MITSUBISHI ELECTRIC

*Changes for the Better*

for a greener tomorrow

SENSORLESS SERVO

# FR-E700EX
# MM-GKR

SENSORLESS SERVO


*Taking Drive Systems to New Places*

# "Mitsubishi sensorless servos"— The new choice in drive systems

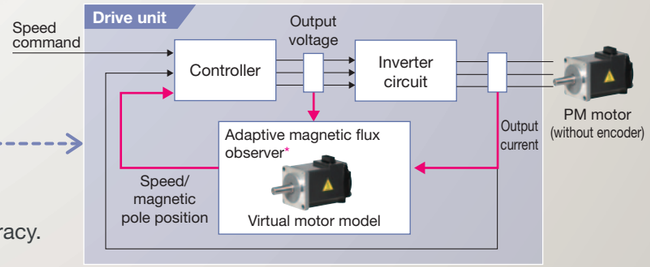
**High accuracy** even with no encoder

**No encoder means compact size**


## PM sensorless vector control

Magnetic pole position and speed are detected without the use of a sensor (encoder).
A PM motor (magnet motor) is driven in high-accuracy.

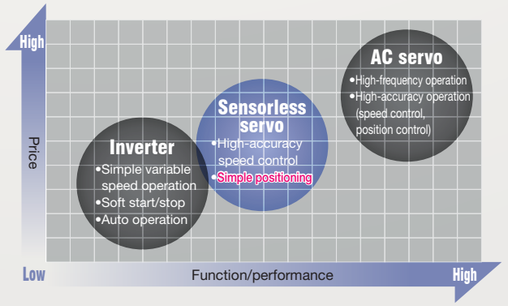
PM sensorless vector control image




*An adaptive magnetic flux observer is a control system that uses a virtual motor model inside the drive unit to detect the motor speed and pole position from the motor voltage and current.

Sensorless servo system is a combination of a dedicated drive unit and dedicated sensorless PM motor (magnet motor).
Sensorless servos realize high-accuracy operation (PM sensorless vector control) without the use of an encoder, facilitating the construction of highly reliable drive systems capable of contributing to energy saving.

High accuracy | Compact size | High reliability | Energy saving




| | Inverter | Sensorless servo | AC servo |
|---|---|---|---|
| Control amp | FR-E700, FR-A700 | FR-E700EX | MR-J4 |
| | General-purpose inverter | Sensorless servo dedicated drive unit | General-purpose servo amplifier |
| Motor | General-purpose motor, Geared motor | Sensorless PM motor | Servo motor |
| | Induction motor (IM) | PM motor | |
| | Without encoder | | With encoder |
| Energy saving | ○ | ◎ | ◎ |
| Wire saving | ◎ | ◎ | ○ |
| Downsizing (motor) | △ | ◎ | ○ |
| Reliability (motor) | ◎ | ◎ | ○ |
| Control performance | △ | ○ | ◎ |
| Positioning control accuracy | × | △ | ◎ |

◎: Great effect expected ○:Effect expected △: Average ×: Not available

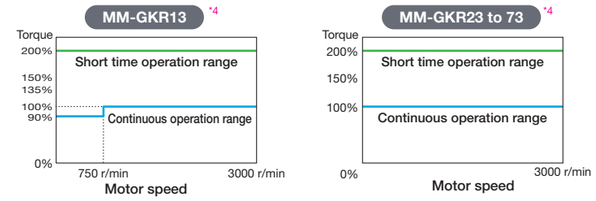


## High accuracy even with no encoder

High accuracy

### Uniform product manufacturing with stable speed control

- Operation is possible at a stable speed resistant to load fluctuations.
  Speed fluctuation: ±0.05%*1
  Speed control range: 1:1000*2
  Speed response: 100 Hz*3
- Holding torque is generated by the zero speed control and servo lock functions when the motor stops, preventing movements caused by external forces.



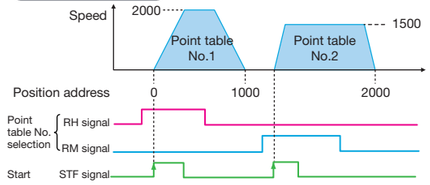

### Positioning possible without encoder

- Built-in positioning function (point table method) using contact signals and CC-Link communication (option). *5
  Position data (target position, speed, acceleration/deceleration time) and so on can be set in the parameters. Positioning is possible for up to 7 points.
  Positioning operation is performed by selecting point table numbers with external interface signals. Continuous positioning is possible.
  Positioning accuracy: ±1.8° *6
  Motor internal command resolution: 5120 [pulses/rev.]

Point table setting example

| Point table No. | Position data | Maximum speed | Acceleration time | Deceleration time | Auxiliary function |
|---|---|---|---|---|---|
| 1 | 1000 | 2000 r/min | 1.00 s | 1.00 s | 0 |
| 2 | 2000 | 1500 r/min | 0.50 s | 0.50 s | 0 |
| : | : | : | : | : | : |
| 7 | 3000 | 3000 r/min | 1.00 s | 1.00 s | 10 |

Operation example




*1: When load fluctuating between 1 and 100%

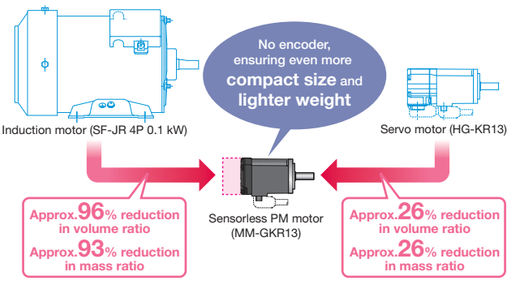
$$\text{Speed regulation} = \frac{\text{speed with no load - speed with rated load}}{\text{rated speed}} \times 100(\%)$$

*2: Speed becomes irregular in the low-speed range (approx. 100 r/min. or less) due to torque ripple caused by motor magnet attraction and repulsion forces.
*3: When stand-alone 0.1 kW motor operating at rated speed.
*4: Continuous operation torque of 80% or less at 6 r/min. or less.
*5: Not compatible with absolute position detection system.
*6: If input voltage of 200 to 220 VAC, and wiring length of 5 m or shorter.

## No encoder means compact size

Compact size

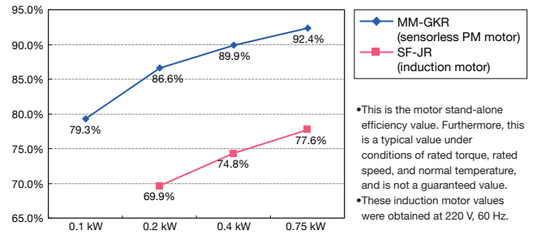
- Compact, lightweight motor with no encoder also contributes to machine downsizing.
- No cooling fan, ensuring low noise. Ideal for use in clean rooms.




## High-efficiency motor contributes to energy saving

Energy saving

- A sensorless PM motor is a high-performance, energy-saving motor incorporating a powerful permanent magnet (high-performance magnet) in the rotor, helping to realize machine energy saving.




- This is the motor stand-alone efficiency value. Furthermore, this is a typical value under conditions of rated torque, rated speed, and normal temperature, and is not a guaranteed value.
- These induction motor values were obtained at 220 V, 60 Hz.

## No encoder means high reliability

High reliability

- There is less possibility of a breakdown by eliminating encoders with their electronic components, facilitating improved reliability. Time spent on wiring work can also be minimized.
- With a protective structure conforming to IP65, this motor is highly resistant to water and dust, allowing usage with confidence even in poor environments.

## Motors with reduction gears are also compact and highly efficient

Compact size | Energy saving

- Newly-developed dedicated reduction gear for motor integration. Compact size, light weight, and high efficiency have been realized with a locked train gear system*7, and aluminum gear case.

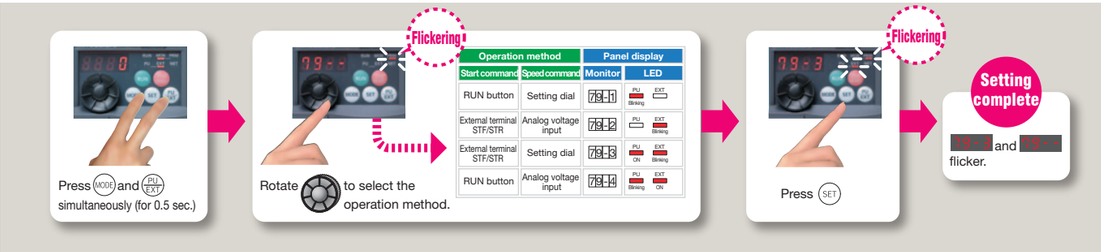
*7: A single helical gear engages with multiple helical gears to devide the load.

## Full of easy-to-use functions

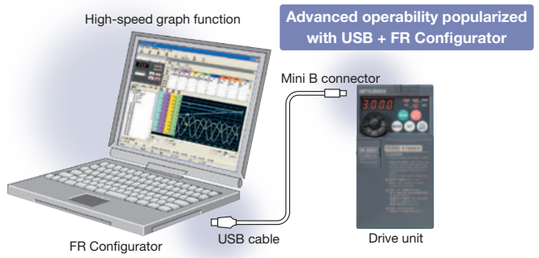
**Compact, high-performance drive unit**

### Outstanding operability

- Operation is easy with the popular setting dial.
  Speed and parameters can be set with frustration-free operability.
- **Pr.79 Operating mode selection** suitable for start and speed command combinations can be set easily.




- The drive unit is equipped with a USB connector (mini B connector) to facilitate easy setting with FR Configurator (will be compatible soon) from the computer.




- An optional enclosure surface operation panel (FR-PA07) can be connected. *1
  The drive unit operation panel cannot be removed.

- An optional parameter unit (FR-PU07) can also be connected. *1
- Featuring helpful setting features such as direct input with ten-key pad, operating status display, and help function.
- Parameter settings for up to three units can be saved.

*1: A separate parameter unit connection cable (FR-CB20□) is required.

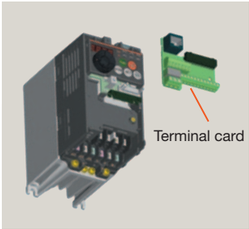
### Worry-free maintainability

- The capacitors *2 have a ten-year design life.

*2: Surrounding air temperature: annual average 40°C (there should be no corrosive gas, flammable gas, oil mist, or dust)
Output current: motor rated current
The design life is a calculated value, not a guaranteed value.

- With the self-diagnosis function, part life warnings are output, allowing the degree of part degradation to be monitored, and thus facilitating scheduled preventative maintenance.
- A comb-shaped wiring cover can be fitted after wiring work, allowing easy wiring.
- Replacement is easy with the adoption of a removable control terminal block.


Comb-shaped wiring cover



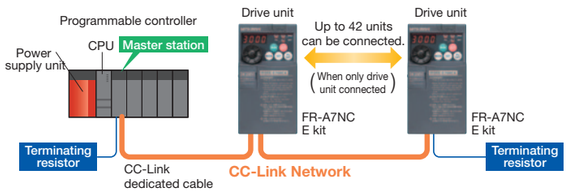

### Side-by-side space saving installation

Lateral, side-by-side installation *3 is possible, saving space.

*3: Use the drive unit in a surrounding air temperature of 40°C or less.

### Compatible with CC-Link communication (option)

- Mitsubishi programmable controllers (Q, FX, L Series, etc.) can be connected via CC-Link. Drive units can be operated, operation monitored, and parameters changed from the programmable controller.

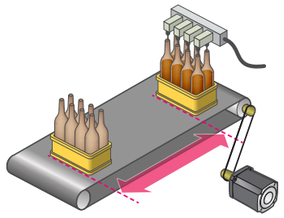



## Application examples

### • Filling machines (transfer conveyor) — Position control

**Merits**

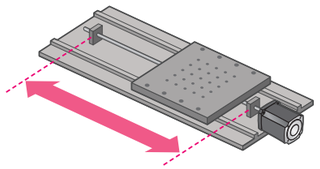
- The conveyor can be stopped accurately at the filling position without the use of an external sensor.
- Being conformed to IP65 (motor), operation is ensured even when liquids are spilled.
- No encoder, ensuring wire reduction.



### • Conveyors (ball screw) — Position control

**Merits**

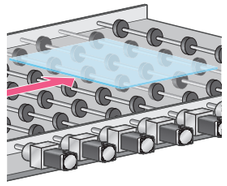
- High-accuracy stopping is possible even after repeated movements of back and forth.
- Machine miniaturization can be realized.
- No cooling fan in the motor, ensuring low noise levels.



### • Glass substrate conveyance — Speed control

**Merits**

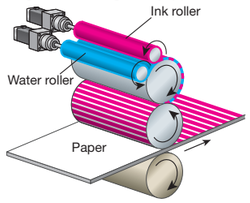
- Slow, stable product conveyance is realized with low-speed, high-torque operation.
- High-accuracy operation is possible with direct drive using no drive belt.
- No encoder means less wiring.
- The motor has no cooling fan, ensuring no dust take-up. Ideal for use in clean rooms.



### • Printing machines — Speed control

**Merits**

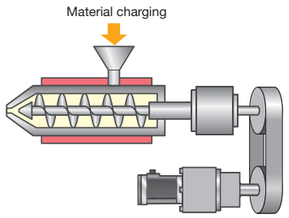
- Stable supply of water and ink is realized with constant speed operation with minimum speed fluctuations.
- Being conformed to IP65 (motor) operation is ensured even when water or ink is splattered.
- Stable operation has also been realized for the impact load generated when supplying ink using a reduction gear equipped motor.




### • Raw material supply machines, extruders — Speed control

**Merits**

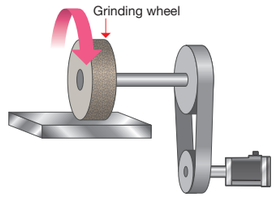
- Highly resistant to load fluctuations while charging materials this ensures that materials are supplied in stable quantities.
- Machine can be downsized.
- Consumes less energy and is quieter in comparison to induction motors.




### • Grinder (machine tools) — Speed control

**Merits**

- Swift tracking (fast-response) and high rotational accuracy enables stable machining.
- Machine can be downsized.




## Line up

### Drive unit

**Model**

**FR - E720EX - 0.75 K**

| Symbol | Voltage class |
|---|---|
| E720EX | Three-phase 200V class |

| Symbol | Drive unit capacity |
|---|---|
| 0.1 to 0.75 | Represents the capacity (kW). |

| Drive unit model | 0.1 | 0.2 | 0.4 | 0.75 |
|---|---|---|---|---|
| FR-E720EX-□K | ● | ● | ● | ● |

●: Available

Compatible with UL (UL 508C), cUL (CSA C22.2 No.14), EC Directives (CE marking), Radio Waves Act (South Korea)

Being RoHS compliant, the FR-E700EX series drive units are friendly to people and to the environment.

### Motor

**Model**

**MM - GKR 1 3 □ □ □**

| Symbol | Rated output (kW) |
|---|---|
| 1 | 0.1 |
| 2 | 0.2 |
| 4 | 0.4 |
| 7 | 0.75 |

| Symbol | Rated speed (r/min) |
|---|---|
| 3 | 3000 |

| Symbol | Oil seal |
|---|---|
| – | Not used |
| J | Used*1*2 |

| Symbol | Reduction gear*3 |
|---|---|
| – | Not used |
| G0 | General industrial machine supported (flange installation) |

| Symbol | Shaft end |
|---|---|
| – | Standard (straight shaft) |
| K | Shaft with keyway (with or without key)*4 |
| D | D-cut shaft*4 |

*1: The reduction gear equipped models do not have the oil seal.
*2: The motor with the oil seal has an outline dimension different from the standard motor. For the details, please contact your sales representative.
*3: For the applicable models and detailed specifications, refer to page 10.
*4: For the applicable models and detailed specifications, refer to page 13.

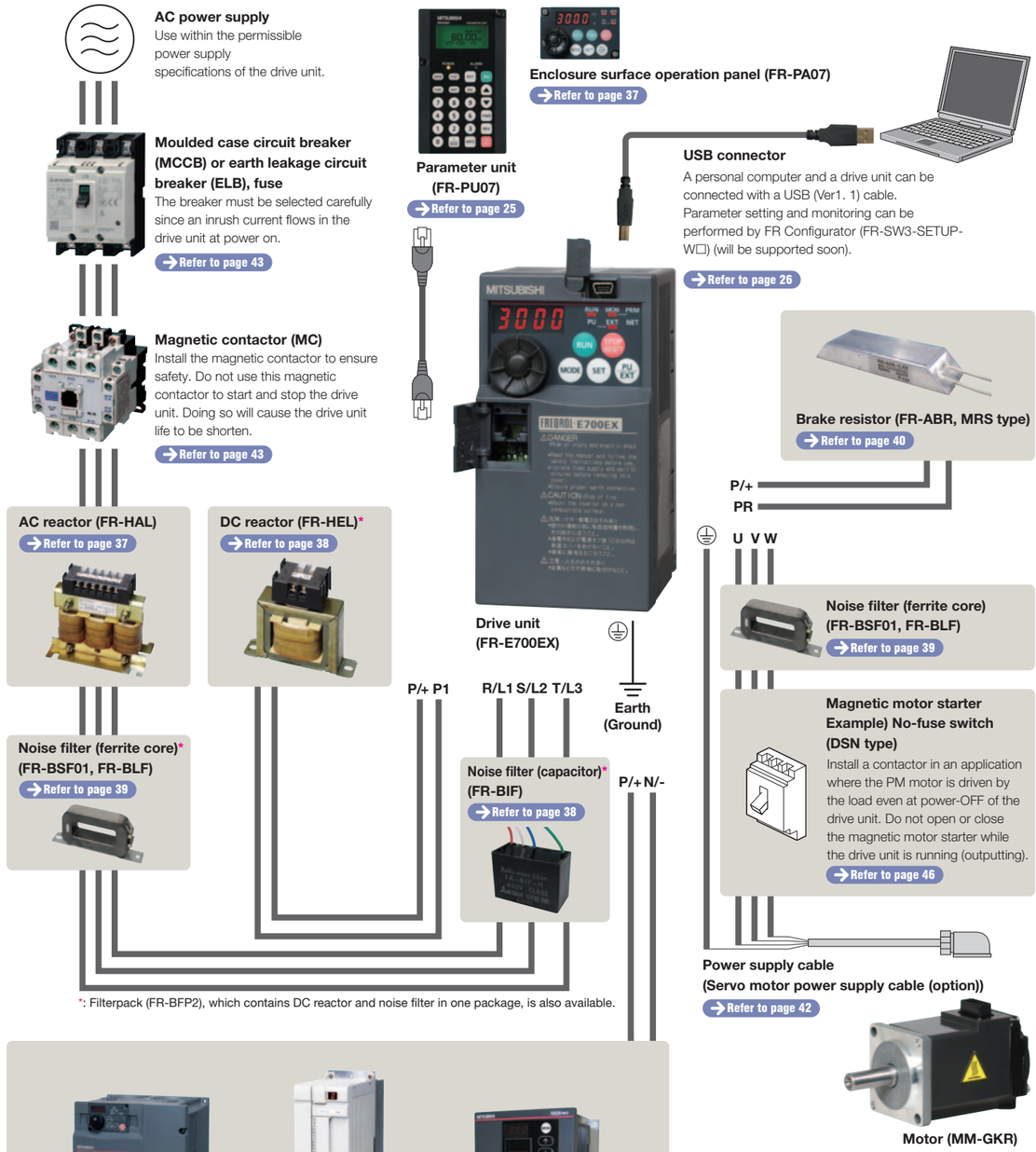
| Motor model | 13 | 23 | 43 | 73 |
|---|---|---|---|---|
| MM-GKR□□ | ● | ● | ● | ● |

●: Available

Compatible with UL (UL1004-1/UL1004-6), CSA (CSA C22.2 No.100), EC Directives (CE marking)

Being RoHS compliant, the MM-GKR series motors are friendly to people and to the environment.

## Connection example




*: Filterpack (FR-BFP2), which contains DC reactor and noise filter in one package, is also available.

: Install these options as a required.

**Devices connected to the output**

Do not install a power factor correction capacitor, surge suppressor or noise filter (capacitor) on the output side of the drive unit. When installing a moulded case circuit breaker on the output side of the drive unit, contact each manufacturer for selection of the moulded case circuit breaker.

**Earth (Ground)**

To prevent an electric shock, always earth (ground) the motor and drive unit.

## Drive unit rating

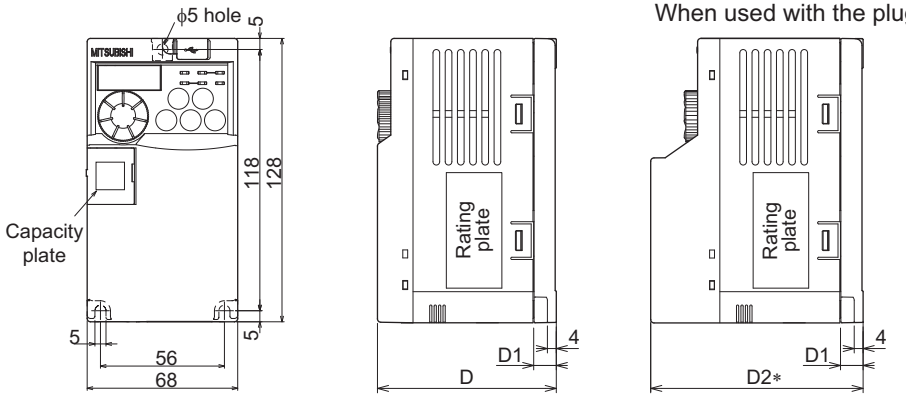
●Three-phase 200V power supply

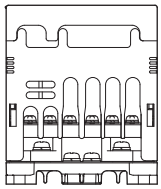
| Model FR-E720EX-□□K | | 0.1 | 0.2 | 0.4 | 0.75 |
|---|---|---|---|---|---|
| Applicable motor capacity (kW)*1 | | 0.1 | 0.2 | 0.4 | 0.75 |
| Output | Rated current (A) | 0.8 | 1.5 | 3 | 5 |
| | Overload current rating | 150% 60s, 200% 3s (reference rated motor current, inverse-time characteristics) | | | |
| Power supply | Rated input AC voltage/frequency | Three-phase 200 to 240V 50Hz/60Hz | | | |
| | Permissible AC voltage fluctuation | 170 to 264V 50Hz/60Hz | | | |
| | Permissible frequency fluctuation | ±5% | | | |
| Protective structure | | Enclosed type (IP20) | | | |
| Cooling system | | Self-cooling | | | |
| Approximate mass (kg) | | 0.5 | 0.5 | 0.7 | 1.0 |

*1 The applicable motor capacity indicates the capacity of the MM-GKR series.

