

# MITSUBISHI

## General Purpose AC SERVO

### MELSERVO-J3 Series

## AC Servo Amplifier MR-J3-□A-RJ158

### EtherCAT Communication Option MR-J3-T04

## – Specifications –

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Made by Takuya Sakaishi

Takuya Sakaishi  
Assistant Manager  
Drive System Standard Development Section  
Drive System Department  
Mitsubishi Electric Co. Nagoya Works

Approved by Kazutaka Takahashi

Kazutaka Takahashi  
Manager  
Drive System Standard Development Section  
Drive System Department  
Mitsubishi Electric Co. Nagoya Works

Revisions		
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*	First edition	2011-12-1 Sakaishi

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## 1. Functions and Configuration

### 1.1. Introduction

MR-J3-□A-RJ158 is an AC servo amplifier based on the MR-J3-□A series, and is compatible with high speed communication through the open network EtherCAT. This product is used with an EtherCAT communication unit MR-J3-T04 attached, and the following control modes are available.

Operation mode	Abbreviation	Explanation	Remark
Cyclic synchronous velocity mode	csv	Speed control mode	Speed control mode with sending slope command to amplifier from controller. (Amplifier does not have slope command generation function.)
Cyclic synchronous position mode	csp	Position control mode	Position control mode with sending slope command to amplifier from controller. Only available to use absolute position data Command. (Amplifier does not have slope command generation function.)
Homing mode	hm	Home position return mode	—

Specifications not described in this document are the same as those of the standard servo amplifier. Refer to the following manual.

- MELSERVO-J3-A Servo Amplifier Instruction Manual

This product is developed and reviewed using a master controller whose configuration is shown in the following table. For the control of this product, please use an EtherCAT master controller compatible to the environment shown below.

Item	Manufacturer	Name, contents, etc.
Master controller PC OS	Microsoft	Windows XP Service Pack 3
Software PLC	Beckhoff Automation GmbH	TwinCAT PLC v2.11.1549
LAN adapter	Beckhoff Automation GmbH	FC9011
Master controller PC CPU	Intel	Core2 Duo 2.4GHz
Master controller PC memory	—	2GB

\* If you would like to use 17 axes or more, please contact to Mitsubishi sales office. (We have confirmed the synchronous operation of the MR-J3-□A-RJ158 with 16 axes connected in the above environment. However, we do not secure the proper operation in all environments satisfying the above conditions. Please select a master controller which satisfies the purpose of use and operate the system.)

## 1.2. Specifications

### 1.2.1. Servo amplifier specifications

#### (1) 200V and 100V class

Servo amplifier MR-J3-□A -RJ158			10A	20A	40A	60A	70A	100A	200A(N)	350A	500A	700A	11KA	15KA	22KA	10A1	20A1	40A1		
Main circuit power supply	Voltage/frequency	3-phase 200 to 230VAC, 50/60Hz Or 1-phase 230VAC, 50/60Hz						3-phase 200 to 230VAC 50/60Hz						1-phase 100 to 120VAC 50/60Hz						
	Permissible voltage fluctuation	For 1-phase 230VAC: 207 to 253VAC For 3-phase 200 to 230VAC: AC170 to 253V170 to 253VAC						3-phase 170 to 253VAC						1-phase 85 to 132VAC						
	Permissible frequency fluctuation	Within ±5%																		
	Power supply capacity	Refer to the section 11.2 of "MR-J3-A Servo Amplifier Instruction Manual"																		
	Inrush current	Refer to the section 11.5 of "MR-J3-A Servo Amplifier Instruction Manual"																		
Control circuit power supply	Voltage/frequency	1-phase 200 to 230VAC, 50/60Hz												1-phase 100 to 120VAC 50/60Hz						
	Permissible voltage fluctuation	1-phase 170 to 253VAC												1-phase 85 to 132VAC						
	Permissible frequency fluctuation	Within ±5%																		
	Input	30W						45W						30W						
	Inrush current	Refer to the section 11.5 of "MR-J3-A Servo Amplifier Instruction Manual"																		
Interface power supply	Voltage/frequency	24VDC±10%																		
	Power supply capacity	300mA (Note 1)																		
Control system	Sine-wave PWM control, current control system																			
Dynamic brake	Built-in						External						Built-in							
Protective functions	Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), servo motor overheat protection, encoder error protection, regenerative error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error																			
Position control mode (csp)	EtherCAT Position cmd.	By absolute position command for target position object																		
	In-position range	0~±65535 pulse																		
	Excessive error range	±3 rotations																		
	Torque limit	Set via Parameters (Parameter No.PA11,PA12,PC35) Or set Positive/Negative torque limit value object																		
Speed control mode (csv)	EtherCAT Speed cmd.	By speed command for Target velocity object. Unit is 0.001r/min (last column is invalid)																		
	Speed fluctuation ratio	±0.01% or less (Load fluctuation 0 to 100%) 0% (Power supply fluctuation ±10%)																		
	Torque limit	Set via Parameters (Parameter No.PA11,PA12,PC35) Or set Positive/Negative torque limit value object																		
Structure	Natural-cooling, open (IP00)						Force-cooling, open (IP00)						Natural-cooling, open (IP00)							
Environment	Ambient temperature	In operation	(Note 2) 0 to 50°C (non freezing)																	
		In storage	-20 to + 65°C (non freezing)																	
	Ambient humidity	In operation	90%RH or less (non condensing)																	
		In storage																		
	Atmosphere	Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt																		
	Elevation	Max. 1000m above sea level																		
Vibration	5.9m/s <sup>2</sup> or less																			
Mass	[kg]	0.8	0.8	1.0	1.0	1.4	1.4	2.3 (2.1)	2.3	4.6	6.2	18.0	18.0	19.0	0.8	0.8	1.0			

Note 1. 300mA is the value applicable when all I/O signals are used. The current capacity can be decreased by reducing the number of I/O points.

2. When closely mounting the servo amplifier of MR-J3-350A or less, operate them at the ambient temperatures of 0 to 45°C or at 75% or smaller effective load ratio.

## (2) 400V class

Servo amplifier MR-J3-□A -RJ158		60A4	100A4	200A4	350A4	500A4	700A4	11KA4	15KA4	22KA4	
Item											
Main circuit power supply	Voltage/frequency	3-phase 380 to 480VAC, 50/60Hz									
	Permissible voltage fluctuation	3-phase 323 to 528VAC									
	Permissible frequency fluctuation	Within ±5%									
	Power supply capacity	Refer to the section 11.2 of "MR-J3-A Servo Amplifier Instruction Manual"									
	Inrush current	Refer to the section 11.5 of "MR-J3-A Servo Amplifier Instruction Manual"									
Control circuit power supply	Voltage/frequency	1-phase 380 to 480VAC, 50/60Hz									
	Permissible voltage fluctuation	1-phase 323 to 528VAC									
	Permissible frequency fluctuation	Within ±5%									
	Input	30W				45W					
	Inrush current	Refer to the section 11.5 of "MR-J3-A Servo Amplifier Instruction Manual"									
Interface power supply	Voltage	24VDC±10%									
	Power supply capacity	(Note) 300mA									
Control system		Sine-wave PWM control, current control system									
Dynamic brake		Built-in						External			
Protective functions		Overcurrent shut-off, regenerative overvoltage shut-off, overload shut-off (electronic thermal relay), servo motor overheat protection, encoder error protection, regenerative error protection, undervoltage, instantaneous power failure protection, overspeed protection, excessive error									
Position control mode (csp)	EtherCAT Position cmd.	By absolute position command for target position object									
	In-position range	0~±65535 pulse									
	Excessive error range	±3 rotations									
	Torque limit	Set via Parameters (Parameter No.PA11,PA12,PC35) Or set Positive/Negative torque limit value object									
Speed control mode (csv)	EtherCAT Speed cmd.	By speed command for Target velocity object. Unit is 0.001r/min (last column is invalid)									
	Speed fluctuation ratio	±0.01% or less (Load fluctuation 0 to 100%) 0% (Power supply fluctuation ±10%)									
	Torque limit	Set via Parameters (Parameter No.PA11,PA12,PC35) Or set Positive/Negative torque limit value object									
Structure		Natural-cooling, open (IP00)			Force-cooling, open (IP00)						
Environment	Ambient temperature	In operation	0 to 55°C (non freezing)								
		In storage	-20 to +65°C (non freezing)								
	Ambient humidity	In operation	90%RH or less (non condensing)								
		In storage									
	Atmosphere		Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt								
	Elevation		Max. 1000m above sea level								
Vibration		5.9m/s <sup>2</sup> or less at 10 to 55Hz (directions of X, Y and Z axes)									
Mass [kg]		1.7	1.7	2.1	4.6	4.6	6.2	18	18	19	

Note. 300mA is the value applicable when all I/O signals are used. The current capacity can be decreased by reducing the number of I/O points.

## 1.2.2. EtherCAT communication (MR-J3-T04) specifications



## (1) MR-J3-T04 specifications

Model			MR-J3-T04		
Input/output			EtherCAT I/F		
Structure			Natural-cooling, open (IP00)		
Environment	Ambient temperature	In operation	0 to 55°C (non freezing)		
		In storage	-20 to +65°C (non freezing)		
	Ambient humidity	In operation	90%RH or less (non condensing)		
		In storage			
	Atmosphere		Indoors (no direct sunlight) Free from corrosive gas, flammable gas, oil mist, dust and dirt		
	Elevation		Max. 1000m above sea level		
Vibration		5.9 [m/s <sup>2</sup> ] or less at 10 to 55Hz (directions of X, Y and Z axes)			
Mass [g]		150g			

### 1.2.3. Handling of MR-J3-200A(N)-RJ158

In addition to the connecting method with screws, alternative connector parts with springs are available. Wires can be easily connected with the connection lever etc. enclosed with the product.

Differences of specifications between MR-J3-200A-RJ158 and MR-J3-200AN-RJ158

Model	MR-J3-200A-RJ158	MR-J3-200AN-RJ158
Outline	Refer to the outline drawing	Refer to the outline drawing
Connector (Enclosed)	Connector for CNP1: PC4/6-STF-7.62-CRWH (Plug) produced by Phoenix Contact Connector for CNP2: 54927-0510 (Plug) produced by molex Connector for CNP3: PC4/3-STF-7.62-CRWH (Plug) produced by Phoenix Contact	Connector for CNP1: 721-207/026-000 (Plug) produced by WAGO Company of Japan Connector for CNP2: 721-205/026-000 (Plug) produced by WAGO Company of Japan Connector for CNP3: 721-203/026-000 (Plug) produced by WAGO Company of Japan
Wiring connection and fixing method	Connector for CNP1, CNP3: Screw fixing Connector for CNP2: Spring fixing	Connector for CNP1 to CNP3: Spring fixing
Mass	2.3kg	2.1kg
Changing earth mark		

### 1.3. Function list

Function	Description	Control mode	Reference
Position control mode	Used as a position control servo operated by EtherCAT command.	P	Section 8.4.2.2
Speed control mode	Used as a speed control servo operated by EtherCAT command.	S	Section 8.4.2.1
Home position return methods	As Homing mode, Proximity Dog type and data set type home position return are available. Data set type home position return is controlled by C_CR and C_CR2 bits of Controlword2 in the speed control mode(CSV) or position control mode(CSP).	H•P•S	Section 8.11.4 Section 8.11.5 Section 8.11.6
High-resolution encoder	The same as standard J3A. High resolution encoder of 262144pulse/rev is used.	H•P•S	
Absolute position detection system	Once you set the origin, you need not do so every time the power turns on.	H•P•S	
Gain switching function	Available by C_CDP bit of Controlword2.	H•P•S	
Advanced vibration suppression control	The same as standard J3A.	P	MR-J3-□A Servo Amplifier Instruction Manual section 8.4
Adaptive filter II	The same as standard J3A.	H•P	MR-J3-□A Servo Amplifier Instruction Manual section 8.2
Low-pass filter	The same as standard J3A.	H•P•S	MR-J3-□A Servo Amplifier Instruction Manual section 8.5
Machine analyzer function	The same as standard J3A.	H•P	
Machine simulation	The same as standard J3A.	H•P	
Gain search function	The same as standard J3A.	H•P	
Robust disturbance compensation	The same as standard J3A.	H•P•S	
Advanced Gain search	The same as standard J3A.	H•P	
Slight vibration suppression control	The same as standard J3A.	H•P	Parameter No. PB24
Auto tuning	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL chapter 7

S-pattern acceleration/deceleration time constant	Acceleration/deceleration time constant is invalid during ordinary operation. When MSTOP, LSP, or LSN is operated, a slow stop occurs according to the time constant.	S	Parameter No. PC03
Regenerative option	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 12.2
Brake unit	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 12.3
Return converter	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 12.4
Alarm history clear	Can be clear by following. •Parameter No. PC18. •Setup software. •The alarm history can be deleted by EtherCAT communication (Clear alarm history object).	H•P•S	Parameter No. PC18 8.9 Alarm object
Input signal selection (Device settings)	LSP and LSN input devices can be assigned to certain pins of the CN1 connectors.	H•P•S	Parameter No. PD03 to 08, PD10 to 12
Output signal selection (Device settings)	Trouble (ALM) and electromagnetic brake interlock (MBR) output devices can be assigned to certain pins of the CN1 connectors.	H•P•S	Parameter No. PD13 to 16, PD18
Torque limit	Torque limit value can be set by parameter No. PA11. PA12, PC35 and via EtherCAT communication. Analog torque limit is not supported.	H•P•S	8.14
Status display	Initialized status at startup is shown on the 7-segment LED display. Other 7-segment LED outputs are the same as standard J3A. However, analog speed command voltage and analog torque command voltage are not displayed.	H•P•S	4.2, chapter 6 and MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 6.3
External I/O signal display	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 6.7
Output signal (DO) forced output	The same as standard J3A.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 6.8
Test operation mode	JOG operation, positioning operation and machine analyzer operation are the same as standard J3A. Self-diagnostics function of amplifier is not available.	H•P•S	MR-J3-□A SERVO AMPLIFIER INSTRUCTION MANUAL section 6.9
Analog monitor output	The same as standard J3A.	H•P•S	Parameter No. PC14
MR Configurator (setup software)	Parameter setting, test operation, status display, etc. can be done with a personal computer. * For restrictions, refer to section 9.1.	H•P•S	9.1

※Control modeH: Homing mode(hm) P:Position control mode (csp) S:Speed control mode (csv)

1.4. Model code definition

1.4.1. Servo amplifier

(1) Rating plate

(2) Model code

Special numbers are added after the servo amplifier model.

**MR - J3 - □ A(N)□ - RJ158**

Series name

Indicates that the servo amplifier meets this specification.

Power supply

Symbol	Power supply
None	3-phase or 1-phase 200 to 230VAC
1	1-phase 100 to 120VAC
4	3-phase 380 to 480VAC

Indicates that the servo amplifier is based on the general purpose interface model.

Rated output

Symbol	Rated output [kw]
10	0.1
20	0.2
40	0.4
60	0.6
70	0.75
100	1
200	2
350	3.5
500	5
700	7
11K	11
15K	15
22K	22

(3) Software version

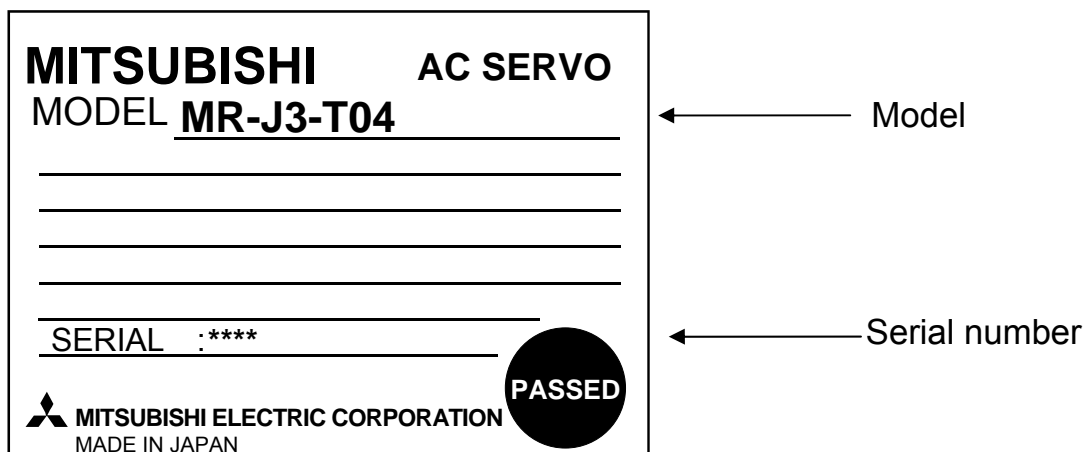
**BCD - B35W051 - A1**

↑  
Indicates that amplifier is available for Cyclic synchronous velocity mode, Cyclic synchronous position mode and Homing mode.



## 1.4.2. EtherCAT communication unit

### (1) Rating plate



### (2) Model code

The model code of an EtherCAT communication unit attached to MR-J3-□A-RJ158 to be used is defined as follows.

**MR - J3 - T04**

Series name

Indicates that the EtherCAT communication unit meets this specification.

## 1.5. Combination with servo motor

This amplifier can use the MR-J3-□A corresponding motors which have encoder with resolution of 262,144[pulse] or 131,072[pulse].



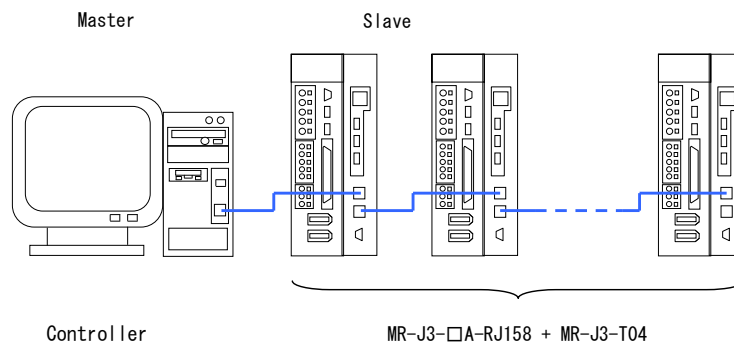
## 1.7. EtherCAT communication specifications

Item	Description	Remarks
EtherCAT communication specifications	CAN application layer over EtherCAT (CoE)	
Application communication specifications	IEC61800-7 CiA402 Drive Profile	Compatible with cyclic synchronous velocity mode (csv)
Physical layer	100BASE-TX	
Communication connector	RJ45: 2 ports (Connector CN10A=IN, CN10B=OUT)	
Communication cable	CAT5e STP 4 pairs straight type	Double-shielded cable is recommended.
Network topology	Line connection	
Communication speed	100Mbps (full duplex)	
Transmission distance between stations	Max. 50m	Total cable length: 100m or less
Number of nodes	Depending on master controller specifications	[*]
SDO communication	Asynchronous (responding within 20ms) Receive: 1 channel Send: 1channel	Not accessible to two or more objects at the same time.
PDO communication	Cycle time : 0.5ms,1ms,2ms (selectable) Receive (RxPDO) 1channel Transmit (TxPDO) 1channel	Data size at default mapping RxPDO 30Bytes TxPDO 26Bytes
PDO Mapping	Variable mapping possible	RxPDO, TxPDO size: maximum 30Bytes
Distribute clock (DC)	Selectable from DC or Free-run mode. (Free-run mode is available only for the test connection.)	DC mode uses the following synchronous setting. Sync0 cycle: Same as PDO communication cycle (0.5ms, 1ms or 2ms). Sync1 cycle: 8ms
EtherCAT secondary address	Not available	Available only for automatic address setting
LED display	LINK/Activity, RUN	
Emergency notification	Emergency notification via PDO communication	When an alarm occurs, Bit 3 (Fault) in the statusword is switched to High.

[\*]The maximum number of nodes specified in the EtherCAT standards is 65535. This product has no restrictions on the number of nodes, other than that in the EtherCAT standards. However, use this product within the range which satisfies the PDO communication timing, indicated in the section 8.2.3. If you would like to use 17 axis or more, please contact to Mitsubishi sales office. (We have conducted connection tests with max 16 axes at our place.)

## 1.8. Example of EtherCAT system configuration

Connect the communication cables as follows.



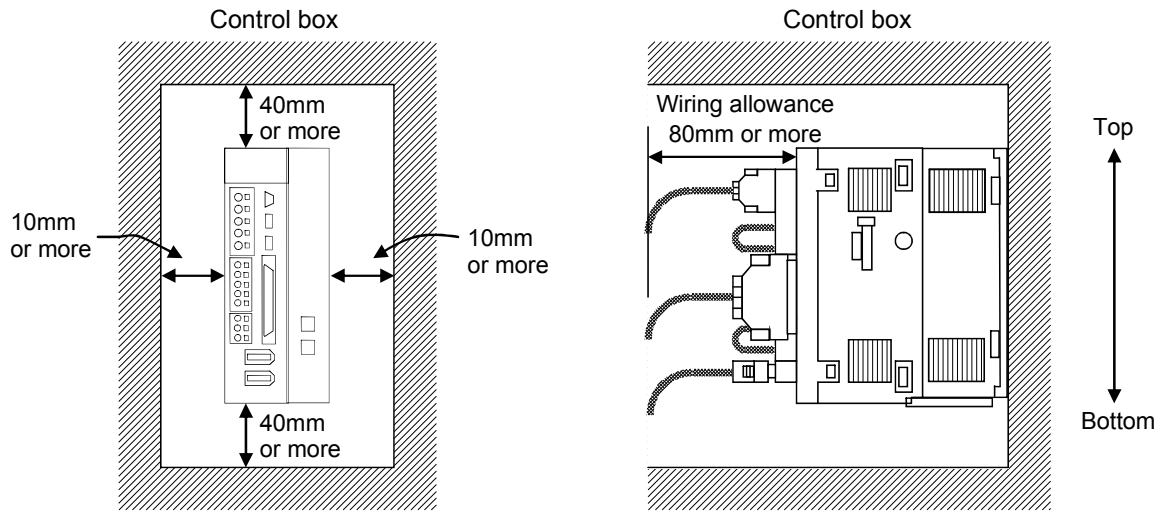
\* Connect in a line topology.

## 2. Installation

### 2.1. Installation direction and space

Leave specified space between the servo amplifier and internal surface of the control box or other equipment. Otherwise, malfunction may occur. Refer to cautions mentioned in "MR-J3-□A Servo Amplifier Instruction Manual" for installing the servo amplifier and EtherCAT communication unit in the control box.

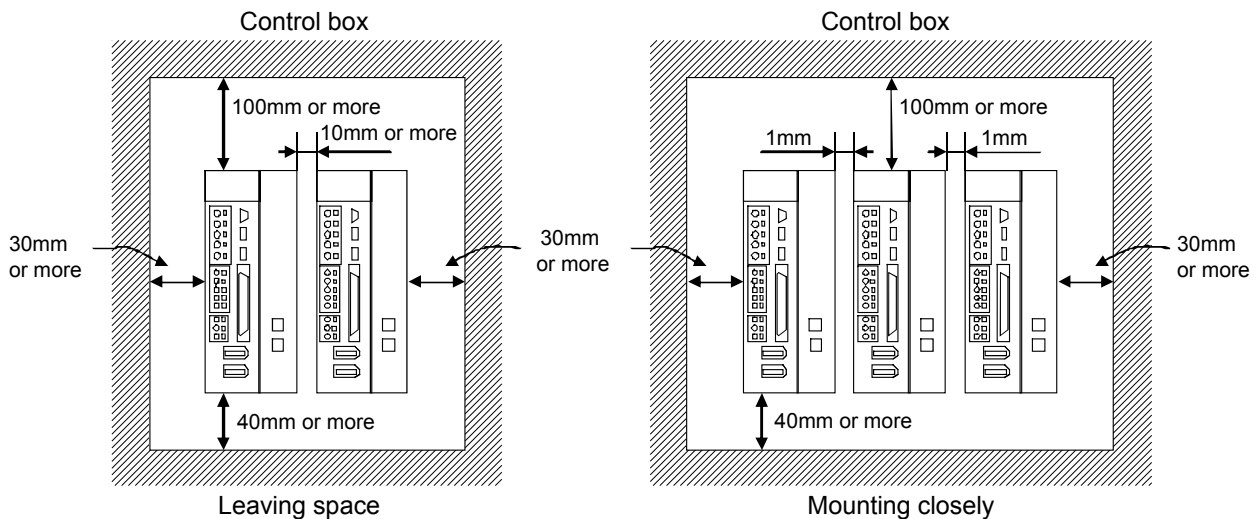
#### (1) Installation of one servo amplifier



#### (2) Installation of two or more servo amplifiers

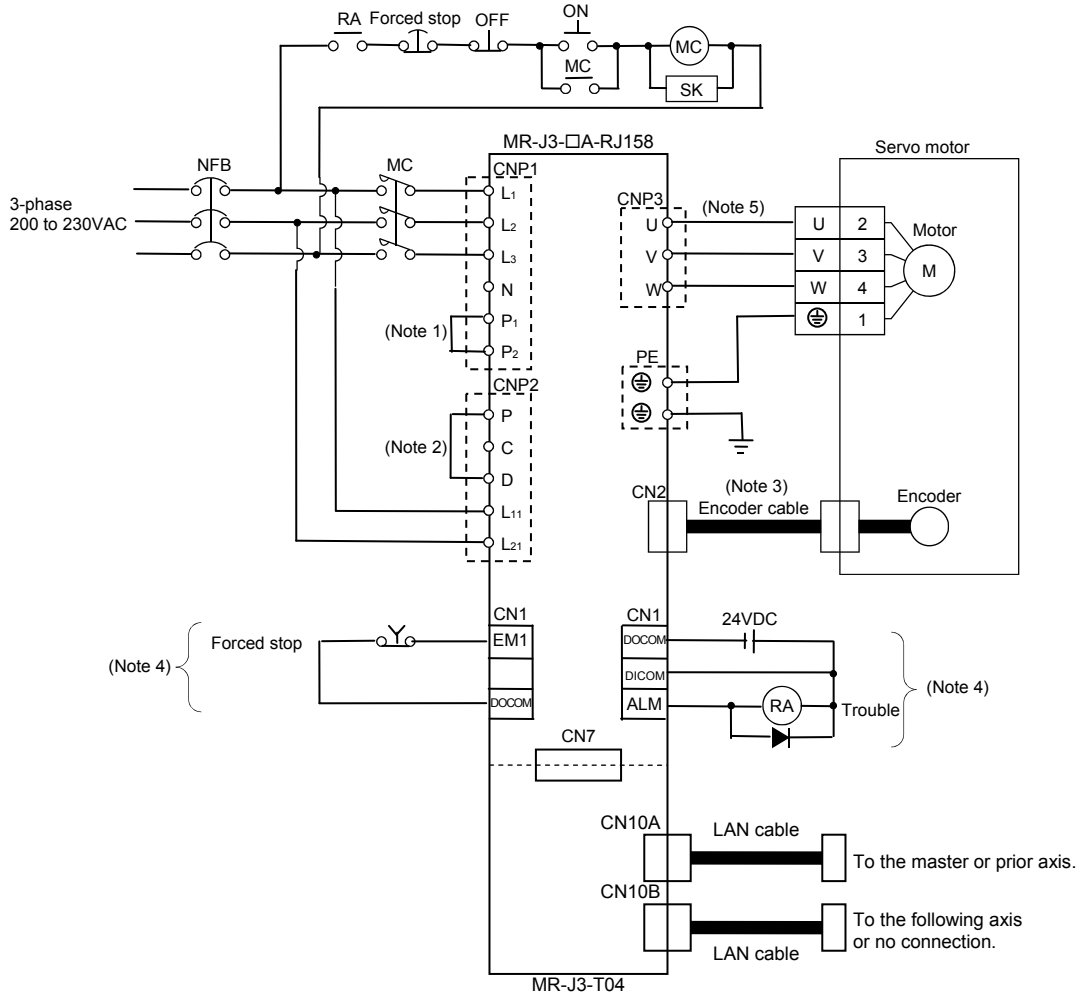
Leave large space between the top of the servo amplifier and the internal surface of the control box, and install a cooling fan to prevent the internal temperature of the control box from exceeding the environmental conditions.

When installing the servo amplifiers closely, leave space of 1mm between the adjacent servo amplifiers in consideration of mounting tolerances. In this case, operate the servo amplifiers at the ambient temperature of 0 to 45°C or at 75% or smaller effective load ratio.



### 3. Signals and Wiring

#### 3.1. Recommended connection of the input power supply circuit



\* The references in the following notes 1 to 4 indicate the corresponding section in "MR-J3-A Servo Amplifier Instruction Manual".

Note 1. Always connect P1 and P2. (Factory-wired) For using power factor improving DC reactors, refer to section 12.10.

