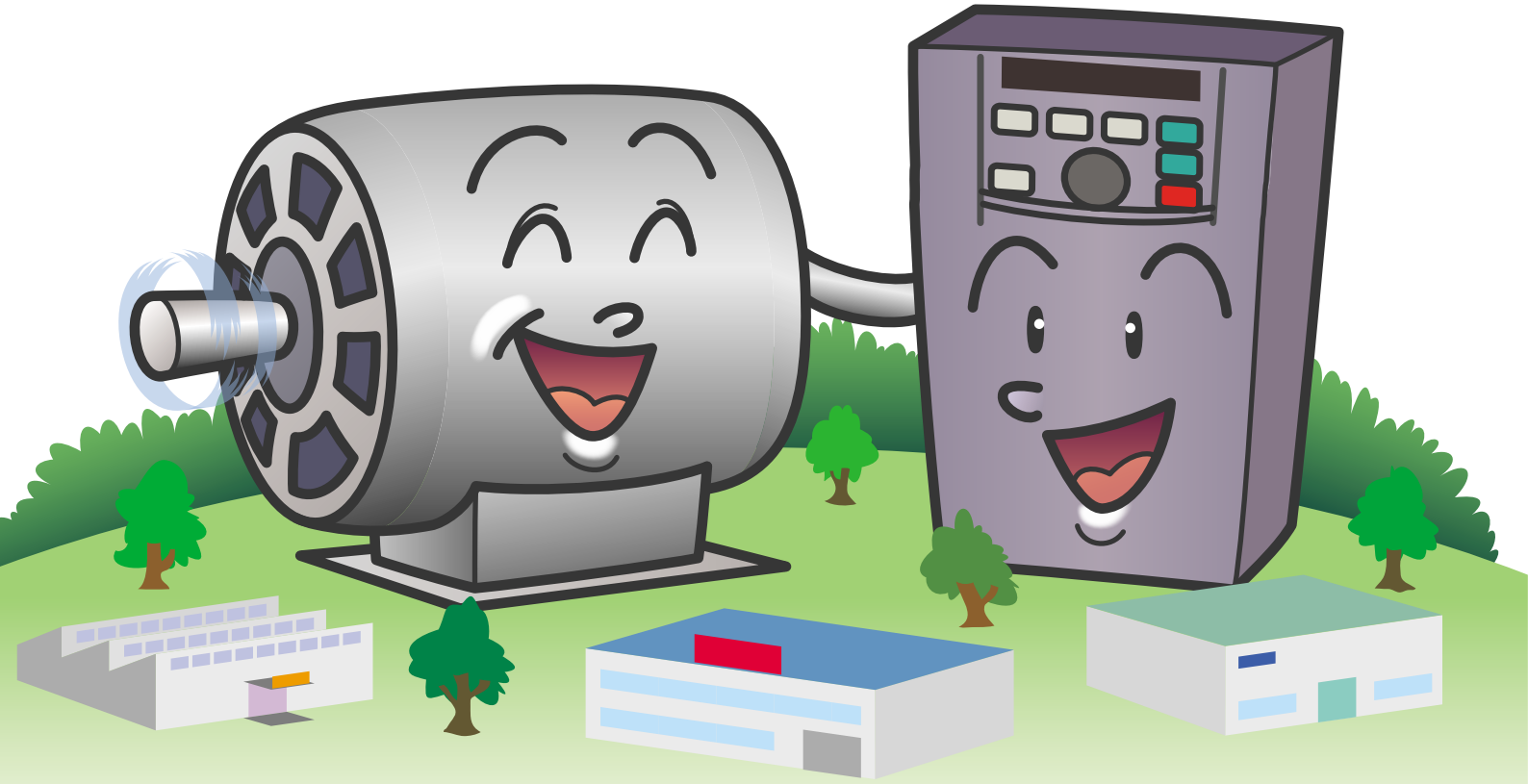
MITSUBISHI ELECTRIC

Changes for the Better

for a greener tomorrow eco Changes

INVERTER

Proposal for Upgrading/ Introducing Inverters



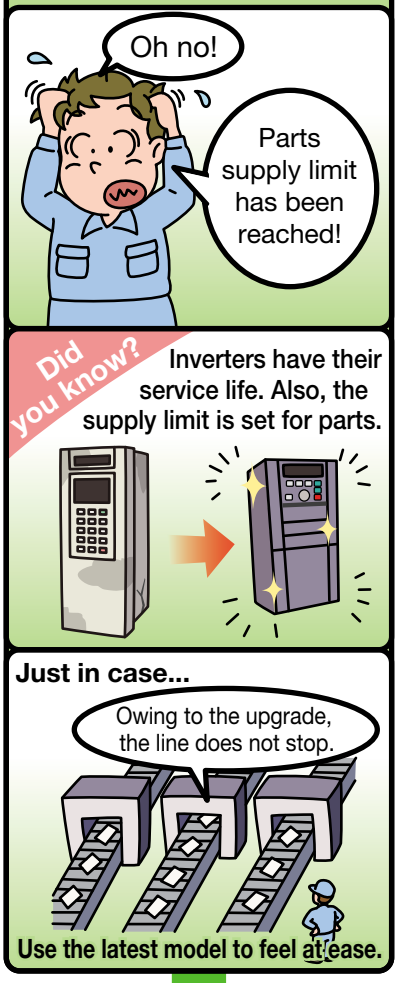
Proposal for Inverter Control

Do you want to improve the existing machinery?

Machines with motors are used in various applications such as driving conveyors or operating fans.
If you consider upgrading your machines, we recommend incorporation of "inverter control" into your system to enable optimal motor control by energy saving operation or a soft start function.
Furthermore, requests to achieve "a little bit more advanced operation" or "energy saving operation" without changing the existing facility can be relatively easily managed by using general-purpose inverters with the existing system. You can gain great advantages.

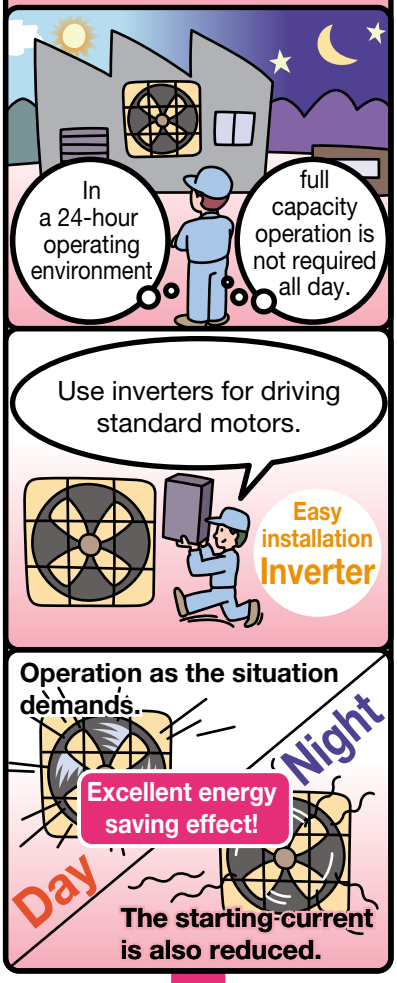
Case studies
Benefits of upgrading systems with different types of motors

For conventional inverter system users



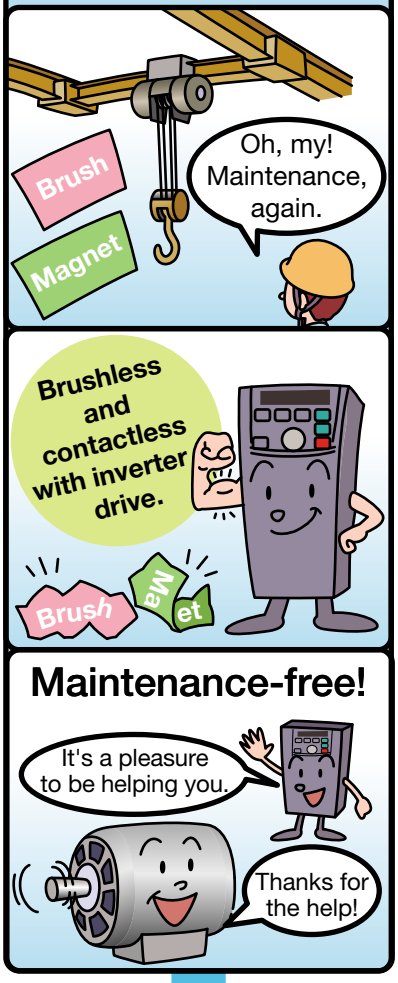
For details, see page 3 and page 4.

