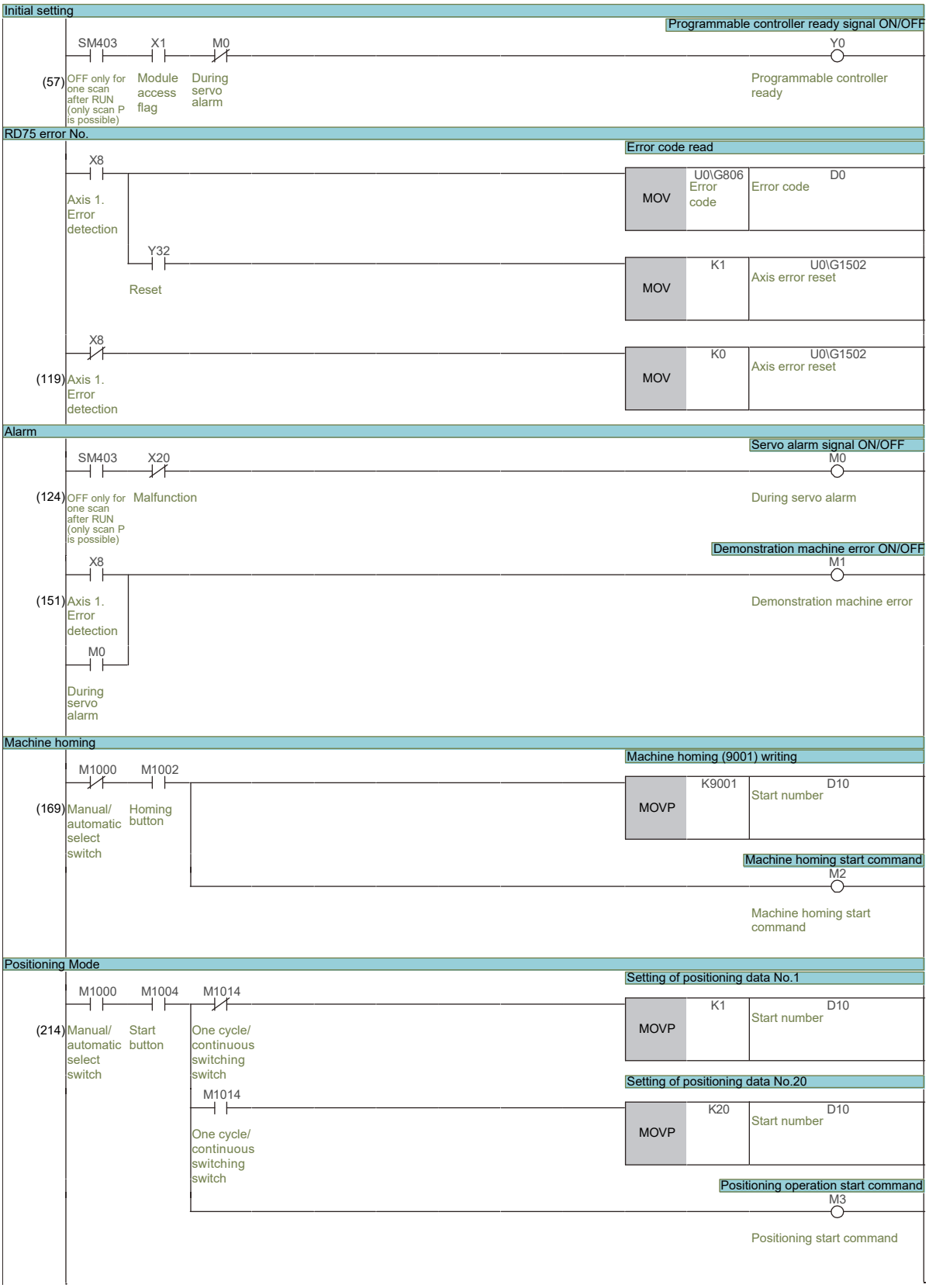
(2) Positioning-data (axis 1)