## Drive unit outline dimension drawings

●FR-E720EX-0.1K to 0.75K



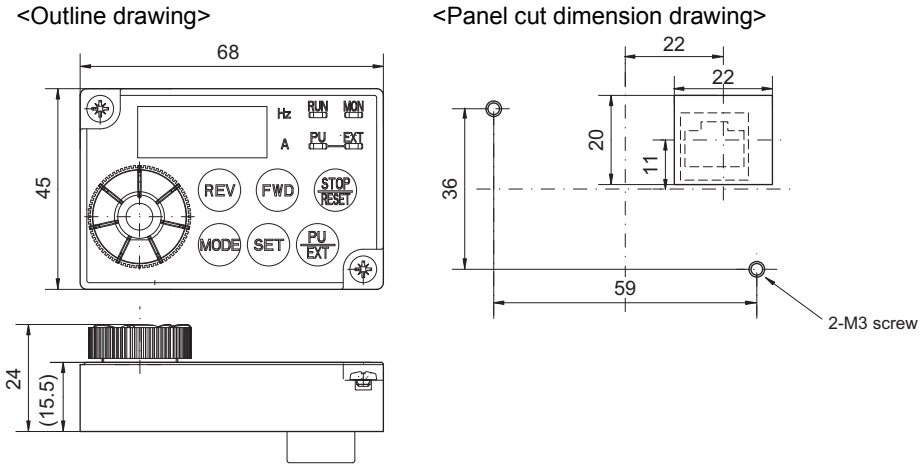



* When the FR-A7NC E kit is mounted, a terminal block protrudes making the depth approx. 2mm greater.

| Drive unit model | D | D1 | D2 |
|---|---|---|---|
| FR-E720EX-0.1K, 0.2K | 80.5 | 10 | 95.6 |
| FR-E720EX-0.4K | 112.5 | 42 | 127.6 |
| FR-E720EX-0.75K | 132.5 | 62 | 147.6 |

(Unit: mm)

●Enclosure surface operation panel (option) (FR-PA07)




(Unit: mm)

## Drive unit common specifications

| | | | | |
|---|---|---|---|---|
| Control specifications | Control method | | | PM sensorless vector control (low-speed range: current synchronization operation) |
| | Carrier frequency | | | 10kHz (when driving an MM-GKR series motor) |
| | Starting torque | | | 200% (initial value) |
| | Initial magnetic pole detection time | | | Approx. 0.1s (performed at start, at SON/LX signal ON.) |
| | Torque limit operation level | | | Operation current level can be set (0 to 200% adjustable), whether to use the function or not can be selected. |
| | Speed control | Speed fluctuation ratio | | ±0.05% *1 |
| | | Speed control range | | Full speed range (speed ratio at digital input 1:1000) |
| | | Speed setting resolution | Analog input | 3r/min/3000r/min (terminal2, 4: 0 to 10V/10-bit)<br>6r/min/3000r/min (terminal2, 4: 0 to 5V/9-bit)<br>3r/min/3000r/min (terminal4: 0 to 20mA/10-bit) |
| | | | Digital input | 1r/min |
| | | Analog speed command input | | Two terminals<br>Terminal 2: 0 to 10V, 0 to 5V can be selected<br>Terminal 4: 0 to 10V, 0 to 5V, 4 to 20mA can be selected |
| | | Acceleration/ deceleration time setting | | 0.01 to 360.00s (acceleration and deceleration can be set individually). |
| | | Acceleration/ deceleration time pattern | | Selectable between the linear acceleration/deceleration and the S-pattern acceleration/deceleration |
| | | Digital speed command input | | Input from the operation panel or parameter unit. Frequency setting increment is selectable. |
| | Position control | Command input method | | Point table method. Position control by an absolute position command is available after home position return. |
| | | Motor internal command resolution | | 5120 [pulses/rev] |
| | | Positioning accuracy | | ±1.8° (mechanical angle of 200 [pulses/rev] resolution equivalent; input voltage of 200V; and wiring length of 5m or less) |
| | Communication specification | | | Built-in to the drive unit : RS-485 communication (Mitsubishi inverter protocol, Modbus-RTU communication)<br>Option: CC-Link communication |
| Operation specifications | Start signal | | | Forward and reverse rotation or start signal automatic self-holding input (3-wire input) can be selected. |
| | Input signal (seven terminals) | | | The following signals can be assigned to *Pr.178 to Pr.184 (input terminal function selection)* : multi-speed selection, second function selection, terminal 4 input selection, JOG operation selection, external thermal input, drive unit operation enable signal, PU operation external interlock, PID control valid terminal, PU-External operation switchover, pre-excitation, output stop, start self-holding selection, stopper control switchover, P/PI control switchover, forward rotation, reverse rotation command, drive unit reset, PU-NET operation switchover, External-NET operation switchover, command source switchover, proximity dog, servo-ON, sudden stop, forward stroke end, and reverse stroke end |
| | Operational functions | | | Upper/lower limit setting, speed jump operation, external thermal relay input selection, forward/ reverse rotation prevention, remote setting, second function, multi-speed operation, regeneration avoidance, operation mode selection, PID control, computer link operation (RS-485), Modbus-RTU |
| | Output signal<br>Open collector output (Two terminals)<br>Relay output (One terminal) | Operating status | | The following signals can be assigned to *Pr.190 to Pr.192 (output terminal function selection)* : drive unit operation, speed reached, overload alarm, speed detection, regenerative brake prealarm, electronic thermal relay function prealarm, drive unit operation ready, output current detection, zero current detection, PID lower limit, PID upper limit, PID forward/reverse rotation output, electromagnetic brake interlock, stroke limit warning, heatsink overheat prealarm, operation ready 2, in-position, travel completed, during PID control, rough match, home position return failure, position detection, position command creating, home position return completed, during retry, life alarm, fault output 3, current average value monitor, maintenance timer alarm, remote output, alarm output, and fault output |
| | | For meter<br>Pulse train output (Max. 2.4kHz: one terminal) | | The following signals can be assigned to *Pr.54 FM terminal function selection* : rotation speed (output frequency), output current (steady), output voltage, speed setting value (frequency setting value), converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, output power, reference voltage output, motor load factor (torque monitor), ideal speed command, speed command, PID set point, PID measured value, motor thermal load factor, and drive unit thermal load factor.<br>Pulse train output (1440 pulses/s/full scale). |

| | | | |
|---|---|---|---|
| Indication | Operation panel<br><br>Parameter unit (FR-PU07) | Operating status | The following operating status can be displayed: rotation speed (output frequency), output current (steady), output voltage, speed setting value (frequency setting value), converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, output power, position pulse, cumulative energization time, actual operation time, motor load factor (torque monitor), position command, ideal speed command, speed command, cumulative power, PID set point, PID measured value, PID deviation, drive unit I/O terminal monitor, motor thermal load factor, and drive unit thermal load factor. |
| | | Fault record | Fault record is displayed when a fault occurs. Past 8 fault records (output voltage/current/frequency/ cumulative energization time right before the fault occurs) are stored. |
| | | Interactive guidance | Function (help) for operation guide *2 |
| Protective/ warning function | | Protective functions | Overcurrent during acceleration, overcurrent during constant speed, overcurrent during deceleration, overvoltage during acceleration, overvoltage during constant speed, overvoltage during deceleration, drive unit protection thermal operation, motor protection thermal operation, heatsink overheat, input phase failure *2, stop by the torque limit, output side earth (ground) fault overcurrent at start *2, output phase failure, external thermal relay operation *2, option fault *3, parameter error, PU disconnection, retry count excess *3, CPU fault, brake transistor alarm, inrush resistance overheat, analog input error, USB communication error, loss of synchronism detection, overspeed occurrence, speed deviation excess detection, excessive position fault, acceleration rate error, internal board fault, internal circuit fault |
| | | Warning functions | Overcurrent torque limit, overvoltage stall prevention, PU stop, parameter write error, regenerative brake prealarm *2, electronic thermal relay function prealarm, maintenance output *3, undervoltage, home position return setting error *3, home position return uncompleted, operation panel lock, password locked *3, drive unit reset |
| Environment | Surrounding air temperature | | -10°C to +50°C (non-freezing) *4 |
| | Ambient humidity | | 90%RH or less (non-condensing) |
| | Storage temperature *5 | | -20°C to +65°C |
| | Atmosphere | | Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.) |
| | Altitude/vibration | | Maximum 1000m above sea level, 5.9m/s $^2$ or less at 10 to 55Hz (directions of X, Y, Z axes) |

*1 During the load fluctuation of 0 to 100%
*2 This operation guide is only available with option parameter unit (FR-PU07).
*3 This protective function does not function in the initial status.
*4 When using the drive units at the surrounding air temperature of 40°C or less, the drive units can be installed closely attached (0cm clearance).
*5 Temperatures applicable for a short time, e.g. in transit.

## Motor rating

| Motor model | MM-GKR□□ | 13 | 23 | 43 | 73 |
|---|---|---|---|---|---|
| Compatible drive unit | FR-E720EX-□K | 0.1 | 0.2 | 0.4 | 0.75 |
| Power supply capacity (kVA) *2 | | 0.3 | 0.5 | 0.9 | 1.3 |
| Continuous characteristic | Rated output (kW) | 0.1 | 0.2 | 0.4 | 0.75 |
| | Rated torque (N·m) *3 | 0.32 | 0.64 | 1.3 | 2.4 |
| Maximum torque (N·m) | | 0.64 | 1.3 | 2.5 | 4.8 |
| Rated speed (r/min) | | 3000 | | | |
| Maximum speed (r/min) | | 3000 | | | |
| Instantaneous permissible rotation speed (r/min) | | 3450 | | | |
| Power rate at continuous constant-torque (kW/s) | | 14.9 | 21.3 | 43.8 | 46.0 |
| Number of poles | | 10 | | | |
| Rated current (A) | | 0.65 | 1.08 | 1.94 | 3.34 |
| Maximum current (A) | | 1.3 | 2.2 | 3.9 | 6.7 |
| Moment of inertia ($\times 10^{-4}$kg·m$^2$) | | 0.0676 | 0.187 | 0.371 | 1.24 |
| Recommended load inertia moment ratio *4 | | 10 times or lower | | | |
| Speed/position detector | | None | | | |
| Oil seal | | None (the oil seal model is also available. (MM-GKR_J)) | | | |
| Heat-resistant class | | 130 (B) | | | |
| Structure | | Totally enclosed self-cooling | | | |
| Protective structure | | IP65 *5 | | | |
| Environment *7 | Surrounding air temperature | 0°C to +40°C(non-freezing), In storage: -15°C to +70°C (non-freezing) | | | |
| | Ambient humidity | 80% RH or less (non-condensing), In storage: 90% RH or less (non-condensing) | | | |
| | Atmosphere | Indoors (avoid direct sunlight), free from corrosive gas, flammable gas, oil mist, dust and dirt | | | |
| | Altitude | Maximum 1,000m above sea level | | | |
| | Vibration *6 | X: 49m/s$^2$, Y: 49m/s$^2$ | | | |
| Vibration class | | V10 *8 | | | |
| Permissible load on the shaft *9 | L (mm) | 25 | 30 | 30 | 40 |
| | Radial (N) | 88 | 245 | 245 | 392 |
| | Thrust (N) | 59 | 98 | 98 | 147 |
| Mass (kg) | | 0.4 | 0.77 | 1.3 | 2.7 |

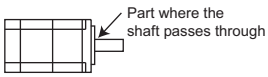
*1 The above characteristics apply when the rated AC voltage is input from the drive unit. Output and rated motor speed are not guaranteed when the power supply voltage drops.

*2 The power supply capacity varies with the value of the power supply side drive unit impedance (including those of the input reactor and cables).

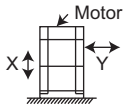
*3 When the motor is used with a machine that produces unbalanced torque such as an elevating axis, the unbalanced torque should be 70% of the rated torque or lower.

*4 This is the ratio of the moment of load inertia to the moment of motor inertia under position control. If the load inertia moment ratio exceeds the described value, please contact your sales representative.

*5 This excludes the part where the shaft passes through. For the motor with a reduction gear, the protective structure of the reduction gear part is equivalent to IP44.

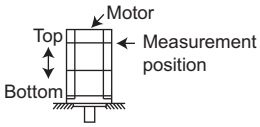



*6 X indicates the direction of the motor's output shaft, and Y indicates the direction vertical to the motor's output shaft. Usually, the indicated value is of the non-load side bracket where the vibration is the greatest.
Bearing is subject to fretting while the motor is stopped. Suppress the vibration to about the half of the permissible value.

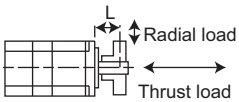



*7 The standard motor may not be used under the condition where it is constantly exposed to oil mist, oil, or water. For the details, please contact your sales representative.

*8 V10 indicates that the vibration amplitude by only a motor is 10μm or lower. The following figure shows the installation orientation of the motor and measurement position when the degree of vibration is measured.




*9 For the permissible load on the shaft, refer to the following figure. Do not apply a load exceeding the value in the table to the shaft.
Each value in the table is for when only one load is applied.




L: Distance from the flange mounting surface to the center of the load

## ●MM-GKR series geared motor specifications

### Reduction-gear-equipped model for general industrial machines: G0

| Model | Output [W] | Reduction ratio | Actual reduction ratio | Moment of inertia J ($\times 10^{-4}$kg·m$^2$) *1 | Permissible load inertia moment ratio *2 (at motor shaft) | Mass(kg) | Lubrication method | Installation orientation |
|---|---|---|---|---|---|---|---|---|
| MM-GKR13G0 | 100 | 1/5 | 42/221 | 0.0720 | 10 times or lower of the moment of motor inertia | 1.1 | Grease (already filled) | Any orientation |
| | | 1/12 | 9/104 | 0.0706 | | 1.1 | | |
| | | 1/20 | 12/247 | 0.0703 | | 1.1 | | |
| | | 1/30 | 24/713 | 0.0768 | | 1.8 | | |
| MM-GKR23G0 | 200 | 1/5 | 44/217 | 0.222 | | 2.5 | | |
| | | 1/12 | 48/589 | 0.204 | | 2.5 | | |
| | | 1/20 | 32/651 | 0.201 | | 2.5 | | |
| | | 1/30 | 24/713 | 0.200 | | 2.5 | | |
| MM-GKR43G0 | 400 | 1/5 | 15/77 | 0.406 | | 3.2 | | |
| | | 1/12 | 9/110 | 0.390 | | 3.2 | | |
| | | 1/20 | 9/189 | 0.399 | | 3.8 | | |
| | | 1/30 | 12/351 | 0.398 | | 3.8 | | |
| MM-GKR73G0 | 750 | 1/5 | 19/95 | 1.37 | | 5.2 | | |
| | | 1/12 | 40/475 | 1.32 | | 5.2 | | |
| | | 1/20 | 14/285 | 1.29 | | 7.0 | | |
| | | 1/30 | 25/722 | 1.28 | | 7.0 | | |

| Item | Specifications |
|---|---|
| Installation procedure | Flange mounting |
| Rotation direction of output axis | Same as that of the motor output axis |
| Backlash *4 | 60 minutes or less at the output shaft of the reduction gear |
| Maximum torque | Twice of the rated torque (For the rated torque, *refer to page 10*.) |
| Permissible rotation speed (motor axis) | 3000r/min (Instantaneous permissible rotation speed: 3450r/min) |
| IP rating | Equivalent to IP44 |
| Vibration resistance | X: 29.4 m/s$^2$, Y: 29.4 m/s$^2$ |
| Reduction gear efficiency *3 | 80% or higher |

*1 This value is a value at the shaft of the motor with a reduction gear.

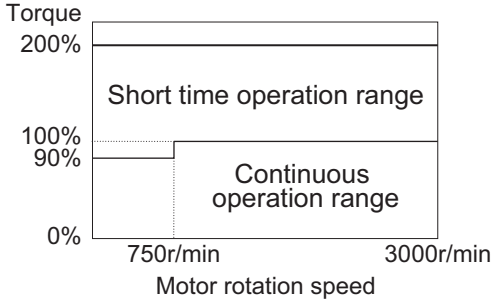
*2 If the value exceeds the described value, please contact your sales representative.

*3 The reduction gear efficiency differs depending on the reduction ratio. Additionally, the reduction gear efficiency varies depending on operating conditions, such as the output torque, rotation speed, and temperature.
The value in the table is a typical value for the rated torque at the rated speed and at a room temperature but not a guaranteed value.

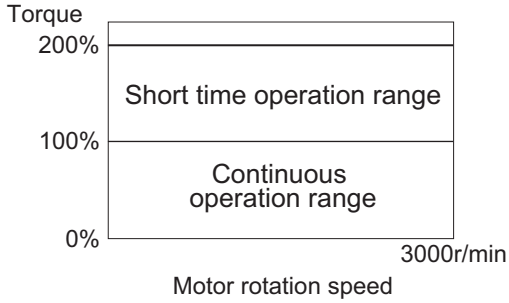
*4 The following conversion formula is used for the unit conversion of the backlash: 1 minute = 0.0167°

## Motor torque characteristic

●MM-GKR13




●MM-GKR23 to 73

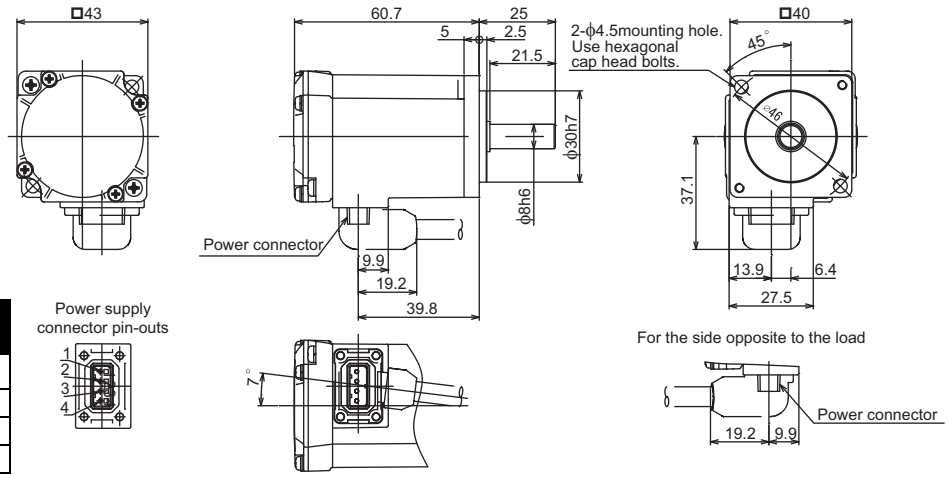



•When the input voltage is low, the torque may be reduced.

•The continuous operation torque becomes 80% at 6r/min or lower.

## Outline drawing of motors

●MM-GKR13

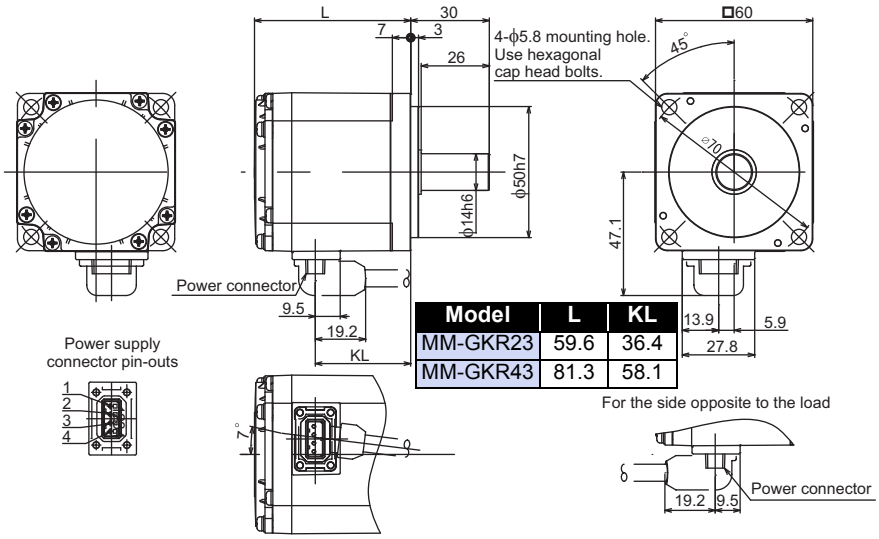



| Pin No. | Signal name |
|---|---|
| 1 | ⏚(PE) |
| 2 | U |
| 3 | V |
| 4 | W |

Power supply connector pin-outs

(Unit: mm)

●MM-GKR23, 43



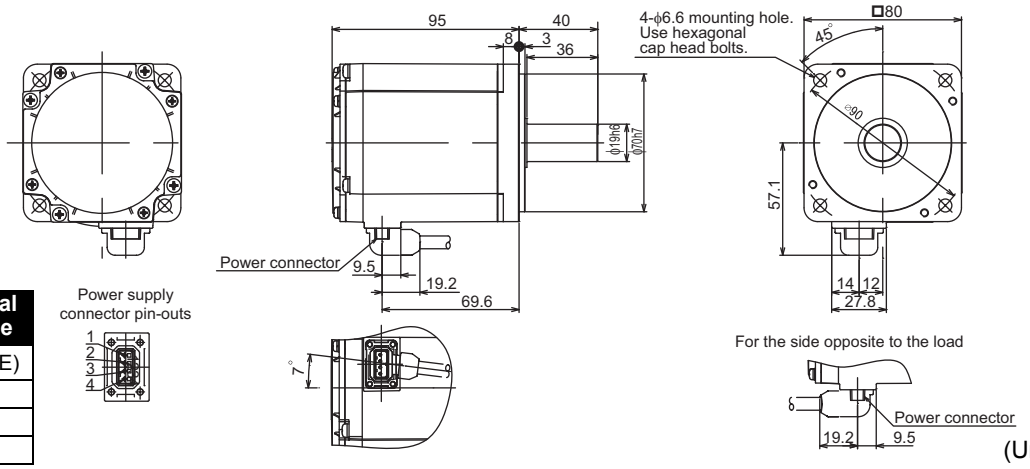

| Model | L | KL |
|---|---|---|
| MM-GKR23 | 59.6 | 36.4 |
| MM-GKR43 | 81.3 | 58.1 |

| Pin No. | Signal name |
|---|---|
| 1 | ⏚(PE) |
| 2 | U |
| 3 | V |
| 4 | W |

Power supply connector pin-outs

(Unit: mm)

●MM-GKR73




| Pin No. | Signal name |
|---|---|
| 1 | ⏚(PE) |
| 2 | U |
| 3 | V |
| 4 | W |

Power supply connector pin-outs

(Unit: mm)

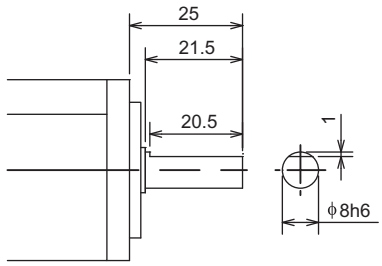
**NOTE**

- **For dimensions without tolerance, general tolerance applies.**
- **Use a friction coupling to fasten a load.**
- **Motors with oil seal (MM-GKR_J) have different dimensions. Contact your local sales office for more details.**

## Special shaft end specifications

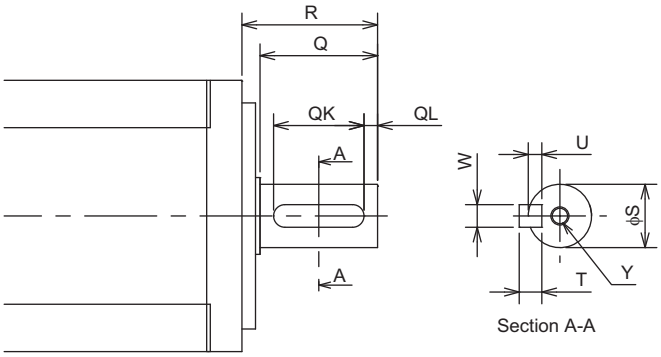
**Motors with the following specifications (with dedicated shaft end) are available by request.**

D-cut shaft ∗1 ...100W




(Unit: mm)

Key shaft (with key) ∗1∗2 ...200W, 400W, 750W



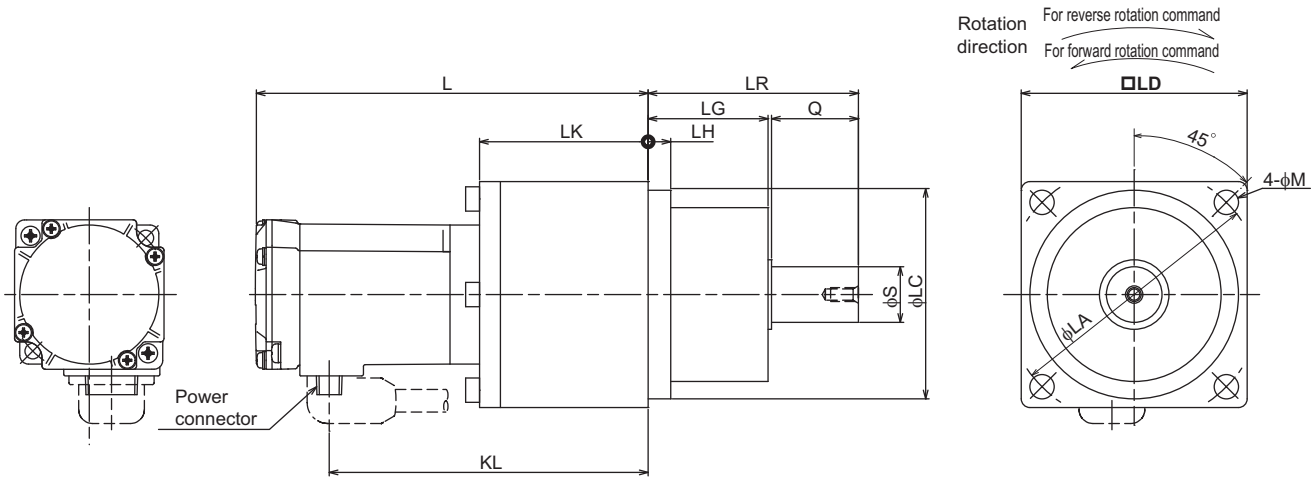

(Unit: mm)

| Model | T | S | R | Q | W | QK | QL | U | Y |
|---|---|---|---|---|---|---|---|---|---|
| MM-GKR23K, 43K | 5 | 14h6 | 30 | 26 | 5 | 20 | 3 | 3 | M4 screw Depth: 15 |
| MM-GKR73K | 6 | 19h6 | 40 | 36 | 6 | 25 | 5 | 3.5 | M5 screw Depth: 20 |

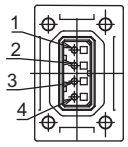
∗1 The motors with dedicated shaft end are not suitable for frequent start/stop applications. Such an operation may result in a fracture of the shaft due to rattling of the key.

∗2 Round head keys.

## MM-GKR series geared motor dimensions




Power supply connector pin-outs




| Pin No. | Signal name |
|---|---|
| 1 | ⏚(PE) |
| 2 | U |
| 3 | V |
| 4 | W |

(Unit: mm)

| Model | Reduction ratio (Actual reduction ratio) | L | LA | LC | LD | S | LH | LK | KL | LG | Q | LR | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MM-GKR13G0 | 1/5 (42/221) | 112.7 | 75 | 60h7 | 65 | 16h6 | 6.5 | 48.5 | 91.7 | 34.5 | 25 | 60.5 | 7 |
| | 1/12 (9/104) | | | | | | | | | | | | |
| | 1/20 (12/247) | | | | | | | | | | | | |
| | 1/30 (24/713) | 127.7 | 100 | 82h7 | 90 | 25h6 | 11.5 | 59 | 106.8 | 37.5 | 35 | 73.5 | 9 |
| MM-GKR23G0 | 1/5 (44/217) | 126.6 | | | | | | | 103.4 | | | | |
| | 1/12 (48/589) | | | | | | | | | | | | |
| | 1/20 (32/651) | | | | | | | | | | | | |
| | 1/30 (24/713) | | | | | | | | | | | | |
| MM-GKR43G0 | 1/5 (15/77) | 148.3 | | | | | | | 125.1 | | | | |
| | 1/12 (9/110) | | | | | | | | | | | | |
| | 1/20 (9/189) | 157.3 | 115 | 95h7 | 100 | 32h6 | 8 | 71 | 134.1 | 39 | 50 | 90 | |
| | 1/30 (12/351) | | | | | | | | | | | | |
| MM-GKR73G0 | 1/5 (19/95) | 176.8 | | | | | | 13.5 | 151.4 | | | | |
| | 1/12 (40/475) | | | | | | | | | | | | |
| | 1/20 (14/285) | 179.8 | 140 | 115h7 | 120 | 40h6 | 12 | 73 | 154.4 | 45 | 60 | 106 | 14 |
| | 1/30 (25/722) | | | | | | | | | | | | |

**NOTE**

- For dimensions without tolerance, general tolerance applies.
- Use a friction coupling to fasten a load.

