eco Changes for a greener tomorrow

MITSUBISHI ELECTRIC
Changes for the Better

FACTORY AUTOMATION

INVERTER
FR-F800

Enhanced Next-Generation Energy-Saving Inverter [Ethernet communication model added to the line-up]

- Energy saving
- Functions ideal for fans and pumps
- Security & safety
- Compatibility with the environment
- Easy setup & operation

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.

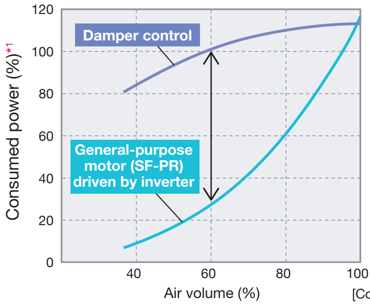
Contents

1 ENERGY SAVING

1 Energy Saving with Inverters

The consumed power of a variable-torque load, such as fans, pumps, and blowers, is proportional to the cube of its rotation speed.
Adjusting the air volume by the inverter rotation speed control can lead to energy savings.

[Example of blower operation characteristic]



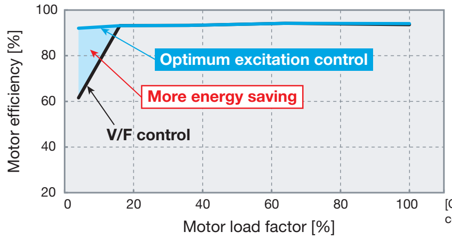
*1: Rated motor output is 100%.

[Compared to our conventional product]

Utilizing the motor capability to the full

Optimum excitation control

- Optimum excitation control continuously adjusts the excitation current to an optimum level to provide the highest motor efficiency. With a small load torque, a substantial energy saving can be achieved. For example, at 4% motor load torque for a general-purpose motor, the motor efficiency under Optimum excitation control is about 30% higher than the motor efficiency under V/F control.



[Compared to our conventional product]

(When the inverter running frequency is 60 Hz and the SF-PR 4P motor (15 kW) is used)

NEW Improving starting torque and saving energy at the same time

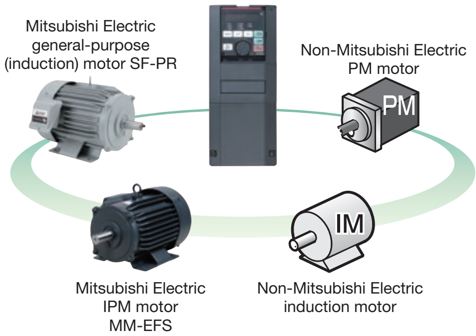
Advanced optimum excitation control

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.
Without the need of troublesome adjustment of parameters (acceleration/deceleration time, torque boost, etc.), acceleration is done in a short time. Also, energy saving operation with the utmost improved motor efficiency is performed during constant-speed operation.
To use Advanced optimum excitation control, set the energy saving control selection parameter (Pr.60) = "9" under Advanced magnetic flux vector control.

NEW Supporting operations of various motors

Offline auto tuning

The offline auto tuning function to measure circuit constants of the motor enables optimal operation of motors even when motor constants vary, when a non-Mitsubishi Electric motor is used, or when the wiring distance is long. Sensorless operation can be performed with Mitsubishi Electric general-purpose (induction) and PM motors (MM-EFS, MM-THE4) as well as non-Mitsubishi Electric general-purpose (induction) and PM motors*2.
The tuning function enables the Advanced optimum excitation control of non-Mitsubishi Electric general-purpose (induction) motors*2, which increases the usability in energy saving applications.



[2] *2: Depending on the motor characteristics, tuning may not be available.

2 Energy Saving with High-Efficiency Motor

In the international context of global warming prevention, many countries in the world have started to introduce laws and regulations to mandate manufacturing and sales of high-efficiency motors. With the use of high-efficiency motors, further energy saving is achieved.

> **[IE code]**
> As an international standard of the efficiency, IEC60034-30 (energy-efficiency classes for single-speed, three-phase, cage-induction motors) was formulated in October 2008. The efficiency is classified into four classes from IE1 to IE4. The larger number means the higher efficiency.

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		—

High — Efficiency — Low

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

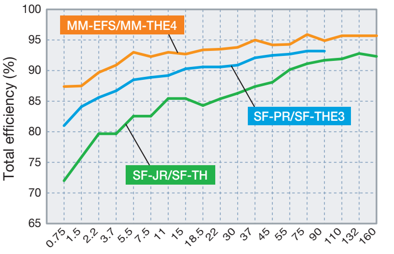
Further energy saving with the premium high-efficiency IPM motor

MM-EFS / MM-THE4

- The IPM motor, with permanent magnets embedded in the rotor, achieves even higher efficiency as compared to the general-purpose motor (SF-PR/SF-THE3).
- The IM driving setting can be switched to IPM driving setting by only one setting. ("12" (MM-EFS/MM-THE4) in the parameter [IPM]. Refer to **page 124** for details.)

Do not drive an IPM motor in the induction motor control settings.

[Comparison of efficiency]



[Compared to our conventional product]

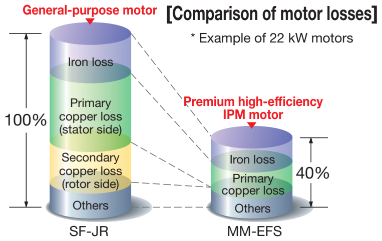
Why is an IPM motor more efficient?

·No current flows to the rotor (secondary side), and no secondary copper loss is generated.
·Magnetic flux is generated with permanent magnets, and less motor current is required.
·Embedded magnets provide reluctance torque*4, and the reluctance torque can be applied.

*4: Reluctance torque occurs due to magnetic imbalance on the rotor.

[Comparison of motor losses]

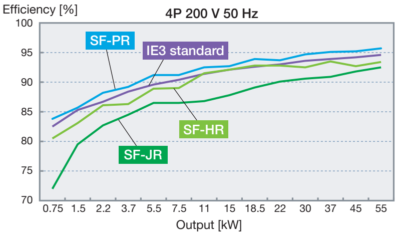
* Example of 22 kW motors



Excellent compatibility with the high-performance energy-saving motor

SF-PR

Motor constants are stored in the inverter. Energy-saving operation can be started just by setting parameters. The SF-PR motor conforms to the Japanese domestic Top Runner Standard (IE3 equivalent). Its energy-saving operation contributes reduction in the electricity charges, which in turn lowers the running cost.
Refer to **page 114** for the other features.

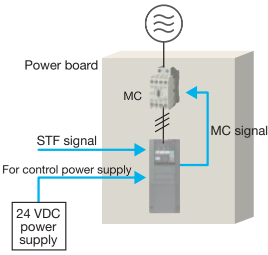


3 Energy-Saving Functions Suitable for Various Systems

Standby power reduction

NEW

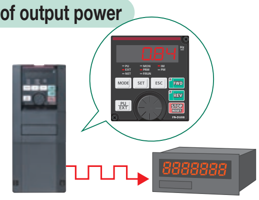
- With the 24 VDC external power supply, the input MC signal can be turned OFF after the motor is stopped, and turned ON before activating the motor. The inverter enables self power management to reduce standby power.
- The inverter cooling fan can be controlled depending on the temperature of the inverter heatsink. Also, signals can be output in accordance with the inverter cooling fan operation. When the fan is installed on the enclosure, the enclosure fan can be synchronized with the inverter cooling fan. Extra power consumption when the motor is stopped can be reduced.



Energy saving at a glance

Energy saving monitor / Pulse train output of output power

- Energy saving monitor is available. The energy saving effect can be checked using an operation panel, output terminal, or network.
- The output power amount measured by the inverter can be output in pulses. The cumulative power amount can be easily checked.



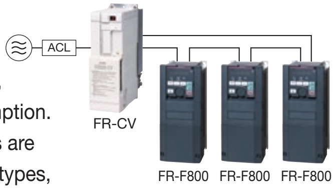
(This function cannot be used as a meter to certify electricity billings.)

Furthermore With the Mitsubishi Electric energy measuring module, the energy saving effect can be displayed, measured, and collected.

Effective use of the regenerative energy Option

FR-CV / FR-HC2

Multiple inverters can be connected to the power regeneration common converter (FR-CV) or the high power factor converter (FR-HC2) through a common PN bus. The regenerated energy is used by another inverter, and if there is still an excess, it is returned to the power supply, saving on the energy consumption. The 355 kW or higher models are inverter-converter separated types, which are suitable for power regeneration.



2 FUNCTIONS IDEAL FOR FANS AND PUMPS

1 Optimum Inverter Capacity Selection

NEW

Multiple rating

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. The optimum inverter capacity can be selected suitable for the motor to be used.
For the 200 V class 90 kW or higher and the 400 V class 75 kW or higher, a motor with one-rank higher capacity can be combined.

