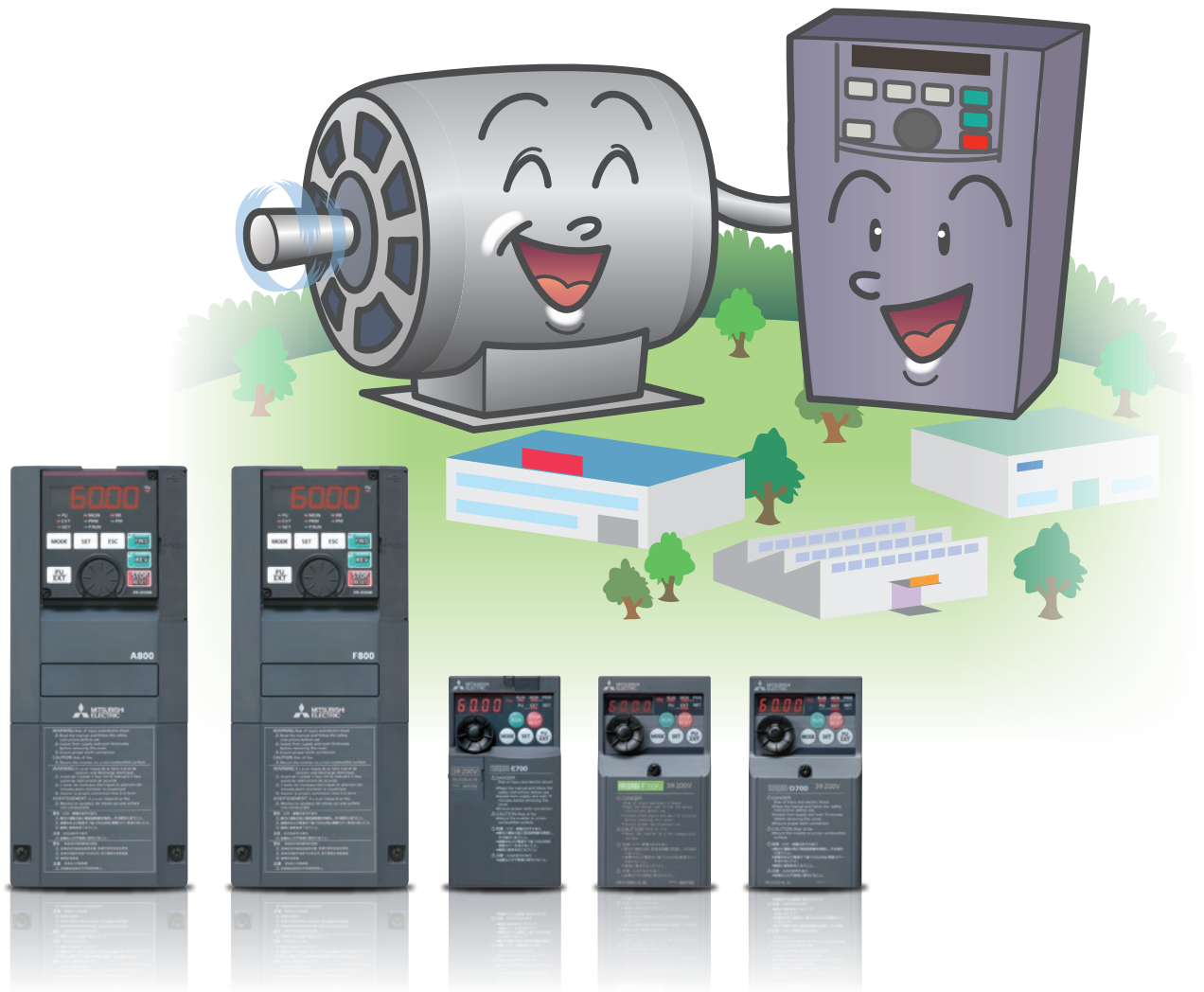


# Proposal for Upgrading/ Introducing Inverters



# GLOBAL IMPACT OF MITSUBISHI ELECTRIC



Through Mitsubishi Electric's vision, "Changes for the Better" are possible for a brighter future.

## *Changes for the Better*

We bring together the best minds to create the best technologies. At Mitsubishi Electric, we understand that technology is the driving force of change in our lives. By bringing greater comfort to daily life, maximizing the efficiency of businesses and keeping things running across society, we integrate technology and innovation to bring changes for the better.

Mitsubishi Electric is involved in many areas including the following

### **Energy and Electric Systems**

A wide range of power and electrical products from generators to large-scale displays.

### **Electronic Devices**

A wide portfolio of cutting-edge semiconductor devices for systems and products.

### **Home Appliance**

Dependable consumer products like air conditioners and home entertainment systems.

