MITSUBISHI ELECTRIC

Mitsubishi Electric AC Servo System

MITSUBISHI ELECTRIC SERVO SYSTEM
MELSERVO-J5

MR-J5 Drive unit
Model
MR-J5D1-100G4_ to MR-J5D1-700G4_
MR-J5D2-100G4_ to MR-J5D2-700G4_
MR-J5D3-100G4_, MR-J5D3-200G4_

Safety Instructions and Precautions for AC Servos

D

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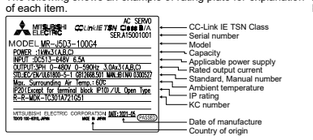
Specifications are subject to change without notice.
Compliance with the indicated global standards and regulations is current as of the release date of this installation guide.
The original instructions for Europe are in English.

IB(NA)-0300527-D(2309)MEE

Contents of the package
Unpack the product and check the rating plate to see if the drive unit is as you ordered.

Contents	Quantity
Drive unit	1
Safety Instructions and Precautions for MR-J5D AC Servos (This guide)	1
Safety Instructions and Precautions for MR-J5 AC Servos (Safety Sub-Function)	1

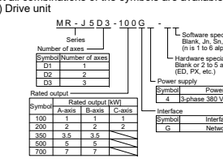
Rating plate
The following shows an example of rating plate for explanation of each item.



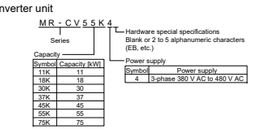
Regulation/legislation marking
An example of regulation/legislation marking is shown below.

Warning plate
The following shows an example of warning plate.

Model
The following describes what each block of a model name indicates.
Not all combinations of the symbols are available.
(a) Drive unit



(b) Converter unit



1. About the manuals

To use the MELSERVO-J5 series safely, read MR-J5 User's Manual carefully.

1.1 MELSERVO-J5 relevant manuals

This installation guide explains how to mount MR-J5 drive units. You can also check it with our website for free.
http://www.mitsubishielectric.com/fa/
If you have any questions about the operation and programming of the equipment described in this guide, contact your local sales office.
In addition, when you mount a protective device, specific technical skills which are not detailed in the guide will be required.

1.2 Purpose of this guide

This installation guide explains the safe operation of MR-J5 drive units for engineers of machinery manufacturers and machine operators. This installation guide does not explain how to operate machines in which safe servo system is, or will be integrated. For detailed information of the products, refer to MR-J5 User's Manual.

1.3 Terms related to safety

1.3.1 IEC 61800-5-2 Stop function
STO function (Refer to IEC 61800-5-2:2016 4.2.3.2 STO.)
The MR-J5 drive units have the STO function. The STO function shuts down energy to servo motors, thus removing torque. This function electronically cuts off power supply in the drive unit.

2. About safety

This chapter explains safety of users and machine operators. Please read the chapter carefully before mounting the equipment. In this installation guide, the specific warnings and cautions levels are classified as follows.

⚠ WARNING	Indicates that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠ CAUTION	Indicates that incorrect handling may cause hazardous conditions, resulting in medium or slight injury.

In this installation guide, cautionary items such as precautions that may lead to property damages, and instructions for other functions are classified as "POINT".

2.1 Professional engineer

Only professional engineers should mount converter units and drive units.
Here, professional engineers should meet all the conditions below.
(1) Persons who took a proper training of related work of electrical equipment or persons who can avoid risk based on past experience.
(2) Persons who have read and familiarized himself/herself with this installation guide and operating manuals for the protective devices (e.g. light curtain) connected to the safety control system.

2.2 Applications of the devices

MR-J5 drive units are used to drive servo motors, and comply with the standards shown below.
- IEC/EN 61800-5-1/GB 12668.501, IEC/EN 61800-3/GB 12668.3/KN 61800-3 (KS C 9800-3), IEC/EN 60204-1 (Stop category)
- ISO/EN ISO 13849-1:2015 Category 3 PL e, IEC/EN IEC 62061:2021 maximum SIL 3, IEC/EN 61800-5-2 (STO)

2.3 Correct use

Use the MR-J5 drive units within specifications. Refer to MR-J5 User's Manual for specifications such as voltage, temperature, etc. Mitsubishi Electric Co. accepts no claims for liability if the equipment is used in any other way or if modifications are made to the device, even in the context of mounting and installation.