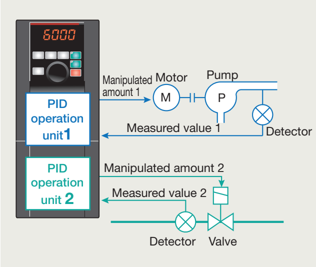
Load	Rating	Overload current rating
Superlight duty	SLD rating	110% 60 s, 120% 3 s (inverse-time characteristics) at surrounding air temperature of 40˚C
Light duty	LD rating	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature of 50˚C

For the list of inverters by rating, refer to **page 13**.

2 Further Enhanced PID Control

NEW System cost reduction **PID multiple loops (two loops)**

Two PID operation units are available in the inverter. The inverter can perform PID control of the motor operation and control the external equipment at the same time. The system cost can be reduced because no external PID controller is required for controlling the external equipment.



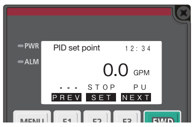
Direct setting of the PID set point

The PID set point can be set directly from the operation panel. The setting can be easily changed at hand.

NEW Visibility improvement Option

With the optional LCD operation panel (FR-LU08), the unit can be changed from "%" to other easy-to-see units. Maintenance and adjustment is facilitated by using a familiar unit of air volume, temperature, etc. for indication.

LCD operation panel (FR-LU08)
(Option)

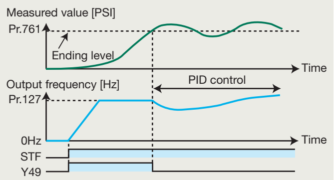


Unit conversion

NEW Avoidance of rapid acceleration/deceleration using PID action

PID pre-charge function

Before PID action, the water flow to the pipe is controlled by operating the motor at a constant speed until the measured value (pressure, etc.) reaches the set level. This function is used to avoid rapid acceleration/deceleration caused by starting the PID action while the pipe is empty, and prevent a water hammer action, etc.

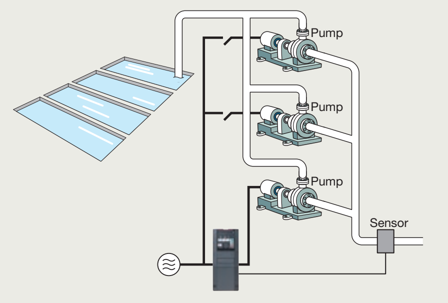


Example of the pre-charge operation
(Ending the pre-charge operation based on the measured value)

NEW Water volume control with multiple pumps

Multi-pump function

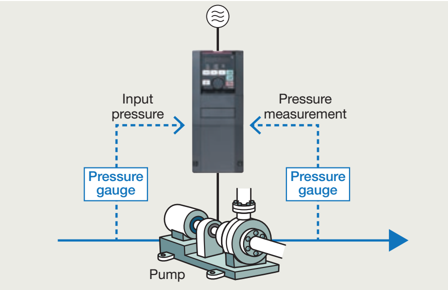
By controlling the pumps connected in parallel (up to four pumps) by the PID control by one inverter, water volume, etc. can be adjusted.
One of the connected pumps is driven by the inverter. Other pumps are driven by commercial power supply. The number of pumps to be driven by commercial power supply is automatically adjusted according to the water volume.



NEW Pump water volume control

PID input pressure control

In order to prevent air intake and cavitation inside the pump, the pump inlet pressure can be controlled so that there is no water shortage.

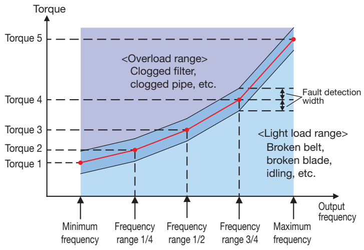


3 Operating Status Monitoring

NEW Detection of mechanical faults

Load characteristics measurement function

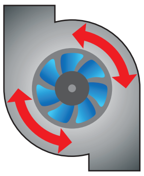
The speed/torque relationship is stored while no fault occurs. By comparing the present load status with the stored load characteristics, out-of-range warnings can be output if applicable. Mechanical faults such as clogging of the filter or breakage of the belt can be easily detected, and maintenance is facilitated.



NEW Cleaning of fans and pumps

Cleaning function

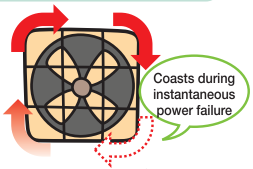
Foreign matter on the impellers or fans of pumps can be removed by repeating forward/reverse rotation and stopping of the motor. (Use this function when a back flush does not pose a problem.) This function can be also automatically started when the result of load characteristics measurement is out of range (overload).



4 Smooth Restart

Automatic restart after instantaneous power failure / flying start function

After an instantaneous power failure, the operation is restartable from the coasting motor speed. With the advanced flying start function, the operation can be smoothly started from low speed.



Automatic restart after instantaneous power failure function

5 Keep Running during Flying Start Operation

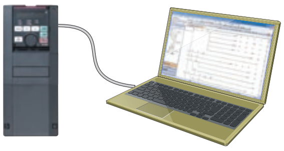
Regeneration avoidance function

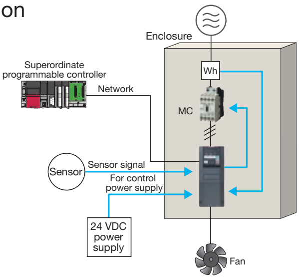
The operation frequency is automatically increased to prevent the regenerative overvoltage fault from occurring. This function is useful when a load is forcibly rotated by another fan in the duct.

6 PLC Control with an Inverter

NEW PLC function in the inverter

- Parameters and setting frequency can be changed at the program. Control programs can be created in sequence ladders using the inverter setup software (FR Configurator2).
- Inverter control such as inverter operations triggered by input signals, signal output based on inverter operation status, and monitor output can be freely customized based on the machine specifications.
- All machines can be controlled by the inverter alone, and control can also be dispersed.
- Time-based operation is possible by using in combination with the real-time clock function (when using an optional LCD operation panel (FR-LU08)).





7 Compatibility with Various Systems

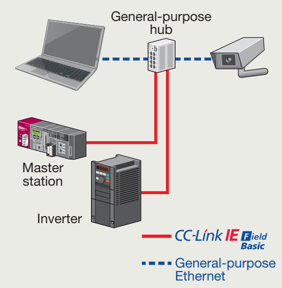
Compatibility with various networks

It supports BACnet® MS/TP as standard, as well as Mitsubishi inverter protocol and MODBUS®RTU (binary) protocol. Communication options are also available for major network protocols such as CC-Link, CC-Link IE Field Network, LONWORKS®, FL remote, PROFIBUS-DP V0, and DeviceNet™.

FR-F800-E

CC-Link IE Field Basic

The CC-Link IE Field Network Basic is supported, so the network can be created easily.
The inverter's status can be monitored and the parameters can be set via Internet.
(MODBUS/TCP and BACnet/IP are also supported.)



Simplified external equipment

The CA-type inverters are available. For the CA type, the monitor output terminal FM/CA operates as terminal CA (analog current output 0 to 20 mA), not as terminal FM (pulse train output). An external converter is not required.
(The factory setting is different for the CA type and the FM type. (Refer to **page 12**.))

8 Mechanical Resonance Suppression

Speed smoothing control

Vibration caused by mechanical resonance can be reduced. (Enabled only under V/F control.)

NEW 9 Extended Functions

Support for up to three types of options

Three types of plug-in options can be attached.
The functions of the inverter can be extended through network. For example, additional I/O terminals can be used.

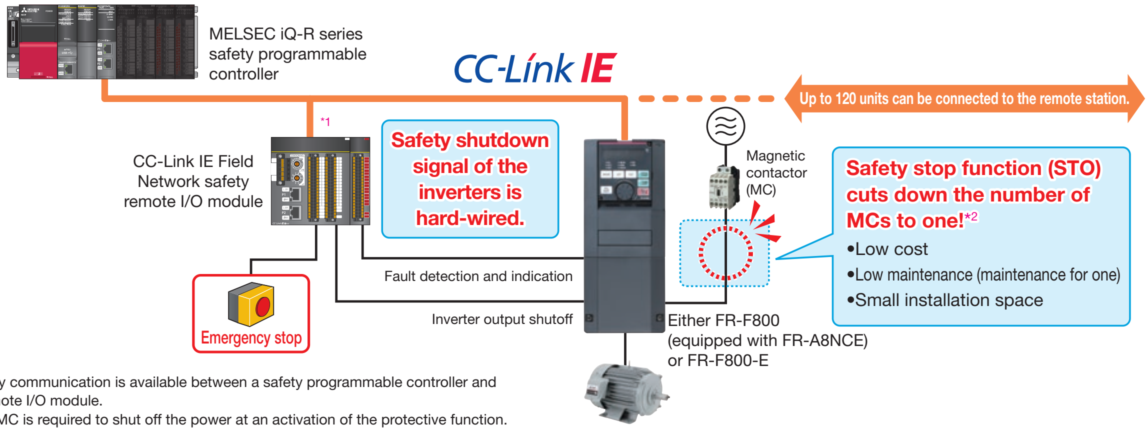
3 SECURITY & SAFETY

1 Improved System Safety

NEW Safety standards compliance

Controls with safety functions can be easily performed.
The Safe Torque Off (STO) safety function is supported by the inverter. The FR-F800 inverter with the safety function complies with safety standards while incurring little expense.