### **Information and Communication Systems**

Commercial and consumer-centric equipment, products and systems.

### **Industrial Automation Systems**

Maximizing productivity and efficiency with cutting-edge automation technology.

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# Proposal for Inverter Control

## Do you want to improve the existing machinery?


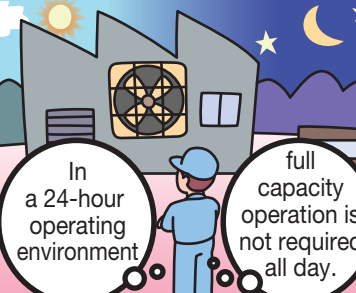
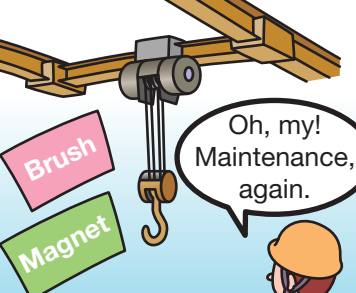
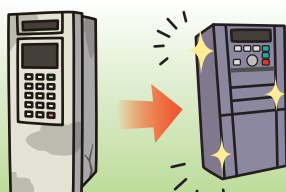
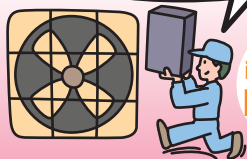
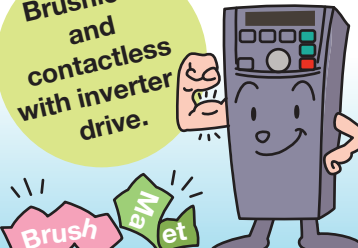

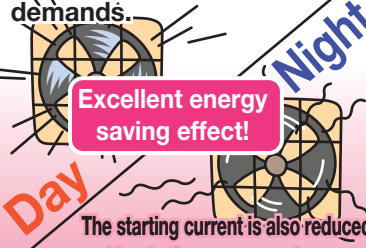
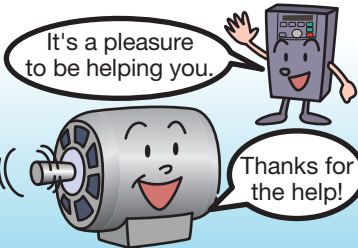
Machines with motors are used in various applications such as driving conveyors or operating fans.

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

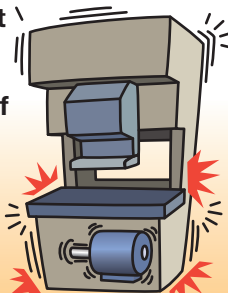
For conventional inverter system users	For commercial power supply system users	For wound rotor motor users
 <p>Oh no!</p> <p>Parts supply limit has been reached!</p>	 <p>In a 24-hour operating environment</p> <p>full capacity operation is not required all day.</p>	 <p>Oh, my! Maintenance, again.</p>
<p><b>Did you know?</b> Inverters have a service life. The supply of parts for them is also limited.</p> 	<p>Use inverters for driving standard motors.</p>  <p>Easy installation Inverter</p>	<p>Brushless and contactless with inverter drive.</p>  <p>Brush Magnet</p>
<p>Just in case...</p> <p>Owing to the upgrade, the line does not stop.</p>  <p>Use the latest model to feel at ease.</p>	<p>Operation as the situation demands.</p> <p>Excellent energy saving effect!</p>  <p>Day Night</p> <p>The starting current is also reduced, making further energy savings.</p>	<p>Maintenance-free!</p> <p>It's a pleasure to be helping you.</p>  <p>Thanks for the help!</p>
<p>For details, see page 6 and page 7.</p>	<p>For details, see page 8.</p>	<p>For details, see page 8.</p>

# 800/700 Series



**For eddy current coupling motor (AS motor) users**

Although it is difficult to obtain this type of motors, they are still being fully used.



**Loss** But, it's time to think of energy saving. **Heat**

**Downsized!**  
Energy saving by driving standard motors by inverters!

For details, see page 9.

**For direct current (DC) motor users**

Brush? It is quite a task to teach how to maintain the motor.

Maintenance and preventive maintenance... Any good ideas?

Using an inverter for speed control may be helpful!

For details, see page 9.

**For prospective IPM motor users**

The time to reduce CO<sub>2</sub> emissions is now...

With the IPM motor... Significant energy saving and CO<sub>2</sub> reduction can be achieved. You can contribute to global warming prevention.