⚠ WARNING ●Risk of electrical shock. Do not touch drive unit and terminals immediately after power-off. Allow approx. 20 minutes for capacitor to discharge.

2.3.1 Peripheral device and power wiring
The followings are selected based on IEC/EN/UL 61800-5-1, and CSA C22.2 No. 274.
(1) Power wiring (local wiring and crimping tool)
The following table shows the stranded wire sizes [AWG] and the crimp terminal symbols rated at 75 °C.

Table 1. Recommended wires

Drive unit *1	75 °C stranded wire [AWG]		
	L11/L21/⏚	L+/L-	U/V/W/E *3
MR-J5D1-100G4	14: a/14: a *2	Bus bar (option)	14/14
MR-J5D1-200G4			14/14
MR-J5D1-350G4			14/14
MR-J5D1-500G4			12/10
MR-J5D1-700G4			10/10
MR-J5D2-100G4			14/14
MR-J5D2-200G4			14/14
MR-J5D2-350G4			14/14
MR-J5D2-500G4			12/10
MR-J5D2-700G4			10/10
MR-J5D3-100G4			14/14
MR-J5D3-200G4			14/14

*1 When connecting to a terminal block, make sure to use the screws provided with the terminal block.
*2 The alphabetical letters in the table indicate the symbols of the recommended crimp terminals. Refer to Table 2 for recommended crimp terminals.
*3 The wire sizes can be selected based on the rated current of the servo motors. The values in the table are sizes based on rated output of the drive units.

Table 2. Recommended crimp terminals

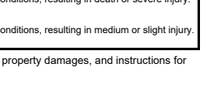
Symbol	Drive unit-side crimp terminals		Manufacturer
	Crimp terminal	Applicable tool	
a	FVD2-4	YNT-1614	JST (J.S.T. Mfg. Co., Ltd.)

*1 The crimp terminal may not be able to be attached depending on its size. Therefore, use a recommended product or equivalent.

(2) Selection example of semiconductor fuse
Use UL recognized semiconductor fuses as the following table. To select different semiconductor fuses from those listed in the table, refer to "MR-J5D User's Manual (Hardware)".

Converter unit	Semiconductor fuse (700 V) SCCR 100 kA
MR-CV11K4	170M1413 (40 A)
MR-CV18K4	170M1416 (80 A)
MR-CV30K4	170M1419 (160 A)
MR-CV37K4	170M1419 (160 A)
MR-CV45K4	170M1420 (200 A)
MR-CV55K4	170M1421 (250 A)
MR-CV75K4	170M1422 (315 A)

(3) Power supply
This converter unit can be supplied from star-connected supply with grounded neutral point of overvoltage category III. For the interface power supply, use an external 24 V DC power supply with reinforced insulation on I/O terminals.
(4) Grounding
To prevent an electric shock, always connect the protective earth (PE) terminal (marked ⏚) of the drive unit to the protective earth (PE) of the cabinet. Do not connect two grounding cables to the same protective earth (PE) terminal. Always connect cables to the terminals one-to-one.
This product can cause a DC current in the protective earthing conductor. To protect direct/indirect contact using an earth-leakage current breaker (RCD), only an RCD of type B can be used for the power supply side of the product.



(5) Motor overload and over temperature protection
The overload protection of the servo motor does not include a thermal memory function, and is not speed sensitive. The drive unit cannot detect overheating of the servo motor. The servo motors are protected by the servo motor overheat protection function of the drive units (a protection characteristic based on 120 % of the rated current). To provide the servo motor with overheat protection, use a magnetic contactor (electromagnetic switch) with a thermal relay. Alternatively, install a thermal sensor or equivalent equipment near the rating plate of the servo motor to check that the servo motor temperature is under 105 °C with sensing device. (Refer to Chapter 4)