For commercial power supply system users



For details, see page 5.

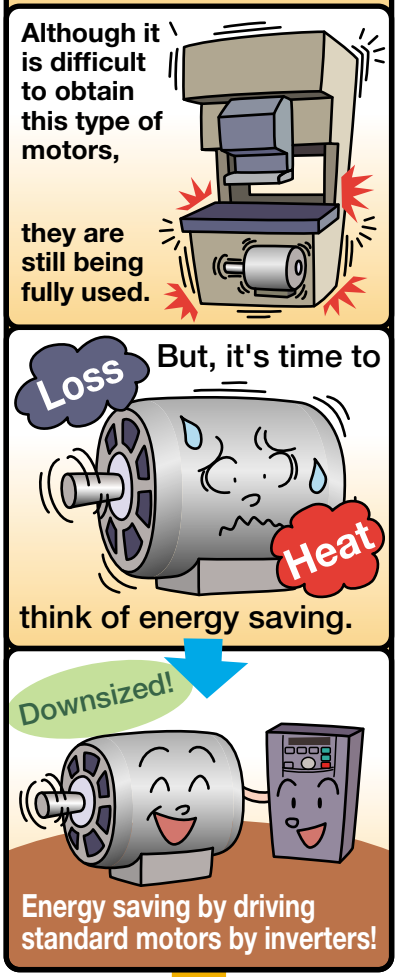
For wound rotor motor users



For details, see page 5.

800/700 Series

For eddy current coupling motor (AS motor) users

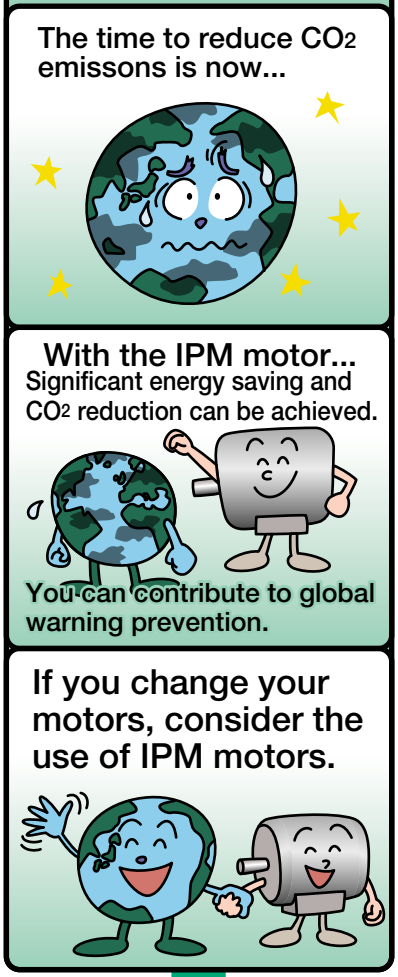


For details, see page 6.

For direct current (DC) motor users

For details, see page 6.

For prospective IPM motor users



For details, see page 8.

Upgrading Existing Inverters

Why upgrading is necessary

- Upgrading of inverters is necessary because limited-life components are used in inverters.
- For some conventional models, the repair components supply has been terminated (refer to page 4). Depending on the service life, faulty components cannot be repaired.
- The existing induction servos (MR-VA) are also replaceable.

Benefits of upgrading

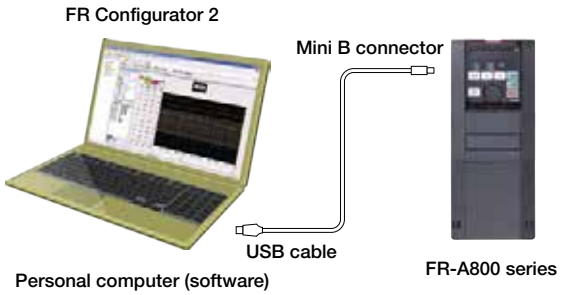
- By using new functions of the replacement model, peripheral devices can be simplified in some cases.
- As compared to the existing inverter, the performance can be improved, and operation and maintenance can be facilitated.

Support tools

- Installation interchange attachments are available for replacement between Mitsubishi inverters.
- By using the conversion function of FR Configurator2, parameter settings can be easily copied from conventional models (700 series or 500 series (to be supported soon)).

Easy maintenance with FR Configurator2 (Option)

Advanced operability popularized with USB + FR Configurator2



Benefits by using the latest Mitsubishi inverter (800 series inverters)

- The service life of the cooling fans is now 10 years[*1].
  The service life can be further extended by ON/OFF control of the cooling fan.
- Capacitors with a design life of 10 years[*1*2] are adapted
  (equivalent to 5000 hours at the surrounding air temperature of 105°C). With these capacitors, the service of the inverter is further extended.

*1: Surrounding air temperature: Annual average of 40°C (free from corrosive gas, flammable gas, oil mist, dust and dirt). The design life is a calculated value and is not a guaranteed product life.
*2: Output current: 80% of the inverter rating

- Life indication of life components

Components	Estimated lifespan of the 800 series	Guideline of JEMA[*3]
Cooling fan	10 years	2 to 3 years
Main circuit smoothing capacitor	10 years	5 years
Printed board smoothing capacitor	10 years	5 years

*3: Excerpts from "Periodic check of the transistorized inverter" of JEMA (Japan Electrical Manufacturer's Association).

- The degree of deterioration of the main circuit capacitor, control circuit capacitor, and inrush current limit circuit can be monitored.
- Using the self-diagnosis function, the part life warning can be output[*4] and the deterioration degree can be monitored. Thus, the self-diagnosis function prevents troubles from occurring.

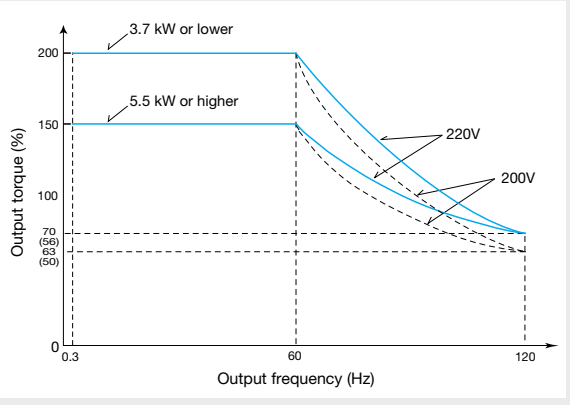
*4: A warning is output when any of the main circuit capacitor, control circuit capacitor, the inrush current limit circuit, and the cooling fan reaches its output level. By setting the relevant parameter beforehand while the motor is stopped, the capacity of the main circuit capacitor can be measured by turning OFF and ON the power supply of the inverter. The warning can be output when the capacity is measured.

Checkpoints for selection

- Check that the rated current and the overload current rating of the replacement inverter are the same or higher than those of the existing inverter.
- Check that the functions used in the existing inverter (multi-speed setting, JOG operation, etc.) are also available in the replacement inverter.
- When the target machine requires sufficient torque in the low-speed range, it is recommended to use a model (FR-A800) with which the low speed torque can be generated by Real sensorless vector control etc.

Example of torque characteristics with Real sensorless vector control for the FR-A800 series (SF-PR 200 V)

Maximum short-time torque



The values in the parentheses are applied to 1.5 kW and 2.2 kW.

Cautionary notes

- Outline dimensions and mounting hole positions may differ. When the mounting hole positions differ, the existing mounting holes can be used as is by using the installation interchange attachment.
- When the outline dimensions become smaller, the existing cable may be too short. Prepare the longer one.