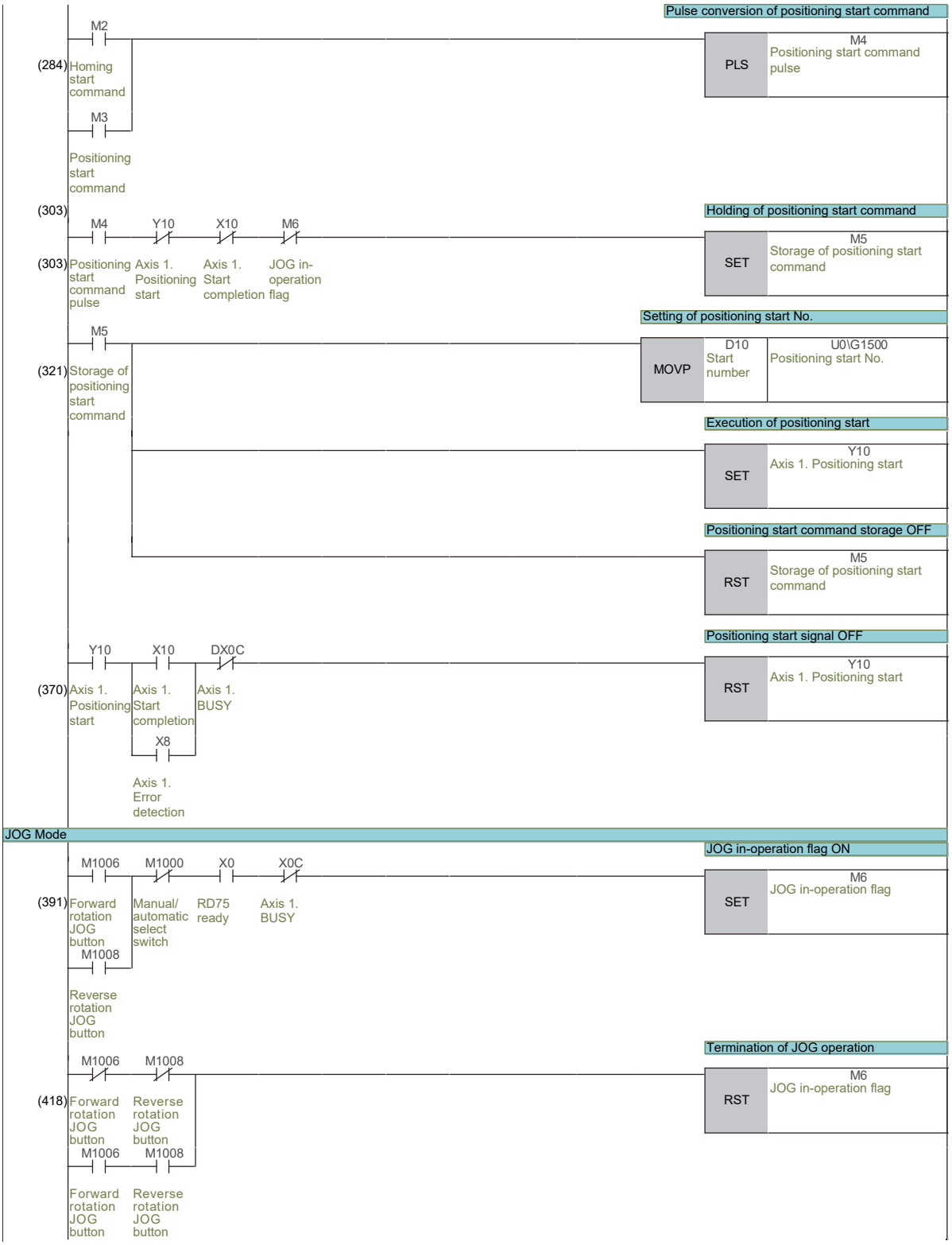
Data No.	Operation pattern	Control method	Acceleration time	Deceleration time	Positioning address	Command speed	Dwell time	M-code
1	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-50000.0	50000.00	500	0
2	1: Continuous	02: INC linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
3	1: Continuous	02: INC linear 1	0: Acceleration time 0	0: Deceleration time 0	-100000.0	100000.00	500	0
4	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
5	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-100000.0	100000.00	500	0
6	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
7	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-50000.0	50000.00	500	0
8	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	150000.0	200000.00	500	0
9	1: Continuous	02: INC linear 1	0: Acceleration time 0	0: Deceleration time 0	-75000.0	100000.00	500	0
10	1: Continuous	02: INC linear 1	0: Acceleration time 0	0: Deceleration time 0	-75000.0	1000.00	1000	0
11	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	75000.0	100000.00	500	0
12	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	75000.0	1000.00	1000	0
13	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-150000.0	200000.00	1000	0
14	0: Exit	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	150000.0	200000.00	2000	0
15								
16								
17								
18								
19								
20	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	0.0	1000.00	0	0
21	0: Exit	83: LOOP	0: Acceleration time 0	0: Deceleration time 0	0.0	0.00	0	65535
22	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-50000.0	50000.00	500	0
23	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
24	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-100000.0	100000.00	500	0
25	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
26	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-100000.0	100000.00	500	0
27	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	50000.0	50000.00	500	0
28	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-50000.0	50000.00	500	0
29	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	150000.0	200000.00	500	0
30	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-75000.0	100000.00	500	0
31	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-75000.0	1000.00	1000	0