2.3.2 Europe/UK compliance
The CE/UKCA marking proves the compliance of the servo product with the essential requirements specified in the relevant EU Directives and UK Regulations, and this marking also applies to machines and equipment incorporating servos.
(1) EMC requirement
MR-J5 drive units comply with EN/BS EN IEC 61800-3. As for I/O wires (max. length 10 m), motor cables and encoder cables (max. length 50 m), use shielded wires and ground the shields. Install the surge protector on the primary side of the drive filter. The recommended products are as follows:
EMC filter: COSEL FSB Series or Soshin Electric HF3000C-SZL series
Surge protector: Okaya Electric Industries RSPD series or Soshin Electric LT-CS-WS series
Line noise filter: Mitsubishi Electric FR-BIF
MR-J5 Series are not intended to be used on a low-voltage network which supplies domestic premises; electromagnetic interference is expected if used on such a network. The installer shall provide a guide for installation and use, including recommended mitigation devices. To avoid the risk of crosstalk to signal cables, the installation instructions shall either recommend that the power interface cable be segregated from signal cables. Install the DC power supply for I/O signals of the drive units in the same cabinet. Do not connect the other electric devices to the DC power supply.
(2) For Declaration of Conformity (DoC)
We declare that the servo amplifiers are in compliance with EC directives (Machinery directive (2006/42/EC), EMC directive (2014/30/EU), Low voltage directive (2014/35/EU), and RoHS directive (2011/65/EU, (EU) 2015/863)) and applicable regulations of the UK. For the copy of Declaration of Conformity, contact your local sales office.

2.3.3 USA/Canada compliance
This drive unit is designed in compliance with UL 61800-5-1 and CSA C22.2 No. 274.
(1) Installation
The minimum cabinet size is 150 % of the total volume of each converter unit and drive unit. Also, design the cabinet so that the ambient temperature in the cabinet is 60 °C or less. The converter unit and drive unit must be installed in the metal cabinet. Additionally, mount the drive unit on a cabinet that the protective earth based on the standard of IEC/EN 60204-1 is correctly connected. For environment, the units should be used in open type (UL 50) and overvoltage category shown in the table in section 8.1. The drive unit needs to be installed at or below pollution degree 2. For connection, use copper wires.
(2) Short-circuit current rating (SCCR)
A short-circuit test has confirmed the suitability for use on a circuit capable of delivering maximum voltage of 500 V and target current of 100 kA or less.
(3) Branch circuit protection
For installation in United States, branch circuit protection must be provided, in accordance with the National Electrical Code and any applicable local codes. For installation in Canada, branch circuit protection must be provided, in accordance with the Canadian Electrical Code and any applicable provincial codes.

2.3.4 South Korea compliance
Products that bear the KC mark comply with the Radio Wave Law. Please note the following to use the product.
이 기기는 업무용 (A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.
(The product is for business use (Class A) and meets the electromagnetic compatibility requirements. The seller and the user must note the above point, and use the product in a place except for home.)

2.4 General cautions for safety protection and protective measures

Observe the following items to ensure proper use of the MR-J5 drive units.
(1) Only qualified personnel and professional engineers should perform the installation of safety components and systems.
(2) When mounting, installing, and using the MR-J5 drive unit, always observe the standards and directives applicable in the respective countries.

2.5 Residual risk

(1) Be sure that all safety related switches, relays, sensors, etc., meet the required safety standards.
(2) Perform all risk assessments and safety level certification to the machine or the system as a whole.
(3) If the upper and lower power modules in the drive unit are shorted and damaged simultaneously, the servo motor may make a half revolution at a maximum.
(4) Only qualified personnel are authorized to install, start-up, repair, or service the machines in which these components are installed. Only trained engineers should install and operate the equipment. (ISO 13849-1:2015 Table F.1 No. 5)
(5) Separate the wiring for safety sub-function from other signal wirings. (ISO 13849-1:2015 Table F.1 No. 1)
(6) Protect the cables with appropriate ways (routing them in a cabinet, using a cable guard, etc.).
(7) Keep the required clearance/creepage distance depending on voltage you use.

2.6 Disposal

Disposal of unusable or irreparable devices should always occur in accordance with the applicable country-specific waste disposal regulations. (Example: European Waste 16 02 14)

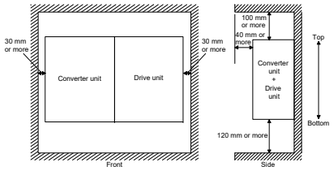
2.7 Lithium battery transportation

To transport lithium batteries, take actions to comply with the instructions and regulations such as the United Nations (UN), the International Civil Aviation Organization (ICAO), and the International Maritime Organization (IMO).
The batteries (MR-BAT6V1SET, MR-BAT6V1SET-A, and MR-BAT6V1) are assembled batteries from two batteries (lithium metal battery CR17335A) which are not subject to the dangerous goods (Class 9) of the UN Recommendations.