- EN ISO 13849-1 PLd / Cat.3
- EN 61508, EN 61800-5-2 SIL2

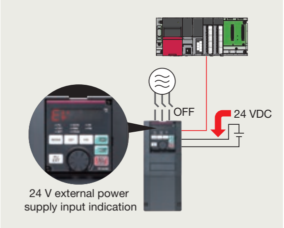


[1]: Safety communication is available between a safety programmable controller and a remote I/O module.
[2]: One MC is required to shut off the power at an activation of the protective function.

2 Reliable and Secure Maintenance

NEW Standard 24 VDC power supply for the control circuit

In addition to the existing power supply input terminals (R1 and S1) of the control circuit, 24 VDC input is equipped as standard. The 24 VDC power supplied from outside can be fed to the control circuit locally.
The parameter setting and communication operation can be done without turning ON the main power.



NEW Prevention of trouble with temperature monitoring

The inverter is equipped with an internal temperature sensor, which outputs a signal when the internal temperature is high. This facilitates the detection of rises in temperature inside the inverter following cooling fan malfunction, or rises in the surrounding air temperature due to inverter operating conditions.

3 Long Life Components and Life Check Function

Long life components

- The service life of the cooling fans is now 10 years[3].
  The service life can be further extended by ON/OFF control of the cooling fan.
- Capacitors with a design life of 10 years[3][4] are adapted.
- Life indication of life components

Components	Estimated lifespan of the FR-F800[3]	Guideline of JEMA[5]
Cooling fan	10 years	2 to 3 years
Main circuit smoothing capacitor	10 years[4]	5 years
Printed board smoothing capacitor	10 years[4]	5 years

[3] 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 from the LD rating and is not a guaranteed product life.
[4] Output current: 80% of the inverter LD rating
[5] Excerpts from "Periodic check of the transistorized inverter" of JEMA (Japan Electrical Manufacturer's Association).

NEW Enhanced life check function

- An internal thermal sensor is equipped to all inverters as standard, which enables monitoring of the installation environment. Use this function as a guide for the life diagnosis.
- Maintenance timers are available for up to three peripheral devices, such as a motor and bearings.

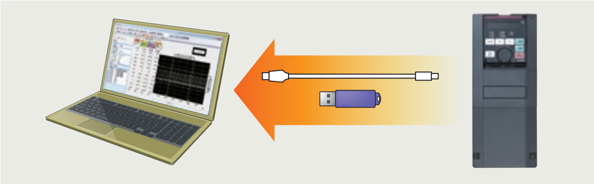
"Maintenance 1 output" warning

4 Quick Reaction to Troubles

NEW Easy fault diagnosis

- The operating status (output frequency, etc.) immediately before the protection function activates can be stored in the inverter built-in RAM with the trace function. The stored data (trace data) can be copied to a USB memory device or directly imported to a computer, facilitating trouble analysis using the inverter setup software (FR Configurator2).

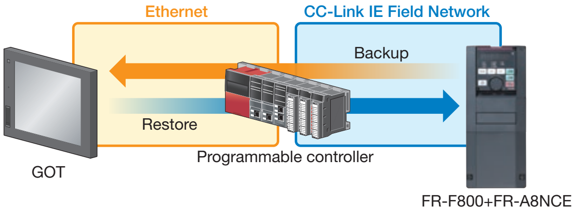
Trace data stored in the built-in RAM is deleted when the power is turned OFF or the inverter is reset.



- Clock setting is now available in addition to the already-available cumulative energization time. The time and date at a protective function activation are easily identified. (The clock is reset at power-OFF.) The date and time are also saved with the trace data, making the fault analysis easier. By using the real-time clock function with the optional LCD operation panel (FR-LU08) (when using battery), the time is not reset even when the power supply is turned OFF.

NEW Backup/restore

- The GOT can be used to back up the inverter's parameter settings or the data used in the inverter's PLC function. The backup stored in the GOT can be used to restore the data in the inverter.



5 Protection of Critical Parameter Settings

Misoperation prevention by setting a password

- Setting a 4-digit password can restrict parameter reading/writing.

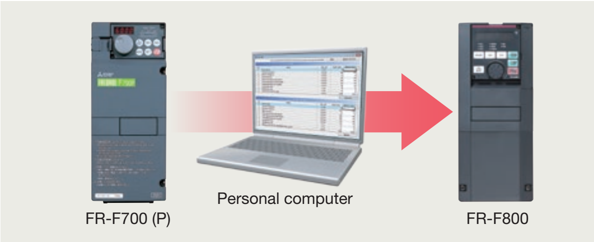
6 Renewal Assurance

Compatibility with existing models

- The inverter installation method is the same as that for the FR-F700(P) series, eliminating any concerns over replacement (except for some capacity models). Furthermore, the FR-F700(P) series control circuit terminal blocks can be installed with the use of an option (FR-A8TAT).

NEW

- The terminal response adjustment function allows a user to adjust the response speed in accordance with the existing facility. (The response time is shorter for the FR-F800 series.)
- In addition to the FR-F700(P) series' parameter settings, the FR-F500 series parameter settings (to be supported soon) can be easily copied to the FR-F800 series by using the conversion function of FR Configurator2. (Refer to **page 18** for FR Configurator2.)



4 COMPATIBILITY WITH THE ENVIRONMENT

1 Suppression of Outgoing Harmonic Current and EMI


AC reactor
(FR-HAL)


DC reactor
(FR-HEL)

- Harmonic current may adversely affect the power supply. To suppress such harmonic current, the power-factor-improving compact AC reactor (FR-HAL) and the DC reactor (FR-HEL) are available. (For the 75 kW or higher inverter, always connect a DC reactor. Select a DC reactor according to the applied motor capacity.)
- By attaching the EMC filter connector to the ON or OFF position, the built-in EMC filter can be set enabled/disabled[*1*2]. When it is enabled, the inverter conforms to the EMC Directive (EN61800-3/2nd Environment Category C3[*3]) by itself.

[*1] Enabling the EMC filter increases leakage current.
[*2] The input side common mode choke, which is built in the 55 kW or lower inverter, is always enabled regardless of the EMC filter ON/OFF connector setting.
[*3] Refer to the EMC Installation Guidelines for the required specifications.

	Capacitive filter	Common mode choke	DC reactor
55 kW or lower	Standard (built-in)	Standard (built-in)	Option (sold separately)
75 kW or higher	Standard (built-in)	Option (sold separately)	Option (sold separately)

- The F800 series 55 kW or lower inverter is equipped with built-in capacitive filters (capacitors) and common mode chokes. By installing the optional DC reactor (FR-HEL), the inverter can confirm with Architectural Standard Specifications (Electrical Installation) and the Architectural Standard Specifications (Machinery Installation) supervised by the Ministry of Land, Infrastructure, Transport and Tourism of Japan. (For the F800 series 75 kW or higher inverter, prepare common mode chokes (line noise filters) and a DC reactor.)
- With a high power factor converter (FR-HC2), the inverter is equivalent to a self-excitation three-phase bridge circuit in the "Harmonic Suppression Guidelines for Specific Consumers" in Japan, and realizes the equivalent capacity conversion coefficient K5=0. For the 355 kW or higher inverters, the converter is separated. Therefore, installation space can be saved when connecting the FR-HC2.


FR-HC2

2 Protected in Hazardous Environments

Inverters with circuit board coating (IEC60721-3-3 3C2/3S2) and plated conductors are available for improved environmental resistance. ("-60" or "-06" is affixed to the end of the inverter model name.)

3 Global Compatibility

- Complies with UL, cUL, and EC Directives (CE marking), and the Radio Waves Act (South Korea) (KC marking). It is also certified as compliant with the Eurasian Conformity (EAC).
- The inverters are compliant with the EU RoHS Directive (Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), friendly to people and to the environment.

c UL us LISTED CE KC EAC

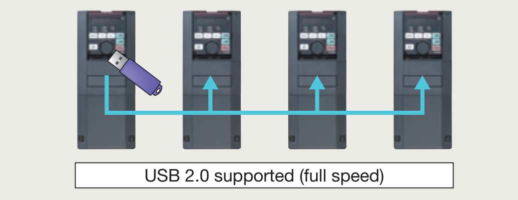
For details of the models compliant with global standards, contact your local sales office.