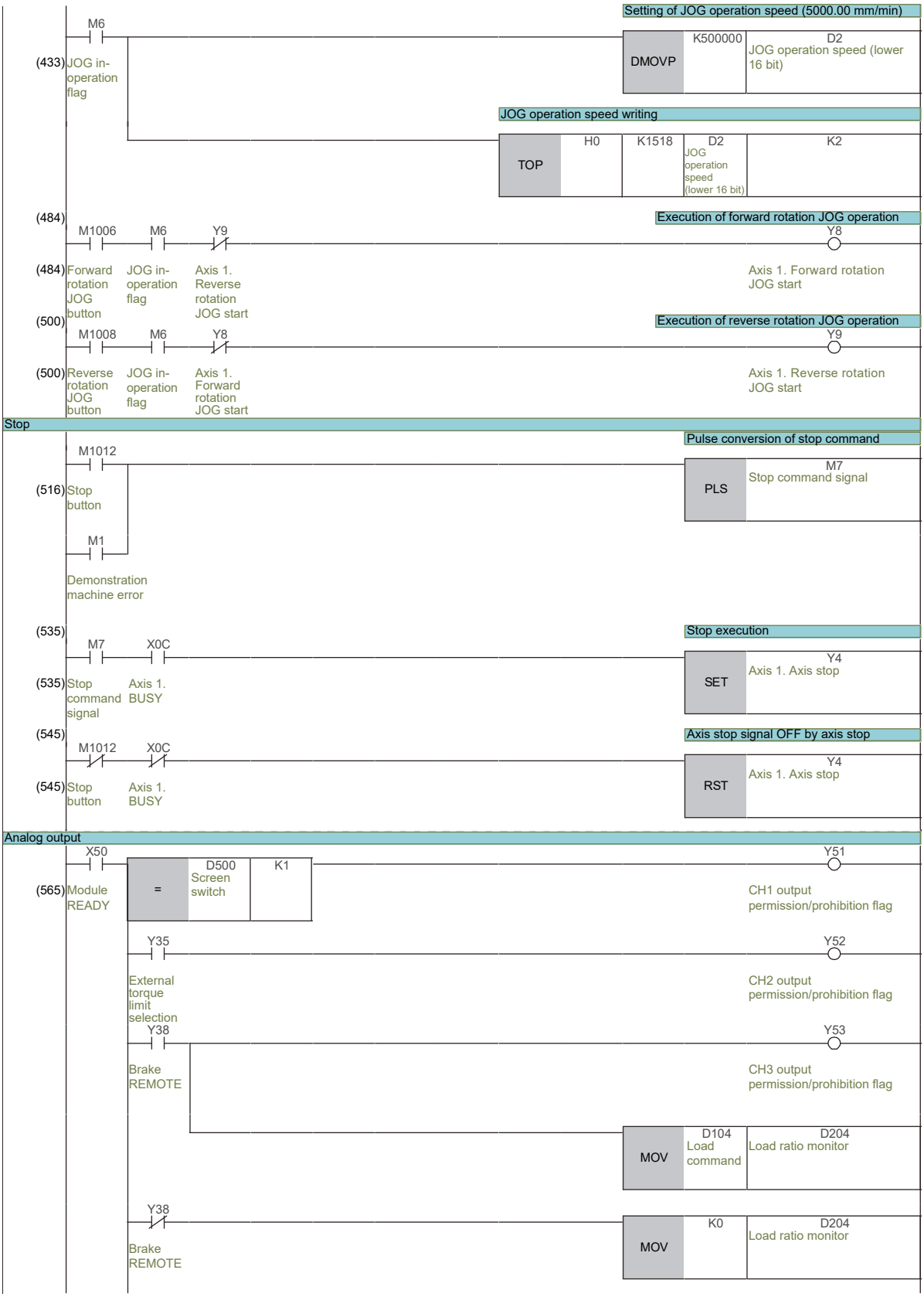
Data No.	Operation pattern	Control method	Acceleration time	Deceleration time	Positioning address	Command speed	Dwell time	M-code
32	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	75000.0	100000.00	500	0
33	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	75000.0	1000.00	1000	0
34	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	-150000.0	200000.00	1000	0
35	1: Continuous	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	150000.0	200000.00	2000	0
36	0: Exit	84: LEND	0: Acceleration time 0	0: Deceleration time 0	0.0	0.00	0	0
37	0: Exit	02: INC Linear 1	0: Acceleration time 0	0: Deceleration time 0	0.0	1000.00	0	0