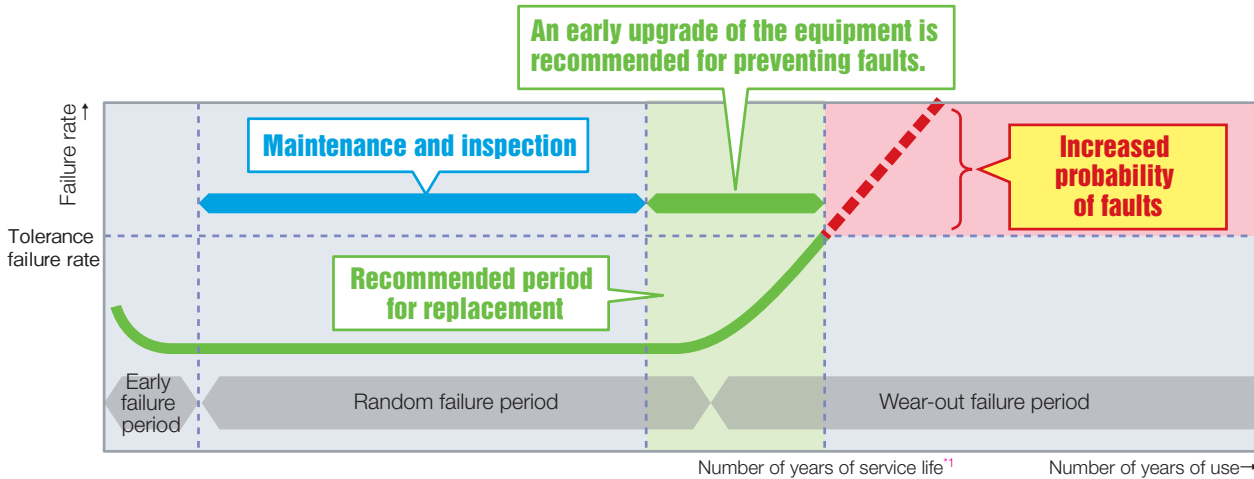
If you change your motors, consider the use of IPM motors.

For details, see page 11.

## Upgrading Existing Inverters

### Why upgrading is necessary

- Upgrading of inverters is necessary because limited-life components are used in inverters. Since electronic components and resin parts in inverters are subject to deterioration, inverters cannot be used forever even if limited-life components or replaceable parts (such as a cooling fan) are replaced. An early upgrade of the equipment is recommended as a preventive measure.



\*1: As a reference, the inverter's service life is about 10 years in general since electronic components and resin parts are subject to deterioration. Reference document: "Planned upgrade of the inverter", JEMA (Japan Electrical Manufacturer's Association)

### 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.

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

### Use of long life components

- The estimated service life of the cooling fans is 10 years<sup>\*1</sup>. The service life of the cooling fan can be improved by performing ON/OFF control.
- Capacitors with a design life of 10 years<sup>\*\*2</sup> 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.

- Estimated service lifespan of the long-life parts

Components	Estimated lifespan of the 800 series	Guideline of JEMA <sup>®</sup>
Cooling fan	10 years	2 to 3 years
Main circuit smoothing capacitor	10 years	5 years
Printed board smoothing capacitor	10 years	5 years

\*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

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

### Enhanced life diagnosis function

- The remaining life can be estimated for the main circuit capacitor, control circuit capacitor, and inrush current limit circuit by checking the deterioration.
- Maintenance timers are available for up to three peripheral devices, such as motor and bearing.

### Worry-free upgrade of conventional inverters

- Installation interchange attachments are available for replacement between Mitsubishi Electric 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)).



"Maintenance 1 output" warning

## Checkpoints and cautionary notes for upgrading

### 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.

### 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	Repairs and spare parts available until <sup>*1</sup>	Alternative model
FR-F2	December 1986	November 1993	FR-F800 FR-A800 <sup>*2</sup>
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 <sup>*2</sup>
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-D700
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-D700
FR-F400	June 1995	June 2002	FR-F800 FR-A800 <sup>*2</sup>
FR-A200	October 1995	October 2002	FR-A800
FR-Z024	October 1995	October 2002	FR-E700 FR-D700
FR-V200	April 1996	April 2003	FR-A800 + FR-A8AP/FR-A8AL/FR-A8TP
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 (3-phase 200 V)	June 2004	June 2011	FR-D700
FR-V200E	October 2004	October 2011	FR-A800 + FR-A8AP/FR-A8AL/FR-A8TP
FR-S500 (3 phase 400 V/1-phase 200 V/1-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-D700
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 (200 V)	October 2011	October 2018	FR-HC2 (200 V)
MT-HC (200 V)	October 2011	October 2018	FR-HC2 (200 V)
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 (400 V)	October 2012	October 2019	FR-HC2 (400 V)
MT-HC (400 V)	October 2012	October 2019	FR-HC2 (400 V)
SC-A	April 2015	April 2022	FR-D700
MD-AX520	September 2015	September 2022	FR-A800
FR-A700	December 2015	December 2022	FR-A800
FR-F700P	September 2016	September 2023	FR-F800
FR-V500	January 2017	January 2024	FR-A800 + FR-A8TP
FR Configurator SW3	October 2017	—	FR Configurator2
FR-B/B3 (FR-A700 Specification)	December 2017	December 2024	FR-B/B3 (FR-A800 Specification)
FR Series manual controller/speed controller	April 2018	April 2025	FR-A800
FR-RC	October 2018	October 2025	FR-XC
FR-CV	June 2019	June 2026	FR-XC

\*1: Repairs are subject to the supply of spare parts and may not be possible even within the specified time period.