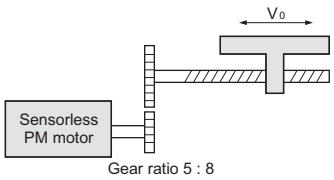
### ●Dedicated specifications for the reduction-gear-equipped MM-GKR series motor

**The MM-GKR□□G0 (reduction-gear-equipped model for general industrial machines) has a straight shaft as standard. The models with a key shaft are also available as dedicated models.**
**For the details, please contact your sales representative.**

## Sensorless PM motors selection example

### (1) Selection criteria

Configurations




| | | | |
|---|---|---|---|
| Feed speed of moving part | $V_0$ = 30000 (mm/min) | $D_B$ = ball screw diameter | 20 (mm) |
| Feed length per cycle | $\ell$ = 375 (mm) | $L_B$ = ball screw length | 500 (mm) |
| Positioning time | $t_0$ = within 1 (s) | $D_{G1}$ = gear diameter (motor shaft) | 25 (mm) |
| Number of feed times (Operating cycle | 40 times/min $t_f$ = 1.5 (s)) | $D_{G2}$ = gear diameter (load shaft) | 40 (mm) |
| Reduction ratio | 1/n = 5/8 | $L_G$ = gear tooth thickness | 10 (mm) |
| Moving part mass | W = 60 (kg) | ρ = density of ball screw material and gear material | 0.0078 (kg/cm$^3$) |
| Drive system efficiency | η = 0.8 | | |
| Friction coefficient | μ = 0.2 | | |
| Ball screw lead | $P_B$ = 16 (mm) | | |

- Motor speed

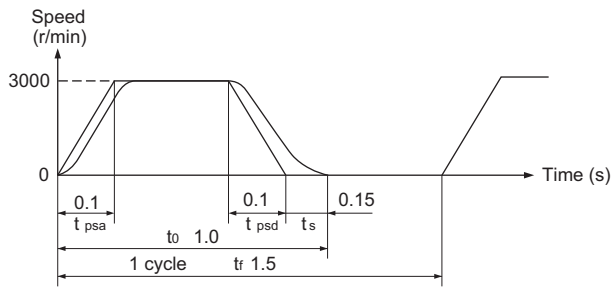
$$N_0 = \frac{V_0}{P_B} \times \frac{1}{1/n} = \frac{30000}{16} \times \frac{8}{5} = 3000 \text{ (r/min)}$$

- Acceleration/deceleration time constant

$$t_{psa} = t_{psd} = t_0 - \frac{\ell}{V_0/60} - t_s = 0.1\text{(s)}$$

$t_s$: settling time. Here it is assumed as 0.15 s.

- Operating pattern




- Select a motor

Selection criteria
Load torque < Rated torque of motor
Moment of inertia of all loads < $J_R$ × Moment of inertia of motor
$J_R$: Recommended load to motor inertia ratio
Select the following motor to meet the criteria above.
MM-GKR23 (rated torque: 0.64 (N·m), max. torque: 1.3 (N·m), moment of inertia: 0.19 (×10$^{-4}$kg·m$^2$))

- Acceleration/deceleration torque

Torque required during acceleration

$$T_{Ma} = \frac{(J_L/\eta + J_M) \times N_0}{9.55 \times 10^4 \times t_{psa}} + T_L = 1.03 \text{ (N·m)}$$

$J_M$: moment of inertia of motor

Torque required during deceleration

$$T_{Md} = -\frac{(J_L \times \eta + J_M) \times N_0}{9.55 \times 10^4 \times t_{psd}} + T_L = -0.30 \text{ (N·m)}$$

Torque required during acceleration/deceleration must be equal to or lower than the max. torque of the motor.

### (2) Selecting rotary motor

- Load torque (converted into the motor shaft)

Travel distance per motor revolution

$$\Delta S = P_B \times \frac{1}{n} = 10 \text{ (mm)}$$

$$T_L = \frac{\mu \times W \times g \times \Delta S}{2 \times 10^3 \pi \eta} = 0.23 \text{ (N·m)}$$

- Load moment of inertia (converted into the motor shaft)

Moving part

$$J_{L1} = W \times \left(\frac{\Delta S \times 10^{-3}}{2\pi}\right)^2 = 1.52 \ (\times 10^{-4} \text{ kg·m}^2)$$

Ball screw

$$J_{L2} = \frac{\pi \times \rho \times L_B}{32} \times D_B^4 \times \left(\frac{1}{n}\right)^2 = 0.24 \ (\times 10^{-4} \text{ kg·m}^2)$$

Gear (motor shaft)

$$J_{L3} = \frac{\pi \times \rho \times L_G}{32} \times D_{G1}^4 = 0.03 \ (\times 10^{-4} \text{ kg·m}^2)$$

Gear (load shaft)

$$J_{L4} = \frac{\pi \times \rho \times L_G}{32} \times D_{G2}^4 \times \left(\frac{1}{n}\right)^2 = 0.08 \ (\times 10^{-4} \text{ kg·m}^2)$$

All load moment of inertia (converted into the motor shaft)

$$J_L = J_{L1} + J_{L2} + J_{L3} + J_{L4} = 1.87 (\times 10^{-4} \text{kg·m}^2)$$

- Continuous effective load torque

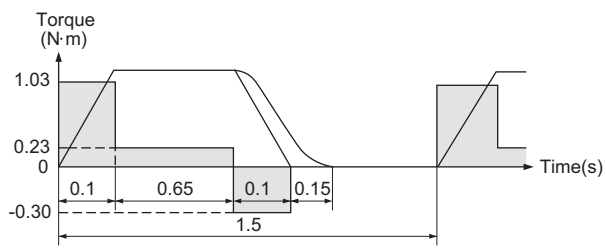
$$T_{rms} = \sqrt{\frac{T_{Ma}^2 \times t_{psa} + T_L^2 \times t_c + T_{Md}^2 \times t_{psd}}{t_f}} = 0.32 \text{ (N·m)}$$

$$t_c = t_0 - t_s - t_{psa} - t_{psd}$$

Continuous effective load torque must be equal to or lower than the rated torque of the motor.

* The continuous effective load torque for operation of MM-GKR13 at low speed (750r/min or lower) must be equal to or less than 90% of the rated torque.

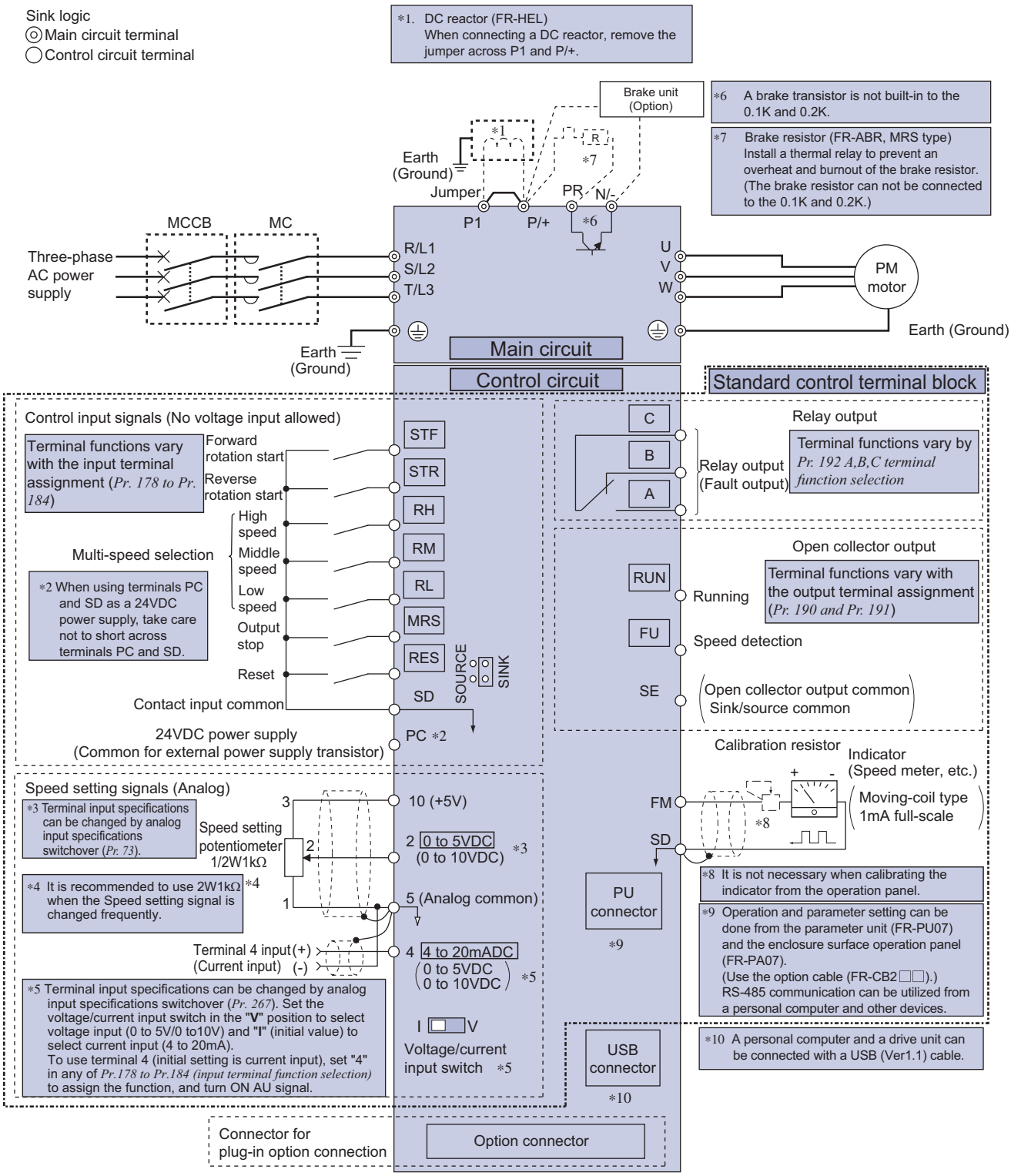
- Torque pattern




- Result

Based on the above, select the following.
Sensorless PM motor MM-GKR23
Drive unit FR-E720EX-0.2K
(The software for capacity selection will be provided at free of charge.)(To be available soon.)

## ●Connection example




**NOTE**

- **To prevent a malfunction caused by noise, separate the signal cables more than 10cm from the power cables. Also separate the main circuit wire of the input side and the output side.**
- **After wiring, wire offcuts must not be left in the drive unit.**
  **Wire offcuts can cause an alarm, failure or malfunction. Always keep the drive unit clean. When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the drive unit.**

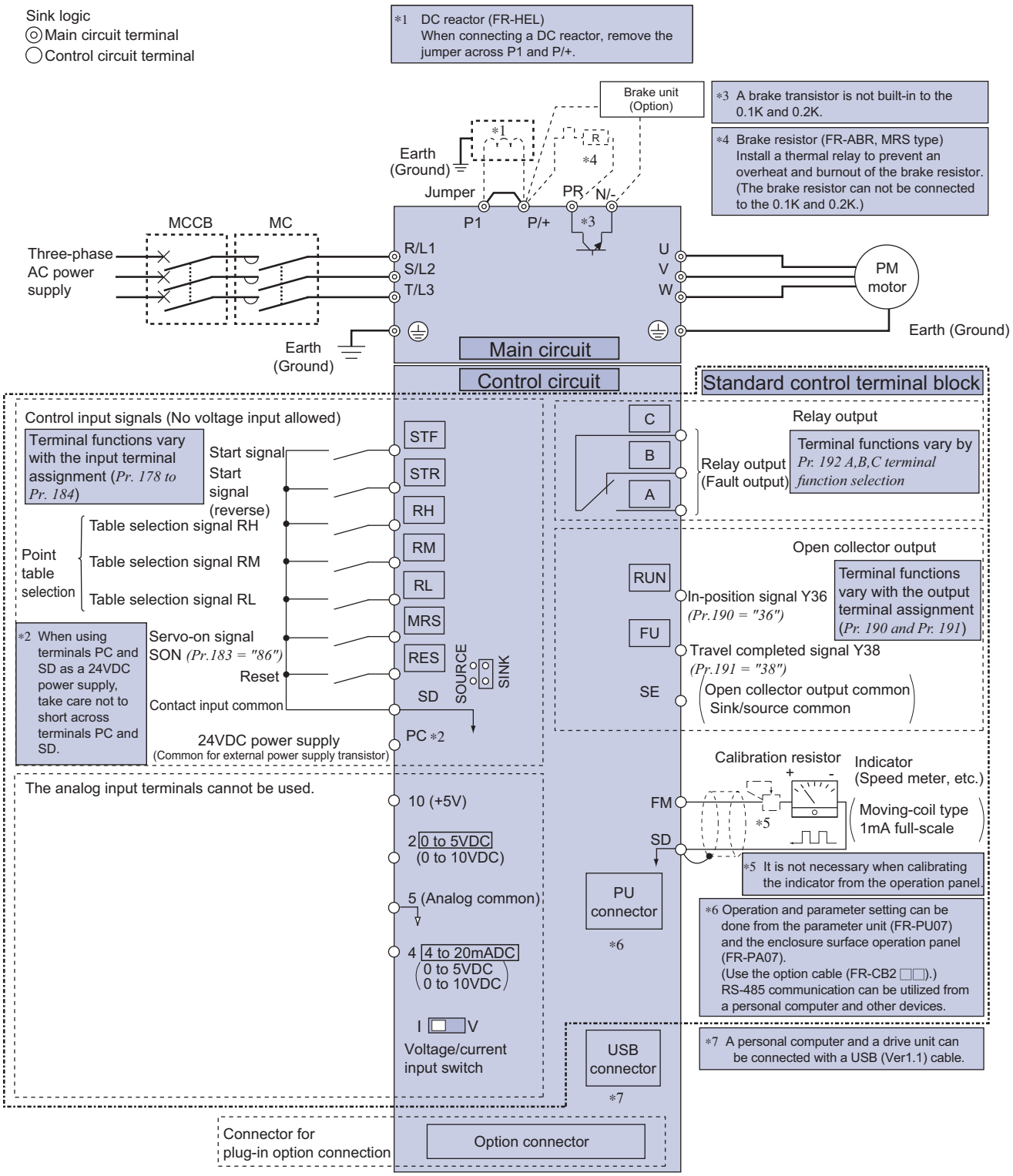
| Type | | Terminal Symbol | Terminal Name | Description | |
|---|---|---|---|---|---|
| Main circuit | | R/L1, S/L2, T/L3 | AC power input | Connect to the commercial power supply. Keep these terminals open when using the high power factor converter (FR-HC2) or power regeneration common converter (FR-CV). | |
| | | U, V, W | Drive unit output | Connect a PM motor. | |
| | | P/+, PR | Brake resistor connection | Connect a brake resistor (MRS type, FR-ABR) across terminals P/+ and PR.<br>(The brake resistor can not be connected to the 0.1K or 0.2K) | |
| | | P/+, N/- | Brake unit connection | Connect the brake unit (FR-BU2), power regeneration common converter (FR-CV) or high power factor converter (FR-HC2). | |
| | | | DC power input | Connect the plus side of the power supply to terminal P/+ and minus side to terminal N/-. | |
| | | P/+, P1 | DC reactor connection | Remove the jumper across terminals P/+ and P1 and connect a DC reactor | |
| | | ⏚ | Earth (Ground) | For earthing (grounding) the drive unit chassis. Must be earthed (grounded). | |
| Control circuit/input signal | Contact input | STF | Forward rotation start | Turn ON the STF signal to start forward rotation and turn it OFF to stop. | When the STF and STR signals are turned ON simultaneously, the stop command is given. |
| | | STR | Reverse rotation start | Turn ON the STR signal to start reverse rotation and turn it OFF to stop. | |
| | | RH, RM, RL | Multi-speed selection | Multi-speed can be selected according to the combination of RH, RM and RL signals. | |
| | | MRS | Output stop | Turn ON the MRS signal (20ms or more) to stop the drive unit output.<br>Use to shut off the drive unit output when stopping the motor by electromagnetic brake. | |
| | | RES | Reset | Used to reset alarm output provided when protective circuit is activated. Turn ON the RES signal for more than 0.1s, then turn it OFF. Initial setting is for reset always. By setting *Pr.75*, reset can be set to enabled only at fault occurrence. Recover about 1s after reset is cancelled. | |
| | | SD | Contact input common (sink) (initial setting) | Common terminal for contact input terminal (sink logic) and terminal FM. | |
| | | | External transistor common (source) | Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the source logic to avoid malfunction by undesirable current. | |
| | | | 24VDC power supply common | Common output terminal for 24VDC 0.1A power supply (PC terminal). Isolated from terminals 5 and SE. | |
| | | PC | External transistor common (sink) (initial setting) | Connect this terminal to the power supply common terminal of a transistor output (open collector output) device, such as a programmable controller, in the sink logic to avoid malfunction by undesirable current. | |
| | | | Contact input common (source) | Common terminal for contact input terminal (source logic). | |
| | | | 24VDC power supply | Can be used as 24VDC 0.1A power supply. | |
| | Speed setting | 10 | Speed setting power supply | Used as power supply when connecting potentiometer for speed setting from outside of the drive unit. | 5.2VDC ± 0.2V<br>permissible load current 10mA |
| | | 2 | Speed setting (voltage) | Inputting 0 to 5VDC (or 0 to 10V) provides the maximum rotation speed at 5V (10V) and makes input and output proportional. Use *Pr.73* to switch between input 0 to 5VDC (initial setting) and 0 to 10VDC input. | Input resistance 10kΩ ± 1kΩ<br>Permissible maximum voltage 20VDC |
| | | 4 | Speed setting (current) | Inputting 4 to 20mADC (or 0 to 5V / 0 to 10V) provides the maximum rotation speed at 20mA and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input is invalid). To use terminal 4 (initial setting is current input), set "4" to any of *Pr.178 to Pr.184 (input terminal function selection)*, and turn AU signal ON. Use *Pr. 267* to switch among input 4 to 20mA (initial setting), 0 to 5VDC, and 0 to 10VDC. Set the voltage/current input switch in the "V" position to select voltage input (0 to 5V/0 to 10V).<br>**Current input (initial status)** **Voltage input**<br>  | Voltage input:<br>Input resistance 10kΩ ± 1kΩ<br>Permissible maximum voltage 20VDC<br>Current input:<br>Input resistance 233Ω ± 5Ω<br>Maximum permissible current 30mA. |
| | | 5 | Speed setting common | Common terminal for the speed setting signals (terminals 2 and 4). Do not earth (ground). | |

| Type | | Terminal Symbol | Terminal Name | Description | |
|---|---|---|---|---|---|
| Control circuit/output signal | Relay | A, B, C | Relay output (fault output) | 1 changeover contact output indicates that the drive unit fault occurs.<br>Fault: discontinuity across B-C (continuity across A-C), Normal: continuity across B-C (discontinuity across A-C) Contact capacity 230VAC 0.3A (power factor = 0.4) 30VDC 0.3A | |
| | Open collector | RUN | Drive unit running | Switched Low when the drive unit rotation speed is equal to or higher than the starting speed (initial value 15r/min). Switched High during stop or DC injection brake operation.* | Permissible load 24VDC (Maximum 27VDC) 0.1A (a voltage drop is 3.4V maximum when the signal is on)<br>* Low is when the open collector output transistor is ON (conducts). High is when the transistor is OFF (does not conduct). |
| | | FU | Speed detection | Switched Low when the drive unit rotation speed is equal to or higher than the preset detected speed and High when less than the preset detected speed.* | |
| | | SE | Open collector output common | Common terminal of terminal RUN and FU. | |
| | Pulse | FM | For meter | Used to output a selected monitored item (such as rotation speed) among several monitored items. (Not output during drive unit reset.) The output signal is proportional to the magnitude of the corresponding monitoring item. | Permissible load current 1mA<br>Output item: Rotation speed (initial setting) 1440 pulses/s at 3000r/min |
| Communication | | — | PU connector | With the PU connector, RS-485 communication can be established.<br>· Conforming standard: EIA-485 (RS-485) · Transmission format: Multi-drop link<br>· Communication speed: 4800 to 38400bps · Overall extension: 500m | |
| | | — | USB connector | FR Configurator can be operated by connecting the drive unit to the personal computer through USB.<br>· Interface: conforms to USB1.1 · Transmission Speed: 12Mbps<br>· Connector: USB mini B connector (receptacle mini B type) | |

**Note**

- **Set *Pr.267* and a voltage/current input switch correctly, then input an analog signal in accordance with the setting. Applying a voltage with voltage/current input switch in "I" position (current input is selected) or a current with switch in "V" position (voltage input is selected) could cause component damage of the drive unit or analog circuit of output devices.**
- **The drive unit will be damaged if power is applied to the drive unit output terminals (U, V, W). Never perform such wiring.**
- **▭ indicates that terminal functions can be selected using *Pr.178 to Pr.192 (I/O terminal function selection)*.**
- **Terminal names and terminal functions are those of the factory set.**
- **When connecting the DC power supply, be sure to connect the plus side of the power supply to terminal P/+ and minus side to terminal N/-. Opposite polarity will damage the drive unit.**

## ●Connection example




**NOTE**

- **To prevent a malfunction caused by noise, separate the signal cables more than 10cm from the power cables. Also separate the main circuit wire of the input side and the output side.**
- **After wiring, wire offcuts must not be left in the drive unit.**
  **Wire offcuts can cause an alarm, failure or malfunction. Always keep the drive unit clean. When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the drive unit.**
- **For the terminal specifications, *refer to page 17* (the functions are those of the initial setting).**

## ●Position control specifications

| Item | | Specifications |
|---|---|---|
| Positioning command input method | | Point table method |
| Command method | Interface | Input terminal selection, RS-485 communication, CC-Link communication (plug-in option) |
| | Number of points | 7 points |
| | Command data setting range | -99999999 to 99999999 |
| | Command setting method | Absolute position command with sign, increment command with sign |
| | Electronic gear ratio | 1/900 to 900 |
| Home position return method | | Data set type, stopper type, home position inobservance (use the servo-ON position as the home position), count type with front end reference |
| Motor internal command resolution | | 5120 [pulses/rev] |
| Positioning accuracy | | ±1.8° (Mechanical angle: Equivalent to the resolution of 200 [pulses/rev]) |
| Other positioning functions | | Sudden stop function, stroke end detection function, roll feed mode, JOG operation, stopper control function, pulse monitor selection function, position control rotation direction selection function |

## ●Input signal

•Using *Pr.178 to Pr.184*, set the functions of the input terminals.

| Setting value | Signal name | Function | Operation |
|---|---|---|---|
| 0 | RL | Table selection signal | Assign the target position, speed, and acceleration/deceleration time to the point tables and select a table using the RH, RM, and RL signals. |
| 1 | RM | | |
| 2 | RH | | |
| 23 | LX | Pre-excitation | Turning ON the LX signal enables the servo lock during stop. |
| 29 | X29 | Stopper control switchover | When the X29 signal is turned ON, the *Pr.513 Stopper control torque limit* setting becomes the torque limit, and it works to prevent activation of E.OLT. |
| 76 | X76 | Proximity dog | When the count type with the front end reference is selected for the home position return method, deceleration is started at the leading edge of the X76 signal ON, and the home position is shifted by the amount of home position shift distance. |
| 86 | SON | Servo-ON | Turning ON the SON signal turns ON the base circuit and sets the drive unit ready for operation (servo-ON status). Turning OFF the SON signal turns OFF the base circuit to cause the motor to coast. |
| 87 | X87 | Sudden stop | When the X87 signal (normally closed input) is turned OFF, the drive unit stops the motor according to the deceleration time slope set in *Pr.464 Digital position control sudden stop deceleration time*. |
| 88 | LSP | Forward stroke end | When the LSP or LSN signal (normally closed input) is turned OFF, the drive unit stops the motor according to the deceleration time slope set in *Pr.464 Digital position control sudden stop deceleration time*. |
| 89 | LSN | Reverse stroke end | |

## ●Output signal

•Using *Pr.190 to Pr.192*, set the functions of the output terminals.