List of alternative models for the conventional series

Conventional series name	Production termination schedule	Repair components supply termination	Alternative model
FR-F2	December 1986	November 1993	FR-F800 FR-A800 *
FR-K	December 1986	November 1993	FR-A800
FR-K400	July 1989	June 1996	FR-A800
FR-F300	July 1989	June 1996	FR-F800 FR-A800 *
FR-K3	July 1989	June 1996	FR-A800
FR-E	September 1993	August 2000	FR-A800
FR-Z020	March 1994	March 2001	FR-E700
FR-Z300	June 1994	June 2001	FR-A800
FR-Z100	December 1994	December 2001	FR-A800
FR-Z123	March 1995	March 2002	FR-E700
FR-F400	June 1995	June 2002	FR-F800 FR-A800 *
FR-A200	October 1995	October 2002	FR-A800
FR-Z024	October 1995	October 2002	FR-E700
FR-V200	April 1996	April 2003	FR-V500 FR-A800 + FR-A8AP
FR-A100	April 1996	April 2003	FR-F800
FR-Z200	June 1996	April 2003	FR-A800
FR-A200E	April 2000	April 2007	FR-A800
MT-A100E	April 2000	April 2007	FR-F800
FR-A100E	September 2000	September 2007	FR-F800
MT-A200E	September 2000	September 2007	FR-A800
FR-U100	September 2001	September 2008	FR-D700
FR-S500 (Three-phase 200 V)	June 2004	June 2011	FR-D700
FR-V200E	October 2004	October 2011	FR-V500 FR-A800 + FR-A8AP
FR-S500 (Three-phase 400 V / single-phase 200 V / single-phase 100 V)	May 2006	May 2013	FR-D700
FR-F500 (L)	May 2006	May 2013	FR-F800
FR-A500 (L)	April 2007	April 2014	FR-A800
FR-A024/A044	December 2008	December 2015	FR-E700
FR-A201E	September 2009	September 2016	FR-A701
FR-S500E	August 2010	August 2017	FR-D700
FR-E500	April 2011	April 2018	FR-E700
FR-F700	August 2011	August 2018	FR-F800
FR-FP700	August 2011	August 2018	FR-F800
FR-HC (200V)	October 2011	October 2018	FR-HC2
MT-HC (200V)	October 2011	October 2018	FR-HC2
MT-B	November 2011	November 2018	FR-B
FR-F500J	April 2012	April 2019	FR-F700PJ
FR-FP500J	April 2012	April 2019	FR-F700PJ
FR-C500	April 2012	April 2019	FR-E700 (Use the FR-E700-NC or the CC-Link option.)
FR-HC (400V)	October 2012	October 2019	FR-HC2
MT-HC (400V)	October 2012	October 2019	FR-HC2

* For the operation where the inverter output current exceeds 120% of its rated current, select the FR-A800 series.

Upgrading from Machinery Systems Driven by Commercial Power Supply

Advantages of using inverters

With the soft start/stop function, mechanical impact/vibration can be reduced. Remarkable energy saving effect can be obtained by decreasing the rotation speed as compared to the commercial power supply operation. Also, variable-speed operation at discretional speed enables optimal operation.

Checkpoints for selection

Select the inverter with the rated current higher than that of the existing motor. During the commercial power supply operation, enough starting torque (about 200%) is generated by applying an overcurrent (500% to 800% of the rated current) at startup. Inverters start motors by gradually increasing frequency. The starting torque at startup is about 100% to 150% (it may differ depending on the control method). Check that the starting torque is enough to enable starting. When a large starting torque is required, or a high torque is required during acceleration/deceleration due to a large J (inertia, moment of inertia), consider the use of the inverter with a one-rank higher capacity.

Cautionary notes

- **Installation of equipment**

  There must be enough space for the inverter, and the programmable controller and relays for controlling the inverter as well. Use the inverter in an enclosure.
  The inverter can be started/stopped by turning ON/OFF of the magnetic contactor connected to the main circuit as is the case with the commercial power supply operation. However, frequent ON/OFF operation of the main circuit causes repeated flowing of an inrush current at power-ON, which may shorten the service life of the inverter (converter section). It is recommended to start/stop the inverter by opening/closing of the terminal STF (STR) and the terminal SD of the inverter.

- **Key points**

  It is important to select the inverter (series, control method, etc.) so that the starting torque necessary to start the target machine can be secured.
  Noises are increased when the inverter is installed. Take measures against noises. For example, avoid parallel wiring between the main circuit wiring and the control system wiring.
  When a 400 V class motor is driven by the inverter, a surge voltage is generated at the motor terminals. Check that the motor is an insulation-enhanced motor.

Upgrading from Wound Rotor Motor Systems

Standard motor + Inverter

Advantages of using inverters

By upgrading the system using a standard motor (three-phase, cage-induction motor) and a general-purpose inverter, maintenance requirements are minimized.

Checkpoints for selection

Check the specifications beforehand. Check if there is no problem with the starting torque, the speed change range, etc. For replacing other manufacturers' wound rotor motors, fully examine characteristics and specifications by comparing the catalogs, etc.

Cautionary notes

Wound rotor motors and standard motors have different installation size. In particular, check the center height (height to the center of the motor shaft) and the shaft length. When the center height or the shaft length is different, the installation size is not compatible. Modification of the machine is required.

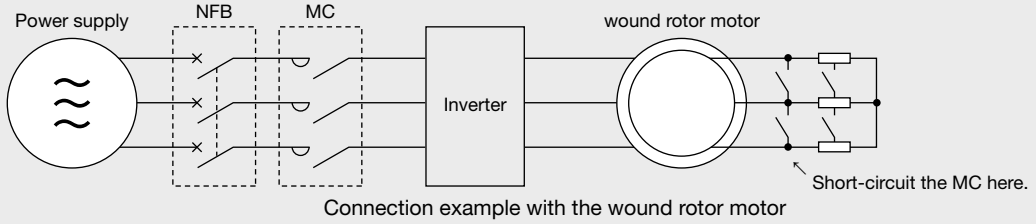
Wound rotor motor

Advantages of using inverters

When the resistors on the secondary side are shorted, wound rotor motors can be used in the same way as cage-induction motors, and maintenance is not required for the magnetic contactors for the resistors on the secondary side. If the motor is modified to short the secondary side inside, maintenance for the slip ring, etc. is not required, either. Also, the motor installation size remains unchanged by using the same motor.

Checkpoints for selection

When the resistor on the secondary side is shorted, wound rotor motors can be used in the same way as cage-induction motors. For crane applications, be careful to avoid interference with any existing patents.



Connection example with the wound rotor motor

Upgrading from Eddy Current Coupling Motor (AS Motor) Systems

Advantages of using inverters

By upgrading the system using a standard motor (three-phase, cage-induction motor) and a general-purpose inverter, maintenance requirements are minimized. Also, as a large loss is generated with the eddy current coupling motor, the energy saving effect can be achieved by upgrading the system.

Checkpoints for selection

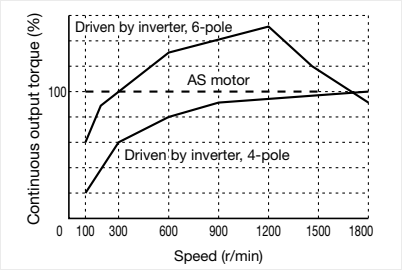
Check the specifications beforehand. Although the inverter-driven type system is advantageous in general, check if there is no problem with the maximum torque, etc. For replacing other manufacturers' eddy current coupling motors, fully examine characteristics and specifications by comparing the catalogs, etc.

Because eddy current coupling motors are selected to cover the mechanical characteristics, it is not necessarily required to match the characteristics between the existing system and the replacement inverter system.

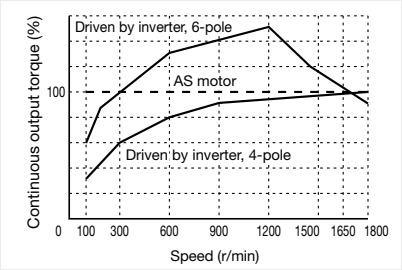
In general, load characteristics (torque) of machinery are classified into the following three types. Compare the characteristics between the eddy current coupling motor and the inverter system, and select the inverter depending on the load characteristics type of the target machine.