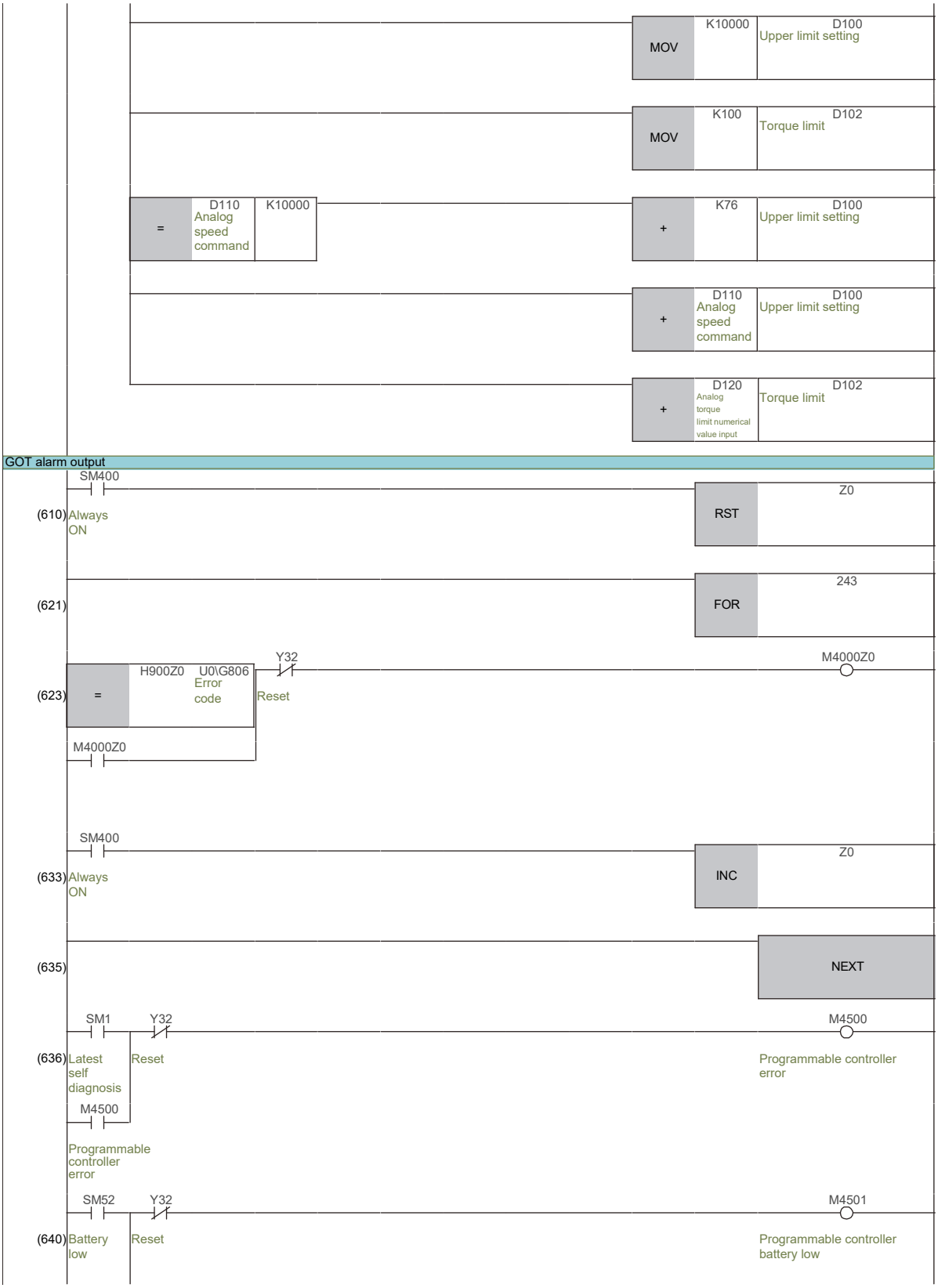
(3) Sequence program

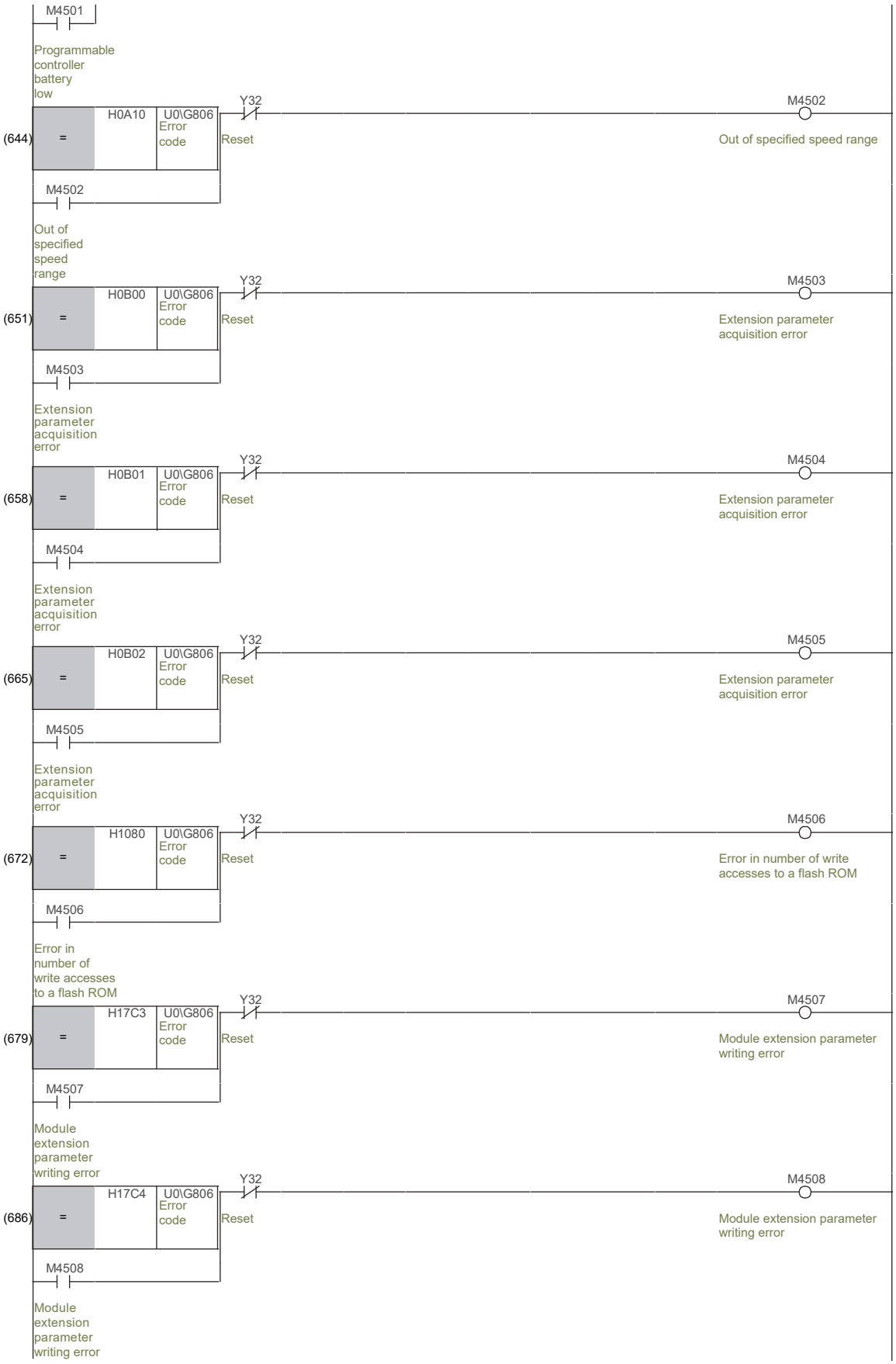


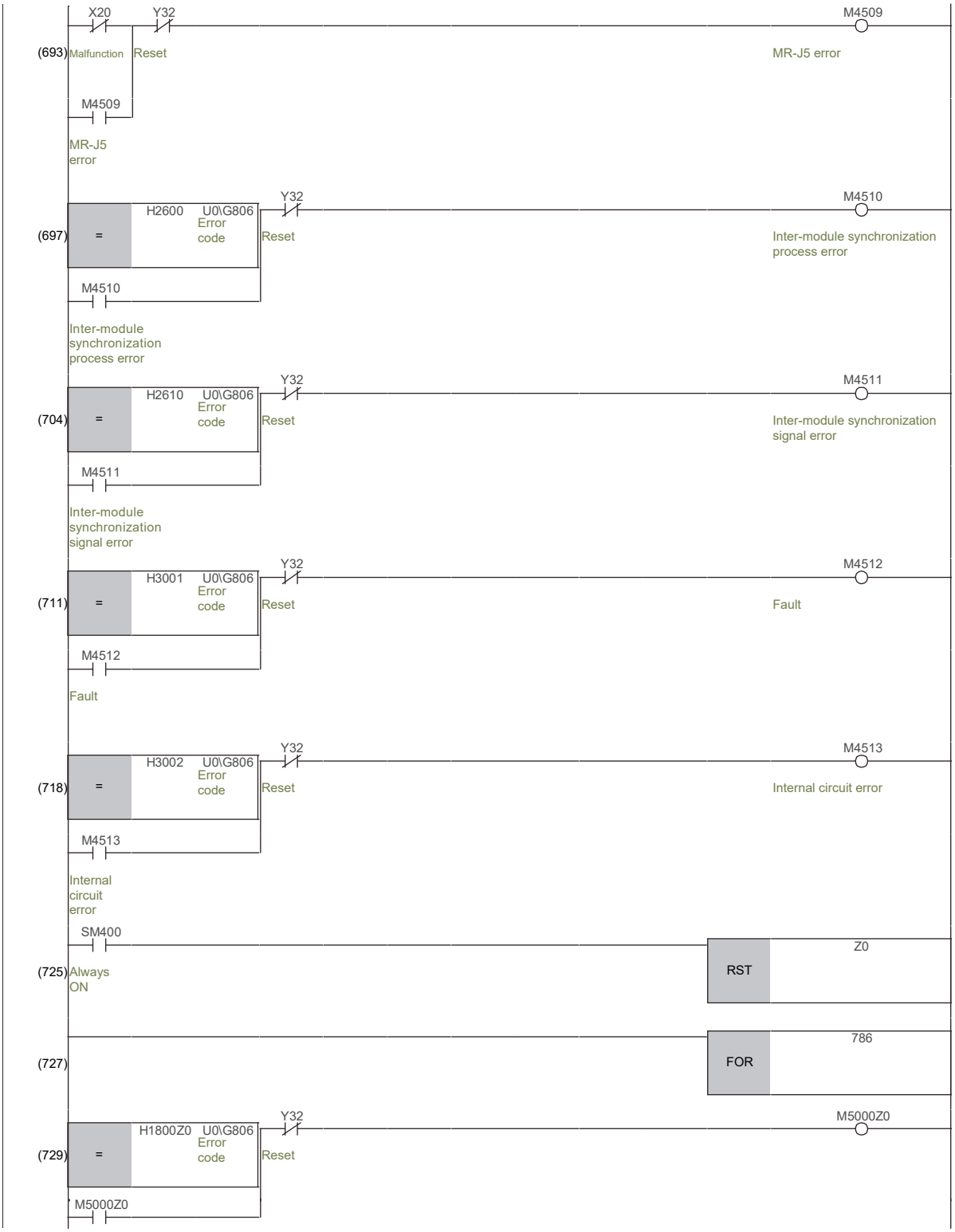

Initial setting
Programmable controller ready signal ON/OFF
SM403
X1
M0
Y0
(57)
OFF only for one scan after RUN (only scan P is possible)
Module access flag
During servo alarm
Programmable controller ready
RD75 error No.
Error code read
X8
MOV
U0\G806
Error code
D0
Axis 1. Error detection
Y32
Reset
K1
U0\G1502
Axis error reset
K0
(119)
Alarm
Servo alarm signal ON/OFF
SM403
X20
M0
(124)
Malfunction
During servo alarm