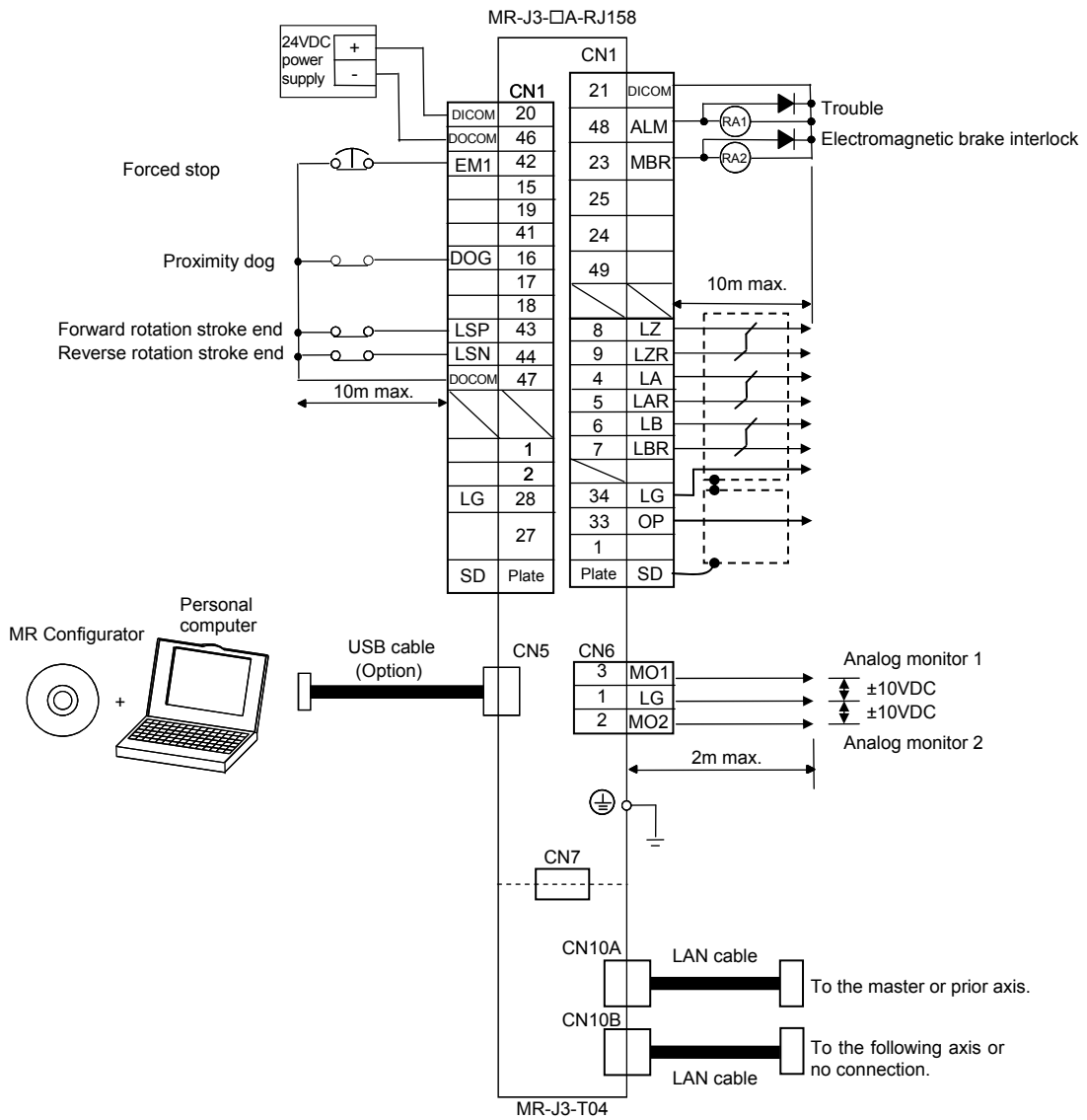
Note 2. Always connect P and D. (Factory-wired.) For using regenerative option, refer to section 12.2.

Note 3. For encoder cable, use of the option cable is recommended. For selecting a cable, refer to section 12.1.

Note 4. This diagram is for sink I/O interface. For the source I/O interface, refer to section 3.8.3.

Note 5. Refer to section 3.10 of "MR-J3-□A Servo Amplifier Instruction Manual".

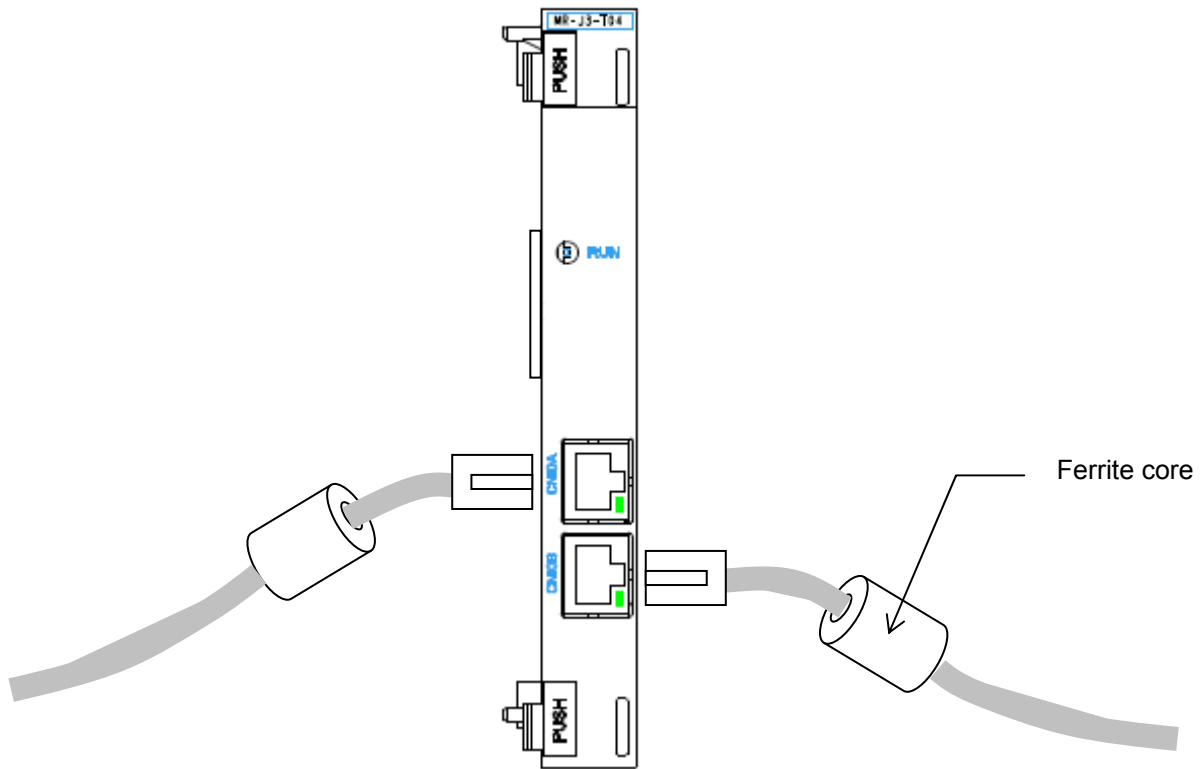
### 3.2. I/O signal connection example



- \* On this product, all DI signals other than EM1, LSP and LSN are invalid.
- \* The input of ST1 (forward rotation start) and ST2 (reverse rotation start) signals of standard J3A is not required.
- \* When using the electromagnetic brake interlock (MBR) with CN1-pin 23, set "0001h" to parameter No. PA04 or "0005h" to parameter No. PD14.
- \* The Length of the LAN cable between stations must be 50m or less, and the total length must be 100m or less.

### 3.3. Mounting ferrite core

As the following figure shows, mount the supplied ferrite core to the EtherCAT cable connected to CN10A and CN10B of MR-J3-T04 within 100mm from each connector. Fix the cable not to stress the connector by the weight of the ferrite core with vibration.



### 3.4. Cable clamp

Clamp the EtherCAT cable inside the control box within about 1m from the servo amplifier. For clamping the cable, attach an earth plate to the control box, peel a part of the cable sheath to expose the external conductor as shown in the next figure, and press that part against the earth plate with the cable clamp. If the cable is thin, clamp several cables in a bunch.

The clamp comes as a set with the earth plate.

#### (c) Cable clamp fitting (AERSBAN-□SET)

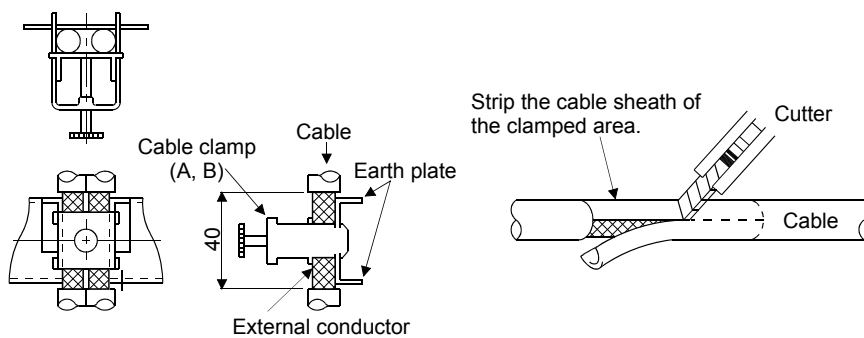
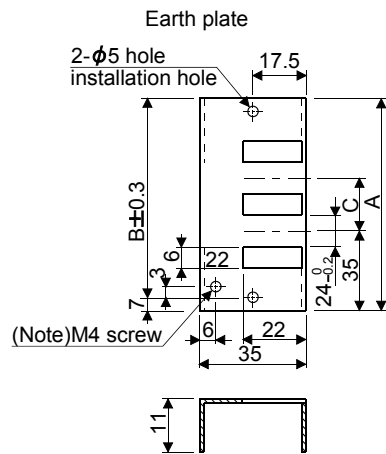


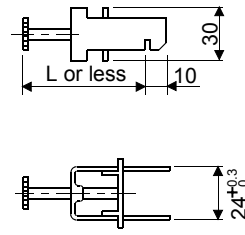
Figure of clamp parts

• Outline drawing

[Unit: mm]



Clamp section diagram



Note. Screw hole for grounding. Connect it to the earth plate of the control box.

Model	A	B	C	Accessory fittings
AERSBAN-DSET	100	86	30	Clamp A: 2pcs.
AERSBAN-ESET	70	56		Clamp B: 1pc.

Clamp fitting	L
A	70
B	45



### 3.5. Outline drawing

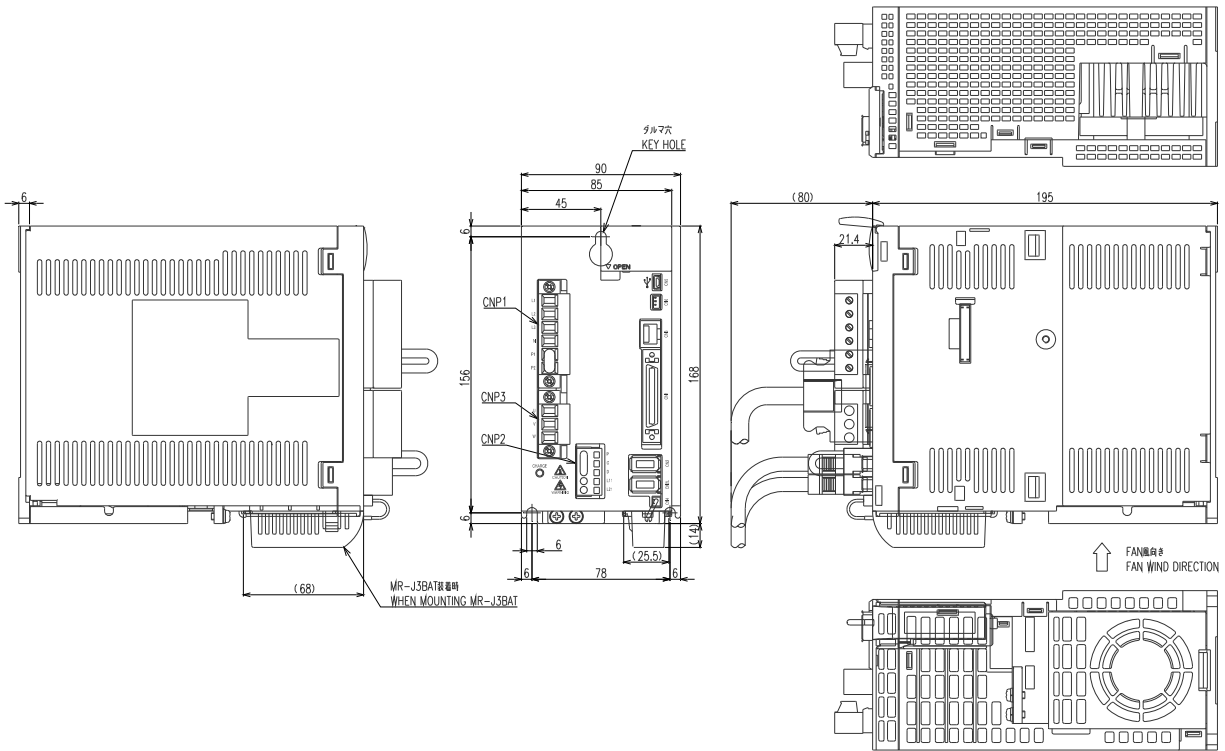
#### 3.5.1. Outline dimensions of servo amplifier (MR-J3-□A-RJ158)

Outline dimensions of this servo amplifier are the same as MR-J3-□A-RJ□.

For 2kW servo amplifiers, their front view, connectors and weight varies according to the model.

##### (1) MR-J3-200A-RJ158

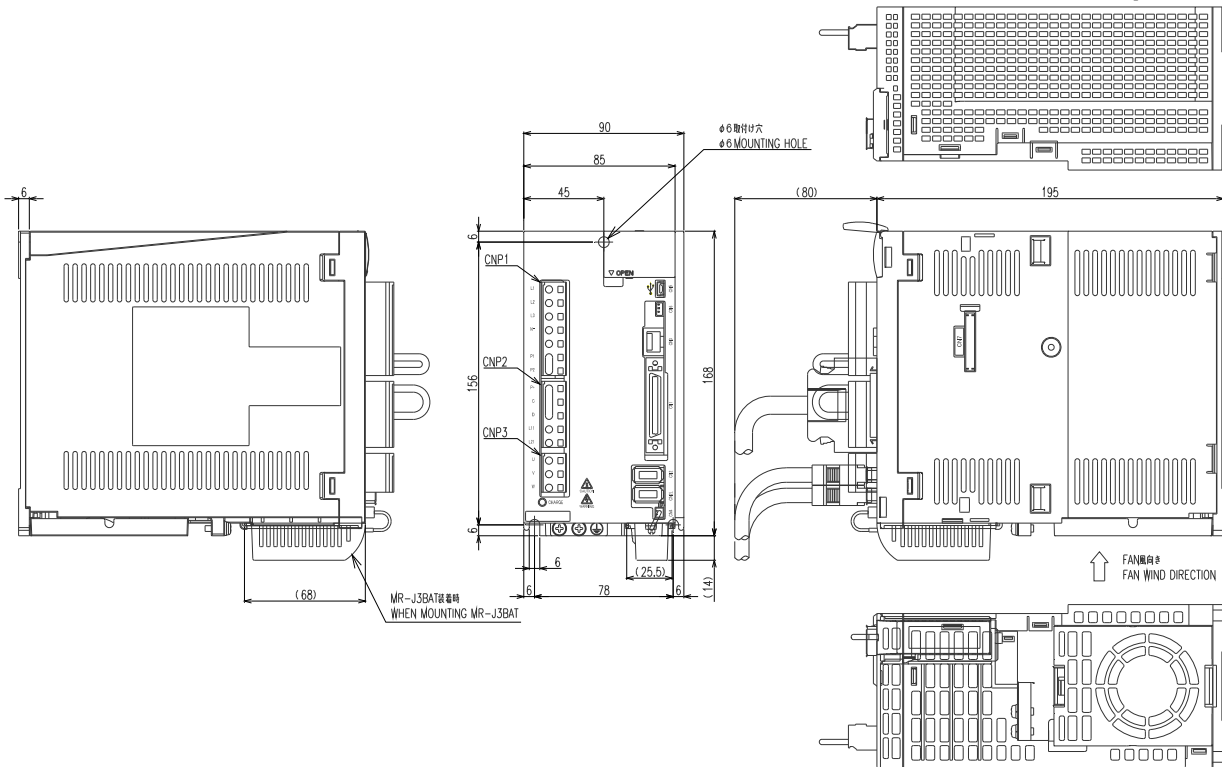
[Unit: mm]



Mass: 2.3[kg]

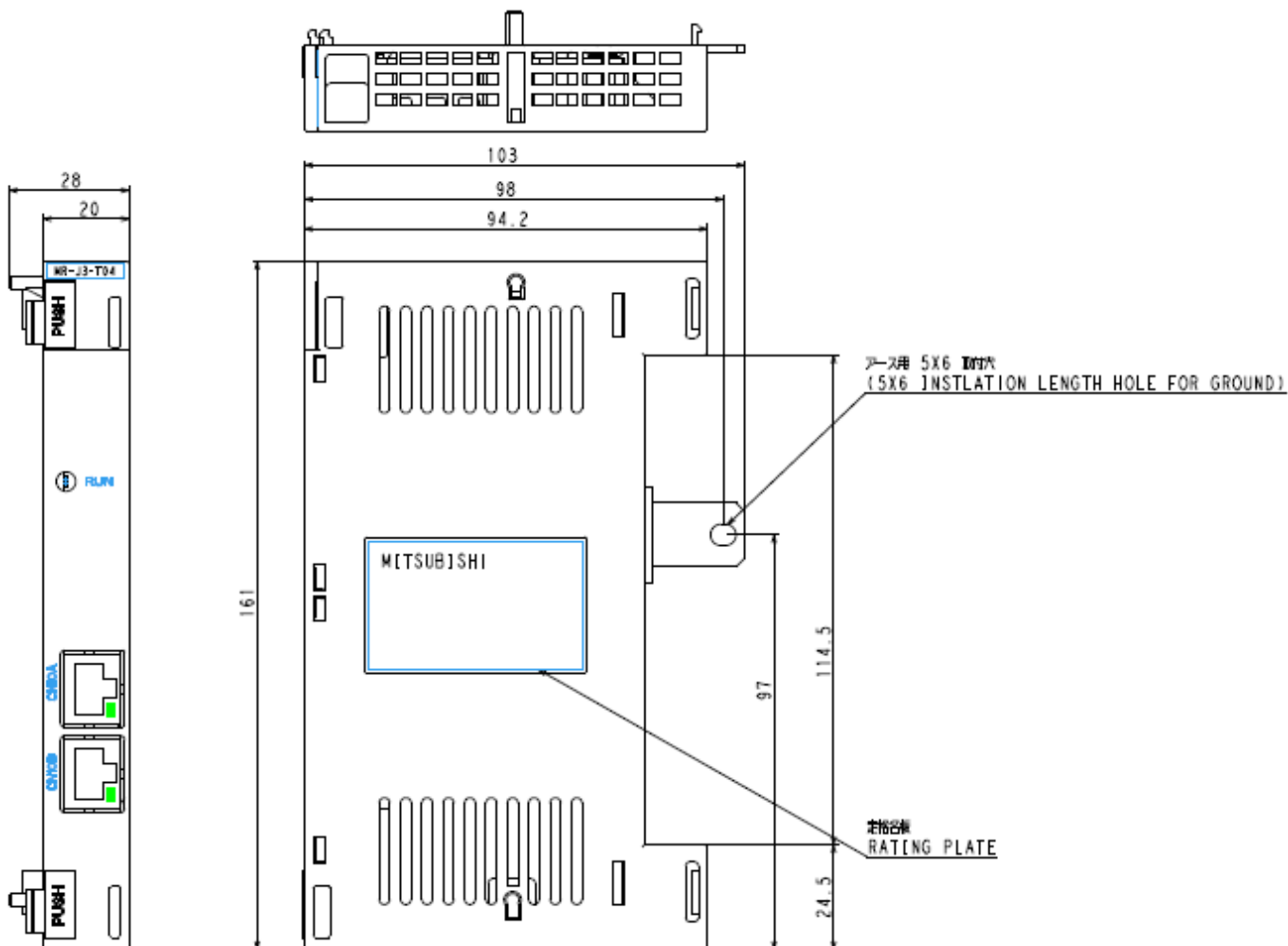
##### (2) MR-J3-200AN-RJ158

[Unit: mm]



Mass: 2.1[kg]

### 3.5.2. Outline dimensions of EtherCAT communication unit (MR-J3-T04)



### Dimensions after installing the optional unit

As the optional unit is added, the amplifier width increases.

Servo amplifier model	Servo amplifier size comparison		
	Before installation	After installation	Increased width
MR-J3-10A/20A-RJ158	40×168×135	<b>60</b> ×168×135	+20mm
MR-J3-40A/60A-RJ158	40×168×170	<b>60</b> ×168×170	+20mm
MR-J3-70A/100A-RJ158	60×168×185	<b>80</b> ×168×185	+20mm
MR-J3-200A/350A-RJ158	90×168×195	<b>105</b> ×168×195	+15mm
MR-J3-500A-RJ158	130×250×200	<b>140</b> ×250×200	+10mm
MR-J3-700A-RJ158	172×300×200	<b>182</b> ×300×200	+10mm
MR-J3-11 to 22KA-RJ158	260×400×260	260×400×260	±0mm
MR-J3-10A1/20A1-RJ158	40×168×135	<b>60</b> ×168×135	+20mm
MR-J3-40A1-RJ158	40×168×170	<b>60</b> ×168×170	+20mm
MR-J3-60A4/100A4-RJ158	60×168×195	<b>80</b> ×168×195	+20mm
MR-J3-200A4-RJ158	90×168×195	<b>105</b> ×168×195	+15mm
MR-J3-350A4/500A4-RJ158	130×250×200	<b>140</b> ×250×200	+10mm
MR-J3-700A4-RJ158	172×300×200	<b>182</b> ×300×200	+10mm
MR-J3-11KA4 to 22KA4-RJ158	260×400×260	260×400×260	±0mm

\* Size comparison (Width [mm] × Height [mm] × Depth [mm])

### 3.6. Input/output compatibility for each unit

Compatible functions for MR-J3-□A-RJ158 + MR-J3-T04 are as follows.

Unit		Compatible functions	J3-□A-RJ158 + MR-J3-T04
EtherCAT communication unit (J3-T04)		Operation start command (controlword)	○
		Position/speed command (Target position / velocity)	○
		Alarm reset (Fault Reset)	○
		Status monitor (CoE SDO Server)	○
		Reading parameter (CoE SDO Server)	○
		Writing parameter (CoE SDO Server)	○ (*1)
Servo amplifier (J3A-RJ158)	DIO/analog input	Forced stop (EM1)	○
		Forward/reverse stroke end (LSP, LSN)	○
		Proximity dog (DOG)	○
	USB/serial (*2)	Monitor	○
		Reading parameter	○
		Writing parameter	○

\*1 Parameter writing via EtherCAT is generally RAM writing. (Change becomes invalid when the power supply is turned OFF.)

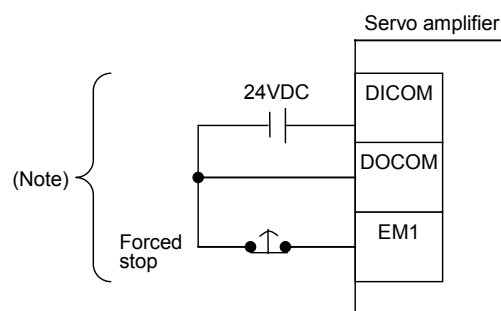
To write parameters into the non-volatile memory (EEPROM), execute it with SDO communication command, using Store Parameter (Index 1010h) (Refer to section 8.10).

\*2 Use of RS422 serial communication is prohibited.

### 3.7. Forced stop

Configure a circuit that shuts off main circuit power as soon as the forced stop input (EM1) is turned OFF. When EM1 is turned OFF, the dynamic brake is operated to bring the servo motor to a sudden stop. At this time, the display shows the servo emergency stop warning (AL.E6). During ordinary operation, do not use the forced stop (EM1) to alternate stop and run. The servo amplifier life may be shortened.

The operation command continues the communication via EtherCAT during the forced stop, and the servo motor will rotate as soon as the forced stop is reset. Therefore, the stop command should be provided during the forced stop for safety. (Enter 0 to the command speed in the speed control mode. On the other hand, in the position control mode, enter the actual position value to the target position.)



Note: For the sink I/O interface. For the source I/O interface, refer to "MR-J3-□A Servo Amplifier Instruction Manual".

### 3.8. Signal arrangements

#### (1) CN1 signal assignment

I/O terminals other than those described below are not available. Do not connect them.

Pin No.	I/O (Note 1)	I/O signals in control modes (Note 2)	
		H·P	S
1			
2			
3		LG	LG
4	O	LA	LA
5	O	LAR	LAR
6	O	LB	LB
7	O	LBR	LBR
8	O	LZ	LZ
9	O	LZR	LZR
10			
11			
12			
13			
14			
15			
16	I	DOG	
17			
18			
19			
20		DICOM	DICOM
21		DICOM	DICOM
22			
23	O	ZSP	ZSP
24			
25			
26			
27			
28		LG	LG
29			
30		LG	LG
31			
32			
33	O	OP	OP
34		LG	LG
35			
36			
37			
38			
39			
40			
41			
42	I	EM1	EM1
43	I	LSP	LSP
44	I	LSN	LSN
45			
46		DOCOM	DOCOM
47		DOCOM	DOCOM
48	O	ALM	ALM
49			
50			

Note 1: I: Input signal 0: Output signal

Note 2: H: Homing mode (hm), P: Position control mode (csp), S: Speed control mode (csv)

(2) Explanation of abbreviations

Those are the same as standard MR-J3-□A except the EM1 and DOG as shown below.

Abbrev.	Signal name
EM1	Forced stop
DOG	Proximity dog

3.9. Signal (device) explanations

(1) Input/output devices

(a) Input devices

All input devices other than EM1, LSP and LSN are invalid. Do not connect them.

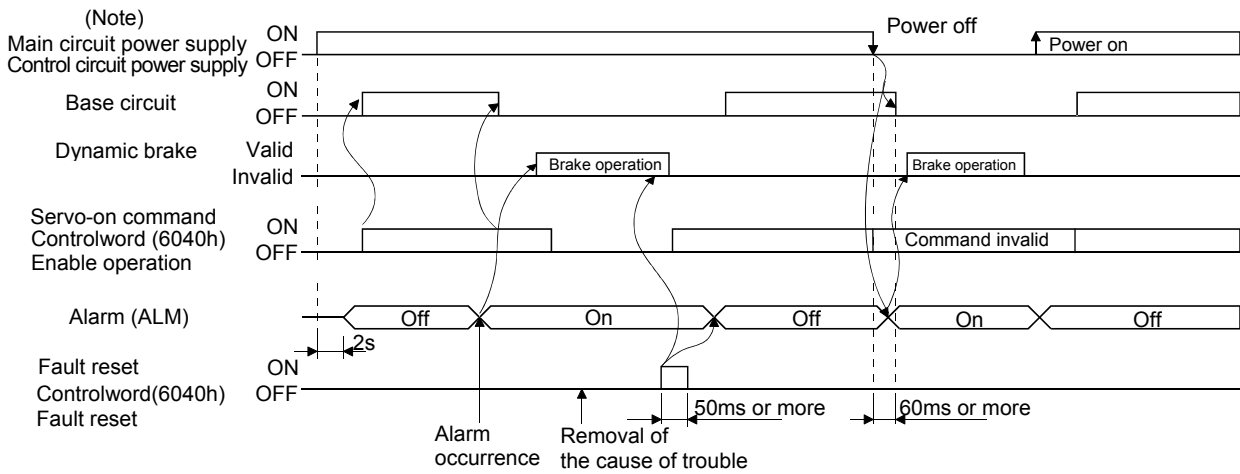
Device	Symbol	Connector pin No.	Function/Applications	I/O division	Control mode																																	
					H·P	S																																
Forward rotation stroke end	LSP	CN1-43	To start operation, turn LSP/LSN ON. If it is turned OFF, a slow stop occurs according to the time constant specified in parameter No. PC02.	DI-1	○	○																																
Reverse rotation stroke end	LSN	CN1-44	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">(Note) Input signal</th> <th colspan="2">Operation</th> </tr> <tr> <th>LSP</th> <th>LSN</th> <th>Counterclockwise direction</th> <th>Clockwise direction</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>1</td> <td style="text-align: center;">○</td> <td style="text-align: center;">○</td> </tr> <tr> <td>0</td> <td>1</td> <td style="text-align: center;">/</td> <td style="text-align: center;">○</td> </tr> <tr> <td>1</td> <td>0</td> <td style="text-align: center;">○</td> <td style="text-align: center;">/</td> </tr> <tr> <td>0</td> <td>0</td> <td style="text-align: center;">/</td> <td style="text-align: center;">/</td> </tr> </tbody> </table> <p>Note. 0: OFF 1: ON</p> <p>Set parameter No. PD01 as indicated below to switch ON the signals (keep terminals connected) automatically in the servo amplifier.</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Parameter No. PD01</th> <th>Auto ON</th> </tr> </thead> <tbody> <tr> <td>□4□□</td> <td>LSP</td> </tr> <tr> <td>□8□□</td> <td>LSN</td> </tr> <tr> <td>□C□□</td> <td>LSP and LSN</td> </tr> </tbody> </table> <p>When LSP or LSN turns OFF, an external stroke limit warning (AL. 99) occurs, and Warning (Bit7 of Statusword; warning bit) turns ON. When WNG is assigned to the output signal device in parameter No. PD13 to PD16 • PD18, the corresponding terminal output is turned OFF.</p>	(Note) Input signal		Operation		LSP	LSN	Counterclockwise direction	Clockwise direction	1	1	○	○	0	1	/	○	1	0	○	/	0	0	/	/	Parameter No. PD01	Auto ON	□4□□	LSP	□8□□	LSN	□C□□	LSP and LSN	DI-1	○	○
(Note) Input signal		Operation																																				
LSP	LSN	Counterclockwise direction	Clockwise direction																																			
1	1	○	○																																			
0	1	/	○																																			
1	0	○	/																																			
0	0	/	/																																			
Parameter No. PD01	Auto ON																																					
□4□□	LSP																																					
□8□□	LSN																																					
□C□□	LSP and LSN																																					
Forced stop	EM1	CN1-42	Turn EM1 off (open between commons) to bring the motor to a forced stop state, in which the base circuit is shut off and the dynamic brake is operated.	DI-1	○	○																																
Proximity dog	DOG	CN1-16	When DOG & SG are shorted, the proximity dog signal is detected. The Logic of the DOG signal can be modified via Parameter No. PD22 <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Parameter No. PD22</th> <th>Proximity dog (DOG) detection logic</th> </tr> </thead> <tbody> <tr> <td>0□□□ (Initial Value)</td> <td>OFF</td> </tr> <tr> <td>1□□□</td> <td>ON</td> </tr> </tbody> </table>	Parameter No. PD22	Proximity dog (DOG) detection logic	0□□□ (Initial Value)	OFF	1□□□	ON	DI-1	○	—																										
Parameter No. PD22	Proximity dog (DOG) detection logic																																					
0□□□ (Initial Value)	OFF																																					
1□□□	ON																																					

\* H: Homing mode (hm), P: Position control mode (csp), S: Speed control mode (csv)

### 3.10. Timing chart

#### (1) When an alarm occurs

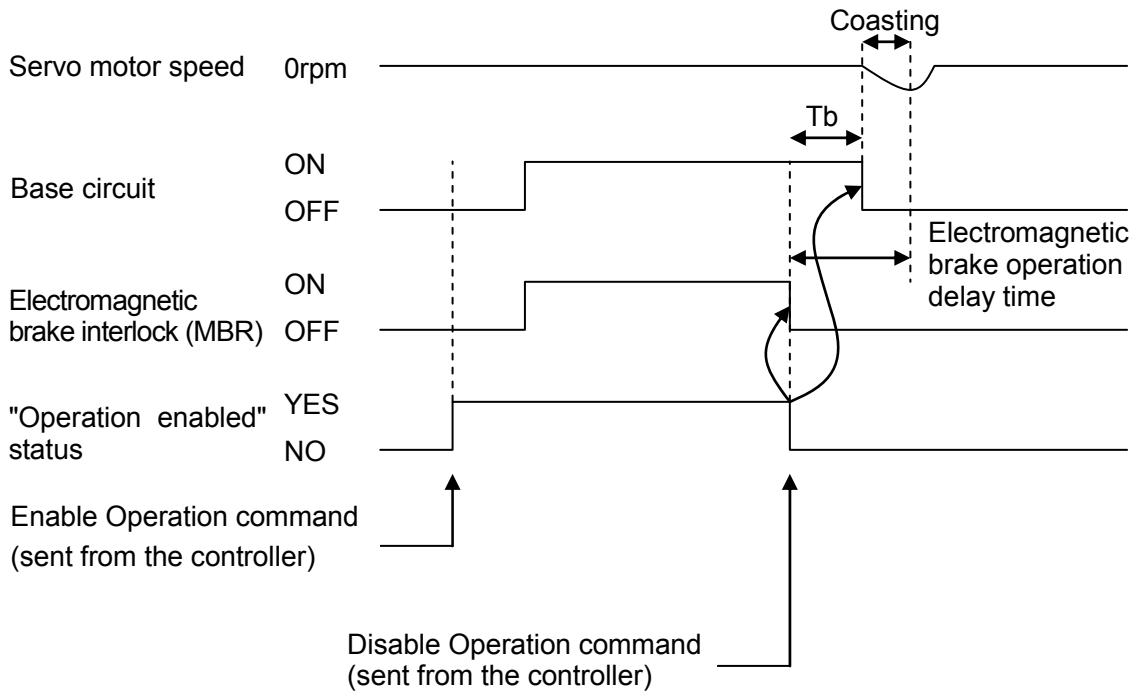
When an alarm occurs in the servo amplifier, the base circuit is shut off and the servo motor is coasted to a stop. Switch off the main circuit power supply in the external sequence. To reset the alarm, switch the control circuit power supply from off to on or execute the fault reset command by the master controller. However, the alarm cannot be reset unless its cause is removed.