- **Constant torque characteristics (constant torque regardless of the running speed)**
  Generally abrasive loads for driving conveyors, carriers, rolls in the process line, etc.
- **Variable torque characteristics (The load torque changes proportionally against the square of the rotation speed.)**
  Fluid loads for driving fans, pumps, blowers, etc.
- **Constant output characteristics (The load torque increases as the running speed decreases. The product of the torque and the speed is constant.)**
  Main shaft drive of machine tools, winding machines (center drive), etc.

3.7 kW or lower



5.5 kW or lower



Comparison of the continuous output torque

When the continuous output of the AS motor is supposed as 100% (60 Hz reference). With the standard torque boost setting of the inverter.

Cautionary notes

[Motor installation size]

Eddy current coupling motors and standard motors have different installation size. In particular, check the center height (height to the center of the motor shaft) and the shaft length. When the center height or the shaft length is different, the installation size is not compatible. Modification of the machine is required.

[Unit installation compatibility]

The external shape and dimensions differ between the AS unit and the inverter. Check the outline dimension drawings.

Upgrading from Direct Current Motor Systems

Advantages of using inverters

By upgrading the system using a standard motor (three-phase, cage-induction motor) and a general-purpose inverter, maintenance requirements are minimized.

Checkpoints for selection

Check the specifications beforehand. Check if there is no problem with the maximum speed, the speed response, the speed change range, etc. For replacing other manufacturers' direct current motors, fully examine characteristics and specifications by comparing the catalogs, etc.

In general, in the case such that sufficient torque is required in the low-speed range, the speed ratio is large, the speed accuracy or the response is important, or torque control is performed, use vector inverters (FR-V500 series) or the FR-A800 series (with the plug-in option FR-A8AP) for replacement to obtain satisfactory performance. When the performance requirement for the target machine is not so critical, general-purpose inverters without vector control may be used for replacement.

Cautionary notes

[Motor installation size]

Direct current motors and standard motors have different installation size. In particular, check the center height (height to the center of the motor shaft) and the shaft length. When the center height or the shaft length is different, the installation size is not compatible. Modification of the machine is required.

[Unit installation compatibility]

The external shape and dimensions differ between the conventional DC amplifier and the inverter. Check the outline dimension drawings.

Mitsubishi Inverter Family Products

FR-A800

IM & IPM　IP55

High Performance and High Functionality Inverter

[Leading drive performance]
- The enhanced Real sensorless vector control and vector control achieves improved speed response and high-speed operation.
- The PM motor auto tuning function enables operation of other manufacturers' permanent magnet (PM) motors.

[Security & safety]
- Controls with safety functions can be easily performed. (Safety stop function)
- 24 VDC control power input is equipped as standard. The parameter setting and communication operation can be done without turning ON the main power.
- The operating status immediately before the protective function is activated can be stored with the trace function, facilitating the trouble analysis at a separate location by using a USB memory device and the inverter setup software (FR Configurator2).

FR-F800

IM & IPM

Enhanced Next-Generation Energy-Saving Inverter

[Energy saving]
- Advanced optimum excitation control, which has been newly developed, provides a large starting torque while maintaining the motor efficiency under the conventional Optimum excitation control.
- The tuning function enables operation of other manufacturers' induction motors and PM motors, which increases the use in the energy saving applications.

[Functions ideal for fans and pumps]
- The rating can be selected between the two types (LD (light duty) or SLD (superlight duty)) depending on the load of the fan/pump to be used (multiple rating).
- The inverter can perform PID control of the motor operation and control the external equipment at the same time (PID multiple loops). The system cost can be reduced.
- By controlling the pumps connected in parallel (up to four pumps) by the PID control, water volume, etc. can be adjusted by one inverter (multi-pump function).

FR-E700

Simple and Powerful Inverter

[Pursuing performance]
- With Advanced magnetic flux vector control, the top-level drive performance has been achieved among compact inverters. More tenacious operation is possible.
  (200% 0.5 Hz (3.7 K or lower) in the Advanced magnetic flux vector control setting)

[Easy to use (Outstanding operability and enhanced expandability)]
- The non-slip setting dial with adaptive scroll speed allows for quick jumps or precise increments based on turning speed.
- USB connection facilitates easy setting with FR Configurator from a personal computer.

[Compact and space-saving]
- The installation size is the same as the conventional models (FR-E500 series) for exchangeability.

FR-F700PJ

IM & IPM

With a Filterpack

Inverter for Air Conditioning

[Suitable for both the general-purpose motor and the IPM motor]
- Both the general-purpose motor and the IPM motor can be operated. The general-purpose motor driving setting can be switched to IPM driving setting by only one setting.

[Reduction in the environmental loads]
- A model with Filterpack as standard (FR-F7☐0PJ-☐F) is available. A Filterpack contains a power factor improving DC reactor essential for air conditioning, a common mode choke (line noise filter), and a capacitive filter (radio noise filter) in one.
- Less wiring and smaller space achieved by using the Filterpack also enable compliance with the Harmonic Suppression Guidelines and the Architectural Standard Specifications in Japan.

FR-D700

Easy and Compact Inverter

[Higher reliability]
- High reliability and safety have been achieved by incorporating spring clamp terminals, the safety stop function, and the password function.

[Compact]
- The installation size is the same as the conventional models (FR-S500 series) for exchangeability.

[Pursuing performance]
- General-purpose magnetic flux vector control ensures reliable operation for applications that require high starting torque.
  (in the 150% 1 Hz General-purpose magnetic flux control setting, when the slip compensation function is enabled)

Capacity table

Model	Inverter capacity *1																																
	0.1	0.2	0.4	0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160	185	220	250	280	315	355	400	450	500	560
FR-A820-☐ FR-A840-☐ FR-A842-☐*2 FR-A846-☐*3																																	
FR-F820-☐ FR-F840-☐ FR-F842-☐*2																																	
FR-E720-☐K*4*5*6 FR-E740-☐K*4*5*6 FR-E720S-☐K*4 FR-E710W-☐K																																	
FR-F720PJ-☐K(F)*7 FR-F740PJ-☐K(F)*7																																	
FR-D720-☐K FR-D740-☐K FR-D720S-☐K FR-D710W-☐K																																	

Voltage class
- Three-phase 200 V
- Three-phase 400 V
- Single-phase 200 V (Note)
- Single-phase 100 V (Note)

(Note) The output is three-phase 200 V.

(to be released soon)

*1: ND rated capacity for the FR-A800 series, and LD rated capacity for the FR-F800 series.
*2: Separated converter type. Always install the converter unit (FR-CC2). (Not required when a high power factor converter (FR-HC2) is used.)
*3: IP55 compatible model.
*4: The safety stop function model is indicated with SC.
*5: The FL remote communication function model is indicated with NF.
*6: The CC-Link communication function model is indicated with NC.
*7: Filterpack (FR-BFP2) is enclosed for the inverter with Filterpack ("F" at the end of its model names marked on the packaging box.)

Further Energy Saving Operation with Premium High-efficiency IPM Motor MM-EFS/MM-THE4 Series

What is an IPM motor?

IPM stands for Interior Permanent Magnet.
An IPM motor is a synchronous motor with permanent magnets embedded inside.

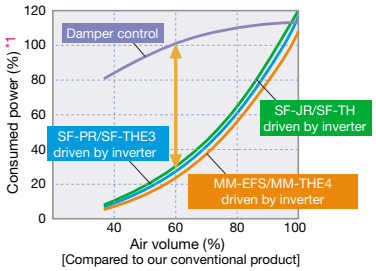
Why is an IPM motor so efficient?

1) No current flows to the rotor (secondary side), and no secondary copper loss is generated.
2) Magnetic flux is generated with permanent magnets, and less motor current is required.
3) Embedded magnets provide reluctance torque, and the reluctance torque can be applied.

Energy saving with speed control

- The consumed power of a variable-torque load, such as fans, pumps, and blowers, is proportional to the cube of its rotation speed.
- This means that controlling the rotation speed to adjust the air volume can lead to energy savings.

[Example of blower operation characteristic]



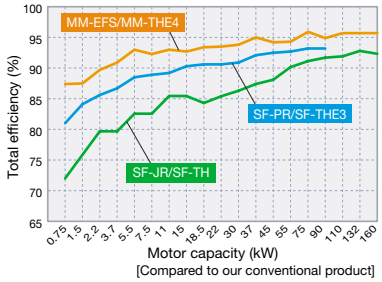
*1: Rated motor output is 100%.