5 EASY SETUP & OPERATION

1 Streamlining the Startup Process

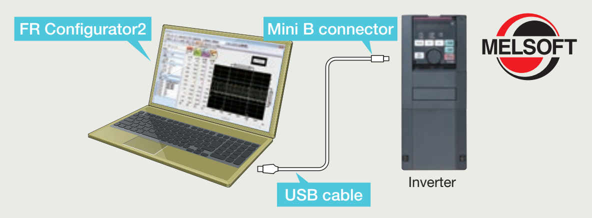
NEW Parameter copy with a USB memory device

A USB host connecter (A type), which allows external device connections, has been added.
Parameters can be copied to commercial USB memory devices.



NEW Easy setup with FR Configurator2

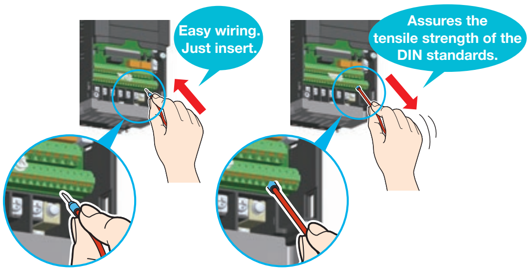
- With the sense of unity with other Mitsubishi Electric FA products with common MELSOFT design and operability, the software is easy to use.
- Easy plug-and-play connection is available to the USB terminal equipped as standard.



- A free trial version, which contains start-up functions, is available. It can be downloaded at Mitsubishi Electric FA Global Website. (Refer to **page 18** for FR Configurator2.)

NEW Easy wiring to the control circuit

Spring clamp terminals have been adopted for control circuit terminals. Wires can be protected against loosening under vibrations during transportation of the inverter. Ten additional terminals are used as compared to the FR-F700(P) series.
Round crimping terminals can also be used by employing a control terminal option (FR-A8TR).



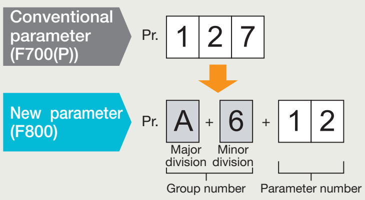
2 Easy-to-follow Display Improves the Operability

NEW Easy operation with GOT

- Automatic communication is possible without specifying any parameter settings simply by connecting to the GOT2000 series.
- The PLC function device monitor can be displayed at the GOT2000 series. Batch control of multiple inverter device monitors is possible with a single GOT unit.
- The sample screen data for the FR-F800 can be found in the screen design software of the GOT2000 series. For the latest version of the screen design software, please contact your local sales office.

NEW Easy-to-follow parameter configuration

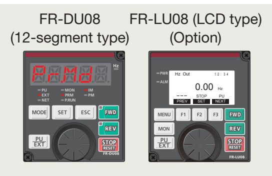
With the parameter setting mode selection of the operation panel, the group parameter mode can be selected to provide intuitive and simple parameter settings. (The conventional parameter setting mode is selected by default.)



Major division	Name
E	Environment
F	Acceleration/deceleration
D	Start and frequency commands
H	Protective function
M	Monitor
T	Multiple function input terminals
C	Motor constant
A	Applications
N	Communication
G	Control

NEW Easy-to-read operation panel

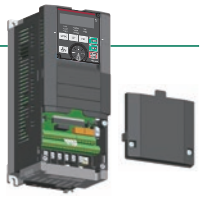
A 5-digit, 12-segment display has been adopted for the operation panel (FR-DU08) for a more natural character display. Furthermore, an optional operation panel (FR-LU08) adopting an LCD panel capable of displaying text and menus is also available.



3 To Aid with Maintenance

Reduced wiring check time

Split-type covers are adapted for all capacity models. Maintenance is now easy because all an operator has to do is to remove the cover for the target wiring area.



NEW Maintenance and control of multiple inverters Option

Serial number reading is possible using the optional LCD operation panel (FR-LU08) or the inverter setup software (FR Configurator2). Administration of different inverters has become much more simple.

Wide range of lineup

Inverter

Standard model

FR-F820-0.75K-1-

Symbol	Voltage class
2	200 V class
4	400 V class

Symbol	Structure, functionality
0	Standard model

Symbol*1	Description
0.75K to 315K	LD rated inverter capacity (kW)
00023 to 12120	SLD rated inverter current (A)

Symbol	Type*2	Communication type
1	FM	RS-485
2	CA	
E1	FM	Ethernet
E2	CA	

Symbol	Circuit board coating (IEC60721-3-3 3C2/3S2 compatible)	Plated conductor
None	Without	Without
60	With	Without
06*3	With	With

Three-phase 200 V class FR-F820-[]*4	0.75K	1.5K	2.2K	3.7K	5.5K	7.5K	11K	15K	18.5K	22K	30K	37K	45K	55K	75K	90K	110K
	00046	00077	00105	00167	00250	00340	00490	00630	00770	00930	01250	01540	01870	02330	03160	03800	04750
	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Three-phase 400 V class FR-F840-[]*4	0.75K	1.5K	2.2K	3.7K	5.5K	7.5K	11K	15K	18.5K	22K	30K	37K	45K	55K	75K	90K	110K
	00023	00038	00052	00083	00126	00170	00250	00310	00380	00470	00620	00770	00930	01160	01800	02160	02600
	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
	132K	160K	185K	220K	250K	280K	315K										
	03250	03610	04320	04810	05470	06100	06830										
	●	●	●	●	●	●	●										

Separated converter type

FR-F842-355K-1-

Symbol	Voltage class
4	400 V class

Symbol	Structure, functionality
2	Separated converter type

Symbol*1	Description
355K to 560K	LD rated inverter capacity (kW)
07700 to 12120	SLD rated inverter current (A)

Symbol	Type*2	Communication type
1	FM	RS-485
2	CA	
E1	FM	Ethernet
E2	CA	

Symbol	Circuit board coating (IEC60721-3-3 3C2/3S2 compatible)	Plated conductor
None	Without	Without
60	With	Without
06	With	With

Three-phase 400 V class FR-F842-[]*5	355K	400K	450K	500K	560K
	07700	08660	09620	10940	12120
	●	●	●	●	●

*1: Models can be alternatively indicated with the inverter rated current (SLD rating).

*2: Specification differs by the type as follows.

Type	Monitor output	Initial setting				
		Built-in EMC filter	Control logic	Rated frequency	Pr.19 Base frequency voltage	Pr.570 Multiple rating setting
FM (terminal FM equipped model)	Terminal FM (pulse train output) Terminal AM (analog voltage output (0 to ±10 VDC))	OFF	Sink logic	60 Hz	9999 (same as the power supply voltage)	1 (LD rating)
CA (terminal CA equipped model)	Terminal CA (analog current output (0 to 20 mADC)) Terminal AM (analog voltage output (0 to ±10 VDC))	ON	Source logic	50 Hz	8888 (95% of the power supply voltage)	0 (SLD rating)

*3: Available for the FR-F820-00340(7.5K) or higher, and the FR-F840-00170(7.5K) or higher.

*4: For the FR-F820-03160(75K) or higher, and the FR-F840-01800(75K) or higher, always connect a DC reactor (FR-HEL), which is available as an option.
Select a DC reactor according to the applied motor capacity.

*5: Always install the converter unit (FR-CC2). (Not required when a high power factor converter (FR-HC2) is used)

Converter unit

FR-CC2-H355K-60

Symbol	Voltage class
H	400 V class

Symbol	Description
355K to 630K	Applicable motor capacity (kW)

Symbol	Circuit board coating (IEC60721-3-3 3C2/3S2 compatible)	Plated conductor
60	With	Without
06	With	With

Three-phase 400 V class FR-CC2-H[] (with the built-in DC reactor)	355K	400K	450K	500K	560K	630K
	●	●	●	●	●	●

●: Released model

Premium high-efficiency IPM motor

55 kW or lower **MM-EFS 7 1M 4 -S10 □ □**

Symbol	Output	Symbol	Output	Symbol	Output
7	0.75 kW	75	7.5 kW	30K	30 kW
15	1.5 kW	11K	11 kW	37K	37 kW
22	2.2 kW	15K	15 kW	45K	45 kW
37	3.7 kW	18K	18.5 kW	55K	55 kW
55	5.5 kW	22K	22 kW		

Symbol	Rated speed*1
1M	1500 r/min
3	3000 r/min

Symbol	Voltage class
None	200 V
4	400 V

Symbol	Dedicated specification
None	Standard model
-S10	Belt drive model

Symbol	Specifications*2
None	Standard model
Q	Class B

Symbol	Specifications*2
None	Standard model
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		—	—	—	—	—	—	—	—	—	—	—	—	—	—	●	●	●	●	●

< Note > •The IPM motor MM-EFS/MM-THE4 series cannot be driven by the commercial power supply.
•For IPM motors, the 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 MM-EFS series IPM motor with the 1500 r/min specification, use a dedicated belt drive motor. The 11 kW or higher motors with 3000 r/min specification are designed for a direct connection only.