#### (2) Servo-on (SON) ON/OFF

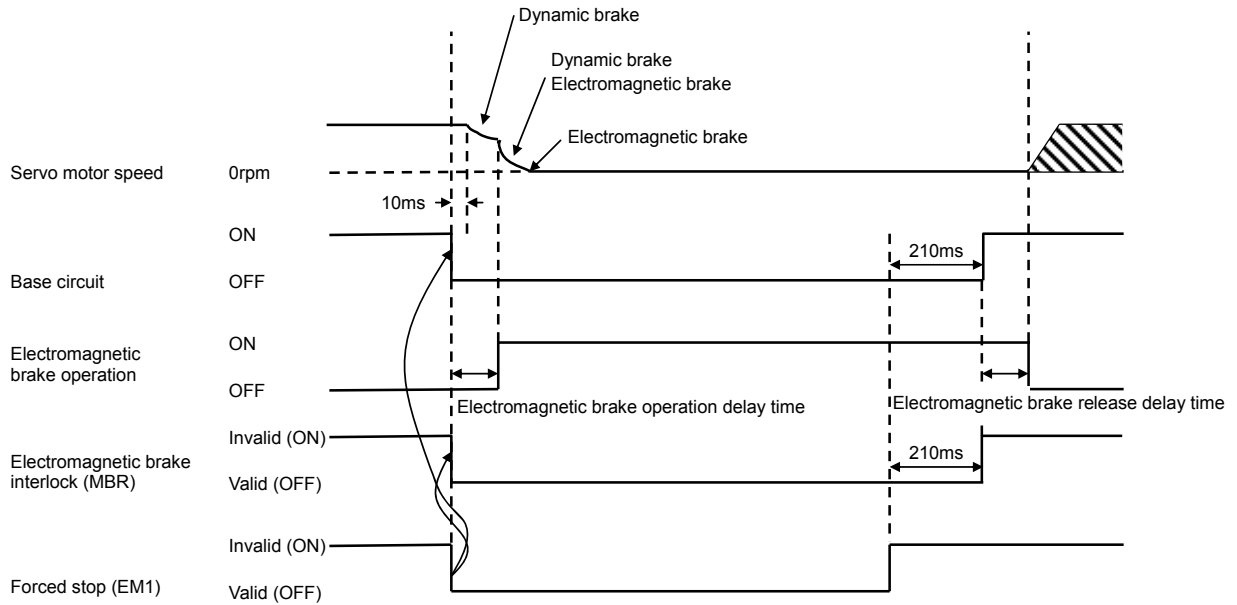
When the Operation enabled status is canceled, the base circuit is shut off after  $T_b$ [ms]. In the condition that  $T_b$  is less than the delay time of electromagnetic brake operation, the servo motor coasts. However, that usage is not recommended. When using on vertical axis, set the time which is as long as the delay time of electromagnetic brake operation and enough to avoid falling.

Set the electromagnetic brake sequence output  $T_b$  in the parameter No. PC16.



\* By sending Enable Operation command or Disable Operation command with Controlword from the controller, the base circuit is turned ON/OFF. Refer to section 8.4.1 for details.

### (3) Forced stop (EM1) ON/OFF



- When EM1 turns off (forced stop state), the electromagnetic brake interlock (MBR) will be turned off, and base circuit will be turned off.

### 3.11. Optional unit initialization time

After the control circuit power supply is switched on, the servo amplifier finishes initializing the optional unit in approx. 2 seconds and accepts the EtherCAT command.

## 4. Startup

### 4.1. Startup procedure

When switching power on for the first time, follow the procedure below to make a startup.

#### (1) Power-on

Switch on the control circuit power supply and then the main circuit power supply. When the control circuit power supply is switched on, "Ab" is shown on the servo amplifier display.

#### (2) Parameter setting

Set the parameters according to the configuration and specification of the machine. The parameters can be set either by the push-button on the front of the servo amplifier or via MR Configurator. Refer to chapter 5 or MR-J3-□A Servo Amplifier Instruction Manual for the description of the parameters. Switch the power off once after setting each parameter. Switch it on again to make the set parameter valid.

The parameter value written via EtherCAT communication is stored in the volatile memory and it returns to the value stored in the non-volatile memory (EEPROM) after power-off.

To write parameters into the non-volatile memory (EEPROM), execute it with SDO communication command, using Store Parameter (Index 1010h) (Refer to section 8.10).

#### (3) Servo-on

Follow the procedure below to servo-on.

Turn ON the forced stop (EM1) after establishment of PDO communication (after the AL state reaches Operational). Send the Enable Operation command with controlword (6040h) from the controller to switch to the operation enabled (servo-on) state (Refer to 8.4.1). Turn ON the forward rotation stroke end (LSP) and the reverse rotation stroke end (LSN). In case of csv mode, the servo motor can be operated at the speed given by Target velocity (60FFh). In case of csp mode, the servo motor can be operated at the speed given by Target position (607Ah).

※Please be attention the input command not to have sudden servo motor rotation at servo-on. (In case of position control mode, please give the current position value for position command when servo-on turns on. (In case of speed control mode, please give zero for speed command when servo-on turns on.)

#### (4) Stop

In any of the following statuses, the servo amplifier interrupts and stops the operation of the servo motor. Refer to MR-J3A Instruction Manual for the servo motor with an electromagnetic brake.

- (a) FSA state is other than Operation enabled (servo-off status).

The base circuit is shut off and the servo motor coasts.

- (b) Alarm occurrence

When an alarm occurs, the base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop.

- (c) Emergency stop (EM1) OFF

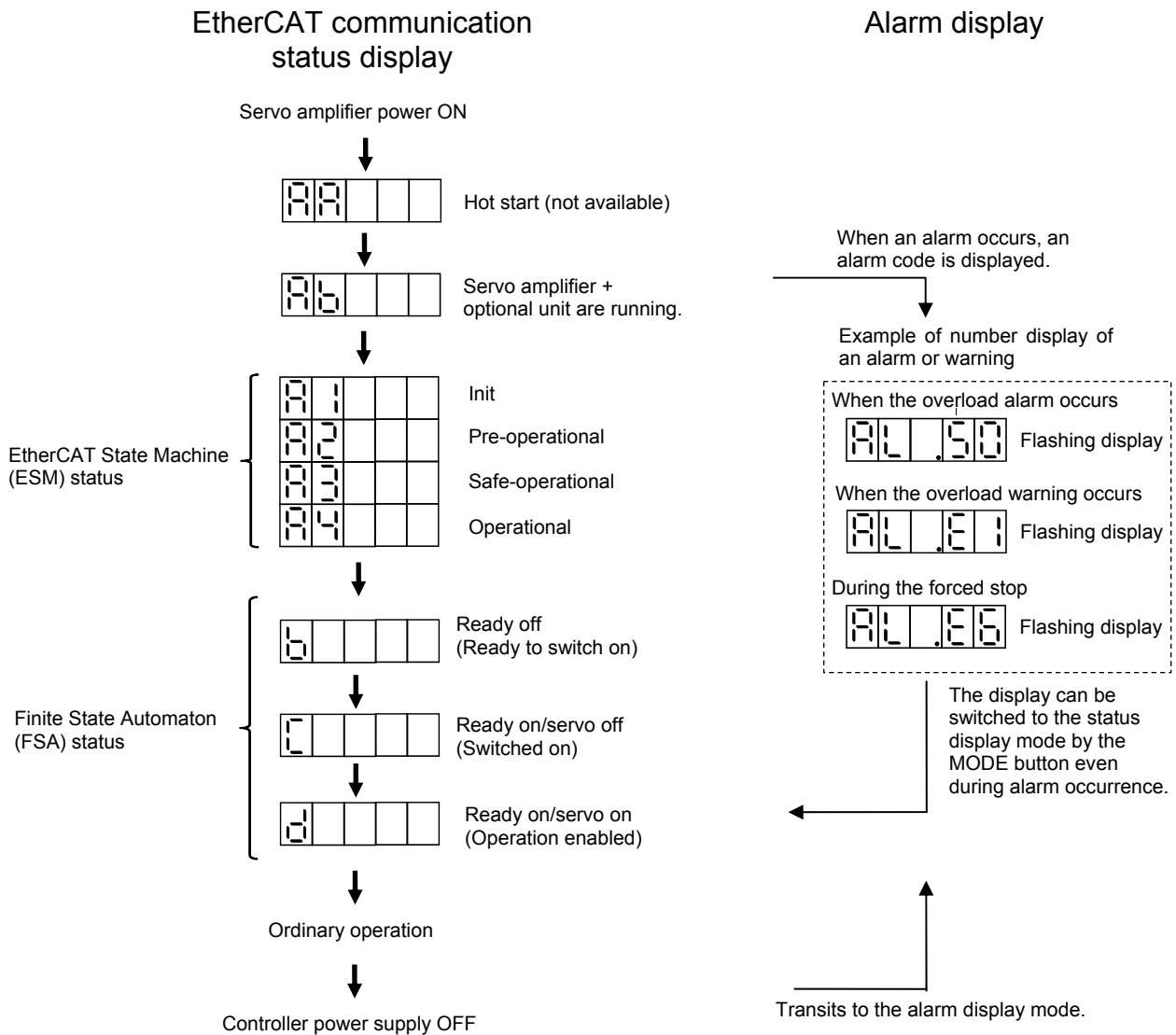
The base circuit is shut off and the dynamic brake is operated to bring the servo motor to a sudden stop. Alarm AL.E6 occurs.



## 4.2. Servo amplifier display

Confirm the communication status with the servo system controller at power-on and diagnose an alarm using the servo amplifier display (5-digit, 7-segment display).

### (1) Display sequence



### 4.3. Test operation

Before starting actual operation, perform test operation to make sure that the machine operates normally. This servo amplifier can perform JOG operation, positioning operation, motor-less operation and machine analyzer operation.

During operation in the EtherCAT mode, the operation mode can be switched to the test operation mode with the operation button of the servo amplifier or by MR Configuration operation. The method to switch to the test operation mode and the operations in the test operation mode are the same as standard MR-J3A.

The operations to switch to the test operation mode during the EtherCAT mode are as below.

- ① Switching to the test operation mode is available in any EtherCAT communication status (AL state).
- ② After switched to the test operation mode, synchronization by Distributed Clocks is canceled, and EtherCAT communication is continued in asynchronous status.
- ③ After switched to the test operation mode, command inputs such as control word and speed command value via EtherCAT are ignored.
- ④ EtherCAT processing other than 3) (such as PDO/SDO communication processing, status feedback and alarm detection) are continued even after switched to the test operation mode.
- ⑤ To operate in the EtherCAT mode after the test operation mode is finished, switch off the MR-J3-□A-RJ158 power supply once and then turn it on again.

\* Take care with the command inputs, to avoid the occurrence of sudden rotations by the switching of the instruction system when transiting from the EtherCAT mode to the test operation mode. (When in the position control mode, enter the position actual value to the position command value. On the other hand, enter 0 to the speed command value when in the speed control mode.)

### 4.4. Power-off sequence

The servo amplifier can stop safely without causing a receive error alarm by the following procedure.

- ① Stop the servo motor rotation by setting 0 as the command speed in speed control mode. Set current position as command position in position control mode.
- ② Send the Shutdown command to switch the FSA state to "Ready to switch on", and the main circuit power supply is turned off. (The alarm detection of the operation error (AL.61) is not executed in "Ready to switch on" state, even switching the AL state to "Safe-Operational".)
- ③ Make EM1 (Forced stop) signal valid (OFF).
- ④ Switch the AL state to "Safe-Operational". (Since then, the switching to "init"/"Pre-Operational" state or their communication stop can be executed without the occurrence of each receive error 1 (AL.34), receive error 2 (AL.36), operation error (AL.61) and synchronization error (AL.76) alarms.
- ⑤ Stop (power supply OFF) the master controller.
- ⑥ Switch the servo amplifier off.

## 5. Parameters

### 5.1. Changed parameters of MR-J3-□A-RJ158

The following table indicates the parameters of MR-J3-□A-RJ158 that changed from standard J3A. The parameters other than below are the same as standard J3A. Do not use other settings than those described in the manual. Otherwise, malfunction or an accident may occur.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range																					
Basic parameters	PA01	*STY	<p>Control mode Control mode setting by this parameter is invalid. Do not change this parameter.</p> <p>* Set the control mode from parameter No. P002 or the Modes of operation object (index 6060h). * The value of this parameter is automatically changed according to the current operating mode.</p> <p>Control mode Select the control mode.</p> <table border="1" style="margin-left: 20px;"> <tr> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;"> </td> </tr> </table> <p style="margin-left: 40px;">↓</p> <p>Control mode 0: Position (Cyclic synchronous position mode) Home position mode (Homing mode) 2: Speed (Cyclic synchronous velocity mode)</p>	0	0	0		0000h	—	Refer to name and function																	
	0	0	0																								
	PA03	*ABS	<p>Absolute position detection system Select the absolute position detection system</p> <table border="1" style="margin-left: 20px;"> <tr> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;">0</td> <td style="width: 20px; text-align: center;"> </td> </tr> </table> <p style="margin-left: 40px;">↓</p> <p>0: Invalid (used in incremental system) 2: Valid (ABS transfer via EteherCAT)</p>	0	0	0		0000h	—	Refer to name and function																	
	0	0	0																								
	PA05	*FBP	<p>For manufacturer setting Setting is invalid. Do not change this parameter.</p>	0	—	0, 1000 to 50000																					
	PA06	*CMX	<p>For manufacturer setting Setting is invalid. Do not change this parameter.</p>	1	—	1 to 1048576																					
PA07	*CDV	<p>For manufacturer setting Setting is invalid. Do not change this parameter.</p>	1	—	1 to 1048576																						
PA14	*POL	<p>Rotation direction selection Select the polarity of the command speed.</p> <p>Command speed polarity in the speed control mode (csv)</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th rowspan="2">Setting value</th> <th colspan="2">Rotating direction of the servo motor</th> </tr> <tr> <th>Command speed &gt; 0</th> <th>Command speed &lt; 0</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">CCW</td> <td style="text-align: center;">CW</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">CW</td> <td style="text-align: center;">CCW</td> </tr> </tbody> </table> <p>Command position polarity in the position control mode (csp) and homing mode (hm)</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th rowspan="2">Setting value</th> <th colspan="2">Rotation direction of the servo motor</th> </tr> <tr> <th>Position address increase</th> <th>Position address decrease</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">0</td> <td style="text-align: center;">CCW</td> <td style="text-align: center;">CW</td> </tr> <tr> <td style="text-align: center;">1</td> <td style="text-align: center;">CW</td> <td style="text-align: center;">CCW</td> </tr> </tbody> </table>	Setting value	Rotating direction of the servo motor		Command speed > 0	Command speed < 0	0	CCW	CW	1	CW	CCW	Setting value	Rotation direction of the servo motor		Position address increase	Position address decrease	0	CCW	CW	1	CW	CCW	0	—	0 to 1
Setting value	Rotating direction of the servo motor																										
	Command speed > 0	Command speed < 0																									
0	CCW	CW																									
1	CW	CCW																									
Setting value	Rotation direction of the servo motor																										
	Position address increase	Position address decrease																									
0	CCW	CW																									
1	CW	CCW																									

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
	PA19	*BLK	Parameter writing inhibit Select the reference/writing range of the parameter.	000Eh	—	Refer to name and function
			Setting value	Reference parameter range	Writing parameter range	
			Others than the following	Basic setting (PA)	←	
		000B	Basic setting (PA), Gain/filter parameters (PB) Extension setting (PC)	←		
		000C	Basic setting (PA), Gain/filter parameters (PB) Extension setting (PC), I/O setting (PD)	←		
		000E	Basic setting (PA), Gain/filter parameters (PB) Extension setting (PC), I/O setting (PD) Option card (PO)	←		
		100B	Basic setting (PA)	Parameter PA19 only		
		100C	Basic setting (PA), Gain/filter parameters (PB) Extension setting (PC), I/O setting (PD)	Parameter PA19 only		
		100E	Basic setting (PA), Gain/filter parameters (PB) Extension setting (PC), I/O setting (PD) Option card (PO)	Parameter PA19 only		

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
Gain Filter Parameter	PB03	PST	Position command acceleration/deceleration time constant (position smoothing) The acceleration/deceleration filter (position smoozing) is invalid during positioning. In this case, the time constant of the parameter is not applied.	0	ms	0~20000
	PB25	*BOP1	Function Selection B-1 The acceleration/deceleration filter is invalid during positioning. In this case, the selection of position command acceleration/deceleration time constant in the parameter is invalid.  Note) When slow stop is executed by LSP, LSN or MSTOP during position control mode (csp), straight accel/decel will be executed.	0000h	—	Refer to name and function

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
Extension setting parameters 1	PC01	STA	Acceleration time constant During the position control operation, acceleration/deceleration filter is invalid and the time constant of this parameter is not applied.	0	ms	0 to 50000
	PC02	STB	Deceleration time constant Used to set the deceleration time required to reach 0r/min from the rated speed. Applied to the deceleration time constant when slow stop is caused by forward rotation stroke end (LSP), reverse rotation stroke end (LSN) and manual stop (MSTOP) function. During the normal speed control or position control operation, acceleration/deceleration filter is invalid and the time constant of this parameter is not applied. The maximum settable deceleration time constant during position control mode is 1000ms.	0	ms	0 to 50000
	PC23	*COP2	Function selection C-2 Select the VC-VLA voltage averaging.  <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;">0</div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;">0</div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;">0</div> <div style="border: 1px solid black; padding: 2px;">0</div> </div> <ul style="list-style-type: none"> <li>→ The function of the servo lock at speed control mode stop is invalid. Please set 0.</li> <li>→ VC/VLA voltage averaging Analog speed command VC and analog speed limitation VLA are invalid. Please set 0.</li> <li>→ Speed limit selection at torque control Torque control mode is not available. Enter 0.</li> </ul>	0000h	—	Refer to name and function
	PC25	*COP4	Function selection C-4 Select the absolute position counter warning.  <div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;">0</div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;">0</div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> </div> <div style="border: 1px solid black; padding: 2px;">0</div> </div> <ul style="list-style-type: none"> <li>→ Selection of the absolute position counter warning (AL-E3) 0: Valid 1: Invalid</li> </ul> <p style="margin-top: 20px;">* When the absolute position counter warning is valid, that warning is output if the travel distance exceeds 32767 or -32768 revolutions. If the warning is unnecessary, set it invalid.</p>	0000h	—	Refer to name and function

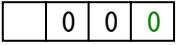
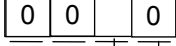
Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
Extension setting parameters 1	PC36	*DMD	LED power-on display selection Select the status display to be provided at power-on.	0000h	—	Refer to name and function
			<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">0</div> <div style="border: 1px solid black; width: 20px; height: 20px; margin-right: 5px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px; margin-right: 5px;"></div> <div style="border: 1px solid black; width: 20px; height: 20px;"></div> </div> <p style="margin-left: 40px;">→ Selection of main status display at power-on</p> <ul style="list-style-type: none"> <li>00 : Cumulative feedback pulse</li> <li>01 : Motor speed</li> <li>02 : Droop pulse</li> <li>03 : Cumulative command pulses</li> <li>04 : Command input pulse frequency</li> <li>05 : EtherCAT communication status</li> <li>06 : EtherCAT communication status</li> <li>07 : Regenerative load ratio</li> <li>08 : Effective load ratio</li> <li>09 : Peak load ratio</li> <li>0A : Instantaneous torque</li> <li>0B : Within one-revolution position (low)</li> <li>0C : Within one-revolution position (high)</li> <li>0D : ABS counter</li> <li>0E : Load inertia moment ratio</li> <li>0F : Bus voltage</li> <li>10~1F : EtherCAT communication status</li> </ul> <p style="margin-left: 40px;">→ Main display change</p> <p style="margin-left: 40px;">0: Depends on the operation mode and control mode</p> <table border="1" style="margin-left: 40px; border-collapse: collapse;"> <thead> <tr> <th>Operation mode</th> <th>Control mode</th> <th>When selecting the automatic display</th> </tr> </thead> <tbody> <tr> <td>EtherCAT</td> <td style="text-align: center;">—</td> <td>EtherCAT communication status</td> </tr> </tbody> </table> <p style="margin-left: 40px;">1: Depends on the last 2 digit setting of this parameter.</p>			
Operation mode	Control mode	When selecting the automatic display				
EtherCAT	—	EtherCAT communication status				

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range																
I/O setting parameters	PD01	*DIA1	Input signal automatic ON selection 1 Select the input devices to be automatically turned ON. <div style="text-align: center;"> </div> <p>Note) In the EtherCAT mode, Auto ON of each input signal of servo-on (SON), proportional control (PC) and external torque limit (TL) is invalid.</p> <p>For example, to turn ON LSP, the setting is "□4□□".</p>	0000h	—	Refer to name and function																
	PD04	*DI2	Input signal device selection 2(CN1-16) The device is allocated to the input signal pin of CN1-16. <div style="text-align: center;"> </div> <p>Selectable functions</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Setting</th> <th>Input signal device</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No function</td> </tr> <tr> <td>1~9</td> <td>Setting prohibited</td> </tr> <tr> <td>A</td> <td>Forward rotation stroke end (LSP)</td> </tr> <tr> <td>B</td> <td>Reverse rotation stroke end (LSN)</td> </tr> <tr> <td>C~2A</td> <td>Setting prohibited</td> </tr> <tr> <td>2B</td> <td>Proximity dog (DOG)</td> </tr> <tr> <td>2C~3F</td> <td>Setting prohibited</td> </tr> </tbody> </table> <p>           Position control mode (csp)            Home position mode (hm)            Speed control mode         </p> <p>CN1-16 pin Select function of the input signal</p>	Setting	Input signal device	0	No function	1~9	Setting prohibited	A	Forward rotation stroke end (LSP)	B	Reverse rotation stroke end (LSN)	C~2A	Setting prohibited	2B	Proximity dog (DOG)	2C~3F	Setting prohibited	0021 212Bh	—	0000 0000h ~ 003F 3F3Fh
	Setting	Input signal device																				
0	No function																					
1~9	Setting prohibited																					
A	Forward rotation stroke end (LSP)																					
B	Reverse rotation stroke end (LSN)																					
C~2A	Setting prohibited																					
2B	Proximity dog (DOG)																					
2C~3F	Setting prohibited																					
PD20	*DOP1	Function selection D-1 Select the stop processing at LSP-LSN signal OFF and the operation at Fault Reset input. <div style="text-align: center;"> </div> <p>           Stop processing at LSP-LSN signal OFF            0 : Slow stop            1 : Setting stop         </p> <p>           Operation at Fault Reset input            0 : Base off            1 : Base not off         </p> <p>Note) The slow stop is always selected at the EtherCAT mode regardless of the setting.</p> <p>Note) Fault Reset is valid only in the Fault (≠Base off) status.</p>	0000h	—	Refer to name and function																	

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
I/O setting parameters	PD22	*DOP3	Function selection D-3 Input logic setting of DOG signal.   <p>Set the clear (CR) In case of this amplifier(MR-J3-□A-RJ158), droop pulses are cleared on the leading edge of CR bit, regardless of PD22 setting.</p> <p>Input logic setting of DOG signal. 0 : open (OFF) = DOG ON 1 : closed (ON) = DOG ON</p>	0000h	—	0000h ~ 1111h
	PD24	*DOP5	Function selection D-5 Set the alarm code output and the selection of an output signal at warning.   <p>Alarm code output (CN1-22, CN1-23, CN1-24) bit2 bit1 bit0 0: Invalid <del>1: Valid</del> * Alarm code output is not available. Enter 0.</p> <p>Selection of output signal at warning 0: WNG turns on at warning. 1: WNG turns on and ALM turns off at warning. When "1" is selected, communication between ALM-SG fails not only at alarm occurrence but also at warning.</p> <p>Note: This is not reflected to bit3 (Fault) output of Statusword.</p>	0000h	—	Refer to name and function

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.



Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range
Option card parameters	PO02	*ECAT	Operation mode Select synchronization mode, control mode, PDO communication cycle.	0000h	—	Refer to name and function
			<div style="display: flex; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 5px;">0</div> <div style="margin-left: 10px;"> <p>Select the synchronization mode                0: Synchronous mode (DC mode)                1: Asynchronous (Free-run mode)</p> <p>※When you select Asynchronous EtherCAT mode, set the parameter No. PO03 to "0200" (select invalid for the detection of the intermittent error of RxPDO reception error and the detection of the incremental counter update error).</p> <p>Initial control mode at power-on                0: speed control mode (Cyclic synchronous velocity mode)                6: home position mode (Homing mode)                8: position control mode (Cyclic synchronous position mode)                9: speed control mode (Cyclic synchronous velocity mode)</p> <p>PDO communication cycle                0 : 0.5ms                1 : 1ms                2 : 2ms</p> <p><b>! CAUTION</b>                ※The asynchronous mode is a mode for master controller virtual connection. The gap of the mutual communication process timings between the master controller and a slave makes the update cycle of PDO communication data (command and feedback data) undetermined, which causes unstable motor rotation and other troubles. In addition, protective functions operated by the detection of an intermittent error of RxPDO reception error and the incremental counter update error cannot be used. Use the synchronous mode when performing real operation.</p> </div> </div>			

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

Class	No.	Abbrev.	Name and function	Initial value	Unit	Setting range																														
Option card parameters	PO03	*CPRO	Communication protection switch Select whether to detect the RxPDO reception error and the incremental counter update error. <div style="text-align: center; margin: 10px 0;"> <table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="padding: 2px 5px;">0</td> <td style="padding: 2px 5px;"> </td> <td style="padding: 2px 5px;">0</td> <td style="padding: 2px 5px;"> </td> </tr> </table>   <div style="display: flex; justify-content: center; gap: 20px;"> <div style="text-align: center;"> </div> </div> </div>	0		0		0000h	—	Refer to name and function																										
			0		0																															
<div style="display: flex; justify-content: space-between;"> <table border="1" style="border-collapse: collapse; width: 45%;"> <thead> <tr> <th colspan="3">RxPDO reception error</th> </tr> <tr> <th>Value</th> <th>Continuous error</th> <th>Intermittent error</th> </tr> </thead> <tbody> <tr> <td>0 :</td> <td>Detection</td> <td>Detection</td> </tr> <tr> <td>1 :</td> <td colspan="2">(Setting prohibited)</td> </tr> <tr> <td>2 :</td> <td>Detection</td> <td>Not detection</td> </tr> <tr> <td>3 :</td> <td colspan="2">(Setting prohibited)</td> </tr> </tbody> </table> <table border="1" style="border-collapse: collapse; width: 45%;"> <thead> <tr> <th colspan="3">Abnormal incremental counter</th> </tr> <tr> <th>Value</th> <th>Continuous error</th> <th>Intermittent error</th> </tr> </thead> <tbody> <tr> <td>0 :</td> <td>Not detection</td> <td>Not detection</td> </tr> <tr> <td>1 :</td> <td>Detection</td> <td>Detection</td> </tr> <tr> <td>2 :</td> <td>Detection</td> <td>Not detection</td> </tr> <tr> <td>3 :</td> <td>Not detection</td> <td>Detection</td> </tr> </tbody> </table> </div> <p>* For details on the incremental counter, refer to section 8.11.1.</p> <p>* When the incremental counter update error detection is made valid at the asynchronous mode, the parameter error alarm (AL.37) occurs.</p> <p>* When you operate the test run connecting a master controller which executes PDO communication with different cycle time against the original setting of cycle time (ex. Free-run mode in TwinCAT), set the parameter No. PO03 to "0200". Also select invalid for the detection of the intermittent error of RxPDO reception error and the detection of the incremental counter update error. However, if the reception of RxPDO is lost for about 7msec continuously, receive error 2 alarm (AL.36) occurs and the motor stops.</p> <p>* When performing real operation, be sure to set the synchronous mode whose PDO communication cycle is 0.5ms, 1ms or 2ms and configure the settings to detect RxPDO reception errors.</p>	RxPDO reception error			Value	Continuous error	Intermittent error	0 :	Detection	Detection	1 :	(Setting prohibited)		2 :	Detection	Not detection	3 :	(Setting prohibited)		Abnormal incremental counter			Value	Continuous error	Intermittent error	0 :	Not detection	Not detection	1 :	Detection	Detection	2 :	Detection	Not detection	3 :	Not detection	Detection
RxPDO reception error																																				
Value	Continuous error	Intermittent error																																		
0 :	Detection	Detection																																		
1 :	(Setting prohibited)																																			
2 :	Detection	Not detection																																		
3 :	(Setting prohibited)																																			
Abnormal incremental counter																																				
Value	Continuous error	Intermittent error																																		
0 :	Not detection	Not detection																																		
1 :	Detection	Detection																																		
2 :	Detection	Not detection																																		
3 :	Not detection	Detection																																		

Note) Switch off the power supply once after setting the parameter indicated with \*. The setting will be completed after turning the power supply on again.

## 6. Display and Operation Sections

### 6.1. Display sequence

Press the "MODE" button once to shift to the next display mode. Refer to MELSERVO-J3-A Servo Amplifier Instruction Manual for the description of the corresponding display mode.

To refer to or set the gain/filter parameters, extension setting parameters, and I/O setting parameters, make them valid with basic setting parameter No. PA19 (parameter writing inhibit).

Display mode transition	Initial screen	Function	Reference
<pre> graph TD     A([Status display]) --&gt; B([Diagnosis])     B --&gt; C([Alarm])     C --&gt; D([Basic setting parameters])     D --&gt; E([Gain/filter parameters])     E --&gt; F([Extension setting parameters])     F --&gt; G([I/O setting parameters])     G --&gt; H([Option parameter])     H --&gt; A     </pre> <p>● Button MODE</p>		Servo status display EtherCAT communication status appears at power-on.	Section 6.3 of MELSERVO-J3-A Servo Amplifier Instruction Manual Section 6.2 in this manual
		Sequence display, external signal display, forced output signal (DO), test operation, software version display, servo motor series ID display, servo motor type ID display, servo motor encoder ID display, parameter writing inhibit next deactivation display.	Section 6.4 of MELSERVO-J3-A Servo Amplifier Instruction Manual
		Current alarm display, alarm history display, parameter error No. display.	Section 6.5 of MELSERVO-J3-A Servo Amplifier Instruction Manual
		Display and setting of basic setting parameters.	Section 6.6 of MELSERVO-J3-A Servo Amplifier Instruction Manual
		Display and setting of gain filter parameters.	Section 5.1 in this manual
		Display and setting of extension setting parameters.	
		Display and setting of I/O setting parameters.	
		Display and setting of option parameters.	Section 5.1 in this manual

Note. When the axis name is set to the servo amplifier using MR Configurator, the axis name is displayed and the servo status is then displayed.

## 6.2. Status display list

The following table lists the servo statuses that may be shown.

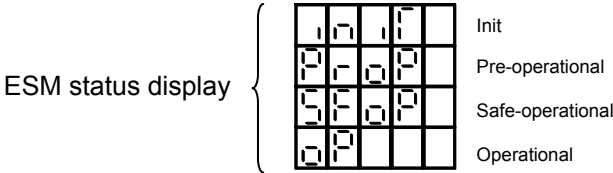
Select the status display mode with the "MODE" button, and then press the "UP"/"DOWN" button to switch the status displays below.

However, the status displays are switched with the "MODE" button during the jog operation, positioning operation and machine analyzer operation.

Status display	Symbol	Unit	Description	Display range
Cumulative feedback pulses	C	pulse	Feedback pulses from the servo motor encoder are counted and displayed. The values in excess of $\pm 99999$ can be counted. However, the counter shows only the lower five digits of the actual value since the servo amplifier display is five digits. Press the "SET" button to reset the display value to zero. The value of minus is indicated by the lit decimal points in the upper four digits.	-99999 to 99999
Servo motor speed	r	r/min	The servo motor speed is displayed. The value rounded off is displayed in 0.1r/min.	-7200 to 7200
Droop pulses	E	pulse	Deviation counter's droop pulses are displayed. When the servo motor is rotating in the reverse direction, the decimal points in the upper four digits are lit. Just the five last digits are displayed (even $\pm 99999$ is exceeded) The number of pulses displayed is in the encoder pulse unit.	-99999 to 99999
Cumulative command pulses	P	pulse	The position command pulse is counted and displayed. Just the five last digits are displayed (even $\pm 99999$ is exceeded) Push the "SET" button to set 0. When the servo motor is rotating in the reverse direction, the decimal points in the upper four digits are lit.	-99999 to 99999
Command pulse frequency	n	kpps	Frequency of the position command input pulse is displayed.	-1500 to 1500
Regenerative load ratio	L	%	The ratio of regenerative power to permissible regenerative power is displayed in %.	0 to 100
Effective load ratio	J	%	The continuous effective load current is displayed. The effective value in the past 15 seconds is displayed relative to the rated current of 100%.	0 to 300
Peak load ratio	b	%	Maximum occurred torque is displayed. The highest value in the past 15 seconds is displayed relative to the rated torque of 100%.	0 to 400
Instantaneous torque	T	%	Torque that occurred instantaneously is displayed. The value of the torque that occurred is displayed in real time relative to the rate torque of 100%.	0 to 400
Within one-revolution position (1 pulse unit)	Cy1	pulse	Position within one revolution is displayed in encoder pulses. The value returns to 0 when it exceeds the maximum number of pulses. However, the counter shows only the lower five digits of the actual value since the servo amplifier display is five digits. The value is incremented in the CCW direction of rotation.	0 to 99999
Within one-revolution position (100 pulse unit)	Cy2	100 pulse	The within one-revolution position is displayed in 100 pulse increments of the encoder. The value returns to 0 when it exceeds the maximum number of pulses. The value is incremented in the CCW direction of rotation.	0 to 2621
ABS counter	LS	rev	Travel distance from the home position in the absolute position detection systems is displayed in terms of the absolute position encoder multi-revolution counter value.	-32768 to 32767
Load inertia moment ratio	dC	Multiplier	The estimated value of load to motor inertia moment ratio to the servo motor shaft inertia moment is displayed.	0.0 to 300.0
Bus voltage	Pn	V	The voltage (across P - N/P+ - N-) of the main circuit converter is displayed.	0 to 900
EtherCAT communication status	ECS	—	EtherCAT communication status is displayed. Press the "SET" button to display ESM status (AL state). [*1]	— (Refer to section 4.2)

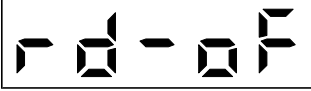
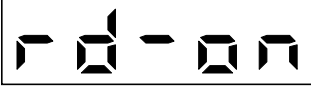







[\*1] The ESM status (AL state) display at the EtherCAT communication status display






Press the "SET" button at the EtherCAT communication status display to switch reciprocally with the ESM status (AL state) display.



### 6.3. Diagnostic mode

Since the "amplifier diagnosis" and "VC automatic offset" function is not available, these display switches in the operation section (push-button) are skipped. The operation of each function through MR Configurator is ignored.

Name		Display	Description
Sequence			Not ready. Indicates that the servo amplifier is being initialized or an alarm has occurred.
			Ready. Indicates that the servo was switched on after completion of initialization and the servo amplifier is ready to operate.
External I/O signal display		Same as the section 6.7 of MR-J3-□A Instruction Manual	Indicates the ON/OFF states of the external I/O signals. The upper segments correspond to the input signals and the lower segments to the output signals.
Output signal (DO) forced output			The digital output signal can be forced ON/OFF. Refer to section 6.8 of MR-J3-□A Servo Amplifier Instruction Manual.
Test operation mode	JOG operation		Jog operation can be performed when there is no command from the external command device. Refer to section 6.9.2 of MR-J3-□A Servo Amplifier Instruction Manual.
	Positioning operation		Positioning operation can be performed when there is no command from the external command device. MR Configurator is required for the positioning operation. Refer to section 6.9.3 of MR-J3-□A Servo Amplifier Instruction Manual.
	Motor-less operation		Without connection to the servo motor, the servo amplifier provides output signals and displays the status as if the servo motor is running actually in response to the input device. Refer to section 6.9.4 of MR-J3-□A Servo Amplifier Instruction Manual.
	Machine analyzer operation		Merely connecting the servo amplifier allows the resonance point of the mechanical system to be measured. MR Configurator is required for the machine analyzer operation. Refer to section 12.8 of MR-J3-□A Servo Amplifier Instruction Manual.
Software version low			Indicates the version of the software.
Software version high			Indicates the system number of the software.

Name	Display	Description
Motor series ID		Press the "SET" button to show the motor series ID of the servo motor currently connected. For indication details, refer to MELSERVO Servo Motor Instruction Manual sold separately.
Motor type ID		Press the "SET" button to show the motor type ID of the servo motor currently connected. For indication details, refer to MELSERVO Servo Motor Instruction Manual sold separately.
Encoder ID		Press the "SET" button to show the encoder ID of the servo motor currently connected. For indication details, refer to MELSERVO Servo Motor Instruction Manual sold separately.
For manufacturer setting		For manufacturer setting
For manufacturer setting		For manufacturer setting

## 7. Troubleshooting

### 7.1. Newly added or changed alarms and warnings

The following table indicates the alarms and warnings added or changed in MR-J3□A-RJ158. Alarms and warnings not indicated below are the same as MR-J3A standard products. If an alarm or warning has occurred, adopt appropriate measures following to section 7.2. When an alarm occurs, ALM is switched off and Fault bit of Statusword is switched ON.

Alarm code output is not supported. Set "□□□□" in parameter No. PD24.

After the causes of the alarms have been removed, the alarm can be deactivated in any of the methods marked ○ in the alarm deactivation column. The warnings are automatically canceled after the causes of occurrence have been removed.

Alarms and warnings list (changed alarms and warnings only)

	Display	Name	Alarm deactivation		
			Power OFF→ON	Press "SET" in the current alarm display	Alarm reset (*Note 1)
Alarm	AL.26	Home position setting error	○		
	AL.34	Receive error 1	○		
	AL.35	Command frequency error	○	○	○
	AL.36	Receive error 2	○		
	AL.37	Parameter error	○		
	AL.61	Operation error	○		
	AL.74	Option card error	○		
	AL.76	Synchronization error	○		

Note 1. Alarm reset by changing the Controlword (6040h) Fault reset from 0 to 1.

	Display	Name
Warning	AL.90	Home position not completed
	AL.96	Home position setting warning
	AL.E9	Main circuit off warning

### 7.2. Remedies for alarms and warnings

When an alarm occurs, the trouble (ALM) switches off and the dynamic brake is operated to stop the servo motor. At this time, the display indicates the alarm No.

When AL.E6 or AL.EA occurs, the servo-off status is established. When another alarm occurs, though the operation can be continued, an alarm may occur or the servo motor does not operate normally.

Display	Name	Description	Cause	Action
AL.13	Clock error	Synchronous signal is faulty.	Noise is contaminated in the synchronous signal.	Configure the synchronization in the master controller again after taking actions against noise and restarting the servo amplifier.
		Printed board fault.	Parts in the servo amplifier or in the optional unit are faulty.	Replace the servo amplifier or the optional unit.
AL.26	Home position setting error	Home position setting could not be made.	C_CR2 bit is turned on when the Z-phase has not been passed.	Turn C_CR2 bit on after the Z-phase has been passed.
AL.34	Receive error 1	PDO communication is faulty.	Update error occurred in the incremental counter.	Update the incremental counter in the specified method, and send PDO. Configure correct synchronization settings.
			Leakage in the synchronization signal reception occurred.	Replace the servo amplifier or the optional unit.



Display	Name	Definition	Cause	Action
AL.35	Command frequency alarm	Input command frequency is too high.	Some commands exceeded the servo motor maximum motor speed.	Check the operation program.
			Command data was damaged by noise contamination.	Take actions against noise.
AL.36	Receive error 2	PDO communication is faulty.	EtherCAT cable is faulty.	Replace the EtherCAT cable.
			Master controller communication settings/processing is faulty.	Use a master controller that satisfies the EtherCAT standards.
			Parts in the servo amplifier or in the optional unit are faulty.	Replace the servo amplifier or the optional unit.
AL.37	Parameter error	Parameter setting is incorrect.	Servo amplifier fault caused the parameter setting to be rewritten.	Replace the servo amplifier.
			Regenerative option not used with servo amplifier was selected in parameter No. PA02.	Set parameter No. PA02 correctly.
			The number of write times to EEPROM exceeded 100,000 due to parameter write, etc.	Replace the servo amplifier.
			The incremental counter update error detection was set to be valid in an asynchronous mode.	Use the module in the asynchronous mode when setting the incremental counter update error detection to be valid.
AL.61	Operation error	AL state changing request occurred in the master controller.	AL state change to other than "Operational" occurred during operation.	Restart the servo amplifier and start the operation again.
AL.74	Option card error	Synchronous signal is faulty.	When failing to perform initial synchronization in synchronous mode.	Configure the correct synchronization in the master controller after taking actions against noise and restarting the servo amplifier.
		Printed board fault.	Optional unit MR-J3-T04 is faulty.	Replace the optional unit.
AL.76	Synchronization error	Synchronous signal is faulty.	Synchronization setting is incorrect.	Configure correct synchronization settings.
			Noise is contaminated in the synchronous signal.	Configure the correct synchronization in the master controller after taking actions against noise and restarting the servo amplifier.
			Connection error with option unit MR-J3-T04.	Review the connection between amplifier and option unit.
		Communication process timing error	Timing error of master controller.	Review timing setting of master controller.
			Communication cable is broken.	Review communication cable. If network structure is changed during EtherCAT communication, all axis can not be guaranteed to use synchronization.

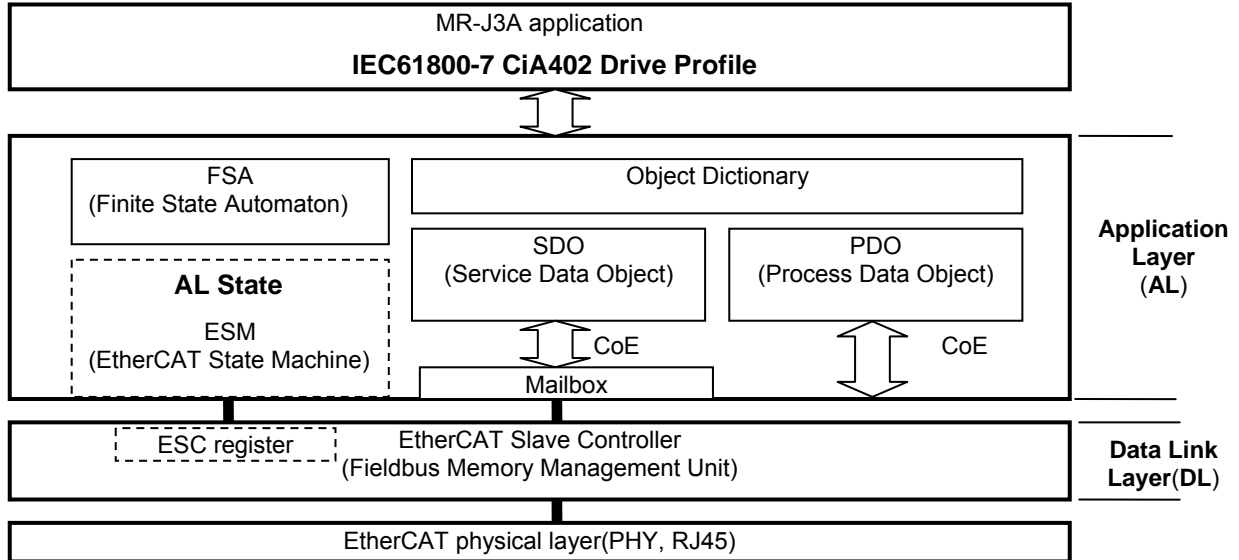
Display	Name	Description	Cause	Action
AL.90	Home position return incomplete	Home position return ended abnormally.	Home position return speed could not be decreased to creep speed.	Review home position return speed, creep speed, and proximity dog position.
			Limit switch was actuated during home position return starting at other than position beyond dog.	
AL.96	Home position setting warning	Home position setting could not be made.	C_CR2 bit is turned on when the Z-phase has not been passed.	Turn C_CR2 bit on after the Z-phase has been passed.
AL.99	Stroke limit warning	The stroke end (LSP or LSN) of the direction which gave instructions was turned off.	The stroke end (LSP or LSN) is turned off.	Review the operation pattern to avoid turning off LSP or LSN.
AL.E9	Main circuit off warning	"Enable operation" is used when a main circuit power supply is off.		Turn ON the main circuit power supply.

## 8. EtherCAT communication specifications

### 8.1. Communication architecture

MR-J3-□A-RJ158 and MR-J3-T04 are compliant to CAN application layer over EtherCAT (CoE) communication specifications. MR-J3-□A-RJ158 operates based on the TwinCAT configurations of software PLC by Beckhoff Automation GmbH.

#### (1) Communication hierarchy model



#### (2) Connection unit

The master controllers and slave stations specified in EtherCAT standards can be connected.

Slave station type	Model
General-purpose servo	MR-J3-□A-RJ158 + MR-J3-T04

#### (3) Device description file

Slave information of MR-J3-□A-RJ158 and MR-J3-T04 is provided as a device description file (ESI file) in XML format. Set up the device description file in the master controller and then configure the slave devices as is written in the description.

#### (4) Vendor ID, product code, revision number

MR-J3-□A-RJ158 has a built-in vendor ID, product code, revision number for distinguish from other EtherCAT slave devices. Set each connected slave device in the master with using the corresponding slave writing file to the vendor ID, product code and revision number. (Use the common slave writing file for the multiple connection of the same model and revision device.)

The S/W version, vendor ID, product code and revision number of MR-J3-□A-RJ158 and MR-J3-T04 are as follows.

S/W version	Vendor ID	Product code	Revision number	Remarks
A1	A1Eh	0000102h	02000000h	Supports three control modes, position control (csp), speed control (csv), and homing mode (hm).

## 8.2. Application Layer

### 8.2.1. AL state

Communication states of MR-J3-□A-RJ158 and MR-J3-T04 are managed by the AL (Application Layer) state. Each of the AL state is described below.

#### (1) AL state

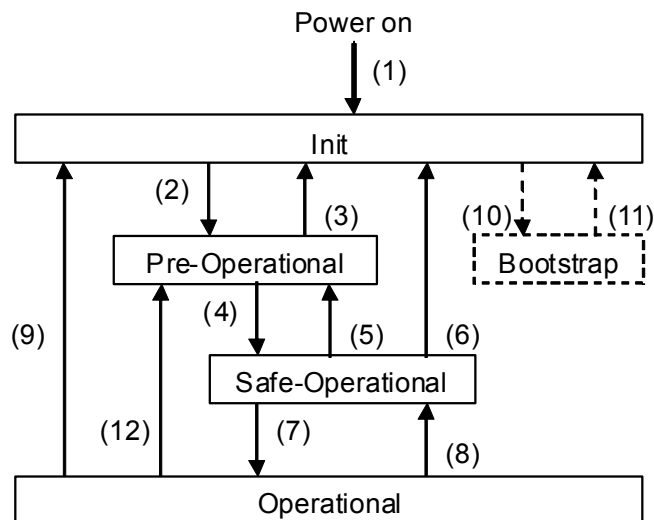
State	Descriptions	MR-J3-□A-RJ158
Init	After the power is ON, the state would be Init state. Neither SDO communication nor PDO communication is available. The master accesses to the DL-Information registers and executes communication initialization.  Without the normal communications restoration due to the error of ESC (EtherCAT Slave Controller), etc., AL state display with the 7-seg LED is set to "init".	○
Pre-Operational	SDO communication is generally available. PDO communication is not available.	○
Safe-Operational	SDO communication is generally available. PDO communication is generally available. Note that operations such as driving servo motor are invalid.  When ESC (EtherCAT Slave Controller) abandons to maintain the Operational state due to the receive error and tries to restore the communications, the state is set to the Safe-Operational state.	○
Operational	Both SDO communication and PDO communication are generally available. This is the normal runtime communication state. Motors should be driven in the Operational state.	○
Bootstrap	MR-J3-□A-RJ158 is not supported.	—

\* ○: Compatible —: Not compatible

Each of the AL state transits with the conditions described in (2) and (3).

After the AL state has transited to the Operational state through the Pre-Operational and the Safe-Operational from Init state, the servo amplifier can be operated.

#### (2) Flows of AL states transition



(3) Transition conditions of AL state

Transition	Action(s)
(1)	Power-on
(2)	Configuring SDO communication: 1) The master configures register of the slave, at least: • DL address register • Sync manager channels for SDO communication 2) The master requests transition of the slave to the <i>pre-operational</i> state. 3) Transits to the <i>pre-operational</i> state.
(4)	Configuring PDO communication: 1) The master configures parameter of PDO mapping etc. using the SDO communication. 2) The master configures SyncManager channel and FMMU [*1] channel for PDO communication. 3) The master requests transition of the slave to the <i>safe-operational</i> state. 4) Transits to the <i>safe-operational</i> state.
(7)	Synchronization: 1) The master and slave execute interpolation synchronization by using <i>distributed clocks</i> . 2) The master starts valid command value output. 3) The master requests transition of the slave to the <i>operational</i> state. 4) Transits to the <i>operational</i> state.
(5), (12)	Transits to the <i>pre-operational</i> state by the following. When the master requests transition of the slave to the <i>pre-operational</i> state. If the usage does not comply with power-off sequence (refer to chapter 4.4), operation error (AL.61) will be detected.
(8)	If the following (A) or (B) is happened, the state will be transited. (A) Transits when the master requests transition of the slave to <i>safe-operational</i> state. If the usage does not comply with power-off sequence (refer to chapter 4.4), operation error (AL.61) will be detected. (B) Transits when ESC (EtherCAT Slave Controller) cannot maintain the Operational state due to a receive error. At this time, the receive error 2 (AL. 36) is detected.
(3), (6), (9)	Transits to the <i>pre-operational</i> state by any of the following (A) or (B). (A) Transits when the master requests transition of the slave to the <i>init</i> state. (B) Transits when the normal communications restoration is considered to be impossible due to error, etc. of ESC (EtherCAT Slave Controller).
(10), (11)	MR-J3-□A-RJ158 is not supported.

\*1 FMMU (Fieldbus Memory Management Unit)

Note that any setting, such as configurations for SDO/PDO communication, SyncManager channel, FMMU, Synchronization, each register of the EtherCAT Slave Controller and others, is specified in EtherCAT standards, and execute them from the master controller.

It is confirmed that MR-J3-□A-RJ158 operates based on the TwinCAT configurations of software PLC by Beckhoff Automation GmbH.

## 8.2.2. PDO communication cycle

PDO communication cycle is selected in the parameter PO02. It can be chosen either one of 0.5ms, 1ms and 2ms. (Refer to 5.1 sections for the setting method)

In addition, it is also possible to select the PDO communication cycle while the MR-J3A-RJ158 is powered ON by rewriting Sync manager2 synchronization(1C32h)'s sub-object cycle time (sub index=2) in SDO download during Pre Operational states, other than using parameter No.PO02. However, this setting is made invalid by power OFF, then value of parameter No.PO02 is applied by next power ON.

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
1C32h	0	RECORD	Sync manager2 synchronization	U8	RO	9	The number of the entries
	1		Synchronization type	U16	RW	2	
	2		Cycle time	U32	RW	500000	PDO communication cycle 500000: 0.5ms 1000000: 1ms 2000000: 2ms PDO communication cycle can be changed by renewal function in Pre Operational states. Other than the above communication cycles can not be set.
	3		Shift time	U32	RO	0	
	4		Synchronization types supported	U16	RO	0004h	
	5		Minimum cycle time	U32	RO	500000	
	6		Calc and copy time	U32	RO	166666	Changes depending on the selected PDO communication cycle. 166666: 0.5ms 216200: 1ms 316200: 2ms
	7		(Reserved)	U32	RO	0	
	8		Get cycle time	U16	RW	0	
	9		Delay time	U32	RO	166666	
1C33h	0	RECORD	Sync manager3 synchronization	U8	RO	9	The number of the entries
	1		Synchronization type	U16	RW	2	
	2		Cycle time	U32	RO		Changed depending on the selected PDO communication cycle. 500000: 0.5ms 1000000: 1ms 2000000: 2ms
	3		Shift time	U32	RO	0	
	4		Synchronization types supported	U16	RO	0004h	
	5		Minimum cycle time	U32	RO	500000	
	6		Calc and copy time	U32	RO	166666	Changed depending on the selected PDO communication cycle. 166666: 0.5ms 216200: 1ms 316200: 2ms
	7		(Reserved)	U32	RO	0	
	8		Get cycle time	U16	RW	0	
	9		Delay time	U32	RO	0	

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
60C2h	0	RECORD	Interpolation time period	U8	RO	2	The number of the entries
	1		Interpolation time period value	U8	RW	5	Changed depending on the selected PDO communication cycle. 5: 0.5ms 1: 1ms 2: 2ms Not possible to change the value manually.
	2		Interpolation time index	I8	RW	-4	Changed depending on the selected PDO communication cycle. -4: 0.5ms -3: 1ms -3: 2ms Not possible to change the value manually.

- After PDO communication is started once using Safe Operational or Operational state after power on, PDO communication cycle is not able to be changed, even returning back to Pre Operational state afterwards.
- When MR-J3A-RJ158 receives the change of PDO communication cycle, the value of subobject Cycle time (Sub index=2) of Sync Manager3 Synchronization (1C33h) will be set same as the PDO communication cycle.
- After changing subobject Cycle time (Sub index=2) of Sync Manager2 Synchronization (1C32h), the time period until that the change of PDO communication cycle being carried out in MR-J3A-RJ158 is not always the same. After changing the Cycle time, obtain the value of subobject cycle time (Sub index=2) of Sync Manager3 Synchronization (1C33h), and please confirm whether the value has been changed in the set communication cycle, then start the PDO communication using Safe Operational state.

### 8.2.3. Synchronization

#### (1) Synchronization setting (DC mode)

MR-J3-□A-RJ158 is designed on the assumption that the synchronous operation is performed with the DC (Distributed Clock) function specified in EtherCAT standards. Therefore, connect to the master controller which corresponds to the DC function and use it in the synchronization valid settings (parameter No.PO02=□□□0h).

Be sure to set the synchronization (DC function) according to the following. If invalid cycles, etc. are set, operation will not be performed properly.

	Sync0	Sync1
Synchronization cycle time	0.5ms (PDO communication cycle 0.5ms) 1ms (PDO communication cycle 1ms) 2ms (PDO communication cycle 2ms) ※Set the same time as PDO communication cycle.	8ms ※Set the fixed time regardless the PDO communication cycle.
Shift time	0	0

It takes some time until the synchronization between stations by the DC function is stabilized. The time to the completion of synchronization varies according to the master controller control method, such as time compensation command of sending cycle. Before the master controller sends the transition command to ESM Operational state (in the Safe Operational state), confirm that the connected station reached the synchronous status by the following methods. If the transition to Operational state and the PDO communication are started in synchronization not completed (unstable) status, a communication error occurs and the motor control is not performed properly. Also, alarms such as receive error may occur.

#### <Method for confirming the synchronous status between EtherCAT Slave Controllers>

The synchronous status between each connected slave and the master controller can be acquired by referring to the device status (DevState) value on the master controller. DevState bit12=0 indicates that the local clock of all connected DC synchronization-compatible slaves are synchronized in the specified window. After confirming that DevState bit12=0, the controller should send instructions for the transition to the Operational state and start the operation of the servo.