Energy saving by driving an IPM motor

•High efficiency with an IPM motor

- The IPM motor, with permanent magnets embedded in the rotor, achieves even higher efficiency as compared to the SF-PR/SF-THE3.

[Comparison of efficiency]



IE4-equivalent efficiency level

- With the premium high-efficiency IPM motor "MM-EFS series and MM-THE4 series", the highest-class efficiency standard, IE4 (super premium efficiency)*2, can be achieved.

*2: As of October 2010

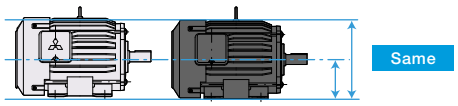
Efficiency class IEC 60034-30	Mitsubishi motor efficiency	
	general-purpose motor	IPM motor
IE4 (super premium efficiency) *3	—	Premium high-efficiency IPM (MM-EFS, MM-THE4)
IE3 (premium efficiency)	Superline premium series (SF-PR)	—
IE2 (high efficiency)	Superline eco series (SF-HR)	—
IE1 (standard efficiency)	Superline series (SF-JR)	—
Below the class		—

High ↑ Efficiency ↓ Low

*3: The details of IE4 are specified in IEC 60034-31.

Simple and reliable transition from general-purpose motors (compatible installation size)

- The frame number (size) is the same as that of the Mitsubishi general-purpose motors, "SF-JR/SF-HR series (55 kW or lower) and SF-TH series (75 kW or higher)". The compatible installation size enables easy replacement from the general-purpose motors.



SF-JR 3.7kW MM-EFS371M4

•Premium high-efficiency IPM motor (MM-EFS/MM-THE4 series)

[55 kW or lower]

M M - E F S 7 1 M 4

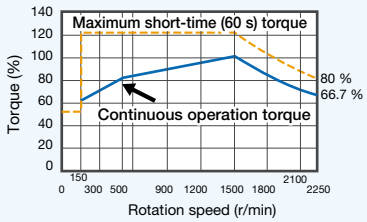
Symbol	Output
Refer to the motor model in the table below.	Refer to the rated output in the table below.

Symbol	Rated rotation speed *1
1M	1500r/min

Symbol	Voltage class
None	200V
4	400V

Symbol	Specifications *2
Q	Class B

Symbol	Specifications *2
P1	Outdoor type



*1: The motor can also be used for applications which required the rated speed of 1800 r/min.
*2: The outdoor type and class B are semi-standard models.

[75 kW or higher]

M M - T H E 4

- The motor can be used for applications which required the rated speed of 1500 r/min and 1800 r/min.
- For dedicated motors such as the outdoor type, the long-axis type, the flange type, the waterproof outdoor type, and the salt-damage proof specification type, contact your sales representative.

Rated output (kW)		0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90	110	132	160
Motor model		7	15	22	37	55	75	11K	15K	18K	22K	30K	37K	45K	55K	–	–	–	–	–
200 V class	MM-EFS□1M	•	•	•	•	•	•	•	•	•	•	•	•	•	•	–	–	–	–	–
400 V class	MM-EFS□1M4	•	•	•	•	•	•	•	•	•	•	•	•	•	•	–	–	–	–	–
200 V class	MM-THE4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	•	–	–	–	–
400 V class		–	–	–	–	–	–	–	–	–	–	–	–	–	–	•	•	•	•	•

•: Released model, –: Not applicable

■ Notes
- The IPM motor MM-EFS/MM-THE4 series cannot be driven by the commercial power supply.
- For IPM motors, the total wiring length is 100 m maximum.
- Only one IPM motor can be connected to an inverter.

Solutions for Maintenance/Inspection of Inverters, Upgrading, and Total System Configuration

Mitsubishi Electric System & Service Co., Ltd. provide support for maintenance and inspection of inverters, engineering works for upgrading to the latest models, and total system upgrade so that our customers can continue using their equipment with confidence for a long time.

System upgrade proposals

Upgrading existing inverters

Replacement of conventional models with the latest models

[Merits]

- Prevention of opportunity loss due to equipment stop by an accidental failure
- Cooling fan change without removing the main circuit wiring
- Reduction in the maintenance cost
- Energy saving effect with the increased motor efficiency by selecting the Optimum excitation control mode (especially for fans and pumps)

Energy saving with inverters

Change from the commercial power supply operation with damper control to the inverter control for loads such as blowers and pumps

[Merits]

- Power saving by the energy saving effect
- More comfortable operation by very fine rotation speed control
- Mechanical design available regardless of the power supply frequency (50/60 Hz)
- Motor cooling fan wind noise reduced by low-speed operation

Replacing variable speed motors

Replacement of eddy current coupling motors (AS motors), direct current (DC) motors, etc. with the general-purpose inverters with induction motors

[Merits]

- Easy maintenance (no need to check or change the brush)
- Reduction in the power supply capacity
- Changeable to the robust "cage-induction motor"

Total system support

Total support for customers from maintenance/inspection of inverters and high-voltage circuit breakers to engineering work for upgrading systems with control panels, programmable controllers, servos, etc.

[Menu]

- Design/manufacturing of control panels for upgrading
- Design / engineering work / adjustment for replacing the discontinued AC servo models
- Design / engineering work / adjustment for upgrading the A (large type) series programmable controllers to the Q series
- Total system proposal for equipment including monitoring

Renewal engineering work procedure

Proposal

Consultation — Confirmation of details

Field investigation — Installation condition check for the target equipment and the optional equipment
- Check for the installation space available inside the enclosure, wiring, etc.
- Check for details of parameter settings
- Check for operation specifications

* We ask for cooperation from those who are familiar with specifications and handling of the equipment.

Estimation — Equipment selection and estimation

Order — Engineering work scheduling

Equipment procurement — Procurement of products and components

System design/manufacturing — Hardware design/manufacturing (as required)
- Software design/manufacturing (as required)

On-site engineering work — Equipment replacement and installation / wiring change

* Intercompatibility attachments are available for shortening the installation work period.

On-site adjustment — Parameter setting and operation check

* We request those who are familiar with specifications and handling of the equipment will be present.

Delivery

Points to be checked

Before upgrading, check the following items.

Check item		Problem	Remedy	
			Inverter	Peripheral devices
Installation	Installation environment	Oil mist, fluff, dust, dirt, etc. are floating in the air.	△: Use totally enclosed structure models.	◎: To be contained in the totally enclosed enclosure.
		When the inverter is installed in the enclosure, the temperature inside the enclosure reaches or exceeds 40°C.	○: Protrude the heatsink out of the enclosure (the attachment is required).	△: Install heat pipes.
	Wiring	The inverter circuit is damaged when a voltage is applied to the secondary side output terminal of the inverter. A different device is misconnected to the connection terminal for the dedicated option. The frequency setting power supply terminal (10) and the common terminal (5) are shorted due to incorrect wiring.	×	◎: Perform a sequence check.
	Power supply capacity	When the inverter is connected near a large-capacity power transformer (with a capacity of 1000 kVA or more with the wiring length shorter than 10 m) or when a power factor correction capacitor is to be switched over, an excessive peak current may flow in the power input circuit, damaging the inverter.	△: Install a power factor improving reactor.	×
		When a thyristor converter or a vacuum contactor exist in the same power supply system, a surge voltage is generated in the power line, and the inverter malfunction occurs.	△: Install a power factor improving reactor.	◎: Provide a separate power supply system.
Performance	Low speed torque shortage	The excitation voltage decreases due to a voltage drop through the motor primary coil and the wiring resistance. The influence is larger during the low-speed operation.	◎: Select the magnetic flux vector control.	×
	Motor noise	A metallic noise is generated from the motor due to the PWM carrier frequency.	◎: Use a high-carrier frequency, or select the Soft-PWM control at a low-carrier frequency. △: Noise reduction reactor	×
	Vibration	The motor vibration increases by PWM switching, and resonance with the machine occurs.	△: Avoid resonance points by changing the carrier frequency or using the frequency jump function.	△: Increase the mechanical rigidity.
Noise		Noise is generated by PWM switching. The noise increases when the carrier frequency is increased for the low acoustic noise operation. Signal cables are adversely affected by the electromagnetic noise of the inverter. (Incorrect input, etc.)	△: Decrease carrier frequency.	△: Change the wiring route, or install a noise filter. Use twisted pair cables for signal cables.
leakage current	Unnecessary operation	A leakage current causes an unnecessary operation of the earth leakage circuit breakers or the earth leakage relays.	△: Decrease carrier frequency.	○: Use the earth leakage circuit breaker designed for harmonics and surge suppression.
		A leakage current flows doe to the stray capacitance between lines, and the thermal relay is activated. A leakage current increases when the carrier frequency is increased for the low acoustic noise operation.	○: Decrease carrier frequency. Use the electronic thermal O/L relay function.	△: Shorten the wiring length.
Power supply harmonics		Due to a large inrush current from the rectifier circuit with a smoothing capacitor, the input voltage waveform is distorted. Suppression of the outgoing current according to the guideline is required.	◎: High power factor converter △: Power factor improving reactor	○: Active filter
Others	Efficiency	Losses are generated in the inverter.	×	△: Cool the inside of the enclosure.
	Power factor	Because of the rectifier circuit with a smoothing capacitor, the effective value of the input current is large.	◎: High power factor converter △: Power factor improving reactor	○: Active filter
	Surge voltage	With the long wiring length, the motor terminal voltage increases by PWM switching and insulation of the 400 V motor is degraded.	◎: Surge voltage suppression filter	◎: Insulation-enhanced motor ○: Shorten the wiring length.