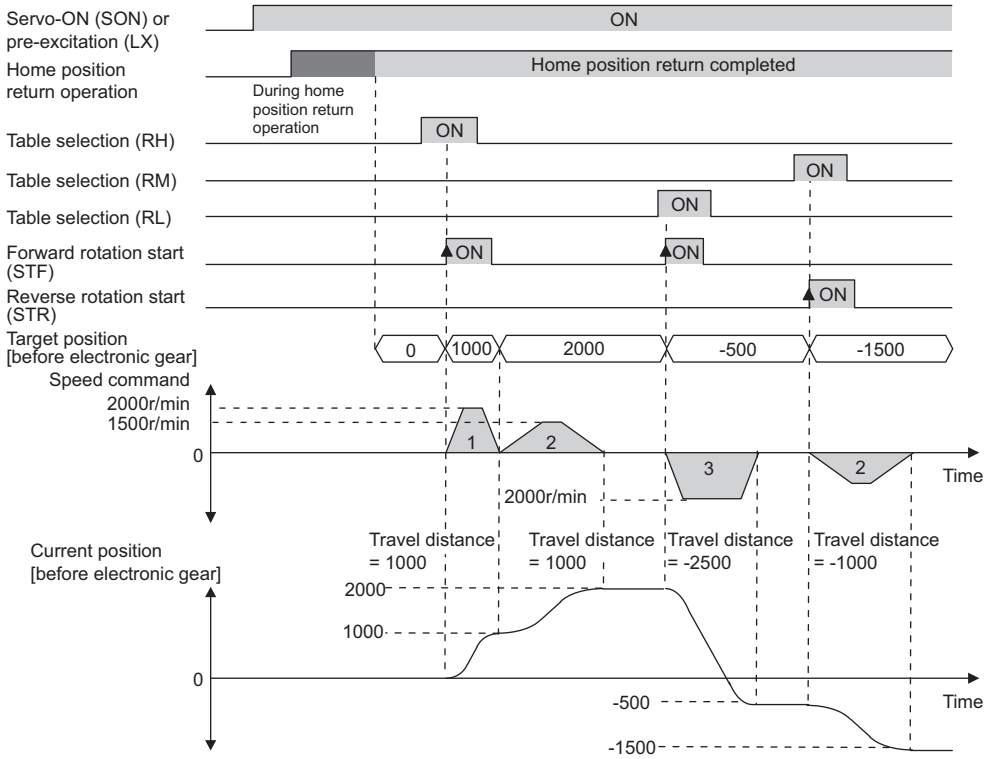
| Setting value | | Signal name | Function | Operation |
|---|---|---|---|---|
| Positive logic | Negative logic | | | |
| 24 | 124 | LP | Stroke limit warning | The stroke limit warning signal (LP signal) is output when the LSP or LSN signal is OFF (normally closed input). |
| 36 | 136 | Y36 | In-position signal | This signal is output when the number of droop pulses drops below the setting of *Pr.426 In-position width*. |
| 38 | 138 | MEND | Travel completed signal | This signal is output when the in-position signal (Y36) is ON and the position command creating signal (PBSY) is OFF. |
| 55 | 155 | CPO | Rough match signal | This signal is output when the remaining command distance falls below the setting of *Pr.507 Rough match output range*. |
| 56 | 156 | ZA | Home position return failure | This signal is output when a home position return failure occurs. |
| 60 | 160 | FP | Position detected signal | This signal is output when the current position exceeds the total of *Pr.510 Position detection lower 4 digits* and *Pr.511 Position detection upper 4 digits*. |
| 61 | 161 | PBSY | Position command creating signal | This signal is output when the position command is being created. |
| 63 | 163 | ZP | Home position return completed signal | This signal is output when home position return has completed. |

## ●Point table method

- Set positioning parameters such as the number of pulses (position) and acceleration/deceleration time in advance to create a point table (point table method). Positioning operation is performed by selecting the point table.
- Operation example (absolute position command)

| Point table | Position data [before electronic gear] | Maximum speed | Acceleration time | Deceleration time | Auxiliary function | | | Table selection signal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sign | Command method | Continuous operation | RH | RM | RL |
| 1 | 1000 | 2000r/min | 1s | 1s | Plus | Absolute position | Continuous | ○ | × | × |
| 2 | 1000 | 1500r/min | 2s | 2s | Plus | Increment | Independent | × | ○ | × |
| 3 | 500 | 2000r/min | 1s | 1s | Minus | Absolute position | Independent | × | × | ○ |

(○: ON, ×: OFF)

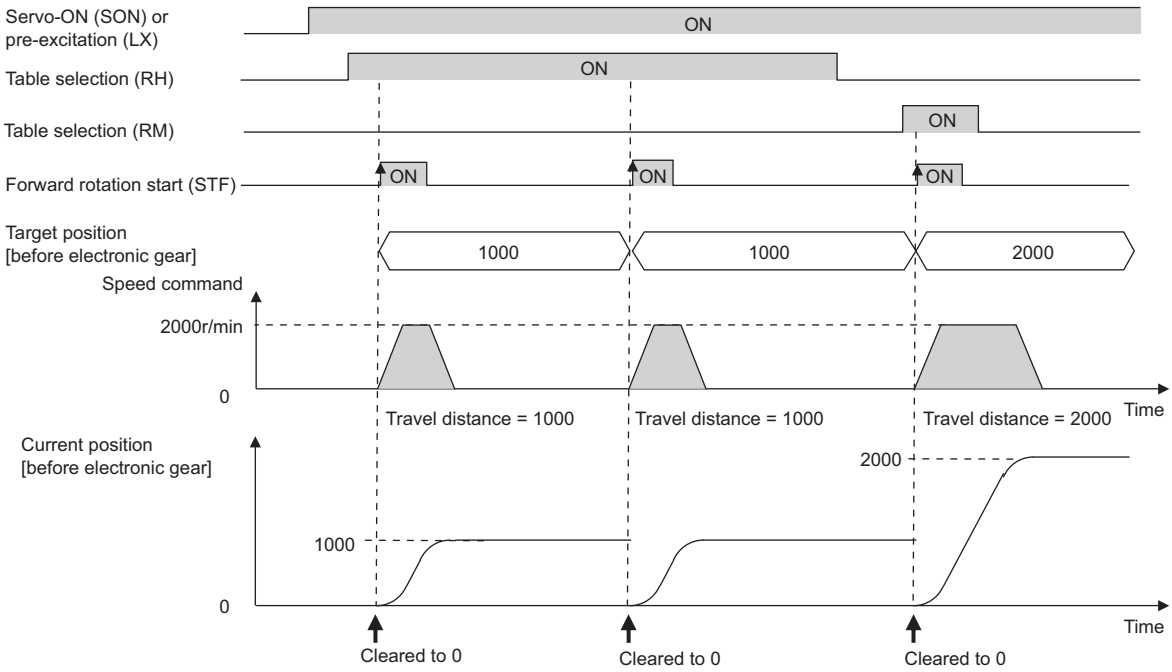


- Operation example (roll feed)

  The current position and position command are set to 0 at start, and then positioning operation is performed. Because the current position and position command are set to 0 at start, position commands are not overflowed and the repeated feed by the increment is available. (The home position return operation is not required.)

| Point table | Position data [before electronic gear] | Maximum speed | Acceleration time | Deceleration time | Auxiliary function | | | Table selection signal | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Sign | Command method | Continuous operation | RH | RM | RL |
| 1 | 1000 | 2000r/min | 1s | 1s | Plus | Increment | Independent | ○ | × | × |
| 2 | 2000 | 2000r/min | 1s | 1s | Plus | Increment | Independent | × | ○ | × |

(○: ON, ×: OFF)



**The operation panel cannot be removed from the drive unit.**

**Operation mode indicator**
PU: ON to indicate PU operation mode.
EXT: ON to indicate External operation mode.
(ON at power-ON at initial setting.)
NET: ON to indicate Network operation mode.
PU, EXT: ON to indicate External/PU combined operation mode 1, 2.
These turn OFF when command source is not on operation panel.

**Unit indicator**
- Hz: ON to indicate frequency. (Flickers when the set frequency monitor is displayed.)
- A: ON to indicate current.

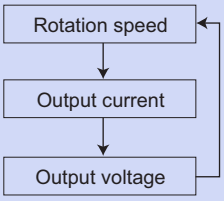
(Both "Hz" and "A" turn OFF when other than the above is displayed.)

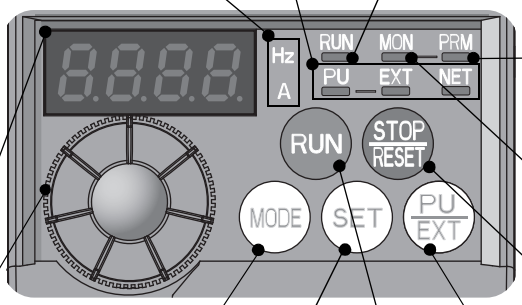
**Monitor (4-digit LED)**
Shows the speed, parameter number, etc.

**Setting dial**
(Setting dial: Mitsubishi drive unit dial)
Used to change the speed setting and parameter settings.
Press to display the following.
- Displays the set speed in the monitor mode
- Present set value is displayed during calibration
- Displays the order in the faults history mode

**Mode switchover**
Used to change each setting mode.
Pressing (PU/EXT) simultaneously changes the operation mode.
Pressing for a while (2s) can lock operation. The key lock is invalid when *Pr.161* = "0 (initial setting)".

**Determination of each setting**
If pressed during operation, the monitor changes as below;




**Operating status indication**
ON or flicker during drive unit operation. *
* ON: When the forward rotation operation is being performed.
Slow flickering (1.4s cycle): When the reverse operation is being performed.
Fast flickering (0.2s cycle): When (RUN) was pressed or the start command was given, but the operation cannot be made. (When the MRS signal is input.)

**Parameter setting mode**
ON to indicate parameter setting mode.

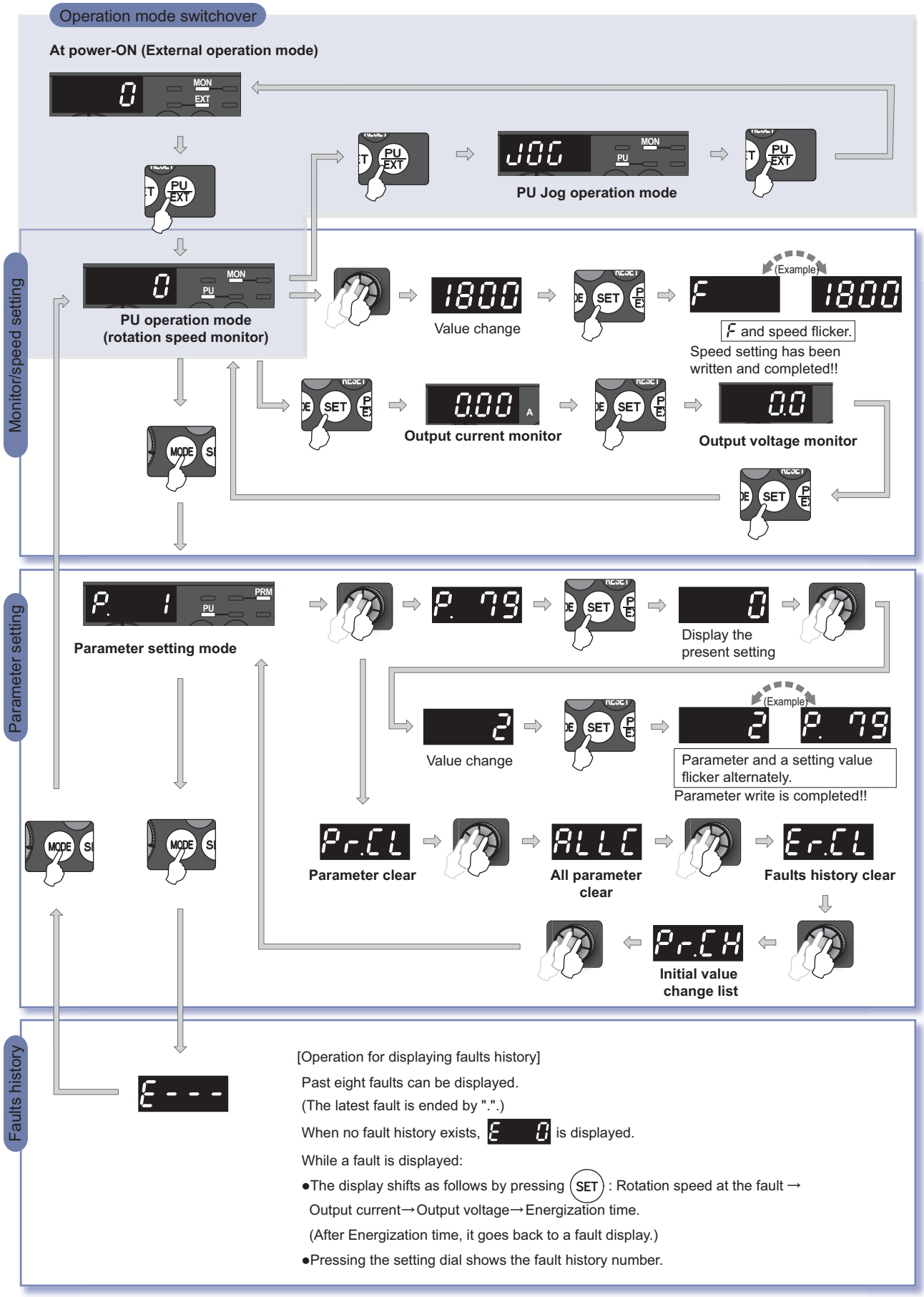
**Monitor indication**
ON to indicate monitoring mode.

**Stop operation**
Used to stop Run command.
Fault can be reset when protective function is activated (fault).

**Operation mode switchover**
Used to switch between the PU and External operation mode.
When using the External operation mode (operation using a separately connected speed setting potentiometer and start signal), press this key to light up the EXT indicator.
(Press (MODE) simultaneously (0.5s) or change, *Pr.79* setting to change to combined mode .)
PU: PU operation mode
EXT: External operation mode. Cancels PU stop also.

**Start command**
The rotation direction can be selected by setting *Pr.40*.

# Basic operation of the operation panel



## Parameter unit (FR-PU07)

- The parameter unit is a convenient tool for drive unit setting such as direct input with a numeric keypad, operation status indication, and help function.
- Parameter setting values of maximum of three drive units can be stored.

∗ The parameter unit connection cable FR-CB20☐ is required for connecting to the drive unit.

FR-PU07

**POWER lamp**
ON when the power is supplied.

**Monitor**
- Liquid crystal display (16 characters × 4 lines with backlight)
- Interactive parameter setting
- Trouble shooting guidance
- Monitor (frequency, current, power, etc.)

**ALARM lamp**
Turns ON to indicate a drive unit alarm occurrence.

**Operation keys**
(Refer to the table on the right.)

| Key | Description |
|---|---|
| PrSET | Used for parameter setting.<br>Press to choose the parameter setting mode. |
| MON | First priority monitor is displayed.<br>In the initial setting, the output frequency is displayed. |
| ESC | Operation cancel key |
| FUNC | Used to display the function menu.<br>A variety of functions can be used on the function menu. |
| SHIFT | Used to shift to the next item in the setting or monitoring mode. |
| 0 to 9 | Used to enter a frequency, parameter number or set value. |
| EXT | Drive unit operates in the External operation mode. |
| PU | Used to select the PU operation mode to display the frequency setting screen. |
| ▲ ▼ | · Used to keep on increasing or decreasing the running frequency. Hold down to vary the frequency.<br>· Press either of these keys on the parameter setting mode screen to change the parameter setting value sequentially.<br>· On the setting screen, these keys are used to move the cursor.<br>· Hold down SHIFT and press either of these keys to advance or return the display screen one page. |
| FWD | Forward rotation command key. |
| REV | Reverse rotation command key. |
| STOP RESET | · Stop command key.<br>· Used to reset the drive unit when an alarm occurs. |
| WRITE | · Used to write a set value in the setting mode.<br>· Used as a clear key in the all parameter clear or alarm history clear mode. |
| • READ | · Used as a decimal point when entering numerical value.<br>· Used as a parameter number read key in the setting mode.<br>· Used as an item select key on the menu screen such as parameter list or monitoring list.<br>· Used as an alarm definition display key in the alarm history display mode.<br>· Used as a command voltage read key in the calibration mode. |

●Main functions

| Function | Description |
|---|---|
| Monitor | 6 types of monitors appear by simply pressing SHIFT . |
| Speed setting | For PU operation mode and External/PU combined operation mode *(Pr.79 ="3")*, speed setting is available.<br>Settings are performed by the direct setting, which sets speed directly by 0 to 9 , and the step setting, which sets speed continuously by ▲ ▼ . |
| Parameter Setting | Reading parameter and changing setting values are easily done. To change the setting value of an parameter, specify the parameter number, or select a parameter from the functional parameter list. |
| Batch copy | FR-PU07 reads parameter settings of a drive unit, and stores three different parameter settings.<br>FR-PU07 can also copy the stored parameter setting to another drive unit of the same series, or verify its stored parameter setting against the parameter setting stored in a drive unit. |
| Operation | Switching between External operation mode [EXT] and PU operation mode [PU] is easy.<br>Start/stop is enabled during PU operation mode and External/PU operation mode *(Pr.79 ="3")*. |

∗ Available function differs by the drive unit. Please refer to the instruction manual of the drive unit and the parameter unit.

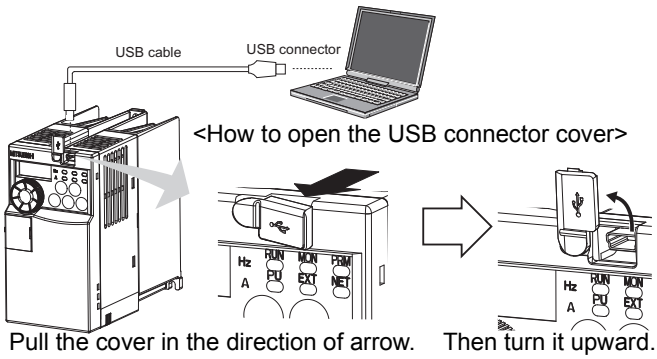
## FR-SW3-SETUP-WE

**(Microsoft® Windows® 2000 Professional SP4 or later, XP Home Edition SP2 or later, XP Professional SP2 or later Windows Vista® SP1 or later, Windows®7 supported)**

FR Configurator is software offers an easy operating environment.
It can be utilized effectively from drive unit setting up to maintenance.
(Some functions of FR Configurator may not support the FR-E700EX.)
Parameter setting, monitoring, etc. can be performed on a display of Windows *1 personal computer.
A personal computer and a drive unit can be easily connected with a USB cable.
(RS-485 communication *2 using PU connector is also available.)
The drive unit on the CC-Link Network can be set via a programmable controller. (FR-SW3-SETUP-WE (CC-Link Seamless))

MITSUBISHI
Integrated FA Software
MELSOFT

**FR Configurator**


*1 Microsoft, Windows, Microsoft Windows2000, Microsoft Windows XP, Microsoft Windows Vista are registered trademarks of Microsoft Corporation in the United States and/or other countries.
*2 RS-485⇔RS-232C converter is required.

### Startup

Desired function can be performed just after a start-up of the software.
(1) Open the recently used System File
(2) Perform Easy Setup
(3) Perform each function
(4) Help


### Easy setup

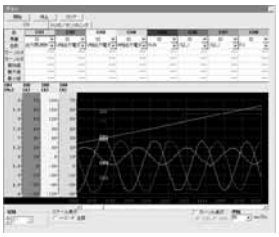
From station number to parameter setting, setting with wizard style dialog (interactive) is available.
Procedure for Easy Setup
(1) System File setting
(2) Communication setting
(3) Drive unit recognition
(4) Control method selection
(5) Motor setting
(6) Start command, frequency command setting
(7) Parameter setting

### Navigation area

In Navigation area, switching ONLINE/OFFLINE and changing operation mode can be performed.
(1) Frequency setting and forward/reverse rotation * [Test operation]
(2) Display the connected drive unit in tree view [System List]
(3) Function setting without regard to parameter number [Basic setting]
(4) Estimates the cause of trouble, and suggest counteraction. [Troubleshooting]*

### Monitor area

In Monitor area, drive unit status can be monitored. Additionally, the three-phase motor current waveform and position control can be monitored.
(1) Displays monitor data in waveform. Displays current waveform with High Speed graph function [Graph].*
(2) Monitors the status of I/O terminals. [I/O Terminal Monitor]
(3) Displays multiple data in batch. [Batch Monitor]



### System area

In System area, parameter setting, Diagnosis, Troubleshooting, etc. can be performed.
(1) Parameter reading, writing, verification, Functional List and Individual List display are available [Parameter List].
(2) Displays faults history and monitor value at each fault occurrence. [Diagnosis]
(3) Parameter setting conversion from conventional models [Convert].*

### Setting wizard

Setting wizard can set parameters with wizard style dialog (interactive). Inputting or selecting required items for each function, and parameter setting can be made, without regard to parameter number.

### Help

Displays operating instructions and details of each parameters.

* This function is not available with FR-SW3-SETUP-WE (CC-Link Seamless).

FR-SW3-SETUP-WE is available for download (free of charge) from the below URL on the Internet. FR Configurator SW3 (FR-SW3-SETUP-WE or FR-SW1-SETUP-WE) needs to be installed to the personal computer prior to updating the software. Also, user registration is required for the download (Registration is free of charge.)
URL http://www.MitsubishiElectric.co.jp/fa/

For simple variable-speed operation of the drive unit, the initial setting of the parameters may be used as they are. Set the necessary parameters to meet the load and operational specifications. Parameter setting, change and check can be made from the operation panel. For details of parameters, refer to the instruction manual.

**REMARKS**

- ◎ indicates simple mode parameters. (initially set to extended mode)
- The shaded parameters in the table allow its setting to be changed during operation even if "0" (initial value) is set in *Pr.77 Parameter write selection* .