\*2: 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 discretionary 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. Use a motor with enhanced insulation.

## 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.

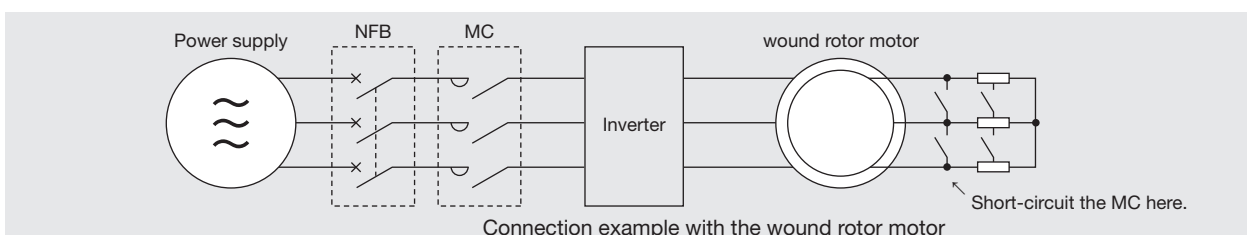
### Wound rotor motor

#### 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.





## 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.

### Cautionary notes

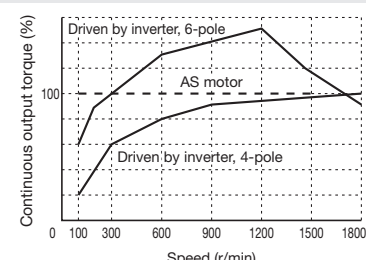
#### [Motor installation size]

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.

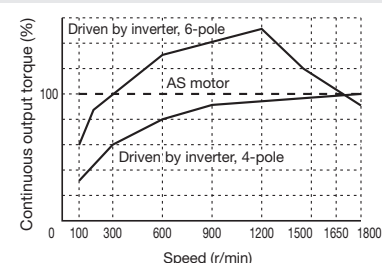
#### [Unit installation compatibility]

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

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.

## 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.

We recommend the use of the FR-A800 series inverter (with a Vector control compatible option) to obtain satisfactory performance in applications where 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. 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.



## 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?

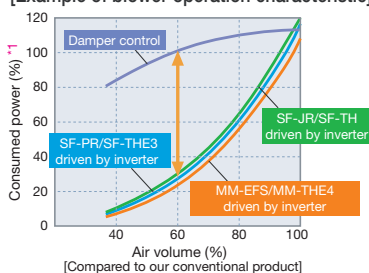
- 1) No current flows to the rotor (secondary side), and no secondary copper loss is generated.
- 2) Magnetic flux is generated with permanent magnets, and less motor current is required.
- 3) Embedded magnets provide reluctance torque, and the reluctance torque can be applied.

### 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%.

### IE4-equivalent efficiency level

With the premium high-efficiency IPM motor MM-EFS series and MM-THE4 series, the efficiency equivalent to IE4 (super premium efficiency), the highest-class efficiency standard, is obtained.\*2

\*2: As of June 2016

Efficiency class IEC 60034-30	Mitsubishi Electric 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	—	—

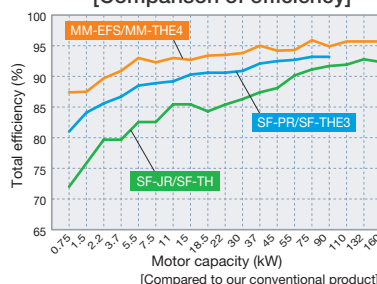
\*3: The details of IE4 are specified in IEC 60034-31.

### Energy saving by driving an IPM motor

#### High efficiency with an IPM motor

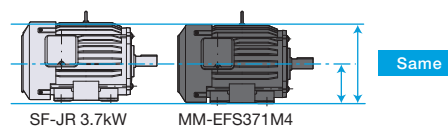
The IPM motor, with permanent magnets embedded in the rotor, achieves even higher efficiency as compared to the SF-PR/SF-THE3.