#### <Method for confirming the synchronous status between EtherCAT Slave Controller and J3A-RJ158 (Host CPU)>

When ESC (EtherCAT Slave Controller) mounted on MR-J3-T04, and CPU and control ASIC mounted on MR-J3-□A-RJ158, etc. are correctly synchronized, the bit14 of Statusword2 (S\_SYNC bit) is turned ON.

#### (2) Asynchronous setting (Free-run mode)

When a master controller with non compatible with DC synchronization or, when a master controller performs PDO communication with a selectable cycle other than selected cycle (0.5ms, 1ms or 2ms), select the asynchronous mode (set parameter PO02=0001h) and simultaneously configure the settings as to not perform PDO communication error intermittent error detection nor incremental counter update error detection (set parameter PO03=0200h) to enable operation.

However, if the reception of RxPDO is lost for about 7msec continuously, receive error 2 alarm (AL.36) occurs and the motor stops.

The asynchronous mode is a mode for master controller virtual connection, and the missing of PDO communication (delay) occurs due to the gap between both communication process timings, according to the deviation of the clocks of master and slave. In this state, problems such as motor control by one cycle-delayed PDO command or feedback of one cycle-delayed status to master occurs, what causes a variation in accelerations. In addition, as the protective function by RxPDO reception error intermittent error detection and incremental counter update cannot be used, take great care at operation.



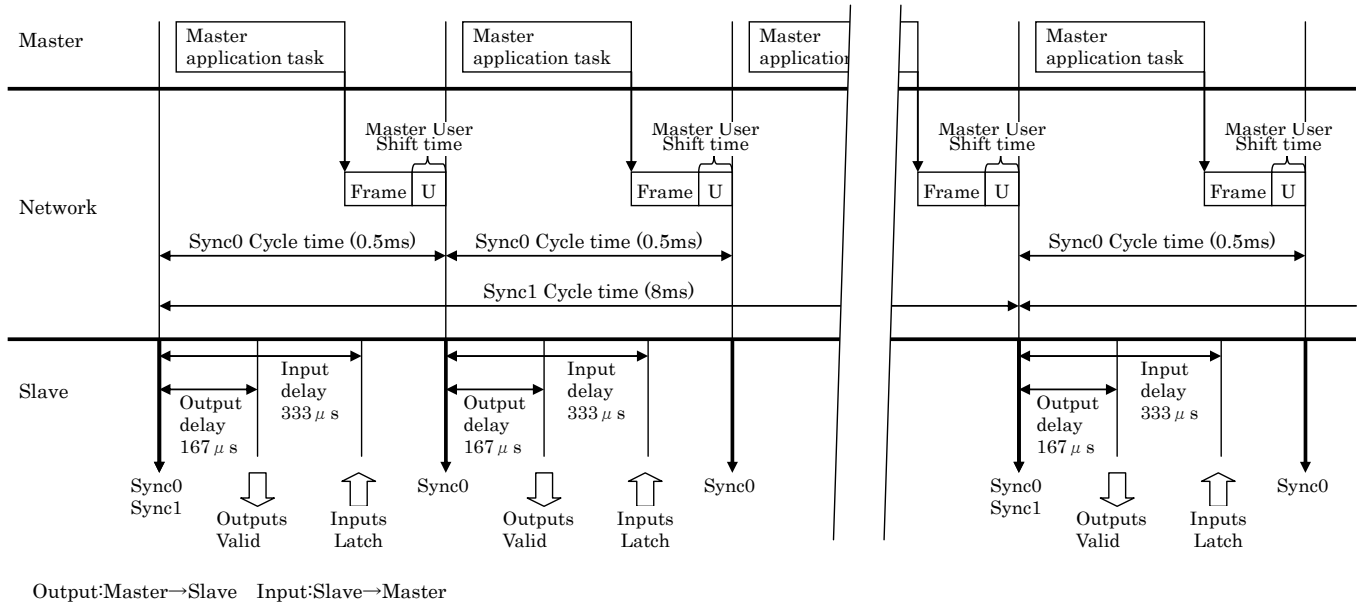
### CAUTION

Asynchronous mode is for test operation.  
When performing real operation, be sure to select the synchronous mode, and validate the safety communication function.

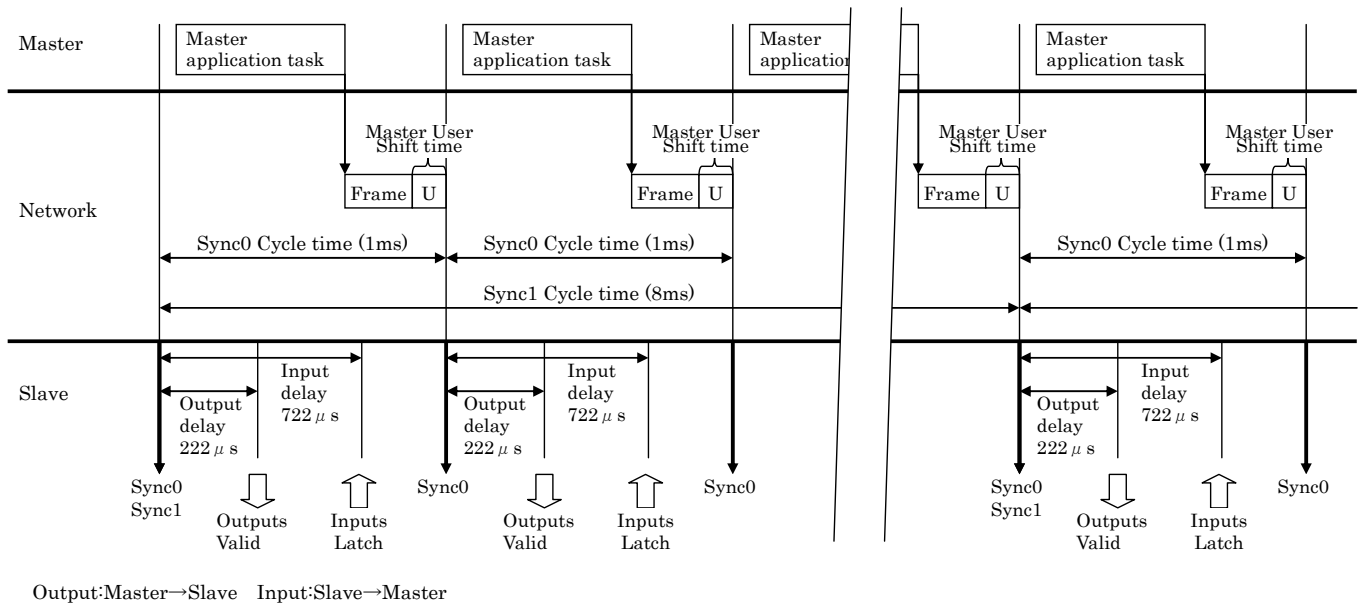


(3) PDO sent/received timing figure in the DC mode

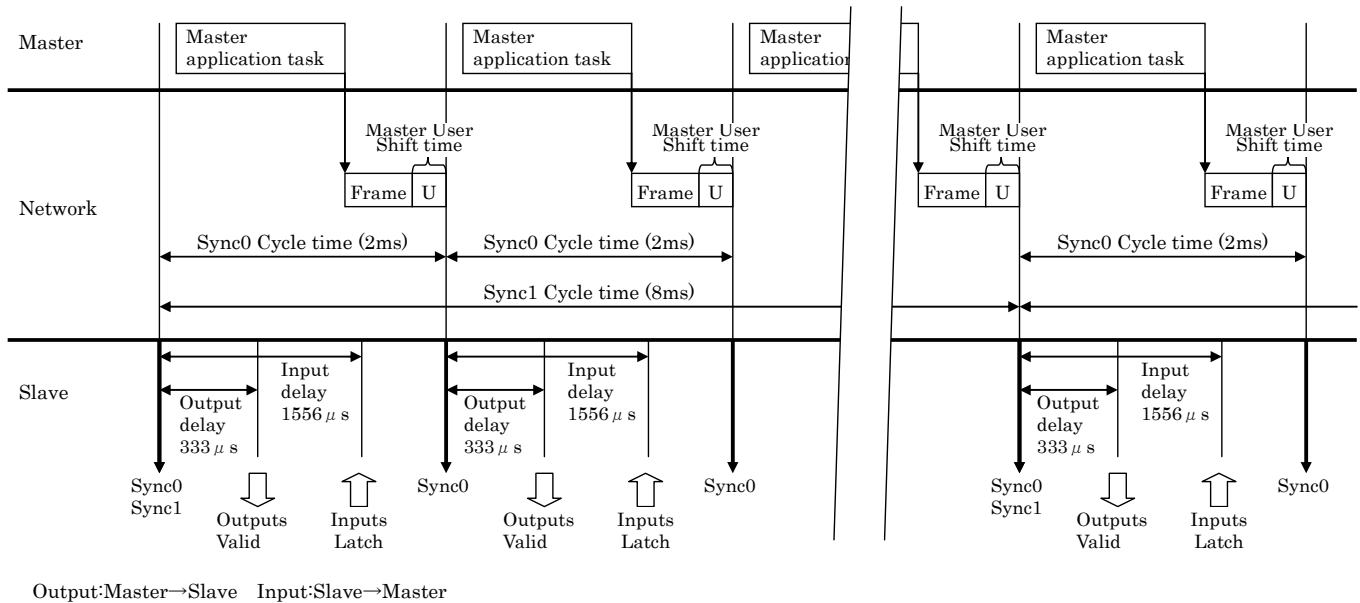
(A) In case of PDO communication cycle = 0.5ms



(B) In case of PDO communication cycle = 1ms



(C) In case of PDO communication cycle = 2ms



\* Execute the PDO data communication of the master controller in the specified timing. Synchronous communication of MR-J3-□A-RJ158 is possible in the TwimCAT default setting timing of software PLC by Beckhoff Automation GmbH. However, if the specified timing is not satisfied due to such as poor processing performance of master controller PC, a communication error may occur.

**CAUTION**

- Please make sure to have above timing for RxPDO command update and sending. If it does not comply with above timing, it causes danger (unstable motor rotation) due to communication failure.
- It is possible to detect communication timing error and to have motor protection operation, by using incremental counter function. Refer to chapter 8.11.1. We recommend to implement incremental counter function into master controller and to use receive error 2 (AL.36. Set by parameter No. PO 03.)

### 8.3. Object dictionary (OD)

For the CAN application layer over EtherCAT function, various data stored in the device such as control parameters, command values and F/B values are defined as objects configured from Index values, object names, object types, Read/Write attributes, etc., and those data can be exchanged between the master and slave devices. The assembly of those objects (table with listed objects, or a concept like that) is called object dictionary (OD). Objects available for MR-J3-□A-RJ158 are described in this manual by each corresponding function.

\* For details of corresponding objects, please refer to the document "ObjectList" apart.

#### 8.3.1. Definition of object dictionary section

The object dictionary is divided into the following sections according to the contents of the data, in the CANopen over EtherCAT standards.

Manufacturer-unique object groups are defined in indexes 2000h to 5FFFh, and all other objects follow definitions established by standards. The following table shows the correspondence between index values and object descriptions.

Definition of object dictionary section

Index	Description
0000h	Reserved
0001h to 025Fh	Definition of data type
0260h to 0FFFh	Reserved
1000h to 1FFFh	Communication profile
2000h to 5FFFh	Manufacturer-inherent (Mitsubishi original definition object groups)
6000h to 9FFFh	Standard device profile (Object groups specified by CiA402 Drive Profile belong to this group)
A000h to BFFFh	Standard interface profile (not used)
C000h to FFFFh	Reserved

Index assignment overview of manufacturer-inherent objects

Index	Description
2000h to 20FF	Control/communication protection/other objects
2100h to 21FFh	Status monitor-related
2200h to 21FFh	Status monitor-related (Spare)
2300h to 231Fh	Parameter-related
2320h to 23FFh	Parameter-related (Spare)
2400h to 5FFFh	Spare

### 8.3.2. Object Dictionary list

The following table shows a list of object dictionaries of MR-J3-□A-RJ158 + MR-J3-T04.

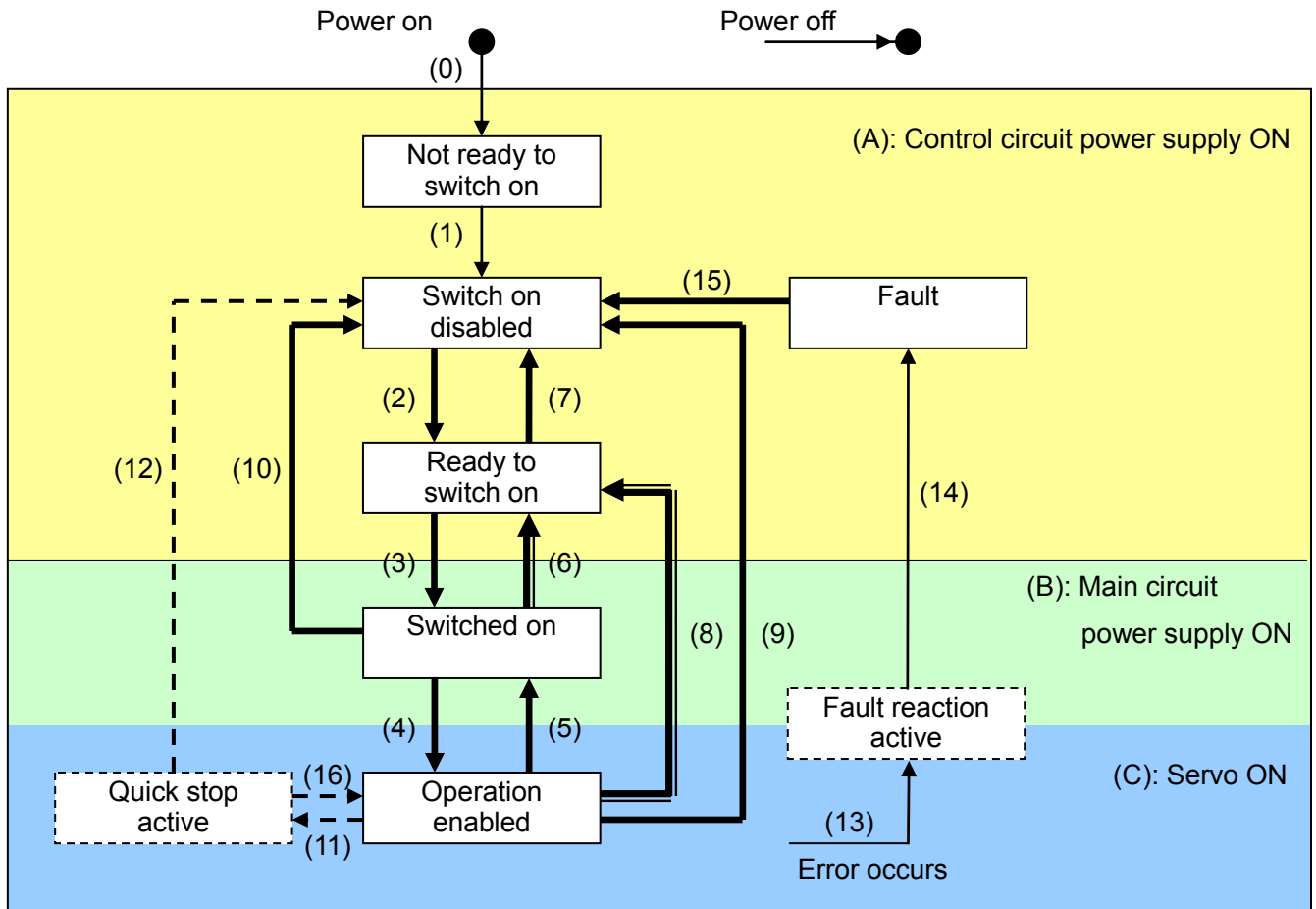
Large classification	Small classification (Index)	Reference	
General objects	Device Type (1000h)	—	
	Manufacturer Software Version (100Ah)	—	
	Store Parameter (1010h)	8.10	
	Identity object (1018h)	—	
PDO Mapping objects	21st receive PDO Mapping (1614h)	8.5.1	
	21st transmit PDO Mapping (1A14h)	8.5.2	
Sync Manager Communication objects	Sync Manager Communication Type (1C00h)	—	
	Sync Manager x PDO Assignment (1C10h to 1C13h)	—	
	Sync Manager x Synchronization (1C32h to 1C33h)	—	
Manufacturer Specific0 Objects	controlword2 to 5 (2001h to 2004h)	8.5.1	
	statusword2 to 5 (2011h to 2014h)	8.5.2	
	Incremental counter (2020h to 2021h)	8.5.1, 8.5.2, 8.11.1	
	Frame ID (2022h to 2023h) (Reserved)	—	
	Slave axis No. (2024h)	8.11.2	
	Alarm history (2030h to 2035h)	8.9	
	Clear alarm history (2040h)	8.9	
	Current alarm (2041h)	8.9	
	Max Velocity (2050h) (Reserved)	—	
	Monitor object (2100h)	8.8	
	Parameter objects (2300h to 2309h)	8.10	
	Device Control	controlword (6040h)	8.5.1
		statusword (6041h)	8.5.2
		Halt option code (605Dh) (Reserved)	8.12
Modes of operation (6060h)		8.4.2	
Modes of operation display (6061h)		—	
Position demand value (6062h)		—	
Position actual value (6064h)		8.5.2, 8.11.3	
Following error window (6065h)		—	
Following error time out (6066h)		—	
Position window (6067h)		8.4.2	
Velocity actual value (606Ch)		8.5.2	
Target torque (6071h) (Reserved)		—	
Torque actual value (6077h)		8.5.2	
Target position (607Ah)		8.5.1, 8.11.3	
Home offset (607Ch)		8.11.4, 8.11.6	
Software position limit (607Dh) (Reserved)		—	
Profile acceleration (6083h) (Reserved)		—	
Homing method (6098h)		8.11.7.1	
Homing speeds (6099h)		8.11.7.1	
Homing acceleration (609Ah)		8.11.7.1	
Interpolation time period (60C2h)		—	
torque limit value (60E0h to 60E1h)		8.5.1, 8.14	
Following error actual value (60F4h)		8.5.2	
Position demand internal value (60FCh)		—	
Target velocity (60FFh)		8.5.1	
Supported drive modes (6502h)		—	

## 8.4. CiA402 Drive Profile

### 8.4.1. FSA (Finite State Automaton) state

Internal status of MR-J3-□A-RJ158 and MR-J3-T04 are managed by the FSA state specified in CiA402. Transition conditions are shown in the followings. The master controls the status by sending commands (setting controlword) after the establishment of PDO communication (after the AL state reaches Operational). Servo motor will be ready to operate when the state transits from the state of "Not ready to switch on" just after the power-on to the state of "Operation enabled" by specified procedure.

(1) FSA state figure



※ Switch On bit (Controlword bit0) can not control the main circuit power supply.

(2) Events and FSA state transitions

Transition	Event(s)	Action(s)
(0)	Control power supply turns ON.	Initializing
(1)	Transits automatically by the control circuit power-ON.	Communication setting
(2)	Transits by <i>shutdown</i> command from the master.	None
(3)	Transits by <i>switch on</i> command from the master.	RA-ON
(4)	Transits by <i>enable operation</i> command from the master.	Operation will be enabled after servo-ON.
(5)	Transits by <i>disable operation</i> command from the master.	Operation will be disabled after servo-OFF.
(6)	Transits by <i>shutdown</i> command from the master.	RA-OFF
(7)	Transits by <i>disable voltage</i> command or <i>quick stop</i> command from the master.	None
(8)	(A) Transits by <i>shutdown</i> command from the master. (B) Transits by main circuit power-OFF.	Operation will be disabled after servo-OFF or RA-OFF.
(9)	Transits by <i>disable voltage</i> command from the master.	Operation will be disabled after servo-OFF or RA-OFF.
(10)	Transits by <i>disable voltage</i> command or <i>quick stop</i> command from the master.	RA-OFF
(11)	Transits by <i>quick stop</i> command from the master.	The quick stop function will be started. (not available)
(12)	(A) Transits automatically when the quick stop is completed. (When quick stop option code is 1, 2, 3 or 4.) (B) Transits by <i>disable voltage</i> command from the master.	Operation will be disabled after servo-OFF or RA-OFF.
(13)	Alarm occurrence	Alarm occurrence reaction processing will be executed.
(14)	Automatic transition	Servo and RA turn OFF after the alarm occurrence reaction processing is completed. Then the operation will be disabled.
(15)	Transits by <i>fault reset</i> command from the master.	Reset the alarm if possible. The fault reset bit in the Controlword will be cleared by the master.
(16)	Transits by <i>enable operation</i> command from the master. (When quick stop option code is 5, 6, 7 or 8.)	Operation will be enabled.

(3) Correspondent Bits of Controlword

Correspondent Bits of Controlword to FSA state commands are shown in the following table. For the list of Controlword Bits, refer to the section of PDO mapping.

Command	Command bit setting in controlword (6040h)					Transition
	Bit7 Fault Reset	Bit3 Enable Operation	Bit2 Quick Stop	Bit1 Enable Voltage	Bit0 Switch On	
Shutdown	0	x	1	1	0	(2), (6), (8)
Switch On	0	0	1	1	1	(3)
Disable Voltage	0	x	x	0	x	(7), (9), (10), (12)
Quick Stop	0	x	0	1	x	(7), (10), (11)
Disable Operation	0	0	1	1	1	(5)
Enable Operation	0	1	1	1	1	(4), (16)
Fault Reset	0⇒1	x	x	x	x	(15)

\* 0: OFF 1: ON x: either ON/OFF

\* Always set 0 to Bit 4, 5 and 6 since they are reserved. MR-J3-□A-RJ158 ignores the said bits.

\* Quick Stop command and function are not available.

\* To avoid commands missing during communication error, the status of Bit7=1 should be maintained for at least 10ms in Fault Reset command.

Note: FSA state transition conditions specified in EtherCAT standards are shown in (1) FSA state figure and (2) Events and FSA state transitions. To transit from the "Switch on disabled" status to "Operation enabled" status, it is necessary to provide each "Shutdown", "Switch on" and "Enable operation" command in order. However, MR-J3-□A-RJ158 can skip intermediate statuses and transit directly to the target status with one command.

Current status	Command	Transition target status
Switch on disabled	Switch on	Switched on
Switch on disabled	Enable operation	Operation enabled
Ready to switch on	Enable operation	Operation enabled

## 8.4.2. Control mode

The control mode is selected by Parameter PO02 after power on. The value of Modes of operation display object (Index 6061h) is set according to the control mode specified in PO02. However, if "Modes of operation object" (Index 6060h) is rewritten during test operation (except for motorless test), "Unsupported access to an object" (0x06 01 00 00) error will occur.

It is possible to switch the control mode during operation with changing the value of Modes of operation object (Index 6060h) by SDO download. However this data will be lost when turning off the power supply.

In the case of switching control mode right after power on, please store the parameter of the PO group in the RAM, using Store Parameter (Index 1010h) after changing parameter No.PO02 by SDO download.

It is not possible to set the control mode by parameter No.PA01. The value of PA01 is automatically changed depending on the control mode. Since MR Configurator does not support correspond, please do not rewrite PA01.

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
6060h	—	VAR	Modes of operation	I8	RW	0	0: No mode change 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode
6061h	—	VAR	Modes of operation display	I8	RO	0 [*1]	-1: Test mode [*2] 0: No mode assigned 6: Homing mode 8: Cyclic synchronous position mode 9: Cyclic synchronous velocity mode
6502h	—	VAR	Supported drive mode	U32	RO	000001A0h [*3]	bit5: Homing mode bit7: Cyclic sync position mode bit8: Cyclic sync velocity mode bit9: Cyclic sync torque mode

※ [\*1] Even though the default value is 0 at Device Description File, the value changes automatically at MR-J3-□A-RJ158 depending on the set value of parameter No.PO02.

※ [\*2] Modes of operation display object (Index 6061h) indicates selecting control mode. However, it returns to the value -1 during test operation (except motorless operation).

※ [\*3] Supported drive mode object (Index 6502h) shows the corresponding control mode.

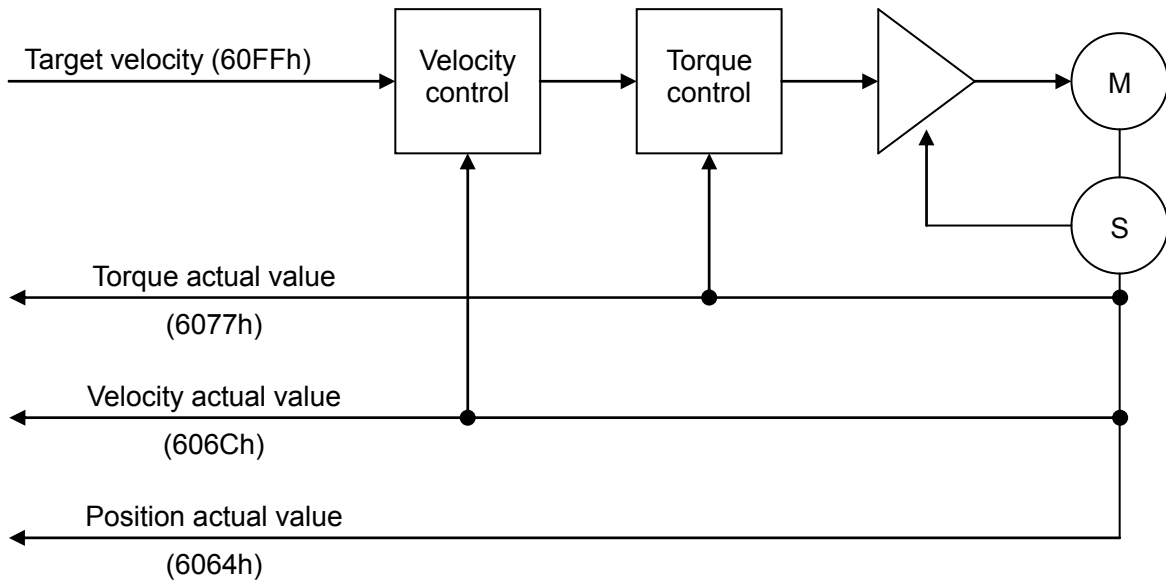
### Precautions of control mode change

- ① When changing control mode, always the Master needs to continue sending the command values accordingly current used control mode and new control mode. At this time, please be careful in order to avoid sudden moves of the motor. For example, when changing from Speed mode to position mode, please set 0 for command speed (Target velocity) and set the position demand value to position command (Target position). i.e. Each appropriate command must be sent for each before/after changing control mode.
- ② Control mode change is only possible when zero speed is detected. Although it is possible to get zero speed status from bit2 (S\_ZSP) of Statusword2, zero speed will be detected within parameter No. PC17 value setting. Then, zero speed means not always motor stop. After confirm motor stop by velocity actual value or position actual value etc, please change the control mode. (Note1)
- ③ Please set the control mode "Modes of operation object" after confirming, that the motor is stopped. If the desired control mode is set by Modes of operation object, it will be switched when changing control mode is possible. But the enough time to change the control mode, is not fixed. So, it must be confirmed whether control mode has been switched properly (by reading the value from the Mode of operation display object).
- ④ When control mode change is properly completed, the Master can stop to transmit the command for the previous control mode.
- ⑤ If control mode change fails, the control mode change is continuously executed until the change condition is satisfied.
- ⑥ If Modes of operation object is mapped into RxPDO, the Modes of operation object can not be changed by SDO communication. In that case, please change the object by PDO communication.

(Note1) The transmission/reflection of stop instruction makes some delay. Position command value is always updated periodically, during motor rotation. Then, if follow-up of current position is executed by setting position command value into target position before motor stop, there is danger possibility to have vibration because the target position is not stable due to difference between position command value and position actual value. Then, please change control mode, after position command value update is stopped.

#### 8.4.2.1 Speed control mode (Cyclic synchronous velocity mode)

The functions and relevant objects of speed control mode (csv) are as follows.

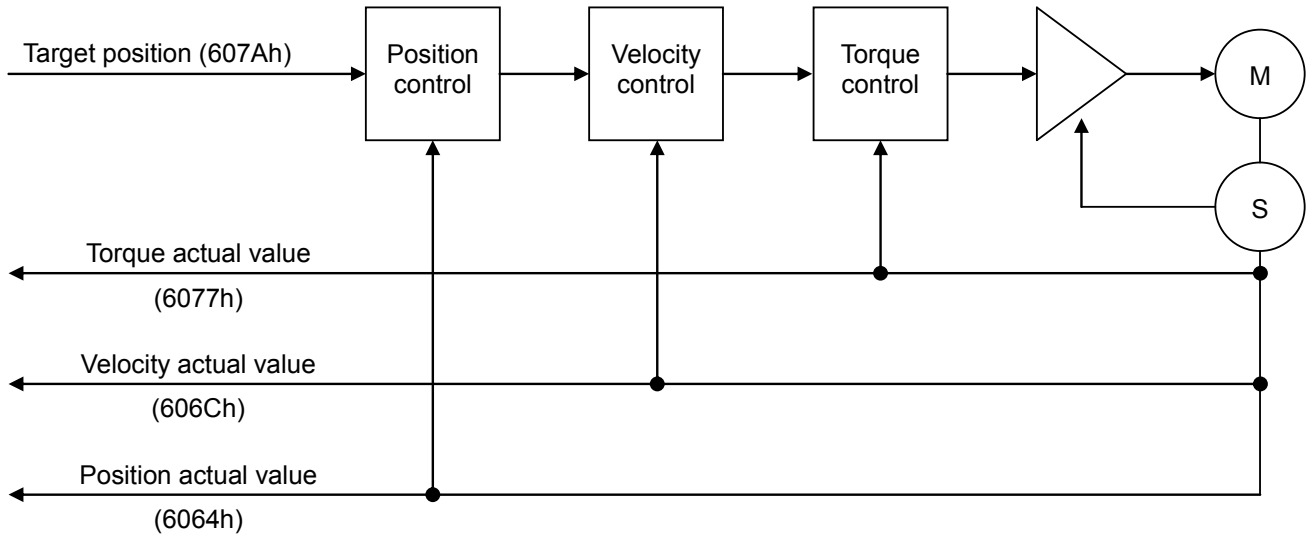


<Special note>

- The acceleration/deceleration time constant (PC01, 02, 03, 30, 31) is invalid during speed control mode (csv). The operation follows the controller command speed (Target velocity).