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Basic functions | ◎ 1 | Maximum setting | 0 to 4800r/min | 1r/min | 3000r/min | |
| | ◎ 2 | Minimum setting | 0 to 4800r/min | 1r/min | 0r/min | |
| | ◎ 4 | Multi-speed setting (high speed) | 0 to 4800r/min | 1r/min | 3000r/min | |
| | ◎ 5 | Multi-speed setting (middle speed) | 0 to 4800r/min | 1r/min | 1500r/min | |
| | ◎ 6 | Multi-speed setting (low speed) | 0 to 4800r/min | 1r/min | 300r/min | |
| | ◎ 7 | Acceleration time | 0 to 360s | 0.01s | 5s | |
| | ◎ 8 | Deceleration time | 0 to 360s | 0.01s | 5s | |
| | ◎ 9 | Electronic thermal O/L relay | 0 to 500A | 0.01A | Rated motor current | |
| DC injection brake | 10 | Coasting speed | 0 to 4800r/min | 1r/min | 90r/min | |
| | 11 | DC injection brake operation time | 0 to 10s | 0.1s | 0.5s | |
| — | 13 | Starting speed | 0 to 4800r/min | 1r/min | 15r/min | |
| JOG operation | 15 | Jog speed setting | 0 to 4800r/min | 1r/min | 150r/min | |
| | 16 | Jog acceleration/deceleration time | 0 to 360s | 0.01s | 0.5s | |
| — | 17 | MRS input selection | 0, 2, 4 | 1 | 0 | |
| Acceleration/ deceleration time | 20 | Acceleration/deceleration reference speed | 12 to 4800r/min | 1r/min | 3000r/min | |
| Torque limit | 22 | Torque limit level | 0 to 200% | 0.1% | 200% | |
| Multi-speed setting | 24 | Multi-speed setting (speed 4) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 25 | Multi-speed setting (speed 5) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 26 | Multi-speed setting (speed 6) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 27 | Multi-speed setting (speed 7) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| — | 29 | Acceleration/deceleration pattern selection | 0, 1, 2 | 1 | 0 | |
| — | 30 | Regenerative function selection | 0, 1 | 1 | 0 | |
| Speed jump | 31 | Speed jump 1A | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 32 | Speed jump 1B | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 33 | Speed jump 2A | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 34 | Speed jump 2B | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 35 | Speed jump 3A | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 36 | Speed jump 3B | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| — | 37 | Speed display | 0, 0.01 to 9998 | 0.001 | 0 | |
| — | 40 | RUN key rotation direction selection | 0, 1 | 1 | 0 | |
| Speed detection | 41 | Up-to-speed sensitivity | 0 to 100% | 0.1% | 10% | |
| | 42 | Speed detection | 0 to 4800r/min | 1r/min | 180r/min | |
| | 43 | Speed detection for reverse rotation | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| Second functions | 44 | Second acceleration/deceleration time | 0 to 360s | 0.01s | 5s | |
| | 45 | Second deceleration time | 0 to 360s, 9999 | 0.01s | 9999 | |
| | 48 | Second torque limit level | 0 to 200%, 9999 | 0.1% | 9999 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Monitor functions | 52 | DU/PU main display data selection | 0, 5, 8 to 12, 14, 19, 20, 23 to 31, 36, 37, 52 to 55, 61, 62, 100 | 1 | 0 | |
| | 54 | FM terminal function selection | 1 to 3, 5, 8 to 12, 14, 21, 24, 36, 37, 52, 53, 61, 62 | 1 | 1 | |
| | 55 | Speed monitoring reference | 0 to 4800r/min | 1r/min | 3000r/min | |
| | 56 | Current monitoring reference | 0 to 500A | 0.01c | Rated motor current | |
| — | 59 | Remote function selection | 0, 1, 2, 3 | 1 | 0 | |
| — | 65 | Retry selection | 0 to 5 | 1 | 0 | |
| Retry | 67 | Number of retries at fault occurrence | 0 to 10, 101 to 110 | 1 | 0 | |
| | 68 | Retry waiting time | 0.1 to 360s | 0.1s | 1s | |
| | 69 | Retry count display erase | 0 | 1 | 0 | |
| — | 70 | Special regenerative brake duty | 0 to 30% | 0.1% | 0% | |
| — | 73 | Analog input selection | 0, 1, 10, 11 | 1 | 1 | |
| — | 74 | Input filter time constant | 0 to 8 | 1 | 1 | |
| — | 75 | Reset selection/disconnected PU detection/PU stop selection | 0 to 3, 14 to 17 | 1 | 14 | |
| — | 77 | Parameter write selection | 0, 1, 2 | 1 | 0 | |
| — | 78 | Reverse rotation prevention selection | 0, 1, 2 | 1 | 0 | |
| — | ◎ 79 | Operation mode selection | 0, 1, 2, 3, 4, 6, 7 | 1 | 0 | |
| Home position return | 110 | Acceleration time for home position return | 0.01 to 360s | 0.01s | 5s | |
| | 111 | Deceleration time for home position return | 0.01 to 360s | 0.01s | 5s | |
| PU connector communication | 117 | PU communication station number | 0 to 31 (0 to 247) | 1 | 0 | |
| | 118 | PU communication speed | 48, 96, 192, 384 | 1 | 192 | |
| | 119 | PU communication stop bit length | 0, 1, 10, 11 | 1 | 1 | |
| | 120 | PU communication parity check | 0, 1, 2 | 1 | 2 | |
| | 121 | Number of PU communication retries | 0 to 10, 9999 | 1 | 1 | |
| | 122 | PU communication check time interval | 0, 0.1 to 999.8s, 9999 | 0.1s | 0 | |
| | 123 | PU communication waiting time | 0 to 150ms, 9999 | 1 | 9999 | |
| | 124 | PU communication CR/LF selection | 0, 1, 2 | 1 | 1 | |
| — | ◎ 125 | Terminal 2 speed setting gain speed | 0 to 4800r/min | 1r/min | 3000r/min | |
| — | ◎ 126 | Terminal 4 speed setting gain speed | 0 to 4800r/min | 1r/min | 3000r/min | |
| PID operation | 127 | PID control automatic switchover speed | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 128 | PID action selection | 0, 20, 21, 50, 51, 60, 61 | 1 | 0 | |
| | 129 | PID proportional band | 0.1 to 1000%, 9999 | 0.1% | 100% | |
| | 130 | PID integral time | 0.1 to 3600s, 9999 | 0.1s | 1s | |
| | 131 | PID upper limit | 0 to 100%, 9999 | 0.1% | 9999 | |
| | 132 | PID lower limit | 0 to 100%, 9999 | 0.1% | 9999 | |
| | 133 | PID action set point | 0 to 100%, 9999 | 0.01% | 9999 | |
| | 134 | PID differential time | 0.01 to 10s, 9999 | 0.01s | 9999 | |
| — | 144 | Speed setting switchover | 2, 4, 6, 8, 10, 102, 104, 106, 108, 110 | 1 | 110 | |
| — | 147 | Acceleration/deceleration time switching speed | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| Current detection | 150 | Output current detection level | 0 to 200% | 0.1% | 150% | |
| | 151 | Output current detection signal delay time | 0 to 10s | 0.1s | 0s | |
| | 152 | Zero current detection level | 0 to 200% | 0.1% | 5% | |
| | 153 | Zero current detection time | 0 to 1s | 0.01s | 0.5s | |
| — | 156 | Torque limit selection | 0 to 31, 100, 101 | 1 | 0 | |
| — | 157 | OL signal output timer | 0 to 25s, 9999 | 0.1s | 0s | |
| — | ◎ 160 | Extended function display selection | 0, 9999 | 1 | 0 | |
| — | 161 | Speed setting/key lock operation selection | 0, 1, 10, 11 | 1 | 0 | |
| — | 168 | Parameter for manufacturer setting. Do not set. | | | | |
| — | 169 | | | | | |
| Cumulative monitor clear | 170 | Watt-hour meter clear | 0, 10, 9999 | 1 | 9999 | |
| | 171 | Operation hour meter clear | 0, 9999 | 1 | 9999 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Input terminal function assignment | 178 | STF terminal function selection | 0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 30, 44, 60, 62, 65 to 67, 76, 86 to 89, 9999 | 1 | 60 | |
| | 179 | STR terminal function selection | 0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 44, 60, 61, 65 to 67, 76, 86 to 89, 9999 | 1 | 61 | |
| | 180 | RL terminal function selection | 0 to 5, 7, 8, 10, 12, 14, 16, 23 to 25, 29, 44, 62, 65 to 67, 76, 86 to 89, 9999 | 1 | 0 | |
| | 181 | RM terminal function selection | | 1 | 1 | |
| | 182 | RH terminal function selection | | 1 | 2 | |
| | 183 | RT terminal function selection | | 1 | 24 | |
| | 184 | AU terminal function selection | | 1 | 62 | |
| Output terminal function assignment | 190 | RUN terminal function selection | 0, 1, 3, 4, 7, 8, 11 to 16, 21, 24, 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124, 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 190, 191, 193, 195, 196, 198, 199, 9999 | 1 | 0 | |
| | 191 | FU terminal function selection | | 1 | 4 | |
| | 192 | ABC terminal function selection | 0, 1, 3, 4, 7, 8, 11 to 16, 21, 24, 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 90, 91, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124, 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 190, 191, 195, 196, 198, 199, 9999 | 1 | 99 | |
| Multi-speed setting | 232 | Multi-speed setting (speed 8) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 233 | Multi-speed setting (speed 9) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 234 | Multi-speed setting (speed 10) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 235 | Multi-speed setting (speed 11) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 236 | Multi-speed setting (speed 12) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 237 | Multi-speed setting (speed 13) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 238 | Multi-speed setting (speed 14) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| | 239 | Multi-speed setting (speed 15) | 0 to 4800r/min, 9999 | 1r/min | 9999 | |
| — | 241 | Analog input display unit switchover | 0, 1 | 1 | 0 | |
| — | 249 | Earth (ground) fault detection at start | 0, 1 | 1 | 0 | |
| — | 250 | Stop selection | 0 to 100s, 1000 to 1100s, 8888, 9999 | 0.1s | 9999 | |
| — | 251 | Output phase loss protection selection | 0, 1 | 1 | 1 | |
| Life diagnosis | 255 | Life alarm status display | (0 to 15) | 1 | 0 | |
| | 256 | Inrush current limit circuit life display | (0 to 100%) | 1% | 100% | |
| | 257 | Control circuit capacitor life display | (0 to 100%) | 1% | 100% | |
| | 258 | Main circuit capacitor life display | (0 to 100%) | 1% | 100% | |
| | 259 | Main circuit capacitor life measuring | 0, 1 (2, 3, 8, 9) | 1 | 0 | |
| — | 267 | Terminal 4 input selection | 0, 1, 2 | 1 | 0 | |
| — | 268 | Monitor decimal digits selection | 0, 1, 9999 | 1 | 9999 | |
| — | 269 | Parameter for manufacturer setting. Do not set. | | | | |
| — | 285 | Excessive speed deviation detection speed | 0 to 360r/min, 9999 | 1r/min | 9999 | |
| — | 295 | Magnitude of speed change setting | 0, 0.01, 0.1, 1, 10 | 0.01 | 0 | |
| Password function | 296 | Password lock level | 0 to 6, 100 to 106, 9999 | 1 | 9999 | |
| | 297 | Password lock/unlock | (0 to 5), 1000 to 9998, 9999 | 1 | 9999 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Digital output | 313 | DO0 output selection | 0, 1, 3, 4, 7, 8, 11 to 16, 21, 24, 26, 33, 36, 38, 47, 55, 56, 60, 61, 63, 64, 90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 121, 124, 126, 133, 136, 138, 147, 155, 156, 160, 161, 163, 164, 190, 191, 193, 195, 196, 198, 199, 9999 | 1 | 9999 | |
| | 314 | DO1 output selection | | 1 | 9999 | |
| | 315 | DO2 output selection | | 1 | 9999 | |
| RS-485 communication | 338 | Communication operation command source | 0, 1 | 1 | 0 | |
| | 339 | Communication speed command source | 0, 1, 2 | 1 | 0 | |
| | 340 | Communication startup mode selection | 0, 1, 10 | 1 | 0 | |
| | 342 | Communication EEPROM write selection | 0, 1 | 1 | 0 | |
| | 343 | Communication error count | — | 1 | 0 | |
| — | 349 | Communication reset selection | 0, 1 | 1 | 0 | |
| — | 374 | Overspeed detection level | 0 to 4800r/min | 1r/min | 3450r/min | |
| — | 375 | Faulty acceleration rate detection level | 0 to 4800r/min, 9999 | 1r/min/ms | 9999 | |
| Position control | 420 | Command pulse multiplication numerator (electronic gear numerator) | 1 to 32767 | 1 | 1 | |
| | 421 | Command pulse multiplication denominator (electronic gear denominator) | 1 to 32767 | 1 | 1 | |
| | 422 | Position control gain | 0 to 150sec$^{-1}$ | 1sec$^{-1}$ | 20sec$^{-1}$ | |
| | 423 | Position feed forward gain | 0 to 100% | 1% | 0% | |
| | 426 | In-position width | 0 to 32767 pulses | 1 pulse | 100 pulses | |
| | 427 | Excessive level error | 0 to 400K pulses | 1K pulse | 40K pulses | |
| | 430 | Pulse monitor selection | 4, 5, 100 to 105, 9999 | 1 | 9999 | |
| | 446 | Model position control gain | 0 to 150sec$^{-1}$ | 1sec$^{-1}$ | 0sec$^{-1}$ | |
| | 453 | High speed during home position return | 0 to 4800r/min | 1r/min | 300r/min | |
| | 455 | Home position return shifting speed | 0 to 4800r/min | 1r/min | 1500r/min | |
| | 463 | Position control rotation direction selection | 0, 1 | 1 | 0 | |
| | 464 | Digital position control sudden stop deceleration time | 0.01 to 360s | 0.01s | 0.01s | |
| | 465 | First target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 466 | First target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 467 | Second target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 468 | Second target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 469 | Third target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 470 | Third target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 471 | Fourth target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 472 | Fourth target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 473 | Fifth target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 474 | Fifth target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 475 | Sixth target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 476 | Sixth target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| | 477 | Seventh target position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 478 | Seventh target position upper 4 digits | 0 to 9999 | 1 | 0 | |
| Remote output | 495 | Remote output selection | 0, 1, 10, 11 | 1 | 0 | |
| | 496 | Remote output data 1 | 0 to 4095 | 1 | 0 | |
| Communication error | 500 | Communication error execution waiting time | 0 to 999.8s | 0.1s | 0s | |
| | 501 | Communication error occurrence count display | 0 | 1 | 0 | |
| | 502 | Stop mode selection at communication error | 0, 1, 2, 3 | 1 | 0 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Maintenance | 503 | Maintenance timer | 0 (1 to 9998) | 1 | 0 | |
| | 504 | Maintenance timer alarm output set time | 0 to 9998, 9999 | 1 | 9999 | |
| Positioning adjustment | 506 | Position detection hysteresis width | 0 to 32767 | 1 | 0 | |
| | 507 | Rough match output range | 0 to 32767 | 1 | 0 | |
| Home position return | 508 | Home position shift amount lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 509 | Home position shift amount upper 4 digits | 0 to 9999 | 1 | 0 | |
| Positioning adjustment | 510 | Position detection lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 511 | Position detection upper 4 digits | 0 to 9999 | 1 | 0 | |
| Stopper control | 512 | Stopper control function selection | 0, 1, 10, 11, 12 | 1 | 0 | |
| | 513 | Stopper control torque limit | 0 to 200% | 1% | 40% | |
| | 514 | Stopper control switchover position lower 4 digits | 0 to 9999 | 1 | 0 | |
| | 515 | Stopper control switchover position upper 4 digits | 0 to 9999 | 1 | 0 | |
| Position control | 525 | First positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 526 | Second positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 527 | Third positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 528 | Fourth positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 529 | Fifth positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 530 | Sixth positioning sub-function | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 10 | |
| | 531 | Seventh positioning sub-function | 0, 10, 100, 110 | 1 | 10 | |
| | 532 | Home position return selection | 2, 3, 4, 6 | 1 | 4 | |
| | 533 | Home position return stopper torque | 0 to 200% | 0.1% | 40% | |
| | 534 | Home position return stopper duration | 0 to 10s | 0.1s | 0.5s | |
| | 535 | Position control terminal input selection | 0, 1, 10, 11, 100, 101, 110, 111 | 1 | 0 | |
| | 536 | Position detection selection | 0, 1, 2 | 1 | 0 | |
| | 537 | Roll feed mode selection | 0, 1 | 1 | 0 | |
| CC-Link | 541 | Frequency command sign selection (CC-Link) | 0, 1 | 1 | 0 | |
| | 542 | Communication station number (CC-Link) | 1 to 64 | 1 | 1 | |
| | 543 | Baud rate selection (CC-Link) | 0 to 4 | 1 | 0 | |
| | 544 | CC-Link extended setting | 0, 1, 12, 14, 18 | 1 | 0 | |
| USB | 547 | USB communication station number | 0 to 31 | 1 | 0 | |
| | 548 | USB communication check time interval | 0 to 999.8s, 9999 | 0.1s | 9999 | |
| Communication | 549 | Protocol selection | 0, 1 | 1 | 0 | |
| | 550 | NET mode operation command source selection | 0, 2, 9999 | 1 | 9999 | |
| | 551 | PU mode operation command source selection | 2 to 4, 9999 | 1 | 9999 | |
| Current average time monitor | 555 | Current average time | 0.1 to 1.0s | 0.1s | 1s | |
| | 556 | Data output mask time | 0 to 20s | 0.1s | 0s | |
| | 557 | Current average value monitor signal output reference current | 0 to 500A | 0.01A | Rated motor current | |
| — | 563 | Energization time carrying-over times | (0 to 65535) | 1 | 0 | |
| — | 564 | Operating time carrying-over times | (0 to 65535) | 1 | 0 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Position control | 578 | First positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 579 | First positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 580 | Second positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 581 | Second positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 582 | Third positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 583 | Third positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 584 | Fourth positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 585 | Fourth positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 586 | Fifth positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 587 | Fifth positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 588 | Sixth positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 589 | Sixth positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 590 | Seventh positioning acceleration time | 0.01 to 360s | 0.01s | 5s | |
| | 591 | Seventh positioning deceleration time | 0.01 to 360s | 0.01s | 5s | |
| — | 665 | Regeneration avoidance speed gain | 0 to 200% | 0.1% | 100% | |
| Adjustment function | 698 | Speed control D gain | 0 to 100% | 0.1% | 0% | |
| | 730 | Speed estimation P gain | 0 to 300%, 9999 | 1% | 9999 | |
| — | 736 | Electromagnetic brake interlock time | 0 to 1s | 0.01s | 0s | |
| Acceleration/ deceleration time | 791 | Acceleration time in low-speed range | 0 to 360s, 9999 | 0.01s | 9999 | |
| | 792 | Deceleration time in low-speed range | 0 to 360s, 9999 | 0.01s | 9999 | |
| — | 800 | Control method selection | 9, 10, 13 | 1 | 10 | |
| — | 802 | Pre-excitation selection (brake operation selection) | 0, 1 | 1 | 0 | |
| Adjustment function | 820 | Speed control P gain | 0 to 1000% | 1% | 100% | |
| | 821 | Speed control integral time | 0 to 20s | 0.001s | 0.2s | |
| | 824 | Torque control P gain | 0 to 200%, 9999 | 1% | 9999 | |
| | 825 | Torque control integral time | 0 to 50ms, 9999 | 0.1ms | 9999 | |
| — | 828 | Model speed control gain | 0 to 1000% | 1% | 60% | |
| — | 853 | Speed deviation time | 0 to 100s | 0.1s | 1s | |
| Additional function | 862 | Notch filter time constant | 0, 10 to 625Hz | 1Hz | 0 | |
| | 863 | Notch filter depth | 0 to 3 | 1 | 0 | |
| — | 870 | Speed detection hysteresis | 0 to 180r/min | 1r/min | 15r/min | |
| — | 871 | Notch filter width | 0 to 3 | 1 | 0 | |
| Protective functions | 872 | Input phase loss protection selection | 0, 1 | 1 | 0 | |
| Control system function | 877 | Feed forward control/model adaptive control selection | 0 to 2 | 1 | 0 | |
| | 878 | Speed feed forward filter | 0 to 1s | 0.01s | 0s | |
| | 879 | Speed feed forward torque limit | 0 to 400% | 0.1% | 150% | |
| | 880 | Load inertia ratio | 0 to 200 times | 0.1 times | 7 times | |
| | 881 | Speed feed forward gain | 0 to 1000% | 1% | 0% | |
| Regeneration avoidance function | 882 | Regeneration avoidance operation selection | 0, 1, 2 | 1 | 0 | |
| | 883 | Regeneration avoidance operation level | 300 to 800V | 0.1V | 400VDC | |
| | 885 | Regeneration avoidance compensation speed limit value | 0 to 540r/min, 9999 | 1r/min | 180r/min | |
| | 886 | Regeneration avoidance voltage gain | 0 to 200% | 0.1% | 100% | |
| Free parameter | 888 | Free parameter 1 | 0 to 9999 | 1 | 9999 | |
| | 889 | Free parameter 2 | 0 to 9999 | 1 | 9999 | |

| Function | Parameter | Name | Setting Range | Minimum Setting Increments | Initial Value | Customer Setting |
|---|---|---|---|---|---|---|
| Calibration parameters | C0 (900) *2 | FM terminal calibration | — | — | — | |
| | C2 (902) *2 | Terminal 2 speed setting bias speed | 0 to 4800r/min | 1r/min | 0r/min | |
| | C3 (902) *2 | Terminal 2 speed setting bias | 0 to 300% | 0.1% | 0% | |
| | 125 (903) *2 | Terminal 2 speed setting gain speed | 0 to 4800r/min | 1r/min | 3000r/min | |
| | C4 (903) *2 | Terminal 2 speed setting gain | 0 to 300% | 0.1% | 100% | |
| | C5 (904) *2 | Terminal 4 speed setting bias speed | 0 to 4800r/min | 1r/min | 0r/min | |
| | C6 (904) *2 | Terminal 4 speed setting bias | 0 to 300% | 0.1% | 20% | |
| | 126 (905) *2 | Terminal 4 speed setting gain speed | 0 to 4800r/min | 1r/min | 3000r/min | |
| | C7 (905) *2 | Terminal 4 speed setting gain | 0 to 300% | 0.1% | 100% | |
| PU | 990 | PU buzzer control | 0, 1 | 1 | 1 | |
| | 991 | PU contrast adjustment | 0 to 63 | 1 | 58 | |
| — | 997 | Fault initiation | 16 to 18, 32 to 34, 48, 49, 64, 82, 96, 97, 112, 128, 129, 144, 160, 161, 176 to 179, 192, 197, 199 to 201, 208, 209, 211, 221, 241, 246, 247, 253, 9999 | 1 | 9999 | |
| Clear parameters Initial value change list | Pr.CL | Parameter clear | 0, 1 | 1 | 0 | |
| | ALLC | All parameter clear | 0, 1 | 1 | 0 | |
| | Er.CL | Faults history clear | 0, 1 | 1 | 0 | |
| | Pr.CH | Initial value change list | — | — | — | |

*1 Writing is disabled during the communication via the PU connector (Network operation mode).

*2 The parameter number in parentheses is the one for use with the parameter unit (FR-PU07).

*3 Communication parameters that are not cleared by parameter clear (all clear) via the RS-485 communication. (For the RS-485 communication, refer to the Instruction Manual.)

*4 When a communication option is installed, parameter clear (lock release) during password lock (*Pr.297* ≠ "9999") can be performed only from the communication option.

**REMARKS**

- The unit for parameter setting and its setting range can be changed from "r/min" to "Hz". Use *Pr.144* to change the setting.
- With operation panel, the value up to 9999 can be set. With parameter unit (FR-PU07), up to the highest value in the setting range can be set.
- A value exceeding 3000r/min can be also set, but the actual operation will be limited at 3000r/min, which is the upper speed limit of the motor.

When a fault occurs, the drive unit trips and the PU display automatically changes to one of the following fault or alarm indications.
The error message shows an operational error. It does not trip the drive unit.
Warnings are messages given before faults occur. It does not trip the drive unit.
When a fault occurs, a protective function is activated to trip a drive unit and output a fault signal.

| | Function Name | Description | Display |
|---|---|---|---|
| Error message | Operation panel lock | Appears when operation was tried during operation panel lock. | HOLd |
| | Password locked | Password function is active. Display and setting of parameter is restricted. | LOCd |
| | Parameter write error | Appears when an error occurred during parameter writing. | Er1 to Er4 |
| | Drive unit reset | Appears when the RES signal is on. | Err. |
| Warnings | During torque limit | Appears while the torque limit operation is being performed. | OL |
| | Stall prevention | Appears while the stall prevention or regeneration avoidance function is being performed. | oL |
| | Regenerative brake prealarm *2 | Appears if the regenerative brake duty reaches or exceeds 85% of the *Pr.70 Special regenerative brake duty* value. | rb |
| | Electronic thermal relay function prealarm *1 | Appears if the cumulative value of the electronic thermal O/L relay reaches or exceeds 85% of the preset level of *Pr.9 Electronic thermal O/L relay*. | rH |
| | PU stop | Appears when STOP/RESET on the operation panel was pressed during external operation. | PS |
| | Maintenance signal output *2 | Appears when the cumulative energization time has exceeded the maintenance output timer set value. | MT |
| | Home position return error | Appears when an error occurs during the home position return operation under position control. | HP1 HP2 |
| | Undervoltage | Appears when the main circuit power became low voltage. | UV |
| Fault | Overcurrent trip during acceleration | Appears when an overcurrent occurred during acceleration. | E.OC1 |
| | Overcurrent trip during constant speed | Appears when an overcurrent occurred during constant speed operation. | E.OC2 |
| | Overcurrent trip during deceleration or stop | Appears when an overcurrent occurred during deceleration and at a stop. | E.OC3 |
| | Regenerative overvoltage trip during acceleration | Appears when an overvoltage occurred during acceleration. | E.OV1 |
| | Regenerative overvoltage trip during constant speed | Appears when an overvoltage occurred during constant speed operation. | E.OV2 |
| | Regenerative overvoltage trip during deceleration or stop | Appears when an overvoltage occurred during deceleration and at a stop. | E.OV3 |
| | Drive unit overload trip (electronic thermal relay function) *1 | Appears when the electronic thermal relay function for drive unit element protection was activated. | E.THT |
| | Motor overload trip (electronic thermal relay function) *1 | Appears when the electronic thermal relay function for motor protection was activated. | E.THM |
| | Fin overheat | Appears when the heatsink overheated. | E.FIN |
| | Input phase loss *2 | Appears if one of the three phases on the drive unit's input side is lost. It may also appear when the input powers to the three phases are largely unbalanced. | EI LF |
| | Stop by the torque limit | Appears when the rotation speed drops to 18r/min as a result of deceleration due to the excess motor load. | E.OLT |
| | Loss of synchronism detection | Appears when the operation is not synchronized or is performed with no motor connected. | E.SOT |
| | Brake transistor alarm detection | This function stops the drive unit output if an alarm occurs in the brake circuit, e.g. damaged brake transistors. In this case, the drive unit must be powered off immediately. | E. bE |
| | Output side earth (ground) fault overcurrent *2 | Appears when an earth (ground) fault occurred on the drive unit's output side. (detects only at a start) | E. GF |
| | Output phase loss | While the drive unit is running, the drive unit trips if one of the three phases (U, V, and W) on the output side of the drive unit is lost. | E. LF |
| | External thermal relay operation *2 | Appears when the external thermal relay connected to the terminal OH operated. | E.OHT |
| | Option fault | Appears when a communication option is connected while *Pr.296 Password lock level* ="0 or 100". | E.OPT |
| | Communication option fault | Appears when a communication line error occurs in the communication option. | E.OP1 |
| | Option fault | Appears when a contact fault or the like of the connector between the drive unit and plug-in option occurs. | E. 1 |
| | Parameter storage device fault | Appears when operation of the element where parameters stored became abnormal. (control board) | E. PE |
| | Internal board fault | When a combination of control board and main circuit board is wrong, the drive unit is tripped. | E.PE2 |
| | PU disconnection | Appears when a communication error between the PU and drive unit occurred, the communication interval exceeded the permissible time during the RS-485 communication with the PU connector, or communication errors exceeded the number of retries during the RS-485 communication. | E.PUE |
| | Retry count excess *2 | Appears when the operation was not restarted within the set number of retries. | E.RET |
| | CPU fault | Appears during the CPU and peripheral circuit errors occurred. | E. 6 E. 7 E.CPU |
| | Inrush current limit circuit fault | Appears when the resistor of the inrush current limit circuit overheated. | EI OH |
| | Analog input fault | Appears if voltage(current) is input to terminal 4 when the setting in *Pr.267 Terminal 4 input selection* and the setting of voltage/current input switch are different. | E.AI E |
| | Overspeed occurrence | Appears when the motor rotation speed exceeds the setting of *Pr.374 Overspeed detection level*. | E. OS |
| | Speed deviation excess detection | Appears when the difference between the commanded speed and the motor rotation speed stays greater than the *Pr.285 Excessive speed deviation detection speed* setting for the time set in *Pr.853 Speed deviation time*. | E.OSd |
| | Excessive position error | Appears when the difference between the position command (before the electronic gear) and the current position (after the electronic gear) has exceeded the *Pr.427 Excessive level error* under position control. | E. Od |
| | Acceleration rate error | Appears when the acceleration rate of the motor rotation speed has exceeded the setting of *Pr.375 Faulty acceleration rate detection level*. | E. OA |
| | USB communication fault | Appears when the communication has been disconnected for the time set in *Pr.548 USB communication check time interval*. | E.USb |
| | Internal circuit fault | Appears when an internal circuit error occurred. | E. 13 E.SAF |

*1 Resetting the drive unit initializes the internal thermal integrated data of the electronic thermal relay function.
*2 This protective function does not function in the initial status.