[Comparison of efficiency]



### 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.



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

[55 kW or lower]

**MM-EFS 71M4**

Symbol	Output	Symbol	Rated rotation speed *1	Symbol	Voltage class	Symbol	Dedicated specification	Symbol	Specifications *2	Symbol	Specifications *2
Refer to the motor model in the table below.	Refer to the rated output in the table below.	1M	1500 r/min	None	200 V	None	Standard	None	Standard	None	Standard
		3	3000 r/min	4	400 V	-S10	Belt drive model	Q	Class B	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]

**MM-THE4**

•The motor can be used for applications which required the rated speed of 1500 r/min and 1800 r/min.

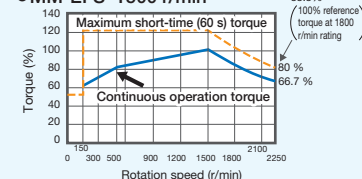
•For dedicated motors such as the outdoor type, the long-axis type, the flange type, the waterproof outdoor type, and the corrosion proof type, contact your sales representative.

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	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	MM-EFS□1M-S10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	MM-EFS□3	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
400 V class	MM-EFS□1M4	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	MM-EFS□1M4-S10	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	MM-EFS□34	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
200 V class	MM-THE4	—	—	—	—	—	—	—	—	—	—	—	—	—	•	•	•	•	•
400 V class	MM-THE4	—	—	—	—	—	—	—	—	—	—	—	—	—	•	•	•	•	•

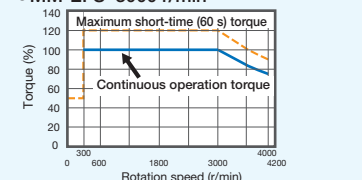
#### Notes

- 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.
- For belt drive application of the 11 kW or higher motor with the 1500 r/min specification, use a dedicated motor.

#### MM-EFS 1500 r/min



#### MM-EFS 3000 r/min



•: Released model, -: Not applicable

# 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, installation 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)