●: Released model —: Not applicable

Inverter by rating

•200 V class

Inverter model FR-F820-□		SLD (superlight duty)		LD (light duty, initial value)	
		Motor capacity (kW)*1	Rated current (A)	Motor capacity (kW)*1	Rated current (A)
0.75K	00046	0.75	4.6	0.75	4.2
1.5K	00077	1.5	7.7	1.5	7
2.2K	00105	2.2	10.5	2.2	9.6
3.7K	00167	3.7	16.7	3.7	15.2
5.5K	00250	5.5	25	5.5	23
7.5K	00340	7.5	34	7.5	31
11K	00490	11	49	11	45
15K	00630	15	63	15	58
18.5K	00770	18.5	77	18.5	70.5
22K	00930	22	93	22	85
30K	01250	30	125	30	114
37K	01540	37	154	37	140
45K	01870	45	187	45	170
55K	02330	55	233	55	212
75K	03160	75	316	75	288
90K	03800	90/110	380	90	346
110K	04750	132	475	110	432

•400 V class

Inverter model FR-F84□-□		SLD (superlight duty)		LD (light duty, initial value)	
		Motor capacity (kW)*1	Rated current (A)	Motor capacity (kW)*1	Rated current (A)
0.75K	00023	0.75	2.3	0.75	2.1
1.5K	00038	1.5	3.8	1.5	3.5
2.2K	00052	2.2	5.2	2.2	4.8
3.7K	00083	3.7	8.3	3.7	7.6
5.5K	00126	5.5	12.6	5.5	11.5
7.5K	00170	7.5	17	7.5	16
11K	00250	11	25	11	23
15K	00310	15	31	15	29
18.5K	00380	18.5	38	18.5	35
22K	00470	22	47	22	43
30K	00620	30	62	30	57
37K	00770	37	77	37	70
45K	00930	45	93	45	85
55K	01160	55	116	55	106
75K	01800	75/90	180	75	144

Inverter model FR-F84□-□		SLD (superlight duty)		LD (light duty, initial value)	
		Motor capacity (kW)*1	Rated current (A)	Motor capacity (kW)*1	Rated current (A)
90K	02160	110	216	90	180
110K	02600	132	260	110	216
132K	03250	160	325	132	260
160K	03610	185	361	160	325
185K	04320	220	432	185	361
220K	04810	250	481	220	432
250K	05470	280	547	250	481
280K	06100	315	610	280	547
315K	06830	355	683	315	610
355K	07700	400	770	355	683
400K	08660	450	866	400	770
450K	09620	500	962	450	866
500K	10940	560	1094	500	962
560K	12120	630	1212	560	1094

•Overload current rating

SLD	110% 60 s, 120% 3 s (inverse-time characteristics) at surrounding air temperature of 40°C
LD	120% 60 s, 150% 3 s (inverse-time characteristics) at surrounding air temperature of 50°C

*1: Indicates the maximum capacity applicable with the Mitsubishi Electric 4-pole standard motor.

For selection of the DC reactor and the converter unit, refer to **page 113**.

Trial Calculation Example of Energy Saving Effect

The longer the operating period with medium air volume is, the higher energy saving effect obtained with an inverter.

(Conditions: The electricity cost is 14 yen/kWh. The CO2 emission is 1,000 kWh ≈ 0.55 ton-CO2)

Water-cooling pump for a showcase

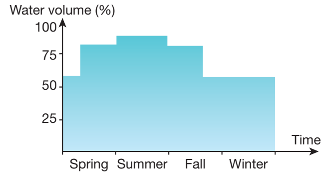
Commercialpower supply (valve) + General-purpose motor (SF-PR)
▼
Inverter + General-purpose motor (SF-PR)

Condition

[Units to drive]

- Water-cooling pump
  2.2 kW x 2 units

Operation patterns



8760 hours/year

- **With commercial power supply**
  Approx. 0.04 million kWh
  Approx. 0.56 million yen
- **With inverter**
  Approx. 0.02 million kWh
  Approx. 0.29 million yen

- **Annual energy saving effect**
  (differences in the amount and cost)
  Approx. 0.02 million kWh
  Approx. 0.27 million yen

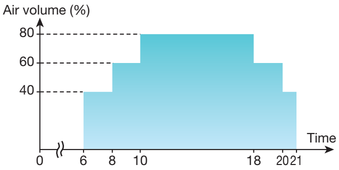
- **Annual CO2 emission reduction**
  Approx. 0.02 million kWh **10.7 tons**

Air conditioning in a Mitsubishi plant

Inverter + General-purpose motor (SF-JR)
▼
Inverter + General-purpose motor (SF-JR)

[Units to drive]

- Ventilator
  0.75 kW x 3 units
  1.5 kW x 1 unit
  2.2 kW x 3 units
- Air conditioner
  15 kW x 1 unit
  18.5 kW x 1 unit
  30 kW x 2 units



5475 hours/year

- **With SF-JR**
  Approx. 0.25 million kWh
  Approx. 3.44 million yen
- **With SF-PR**
  Approx. 0.23 million kWh
  Approx. 3.20 million yen

- **Annual energy saving effect**
  (differences in the amount and cost)
  Approx. 0.017 million kWh
  Approx. 0.24 million yen

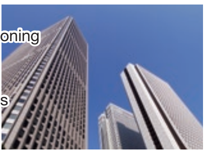
- **Annual CO2 emission reduction**
  Approx. 0.017 million kWh **9.5 tons**

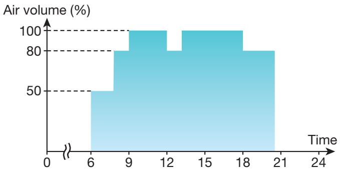
Air conditioning in a building

Inverter + General-purpose motor (SF-PR)
▼
Inverter + IPM motor (MM-EFS)

[Units to drive]

- Fan for air conditioning
  5.5 kW x 10 units
  7.5 kW x 10 units
  3.7 kW x 100 units





5110 hours/year

- **With SF-PR**
  Approx. 2.23 million kWh
  Approx. 31.27 million yen
- **With IPM motor**
  Approx. 2.10 million kWh
  Approx. 29.43 million yen

- **Annual energy saving effect**
  (differences in the amount and cost)
  Approx. 0.131 million kWh
  Approx. 1.84 million yen

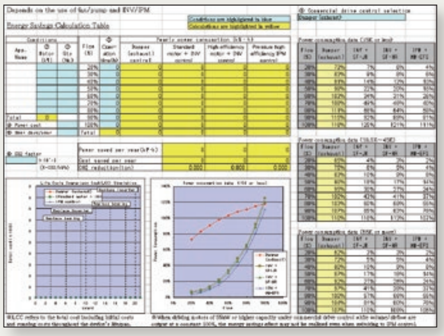
- **Annual CO2 emission reduction**
  Approx. 0.131 million kWh **72.3 tons**

(Annual) energy saving effect produced by replacing to IPM motors driven with inverters

Your best assistant - Mitsubishi Electric inverter software

IPM energy savings simulation file

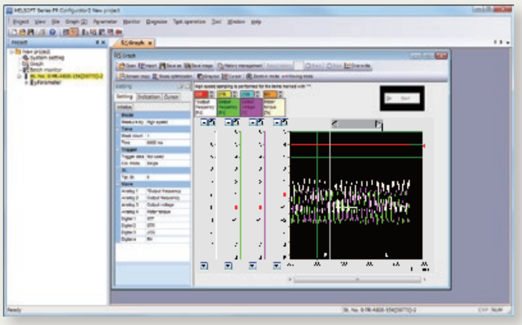
The IPM energy savings simulation file calculates the energy saving effect and CO2 reduction rate achieved by replacing commercial power supply (damper/valve control) operation with IPM motor operation by inverter. This file requires inputs such as the capacity, quantity, air volume, and operating time of motors.



IPM energy savings simulation file

FR Configurator2 (SW1DND-FRC2) Option

Support tool for the inverter operations from start-up to maintenance.
Refer to **page 18** for details.



Example Applications

BEST SUITED FOR EVERY MACHINE

Cooling tower

PID control

A sensor monitors a cooling water temperature, which enables the operation corresponding to the target temperature. The system cost can be reduced because no external PID controller is required.