#### 8.4.2.2 Position control mode (Cyclic synchronous position mode)

The function and relevant objects of position control mode (csp) are as follows.



< Special note >

- Acceleration time constant (PB03) at position control mode (csp) is invalid. Operation is executed according to controller's position instruction (Target position).



## 8.5. PDO communication

In PDO (Process Data Object) communication, the command data and feedback data communicates between the master controller and slaves at a constant frequency. For MR-J3-□A-RJ158 and MR-J3-A-T04, the PDO mapping is fixed and cannot be changed.

### 8.5.1. RxPDO object mapping

In the default configuration, the following objects are sent from the master to the slave via RxPDO (master ⇒ slave run time communication direction).

Corresponding to the variable mapping function, the object sent and received by the PDO communication can be selected. For the object mapping changing method, please refer to chapter 8.6.

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Object Dictionary (Index)
Byte0	Incremental counter (RxPDO)								(Index 2020h-00h) Incremental counter (RxPDO)
Byte1	—								
Byte2	FR	OMS			EO	QS	EV	SO	(Index 6040h-00h) controlword
Byte3	—	—	—	—	—	OMS			
Byte4	C_CR	C_CR2	C_PC	C_TL1	C_TL	C_CDP	—	—	(Index 2001h-00h) controlword2
Byte5	—	—	—	—	—	—	—	C_MSTOP	
Byte6	—	—	—	—	—	—	—	—	(Index 2002h-00h) controlword3
Byte7	—	—	—	—	—	—	—	—	
Byte8	—	—	—	—	—	—	—	—	(Index 2003h-00h) controlword4
Byte9	—	—	—	—	—	—	—	—	
Byte10	—	—	—	—	—	—	—	—	(Index 2004h-00h) controlword5
Byte11	—	—	—	—	—	—	—	—	
Byte12	Target position Unit: 1pulse/LSB (Increase address: Motor rotates as CCW direction. Can change the polarity by Parameter PA14.)								(Index 607Ah-00h) Target position
Byte13									Valid only in position control mode(csp).
Byte14									
Byte15									
Byte16	Target velocity [*1] Unit: 0.001r/min/LSB [*2] (Positive number: Motor rotates as CCW. Can change the polarity by Parameter PA14.)								(Index 60FFh-00h) Target velocity
Byte17									Valid only in speed control mode(csv).
Byte18									
Byte19									
Byte20	—								(Index 2050h-00h) Max velocity
Byte21									
Byte22									
Byte23									
Byte24	—								(Index 6071h-00h) Target torque
Byte25									
Byte26	Positive torque limit value								(Index 60E0h-00h) Positive torque limit value
Byte27	Unit: 0.1%/LSB (100% rated torque conversion)								
Byte28	Negative torque limit value								(Index 60E1h-00h) Negative torque limit value
Byte29	Unit: 0.1%/LSB (100% rated torque conversion)								

\* All data should be processed in little endian order.

\* Objects and functions in the shaded region in the table are not available. (Only the mapping of empty objects)

[\*1] When the target velocity exceeds 120% of the maximum motor speed, the operation follows the target velocity which is fixed to 120% of the maximum motor speed. For the maximum motor speed, refer to the product catalogs.

[\*2] The unit of command speed is 0.001r/min/LSB. However, the data is rounded down to the nearest 0.01, in amplifier.

### Controlword (6040h)

Bit	Symbol	Description	MR-J3-□A-RJ158
0	SO	Switch on	○
1	EV	Enable Voltage	○
2	QS	Quick stop	△
3	EO	Enable operation	○
4	OMS	Operation mode specific ※ Depending on the control mode, the content is different.	○
5			
6			
7	FR	Fault reset	○
8	H	Halt	○
9	OMS	Operation mode specific ※ Depending on the control mode, the content is different.	○
10	—	(Not used)	—
11	—	(Not used)	—
12	—	(Not used)	—
13	—	(Not used)	—
14	—	(Not used)	—
15	—	(Not used)	—

\* ○: Compatible, —: Not compatible, △: Used for changing the FSA state; however, not available for the Quick Stop function.

\* Objects and functions in the shaded region in the table are not available with the software version A0A.

\* Bit 0 to 3 and 7 are used for FSA state change. For details on the bit setting, refer to (3) of section 8.4.1.

\* The function of HALT function is invalid in the speed control (csv) mode and position control (csp) mode.

※ Speed control mode (csv) and position control mode (csp) are invalid at OMS bit (Bit4-6,8-9).

### OMS bit allocation during homing mode (hm)

Bit	Content	Description	MR-J3-□A-RJ158
4	HOS	Homing operation start 0: Do not start homing procedure 1: Start or continue homing procedure	○
5	—	(reserved)	—
6	—	(reserved)	—
8	HALT	Halt 0: bit 4 enable 1: Stop axis according to halt option code (605Dh)	○
9	—	(reserved)	—

### Controlword2 (4001h)

Bit	Symbol	Description	MR-J3-□A-RJ158		
			H	P	S
0	—	(Not used)	—	—	—
1	—	(Not used)	—	—	—
2	C_CDP	Gain switch	○	○	○
3	C_TL	Controller torque limit selection	○	○	○
4	C_TL1	Internal torque limit selection	○	○	○
5	C_PC	Proportion control	○	○	○
6	C_CR2	Clear 2	—	○	○
7	C_CR	Clear	—	○	○
8	C_MSTOP	When the manual stop 1 is set, a slow stop occurs. This bit is also used for the restart control at the reaching of the stroke end.	—	○	○
9	—	(Not used)	—	—	—
10	—	(Not used)	—	—	—
11	—	(Not used)	—	—	—
12	—	(Not used)	—	—	—
13	—	(Not used)	—	—	—
14	—	(Not used)	—	—	—
15	—	(Not used)	—	—	—

\* Controlword2 is a Mitsubishi original definition object.

\* H: Homing mode (hm), P: Position control mode (csp), S: Speed control mode (csv)  
(○: Compatible, —: Not compatible)

\* Objects and functions in the shaded region in the table are not available.

\* Bit 6 and 7 are used for the home position setting. For details, refer to 8.11.6

### 8.5.2. TxPDO object mapping

In the default configuration, the following objects are sent to the master from the slave via TxPDO (slave ⇒ master run time communication direction). Corresponding to the variable mapping function, the object sent and received by the PDO communication can be selected. For the object mapping changing method, please refer to paragraph 8.6.

	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Object Dictionary (Index)
Byte0	Incremental counter (TxPDO)								(Index 2021h-00h) Incremental counter (TxPDO)
Byte1	—								
Byte2	W	SOD	QS	VE	F	OE	SO	RTSO	(Index 6041h-00h)
Byte3	—	S_FLW	OMS		ILA	TR	RM	—	statusword
Byte4	S_ZPAS	S_CDPS	S_INP	—	S_TLC	S_ZSP	S_SA	S_TST	(Index 2011h-00h)
Byte5	S_BWNG	S_SYNC	S_LSN	S_LSP	S_ABSV	S_MBR	S_OP	S_OSET	statusword2
Byte6	—	—	—	—	—	—	—	—	(Index 2012h-00h)
Byte7	—	—	—	—	—	—	—	—	statusword3
Byte8	—	—	—	—	—	—	—	—	(Index 2013h-00h)
Byte9	—	—	—	—	—	—	—	—	statusword4
Byte10	—	—	—	—	—	—	—	—	(Index 2014h-00h)
Byte11	—	—	—	—	—	—	—	—	statusword5
Byte12	Position actual value								(Index 6064h-00h)
Byte13	Unit: 1pulse/LSB								Position actual value
Byte14	When the position address increases, the motor rotates in CCW direction. The logic								
Byte15	can be reversed by parameter PA14								
Byte16	Velocity actual value								(Index 606Ch-00h)
Byte17	Unit: 0.001r/min/LSB								Velocity actual value
Byte18	(Counter clockwise rotation: Positive number.								
Byte19	The logic can be reversed by parameter PA14)								
Byte20	Following error actual value								(Index 60F4h-00h)
Byte21	Width error (accumulation pulse) present value								Following error actual value
Byte22	Unit: 1pulse/LSB								
Byte23									
Byte24	Torque actual value								(Index 6077h-00h)
Byte25	Unit: 0.1%/LSB (100% rated torque conversion)								Torque actual value

\* All data should be processed in little endian order.

\* Objects and functions in the shaded region in the table  are not available. (Only the mapping of empty objects)

Statusword (6040h)

Bit	Symbol	Description	MR-J3-□A-RJ158
0	RTSO	Ready to switch on	○
1	SO	Switched on	○
2	OE	Operation enabled	○
3	F	Fault	○
4	VE	Voltage enabled	○
5	QS	Quick stop 0: During quick stop 1: During non-quick stop (including during test mode) * Always 1, since the quick stop function is not supported.	○
6	SOD	Switch on disabled	○
7	W	Warning 0: Warning not occurred 1: Warning occurred	○
8	—	(Not used)	—
9	RM	Remote 0: Not in compliance with Controlword command 1: In compliance with Controlword command * Turns to 1 during Operation state in the normal operation or during the motor-less operation mode.	○
10	TR	Target reached 0: Positioning not completed 1: Positioning completed TR turns on when the number of droop pulses is in the preset inposition range (parameter No.PA10, position window (Index: 6067h)).	○
11	ILA	Internal limit active 0: Software position limit not reached 1: Software position limit reached	○
12	OMS	Operation mode specific	○
13		* The content varies according to the control mode.	
14	S_FLW	Follow up trigger 1: Position follow up request state ※ When stopping is caused since the stroke end is reached or MSTOP function is executed, the timing for follow-up of current position by this bit. For more information, refer to the section 8.10.6 and 8.12.	○
15	—	(Not used)	—

\* ○: Compatible —: Not compatible

\* Objects and functions in the shaded region in the table are not available.

\* Bit 0 to 3, 5 and 6 are switched according to the FSA state or to the internal status of MR-J3-□A-RJ158. Details are shown in the following table "State coding (in the EtherCAT mode or during the motor-less operation)".

\* After excluding the motor-less operation and transiting to the test operation mode, FSA state administration in compliance with Controlword is not executed. However, the output of Statusword Bit0 to 3, 5 and 6 is continued according to the internal status of the servo amplifier. Details are shown in the following table "State coding (after moving to the test mode)".

\* Each bit of TR and ILA is valid only in position control mode. (Not available with the A0 version)

\* TR bit is invalid in speed control mode and position control mode.

\* ILA, S\_FLW bits are only available in position control mode. The TR bit is only valid during home position mode (hm).

State coding (in the EtherCAT mode or during the motor-less operation)

Statusword (bin)	FSA state
x0xx xxx0 x0xx 0000	Not ready to switch on [*1]
x0xx xxx0 x1xx 0000	Switch on disabled
x0xx xxx0 x01x 0001	Ready to switch on
x0xx xxx0 x01x 0011	Switched on
x0xx xxx0 x01x 0111	Operation enabled
x0xx xxx0 x00x 0111	Quick stop active
x0xx xxx0 x0xx 1111	Fault reaction active
x0xx xxx0 x0xx 1000	Fault

\* Not available with the status shaded in the table.

[\*1] Statusword is not sent in the Not ready to switch on status.

State coding (after moving to the test mode)

Statusword (bin)	Conditions during the test mode excluding the motor-less operation	After exiting the test mode
10xx xx00 x01x 0001	Main circuit power supply OFF status	Main circuit power supply OFF status
10xx xx00 x01x 0011	Main circuit power supply ON status	
10xx xx00 x01x 0111	Servo-on status	
10xx xx00 x01x 1000	Fault	Fault

OMS bit assignment in speed control mode

Bit	Name	Description	MR-J3-□A-RJ158
12	Target velocity ignored	0: Scrapping the target velocity. 1: Using the target velocity as the speed control loop input	○
13	—	(Reserved)	—

\* ○: Compatible —: Not compatible

\* Objects and functions in the shaded region in the table  are not available.

OMS bit assignment in the position control mode

Bit	Name	Description	MR-J3-□A-RJ158
12	Target position ignored	0: Canceling Target position 1: Using Target position as position loop input	○
13	Following error	0: No droop pulses 1: There are Droops pulses ※ It will be 1, if set time (unit: msec) using Following error time out object (6066h) is continually Following error actual value(60F4h) $\geq$ Following error window(6065h)	○

※ ○: compatible —: Not compatible

OMS bit allocation during home position mode (hm)

Bit	Content	Description	MR-J3-□A-RJ158
12	Homing attained	See below table	○
13	Homing error	See below table	○

※ ○: corresponding —: not corresponding

bit 10, 12, 13 definition at Homing mode (hm)

Bit 13	Bit 12	Bit 10	Definition
0	0	0	Homing is in progress
0	0	1	Homing is interrupted or not started yet.
0	1	0	Homing is finished, but the position does not reach to target.
0	1	1	Homing is completed successfully.
1	0	0	Homing error occurred, velocity is not 0.
1	0	1	Homing error occurred, velocity is 0
1	1	x	reserved

※ x: Indefinite

※ During servo off bit10=bit12=0.

Statusword2 (4011h)

Bit	Symbol	Description	MR-J3-□A-RJ158		
			H	P	S
0	S_TST	Test mode flag [*1] 0: normal status 1 :after moving to the test mode	○	○	○
1	S_SA	Speed reached 1: The servo motor speed is reaching the command speed Always 1 when the command speed is 20rpm or less.	—	—	○
2	S_ZSP	Zero speed 1: The servo motor speed is zero speed (50rpm) or less. The zero speed can be changed by parameter No. PC17.	○	○	○
3	S_TLC	Limiting torque 1: Generated torque has reached the torque limit value. For the valid torque limit values, refer to 8.13	○	○	○
4	S_VLC	Limiting speed	—	—	—
5	S_INP	Positioning completion 0 : Positioning not completed 1: Positioning completed S_INP turns on when the number of droop pulses is in the preset inposition range (parameter No.PA10, position window (Index: 6067h)).	○	○	—
6	S_CDPS	Variable gain selection	○	○	○
7	S_ZPAS	Z phase has been passed. 0: After turning on, Z phase has not been passed. 1: After turning on, Z phase is passed once.	○	○	○
8	S_OSET	Home position setting is completed. 1: Home position setting by C_CR or C_CR2 is completed.	—	○	○
9	S_OP	Encoder Z-phase pulse 1: Encoder output is at the zero-point position.	○	○	○
10	S_MBR	Electromagnetic brake interlock 0: With the servo-off or alarm occurrence	○	○	○
11	S_ABSV	Absolute position erasing 1: With absolute position erased.	○	○	○
12	S_LSP	Forward rotation stroke end input state 1: LSP signal is turned ON or LSP Auto ON is valid.	○	○	○
13	S_LSN	Reverse rotation stroke end input state 1: LSN signal is turned ON or LSN Auto ON is valid.	○	○	○
14	S_SYNC	Synchronous check flag [*2] 0: Synchronization not completed 1: Synchronization completed	○	○	○
15	S_BWNG	Battery warning 1: With battery cable disconnection warning (AL.92) or battery warning (AL.9F) occurrence.	○	○	○

\* Statusword2 is a Mitsubishi original definition object.

\* H : Homing mode (hm), P: Position control mode (csp), S: Speed control mode (csv) (○: Compatible, —: Not compatible)

\* Objects and functions in the shaded region in the table are not available.

[\*1] Bit is 1 during the test operation or after finishing the operation. In the 1 status, motors cannot be driven by EtherCAT command. To restart the operation, turn OFF the motor and start it again.

[\*2] When ESC (EtherCAT Slave Controller) mounted with MR-J3-T04, and CPU and control ASIC mounted with MR-J3-□A-RJ158, etc. are correctly synchronized, the bit14 of Statusword2 (S\_SYNC bit) is turned ON.S\_SYNC indicates the synchronization established status in each MR-J3-□A-RJ158 inside, and not the synchronous status with other slaves and the master controller.

### 8.5.3. RxPDO object definition

The following objects can be mapped to RxPDO.

Index	Sub-idx	Object	Name	Type	Attr.	Default value	Description
2020h	—	VAR	Incremental counter(RxPDO)	U8	RW	—	Counter for communication check (For RxPDO)
2022h	—	VAR	Frame ID (RxPDO) (not supported)	U8	RW	—	(Reserved) Frame ID for communication check (For RxPDO)
6040h	—	VAR	Controlword	U16	RW	0	For the meaning of each bit, refer to 8.5.1.
2001h	—	VAR	Controlword2	U16	RW	0	For the meaning of each bit, refer to 8.5.1.
2002h	—	VAR	Controlword3 (not supported)	U16	RW	0	(Reserved)
2003h	—	VAR	Controlword4 (not supported)	U16	RW	0	(Reserved)
2004h	—	VAR	Controlword5 (not supported)	U16	RW	0	(Reserved)
607Ah	—	VAR	Target position	I32	RW	0	Valid only in position control mode. Unit: 1pulse/LSB
60FFh	—	VAR	Target velocity	I32	RW	0	Command speed Valid only in speed control mode. Unit: 0.001r/min/LSB [*1] Positive number: Counter clockwise rotation Negative number: Clockwise rotation
2050h	—	VAR	Max velocity (not supported)	U32	RW	0	Max velocity Valid only in torque control mode. Unit: 0.001r/min/LSB Rated speed of the connected servo motor when "0" is set. Setting range is from 0 to 7FFFFFFFh.
6071h	—	VAR	Target torque (not supported)	I16	RW	0	Valid only in torque control mode. Unit: 0.1%/LSB (100% rated torque conversion)
60E0h	—	VAR	Positive torque limit value	U16	RW	3000	Positive torque limit value Unit: 0.1%/LSB (100% rated torque conversion)
60E1h	—	VAR	Negative torque limit value	U16	RW	3000	Negative torque limit value Unit: 0.1%/LSB (100% rated torque conversion)
6060h	—	VAR	Modes of operation	I8	RW	0	0: No mode change 6: Homing mode 8: Cyclic sync position mode 9: Cyclic sync velocity mode

\* All data should be processed in little endian order.

\* Not available with the objects and functions shaded  in the table. (Only the mapping of empty objects)

\* [\*1] The unit of command speed is 0.001r/min/LSB. However, the data is rounded down to the nearest 0.01, in amplifier.

Object which is needed to map to RxPDO to motor control

Index	Object name	Homing mode(hm)	Cyclic synchronous position mode (csp)	Cyclic synchronous velocity mode (csv)
2020h	Incremental counter (RxPDO)	○	○	○
6040h	Controlword	◎	◎	◎
2001h	Controlword2	○	○	○
607Ah	Target position	—	◎	—
60FFh	Target velocity	—	—	◎

◎ : Need to map    ○ : Recommend to map    — : No need to map

#### 8.5.4. TxPDO object definition

The following objects can be mapped to TxPDO.

Index	Sub-idx	Object	Name	Type	Attr.	Default value	Description
2021h	—	VAR	Incremental counter(TxPDO)	U8	RO	—	Counter for communication check (For TxPDO)
2023h	—	VAR	Frame ID (TxPDO) (not supported)	U8	RO	—	Frame ID for communication check (For TxPDO)
6041h	—	VAR	Statusword	U16	RO	—	Reading the status For the meaning of each bit, refer to 8.5.2.
2011h	—	VAR	Statusword2	U16	RO	—	Reading the status 2 For the meaning of each bit, refer to 8.5.2.
2012h	—	VAR	Statusword3 (not supported)	U16	RO	—	(Reserved)
2013h	—	VAR	Statusword4 (not supported)	U16	RO	—	(Reserved)
2014h	—	VAR	Statusword5 (not supported)	U16	RO	—	(Reserved)
6064h	—	VAR	Position actual value	I32	RO	—	Position actual value Unit: 1pulse/LSB
606Ch	—	VAR	Velocity actual value	I32	RO	—	Velocity actual value Unit: 0.001r/min/LSB
60F4h	—	VAR	Following error actual value	I32	RO	—	Following error actual value Valid only in position control mode. Unit: 1pulse/LSB
6077h	—	VAR	Torque actual value	I16	RW	—	Torque actual value Unit: 0.1%/LSB (100% rated torque conversion)
6061h	—	VAR	Modes of operation display	I8	RO	—	-1: Test mode [*1] 0: No mode assigned 6: Homing mode 8: Cyclic sync position mode 9: Cyclic sync velocity mode
6062h	—	VAR	Position demand value	I32	RO	—	Internal value of position command (command unit) Unit: 1Pulse/LSB
60FCh	—	VAR	Position demand internal value	I32	RO	—	Internal value of position command (Encoder unit) Unit: 1Pulse/LSB
2041h	—	VAR	Current alarm	U16	RO	—	Effective Alarm

\* All data should be processed in little endian order.

\* Not available with the objects and functions shaded  in the table. (Only the mapping of empty objects)

[\*1] Modes of operation display object (Index 6061h) shows the current selected control mode. However, during or after test operation (except motor-less operation), this object send “-1”.

Object which is needed to map to TxPDO to motor control

Index	Object name	Homing mode (hm)	Cyclic synchronous position mode (csp)	Cyclic synchronous velocity mode (csv)
2021h	Incremental counter (TxPDO)	○	○	○
6041h	Statusword	◎	◎	◎
2011h	Statusword2	○	○	○
6064h	Position actual value	○	○	○
606Ch	Velocity actual value	○	○	○

◎ : Need to map      ○ : Recommend to map



## 8.6. Changeable mapping function of PDO communication data

This amplifier has changeable mapping function to arbitrarily map of arbitrary object for RxPDO and TxPDO data. Please change in the PDO mapping as described below.

### 8.6.1. PDO mapping restrictions

- The total number of object for RxPDO and TxPDO, which can be mapped, is each 15 or less.
- The maximum size of the object mapping for RxPDO and TxPDO is each 30 bytes or less.
- PDO mapping can be changed during only pre operational state. Once the state goes to safe operational state or operational state, PDO mapping can not be changed, even the state is returned to operational state.
- Only 21st receive PDO Mapping (1614h) and 21st transmit PDO Mapping (1A14h) can be used for changeable mapping function.
- “Complete Access” is not available. The rewriting of map object can be done by SDP downloading as each sub object.
- Can adjust an alignment of object layout, by inserting gap(Index:0000h、 Sub-Index:0) into mapping object. Gap size 0, 8, 16, 24 or 32 bit can be inserted.
- If same object is mapped twice or more into RxPDO, the object data which has the biggest number of Sub-Index will be valid.

### 8.6.2. Changing procedure of PDO mapping

- ①After the power supply is turned on, go to Pre Operational state.
- ②Write 「0」 into the Sub-Index 0 of the PDO mapping object (RxPDO=1614h, TxPDO=1A14h).  
(PDO mapping object will be invalid. Then, it is available to change PDO mapping.)
- ③The object information is written inside the the PDO mapping object's Sub-Index1~15.  
Object information is 4 byte data based on the following item.
  - Index(2byte)
  - Sub-Index(1byte)
  - Object size (1byte) ※The unit of the object is bit.
 (Example) In case of mapping Target velocity(60FFh) into first 4byte of RxPDO.  
Write “60 FF 00 20” into “Index:1614h Sub-Index:1”.
- ④Write the number of using entry, into Sub-Index0 of PDO mapping object.  
(Then PDO mapping object will be valid, and it is unavailable to change PDO mapping.)

### Object definition of PDO mapping

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
1614h	0	ARRAY	21st receive PDO Mapping	U8	RW	13	Number of entry
	1		Mapping entry 1	U32	RW	20200008h	Default:Incremental counter
	2		Mapping entry 2	U32	RW	20220008h	Default:Frame ID
	3		Mapping entry 3	U32	RW	60400010h	Default:controlword
	4		Mapping entry 4	U32	RW	20010010h	Default:controlword2
	5		Mapping entry 5	U32	RW	20020010h	Default:controlword3
	6		Mapping entry 6	U32	RW	20030010h	Default:controlword4
	7		Mapping entry 7	U32	RW	20040010h	Default:controlword5
	8		Mapping entry 8	U32	RW	607A0020h	Default:Target position
	9		Mapping entry 9	U32	RW	60FF0020h	Default:Target velocity
	10		Mapping entry 10	U32	RW	20500020h	Default:Max velocity
	11		Mapping entry 11	U32	RW	60710010h	Default:Target torque
	12		Mapping entry 12	U32	RW	60E00010h	Default:Positive torque limit value
	13		Mapping entry 13	U32	RW	60E10010h	Default:Negative torque limit value
	14		Mapping entry 14	U32	RW	00000000h	Default: empty
15	Mapping entry 15	U32	RW	00000000h	Default: empty		
1A14h	0	ARRAY	21st transmit PDO Mapping	U8	RW	11	Number of entry
	1		Mapping entry 1	U32	RW	20210008h	Default:Incremental counter
	2		Mapping entry 2	U32	RW	20230008h	Default:Frame ID
	3		Mapping entry 3	U32	RW	60410010h	Default:statusword
	4		Mapping entry 4	U32	RW	20110010h	Default:statusword2
	5		Mapping entry 5	U32	RW	20120010h	Default:statusword3

	6		Mapping entry 6	U32	RW	20130010h	Default:statusword4
	7		Mapping entry 7	U32	RW	20140010h	Default:statusword5
	8		Mapping entry 8	U32	RW	60640020h	Default:Position actual value
	9		Mapping entry 9	U32	RW	606C0020h	Default:Velocity actual value
	10		Mapping entry 10	U32	RW	60F40020h	Default:Following err actual value
	11		Mapping entry 11	U32	RW	60770010h	Default:Torque actual value
	12		Mapping entry 12	U32	RW	00000000h	Default: empty
	13		Mapping entry 13	U32	RW	00000000h	Default: empty
	14		Mapping entry 14	U32	RW	00000000h	Default: empty
	15		Mapping entry 15	U32	RW	00000000h	Default: empty
1C12h	0	ARRAY	Sync Manager 2 PDO Assignment	U8	RO	1	Number of entry
	1		PDO Mapping object index of assigned RxPDO	U16	RO	1614h	Designation of 21 <sup>st</sup> receive PDO Mapping.
1C13h	0	ARRAY	Sync Manager 3 PDO Assignment	U8	RO	1	Number of entry
			PDO Mapping object index of assigned TxPDO	U16	RO	1A14h	Designation of 21 <sup>st</sup> transmit PDO Mapping.

PDO mapping object (RxPDO=1614h、TxPDO=1A14h) can be saved into nonvolatile memory.

In order to save the changed PDO mapping into nonvolatile memory, please use Store Parameter(Index:1010h、Sub-Index:15). Refer to Chapter 8.10.2.

When the power turn on, the PDO mapping data in nonvolatile memory will be reflected as PDO mapping object.

### CAUTION

- Please make sure to read/write PDO data at master controller based on PDO mapping which is set at servo amplifier. If master controller read/write PDO data with difference against PDO mapping, it is danger. For example; An unintended data is used as command for motor control.

## 8.7. SDO communication

SDO (Service Data Object) communication transmits object data between Master controller (client) and Slaves (server) asynchronously.

### 8.7.1. SDO communication-related services

The following services related to SDO communication are available for MR-J3-□A-RJ158 + MR-J3-T04.

Service	Description
SDO Download	Object value download (writing from controller to servo amplifier)
SDO Upload	Object value upload (reading from servo amplifier to controller)
Get OD List	Returns the list of the accessible object indexes.
Get Object Description	Returns the detailed information on the specified index objects.
Get Entry Description	Returns the detailed information on the specified sub index entries.

For details on the data format of requests and responses to the services etc., refer to the EtherCAT standard of such as IEC61158.

SDO communication-related services are treated as asynchronous processing. Each SDO services request sent from the master (client) are kept in mailbox, and slaves (server) respond to the requests as needed in order. When multiple requests are received, they are stored in the mailbox in order. Requests are processed one by one in the arrival order, and simultaneous response processing for multiple requests is not performed. As a restriction of the master, do not send multiple requests at the same time. When the master sends a SDO service request, acquire the response from the slave, and send the next request after making sure that the slave finished the last processing.

#### (1) SDO Download service

Writes the specified value to the object which corresponds to the Index and Sub Index values. Both Index and Sub Index values are specified when the master sends the SDO Download request. However, writing to objects mapped to PDO causes an error to avoid the object value unconformity occurrence. MR-J3-□A-RJ158 recognizes the white value as the data type of white target object. Make sure to set the write value according to the data type of target object.

For this service, the following error codes (SDO Abort Code) are given according to the condition.

SDO Abort Code	Meaning	Condition
0x06 02 00 00	The object does not exist in the object dictionary	This code is given when specifying a nonexistent index value.
0x06 09 00 11	Subindex does not exist	This code is given when specifying a nonexistent sub index value.
0x06 01 00 02	Attempt to write to a read only object	1) This code is given when writing to a "Read only" object. 2) Wrote in object which was unwritable as current AL state, even it was not read- only object as all AL state.
0x06 01 00 00	Unsupported access to an object	1) Wrote in object, where PDO mapping is done. 2) During PDO mapping object unchangeable state, the following was done. - Written in Sub-Index 0 excluding "0". - Written in Sub-Index1-15.
0x06 04 00 41	The object can not be mapped into the PDO	PDO mapping object was written in an object that is not able to do PDO mapping.
0x06 04 00 42	The number and length of the object to be mapped would exceed the PDO length	The total size of the object exceeds 30bytes.
0x06 09 00 30	Value range of parameter exceeded	This code is given when writing a value outside the parameter range.
0x06 09 00 31	Value of parameter written too high	This code is given when writing a value greater than the parameter range.
0x06 09 00 32	Value of parameter written too low	This code is given when writing a value lower than the parameter range.
0x08 00 00 20	Data cannot be transferred or stored to the application	This code is given when writing to a parameter object which is outside of the writing range of parameter block setting.