### 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"

### 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

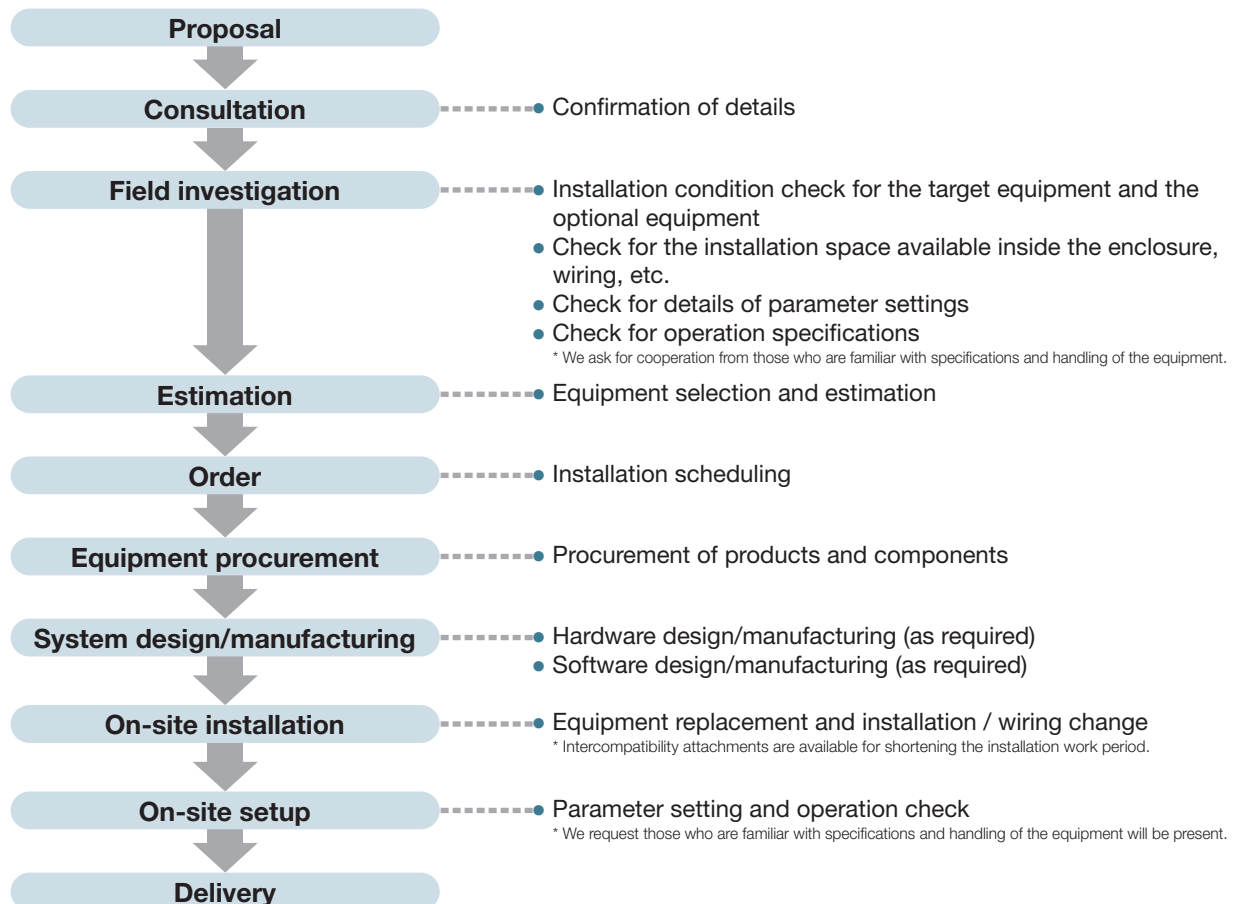
### Total system support

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

**[Menu]**

- Design/manufacturing of control panels for upgrading
- Planning/installation/setup when replacing the discontinued AC servo models
- Planning/installation/setup when upgrading programmable controllers
- Total system proposal for equipment including monitoring

## Renewal installation procedure



## 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.	◎: Change the control method.	×
	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. ○: Sine wave filter <sup>*1</sup>	×
	Vibration	The motor vibration increases by PWM switching, and resonance with the machine occurs.	○: Sine wave filter <sup>*1</sup> △: 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 due 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 ○: 12-phase rectifier <sup>*2</sup> △: 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 ○: Sine wave filter <sup>*1</sup>	◎: Insulation-enhanced motor ○: Shorten the wiring length.

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

\*1: It can be used for the operation of a 75K or higher inverter or a 75 kW or higher motor under V/F control.

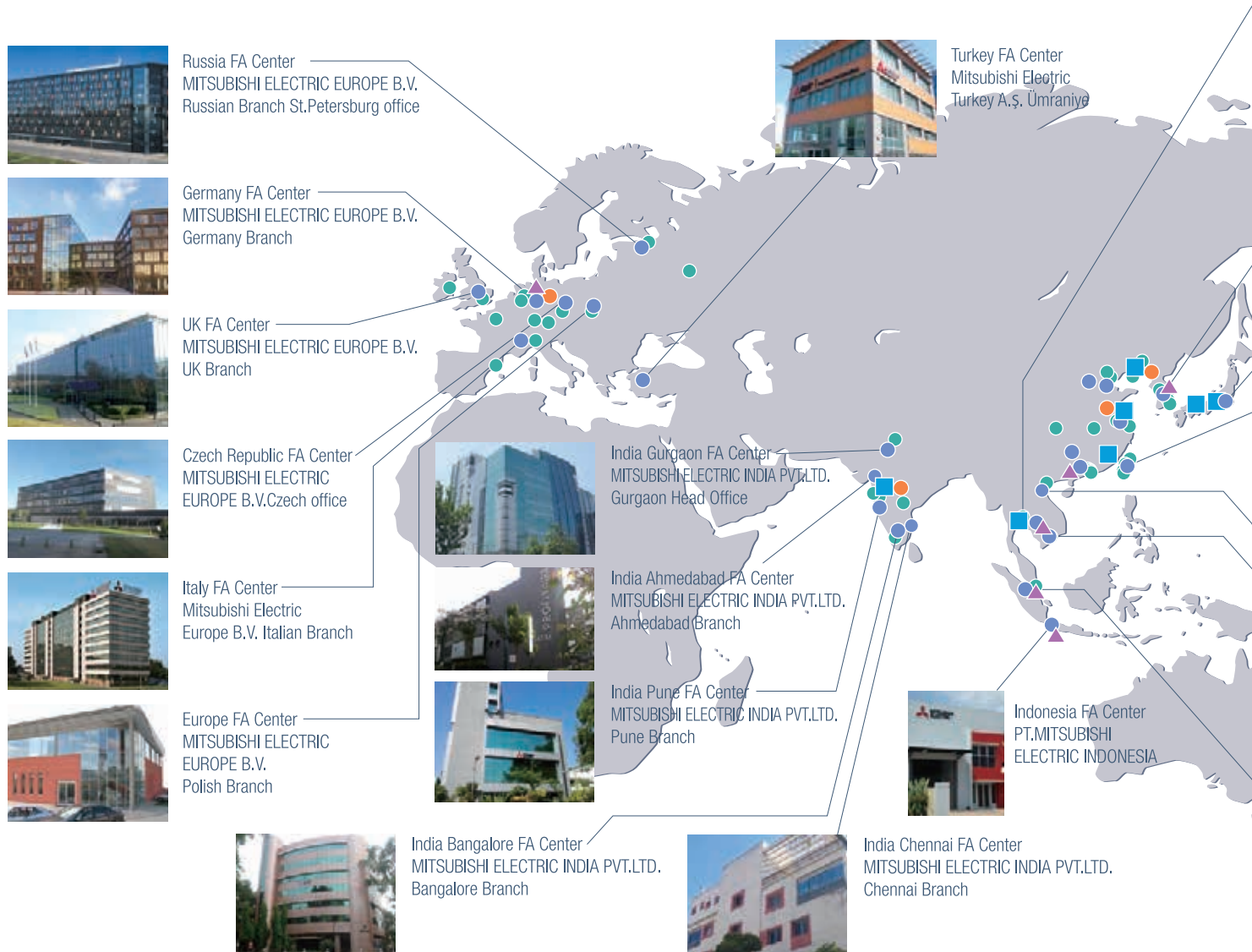
\*2: It can be used for the converter unit (FR-CC2).