Electronic bypass function

The inverter contains complicated sequence circuits for switching between the commercial power supply operation and inverter operation.
The operation can be automatically switched over to the commercial power supply operation if a fault occurs in the inverter.

Building water pumps

Multi-pump function NEW

By controlling the pumps connected in parallel (up to four pumps) by the PID control by one inverter, water volume, etc. can be adjusted.

PID pre-charge function NEW

The system avoids sudden acceleration at the pump start and prevents the pump from being damaged by water hammer.

Load characteristics measurement function NEW

The system quickly detects faults such as adhesion of foreign matter to the impellers, etc.

Air conditioning of buildings

PM motor control

Driving a PM motor, which is more efficient than an induction motor, achieves more energy savings.

Automatic restart after instantaneous power failure / flying start function

When the power is restored after an instantaneous power failure, the operation can be restarted from the motor coasting speed. Even if a flying start changes the rotation direction, the operation can be smoothly started.

PID control PID forward/reverse action switchover

The forward/reverse rotation under PID control can be switched by turning ON/OFF the signal input, which allows easy switching between the heating and cooling temperature controls.

BACnet®MS/TP NEW

BACnet®MS/TP is a suitable network for use with air conditioning controls. This makes it possible to achieve efficient air conditioning controls with all-in-one management of the air conditioning in the entire building.

Compressor

Advanced optimum excitation control NEW

While saving energy just as with the conventional Optimum excitation control, the new Advanced optimum excitation control provides a large starting torque, which allows for both a large starting torque and energy saving operation.

High-speed operation NEW

[Maximum output frequency]

- V/F control 590 Hz
- Advanced magnetic flux vector control 400 Hz

CONTRIBUTION TO FACTORY AUTOMATION

The PLC function will help you to provide the control sequence best suited for the machine specifications.

1 Inverter operation sequence customized for the machine

- A set of operations (operation at different signal inputs, signal and monitor outputs at different inverter status, etc.) can be freely programmed in accordance with the machine specifications. For example, a shutter opening/closing can be performed based on a signal from a sensor, or based on the opening/closing times.
  Control programs can be created in sequence ladders using the inverter setup software (FR Configurator2).

2 Realizes the decentralized control

- The control of the whole system is decentralized to inverters that mange their subordinating devices individually.
- A group of dedicated sequence programs is created and saved in each inverter. The master controller no longer has to process all the sequence programs, and the decentralized system accepts program changes more flexibly.

3 Automatic operation in accordance with the time

- With the real-time clock, automatic operation can be performed at certain times (when the optional LCD operation panel (FR-LU08) is used).

4 Useful functions

• User parameter

Up to 50 parameters, which are linked with the data registers, can be saved. The variables (data registers) used in the PLC function can be saved as inverter parameters. Furthermore, parameter settings can be saved in the EEPROM of inverter. When results of calculation using the PLC function are saved in the parameters, the data can be retained after the power is turned OFF.

• User initiated fault

Inverter output can be shut off under conditions other than those of the existing protective functions. Up to five specific fault-initiating conditions can be set to activate a protective function and shut off the inverter output.

• Monitored item for the user

Special register values can be displayed for monitoring on the operation panel. Arbitrary data designated by the user such as results of calculation using the PLC function can be displayed.

• Inverter parameter read/write

Parameter settings can be changed using sequence programs. The acceleration/deceleration patterns can also be set with sequence programs to be changed at certain operation statuses. You can choose RAM or EEPROM to save the parameter settings. When the settings are changed frequently, choose RAM.

• PID function

Two different loops of PID inverter operations can be pre-set, and those can be controlled using sequence programs.

• Inverter operation lock

The inverter operation can be restricted for the command sources other than the sequence programs.

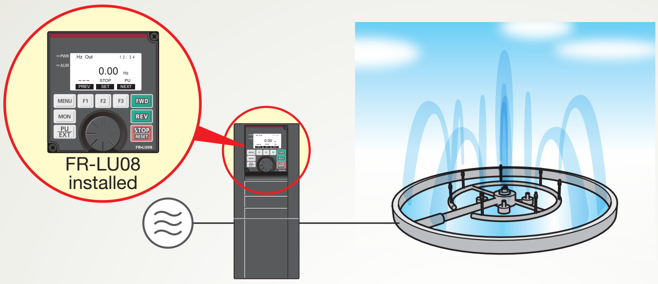
PLC function

Item	Description
I/O	
General-purpose I/O	Sequence programs enable I/O signal transmission to/from the inverter and its plug-in options.
Analog I/O	Sequence programs enable reading of analog input values or analog output transmission by the inverter, and analog output transmission to the plug-in options.
Pulse train I/O	Sequence programs enable pulse train inputs (to terminal JOG) and pulse train outputs (from terminal F/C(FM)).
Inverter parameter read/write	Sequence programs enable inverter parameter write/read.
User parameter	Fifty user parameters (Pr.1150 to Pr.1199) are available and are linked with the data registers D206 to D255, which accept direct access by sequence programs.
CC-Link	A plug-in option (FR-A8NC) enables handling of remote registers as arbitrary data in the sequence programs.
Special function	
PID operation	Inverter's PID operations can be set (up to two loops).
User initiated fault	Up to five fault-initiating conditions can be set to activate a protective function.
Fault clear	The protective function occurring in the inverter can be reset.
Inverter operation lock	Inverters can start up while the PLC function is running.
Monitored item for the user	Desired data is displayable on the operation panel.

Application Example

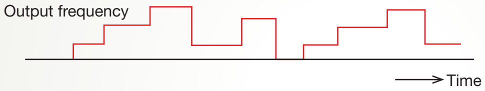
Fountain height control

Controlling the water pressure (rotations per minute) allows the fountain height to be changed. PLC programs allow various operation patterns to create a variety of effects.
The time-based automatic operation is possible by using the sequence programs in combination with the real-time clock function (when using an optional LCD operation panel (FR-LU08)).



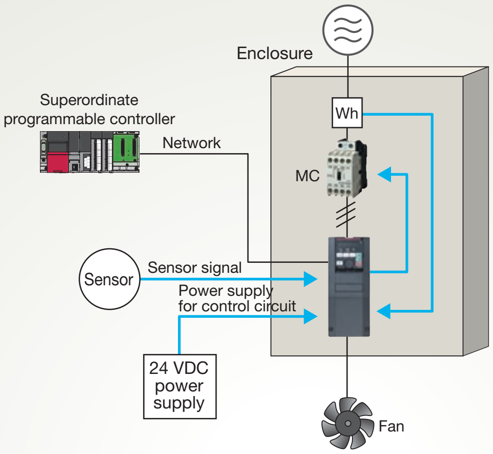
Inverter parameter read/write

Inverter parameters can be changed through the sequence programs.
The height and duration of the spouting water can be set.



Fan control

Signals sent via the enclosure (relay panel, etc.) such as input magnetic contactor signals, watt hour meter signals, and sensor signals can be read directly into the inverter and controlled. A fan can be controlled in accordance with the conditions without using relays, etc.
Furthermore, by using an external 24 VDC power source for the control power supply, input machine signals can be turned ON and OFF regardless of whether there is an input power source. And by employing an external 24 VDC power supply for the control power, input machine signals can be turned ON and OFF, regardless of the existence of a main circuit power supply.



CC-Link

A plug-in option (FR-A8NC) enables handling of remote registers as arbitrary data in the sequence programs.
A variety of equipment inside the factory can be centrally controlled with a CC-Link Network.

Inverter setup software

FR Configurator2 (SW1DND-FRC2)

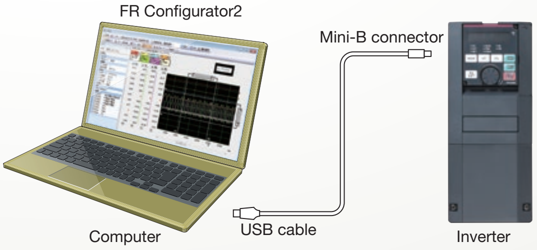
DELIVERING A COMFORTABLE INVERTER

From inverter startup to maintenance, this versatile software allows the user to specify settings easily at the computer.

[Compatible operating systems]
Windows® 10, Windows® 8.1/Pro/Enterprise, Windows® 8, Windows® 7 (32-bit/64-bit), Windows Vista® (32-bit)

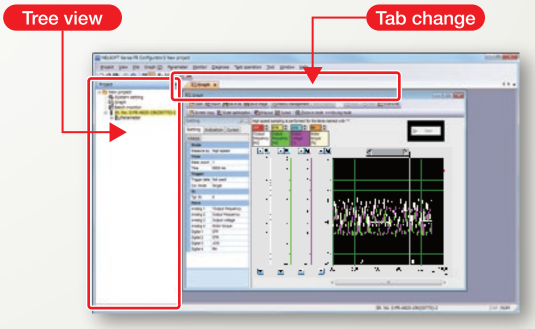
Easy connection with a USB cable

A USB connector (Mini-B connector) is provided as standard. Easy connection to the computer without the need for a converter.