3. Mounting/dismounting

Installation direction and clearances

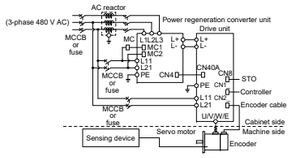
POINT
●To prevent malfunction, install the drive unit in the specified direction.
●Mount the drive unit on a cabinet which meets IP54 in the correct vertical direction to maintain pollution degree 2.



4. Electrical Installation and configuration diagram

POINT
●The installation complies with IEC/EN 60204-1. The voltage supply to machines must be 20 ms or more of tolerance against instantaneous power failure as specified in IEC/EN 60204-1
●To prevent unexpected movement of the servo motor, securely connect the wire with the specified method and torque.

The following shows representative configuration examples to conform to the IEC/EN/UL/CSA standards.
The connectors described by rectangles are safely separated from the main circuits described by circles.

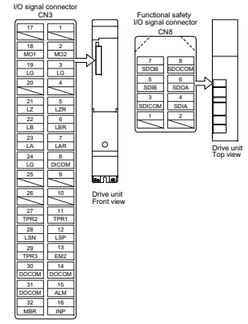


Connectable motors are limited as follows:
(1) Servo motors manufactured by Mitsubishi Electric (HK series)
(2) Other servo motors complying with IEC 60034-1 which are used with a Mitsubishi Electric serial interface-compatible encoder or with an A/B/Z-phase differential output type encoder

5. Signals

5.1 Signal

The following shows MR-J5D1-100G4 signals as a typical example. For other drive units, refer to "MR-J5D User's Manual (Hardware)".



5.2 I/O device

Input device

Symbol	Device	Connector	Pin No.
EM2	Forced stop 2	CN3	20
SDICOM	Common terminal for input signals SDIA/SDIB		3
SDIA	SDIA state input	CN8	4
SDIB	SDIB state input		5

Output device

Symbol	Device	Connector	Pin No.
SDOCOM	Common terminal for output signals SDOA/SDOB	CN8	8
SDOA	SDIA monitor output signal		6
SDOB	SDIB monitor output signal		7

6. Maintenance, service and trouble shooting

Only qualified personnel should attempt inspections.
For repair and parts replacement, contact your local sales office.

6.1 Inspection items

It is recommended that the following points periodically be checked.
(1) Check for loose terminal block screws. Retighten any loose screws.

Drive unit	Tightening torque [N•m]								
	L+	L-	L11	L21	U	V	W	E	PE
MR-J5D_-_G_	3.0		1.2						6.0

(2) Servo motor bearings, brake section, etc. for unusual noise.
(3) Check the cables and the like for scratches or cracks. Perform periodic inspection according to operating conditions.
(4) Check that the connectors are securely connected to the servo motor.
(5) Check that the wires are not coming out from the connector.
(6) Check for dust accumulation on the drive unit.
(7) Check for unusual noise generated from the drive unit.
(8) Check the servo motor shaft and coupling for connection.
(9) Make sure that the emergency stop circuit operates properly such that an operation can be stopped immediately and a power is shut off by the emergency stop switch.

6.2 Parts having service life

Service life of the following parts is listed below. However, the service life varies depending on operation and environment. If any fault is found in the parts, they must be replaced immediately regardless of their service life. For parts replacement, please contact your local sales office.

Part name	Life guideline
Relay	Number of power-on, dynamic brake stop, and forced stop times: 100,000 times
Cooling fan	50,000 hours to 70,000 hours (7 years to 8 years)
Battery backup time *1	Approximately 20,000 hours (equipment power supply: off, ambient temperature: 20 °C)
Battery life *2	5 years from date of manufacture

*1 For details, refer to "MR-J5D User's Manual (Hardware)".
*2 Quality of the batteries degrades by the storage condition. The battery life is 5 years from the production date regardless of the connection status.

6.3 Trouble shooting for safety sub-function

For the alarms and warnings related to the safety sub-function, refer to "MR-J5 Safety Instructions and Precautions for AC Servos (Safety Sub-Function) (IB(NA)0300516)".

7. Environment

Transport the products correctly according to their mass.
For detailed information on transportation and handling of the battery, refer to "MR-J5D User's Manual (Hardware)".
Install the product in a load-bearing place of converter unit, drive unit, and servo motor in accordance with the User's manual.
Do not put excessive load on the machine.

When you keep or use it, please fulfill the following environment.