Effect: ◎: Solved. ○: Largely improved. △: Improved, but not enough. ×: Difficult to remedy.

We visualize our customers' factories to solve problems and troubles.

"Visualization" of production and energy achieves future factories that advance one step forward.

The integrated solution, e-F@ctory, is based on our consolidated know-how, which has been developed through our own experiences as a user of FA products. Our e-F@ctory provides total cost reduction ranging from development to production and maintenance to achieve optimized production. This solution makes it possible to save energy and to optimize production by "visualization" that links upstream information systems and production site information, thus solving various problems on production sites.

Sharing information across production systems

MES Interface

Information sharing is easy and inexpensive because communication gateways, such as personal computers, are not necessary to connect factory equipment to the Manufacturing Execution System (MES).

Optimizing production from a TCO* stand point

iQ Platform

Factory automation components such as controllers, human-machine interfaces, engineering environments, and networks are all seamlessly integrated to reduce TCO across different stages, from development to production and maintenance.

* TCO : Total Cost of Ownership

iQ Platform

Visualization of energy consumption

e&eco-F@ctory

It is indispensable for today' s factory to be energy conscious and efficient. The e-F@ctory solution enables management of specific energy consumption, which provides the visibility needed to improve productivity. Additionally, this solution takes the total life cycle into account, including factors such as “measurement and diagnosis”, “countermeasures”, and “operation and management”. Backed by several successes and achievements, our know-how will support your energy saving efforts.

iQ Platform

Network

CC-Link Family, the open field network of the world standard, and SSCNET III/H, the servo network for achieving high-speed processing and enhancement of instruction synchronization, flexibly expanding the connectivity among equipment and devices in the e-F@ctory environment.

iQ Platform-compatible equipment

The inter-multi-CPU high-speed base unit provides slots for arbitrarily connecting programmable controllers, motion controllers, on-line CNCs, and robot controllers. Data communication speed among devices is enhanced, and their compatibility is extremely improved.

iQ Platform-compatible engineering environments

Design information is integrated and shared at stages from system design to programming, tests and startup, and operation and maintenance. In addition, programming software programs for programmable controllers, motion controllers, on-line CNCs, robots, inverters, and GOTs, which are separately provided in a conventional environment, can be integrated.

e-F@ctory

Products for achieving e-F@ctory

ERP
Operation and planning system
MES
Manufacturing execution system

Information system

"Visualization" by information linkage

Ethernet
Information network

Diagnosis unit with MES Interface (MELQIC)
HMI with MES Interface
Programmable Controllers with MES Interface
EcoServer III

MES linkage function

Production site

Robots
Safety Controllers
Motion Controllers
Programmable Controllers
Electrical-Discharge Machines
Laser Processing Machines

CC-Link
CC-Link IE
Field network

Field network
B/NET

Safety field network
CC-Link Safety
Safety remote I/O

Field network
CC-Link
CC-Link IE

Energy measurement unit
MDU breaker
Electronic multi-indicating instrument

Servo-network
SSCNETIII/H
SERVO SYSTEM CONTROLLER NETWORK
AC Servo

Programmable Controllers
Geared motor
Robots

CC-Link-AnyWire
Bitty Bridge

Reduced wiring network
CC-Link/LT
Remote I/O

Sensor network
Anywire
Foolproof terminal
Mapping sensor terminal

Inverter

[Related Factory Automation Products]

PLC | MELSEC iQ-R Series

Revolutionary, next generation controllers building a new era in automation

◎High-speed, high-accuracy multiple CPU control system based on the iQ Platform
◎New high-speed system bus and inter-module sync realizes improved productivity and reduced TCO*
◎Reducing development costs through intuitive engineering (GX Works3)
◎Robust security features (such as security key authentication, IP filter)

Product Specifications

Program capacity	40K steps to 1200K steps
LD instruction speed	0.98 ns
Available modules	I/O, analog, high-speed counter, positioning, simple motion, network module
Control system architecture	Rack-mounted modular based system
Supported networks	Ethernet, CC-Link IE Control Network, CC-Link IE Field Network, CC-Link, RS-232, RS-422/485

*Total Cost of Ownership

Programmable Controller | MELSEC-L Series

"Light & Flexible" condensing various functions easily and flexibly.

◎CPU equipped as a standard with various functions including counter, positioning and CC-Link.
◎The base-less structure with high degree of freedom saves space in the control panel.
◎Easily confirm the system status and change the settings with the display unit.
◎Ten models are available in program capacities from 20 k steps to 260 k steps.

Product specifications

Program capacity	20 k steps/60 k steps/260 k steps
Number of input/output points [X/Y]	1024 points/4096 points
Number of input/output device points [X/Y]	8192 points
Basic instruction processing speed (LD instruction)	60 ns/ 40 ns/ 9.5 ns
External connection interface	USB, Ethernet, RS-232, SD memory card, CC-Link (L26CPU-BT/PBT)
Function modules	I/O, analog, high-speed counter, positioning, simple motion, temperature control, network module
Unit expansion style	Base-less structure
Network	Ethernet, CC-Link IE Field network, CC-Link, CC-Link/LT, SSCNETIII(/H), RS-232, RS-422

Programmable Controller | MELSEC-F Series

All-in-One Micro Programmable Controller equipped with all necessary functions in a compact body

◎Supporting small-scale control from 10 points to 384 points (using CC-Link) with an outstanding cost performance.
◎Wide range of options available for additional functions required by your system.
◎Easy to use and highly reliable. More than 12 million units have shipped worldwide. (April 2013)
◎Small-scale control is available in various networks such as CC-Link, Ethernet, and MODBUS.

Product specifications

Program capacity	16k steps (FX_{3S}) to 64 k steps (FX_{3U}/FX_{3UC})
Number of input/output points	10 points (FX_{3S}) to 384 points (FX_{3U}/FX_{3UC} with CC-Link)
Basic instruction processing speed	0.21μs (FX_{3S}) to 65 ns (FX_{3U}/FX_{3UC})
External connection interface	RS-422, USB (FX_{3S}/FX_{3G}/FX_{3GC}/FX_{3GE} only), Ethernet (FX_{3GE} only), CC-Link/LT (FX_{3UC}-32MT-LT(-2) only)
Built-in functions	I/O, high-speed counter input, positioning pulse output, analog (FX_{3GE} only)
Extended functions	I/O, analog, temperature control, high-speed counter, positioning, network
Unit expansion style	Backplane-less design
Network	Ethernet, CC-Link, CC-Link/LT, SSCNETⅢ, CANopen, J1939, RS-232C, RS-422, RS-485, MODBUS

HMI | Graphic Operation Terminal GOT2000 Series GT27 Model

To the top of HMIs with further user-friendly, satisfactory standard features.