## Option list

By fitting the following options to the drive unit, the drive unit is provided with more functions.
One type of plug-in option can be mounted.

| | | Name | Model | Applications, Specifications, etc. | Applicable drive unit |
|---|---|---|---|---|---|
| Plug-in type | Communication | CC-Link communication | FR-A7NC E kit | This option allows the drive unit to be operated or monitored or the parameter setting to be changed from a programmable controller, etc. | All models |
| Stand-alone shared | | Parameter unit | FR-PU07 | Interactive parameter unit with LCD display | All models |
| | | Enclosure surface operation panel | FR-PA07 | This operation panel enables drive unit operation and monitoring of frequency, etc. from the enclosure surface | |
| | | Parameter unit connection cable | FR-CB20☐ | Cable for connection of operation panel or parameter unit.<br>☐ indicates a cable length. (1m, 3m, or 5m) | |
| | | USB cable | MR-J3USBCBL3M<br>Cable length 3m | Connector for amplifier mini-B connector (5 pin) — Connector for personal computer A connector | |
| | | DIN rail attachment | FR-UDA01 | Attachment for installation on a DIN rail | Applicable to some capacities |
| | | AC reactor | FR-HAL | For harmonic current reduction and drive unit input power factor improvement | Applicable to some capacities |
| | | DC reactor | FR-HEL | | |
| | | EMC Directive compliant noise filter | SF | EMC Directive (EN61800-3 C3) compliant noise filter | Applicable to some capacities |
| | | Radio noise filter | FR-BIF(H) | For radio noise reduction (connect to the input side) | All models |
| | | Line noise filter | FR-BSF01, FR-BLF | For line noise reduction | All models |
| | | Filterpack | FR-BFP2 | Combination of power factor improving DC reactor, common mode choke, and capacitative filter | 0.4K or higher |
| | | Brake resistor | MRS type | For increasing the regenerative braking capability (permissible duty 3%ED) | 0.4K or higher |
| | | High-duty brake resistor | FR-ABR | For increasing the regenerative braking capability (permissible duty 10%/6%ED) | 0.4K or higher |
| | | Brake unit, Resistor unit, Discharging resistor | FR-BU2, GZG type | For increasing the braking capability of the drive unit (for high-inertia load or negative load).<br>Brake unit, electrical-discharge resistor and resistor unit are used in combination. | 0.4K or higher |
| | | Power regeneration common converter<br>Stand-alone reactor dedicated for the FR-CV | FR-CV<br>FR-CVL | Unit which can return motor-generated braking energy back to the power supply in common converter system | Applicable to some capacities |
| | | High power factor converter | FR-HC2 | The high power factor converter switches the converter section on/off to reshape an input current waveform into a sine wave, greatly suppressing harmonics. (Used in combination with the standard accessory.) | |
| FR series manual controller/speed controller | | Manual controller | FR-AX | For independent operation. With a frequency meter, a frequency potentiometer and a start switch. | All models |
| | | DC tach. follower | FR-AL | For synchronous operation (1VA) by external signal (0 to 5V, 0 to 10V DC) *1 | |
| | | Three speed selector | FR-AT | For three speed switching, among high, middle and low speed operation (1.5VA) *1 | |
| | | Motorized speed setter | FR-FK | For remote operation. Allows operation to be controlled from several places (5VA). *1 | |
| | | Ratio setter | FR-FH | For ratio operation. The ratios of five drive units can be set (3VA). *1 | |
| | | Speed detector | FR-FP | For tracking operation by a pilot generator (PG) signal (3VA) *1 | |
| | | Master controller | FR-FG | Master controller (5VA) for parallel operation of multiple (maximum 35) drive units. *1 | |
| | | Soft starter | FR-FC | For soft start and stop. Enables acceleration/deceleration in parallel operation (3VA). *1 | |
| | | Deviation detector | FR-FD | For continuous speed control operation. Used in combination with a deviation sensor or synchro (5VA). *1 | |
| | | Preamplifier | FR-FA | Used as an A/V converter or arithmetic amplifier (3VA) *1 | |

| | Name | Model | Applications, Specifications, etc. | Applicable drive unit |
|---|---|---|---|---|
| Others | Power supply cable (Servo motor connection cable) | MR-PWS1CBL□M-A1-H/A1-L/A2-H/A2-L<br>MR-PWS2CBL03M-A1-L/A2-L | Cable for connecting the drive unit and motor | All models |
| | Pilot generator | QVAH-10 | For tracking operation. 70V/35VAC 500Hz (at 2500r/min) | |
| | Deviation sensor | YVGC-500W-NS | For continuous speed control operation (mechanical deviation detection). Output 90VAC/90°C | |
| | Frequency setting potentiometer | WA2W 1kΩ | For frequency setting. Wire wound 2W 1kW B characteristic | |
| | Analog frequency meter (64mm × 60mm) | YM206NRI 1mA | Dedicated frequency meter (graduated to 120Hz). Moving-coil type DC ammeter | |
| | Calibration resistor | RV24YN 10kΩ | For frequency meter calibration. Carbon film type B characteristic | |
| | FR Configurator SW3 (VFD setup software) | FR-SW3-SETUP-WE | Supports a drive unit startup to maintenance. | |

*1 Rated power consumption. The power supply specifications of the FR series manual controllers and speed controllers are 200VAC 50Hz, 220V/220VAC 60Hz, and 115VAC 60Hz.

## Stand-alone option

| Name (Model) | Specifications, Structure, etc. |
|---|---|

### Enclosure surface operation panel FR-PA07

- Enables drive unit operation and monitoring of frequency setting, etc. from the enclosure surface.
- Approximate dimension

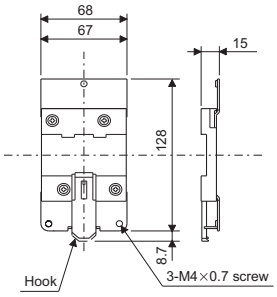
| Item | Specifications |
|---|---|
| Surrounding air temperature | -10°C to +50°C (non-freezing) |
| Ambient humidity | 90%RH or less (non-condensing) |
| Storage temperature | -20°C to +60°C |
| Atmosphere | Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt) |
| Altitude/vibration | Maximum 1,000m above sea level. 5.9m/s$^2$ or less |
| Power supply | Supplied from the drive unit. |
| Connection method | Connection using the parameter unit connection cable (FR-CB20☐) |

- Outline dimension and enclosure cut dimensions (Refer to *page 7*)

(Note)1. The operation panel cannot be removed from the drive unit.
2. The separate parameter unit connection cable (FR-CB20☐) is required.

### DIN rail mounting attachments FR-UDA01

- Supports installation of FR-E700EX series on a DIN rail.
- Approximate dimension



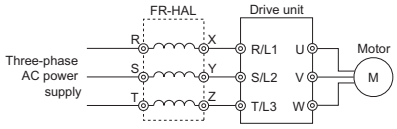

(Unit: mm)

### AC reactor (for power coordination) FR-HAL-☐K

- When installed at the input side of the drive unit, this option improves the power factor and suppresses the input side harmonic current.
- Selection method

Select an AC reactor according to the applied motor capacity.

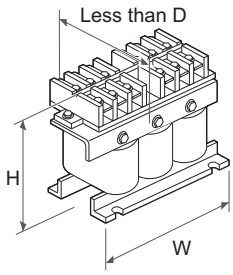
- Connection diagram




- Outline dimension

| | Model | W | D | H | Mass (kg) |
|---|---|---|---|---|---|
| 200V | 0.4K | 104 | 72 | 99 | 0.6 |
| | 0.75K | 104 | 74 | 99 | 0.8 |

(Unit: mm)




(Note)1. Make a selection according to the applied motor capacity.
2. Approximately 88% of the power factor improving effect can be obtained (92.3% when calculated with 1 power factor for the fundamental wave according to the Architectural Standard Specifications (Electrical Installation) (2013 revision) supervised by the Ministry of Land, Infrastructure, Transport and Tourism of Japan).
3. Outline dimension drawing shown is of a typical model. The shape differs according to each models.
4. Install the AC reactor (FR-HAL) on a horizontal or vertical plane.

| Name (Model) | Specifications, Structure, etc. |
|---|---|

## DC reactor (for power coordination) FR-HEL-□K

●When installed in the DC section of the drive unit, the DC reactor improves the power factor and suppresses the input side harmonic current.

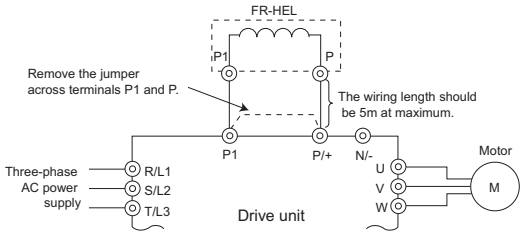
### ● Selection method

Select a DC reactor according to the applied motor capacity.

### ● Connection diagram

Connect a DC reactor to the drive unit terminals P1 and P. Before connecting, make sure to remove the jumper across the terminals P1 and P.
(If the jumper is left attached, no power factor improvement can be obtained.)

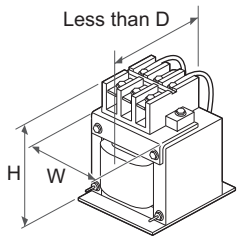
The connection cable between the reactor and the drive unit should be as short as possible (5m or less).




### ● Outline dimension

(Unit: mm)

| Model | | W | D | H | Mass (kg) |
|---|---|---|---|---|---|
| 200V | 0.4K | 70 | 61 | 71 | 0.4 |
| | 0.75K | 85 | 61 | 81 | 0.5 |

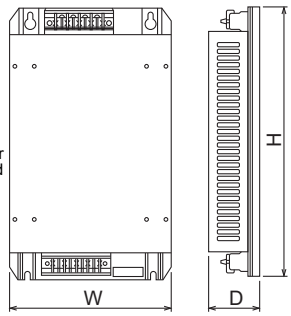



(Note)1. Be sure to remove the jumper across the drive unit terminals P/+ and P1.
(A failure to do so will produce no power factor improving effect)
2. The wiring length between the reactor and drive unit should be within 5m.
3. The size of the cables used should be equal to or larger than that of the power supply cables (R/L1, S/L2, T/L3).
4. Make a selection according to the motor capacity.
5. Approximately 93% of the power factor improving effect can be obtained (94.4% when calculated with 1 power factor for the fundamental wave according to the Architectural Standard Specifications (Electrical Installation) (2013 revision) supervised by the Ministry of Land, Infrastructure, Transport and Tourism of Japan).
6. Outline dimension drawing shown is of a typical model. The shape differs according to each models.
7. Install the DC reactor (FR-HEL) on horizontal or vertical plane.

## EMC Directive compliant EMC filter SF□

●The EMC Directive compliant EMC filter (EN61800-3 2nd Environment Category C3) is a filter compliant with the EU EMC Directive (EN61800-3 2nd Environment Category C3).

| EMC Filter Model | Intercompatibility Attachment *1 | Outline Dimension (Unit: mm) | | | Mass (kg) | Leakage Current (mA) *2 (Reference Value) | Loss (W) |
|---|---|---|---|---|---|---|---|
| | | W | H | D | | | |
| SF1306 | — | 110 | 200 | 36.5 | 0.7 | 10 | 7.3 |

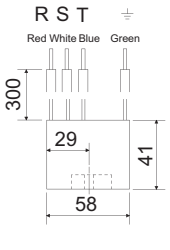



*1 Depth is 12mm deeper when an intercompatibility attachment is installed.
*2 Leakage current for one phase of three-phase three-wire star-connection power supply. Leakage current for all phases of three-phase three-wire delta-connection power supply is three times greater than the indicated value.
(Note)This is a sample outline dimension drawing. The shape differs by the model.

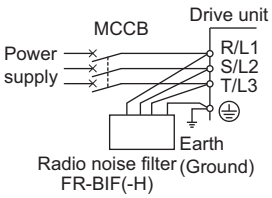
● Countermeasures for leakage current
Take the following actions to prevent malfunction of peripheral devices or an electric shock caused by leakage current.
1) Earth (ground) the EMC filter before connecting the power supply. When doing so, confirm that earthing (grounding) is securely performed through the earthing (grounding) part of the enclosure.
2) Select an appropriate earth leakage circuit breaker or an earth leakage relay by considering leakage current of the EMC filter. Note that earth leakage circuit breaker may not be used in some cases such as when leakage current of the EMC filter is too large. In that case, use an earth leakage relay with high sensitivity. When both of earth leakage circuit breaker and earth leakage relay cannot be used, securely earth (ground) as explained in 1).

## Radio noise filter FR-BIF

### ● Outline dimension




(Unit: mm)



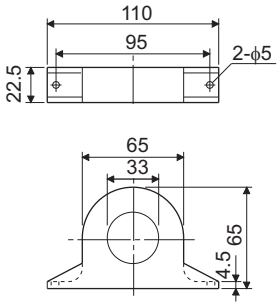

(Note) 1. Cannot be connected to the drive unit output side.
2. Wire should be cut as short as possible, and connect to the drive unit terminal block.

| Name (Model) | Specifications, Structure, etc. |
|---|---|

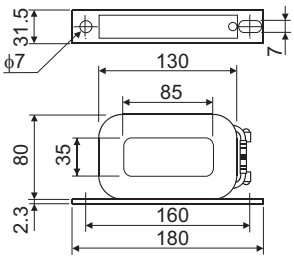
## Line noise filter FR-BSF01 (for drive units with small capacities) FR-BLF

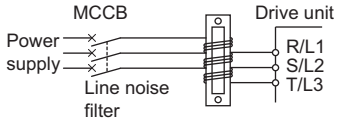
● Outline dimension

FR-BSF01




FR-BLF




(Note)1. Each phase should be wound at least 3 times (4 turns) in the same direction.
(The greater the number of turns, the more effective result is obtained.)
When using several line noise filters to make 4T or more, wind the phases(cables) together. Do not use different line noise filters for different phases.
2. When the thickness of the wire prevents winding, use at least 4 in series and ensure that the current passes through each phase in the same direction.
3. Can be used on the output side in the same way as the input side. When using a line noise filter at the output side, the filter body may heat up. Do not wind the cable more than 3 times (4T) for each line noise filter installed at the output side.
4. Use FR-BSF01 for the drive units with small capacities. Thick wires (38mm$^2$ or more) can not be used. In such cases, use the FR-BLF.
5. Do not wind an earthing (grounding) cable.

## Filterpack FR-BFP2-□K

● Using the option, the drive unit may conform to the Japanese guideline for reduction of harmonic emission.

● Specification

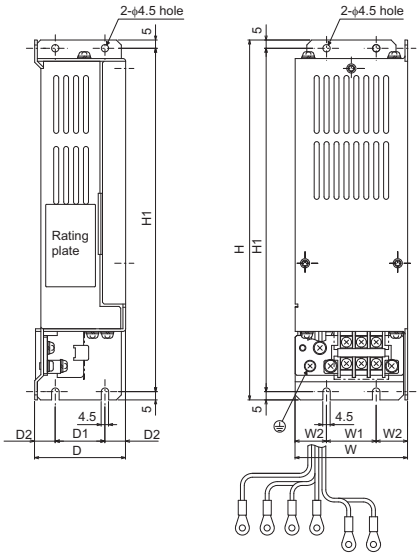
•Three-phase 200V power input model

| Model FR-BFP2-□K | | 0.4 | 0.75 |
|---|---|---|---|
| Permissible drive unit output current (A) ∗1 | | 2.5 | 4.2 |
| Approximate mass (kg) | | 1.3 | 1.4 |
| Power factor improving reactor | | Install a DC reactor on the DC side. (93% to 95% of power supply power factor under 100% load) (94.4% ∗3) | |
| Noise filter | Common mode choke | Install a ferrite core on the input side. | |
| | Capacitive filter | About 4mA of capacitor leakage current ∗2 | |
| Protective structure (JEM1030) | | Open type (IP00) | |

∗1 Select a capacity for the load (drive unit output) current to be equal to or less than the permissible drive unit output current.
∗2 The indicated leakage current is for one phase of the three-phase three-wire star-connection power supply.
∗3 The values in parentheses are calculated by applying 1 power factor to the reference wave form in accordance with the Architectural Standard Specifications (Electric Installation) (2013 revisions) in Japan.)

● Outline dimension drawing

<FR-BFP2-0.4K, 0.75K>



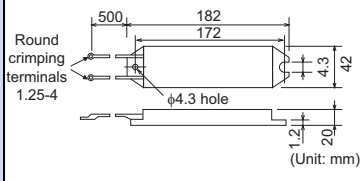

| Capacity | | W | W1 | W2 | H | H1 | D | D1 | D2 |
|---|---|---|---|---|---|---|---|---|---|
| 200V | 0.4K, 0.75K | 68 | 30 | 19 | 218 | 208 | 60 | 30 | 15 |

(Unit: mm)

(Note)1. The option can be installed to the back or to the side.
2. Above outline dimension drawings are examples. Dimensions differ by model.

## Brake resistor MRS type

● Outline dimension



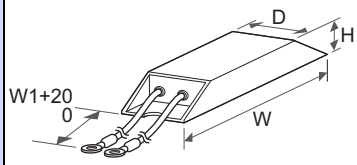

| | Resistor Model | Control Torque / Permissible Duty | Resistance Value (Ω) | Permissible Power (W) | Applicable Motor Capacity (kW) | Thermal RelayType (Mitsubishi Product) |
|---|---|---|---|---|---|---|
| 200V | MRS120W200 | 150% torque 3%ED | 200 | 15 | 0.4 | TH-N20CXHZ-0.7A |
| 200V | MRS120W100 | 150% torque 3%ED | 100 | 30 | 0.75 | TH-N20CXHZ-1.3A |

(Note)1. The temperature of the brake resistor becomes 200°C or more depending on the operation frequency, care must be taken for installation and heat dissipation.
2. The brake resistor can not be used with the 0.1K and 0.2K.
3. Do not remove the jumper across terminal P/+ and P1 except when connecting a DC reactor.

| Name (Model) | Specifications, Structure, etc. |
|---|---|

## High-duty brake resistor FR-ABR-☐K

● Outline dimension




| | Brake Resistor Model | Permissible Brake Duty | Outline Dimension W | W1 | D | H | Resistance Value (Ω) | Approx. Mass (kg) | Thermal Relay Type (Mitsubishi Product) |
|---|---|---|---|---|---|---|---|---|---|
| 200V | FR-ABR-0.4K | 10% | 140 | 500 | 40 | 21 | 200 | 0.2 | TH-N20CXHZ-0.7A |
| 200V | FR-ABR-0.75K | 10% | 215 | 500 | 40 | 21 | 100 | 0.4 | TH-N20CXHZ-1.3A |

(Note)1.The regenerative brake duty setting should be less than the permissible brake duty in the table above.
2.The temperature of the brake resistor could become 300°C or more depending on the operation frequency. Care must be taken for installation and heat dissipation.
3.The brake resistor cannot be used with the 0.1K and 0.2K.
4.Do not remove the jumper across terminal P/+ and P1 except when connecting a DC reactor.

## Brake unit FR-BU2-☐K

## Discharging resistor GZG type GRZG type

● Specification

<Brake unit>

| Model FR-BU2-☐ | 200V 1.5K |
|---|---|
| Applicable motor capacity | 0.4kW, 0.75kW |
| Connected brake resistor | GZG 300W-50Ω (one) |
| Multiple (parallel) operation | Up to 10 units ＊ |
| Approximate mass (kg) | 0.9 |

＊ The torque is limited according to the permissible current amount of the connected drive unit.

<Discharging resistor>

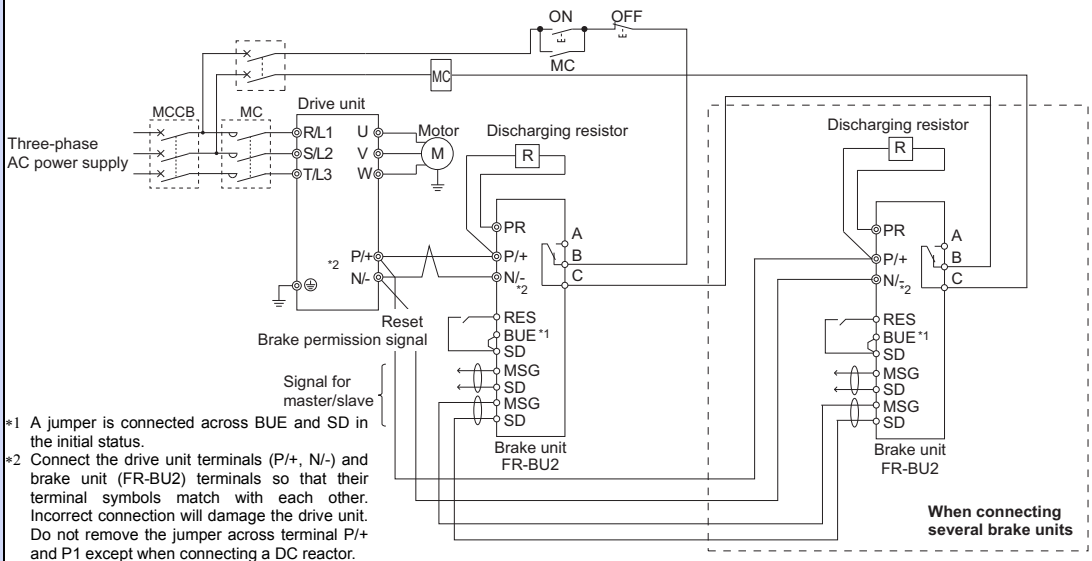
| Model GRZG Type | 200V GZG300W-50Ω |
|---|---|
| Number of connectable devices | one |
| Brake resistor total resistance value (Ω) | 50 |
| Continuous permissible power (W) | 100 |

● Selection

The maximum temperature rise of the discharging resistors is approximately 100°C. Use heat-resistant wires and wire to avoid contact with resistors.

| Braking Torque \ Motor (kW) | 0.4 | 0.75 |
|---|---|---|
| 50% 30s | FR-BU2-1.5K | |
| 100% 30s | FR-BU2-1.5K | |

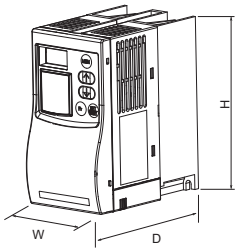
● Connection diagram




＊1 A jumper is connected across BUE and SD in the initial status.
＊2 Connect the drive unit terminals (P/+, N/-) and brake unit (FR-BU2) terminals so that their terminal symbols match with each other. Incorrect connection will damage the drive unit. Do not remove the jumper across terminal P/+ and P1 except when connecting a DC reactor.

● Outline dimension drawings

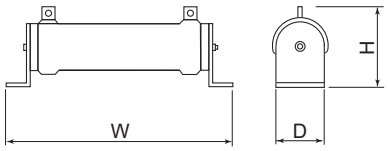
<FR-BU2>




| Model | W | H | D |
|---|---|---|---|
| FR-BU2-1.5K | 68 | 128 | 132.5 |

(Unit: mm)

<GZG>

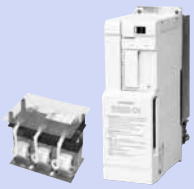



| Model | W | H | D |
|---|---|---|---|
| GZG300W | 335 | 40 | 78 |

(Unit: mm)

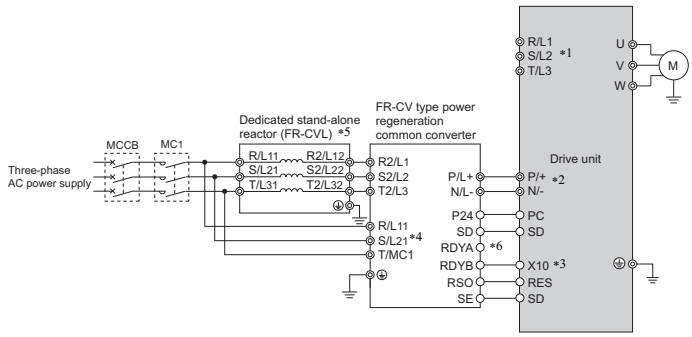
| Name (Model) | Specifications, Structure, etc. |
|---|---|

## Power regeneration common converter FR-CV-□K



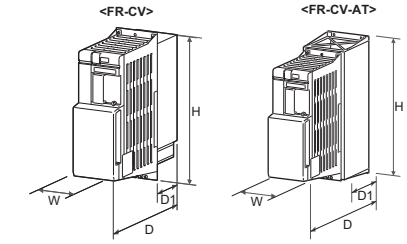
- Enables 100%-torque continuous regeneration to support continuous regenerative operation for line control, etc. (Maximum torque 150% 60s)
- Eliminates the need to use a brake unit with each drive unit, reducing total space and total cost.
- Saves energy since regeneration energy is used by the other drive units and excess energy is returned to the power supply.
- Heatsink protrusion type has the heat generating section outside of the enclosure, and exhaust the converter generated heat to the outside of enclosure.

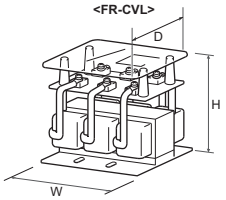
### ● Connection diagram




*1 Do not connect anything to the power input terminals (R/L1, S/L2, T/L3). Incorrect connection will damage the drive unit. Opposite polarity of terminals N/-, P/+ will damage the drive unit.
*2 Do not insert an MCCB between the terminals P/+-N/- (between P/L+-P/+, between N/L--N/-). Connect the drive unit terminals (P/+, N/-) and power regeneration common converter terminals so that their terminal symbols match with each other. Incorrect connection will damage the drive unit. Do not remove a jumper across terminal P/+ and P1.
*3 Assign the terminal for X10 signal using any of *Pr. 178 to Pr. 184 (input terminal function selection)*.
*4 Always connect the power supply and terminals R/L11, S/L21, and T/MC1. If the drive unit is operated without connection, the power regeneration common converter will be damaged.
*5 Install the dedicated stand-alone reactor (FR-CVL) on a horizontal place.
*6 Be sure to connect terminal RDY of the FR-CV to the X10 or MRS signal assigned terminal of the drive unit, and connect terminal SE of the FR-CV to terminal SD of the drive unit. Without proper connection, FR-CV will be damaged.

### ● Outline dimension drawings




FR-CV (Unit mm)

| Voltage/Capacity | | W | H | D | D1 |
|---|---|---|---|---|---|
| 200V | 7.5K/11K | 90 | 300 | 303 | 103 |
| | 15K | 120 | 300 | 305 | 105 |
| | 22K/30K | 150 | 380 | 322 | 122 |
| | 37K/55K | 400 | 620 | 250 | 135 |

FR-CV-AT (Unit mm)

| Voltage/Capacity | | W | H | D | D1 |
|---|---|---|---|---|---|
| 200V | 7.5K/11K | 110 | 330 | 315 | 115 |
| | 15K | 130 | 330 | 320 | 120 |
| | 22K/30K | 160 | 410 | 350 | 150 |

FR-CVL (Unit mm)

| Voltage/Capacity | | W | H | D |
|---|---|---|---|---|
| 200V | 7.5K/11K/15K | 165 | 130 | 155 |
| | 22K | 165 | 140 | 155 |
| | 30K | 215 | 160 | 175 |
| | 37K | 220 | 320 | 200 |
| | 55K | 250 | 335 | 225 |

## High power factor converter FR-HC2-□K


- Substantially suppresses power harmonics to realize the equivalent capacity conversion coefficient K5=0 in the "Harmonic Suppression Guidelines for Consumers Who Receive High Voltage or Special High Voltage".
- Has the power regeneration function as standard.
- Connects multiple drive units to enable common converter system operation.