# MEMO

# MEMO

# Mitsubishi Electric's global FA network delivers reliable technologies and security around the world.

■ Production base   
 ● Development center   
 ● Global FA Center   
 ▲ Mechatronics showroom   
 ● Mitsubishi Electric sales office



## Available services



### Technical consultation (engineering)

Our Japanese and/or local staff offer technical advice, and can also propose the best products and systems for a customer's specific application needs.



### Showrooms

The latest automation technologies, including programmable controllers, HMIs, inverters, servo systems, and industrial automation machinery such as electrical-discharge machines, laser processing machines, CNCs, and industrial robots can be seen at Mitsubishi Electric showrooms.



### Training

From basic operations to applied programming, our training schools offer regular courses that use actual machines. We also offer customized training programs and onsite training sessions.



### Technical support

Our FA centers and service shops work together to provide repairs, onsite engineering support, and spare parts.



### Repairs

Handle repairs of our FA products.



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Service bases are established around the world to provide the same services as in Japan globally. Overseas bases are opening one after another to support our customers' business expansion.

Area	Our overseas	FA centers
EMEA	26	7
China	17	4
Asia	31	13
Americas	15	6
Others	1	0
Total	90	30

As of July 2017

North America FA Center  
 MITSUBISHI ELECTRIC  
 AUTOMATION,INC.

Mexico Monterrey FA Center  
 Monterrey Office, Mitsubishi  
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 Mexico Branch, Mitsubishi  
 Electric Automation, Inc.

Brazil FA Center  
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Brazil Votorantim FA Center  
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China

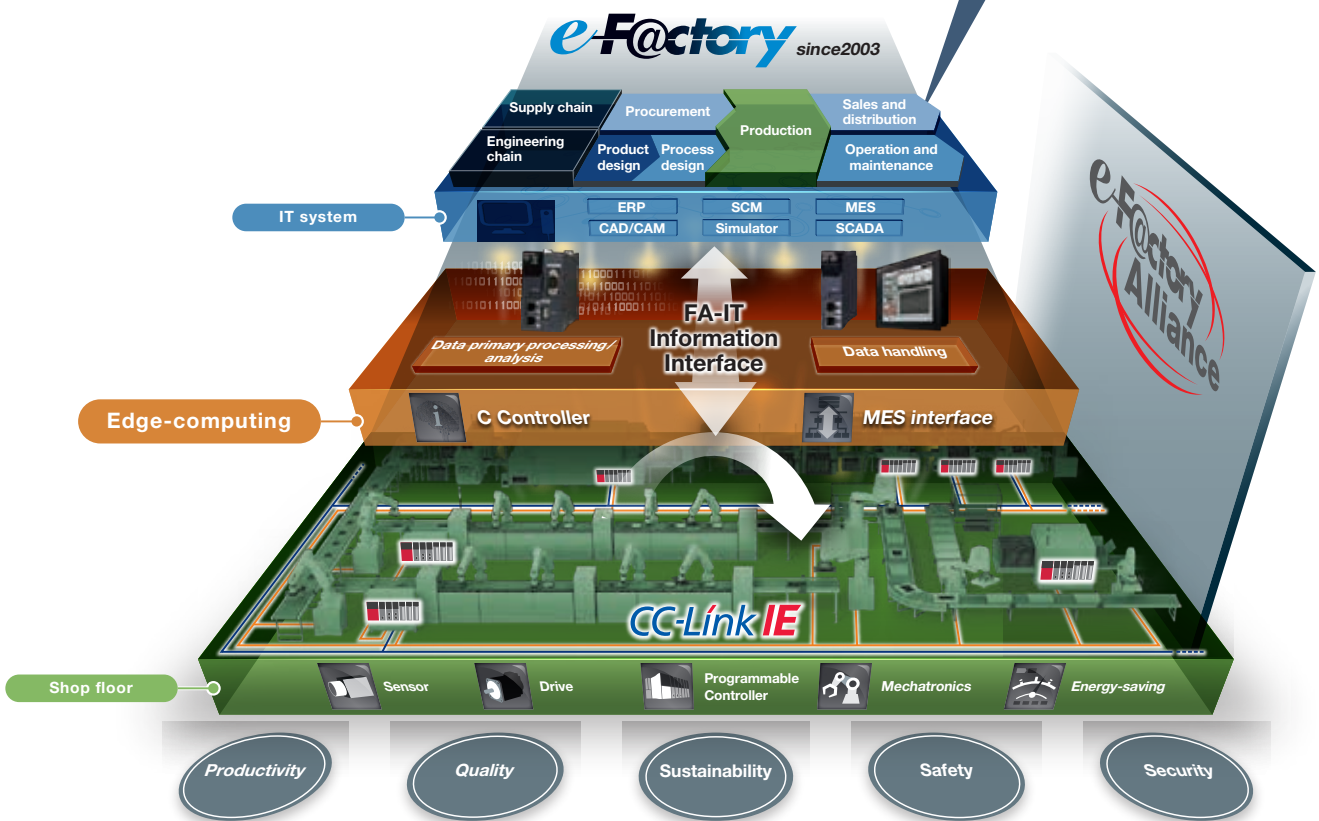
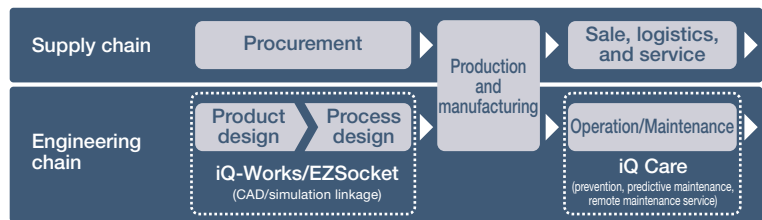
Shanghai FA Center  
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# This solution solves customers' issues and concerns by enabling visualization and analysis that lead to improvements and increase availability at production sites.