(2) SDO Upload service

Returns the value of the object which corresponds to the Index and Sub Index values. Both Index and Sub Index values are specified when the master sends SDO Upload request.

For this service, the following error codes (SDO Abort Code) are given according to the condition.

SDO Abort Code	Meaning	Condition
0x06 02 00 00	The object does not exist in the object dictionary	This code is given when specifying a nonexistent index value.
0x06 09 00 11	Subindex does not exist	This code is given when specifying a nonexistent sub index value.
0x06 01 00 01	Attempt to read to a write only object	This code is given when reading from a "Write only" object.
0x06 01 00 00	Unsupported access to an object	1) This code is given when reading from a parameter object which is outside the reference range of parameter block setting. 2) This code is given when reading from an object which is not "Write only", but "Read invalid" at AL state.

(3) Get OD List service

According to the List Type value which is specified when the master provides a Get OD List request, the number of corresponding objects to each List Type or the Index list of corresponding objects is returned in RES packet. Addressable List Type values are as follows.

List Type value	Description
0x00	Returns the number of corresponding objects to each List Type 0x01 to 0x05.
0x01	Returns to the index list of all objects.
0x02	Returns the index list of objects which can be mapped to RxPDO.
0x03	Returns the index list of objects which can be mapped to TxPDO.
0x04	Returns the index list of objects which require backups.
0x05	Returns the index list of objects which are used as start-up parameters.

For this service, the following error codes (SDO Abort Code) are given according to the condition.

SDO Abort Code	Meaning	Condition
0x08 00 00 00	General error	This code is given when specifying a list type value outside the standards.

(4) Get Object Description service

Returns object data types, the maximum value of Sub Index, object codes and object names in RES packet which correspond to the Index value. The Index value is specified when the master provides a Get Object Description request.

The object name returned by this service needs to be within 46 characters, for convenience of name data internal management. Also, the object name may be different from the object definition name in the device description file.

List of Data Type of RECORD type objects

Index	Object Name	Data Type
1010h	Store Parameter	07h
1018h	Identity object	23h
1614h	21st receive PDO Mapping	21h
1A14h	21st transmit PDO Mapping	21h
1C12h~1C13h	Sync Manager X PDO Assignment	06h
1C32h~1C33h	Sync Manager X Synchronization	29h
2030h~2035h	Alarm history 0~5	40h
2100h	Monitor (Servo)	41h
2300h~2309h	Parameter group settings Basic setting (PA) to Option unit (PO)	50h
60C2h	Interpolation time period	80h

List of object codes

Object Code value	Description	
7	Variable	Single value
8	Array	Contains two or more sub indexes (elements) and each element object belongs to the same data type.
9	Record	Contains two or more sub indexes (elements) and each element object belongs to a different data type.

For this service, the following error codes (SDO Abort Code) are given according to the condition.

Responding error of Get Object Description

SDO Abort Code	Meaning	Condition
0x06 02 00 00	The object does not exist in the object dictionary	This code is given when specifying a nonexistent index value.

(5) Get Entry Description service

Returns object data types, object data length, object access authority and the information specified by the master in Value Info, all corresponding to the Index and Sub Index values, in RES packet. The Index and Sub Index values are specified when the master provides a Get Object Description request.

Value Info is given in 8-bit values, and returns the information corresponding to the bit which is set "1". When multiple bits of bit 4 to 6 in Value Info receive "1" as the Get Entry Description request, only one bit should be responded and other bits are ignored by giving the priority to the reference information for the lower bit.

Access authority is returned with a 16-bit value in which "1" is set to the corresponding bit.

Bit Number	Reference information	MR-J3-□A-RJ158
Bit 0	Access authority	○
Bit 1	Object category (Reserved)	—
Bit 2	Availability of PDO mapping	○
Bit 3	Unit Type (Reserved)	—
Bit 4	Default value	○
Bit 5	Minimum value	○
Bit 6	Maximum value	○
Bit 7	Not used	—

Bit Number	Meaning
Bit 0	Available for reading at PRE-OPE.
Bit 1	Available for reading at SAFE-OPE.
Bit 2	Available for reading at OP.
Bit 3	Available for writing at PRE-OPE.
Bit 4	Available for writing at SAFE-OPE.
Bit 5	Available for writing at OP.
Bit 6	Available for RxPDO mapping.
Bit 7	Available for TxPDO mapping.
Bit 8	Backup object
Bit 9	Object for configuration
Bit 10-15	Not used

For this service, the following error codes (SDO Abort Code) are given according to the condition.

SDO Abort Code	Meaning	Condition
0x06 02 00 00	The object does not exist in the object dictionary	This code is given when specifying a nonexistent index value.
0x06 09 00 11	Subindex does not exist	This code is given when specifying a nonexistent sub index value.
0x08 00 00 00	General error	This code is given when specifying a "Value Info" value which is outside the standards or not compatible.

## 8.8. Status monitor object

The master station can monitor the servo amplifier status by acquiring object values of Monitor 1 to 25 via SDO communication.

"Data" type is integer 32, and the unit of each monitor value is the same as MR-J3-□A standard products.

In the serial communication, 48-bit format added by display type and decimal position information is used. However, this object uses the 32-bit data since the display types and the decimal positions are fixed to the corresponding monitor information.

Index	Sub-Idx	Obj-Code	Name	Type	default	Description
2100h	0	RECORD	Monitor (Servo)	U8	25	Number of entries
	1		Monitor 1 Cumulative feedback pulses	I32	—	Cumulative feedback pulses (Unit: pulse) Cumulative feedback pulses are cleared by the writing of "0000 1EA5h".
	2		Monitor 2 Servo motor speed	I32	—	Servo motor speed (Unit: r/min)
	3		Monitor 3 Droop pulses	I32	—	Droop pulses (Unit: pulse)
	4		Monitor 4 Cumulative command pulses	I32	—	Cumulative command pulses (Unit: pulse) Cumulative command pulses are cleared by the writing of "0000 1EA5h".
	5		Monitor 5 Command pulse frequency	I32	—	Command pulse frequency (Unit: kpps)
	6		Monitor 6 (not supported) Analog speed command voltage	I32	—	(Reserved)
	7		Monitor 7 (not supported) Analog torque command voltage	I32	—	(Reserved)
	8		Monitor 8 Regenerative load ratio	I32	—	Regenerative load ratio (Unit: %)
	9		Monitor 9 Effective load ratio	I32	—	Effective load ratio (Unit: %)
	10		Monitor 10 Peak load ratio	I32	—	Peak load ratio (Unit: %)
	11		Monitor 11 Instantaneous torque	I32	—	Instantaneous torque (Unit: %)
	12		Monitor 12 Within one-revolution position	I32	—	Within one-revolution position (Unit: pulse)
	13		Monitor 13 ABS counter	I32	—	ABS counter (Unit: rev)
	14		Monitor 14 Load inertia moment ratio	I32	—	Load inertia moment ratio (Unit: multiplier)
	15		Monitor 15 Bus voltage	I32	—	Bus voltage (Unit: V)
	16		Monitor 16 (not supported) Ext. encoder cumulative F/B pulses	I32	—	(Reserved)
	17		Monitor 17 (not supported) External encoder droop pulses	I32	—	(Reserved)
	18		Monitor 18 (not supported) In 1-rev pos. of ext. encoder	I32	—	(Reserved)
	19		Monitor 19 (not supported) External encoder ABS counter	I32	—	(Reserved)
	20		Monitor 20 (not supported) Analog monitor output voltage 1	I32	—	(Reserved)
	21		Monitor 21 (not supported) Analog monitor output voltage 2	I32	—	(Reserved)
	22		Monitor 22 (not supported) Cumulative encoder output pulses	I32	—	(Reserved)
	23		Monitor 23 (not supported) Motor thermistor temperature	I32	—	(Reserved)
	24		Monitor 24 (not supported) Motor side cumu. FBpls (BeforGear)	I32	—	(Reserved)
25	Monitor 25 (not supported) Electreal angle	I32	—	(Reserved)		

\* Objects and functions in the shaded region in the table are not available.

## 8.9. Alarm objects

The master can detect whether an alarm occurs or not in slaves via PDO communication by the statusword bit 3 and 7. Newest and oldest five alarms can be referred as the alarm history by acquiring the following relevant object values via SDO communication.

Index	Sub	Obj.	Name	Type	R/W	Description
2030h	0	RECORD	Alarm history 0	U8	ro	Number of entries
	1		Alarm No.	U16	ro	
	2		Alarm time (Hour)	U32	ro	Elapsed time from the servo amplifier startup (Unit: hour)
	3		Alarm detail	U16	ro	Displays the cause of alarm occurrence in detail.
2031h		RECORD	Alarm history 1		ro	The notations for Sub1, 2, and 3 are abbreviated. (The same as Index 2200h)
:						The notations for second to fourth alarm in past are abbreviated. (The same as Index 2200h)
2035h		RECORD	Alarm history 5		ro	The notations for Sub1, 2, and 3 are abbreviated. (The same as Index 2200h)
2040h	—	VAR	Clear alarm history	U16	wo	Writing "1EA5" clears alarm history.
2041h	—	VAR	Current alarm	U16	ro	Perform the alarm reset with FaultReset of controlword.

## 8.10. Parameter objects

### 8.10.1. Parameter objects excerpts

Each servo parameter of PA01 to PO08 corresponds one-to-one with each sub object of parameter objects (Index 3000h to 3009h). The master writes values to the parameter objects via the SDO communication to change the operation parameters. However, once the power is turned off, the changes are not kept for the next start-up and later. To keep the changes of setting values after the power is turned off, use the Store Parameter object (Index 1010h) to save the parameter setting values in the non-volatile memory.

To change parameters to which the setting change is applied after the power is turned on again (parameters with \* on their abbreviations), change the values of corresponding object, perform Store Parameter, and then turn the power on again.

The following table shows the excerpt of the parameter objects. Each parameter group has the RECORD type object and each sub object corresponds to an individual parameter. For details on parameters, refer to chapter 5 or MELSERVO-J3-□A Servo Amplifier Instruction Manual.

Index	Sub	Obj.	Name	Type	R/W	Description
2300h	0	RECORD	Basic setting (PA)	U8	ro	Parameter group A Number of entries
	1		PA01 Control mode	I32	rw	
	2		PA02 Regenerative option	I32	rw	
	...					
	19		PA19 Parameter write inhibit	I32	rw	
2301h	0	RECORD	Gain/Filter (PB)	U8	ro	Parameter group B Number of entries
	1		PB01 Adaptive tuning mode (Adaptive filter 2)	I32	rw	
	...					
	45		PB45 For manufacturer setting	I32	rw	
2302h	0	RECORD	Extension setting (PC)	U8	ro	Parameter group C Number of entries
	1		PC01 Acceleration time constant	I32	rw	
	...					
	50		PC50 For manufacturer setting	I32	rw	
2303h	0	RECORD	I/O setting (PD)	U8	ro	Parameter group D Number of entries
	1		PD01 Input signal automatic ON selection 1	I32	rw	
	...					
	30		PD30 For manufacturer setting	I32	rw	
2309h	0	RECORD	Option unit (PO)	U8	ro	Parameter group O Number of entries
	1		PO01 For manufacturer setting	I32	rw	
	...					
	8		PO08 For manufacturer setting	I32	rw	

\* In the above table and the device description (ESI) file, the access authority of each parameter object is indicated that reading and writing are allowed. However, the actual access authority is limited by the setting of parameter No. PA19 (refer to section 5.1).

### 8.10.2. Storing in the non-volatile memory (Store Parameter)

The parameter setting stored in each object of Index 3001h to 3009h can be stored in the non-volatile memory which is built in the servo amplifier with using the Store Parameter object (Index 1010h).

At the next power-on, the servo amplifier starts with the parameter settings stored in the non-volatile memory. To change parameters to which the setting is applied after the power is turned on, it is necessary to save the parameters in the non-volatile memory after changing parameters and start the servo amplifier again.

Repeating the parameter writing to the non-volatile memory shortens the non-volatile memory life. The maximum number of using Store Parameter is 100,000 times.

Index	Sub	Obj.	Name	Type	R/W	Description
1010h	0	ARRAY	Store Parameter	U8	ro	Number of entries
	1		Store all parameters	U32	rw	Stores all parameter objects of Index 3000h to 3009h.  Writing 65766173h (= inverse order of "save" ASCII code) writes the parameter values in the non-volatile memory. (After the parameter values are stored in the non-volatile memory, this object value will return to 0.)
	2		Store communication parameters (not supported)	U32	rw	Not available. (Communication parameter storage)
	3		Store application parameters (not supported)	U32	rw	Not available. (Application parameter storage)
	4		Store basic setting (PA)	U32	rw	Stores the parameter objects in a corresponding group.
	5		Store Gain/Filter (PB)	U32	rw	
	6		Store extension setting (PC)	U32	rw	Writing 65766173h (= inverse order of "save" ASCII code) writes the parameter values in the non-volatile memory. (After the parameter values are stored in the non-volatile memory, this object value will return to 0.)
	7		Store I/O setting (PD)	U32	rw	
	8		For manufacturer setting 1	U32	rw	
	9		For manufacturer setting 2	U32	rw	
	10		For manufacturer setting 3	U32	rw	
	11		For manufacturer setting 4	U32	rw	
	12		For manufacturer setting 5	U32	rw	
	13		Store option unit (PO)	U32	rw	The following Sub-Indexes cannot be used since they are for the manufacturer setting. Sub-Index Name 8 For manufacturer setting 1 9 For manufacturer setting 2 10 For manufacturer setting 3 11 For manufacturer setting 4 12 For manufacturer setting 5
	14		Store special setting	U32	rw	Stored in following objects(6098h, 6099h, 609Ah, 2080h)
15	Store PDO mapping	U32	rw	Stored in the following mapping objects (1614h, 1A14h)		

Object list which are saved by Store special setting (Sub-index14)

Index	Sub-index	Name	Description
6098h	0	Homing Method	Home position Method
6099h	1	Speed during search for switch	speed until dog signal turns on
	2	Speed during search for zero	speed after dog signal turns on
609Ah	0	Homing acceleration	Acceleration during home position
2080h	0	Home position shift distance	Amount of movement Z signal is detected

Performing Read of each sub index value of each Store Parameter object (Index 1010h) via the SDO Upload service returns the storage availability of the non-volatile memory of corresponding parameter group. The storage availability of the non-volatile memory of each parameter group is switched according to the setting of parameter No. PA19 (refer to section 5.1).

Return value	Description
00000003h	Available for storing parameters in non-volatile memory
00000000h	Not available for storing parameters in non-volatile memory



## 8.11. Applications

### 8.11.1. Incremental counter

In the synchronous EtherCAT mode (parameter No. PO02 = 0000h), the incremental counter is available for the purpose of operation protection when a PDO communication error (missing or delay) occurs. Set the existence or nonexistence of the incremental counter update error detection (AL.34) on the servo amplifier with using the communication protection switch (parameter No. PO03). However, despite of the communication protection switch, the value of received incremental counter added by one is sent to the servo amplifier side. (It is also possible to use it in the master side only, for detecting incremental counter update error.)

The incremental counter value is represented as an unsigned 8 bit integer from 0 to 255. In addition, the value is added sequentially every time the upper and lower PDO communication is performed. When the value exceeds 255, it returns to 0.

For enhancing the security at communication error occurrence, the use of incremental counter is recommended.

#### CAUTION

Incremental counter function is very useful to detect PDO communication failure due to following case.

We strongly recommend to use this function.

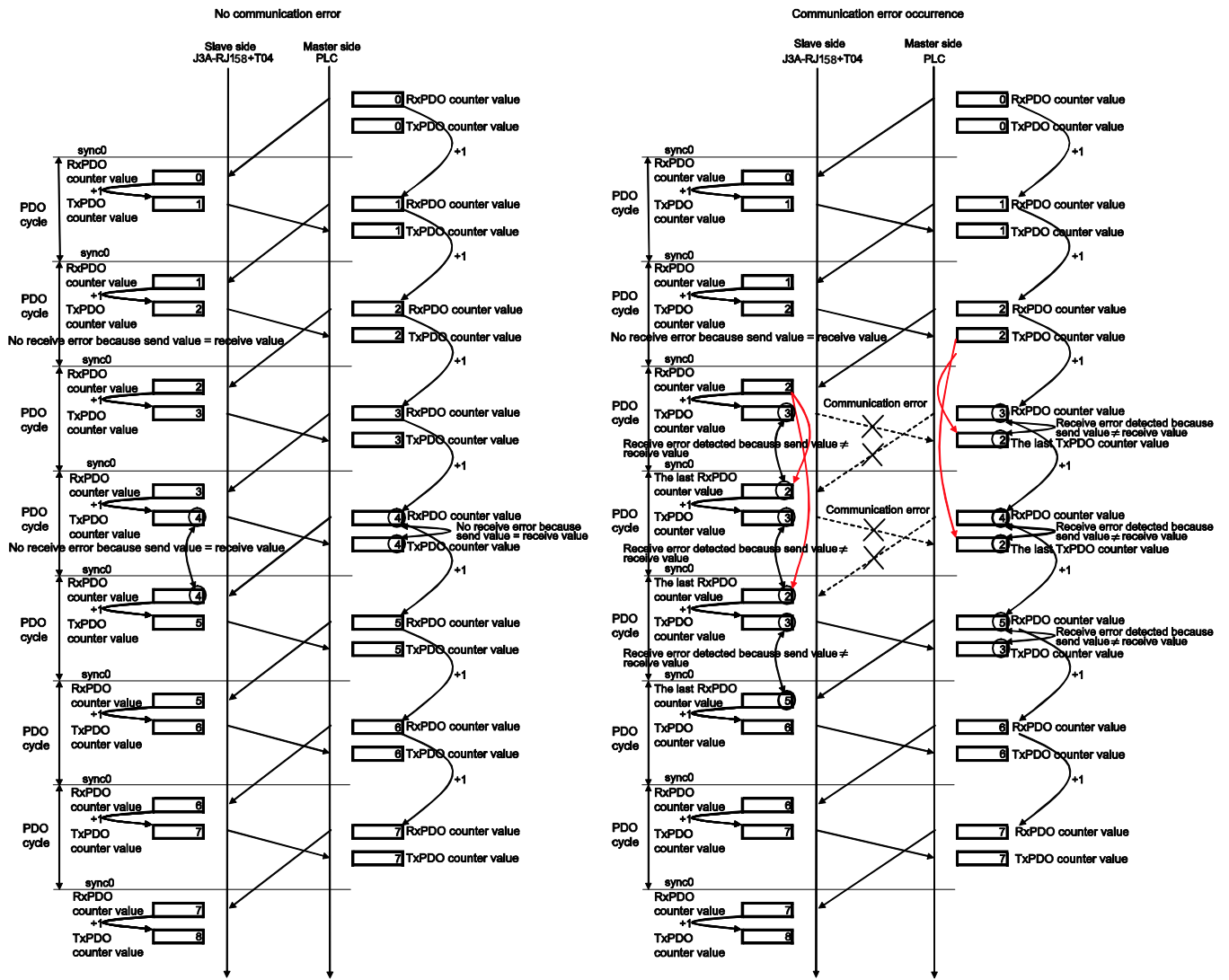
- Synchronization failure due to process or setting problem of Distributed Clock.
- Communication cycle mismatch or process timing failure of PDO communication between master and slave.
- PDO communication failure due to broken cable etc.

#### <Master side processing supposed by Mitsubishi>

- Set the value, which "1" is added to the counter value sent in the previous communication cycle, to the Incremental counter (RxPDO) object (Index:2500h), and send the value at each RxPDO send.
- Return the counter value to 0 when the counter value exceeds 255.
- Start updating the incremental counter value at the same time PDO communication starts.
- Ordinarily, the value, which "1" is added to the counter value sent in RxPDO, is set to the Incremental counter (TxPDO) object (Index:2501h) and returned from the servo amplifier. If some error occurs in the PDO communication, the master receives a value other than sent counter value +1. Take corrective action such as stopping the driving servo motor, as necessary.

#### <Servo amplifier side processing>

- The servo amplifier receives RxPDO and sets the value, which "1" is added to the counter value acquired from the Incremental counter (RxPDO) object (Index:2500h), to the Incremental counter (TxPDO) object (Index:2501h) and returns it by TxPDO.
- If the servo amplifier cannot receive RxPDO due to the communication error or others, sets the value, which "1" is added to the latest counter value received normally, to the Incremental counter (TxPDO) object (Index:2501h) and returns it.
- If the counter value exceeds 255, the servo amplifier returns 0.
- If MR-J3-□A-RJ158 receives a value other than the previous received counter value +1, it regards that some error occurs in the PDO communication. When the incremental counter update error detection is made valid by parameter No. PO03, if amplifier receive abnormal counter value consecutively or frequently more than regulated level, the receive error 2 (AL.34) will be happen and motor will be stopped.



Incremental counter update image

### 8.11.2. Axis number display function

Writing axis numbers to the Slave Axis No. object by SDO Download displays the axis numbers in the right 4 digits on the 7-segment LED as each status of b (Ready off), C (Ready on/servo off), and d (Ready on/servo on) during the EtherCAT communication status display. The correspondent relations between the target axis for sending the EtherCAT communication command from the master controller and each servo amplifier (axis) can be visually confirmed.

Index	Sub-idx	Object	Name	Type	Attr.	Default value	Description
2024h	—	VAR	Slave Axis No.	U16	RW	0	0000h: Axis number is not displayed in the 7-segment LED. 0001h to FFFFh: Axis number is displayed in the 7-segment LED.

Example of axis number 7-segment LED display



When no axis number is set (0000h is set)



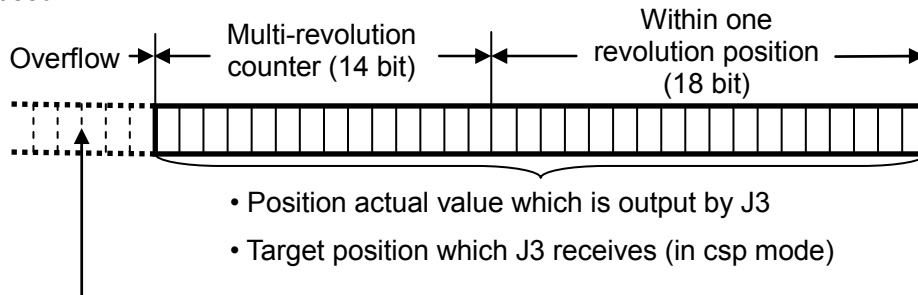
When 89ABh is set for the axis number

### 8.11.3. Position description in MR-J3-□A-RJ158

The current position and target position (which is used in the position control mode) are described with absolute positions of signed 32 bit value between -2,147,483,648 and 2,147,483,647.

$$\text{Absolute position} = \text{Multi-revolution counter} \times \text{Encoder resolution for one motor revolution} + \text{Within one-revolution position}$$

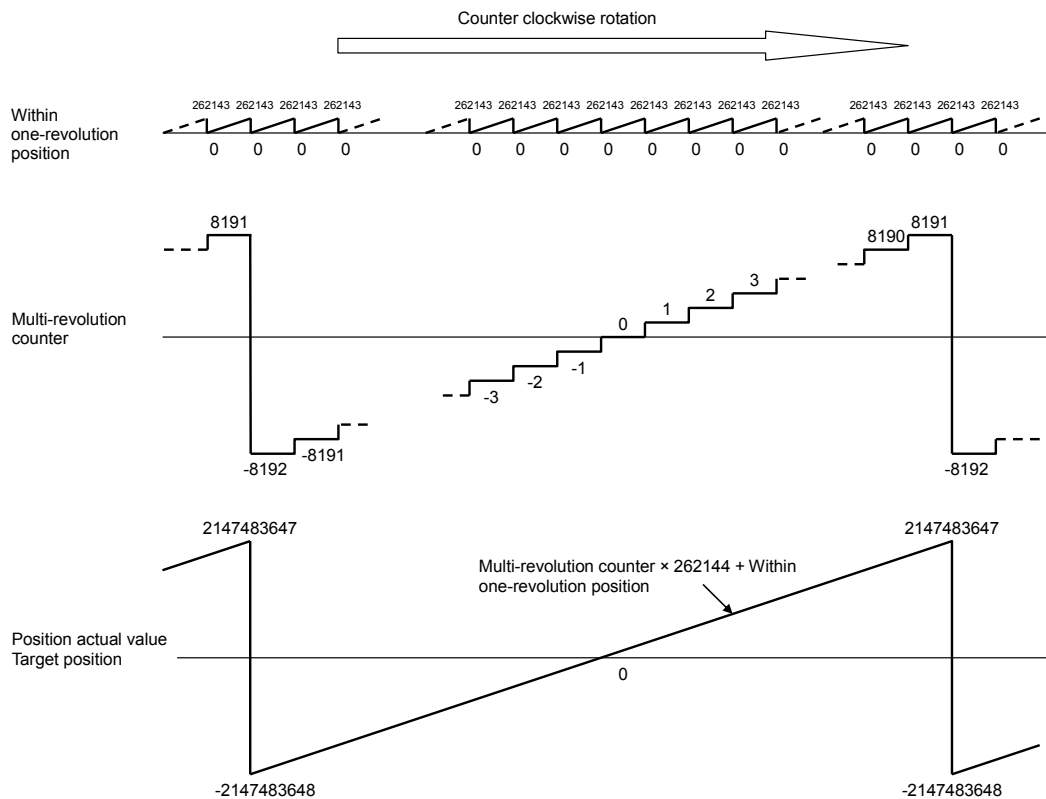
The following shows the positions when the motor whose encoder resolution for one motor revolution is 262,144 pulses (18 bit) is used.



For multi-revolution counter positions which exceed the value of 14 bit, manage them from the controller.

#### Position data format

The following figure shows the relation among within one-revolution position/multi-revolution counter/current (target) position.



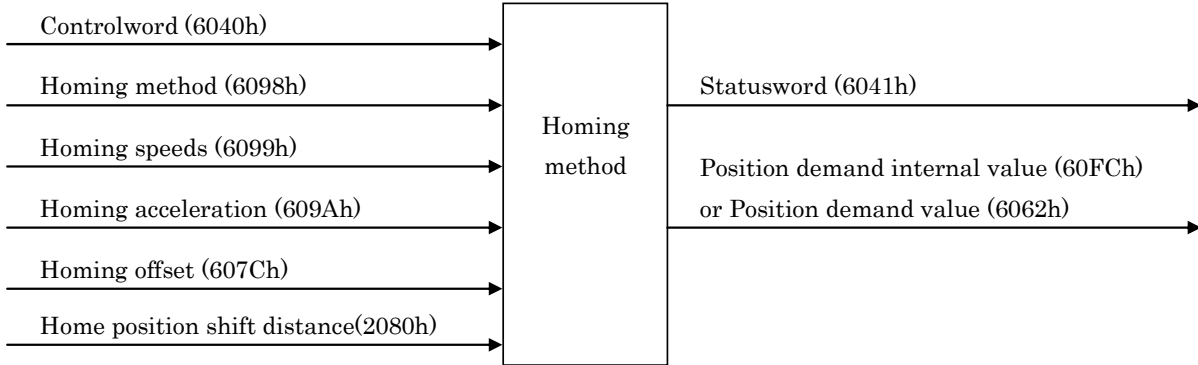
**Relation among within one-revolution position/multi-revolution counter/current position**

### 8.11.4. Homing mode

Corresponding to the EtherCAT Homing mode standard. Please write “6” into Modes of operation object (6060h), in order to change to homing mode (hm). Please refer to chapter 8.4.2 for details of switching the control mode.

#### 8.11.4.1. Regarding Objects

The object which have relation to Home position mode, are as following.



Object definition related to home position mode (hm)

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
607Ch	0	VAR	Home offset	I32	RO	—	When the power turns on, the homing position data in nonvolatile memory will be written to this object. If homing is done by homing mode (hm), the homing position will be updated.
6098h	0	VAR	Homing method	I8	RW	-1	The home position method specified. -1: Dog type home position(forward direction) -17: Dog type starting point return (reverse direction) 35: Data set type.
6099h	0	ARRAY	Homing speeds	U8	RW	2	Home position speed entries number
	1		Speed during search for switch	U32	RW	500000	Speed until dog signal is detected.[*1] Unit: 0.001r/min/LSB *2 Range: 0~maximum motor speed
	2		Speed during search for zero	U32	RW	10000	Speed after dog signal is detected.[*1] Unit: 0.001r/min/LSB *2 Range: 0~maximum motor speed
609Ah	0	VAR	Homing acceleration	U32	RW	100	Home position acceleration time constant Unit: Msec
2080h	0	VAR	Home position shift distance	U32	RW	0	Shift distance from Z phase, will be set into this object. Unit: Pulse

※ [\*2] In case of detection stroke end at homing mode (hm), slow stop will not be executed. (Will have sudden stop.) Then, please be careful about homing speed setting.

※ [\*1] Although the setting unit of homing speed is 0.001r/min/LSB, the data is rounded down to the nearest 0.01, in amplifier.

After setting the home position parameter for the above mentioned object, the home position begins with the bit 4 operation of Controlword.

About Controlword and Statusword bit assignment during homing (hm), refer to chapter 8.4.1 and 8.4.2.