◎Comfortable screen operation even if high-load processing (e.g. logging, device data transfer) is running. (Monitoring performance is twice faster than GT16)

◎Actual usable space without using a SD card is expanded to 128MB for more flexible screen design.

◎Multi-touch features, two-point press, and scroll operations for more user-friendliness.

◎Outline font and PNG images for clear, beautiful screen display.

Product Specifications

Screen size	15", 12.1", 10.4", 8.4"
Resolution	XGA, SVGA, VGA
Intensity adjustment	32-step adjustment
Touch panel type	Analog resistive film
Built-in interface	RS-232, RS-422/485, Ethernet, USB, SD card
Applicable software	GT Works3
Input power supply voltage	100 to 240VAC (+10%, −15%), 24VDC (+25%, −20%)

AC Servo | Mitsubishi General-Purpose AC Servo MELSERVO-J4 Series

Industry-leading level of high performance servo

◎Industry-leading level of basic performance: Speed frequency response (2.5kHz), 4,000,000 (4,194,304p/rev) encoder

◎Advanced one-touch tuning function achieves the one-touch adjustment of advanced vibration suppression control Ⅱ, etc.

◎Equipped with large capacity drive recorder and machine diagnosis function for easy maintenance.

◎2-axis and 3-axis servo amplifiers are available for energy-conservative, space-saving, and low-cost machines.

Product Specifications

Power supply specifications	1-phase/3-phase 200V AC, 1-phase 100V AC, 3-phase 400V AC
Command interface	SSCNET Ⅲ/H, SSCNET Ⅲ (compatible in J3 compatibility mode), CC-Link IE Field Network interface with Motion, pulse train, analog
Control mode	Position/Speed/Torque/Fully closed loop
Speed frequency response	2.5kHz
Tuning function	Advanced one-touch tuning, advanced vibration suppression control Ⅱ, robust filter, etc.
Safety function	STO, SS1 SS2, SOS, SLS, SBC, SSM (compatible when combined with motion controller)
Compatible servo motor	Rotary servo motor (rated output: 0.05 to 22kW), linear servo motor (continuous thrust 50 to 3000N), direct drive motor (rated torque: 2 to 240N・m)

AC Servo | Mitsubishi General-Purpose AC Servo MELSERVO-JE Series

High performance and easy to use servo system for all machines

◎Easy To Use: The advanced one-touch tuning function enables servo adjustment with one-touch ease without a personal computer.

◎High Performance: Class top-level basic performance including speed frequency response of 2.0kHz.

◎Global Standard: Digital input/output is compatible with both sink and source type connections as a standard.

Product specifications

Power supply specifications	1-phase/3-phase 200V AC
Command interface	Pulse train, analog
Control mode	Position/speed/torque
Speed frequency response	2.0kHz
Tuning function	Advanced one-touch tuning, advanced vibration control II, robust filter, etc.
Compatible servo motor	Rotary servo motor (rated output: 0.1 to 3kW)

[Related Factory Automation Products]

Three-Phase Motor | High Performance Energy-Saving Motor Super Line Premium Series SF-PR

Premium Efficiency & Compatible. New Launch of Super Line Prem ium Series SF-PR Model

◎Compared to general-purpose motor SF-JR model, generated loss is reduced by 37% on average, and it is compatible with highly efficient premium IE3.

◎Easy replacement is achieved as mounting dimension (frame number) is compatible with general-purpose motor SF-JR model.

◎One motor can accommodate different power sources of Japan and the U.S. Three ratings in Japan meet the Top Runner standards, while it corresponds to EISA in the U.S.

◎Can be driven by inverters as standard. Advanced magnetic-flux vector control by our FR-A800/700 achieves steady torque drive up to 0.5Hz.

Product Specifications

Number of poles	2-poles, 4-poles, 6-poles
Voltage·Frequency	200/200/220/230V 50/60/60/60Hz EISA 230V 60Hz or 400/400/440/460V 50/60/60/60Hz EISA 460V 60Hz
Exterior	Totally enclosed fan cooled type (inside, outside installation)
Protection system	IP44
Electrically-driven power system	Motor with 2-poles over 11kW is dedicated for a direct connection. Motors with 4-poles and 6-poles are for both direct and crossed belt connections.
Rotation direction	Counter-clock-wise (CCW) direction viewed from the edge of axis.
Compatible standard	JEC-2137-2000 (Efficiency is compatible with IEC 60034-30.)

Robot | MELFA F Series

High speed, high precision and high reliability industrial robot

◎Compact body and slim arm design, allowing operating area to be expanded and load capacity increased.

◎The fastest in its class using high performance motors and unique driver control technology.

◎Improved flexibility for robot layout design considerations.

◎Optimal motor control tuning set automatically based on operating position, posture, and load conditions.

Product Specifications

Degrees of freedom	Vertical:6 Horizontal:4
Installation	Vertical:Floor-mount, ceiling mount, wall mount (Range of motion for J1 is limited) Horizontal:Floor-mount
Maximum load capacity	Vertical:2-20kg Horizontal:3-20kg
Maximum reach radius	Vertical:504-1503mm Horizontal:350-1,000mm

EDM | Wire EDM MV1200R

Next-generation Innovations of our best selling Performance Machine.

◎Total running cost reduced up to 42%, which is accounted for 90% by filter, ion exchange resin and power consumption.
◎Improved productivity by an innovative automatic wire threading.
◎Faster machining is realized with improved power-supply performance.
(Rz3. 5μm/Ra0. 45μm with 3cuts) (Rz2. 0μm/Ra0. 28μm with 4cuts)

Product Specifications

Model		MV1200R
Machining travel (X×Y×Z)[mm]	(in)	400(15.7)×300(11.8)×220(8.7)(XY axis OPT-drive specifications)
Machining travel (U×V)[mm]	(in)	±60(2.4)×±60(2.4)(OPT-drive specifications)
Max. taper angle [°]		15° (maximum 200mm)(7.9")
Max. workpiece dimensions [mm]	(in)	810(31.9)×700(27.6)×215(8.5)
Wire diameter [mm]	(in)	0.1(.004) to 0.3(.012)※1
Dielectric fluid		Water
Footprint (W×D)[mm]	(in)	2025(79.7)×2760(108.7)

※1:Φ0.2(0.08) DD guides and Φ1.5(0.06) jet nozzle are standard equipment.

Laser Processing Machine | CO_2 2-Dimensional Laser Processing Machine eX-Series

A global standard CO_2 2-dimensional laser processing systems.

◎Productivity has been dramatically enhanced owing to improved acceleration and the latest control technologies exclusive to Mitsubishi Electric.

◎2 Action Cutting allows for the entire process, from job setup to parts cutting, to be completed in two simple actions.

◎When not processing, the system switches to ECO mode and the resonator stops idling. Minimizes energy consumption, reducing running costs by up to 99%*1 during standby.

*1: Compared to the previous LV-Series with Mitsubishi's designated benchmark shape.

Product specifications

Model Name	ML3015eX
Drive system	Flying optic (3-axis beam movement)
Stroke (X×Y×X) [mm]	3100×1565×150
Rapid feedrate [m/min]	X,Y axes: Max. 100; Z-axis: Max. 65
Processing feedrate [m/min]	Max. 50
Positioning accuracy [mm]	0.05 / 500 (X,Y axes)
Repeat accuracy [mm]	± 0.01 (X,Y axes)
Rated output [W]	4500

Laser Processing Machine for Substrate Drilling | GTW4 Series

Ever-evolving global standard machine

◎Newly-developed super-fast galvano and 360W high-power resonator achieve industry-leading productivity.

◎Laser beam generated by unparalleled resonator enables stable high-quality copper-direct processing on various surface treatments.

◎Single machine can support variety of processing application with Mitsubishi unique powerful laser and optimum beam control.

◎Original resonator structure, which can be refreshed by replacing some parts only, realizes low operating cost.

Product specifications

Model name	ML605GTW4(-H)-5350U／ML605GTW4(-P)-5350U／ML706GTW4-5350U
Processing workpiece dimensions (mm)	620×560／815×662
XY table maximum feedrate (m/min)	50
Laser type	CO_2 laser
Oscillator power (W)	360W
Oscillator set pulse frequency	10 to 10000Hz

CNC | Mitsubishi CNC M700V Series

High-grade model equipped with advanced complete nano control

◎Achieve complete nano control with the latest RISC-CPU and high-speed optical servo network.