Utilizing our FA and IT technologies and collaborating with e-Factory Alliance partners, we reduce the total cost across the entire supply chain and engineeringchain, and support the improvement initiatives and one-step-ahead manufacturing of our customers.



FA integrated solutions reduce total cost



Overall production information is captured in addition to energy information, enabling the realization of efficient production and energy use (energy savings).

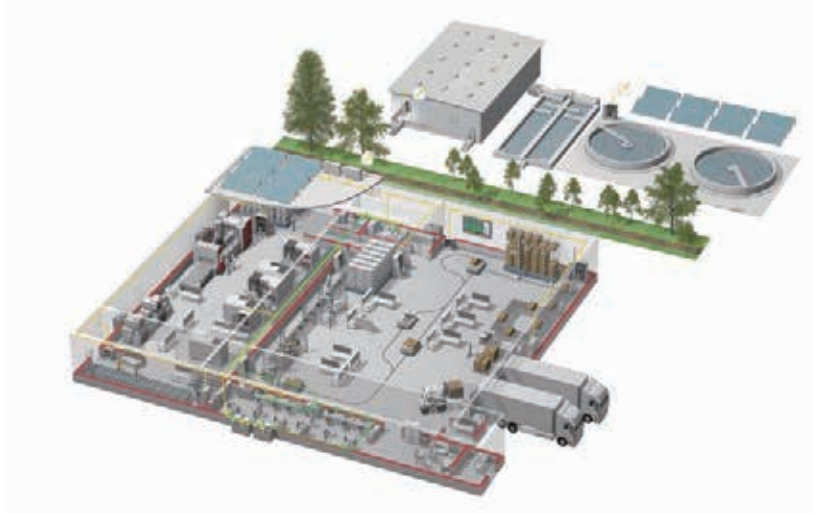
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The Mitsubishi brand name is recognized around the world as a symbol of premium quality.

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This is why you can rely on Mitsubishi Electric automation solution - because we know first hand about the need for reliable, efficient, easy-to-use automation and control in our own factories.

As one of the world's leading companies with a global turnover of over 4 trillion Yen (over \$40 billion), employing over 100,000 people, Mitsubishi Electric has the resource and the commitment to deliver the ultimate in service and support as well as the best products.



Low voltage: MCCB, MCB, ACB



Medium voltage: VCB, VCC



Power monitoring, energy management



Compact and Modular Controllers



Inverters, Servos and Motors



Visualisation: HMIs



Numerical Control (NC)



Robots: SCARA, Articulated arm



Processing machines: EDM, Lasers, IDS



Transformers, Air conditioning, Photovoltaic systems

\* Not all products are available in all countries.

# **mitsubishi electric corporation**

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