### ● Specifications

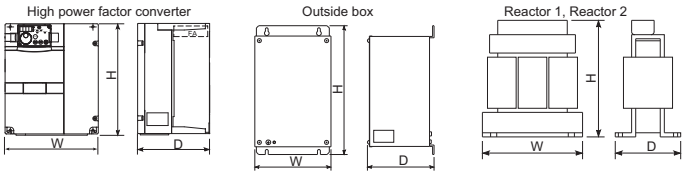
| Model FR-HC2□□ *2 | 200V | | | | |
|---|---|---|---|---|---|
| | 7.5K | 15K | 30K | 55K | 75K |
| Applicable drive unit capacity *1 | 3.7K to 7.5K | 7.5K to 15K | 15K to 30K | 30K to 55K | 37K to 75K |
| Rated input voltage/ frequency | Three-phase 200V to 220V 50Hz<br>200V to 230V 60Hz | | | | |
| Rated input current (A) | 33 | 61 | 115 | 215 | 278 |

*1 The applicable capacity to the high power factor converter is the total capacity of the drive units.
*2 If a high power factor converter (FR-HC2) is purchased, it comes with reactor 1 (FR-HCL21), reactor 2 (FR-HCL22), and an outside box (FR-HCB2).

### ● Outline dimension

(Unit: mm)

| Voltage | Capacity | High Power Factor Converter FR-HC2 | | | Reactor 1 FR-HCL21 *1 | | | Reactor 2 FR-HCL22 *1 | | | Outside Box FR-HCB2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | H | D | W | H | D | W | H | D | W | H | D |
| 200V | 7.5K | 220 | 260 | 170 | 132 | 150 | 100 | 237.5 | 230 | 140 | 190 | 320 | 165 |
| | 15K | 250 | 400 | 190 | 162 | 172 | 126 | 257.5 | 260 | 165 | | | |
| | 30K | 325 | 550 | 195 | 195 | 210 | 150 | 342.5 | 305 | 180 | 270 | 450 | 203 |
| | 55K | 370 | 620 | 250 | 210 | 180 | 200.5 | 432.5 | 380 | 280 | | | |
| | 75K | 465 | 620 | 300 | 240 | 215 | 215.5 | 474 | 460 | 280 | 400 | 450 | 250 |




*1 Install the reactor (FR-HCL21, 22) on a horizontal place.

## List of cables and connectors

| Name | Model | Cable length | IP rating *1 | Application | Description |
|---|---|---|---|---|---|
| Power supply cable *2 (For the load side) | MR-PWS1CBL2M-A1-H*4 | 2m | IP65 | For MM-GKR (Direct connection type) | Power supply connector<br>Lead wire<br>* Not a shielded cable |
| | MR-PWS1CBL5M-A1-H*4 | 5m | | | |
| | MR-PWS1CBL10M-A1-H*4 | 10m | | | |
| | MR-PWS1CBL2M-A1-L *3*4 | 2m | | | |
| | MR-PWS1CBL5M-A1-L *3*4 | 5m | | | |
| | MR-PWS1CBL10M-A1-L *3*4 | 10m | | | |
| Power supply cable *2 (For the non-load side) | MR-PWS1CBL2M-A2-H*4 | 2m | | | |
| | MR-PWS1CBL5M-A2-H*4 | 5m | | | |
| | MR-PWS1CBL10M-A2-H*4 | 10m | | | |
| | MR-PWS1CBL2M-A2-L *3*4 | 2m | | | |
| | MR-PWS1CBL5M-A2-L *3*4 | 5m | | | |
| | MR-PWS1CBL10M-A2-L *3*4 | 10m | | | |
| Power supply cable *2 (For the load side) | MR-PWS2CBL03M-A1-L | 0.3m | IP55 | For MM-GKR (Relay connection type | Power supply connector<br>Lead wire<br>* Not a shielded cable |
| Power supply cable *2 (For the non-load side) | MR-PWS2CBL03M-A2-L | 0.3m | IP55 | | |

*1 The listed IP rating indicates the waterproof and dust-proof levels when the connector of the cable is connected to a drive unit or motor. If the IP rating of the drive unit or motor is different from the rating described in this table, the lower rating is applied.

*2 -H and -L indicate the flex life. -H indicates long flex life, and -L indicates standard flex life.

*3 The power supply cable MR-PWS3CBL_M-A_-L, which is a shielded cable, is also available. Please contact your sales representative.

*4 For unlisted lengths
For unlisted lengths of the cables, contact Mitsubishi Electric System & Service Co., Ltd. FA PRODUCT DIVISION by email: oss-ip@melsc.jp

●Detailed model of option cables and connectors

| Model | Power supply connector |
|---|---|
| MR-PWS1CBL_M-A1-H<br>MR-PWS1CBL_M-A1-L<br>MR-PWS1CBL_M-A2-H<br>MR-PWS1CBL_M-A2-L | Plug: KN4FT04SJ1-R<br>Socket contact: ST-TMH-S-C1B-100-(A534G)<br>(Japan Aviation Electronics Industry, Limited) |
| MR-PWS2CBL03M-A1-L<br>MR-PWS2CBL03M-A2-L | Plug: KN4FT04SJ2-R<br>Socket contact: ST-TMH-S-C1B-100-(A534G)<br>(Japan Aviation Electronics Industry, Limited) |

* There are optional cables and connector sets, which have the different shapes but the same model names with the standard models. Both the option models and standard models can be used.

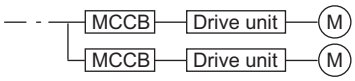
## Peripheral devices/cable size list

Check the model name of the drive unit you purchased. Appropriate peripheral devices must be selected according to the capacity.

Refer to the following list and prepare appropriate peripheral devices.

| Drive unit Model | Motor Output (kW) | Moulded Case Circuit Breaker (MCCB) *1 or Earth Leakage Current Breaker (ELB) *2 (NF, NV type) | | Magnetic Contactor (MC) *3 | | Cable Gauge | | Reactor | |
|---|---|---|---|---|---|---|---|---|---|
| | | Reactor connection | | Reactor connection | | HIV Cables, etc. ($mm^2$) *5 | | FR-HAL | FR-HEL |
| | | Without | With | Without | With | R/L1, S/L2, T/L3 | U, V, W | | |
| FR-E720EX-0.1K | 0.1 | 5A | 5A | S-N10 | S-N10 | 2 | — (*6) | 0.4K *4 | 0.4K *4 |
| FR-E720EX-0.2K | 0.2 | 5A | 5A | S-N10 | S-N10 | 2 | — (*) | 0.4K *4 | 0.4K *4 |
| FR-E720EX-0.4K | 0.4 | 5A | 5A | S-N10 | S-N10 | 2 | — (*6) | 0.4K | 0.4K |
| FR-E720EX-0.75K | 0.75 | 10A | 10A | S-N10 | S-N10 | 2 | — (*6) | 0.75K | 0.75K |

*1 •Select an MCCB according to the drive unit power supply capacity.
•Install one MCCB per drive unit.




*2 For the use in the United States or Canada, select a UL and cUL certified fuse with Class T fuse equivalent cut-off speed or faster with the appropriate rating for branch circuit protection. Alternatively, select a UL489 molded case circuit breaker (MCCB).

*3 Magnetic contactor is selected based on the AC-1 class. The electrical durability of magnetic contactor is 500,000 times. When the magnetic contactor is used for emergency stop during motor driving, the electrical durability is 25 times.
If using an MC for emergency stop during motor driving, select an MC regarding the drive unit input side current as JEM1038-AC-3 class rated current.

*4 The power factor may be slightly lower.

*5 The cable size is that of the cable (HIV cable (600V class 2 vinyl-insulated cable) etc.) with continuous maximum permissible temperature of 75°C. It assumes that the surrounding air temperature is 50°C or less and the wiring distance is 20m or less.

*6 The gauge is 0.75$mm^2$ (AWG19 or AWG18) for the motor power supply cable for the MM-GKR series (MR-PWS1CBL□M-A□-□).

### Note

- **When the breaker on the drive unit input side trips, check for the wiring fault (short circuit), damage to internal parts of the drive unit, etc. Identify the cause of the trip, then remove the cause and power on the breaker.**

### REMARKS

- The following table indicates a selection example for the 600V grade heat-resistant PVC insulated cable (HIV cable) with the reference wiring length of 30m.
  Power supply connector compatible with MM-GKR series

| Motor model | Cable gauge ($mm^2$) for power supply or earth (ground) (U, V, W, or ⏚) (under general environment) |
|---|---|
| MM-GKR13, 23, 43 ,73 | 0.75(AWG 18) |

*1 Use a fluorinated resin cable (0.75$mm^2$ (AWG18)) for the motor power supply connector.

*2 The gauge is for the wiring length of 10m. For the wiring length longer than 10m, use MR-PWS2CBL03M-A_-L and an HIV cable having the gauge of 1.25$mm^2$ (AWG16) for extension.

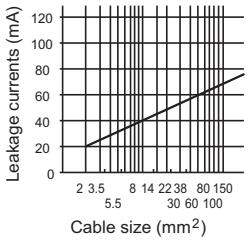
*3 For compliance with UL/CSA standard, use MR-PWS2CBL03M-A_-L and an HIV cable having the gauge of 2$mm^2$ (AWG14) for extension.

## Selecting the rated sensitivity current for the earth leakage current breaker

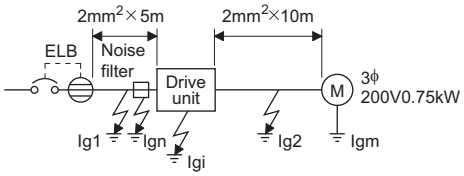
When using the earth leakage current breaker with the drive unit circuit, select its rated sensitivity current as follows, independently of the PWM carrier frequency.

- Breaker designed for harmonic and surge suppression
  Rated sensitivity current IΔn≥10×(Ig1+Ign+Igi+Ig2+Igm)
- Standard breaker
  Rated sensitivity current IΔn≥10×{Ig1+Ign+Igi+3X(Ig2+Igm)}
  Ig1, g2 : Leakage currents in wire path during commercial power supply operation
  Ign : Leakage current of drive unit input side noise filter
  Igm : Leakage current of motor (leakage current of MM-GKR series motor: 0mA)
  Igi : Leakage current of drive unit

Example of leakage current of cable path per 1km during the commercial power supply operation when the CV cable is routed in metal conduit (200V 60Hz)




Example




(Note)1.Install the earth leakage breaker (ELB) on the input side of the drive unit.
2.In the 人 connection earthed-neutral system, the sensitivity current is blunt against an earth (ground) fault in the drive unit output side. Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes. (NEC section 250, IEC 536 class 1 and other applicable standards)

● Selection example (in the case of the above figure)

| | Breaker Designed for Harmonic and Surge Suppression | Standard Breaker |
|---|---|---|
| Leakage current Ig1 (mA) | $20 \times \frac{5m}{1000m} = 0.1$ | |
| Leakage current Ign (mA) | 0 | |
| Leakage current Igi (mA) | 1 | |
| Leakage current Ig2 (mA) | $20 \times \frac{10m}{1000m} = 0.2$ | |
| Motor leakage current Igm (mA) | 0 | |
| Total leakage current (mA) | 1.3 | 1.7 |
| Rated sensitivity current (mA) (≥Ig×10) | 15 | 30 |

## Precautions for use of the drive unit

⚠ Safety Precautions

- To operate the drive unit correctly and safely, be sure to read the "instruction manual" before starting operation.
- This product has not been designed or manufactured for use with any equipment or system operated under life-threatening conditions.
- Please contact our sales office when you are considering using this product in special applications such as passenger mobile, medical, aerospace, nuclear, power or undersea relay equipment or system.
- Although this product is manufactured under strict quality control, safety devices should be installed when a serious accident or loss is expected by a failure of this product.
- Do not use the drive unit for a load other than the dedicated sensorless PM motor.

### Operation

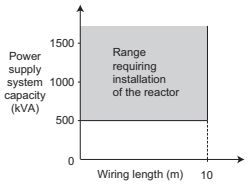
- A magnetic contactor (MC) provided on the input side should not be used to make frequent starts and stops. It could cause the drive unit to fail.
- However, at this time, the motor cannot be brought to a sudden stop. Hence, provide a mechanical stopping/holding mechanism for the machine/equipment which requires an emergency stop.
- It will take time for the capacitor to discharge after shutoff of the drive unit power supply. When accessing the drive unit for inspection, wait for at least 10 minutes after the power supply has been switched off, and check to make sure that there are no residual voltage using a tester or the like.

### Wiring

- Application of power to the output terminals (U, V, W) of the inverter will damage the drive unit. Therefore, fully check the wiring and sequence to ensure that wiring is correct, etc. before powering on.
- The terminals P/+, PR, P1, N/- are provided for connection of a dedicated option. Do not connect anything other than a dedicated option and DC power supply. Do not short the frequency setting power supply terminal 10 and common terminal 5 or the terminal PC and terminal SD.

### Power supply

- When the drive unit is connected under a large-capacity power transformer (500kVA or more transformer) or when a power capacitor is to be switched over, an excessive peak current may flow in the power input circuit, damaging the drive unit.
  To prevent this, always install an optional AC reactor (FR-HAL).




- If a surge voltage occurs in the power supply system, this surge energy may flow into the drive unit, causing the drive unit to display overvoltage protection (E.OV□) and come to a drive unit trip. To prevent this, always install an optional AC reactor (FR-HAL).

### Installation

- Avoid hostile environment where oil mist, fluff, dust particles, etc. are suspended in the air, and install the drive unit in a clean place or put it in an ingress-protected "enclosed" enclosure.
  When placing the drive unit in an enclosure, determine the cooling system and enclosure dimensions so that the surrounding air temperature of the drive unit is within the permissible value. (*Refer to page 8* for the specified value)
- Do not install the drive unit on wood or other flammable material as it will be hot partly.
- Install the drive unit in the vertical orientation.

### Setting

- The motor can be operated as fast as a maximum of 3000r/min by parameter setting. Therefore, incorrect setting can cause a danger. Set the upper limit using the maximum speed limit setting function.
- A setting higher than the initial value of DC injection brake operation voltage or operation time can cause motor overheat (electronic thermal relay error).
- Do not set *Pr.70 Special regenerative brake duty* except for using the optional brake resistor. This function is used to protect the brake resistor from overheating. Do not set the value exceeding permissible duty of the brake resistor.

## Precautions for selection

### Acceleration/deceleration times

- The acceleration/deceleration time of the motor depends on the motor-generated torque, load torque and moment of inertia of the load.
- When the torque limit function is activated during acceleration/deceleration, increase the acceleration/deceleration time as the actual time may become longer.
- To decrease the deceleration time, it is necessary to add optional brake resistor MRS type or FR-ABR (for the 0.4K or higher), the brake unit (FR-BU2), power regeneration common converter (FR-CV), or a similar device to absorb braking energy.

### Power transfer mechanism (reduction gear, belt, chain, etc.)

- When an oil-lubricated gear box, speed change/reduction gear or similar device is used in the power transfer system, note that continuous operation at low speed only may deteriorate oil lubrication, causing seizure.

### Instructions for overload operation

- When performing operation of frequent start/stop of the drive unit, rise/fall in the temperature of the transistor element of the drive unit will repeat due to a repeated flow of large current, shortening the life from thermal fatigue. Since thermal fatigue is related to the amount of current, the life can be increased by reducing current at locked condition, starting current, etc. Decreasing current may increase the life. However, decreasing current will result in insufficient torque and the drive unit may not start. Therefore, choose the drive unit which has enough allowance for current.

# Precautions for the use of a sensorless PM motor

⚠ SAFETY INSTRUCTIONS

- Do not use a sensorless PM motor for an application where the motor is driven by the load and runs at a speed higher than the maximum motor speed.

## Cautions for model selection

- Select a sensorless PM motor which has the rated torque equal to or higher than the continuous effective torque.
- When unbalanced torque is generated, such as in a vertical lift machine, it is recommended that the unbalanced torque of the machine be kept under 70% of the sensorless PM motor rated torque.
- Create the operating pattern by considering the settling time.
- The load to motor inertia ratio must be equal to or below the recommended ratio. If the ratio is too large, the expected performance may not be achieved.

## Combination of motor and drive unit

- Use the same sensorless PM motor capacity as the drive unit capacity.
- Only one sensorless PM motor can be connected to a drive unit.
- A sensorless PM motor cannot be driven by the commercial power supply.
- Do not use a synchronized or induction-synchronized motor, that is not a sensorless PM motor.

## Installation

- While power is ON or for some time after power-OFF, do not touch the motor since the motor will be extremely hot. Touching these devices may cause a burn.
- Do not drop or apply a strong impact on the motor as they are precision devices. They may be damaged from such stress or shock.
- Do not get on or place heavy objects on the motor. Doing so may result in an injury or damage.
- The system must withstand high speeds and high acceleration/deceleration.
- Ensure the machine rigidity, and keep the machine resonance point at a high level.
- Mount the motor on a nonflammable material. Mounting them directly on or near flammable material may result in fires.
- Securely fix the motor onto the machine. Insufficient fixing may cause the motor to be dislocated during operation.
- Install electrical and mechanical stoppers at the stroke end.
- Do not hammer the shaft of the motor and the rotor of the motor when installing a pulley or a coupling. Doing so will cause a failure.
  For the motor with a key shaft, fit the pulley or a coupling into a place using the screw hole at the shaft end. Use a pulley extractor when removing the pulley.
- When installing the motor with its shaft facing upward, take measures on the machine side to prevent oils from infiltrating into the motor from the gear box, etc.

## Wiring

- Applying the commercial power supply to input terminals (U, V, W) of a sensorless PM motor will burn the sensorless PM motor. The sensorless PM motor must be connected with the output terminals (U, V, W) of the drive unit.
- The sensorless PM motor is a synchronous motor with embedded magnets. High-voltage is generated at motor terminals while the motor is running even after the drive unit power is turned OFF. Before wiring or inspection, confirm that the motor is stopped.
  For applications where the motor is driven by the load, the low-voltage manual contactor, which is installed at the drive unit's output side, must be opened before wiring or inspection. Otherwise an electric shock may occur.
  The drive unit power must be turned ON before closing the contacts of the contactor at the output side. Do not use a magnetic contactor at the drive unit's output side.
- Match the input terminals (U, V, W) of the motor and the output terminals (U, V, W) of the drive unit when connecting.
- When the sensorless PM motor is connected, the wiring length must be 30m or shorter.
- Securely earth (ground) the unit to prevent electric shocks and to stabilize the electric potential in the control circuit.
- Connect the earthing (grounding) wire to the protective earth (PE) terminal via the drive unit protective earth (PE) terminal for the motor earthing (grounding).
- Faults such as a position mismatch may occur if the earthing (grounding) is insufficient.
- Check the wiring and sequence programs thoroughly before switching the power ON.
- Carefully select the cable clamping method, and make sure that bending stress and the stress of the cable's own weight are not applied on the cable connection section.
- In an application where the motor moves, determine the cable bending radius according to the cable bending life and wire type.

## Operation

- It takes approx. 0.1s (magnetic pole detection time) to start a motor after a start signal is input.
- The sensorless PM motor is a synchronous motor with embedded magnets. If an instantaneous power failure occurs to cause the motor to coast, induced voltage is generated.
  The drive unit's DC bus voltage rises if the motor coasts fast in this condition. When using the automatic restart after instantaneous power failure function, it is recommended to also use the regenerative avoidance operation to make startups stable.
- Do not use a product which is damaged or has parts missing. In that case, replace the product.
- Do not apply a load exceeding the tolerable load onto the motor rotor. The shaft or the rotor may break.
- Torque may drop due to temperature increase of the motor. Be sure to use the motor within the specified ambient temperature.

## Others

- Do not touch the motor with wet hands.
- Do not modify the motor.

## Installation and selection of moulded case circuit breaker

Install a moulded case circuit breaker (MCCB) on the power receiving side to protect the wiring of the drive unit input side. For MCCB selection, refer to *page 43* since it depends on the drive unit power supply side power factor (which changes depending on the power supply voltage, output frequency and load). Especially for a completely electromagnetic MCCB, one of a slightly large capacity must be selected since its operation characteristic varies with harmonic currents. (Check it in the data of the corresponding breaker.) As an earth leakage current breaker, use the Mitsubishi earth leakage current breaker designed for harmonics and surge suppression. *(Refer to page 44)*

When installing a moulded case circuit breaker on the output side of the drive unit, contact each manufacturer for selection of the moulded case circuit breaker.

## Handling of the drive unit input side magnetic contactor

- For operation via external terminal (terminal STF or STR used), provide an input side MC to prevent an accident caused by a natural restart at power recovery after a power failure, such as an instantaneous power failure, and to ensure safety for maintenance work. Do not use this magnetic contactor to make frequent starts and stops. (The switching life of the drive unit input circuit is about 1,000,000 times.) For parameter unit operation, an automatic restart after power failure is not made and the MC cannot be used to make a start. Note that the primary side MC may be used to make a stop but the regenerative brake specific to the drive unit does not operate and the motor is coasted to a stop.
- Installation of a magnetic contactor at the input side is recommended. A magnetic contactor avoids overheat or burnout of a brake resistor when heat capacity of the resistor is insufficient or a brake regenerative transistor is damaged with short while connecting an optional brake resistor. In this case, shut-off the magnetic contactor when fault occurs and drive unit trips.

## Handling of the drive unit output side magnetic contactor

Do not install a magnetic contactor at the drive unit's output side.

## Thermal relay installation

When installing a thermal O/L relay (OCR) between the drive unit and motor to protect the motor from overheating, set the electronic thermal O/L relay of the drive unit to 0A. Note that the current indicated on the motor rating plate is affected by the line-to-line leakage current *(Refer to page 48)* when selecting the setting for a thermal relay.

## Measuring instrument on the output side

When the drive unit-to-motor wiring length is large, the meters and CTs may generate heat due to line-to-line leakage current. Therefore, choose the equipment which has enough allowance for the current rating.

## Disuse of power factor improving capacitor (power capacitor)

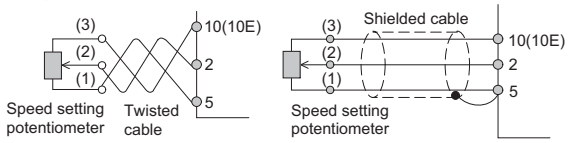
The power factor improving capacitor and surge suppressor on the drive unit output side may be overheated or damaged by the harmonic components of the drive unit output. Also, since an excessive current flows in the drive unit to activate overcurrent protection, do not install a capacitor or surge suppressor. For power factor improvement, use a DC reactor *(Refer to page 37)*.

## Wire thickness and wiring distance

When the wiring length between the drive unit and motor is long, use thick wires so that the voltage drop of the main circuit cable is 2% or less especially at low speed output. (A selection example for the wiring distance of 20m is shown on *page 43*)

For remote operation via analog signal, wire the control cable between the operation box or operation signal and drive unit within 30m and away from the power circuits (main circuit and relay sequence circuit) to prevent induction from other devices.

When using the external potentiometer instead of the parameter unit to set the speed, use a shielded or twisted cable, and do not earth (ground) the shield, but connect it to terminal 5 as shown below




## Earth (Ground)

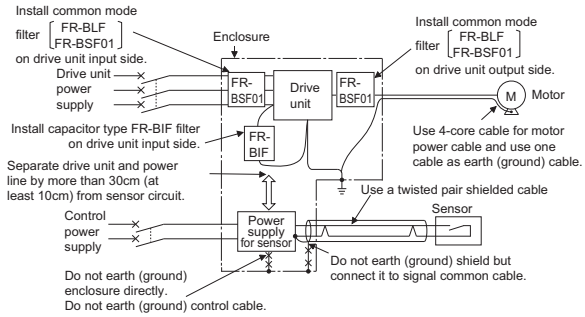
Always earth (ground) the drive unit and motor. In addition, always use the earth (ground) terminal of the drive unit to earth (ground) the drive unit. (Do not use the case and chassis)

## Noise

The effect of electromagnetic interference must be reduced by using a noise filter or by other means. Otherwise nearby electronic equipment may be affected. Consider countermeasures referring to the following countermeasure examples.

- As measures against AM radio broadcasting noise, radio noise filter FR-BIF produces an effect.
- As measures against sensor malfunction, line noise filter FR-BSF01, FR-BLF produces an effect.
- As measures against induction noise from the power cable of the drive unit, an effect is produced by putting a distance of 30cm (at least 10cm) or more and using a twisted pair shielded cable as a signal cable. Do not earth (ground) shield but connect it to signal common cable.

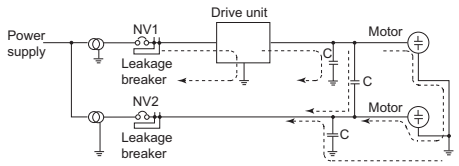
Noise reduction examples



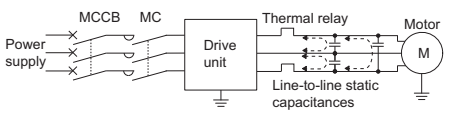
## Leakage currents

Capacitances exist between the drive unit I/O cables, other cables and earth and in the motor, through which a leakage current flows.
Therefore, take the following measures. Select the earth leakage current breaker according to its rated sensitivity current, independently of the carrier frequency setting. *(Refer to page 44)*

### To-earth (ground) leakage currents

| Type | Influence and Measures |
|---|---|
| Influence and measures | • Leakage currents may flow not only into the drive unit's own line but also into the other line through the earth (ground) cable, etc. These leakage currents may operate earth (ground) leakage circuit breakers and earth leakage relays unnecessarily.<br>●Countermeasures<br>• Use an earth leakage circuit breaker with a weak sensitivity in a high frequency range.<br>The output current of the drive unit contains a high-frequency leakage current component, which gives relatively low impacts to human bodies. The detention level for this high-frequency leakage current component can be set weaker to prevent unnecessary operations.<br>• Minimize the stray capacitance between the earth.<br>Use the cables insulated with low dielectric constant material, and perform wiring to make the wiring length between the drive unit and the motor to be as short as possible. |
| Undesirable current path |  |

### Line leakage current

| Type | Influence and Measures |
|---|---|
| Influence and measures | • This leakage current flows via a static capacitance between the drive unit output cables.<br>• The external thermal relay may be operated unnecessarily by the harmonics of the leakage current.<br>●Countermeasures<br>• Use *Pr.9 Electronic thermal O/L relay*<br>• To ensure that the motor is protected against line-to-line leakage currents, it is recommended to use a temperature sensor to directly detect motor temperature. |
| Undesirable current path |  <br>**Line-to-line leakage currents path** |

### ●Harmonic suppression guideline

Harmonic currents flow from the drive unit to a power receiving point via a power transformer. The harmonic suppression guideline was established to protect other consumers from these outgoing harmonic currents.