	Operation	Transportation	Storage
Ambient temperature	0 °C to 60 °C (non-freezing) Class 3K3 (IEC 60721-3-3)	-25 °C to 70 °C (non-freezing) Class 2K12 (IEC 60721-3-2)	-25 °C to 70 °C (non-freezing) Class 1K4 (IEC 60721-3-1)
Ambient humidity	5 %RH to 95 %RH (non-condensing)	5 %RH to 95 %RH (non-condensing)	5 %RH to 95 %RH (non-condensing)
Ambience	Indoors (no direct sunlight); no corrosive gas, inflammable gas, oil mist or dust		
Altitude/ atmospheric pressure	Altitude: Max. 2000 m *1	Transportation conditions: Overland/sea transportation, or transporting by an airplane whose cargo compartment is pressurized at 700 hPa or higher	Atmospheric pressure: 700 hPa to 1060 hPa (Equivalent to altitudes from -400 m to 3000 m)
Vibration resistance	Under intermittent vibration: 10 Hz to 57 Hz, displacement amplitude 0.075 mm 57 Hz to 150 Hz, acceleration amplitude 9.8 m/s² Class 3M1 (IEC 60721-3-3) Under continuous vibration (X, Y, Z axes): 10 Hz to 55 Hz, acceleration amplitude 5.9 m/s²	2 Hz to 9 Hz, displacement amplitude (single amplitude) 7.5 mm 9 Hz to 200 Hz, acceleration amplitude 20 m/s² Class 2M3 (IEC 60721-3-2)	2 Hz to 9 Hz, displacement amplitude (single amplitude) 1.5 mm 9 Hz to 200 Hz, acceleration amplitude 5 m/s² Class 1M2 (IEC 60721-3-1)

*1 For the restrictions on the use of this product at altitude exceeding 1000 m, refer to MR-J5D User's Manual (Hardware).

8. Specifications

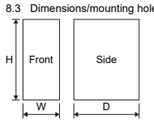
8.1 MR-J5 drive unit

Item		MR-J5D_-_G4_
Power supply	Main circuit	513 V DC to 648 V DC
	Control circuit (line voltage)	1-phase 380 V AC to 480 V AC 50 Hz/60 Hz
	Interface (SELV)	24 V DC (required current capacity: MR-J5D1-_G4_ 300 mA; MR-J5D2-_G4_ 350 mA; MR-J5D3-_G4_ 450 mA)
Control method		Sine-wave PWM control, current control method
Pollution degree		2 (IEC/EN 60664-1)
Overvoltage category		III (IEC/EN 60664-1)
Protective class		I (IEC/EN 61800-5-1)
Enclosure		Open type, IP20 (The IP rating of the terminal block is IP10.)
Short-circuit current rating (SCCR)		100 kA

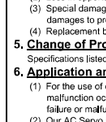
8.2 Functional safety

For functional safety specifications, refer to "MR-J5 Safety Instructions and Precautions for AC Servos (Safety Sub-Function) (IB(NA)0300516)".

8.3 Dimensions/mounting hole process drawing



Drive unit	Variable dimensions [mm]			Mass [kg]
	W	H	D	
MR-J5D1-100G4/MR-J5D1-200G4/ MR-J5D1-350G4	60	380	280	5.5
MR-J5D1-500G4/MR-J5D1-700G4	60	380	280	4.6
MR-J5D2-100G4	60	380	280	5.7
MR-J5D2-200G4/MR-J5D2-350G4	60	380	280	5.6
MR-J5D2-500G4/MR-J5D2-700G4	75	380	280	6.2
MR-J5D3-100G4	60	380	280	5.9
MR-J5D3-200G4	60	380	280	5.8



Drive unit	Variable dimensions [mm]			Screw size
	a	b	c	f
MR-J5D1-100G4/MR-J5D1-200G4/ MR-J5D1-350G4/MR-J5D1-500G4/ MR-J5D1-700G4/MR-J5D2-100G4/ MR-J5D2-200G4/MR-J5D2-350G4/ MR-J5D2-500G4/MR-J5D2-700G4/ MR-J5D3-100G4/MR-J5D3-200G4	30	360	10	M5

9. Check list for user documentation

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MR-J5 installation checklist for manufacturer/installer

The following items must be satisfied by the initial test operation at least. The manufacturer/installer must be responsible for checking the standards in the items.
Maintain and keep this checklist with related documents of machines to use this for periodic inspection.