◎Realize super-high grade processing by combining the complete nano control, state-of-the-art SSS control and OMR control, etc.

◎Display of essential information of grouped on three screens to greatly reduce processing setup time with easy operability.

◎The M700VW Series with WindowsXPe and M700VS Series with integrated control unit and display type are available.

Product Specifications

Maximum number of control axes (NC axes + spindles + PLC axes)	16 axes (M720VW/M720VS have 12 axes)
Maximum number of part systems	Machining center system: 2 systems Lathe system: 4 systems
Least command increment	1nm (M720VW/M720VS 0.1μm))
Least control increment	1nm
Maximum program capacity	2,000kB(5,120m)
Maximum PLC program capacity	128,000 steps
Main functions (for machining center)	Simultaneous 5-axis machining, SSS control, high-speed high-accuracy control, tool nose point control, tilt plane machining, etc.
Main functions (for lathe)	Milling interpolation, 2-system simultaneous thread cutting, inter-system control axis synchronization, control axis superimposition, combination control, etc.

[Related Factory Automation Products]

Low Voltage Circuit Breakers | Mitsubishi WS-V Series Molded Case Circuit Breakers, Earth Leakage Circuit Breakers

Technologies based on long year experience realize more improved performance.

◎The new electronic circuit breakers can display various measurement items.

◎Improvement of breaking performance with new breaking technology “Expanded ISTAC”.

◎Compliance with global standard for panel and machine export.

◎Commoditization of internal accessories for shorter delivery time and stock reduction.

Product Specifications.

Frame	32-250A Frame
Applicable standard	Applicable to IEC, GB, UL, CSA, JIS and etc.
Expansion of UL listed product line-up	New line-up of 480VAC type with high breaking performance for SCCR requirement
Commoditization of internal accessories	Reduction of internal accessory types from 3 to 1
Commoditization for AC and DC circuit use	Common use of 32/63A frame in both AC and DC circuit
Compact size for easy to use	Thermal adjustable and electronic circuit breakers are same size as 250AF fixed type
Measuring Display Unit (MDU) breakers	MDU breakers measure, display and transmit energy date to realize energy management.

Magnetic Starter | MS-T Series

Exceed your expectations.

◎10A frame model is over 16% smaller with a width of just 36mm!!

◎New integrated terminal covers.

◎Reduce your coil inventory by up to 50%.

◎Be certified to the highest international levels while work is ongoing to gain other country.

Product specifications

Frame	10 A to 32 A
Applicable standards	Certification to various standards including IEC, JIS, CE, UL, TÜV, CCC.
Terminal cover	Standard terminal cover improves safety, simplifies ordering, and reduces inventory, etc.
Improved wiring	Wiring and operability are improved with streamlining wiring terminal BC specifications.
Operation coil rating	Wide range of operation coil ratings reduces number of coil types from 14 (N Series) to 7 types and simplifies selection.
Option units	Diverse lineup includes Auxiliary Contact Block, Operation Coil Surge Absorber Unit, Mechanical Interlock Unit.

Low-voltage switch | Mitsubishi Motor Circuit Breaker MMP-T Series

Introducing a Motor Circuit Breaker from Mitsubishi Electric!

◎Design smaller panels by using the Motor Circuit Breaker, various options and MS-T Series Magnetic Contactor.

◎Prevent secondary damage with Motor Circuit Breaker and Magnetic Contactor combination.

◎Streamlined wiring terminal BC specifications (option) contribute to improving your productivity.

◎Supports your overseas business with compliance to various International Standards as well as the UL Type E/F combination.

Product specifications

Rated current	0.16 A to 32 A (15 types)
Applicable (compliant) standards	Standard product compliant with various International Standards including IEC, JIS, CCC, TÜV and UL (certified)
Wiring types	Bare wire, rod terminal, Y crimp and round crimp supported
Improvement of wiring	Wiring and operability are improved with connection conductor unit and streamlined wiring terminal BC specifications (option)
Optional units	Auxiliary/Alarm Contact Unit, Short-Circuit Indicator Unit, Line Side Terminal Adapter, Connection Conductor Unit, etc., available
DIN rail mounting	Standard product mountable on rail
Finger protection support	Standard product compliant with IP20 from front side of terminals
Application in North America	Type E/F combination certification acquired. Compatible up to maximum SCCR value 50 kA

Global network for comprehensive support of

Global FA Center | FA Center Satellite (China) | Mechatronics Service Base (China) | Mitsubishi Sales Offices | Production Facility | Development Center

Ratingen, Germany

Mitsubishi Electric Europe B.V.
German Branch (Germany FA Center)

Kraków, Poland

Mitsubishi Electric Europe B.V.
Polish Branch
(Europe FA Center)

Hatfield, UK

Mitsubishi Electric Europe B.V.
UK Branch (UK FA Center)

Praha, Czech Republic

Mitsubishi Electric Europe B.V.
Czech Branch
(Czech Republic FA Center)

Pune, Gurgaon, Bangalore, Chennai, Ahmedabad, India

Mitsubishi Electric India Pvt. Ltd.

Bangkok, Thailand

Mitsubishi Electric Factory Automation
(Thailand) Co., Ltd. (Thai FA Center)

Singapore

Mitsubishi Electric
Asia Pte, Ltd. (ASEAN FA Center)

Beijing

Mitsubishi Automation (China) Ltd.
Beijing Office (Beijing FA Center)

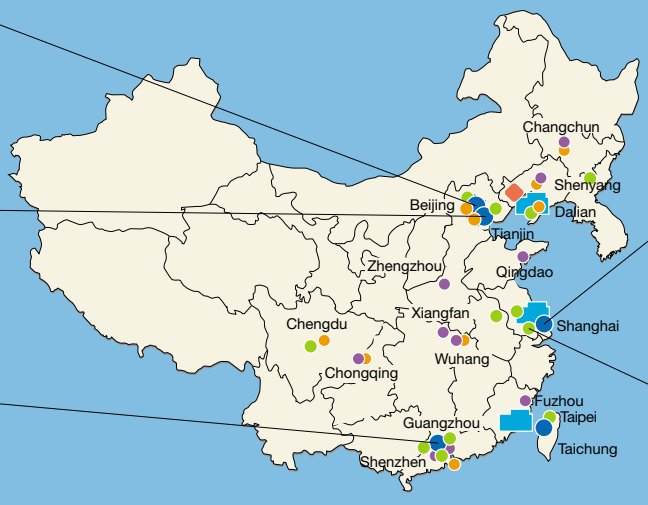
Tianjin

Mitsubishi Automation (China) Ltd.
Tianjin Office (Tianjin FA Center)

Guangzhou

Mitsubishi Electric Automation
(China) Ltd. Guangzhou
Office (Guangzhou FA Center)

China (including Hong Kong District)



Shanghai

Mitsubishi Automation (China) Ltd.
(Shanghai FA Center)

Shanghai

Mitsubishi Electric Automation
Solution Center

customers' manufacturing.

Service bases are established around the world to globally provide the same services as in Japan.

Overseas bases are opened one after another to support business expansion of our customers.

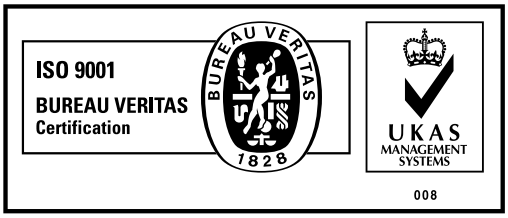
Overseas bases | As of July 2014 * Some includes distributors

Area	Our overseas offices	FA Center (Satellite)	Bases providing our products	Countries (Regions)
EMEA	11	6 (2)	146	54
China	13	4 (10)	171	1
Asia	21	13	79	10
America	14	4 (0)	130	16
Others	1	0	3	2
Total	60	27 (12)	529	83

⚠ Safety Warning

To ensure proper use of the products listed in this catalog, please be sure to read the instruction manual prior to use.

Mitsubishi Electric Corporation Nagoya Works is a factory certified for ISO14001 (standards for environmental management systems)and ISO9001(standards for quality assurance management systems)



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