- "Harmonic suppression guideline for consumers who receive high voltage or special high voltage"
  This guideline sets forth the maximum values of harmonic currents outgoing from a high-voltage or especially high-voltage consumer who will install, add or renew harmonic generating equipment. If any of the maximum values is exceeded, this guideline requires that consumer to take certain suppression measures.

Users who use models other than the target models are not covered by the guideline. However, we ask to connect an AC reactor or a DC reactor as before to the users who are not covered by the guideline.
For compliance to the harmonic suppression guideline for consumers who receive high voltage or special high voltage

| Input Power Supply | Target Capacity | Countermeasures |
|---|---|---|
| Three-phase 200V | All capacities | Make a judgment based on "Harmonic suppression guideline for consumers who receive high voltage or special high voltage" issued by the Japanese Ministry of Economy, Trade and Industry (formerly Ministry of International Trade and Industry) in September 1994 and take measures if necessary. For calculation method of power supply harmonics, refer to materials below.<br>Reference materials<br>• "Harmonic suppression measures of the inverter" Jan. 2004 Japan Electrical Manufacturer's Association<br>• "Calculation method of harmonic current of the general-purpose inverter used by specific consumers" JEM-TR201 (revised in Dec. 2003): Japan Electrical Manufacturer's Association Japan Electrical Manufacturer's Association |

For compliance to "Harmonic suppression guideline of the transistorized inverter (input current of 20A or less) for consumers other than specific consumers" published by JEMA.
Connect the AC reactor or DC reactor recommended in a catalog or an instruction manual.
Reference materials

- "Harmonic suppression guideline of the general-purpose inverter (input current of 20A or less)" JEM-TR226 (revised in Dec. 2003): Japan Electrical Manufacturer's Association

●Calculation of outgoing harmonic current

Outgoing harmonic current = fundamental wave current (value converted from received power voltage) × operation ratio × harmonic content

•Operation ratio: Operation ratio = actual load factor operation time ratio during 30 minutes
•Harmonic content: Found in Table.

Table 1: Harmonic Contents (Values at the fundamental current of 100%)

| | Reactor | 5th | 7th | 11th | 13th | 17th | 19th | 23rd | 25th |
|---|---|---|---|---|---|---|---|---|---|
| Three-phase bridge (Capacitor smoothing) | Not used | 65 | 41 | 8.5 | 7.7 | 4.3 | 3.1 | 2.6 | 1.8 |
| | Used (AC side) | 38 | 14.5 | 7.4 | 3.4 | 3.2 | 1.9 | 1.7 | 1.3 |
| | Used (DC side) | 30 | 13 | 8.4 | 5.0 | 4.7 | 3.2 | 3.0 | 2.2 |
| | Used (AC, DC sides) | 28 | 9.1 | 7.2 | 4.1 | 3.2 | 2.4 | 1.6 | 1.4 |

Table 2: Rated Capacities and Outgoing Harmonic Currents for Three-phase Drive Unit Drive

| Applied Motor kW | Rated Current [A] 200V | Fundamental Wave Current Converted from 6.6kV (mA) | Rated Capacity (kVA) | Outgoing Harmonic Current Converted from 6.6kV (mA) (No reactor, 100% operation ratio) 5th | 7th | 11th | 13th | 17th | 19th | 23rd | 25th |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.1 | 0.61 | 18 | 0.22 | 11.7 | 7.38 | 1.53 | 1.386 | 0.774 | 0.558 | 0.468 | 0.324 |
| 0.2 | 0.98 | 30 | 0.35 | 19.5 | 12.3 | 2.55 | 2.31 | 1.29 | 0.93 | 0.78 | 0.54 |
| 0.4 | 1.61 | 49 | 0.57 | 31.85 | 20.09 | 4.165 | 3.773 | 2.107 | 1.519 | 1.274 | 0.882 |
| 0.75 | 2.74 | 83 | 0.97 | 53.95 | 34.03 | 7.055 | 6.391 | 3.569 | 2.573 | 2.158 | 1.494 |

## Major difference with the AC servo system

| Item | | Sensorless servo | AC servo | |
|---|---|---|---|---|
| | | | JN series | J4 series |
| Control mode | | Speed control<br>Position control | Speed control<br>Position control<br>Torque control | Speed control<br>Position control<br>Torque control |
| Encoder | | Without | With | With |
| Initial magnetic pole detection | | Required<br>(detection time: about 0.1s) | Not required because the encoder is provided. | Not required because the encoder is provided. |
| Speed fluctuation ratio (Load fluctuation 0 to 100%) | Digital input | ±0.05% or lower | ±0.01% or lower | ±0.01% or lower |
| | Analog input (Surrounding air temperature: 25±10°C) | ±0.5% or lower | — | ±0.2% or lower |
| Speed control range | | 1: 1000 | 1: 5000<br>(internal speed command) | 1: 2000<br>(analog speed command)<br>1: 5000<br>(internal speed command) |
| Command resolution/encoder resolution | | 5120 pulses/rev | 131072 pulses/rev<br>(Incremental) | 4194304 pulses/rev<br>(absolute) |
| Positioning accuracy | | ±1.8° | — | — |
| Maximum torque | | 200% | 300% | 350% |
| Dynamic brake | | None<br>(must be provided externally) | Built-in | Built-in |

## Precautions when replacing the servo system

The control method is PM sensorless vector control. Several restrictions are applied because the encoder is not provided and others.
When using this drive unit and a sensorless PM motor, always check the machine operation in the actual system.

### Restrictions

- In positioning operation, the home position is cleared at servo-OFF or power-OFF because no sensor (encoder) is provided. Always perform the home position return again.
- In a low-speed operation or at a stop, torque ripples or uneven rotation is caused. (The operating conditions and parameter setting affect these.)
- The positioning accuracy is ±1.8°, and the speed control range is 1:1000. However, a slight vibration at a stop or uneven rotation may occur due to torque ripples. In such a case, ±1.8° is the average positioning accuracy, and 1:1000 is the average speed control range.
  The maximum wiring length to the motor is 30m. However, to ensure the positioning accuracy of ±1.8°, the wiring length must be within 5m and the power supply voltage must be between 200 and 220V.
- The best response level in the middle-speed range or higher is 100Hz, but the response level is decreased (to about 50Hz) in the low-speed range (0.1kW: 600r/min or lower or 0.2 to 0.75kW: 300r/min or lower).
- Sensors such as an encoder are not provided.
  When mechanical protection is necessary for a position, install such protection externally.
- No dynamic brake circuit is built in. Prepare a dynamic brake externally if needed.
- Position deviation or an error may occur due to sudden deceleration of about 0.05 second or lower (3000r/min → 0r/min) or the impact torque exceeding 100% around the zero speed. Check the operation, and adjust the deceleration time, speed response level, and model adaptive control gain as necessary to prevent position deviation or errors.

### Motor structure (compared with the servo motor HG-KR)

- The bracket at the non-load side of MM-GKR13 is larger.
  (Servo motor: □40, MM-GKR: □43)
- [Reduction gear equipped model] The lengths of the installation bolts are different.
- [Reduction gear equipped model] The shapes of the gear heads are different.

### Motor specifications (compared with the servo motor HG-KR)

- The 50W capacity model is not available.
- The continuous rated torque is 90% at 750r/min or lower of MM-GKR13.
- The maximum torque is smaller.
  (Servo motor: 350%, MM-GKR: 200%)
- The maximum rotation speed is slower.
  (Servo motor: 6000r/min, MM-GKR: 3000r/min)
- The moment of inertia is different.
  (For the model without a reduction gear, the moment of inertia is lower by 0 to 16%.)
- The recommended load inertia moment ratio (under position control) is lower.
  (Servo motor: 17 to 26 times or lower, MM-GKR: 10 times or lower)
- Although no sensor (encoder) is provided, the IP rating and environment conditions are the same.
  ∗ Note that problems related to the sensor (encoder) do not occur.
- [Reduction gear equipped model] Reduction gear equipped model has the IP rating of IP44.

### Others

- The available power supply input is three-phase 200 to 240V only.
- Only the electronic thermal O/L relay is provided as the temperature protective function.
  (Servo motor: Electronic thermal O/L relay and encoder thermistor, MM-GKR: Electronic thermal O/L relay)
- In the low-speed range (750r/min or lower for the 0.1kW motor, 300r/min or lower for the 0.2 to 0.75kW motors.), high-frequency tone is heard because of the high frequency superposition control.
- The maximum wiring length between the drive unit and motor is 30m.

When using this product, please note the warranty described below.

## 1. Warranty period and coverage

We will repair any failure or defect (hereinafter referred to as "failure") in our FA equipment (hereinafter referred to as the "Product") arisen during warranty period at no charge due to causes for which we are responsible through the distributor from which you purchased the Product or our service provider. However, we will charge the actual cost of dispatching our engineer for an on-site repair work on request by customer in Japan or overseas countries. We are not responsible for any on-site readjustment and/or trial run that may be required after a defective unit are repaired or replaced.

[Term]

The term of warranty for Product is twelve months after your purchase or delivery of the Product to a place designated by you or eighteen months from the date of manufacture whichever comes first ("Warranty Period"). Warranty period for repaired Product cannot exceed beyond the original warranty period before any repair work.

[Limitations]

(1) You are requested to conduct an initial failure diagnosis by yourself, as a general rule. It can also be carried out by us or our service company upon your request and the actual cost will be charged.
However, it will not be charged if we are responsible for the cause of the failure.

(1) This limited warranty applies only when the condition, method, environment, etc. of use are in compliance with the terms and conditions and instructions that are set forth in the instruction manual and user manual for the Product and the caution label affixed to the Product.

(2) Even during the term of warranty, the repair cost will be charged on you in the following cases;
1) a failure caused by your improper storing or handling, carelessness or negligence, etc., and a failure caused by your hardware or software problem
2) a failure caused by any alteration, etc. to the Product made on your side without our approval
3) a failure which may be regarded as avoidable, if your equipment in which the Product is incorporated is equipped with a safety device required by applicable laws and has any function or structure considered to be indispensable according to a common sense in the industry
4) a failure which may be regarded as avoidable if consumable parts designated in the instruction manual, etc. are duly maintained and replaced
5) any replacement of consumable parts (condenser, cooling fan, etc.)
6) a failure caused by external factors such as inevitable accidents, including without limitation fire and abnormal fluctuation of voltage, and acts of God, including without limitation earthquake, lightning and natural disasters
7) a failure generated by an unforeseeable cause with a scientific technology that was not available at the time of the shipment of the Product from our company
8) any other failures which we are not responsible for or which you acknowledge we are not responsible for

## 2. Term of warranty after the stop of production

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

## 3. Service in verseas ountries

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

## 4. Exclusion of responsibility for compensation against loss of pportunity, secondary loss, etc.

Whether under or after the term of warranty, we assume no responsibility for any damages arisen from causes for which we are not responsible, any losses of opportunity and/or profit incurred by you due to a failure of the Product, any damages, secondary damages or compensation for accidents arisen under a specific circumstance that are foreseen or unforeseen by our company, any damages to products other than the Product, and also compensation for any replacement work, readjustment, start-up test run of local machines and the Product and any other operations conducted by you.

## 5. Change of Product specifications

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

## 6. Application and use of the Product

(1) For the use of our product, its applications should be those that may not result in a serious damage even if any failure or malfunction occurs in product, and a backup or fail-safe function should operate on an external system to product when any failure or malfunction occurs.

(2) Our product is designed and manufactured as a general purpose product for use at general industries.
Therefore, applications substantially influential on the public interest for such as atomic power plants and other power plants of electric power companies, and also which require a special quality assurance system, including applications for railway companies and government or public offices are not recommended, and we assume no responsibility for any failure caused by these applications when used.
In addition, applications which may be substantially influential to human lives or properties for such as airlines, medical treatments, railway service, incineration and fuel systems, man-operated material handling equipment, entertainment machines, safety machines, etc. are not recommended, and we assume no responsibility for any failure caused by these applications when used.
We will review the acceptability of the abovementioned applications, if you agree not to require a specific quality for a specific application. Please contact us for consultation.

# [ Related Factory Automation Products ]

## PLC | MELSEC-Q Series Universal Model

Introducing the high-speed QCPU (QnUDVCPU) for faster processing of large data volumes.

◎Realize high-speed, high-accuracy machine control with various iQ Platform compatible controllers and multiple CPUs.
◎Easily connect to GOTs and Programming tools using built-in Ethernet port.
◎25 models from 10k step small capacity to 1000k step large capacity, are available.
◎Seamless communication and flexible integration at any network level.

Product Specifications

| | |
|---|---|
| Program capacity | 10k steps to 1000k steps |
| Number of I/O points [X/Y], number of I/O device points [X/Y] | 256 points to 4096 points/8192 points |
| Basic instruction processing speed (LD instruction) | 120 ns to 1.9 ns |
| External connection interface | USB (all models equipped), Ethernet, RS-232, memory card, extended SRAM cassette |
| Function module | I/O, analog, high-speed counter, positioning, simple motion, temperature input, temperature control, network module |
| Module extension style | Building block type |
| Network | Ethernet, CC-Link IE controller network, CC-Link IE field network, CC-Link, CC-Link/LT, MELSECNET/H, SSCNETⅢ (/H), AnyWire, RS-232, RS-422 |

## Programmable Controller | MELSEC-L Series

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

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

Product specifications

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

## HMI | Graphic Operation Terminal GOT2000 Series GT27 Model

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

◎Comfortable screen operation even if high-load processing (e.g. logging, device data transfer) is running. (Monitoring performance is twice faster than GT16)
◎Actual usable space without using an SD card is expanded to 128MB for more flexible screen design.
◎Multi-touch features, two-point press, and scroll operations for more user-friendliness.
◎Outline font and PNG images for clear, beautiful screen display.

Product Specifications

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

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

Industry-leading level of high performance servo

◎Industry-leading level of basic performance: Speed frequency response (2.5kHz), 4,000,000 (4,194,304p/rev) encoder
◎Advanced one-touch tuning function achieves the one-touch adjustment of advanced vibration suppression control Ⅱ, etc.
◎Equipped with large capacity drive recorder and machine diagnosis function for easy maintenance.
◎2-axis and 3-axis servo amplifiers are available for energy-conservative, space-saving, and low-cost machines.

Product Specifications

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

## Magnetic Starter | MS-T Series

Exceed your expectations.

◎10A frame model is over 16% smaller with a width of just 36mm!!
◎New integrated terminal covers.
◎Reduce your coil inventory by up to 50%.
◎Be certified to the highest international levels while work is ongoing to gain other country.

Product specifications

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

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

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

◎Compared to general-purpose motor SF-JR model, generated loss is reduced by 37% on average, and it is compatible with highly efficient premium IE3.
◎Easy replacement is achieved as mounting dimension (frame number) is compatible with general-purpose motor SF-JR model.
◎One motor can accommodate different power sources of Japan and the U.S. Three ratings in Japan meet the Top Runner standards, while it corresponds to EISA in the U.S.
◎Can be driven by inverters as standard. Advanced magnetic-flux vector control by our FR-A800 achieves steady torque drive up to 0.5Hz.

Product Specifications

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

# [ Related Factory Automation Products ]

## Robot | MELFA F Series

High speed, high precision and high reliability industrial robot

◎Compact body and slim arm design, allowing operating area to be expanded and load capacity increased.
◎The fastest in its class using high performance motors and unique driver control technology.
◎Improved flexibility for robot layout design considerations.
◎Optimal motor control tuning set automatically based on operating position, posture, and load conditions.

Product Specifications

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

## CNC | Mitsubishi Numerical Control Unit C70 Series

iQ Platform compatible CNC to provide TCO reduction effect.

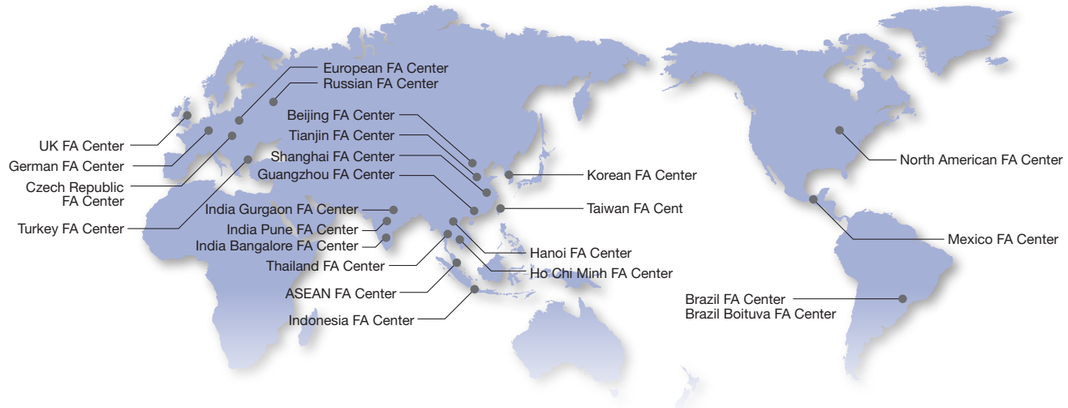
◎A CNC structured in building block method on iQ Platform.
◎High performance CNC integrated with high-speed PLC offers high-speed control to reduce cycle time.
◎A wide variety of FA products helps construct flexible lines.

Product specifications

| | |
|---|---|
| Maximum number of control axes (NC axis + spindle + PLC axis) | 16 axes |
| Maximum number of part system | Machining center system: 7 systems, Lathe system: 3 systems |
| Maximum number of NC axes per part system | 8 axes |
| Maximum program capacity | 2,000 kB (5,120 m) |
| Maximum number of files to store | 124 files/252 files |
| Number of input/output points | 4,096 points |
| Safety observation function | Safety signal comparison function, speed monitoring function, duplexed emergency stop |

For detailed information, please refer to: http://www.mitsubishielectric.com/fa/worldwide/index.html

## •International FA Center




**•Shanghai FA Center**
**MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD.**
10F, Mitsubishi Electric Automation Center, No.1386 Hongqiao Road, Changning District, Shanghai, China
TEL. 86-21-2322-3030
FAX. 86-21-2322-3000 (9611#)

**•Beijing FA Center**
**MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD.**
**Beijing Office**
Unit 908, Office Tower 1, Henderson Centre, 18 Jianguomennei Avenue, Dongcheng District, Beijing, China
TEL. 86-10-6518-8830
FAX. 86-10-6518-3907 (Before Service)
FAX. 86-10-6518-2938 (After Service)

**•Tianjin FA Center**
**MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD.**
**Tianjin Office**
Room 2003 City Tower, No.35, Youyi Road, Hexi District, Tianjin, China
TEL. 86-22-2813-1015
FAX. 86-22-2813-1017

**•Guangzhou FA Center**
**MITSUBISHI ELECTRIC AUTOMATION (CHINA) LTD.**
**Guangzhou Office**
Room 1609, North Tower, The Hub Center, No.1068, Xingang East Road, Haizhu District, Guangzhou, China
TEL. 86-20-8923-6730
FAX. 86-20-8923-6715

**•Korean FA Center**
**MITSUBISHI ELECTRIC AUTOMATION KOREA CO., LTD.**
B1F, 2F, 1480-6, Gayang-Dong, Gangseo-Gu, Seoul, 157-200, Korea
TEL. 82-2-3660-9630
FAX. 82-2-3663-0475

**•Taiwan FA Center**
**MITSUBISHI ELECTRIC TAIWAN CO.,LTD.**
No.8-1, Industrial 16th Road, Taichung Industrial Park, Taichung City 40768 Taiwan, R.O.C.
TEL. 886-4-2359-0688
FAX. 886-4-2359-0689

**SETSUYO ENTERPRISE CO., LTD.**
3F, No.105, Wugong 3rd Road, Wugu District, New Taipei City 24889, Taiwan, R.O.C.
TEL. 886-2-2299-9917
FAX. 886-2-2299-9963

**•Thailand FA Center**
**MITSUBISHI ELECTRIC FACTORY AUTOMATION (THAILAND) CO., LTD.**
12th Floor, SV.City Building, Office Tower 1, No. 896/19 and 20 Rama 3 Road, Kwaeng Bangpongpang, Khet Yannawa, Bangkok 10120, Thailand
TEL. 66-2682-6522
FAX. 66-2682-6020

**•ASEAN FA Center**
**MITSUBISHI ELECTRIC ASIA PTE. LTD.**
307, Alexandra Road, Mitsubishi Electric Building, Singapore 159943
TEL. 65-6470-2480
FAX. 65-6476-7439

**•Indonesia FA Center**
**PT. MITSUBISHI ELECTRIC INDONESIA**
Gedung Jaya 11th Floor, JL MH. Thamrin No.12, Jakarta, Pusat 10340, Indonesia
TEL. 62-21-3192-6461
FAX. 62-21-3192-3942

**•Hanoi FA Center**
**MITSUBISHI ELECTRIC VIETNAM COMPANY LIMITED**
**Hanoi Branch**
Unit 9-05, 9th Floor, Hanoi Central Office Building, ]
44B Ly Thuong Kiet Street, Hoan Kiem District, Hanoi City, Vietnam
TEL. 84-4-3937-8075
FAX. 84-4-3937-8076

**•Ho Chi Minh FA Center**
**MITSUBISHI ELECTRIC VIETNAM COMPANY LIMITED**
Unit 01 - 04, 10th Floor, Vincom Center, 72 Le Thanh Ton Street, District 1, Ho Chi Minh City, Vietnam
TEL. 84-8-3910-5945
FAX. 84-8-3910-5947

**•India Pune FA Center**
**MITSUBISHI ELECTRIC INDIA PVT. LTD. Pune Branch**
Emerald House, EL-3, J Block, M.I.D.C., Bhosari, Pune, 411026, Maharashtra State, India
TEL. 91-20-2710-2000
FAX. 91-20-2710-2100

**•India Gurgaon FA Center**
**MITSUBISHI ELECTRIC INDIA PVT. LTD.**
**Gurgaon Head Office**
2nd Floor, Tower A & B, Cyber Greens, DLF Cyber City, DLF Phase - Ⅲ, Gurgaon - 122002 Haryana, India
TEL. 91-124-463-0300
FAX. 91-124-463-0399

**•India Bangalore FA Center**
**MITSUBISHI ELECTRIC INDIA PVT. LTD.**
**Bangalore Branch**
Prestige Emerald, 6th Floor, Municipal No.2, Madras Bank Road, Bangalore 560001, India
TEL. 91-80-4020-1600
FAX. 91-80-4020-1699

**•North American FA Center**
**MITSUBISHI ELECTRIC AUTOMATION, INC.**
500 Corporate Woods Parkway, Vernon Hills, IL 60061, U.S.A.
TEL. 1-847-478-2334
FAX. 1-847-478-2253

**•Mexico FA Center**
**MITSUBISHI ELECTRIC AUTOMATION, INC.**
**Mexico Branch**
Mariano Escobedo #69, Col.Zona Industrial, Tlalnepantla Edo, C.P.54030, Mèxico
TEL. 52-55-3067-7511

**•Brazil FA Center**
**MITSUBISHI ELECTRIC DO BRASIL COMÉ RCIO E SERVIÇOS LTDA.**
Rua Jussara, 1750 - Bloco B- Sala 01 Jardim Santa Cecilia- CEP 06465-070, Barueri, Sao Paulo, Brazil
TEL. 55-11-4689-3000
FAX. 55-11-4689-3016

**•Brazil Boituva FA Center**
**MELCO CNC DO BRASIL COMÉRCIO E SERVIÇOS S.A.**
Acesso Jose Sartorelli, KM 2.1 CEP 18550-000 Boituva-SP, Brasil
TEL. 55-15-3363-9900
FAX. 55-15-3363-9911

**•European FA Center**
**MITSUBISHI ELECTRIC EUROPE B.V. Polish Branch**
32-083 Balice ul. Krakowska 50, Poland
TEL. 48-12-630-47-00
FAX. 48-12-630-47-01

**•German FA Center**
**MITSUBISHI ELECTRIC EUROPE B.V. German Branch**
Gothaer Strasse 8, D-40880 Ratingen, Germany
TEL. 49-2102-486-0
FAX. 49-2102-486-1120

**•UK FA Center**
**MITSUBISHI ELECTRIC EUROPE B.V. UK Branch**
Travellers Lane, Hatfield, Hertfordshire, AL10 8XB, U.K.
TEL. 44-1707-28-8780
FAX. 44-1707-27-8695

**•Czech Republic FA Center**
**MITSUBISHI ELECTRIC EUROPE B.V. Czech Branch**
Avenir Business Park, Radicka 751/113e, 158 00 Praha5, Czech Republic
TEL. 420-251-551-470
FAX. 420-251-551-471

**•Russian FA Center**
**MITSUBISHI ELECTRIC EUROPE B.V. Russian Branch**
**St. Petersburg office**
Piskarevsky pr. 2, bld 2, lit "Sch", BC "Benua", office 720; 195027, St. Petersburg, Russia
TEL. 7-812-633-3497
FAX. 7-812-633-3499

**•Turkey FA Center**
**MITSUBISHI ELECTRIC TURKEY A.Ş Ü mraniye Branch**
Şerifali Mahallesi Nutuk Sokak No:5 TR-34775 Ümraniye, İstanbul, Türkey
TEL. 90-216-526-3990
FAX. 90-216-526-3995

## ⚠ Safety Warning

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

**MITSUBISHI ELECTRIC CORPORATION**

HEAD OFFICE: TOKYO BLDG., 2-7-3, MARUNOUCHI, CHIYODA-KU, TOKYO 100-8310, JAPAN

L(NA)06080ENG-A(1310)MEE