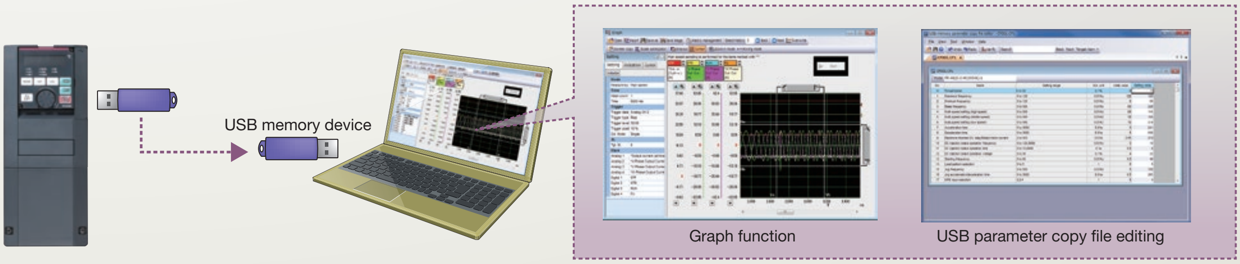
Intuitive user interface

Connected inverters are displayed in tree view format. Windows for each function can be accessed by changing the tab for maximum efficiency.



Work can be carried out away from the equipment using a USB memory device

By loading trace data and parameter settings copied to a USB memory device into FR Configurator2, analysis and adjustments can be carried out with ease away from the equipment.

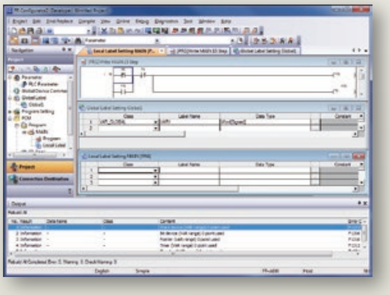


Graph function

USB parameter copy file editing

Sequence control (Developer function)

The Developer function is used for creating sequence programs and writing them to the inverter to enable the use of the PLC function of the inverter.



Free trial version Supported

The function with the marking above is available in the free trial version (usable free of charge with limited functions). It can be downloaded at Mitsubishi Electric FA Global Website.

Function	Free trial version
Parameter list	○
Diagnosis	○
Graph	×
Batch monitor	×
Test operation	○
I/O terminal monitor	×
Convert	○

Function	Free trial version
Developer	×
USB memory parameter copy file edit	×
Ethernet parameter setting	○
iQSS backup file conversion	○
Help	○

○: Available, ×: Not available

A full functional trial version, which has the same functionality as the release version, is also offered for a limited period of 20 days.

OPERATING ENVIRONMENT

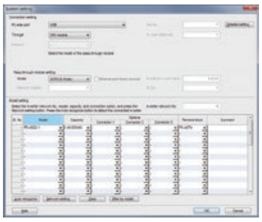
Startup

1 Efficient startup settings

System settings

Free trial version Supported

This sets the method used to connect the inverters and the computer. Automatic recognition of connected inverters can also be set. The station number, model, capacity, and plug-in options of the connected inverters can also be set manually.



Test operation

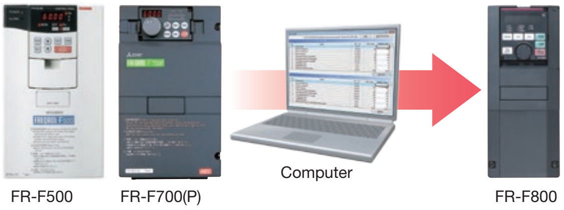
Free trial version Supported

Operating commands, frequency settings, and the operating mode can be set for the selected inverter.

Conversion function

Free trial version Supported

Parameters can be set with the parameter auto conversion function when renewing from the FR-F700(P) series or FR-F500 series.



Parameter settings for Ethernet communication (FR-F800-E only)

The network number, station number, host name, IP address, and subnet mask can be set.
At the initial startup of FR Configurator2, inverters connected to the same network are detected automatically.

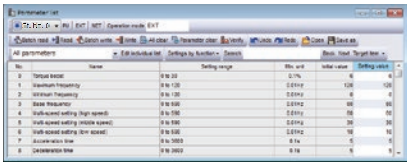
Operation

2 Perform pre-operation adjustments and checks during operation with ease

Parameter list

Free trial version Supported

Parameters for selected station numbers can be displayed and changed.



I/O signals can be assigned using settings by function.

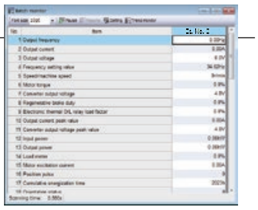
Offline auto tuning

Tuning is performed in wizard format after specifying necessary parameter settings.

Batch monitor function

Multiple inverter monitor items can be monitored simultaneously.

With a terminal monitor, the ON/OFF status can be monitored.



USB memory parameter copy file edit

Parameter settings (USB memory device parameter copy file) read from the inverter to a USB memory device can be edited.
With the iQSS backup file conversion function, the files in the backup/restore format generated by the GOT can be converted and edited.

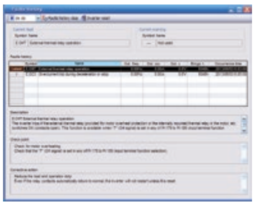
Maintenance

3 Easy-to-follow platform facilitates easy maintenance

Diagnosis (fault history)

Free trial version Supported

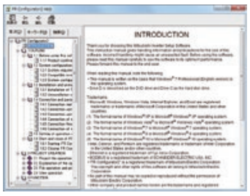
Inverter fault history can be read and displayed together with the alarm occurrence time.
Activating faults can be displayed, and inverters can also be reset.



Help

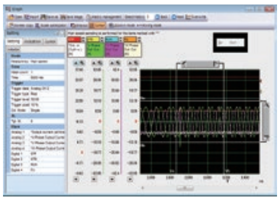
Free trial version Supported

Displays the content of inverter and software Instruction Manuals.



Graph function

Inverter data can be sampled and displayed in a graphical format.
Trace data can also be read and displayed in a graph.