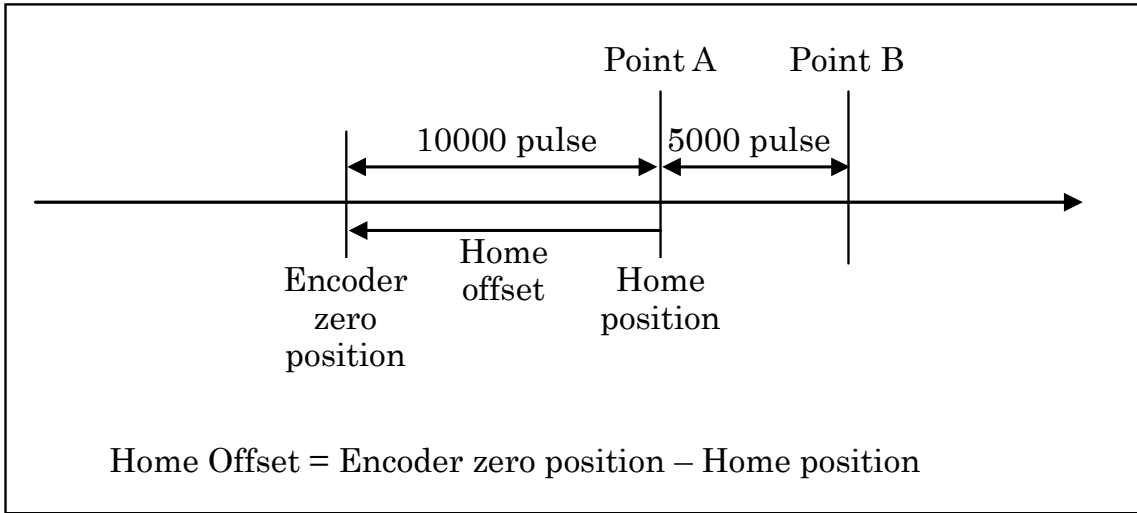
The object which has relation to Homing (hm), can be saved into nonvolatile memory. (Index:2080h、6098h、6099h、609Ah)

In order to save the object which has relation to Homing (hm) into nonvolatile memory, please use Store Parameter(Index:1010h、Sub-Index:14). Refer to Chapter 8.9.2.

When the power turns on, the object in nonvolatile memory will be reflected as the object which has relation to Homing (hm).

8.11.4.2. Relataion between Home offset, home position and Target position

The following figure shows the relation between Home offset, home position and Target position with example value.



In case of above figure, Homeoffset = 0 – 10000 = - 10000

If we hope to move motor by Point B, Target position command = 5000 - (- 10000) = 15000

If we hope to move motor by Point A, Target position command = 0 - (- 10000) = 10000

Difference between target point and Home position

Home offset

This relation can be used for also chapter 8.11.6.

### 8.11.5. Homing method

The homing method in homing (hm) must be set by Homing method object (Index: 6098h). MR-J3-□A-RJ158's Homing method corresponds to following methods -1,-17,35.

- Method -1 : Homing on home switch and index pulse (positive initial motion)

First moving direction is forward direction. Servo will set "first Z phase pulse position on the forward direction soon after dog signal is turned off", as homing position. If motor reach to forward stroke end, motor move to reverse side until motor reach to reverse side dog edge, then motor retry homing(\*A).

If homing starts from dog signal ON, first moving direction is reverse direction. After that, the action is same as \*A.

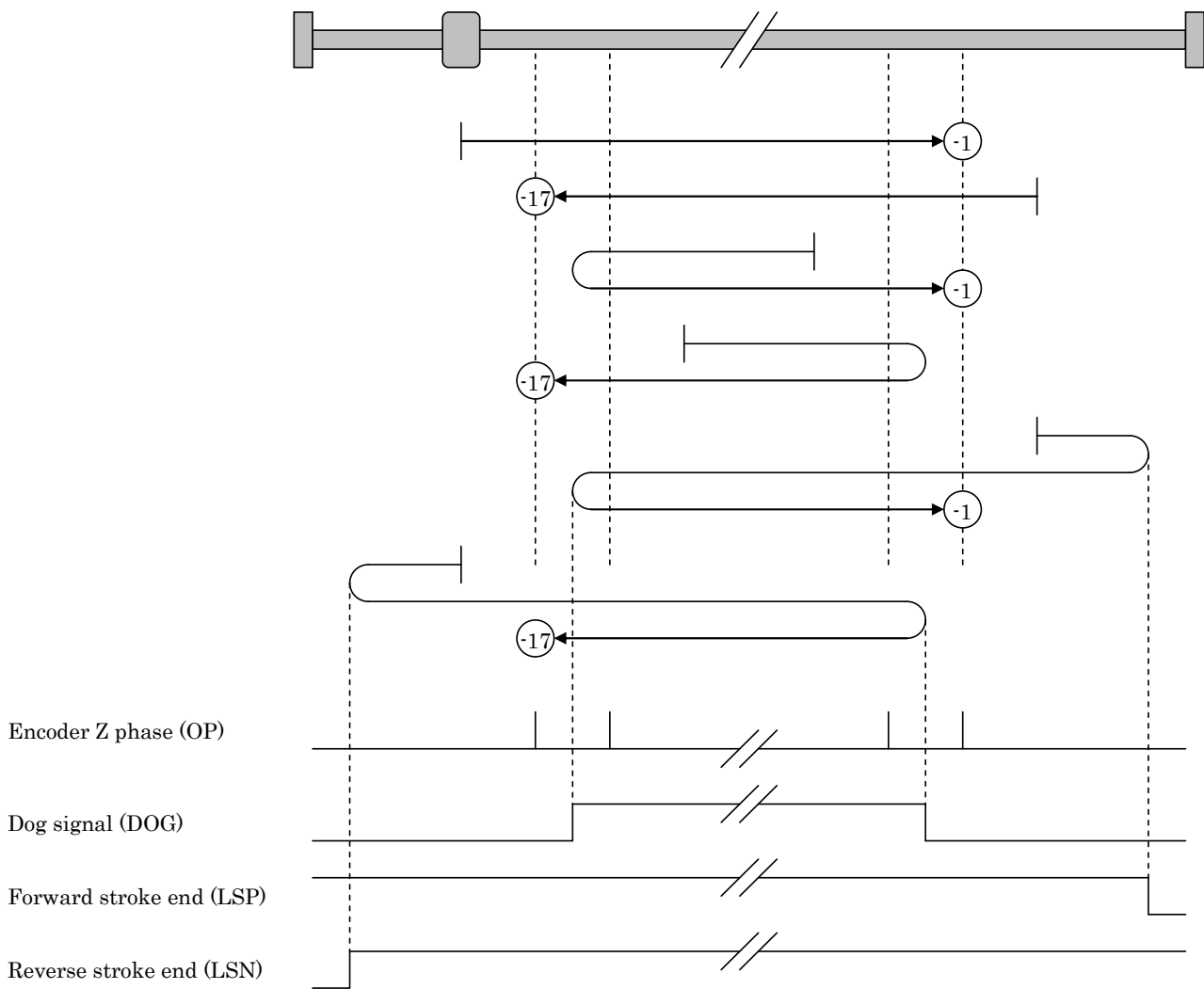
This method is Mitsubishi original. This is similar Method 10 of EtherCAT standard. But, the servo halfway point is difference against Method 10. Then, we define that this method is Mitsubishi original.

- Method -17 : Homing on home switch and index pulse (negative initial motion)

First moving direction is reverse direction. Servo will set "first Z phase pulse position on the reverse direction soon after dog signal is turned off", as homing position. If motor reach to reverse stroke end, motor move to forward side until motor reach to forward side dog edge, then motor retry homing(\*B).

If homing starts from dog signal ON, first moving direction is forward direction. After that, the action is same as \*B.

This is similar Method 14 of EtherCAT standard. But, the servo halfway point is difference against Method 14. Then, we define also that this method is Mitsubishi original.



**Homing method -1,-17 flow chart**

- Method 35 : Homing on index pulse

This method is to set "the current position x (-1)" into home offset object (Index 607Ch) as home position. It is also able to be used other than Operation enabled state.

### 8.11.6. Home position setting

If it is preference to set a home position without operation mode change (ex. Position control mode to Homing mode), here is another method as following.

Make the home position setting with using the C\_CR or C\_CR2 bit of Controlword2.

- After the C\_CR bit is turned on, MR-J3-□A-RJ158 stores the current position data  $\times (-1)$  as the home position data in the Home offset object (Index: 607Ch). In addition, when using absolute position detection system, it stores the same home position data in the non-volatile memory equipped with MR-J3-□A-RJ158 [\*1]. To be exact, when using the C\_CR bit, the position data displaced for "Travel speed"  $\times$  "Communication delay time" is stored after the C\_CR bit in the master is turned on. Therefore, when it is difficult to make the home position setting in the status that position stops after moving to the target home position in such as speed control mode, it is recommended to use the C\_CR2 bit.
- After the C\_CR2 bit is turned on, MR-J3-□A-RJ158 stores the last Z-phase position  $\times (-1)$  as the home position data in the Home offset object (Index: 607Ch). In addition, when using absolute position detection system, it stores the same home position data in the non-volatile memory equipped with MR-J3-□A-RJ158 [\*1]. When using C\_CR2 bit, the last Z-phase position  $\times (-1)$  can be acquired without influences of "Communication delay time".
- \* For both C\_CR bit and C\_CR2 bit, the position is acquired and stored at the timing of rising edge (switching from OFF to ON). At the timing of falling edge (switching from ON to OFF), nothing is performed. (The home position is kept stored.) You can turn the bit off at any timing.
- \* When both C\_CR bit and C\_CR2 bit are turned on, either of current position  $\times (-1)$  or last Z-phase position  $\times (-1)$  is stored depending on the timing of the signal which becomes on later. When the C\_CR bit and C\_CR2 bit are simultaneously turned on in the same PDO communication cycle, the C\_CR2 bit is given priority and the last Z-phase position data is stored.
- \* When using absolute position detection system, the maximum number of home position setting is 100,000 times.

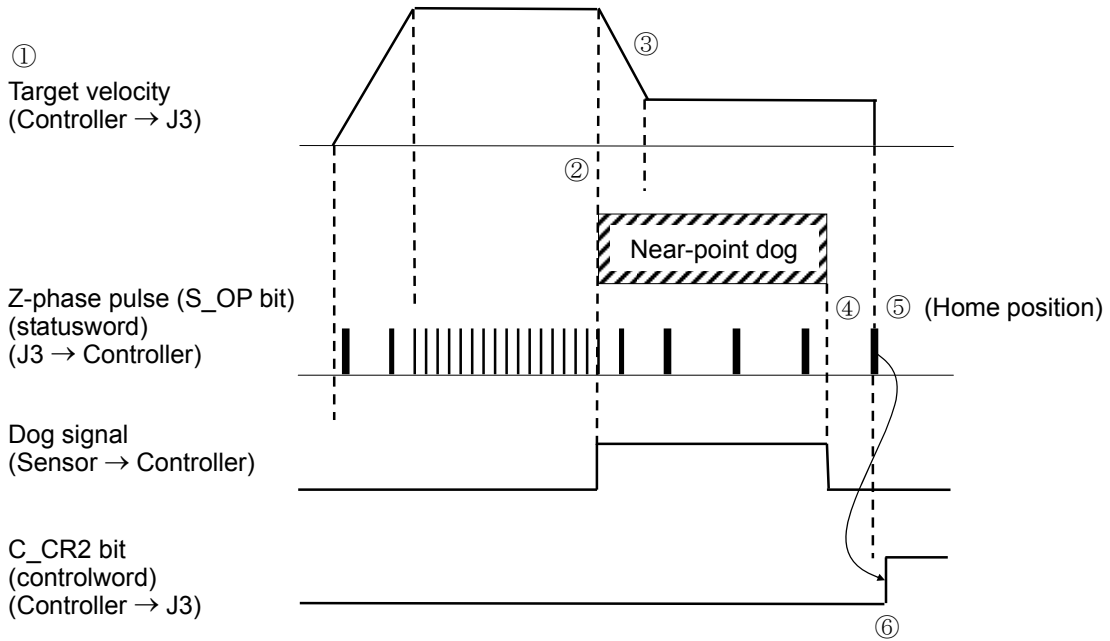
[\*1] At the next startup of MR-J3-□A-RJ158, the home position data stored in the non-volatile memory is set to the Home offset object. Once the home position setting is made, the master can acquire the same home position again by reading the Home offset object value even after the MR-J3-□A-RJ158 is turned off [\*2].

[\*2] When using the absolute position detection system (when the parameter No. PA03 is set to 0002h), the system always detects the absolute position of the machine and keeps it battery backed, independently of whether the MR-J3-□A-RJ158 power is on or off. Therefore, once the home position is set, home position setting is not needed when power is switched on thereafter. Even when not using absolute position detection system, the home position data stored in the non-volatile memory can be acquired from the Home offset object at MR-J3-□A-RJ158 power-on. However, as the encoder position becomes undetermined, a new home position setting is required.

#### Definition of Home Offset object

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
607Ch	0	VAR	Home offset	I32	RO	—	The home position kept in the non-volatile memory is stored at power-on. The home position can be updated by C_CR or C_CR2 bit.

### 8.11.6.3. Recommended method of home position setting in speed control (csv) mode



Recommended home position setting sequence in speed control mode

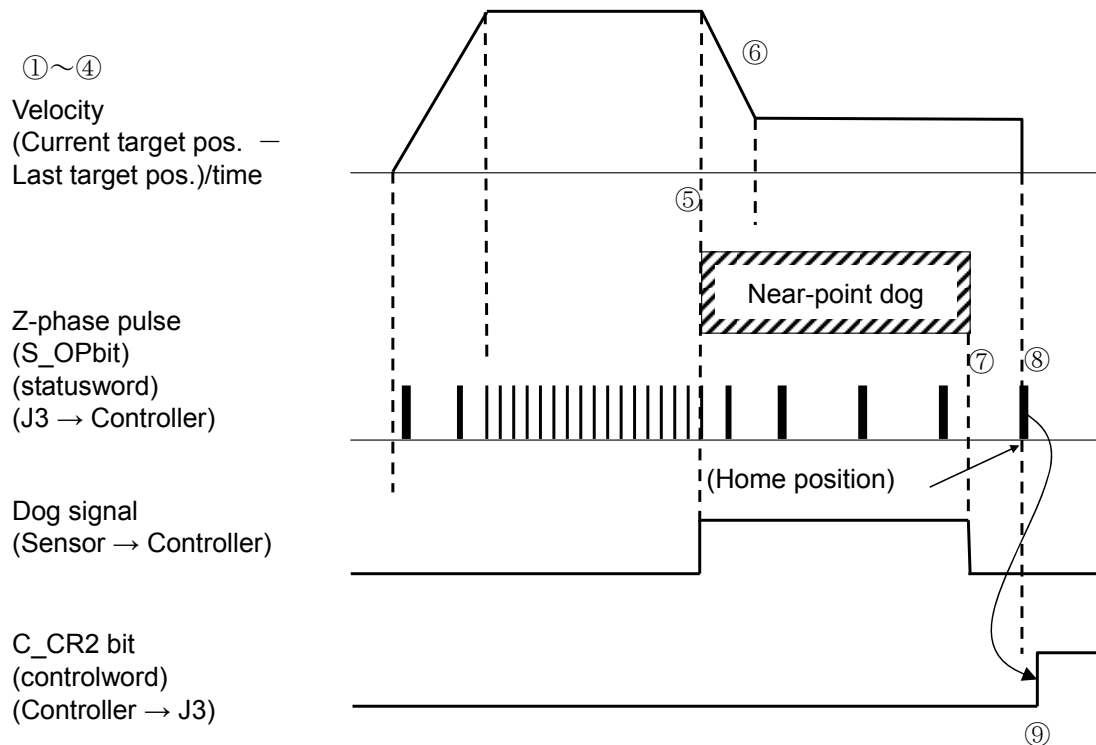
#### Recommended home position setting sequence in speed control mode

- ① The controller sends the speed command value to the home position direction to induce the servo.
- ② Detect the start edge of the dog sensor.
- ③ Decelerate to the creep speed.
- ④ Detect the terminal edge of the dog sensor.
- ⑤ Detect the Z-phase (home position to be targeted) which the dog sensor has passed. [\*]
- ⑥ The controller sends the stop instruction to J3 (Target velocity=0), then the motor stops and C\_CR2 bit turns on. (The J3 stores the last Z-phase ⑤) × (-1) in the Home Offset object.)
- ⑦ The controller reads the Home Offset object value from J3 via the SDO communication. Since then, this value is handled as a home position. In addition, it sends the travel command to J3 as needed and the servo amplifier is returned to the home position.

[\*] If ⑥ (turning the C\_CR2 bit on) is performed when the Z-phase has not been passed, home position setting error (AL.96) occurs. Make sure to perform 6) after the servo amplifier started and the Z-phase has been passed at least once. After the servo amplifier starts, passing the Z-phase once or more sets 1 to the S\_ZPAS bit (Bit7 of statusword2).



#### 8.11.6.4. Recommended method of home position setting in position control (csp) mode



Recommended home position setting sequence in position control mode

#### Recommended home position sequence at position control mode (csp)

Before the controller switches to operation state, it receives from J3 the current position (Index 6064 h).

- ① Set the current position ① into target position (Index 607Ah). (Avoid to move to unexpected target position soon after transition to Operational state.)
- ② Switching to Operation state. (The position command control and the target position are valid at the same time.)
- ③ Controller generates the target position based on initial target position (②) and send it to servo amplifier, in order to guide servo to homing direction, until homing is completed.
- ④ The beginning edge of the DOG sensor is detected.
- ⑤ Deceleration to creep speed.
- ⑥ End of the DOG signal is detected.
- ⑦ Moving until Z signal is passed (The home position will be the target position) .[\*]
- ⑧ After detection Z phase, controller stops to update position command. After that, controller turn on C\_CR2 bit, after motor stop. Then J3 save "Z phase position⑧ x (-1)"into Home offset object.
- ⑨ Controller read Home offset object value from J3 via SDO communication. After that, the value will be used as homing position.

[\*]When ⑨ (The C\_CR2 bit is turned on) is executed and the Z signal is not passed, warning (AL.96) is generated. When turning on the servo amplifier, please be sure that the Z signal is detected before executing ⑨.

#### 8.11.6.5. Home position setting using the current position acquire function (clear)

When the servo can be previously induced and stopped at the target home position, the current position x (-1) can be set as a home position by turning on the clear signal (C\_CR bit of controlword2) at the target position.

### 8.11.7. Stroke end

#### 8.11.7.1. Operation at reaching of stroke end

When the forward/reverse rotation stroke end is valid (input=Low) during position control mode (csp) or speed control mode (csv), a slow stop occurs. (The sudden stop/slow stop setting by parameter No. PD20 is invalid.) Considering the stop distance, install the limit switch securing an enough margin in relation to the load side. Even if stroke end invalid (Input=high) occurs, the command speed is not accepted until the motor stops once.

#### Operation at reaching of stroke end

Operation Mode	Description
Homing	When executing Homing method-1 and the reverse stroke end (LSN) is valid, Homing error occurs (Statusword bit13 turns on). The Homing will be interrupted and the axis stops rapidly. When executing Homing method-17 and the forward stroke end (LSP) is valid, Homing error occurs (Statusword bit13 turns on). The Homing will be interrupted and the axis stops rapidly.
Cyclic synchronous position	The command position is discarded, and deceleration stop occurs according to parameter No. PC02 (Deceleration time constant) up to the command position just before the stroke end is valid.
Cyclic synchronous velocity	The command speed is discarded, and deceleration stop occurs according to parameter No. PC02 (Deceleration time constant).

#### 8.11.7.2. Master controller processing at reaching of stroke end

When reaching the stroke end, perform the following processing from the master controller, and restart the operation.

#### Operation restart procedures at reaching of stroke end

Operation Mode	Description
Homing	In case homing error occurs while reaching the stroke end, please check the limit switch and the home switch wiring.
Cyclic synchronous position	<ol style="list-style-type: none"> <li>1) When stroke end is valid, the bit12 (S_LSP) or bit13 (S_LSN) of Statusword2 turns to 1, and target position becomes invalid until the motor stops. Master controller should set ON (set 1 to bit8 of Controlword2) the MSTOP function (refer to section 8.12).</li> <li>2) During servo off or servo on, putting out all command pulses, and bit4 (S_FLW) of Statusword becomes 1 when MSTOP function is ON. In this situation, the motor is stop at out of position which has been applied from the master controller. After confirming (Statusword bit4=1), the master controller acquires the position demand value (index 6062h), then the value will be set in the target position and executing present position follow up.</li> <li>3) Please turn off MSTOP function (set 0 to bit8 of Controlword2). It will be possible to control the motor again, since the target position of opposite direction of stroke end are valid (Statusword bit12 Target position ignored=1).</li> <li>4) After returning to the position where the stroke end signals are invalid, forward and reverse target position becomes valid again.</li> </ol> <p><input type="checkbox"/> Please follow the above procedures, otherwise it causes position gap.</p>
Cyclic synchronous velocity	<ol style="list-style-type: none"> <li>1) When stroke end is valid, the bit12 (S_LSP) or bit13 (S_LSN) of Statusword2 turns to 1, and all speed command values become invalid until the motor stops. The master controller should, after confirming the motor stop by the velocity actual value or others, send a speed command value for a direction reverse to the stroke end direction, and restore the motor in a position which the stroke end is invalid.</li> <li>2) After restoring to a position which stroke end is invalid, the speed commands for forward and reverse directions become valid again.</li> </ol>

### 8.12. Halt

When 1 is set to the bit8 of Controlword, the motor stops according to the operation specified in Halt option code (Index 605Dh). Supports slow stop (Halt option code = 1) only. The Halt function is invalid in the speed control (CSV) mode and position control (CSP) mode.

Definition of Halt option code object

Index	Sub-index	Object	Name	Type	Attr.	Default value	Description
605Dh	0	VAR	Halt option code	I16	RW	1	Operation setting at Halt function execution 1:Slow down on slow down ramp and stay in Operation Enabled

### 8.13. MSTOP (Manual Stop) function

When 1 is set to the bit8 of Controlword2, the motor stops according to the time constant specified in parameter No. PC02 (Deceleration time constant).

Even if MSTOP reset (0 is set to the bit8 of Controlword2) occurs during slow stop, the command speed or command position is not accepted until the motor stops once.

After the motor slow stop by MSTOP function, perform the following procedures from the master controller, and restart the operation.

Operation Mode	Description
Homing	The MSTOP function is invalid.
Cyclic synchronous position	1) During servo off or servo on, throwing up all internal command pulses, and when MSTOP function is ON, the bit4 (S_FLW) of Statusword becomes 1. In this situation, the motor is stop at out of position (the target position given by the master controller). After confirmation (Statusword bit4=1), master controller gets the position demand value (index 6062h), then the master controller sets target position and executes present position follow up. 2) Please turn off MSTOP function (set 0 to bit8 of Controlword2). The target position will become valid (Statusword bit12 Target position ignored=1) and it is possible to control the motor again. ※In case of turning off MSTOP function without the present position follow up, sudden motor rotations could occur. Please be aware.
Cyclic synchronous velocity	1) When the motor stops, set 0 to the command speed. 2) If the MSTOP function is turned OFF (0 is set to the bit8 of Controlword2), the command speed becomes valid, and the motor control becomes enabled again.

## 8.14. Torque limit

The torque limit value to be made valid by ON/OFF of controller torque limit selection C\_TL (bit3 of controlword2) or internal torque limit selection C\_TL1 (bit4 of controlword2) can be switched.

In the test operation mode excluding the motor-less operation, the TL1 and TL inputs by controlword2 are ignored and the torque is limited by the parameter No. PA11 and PA12.

### Torque limit selection (at ordinary operation/motor-less operation)

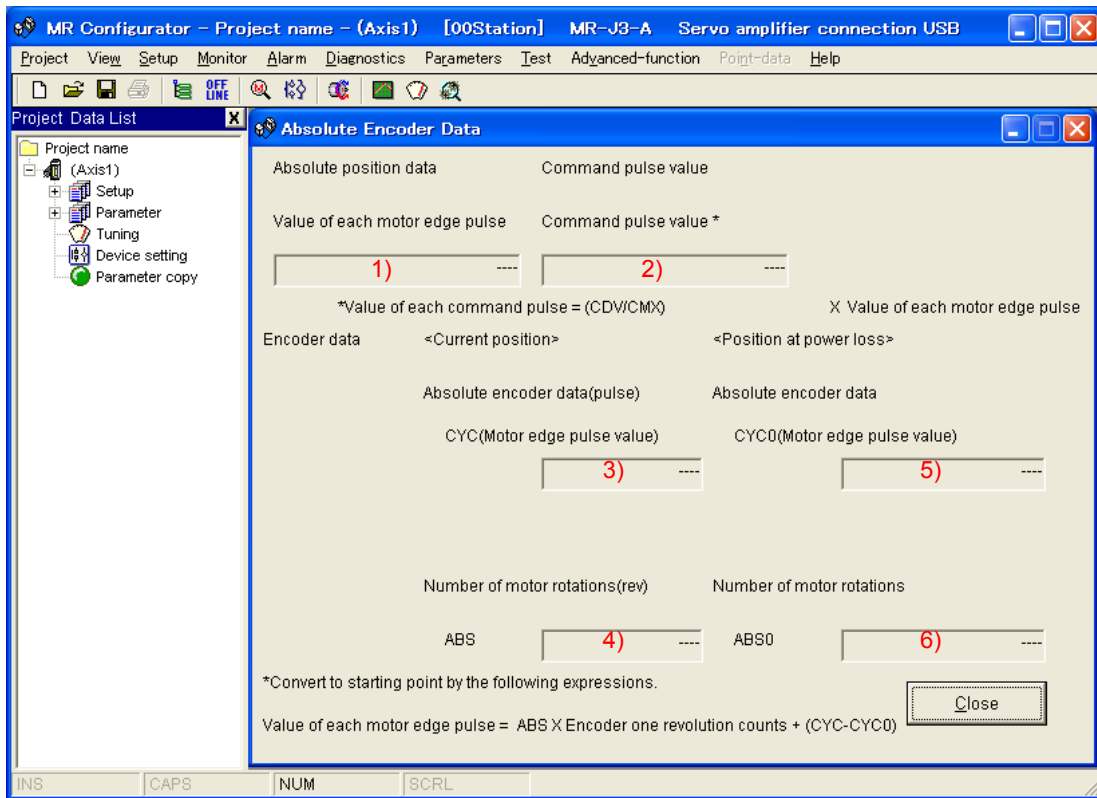
C_TL1	C_TL	Limit value status	Validated torque limit values	
			CCW driving/ CW regeneration	CW driving/ CCW regeneration
0	0		Parameter No. PA11	Parameter No. PA12
0	1	Positive Torque limit value > Parameter No. PA11	Parameter No. PA11	
		Negative Torque limit value > Parameter No. PA12		Parameter No. PA12
		Positive Torque limit value < Parameter No. PA11	Positive Torque limit value	
		Negative Torque limit value < Parameter No. PA12		Negative Torque limit value
1	0	Parameter No. PC35 > Parameter No. PA11, PA12	Parameter No. PA11	Parameter No. PA12
		Parameter No. PC35 < Parameter No. PA11, PA12	Parameter No. PC35	Parameter No. PC35
1	1	Parameter No. PA11, PC35 > Positive Torque limit value	Positive Torque limit value	
		Parameter No. PA12, PC35 > Negative Torque limit value		Negative Torque limit value
		Parameter No. PC35 < Parameter No. PA11, Positive Torque limit value	Parameter No. PC35	
		Parameter No. PC35 < Parameter No. PA12, Negative Torque limit value		Parameter No. PC35
		Parameter No. PC11 < Parameter No. PA35, Positive Torque limit value	Parameter No. PA11	
		Parameter No. PC12 < Parameter No. PA35, Negative Torque limit value		Parameter No. PA12

## 9. Restrictions

### 9.1. MR Configurator

Using the standard MR Configurator (MRZJW3-SETUP221), it is possible to change parameter setting values from the personal computer, display in graph and perform test operation. However, there are some restrictions as indicated below.

- RS-422 communication by CN3 cannot be used. Use a USB cable (MR-J3USBCBL3M).
- Select "MR-J3-A" for the Model Selection in the System Settings screen.
- Each parameter name in the Parameter Setting screen is displayed the same as standard J3A.
- Amplifier diagnosis and VC automatic offset are not supported. The operation of each function through MRConfigurator is ignored.
- In the EtherCAT mode, the display content of absolute position data in the Absolute Encoder Data screen is different from the standard J3A. (Refer to the following figure)



Display item	MR-J3-□A-RJ158 (in EtherCAT mode)	MR-J3-□A
1) Value of each motor edge pulse [pulse]	Current position of motor side (Not cleared by home position setting)	Current position of motor side when home position is 0 (Set to 0 by home position setting)
2) Command pulse value [pulse]	Command pulse (Not cleared by home position setting)	Command pulse (Set to 0 by home position setting)
3) CYC [pulse]	Current within one-revolution data	Same as on the left
4) ABS [rev]	Current multi-revolution data (Not cleared by home position setting)	Rotation amount from home position (Set to 0 by home position setting)
5) CYC0 [pulse]	Within one-revolution data stored as the home position	Same as on the left
6) ABS0 [rev]	Multi-revolution data stored as the home position	Same as on the left

\* As for the MR-J3-□A-RJ158 in EtherCAT mode, the Value of each motor edge pulse = ABS × Encoder one revolution counts + CYC, differently from the remark on the Absolute Encoder Data screen.

\* In case of MR Configurator 2, the restriction is as same as above.