1.	Is it based on directive/standard applied to the machine?	Yes [ ], No [ ]
2.	Is directive/standard contained in Declaration of Conformity (DoC)?	Yes [ ], No [ ]
3.	Does the protection instrument conform to the category required?	Yes [ ], No [ ]
4.	Are electric shock protective measures (protective class) effective?	Yes [ ], No [ ]
5.	Is the STO function checked (test of all the shut-off wiring)?	Yes [ ], No [ ]

Checking the items will not be instead of the first test operation or periodic inspection by professional engineers.

Warranty

1. Warranty period and coverage

We will repair any failure or defect hereinafter referred to as "failure" in our FA equipment hereinafter referred to as the "Product" arisen during warranty period at no charge due to causes for which we are responsible through the distributor from which you purchased the Product or our service provider. However, we will charge the actual cost of dispatching our engineer for an on-site repair work on request by customer in Japan or overseas countries. We are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit are repaired or replaced.
[Term]
For terms of warranty, please contact your original place of purchase.
[Limitations]
(1) You are requested to conduct an initial failure diagnosis by yourself, as a general rule.
It can also be carried out by us or our service company upon your request and the actual cost will be charged. However, it will not be charged if we are responsible for the cause of the failure.
(2) This limited warranty applies only when the condition, method, environment, etc. of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual and user manual for the Product and the caution label affixed to the Product.
(3) Even during the term of warranty, the repair cost will be charged on you in the following cases;
1. a failure caused by your improper storing or handling, carelessness or negligence, etc., and a failure caused by your hardware or software problem
2. a failure caused by any alteration, etc. to the Product made on your side without our approval
3. a failure which may be regarded as avoidable, if your equipment in which the Product is incorporated is equipped with a safety device required by applicable laws and has any function or structure considered to be indispensable according to a common sense in the industry
4. a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
5. any replacement of consumable parts (battery, fan, smoothing capacitor, etc.)
6. a failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning and natural disasters
7. a failure generated by an unforeseeable cause with a scientific technology that was not available at the time of the shipment of the Product from our company
8. any other failures which we are not responsible for or which you acknowledge we are not responsible for

2. Term of warranty after the stop of production

(1) We may accept the repair at charge for another seven (7) years after the production of the product is discontinued. The announcement of the stop of production for each model can be seen in our Sales and Service, etc.
(2) Please note that the Product (including its spare parts) cannot be ordered after its stop of production.

3. Service in overseas countries

Our regional FA Center in overseas countries will accept the repair work of the Product. However, the terms and conditions of the repair work may differ depending on each FA Center. Please ask your local FA center for details.

4. Exclusion of loss in opportunity and secondary loss from warranty liability

Regardless of the gratis warranty term, Mitsubishi shall not be liable for compensation to:
(1) Damages caused by any cause found not to be the responsibility of Mitsubishi.
(2) Loss in opportunity, lost profits incurred to the user by Failures of Mitsubishi products.
(3) Special damages and secondary damages whether foreseeable or not, compensation for accidents, and compensation for damages to products other than Mitsubishi products.
(4) Replacement by the user, maintenance of on-site equipment, start-up test run and other tasks.

5. Change of Product specifications

Specifications listed in our catalogs, manuals or technical documents may be changed without notice.

6. Application and use of the Product

(1) For the use of our AC Servo, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in AC Servo, and a backup or fail-safe function should operate on an external system to AC Servo when any failure or malfunction occurs.
(2) Our AC Servo is designed and manufactured as a general purpose product for use at general industries.
Therefore, applications substantially influential on the public interest for such as atomic power plants and other power plants of electric power companies, and also which require a special quality assurance system, including applications for railway companies and government or public offices are not recommended, and we assume no responsibility for any failure caused by these applications when used.
In addition, applications which may be substantially influential to human lives or properties for such as airlines, medical treatments, railway service, incineration and fuel systems, man-operated material handling equipment, entertainment machines, safety machines, etc. are not recommended, and we assume no responsibility for any failure caused by these applications when used.
We will review the acceptability of the abovementioned applications, if you agree not to require a specific quality for a specific application. Please contact us for consultation.
(3) Mitsubishi Electric shall have no responsibility or liability for any problems involving programmable controller trouble and system trouble caused by DoS attacks, unauthorized access, computer viruses, and other cyberattacks.