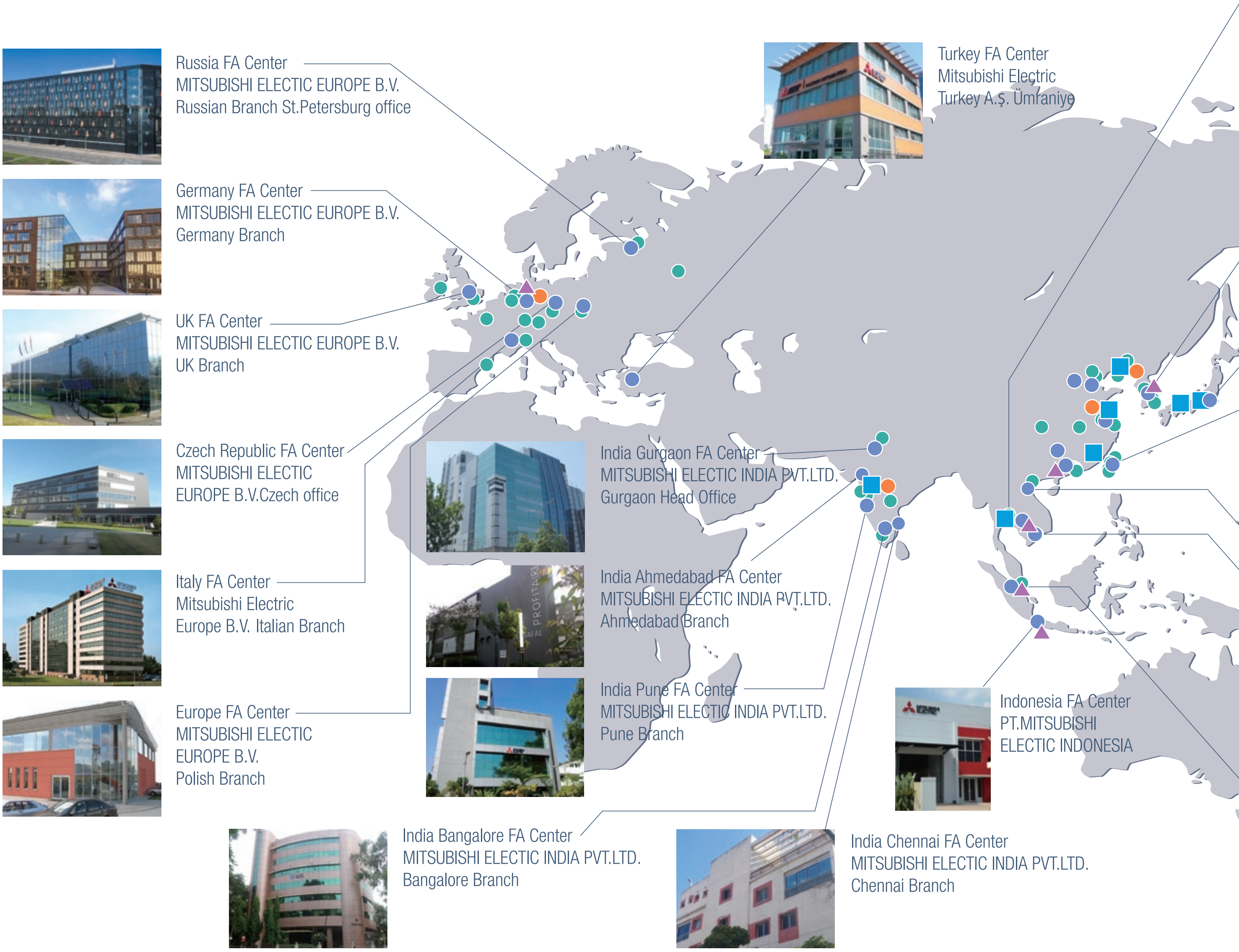
Life diagnosis

Free trial version Supported

Life information read from the inverter is displayed.
An alert icon is shown in the parts life alarm field for the parts recommended for replacement.
The diagnosis result output function is available to output the data of diagnosis results to a file.

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



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Russian Branch St.Petersburg office

Germany FA Center
MITSUBISHI ELECTIC EUROPE B.V.
Germany Branch

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Czech Republic FA Center
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PT.MITSUBISHI
ELECTIC INDONESIA

India Bangalore FA Center
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Bangalore Branch

India Chennai FA Center
MITSUBISHI ELECTIC INDIA PVT.LTD.
Chennai Branch

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.

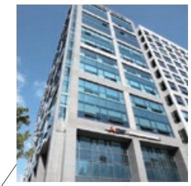
Repairs
Handle repairs of our FA products.

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


Thailand FA Center
MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO.,LTD


Korea FA Center
MITSUBISHI ELECTRIC AUTOMATION KOREA CO.,LTD.


MITSUBISHI ELECTRIC CORPORATION
Factory Automation Systems Group


Taichung FA Center
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Taipei FA Center
SETSUYO ENTERPRISE CO.,LTD


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Mitsubishi Electric Vietnam Company Limited
Hanoi Branch


ASEAN FA Center
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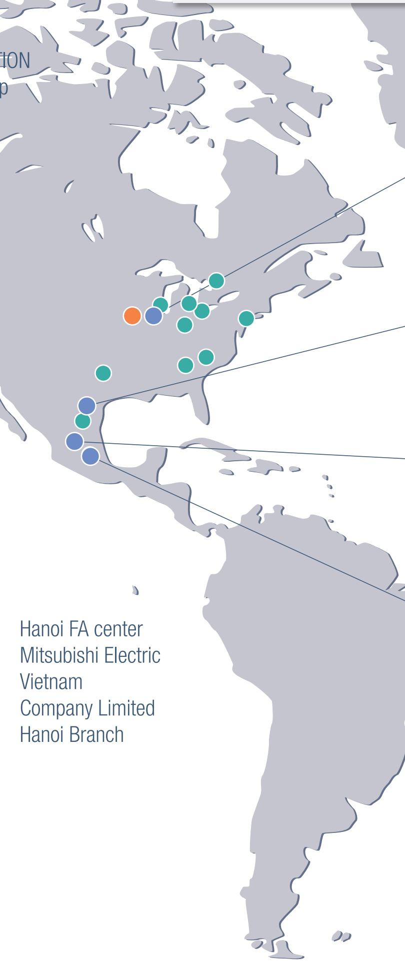
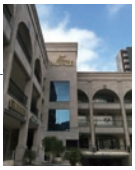
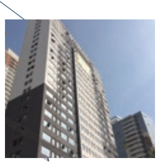



North America FA Center
MITSUBISHI ELECTRIC AUTOMATION,INC.


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


Mexico FA Center
Querétaro Office, Mitsubishi Electric Automation, Inc.


Mexico City FA Center
Mexico FA Center
Mexico Branch, Mitsubishi Electric Automation, Inc.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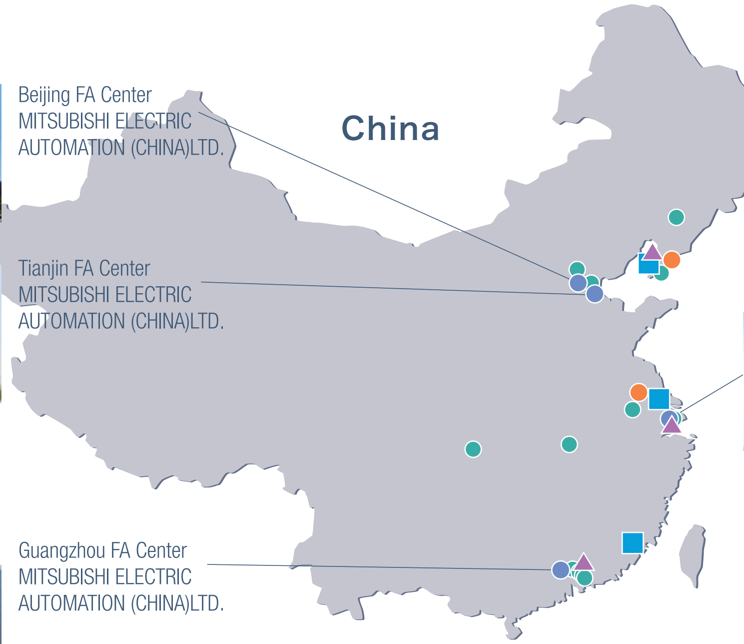

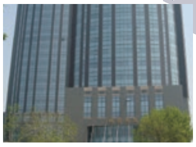
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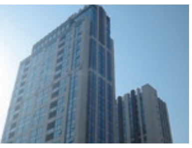
Shanghai FA Center
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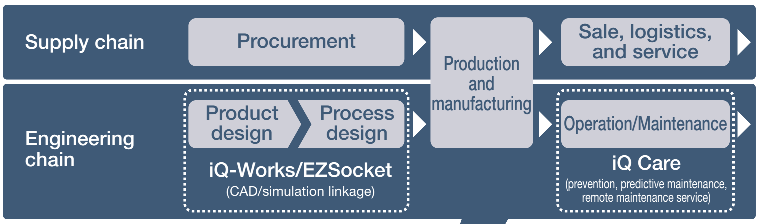
Guangzhou FA Center
MITSUBISHI ELECTRIC AUTOMATION (CHINA)LTD.

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-F@ctory 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.

e-F@ctory

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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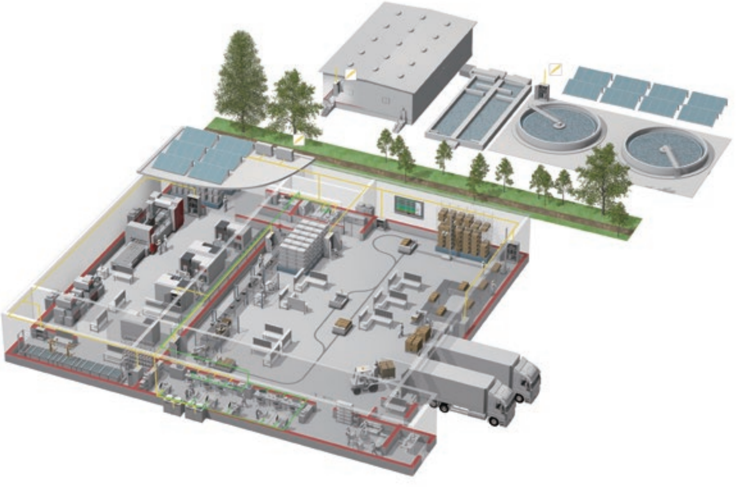
YOUR SOLUTION PARTNER



Mitsubishi Electric offers a wide range of automation equipment from PLCs and HMIs to CNC and EDM machines.

A NAME TO TRUST

Since its beginnings in 1870, some 45 companies use the Mitsubishi name, covering a spectrum of finance, commerce and industry.

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

Mitsubishi Electric Corporation is active in space development, transportation, semi-conductors, energy systems, communications and information processing, audio visual equipment and home electronics, building and energy management and automation systems, and has 237 factories and laboratories worldwide in over 121 countries.

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 Nagoya Works is a factory certified for ISO 14001 (standards for environmental management systems).

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