Demonstration machine error ON/OFF
M1
(151)
Demonstration machine error
During servo alarm
Machine homing
Machine homing (9001) writing
M1000
M1002
MOVP
K9001
D10
Start number
(169)
Manual/ automatic select switch
Homing button
Machine homing start command
M2
Machine homing start command
Positioning Mode
Setting of positioning data No.1
M1004
M1014
K1
(214)
Start button
One cycle/ continuous switching switch
Setting of positioning data No.20
K20
Positioning operation start command
M3
Positioning start command

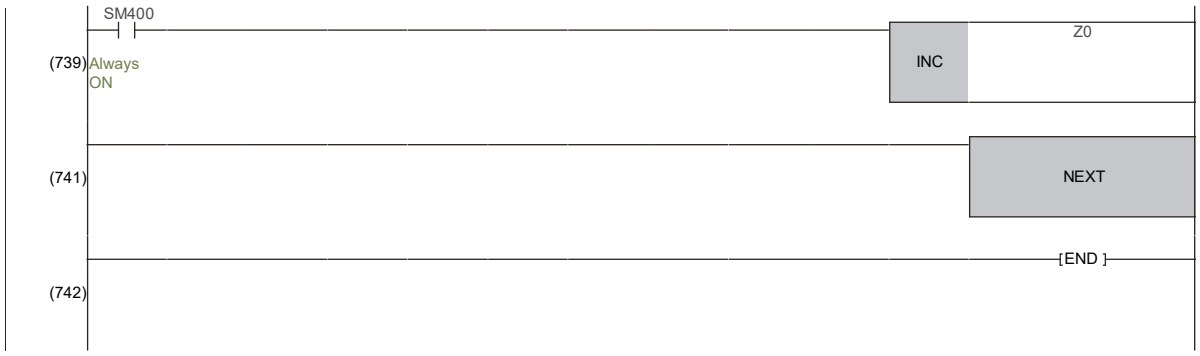

Pulse conversion of positioning start command
M2
(284)
Homing start command
M3
Positioning start command
PLS
M4
Positioning start command pulse
(303)
Holding of positioning start command
M4
Y10
X10
M6
(303)
Positioning start command pulse
Axis 1. Positioning start
Axis 1. Start completion
JOG in-operation flag
SET
M5
Storage of positioning start command
Setting of positioning start No.
M5
(321)
Storage of positioning start command
MOVP
D10
Start number
U0\G1500
Positioning start No.
Execution of positioning start
SET
Y10
Axis 1. Positioning start
Positioning start command storage OFF
RST
M5
Storage of positioning start command
Positioning start signal OFF
Y10
X10
DX0C
(370)
Axis 1. Positioning start
Axis 1. Start completion
Axis 1. BUSY
X8
Axis 1. Error detection
RST
Y10
Axis 1. Positioning start
JOG Mode
JOG in-operation flag ON
M1006
M1000
X0
X0C
(391)
Forward rotation JOG button
Manual/ automatic select switch
RD75 ready
Axis 1. BUSY
M1008
Reverse rotation JOG button
SET
M6
JOG in-operation flag
Termination of JOG operation
M1006
M1008
(418)
Forward rotation JOG button
Reverse rotation JOG button
M1006
M1008
Forward rotation JOG button
Reverse rotation JOG button
RST
M6
JOG in-operation flag


Setting of JOG operation speed (5000.00 mm/min)
M6
(433) JOG in-operation flag
DMOVP
K500000
D2
JOG operation speed (lower 16 bit)
JOG operation speed writing
TOP
H0
K1518
D2
JOG operation speed (lower 16 bit)
K2
(484)
M1006
M6
Y9
Y8
Execution of forward rotation JOG operation
(484) Forward rotation JOG button
JOG in-operation flag
Axis 1. Reverse rotation JOG start
Axis 1. Forward rotation JOG start
(500)
M1008
M6
Y8
Y9
Execution of reverse rotation JOG operation
(500) Reverse rotation JOG button
JOG in-operation flag
Axis 1. Forward rotation JOG start
Axis 1. Reverse rotation JOG start
Stop
M1012
(516) Stop button
M1
Demonstration machine error
Pulse conversion of stop command
PLS
M7
Stop command signal
(535)
M7
X0C
(535) Stop command signal
Axis 1. BUSY
Stop execution
SET
Y4
Axis 1. Axis stop
(545)
M1012
X0C
(545) Stop button
Axis 1. BUSY
Axis stop signal OFF by axis stop
RST
Y4
Axis 1. Axis stop
Analog output
X50
(565) Module READY
=
D500
Screen switch
K1
Y51
CH1 output permission/prohibition flag
Y35
External torque limit selection
Y52
CH2 output permission/prohibition flag
Y38
Brake REMOTE
Y53
CH3 output permission/prohibition flag
MOV
D104
Load command
D204
Load ratio monitor
Y38
Brake REMOTE
MOV
K0
D204
Load ratio monitor


MOV
K10000
D100
Upper limit setting
MOV
K100
D102
Torque limit
=
D110
Analog speed command
K10000
+
K76
D100
Upper limit setting
+
D110
Analog speed command
D100
Upper limit setting
+
D120
Analog torque limit numerical value input
D102
Torque limit
GOT alarm output
SM400
(610)
Always ON
RST
Z0
(621)
FOR
243
(623)
=
H900Z0
U0\G806
Error code
Y32
Reset
M4000Z0
M4000Z0
SM400
(633)
Always ON
INC
Z0
(635)
NEXT
SM1
Y32
M4500
(636)
Latest self diagnosis
Reset
Programmable controller error
M4500
Programmable controller error
SM52
Y32
M4501
(640)
Battery low
Reset
Programmable controller battery low


M4501
Programmable controller battery low
(644)
=
H0A10
U0\G806
Error code
Y32
Reset
M4502
Out of specified speed range
M4502
Out of specified speed range
(651)
=
H0B00
U0\G806
Error code
Y32
Reset
M4503
Extension parameter acquisition error
M4503
Extension parameter acquisition error
(658)
=
H0B01
U0\G806
Error code
Y32
Reset
M4504
Extension parameter acquisition error
M4504
Extension parameter acquisition error
(665)
=
H0B02
U0\G806
Error code
Y32
Reset
M4505
Extension parameter acquisition error
M4505
Extension parameter acquisition error
(672)
=
H1080
U0\G806
Error code
Y32
Reset
M4506
Error in number of write accesses to a flash ROM
M4506
Error in number of write accesses to a flash ROM
(679)
=
H17C3
U0\G806
Error code
Y32
Reset
M4507
Module extension parameter writing error
M4507
Module extension parameter writing error
(686)
=
H17C4
U0\G806
Error code
Y32
Reset
M4508
Module extension parameter writing error
M4508
Module extension parameter writing error


X20
Y32
M4509
(693)
Malfunction
Reset
MR-J5 error
M4509
MR-J5 error
Y32
M4510
H2600
U0\G806
Error code
(697)
=
Reset
Inter-module synchronization process error
M4510
Inter-module synchronization process error
Y32
M4511
H2610
U0\G806
Error code
(704)
=
Reset
Inter-module synchronization signal error
M4511
Inter-module synchronization signal error
Y32
M4512
H3001
U0\G806
Error code
(711)
=
Reset
Fault
M4512
Fault
Y32
M4513
H3002
U0\G806
Error code
(718)
=
Reset
Internal circuit error
M4513
Internal circuit error
SM400
(725)
Always ON
RST
Z0
(727)
FOR
786
Y32
M5000Z0
H1800Z0
U0\G806
Error code
(729)
=
Reset
M5000Z0


SM400
(739)
Always
ON
INC
Z0
(741)
NEXT
[END]
(742)

AC Servo School Text
AC Servo Trouble Shooting Course (MELSERVO-J5)

MODEL	
MODEL CODE	

SH-030389ENG-A (2109) MEE

MITSUBISHI ELECTRIC CORPORATION

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