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

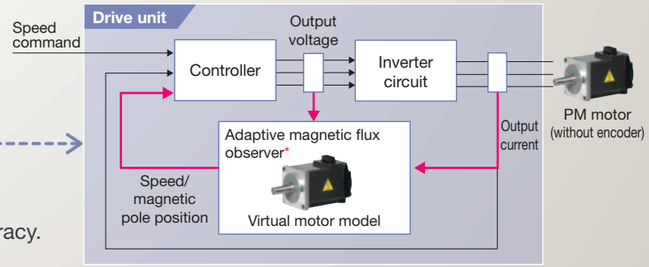
High accuracy even with no encoder

No encoder means compact size

PM sensorless vector control image

PM sensorless vector control

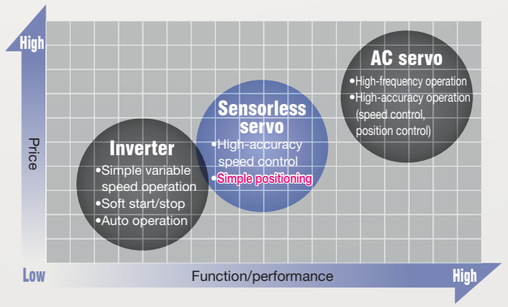
Magnetic pole position and speed are detected without the use of a sensor (encoder).
A PM motor (magnet motor) is driven in high-accuracy.



*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



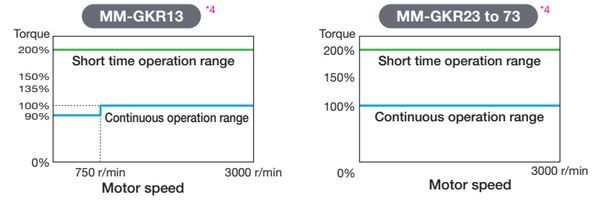
	Inverter	Sensorless servo	AC servo
Control amp	FR-E700 / FR-A700	FR-E700EX	MR-J4
	General-purpose inverter	Sensorless servo dedicated drive unit	General-purpose servo amplifier
Motor	General-purpose motor / Geared motor	Sensorless PM motor	Servo motor
	Induction motor (IM)	PM motor	
	Without encoder		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

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.



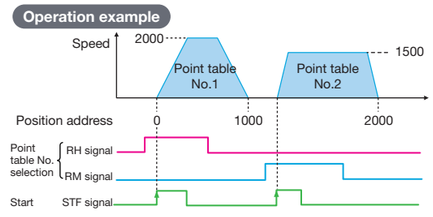
Positioning possible without encoder

- 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%
Speed regulation = (speed with no load - speed with rated load) / rated speed x 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.

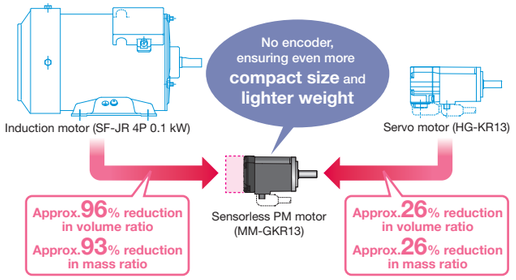
*5: Not compatible with absolute position detection system.

*6: If input voltage of 200 to 220 VAC, and wiring length of 5 m or shorter.

No encoder means compact size

Compact size

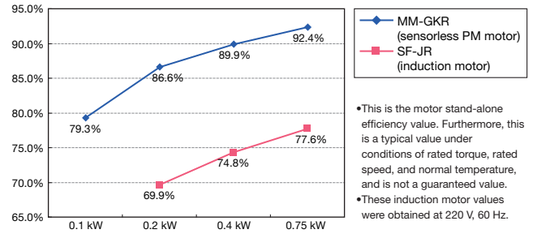
- Compact, lightweight motor with no encoder also contributes to machine downsizing.
- No cooling fan, ensuring low noise. Ideal for use in clean rooms.



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.

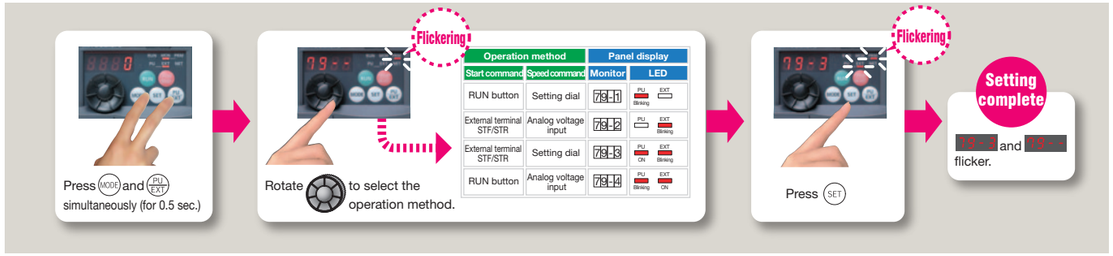
Full of easy-to-use functions

Compact, high-performance drive unit

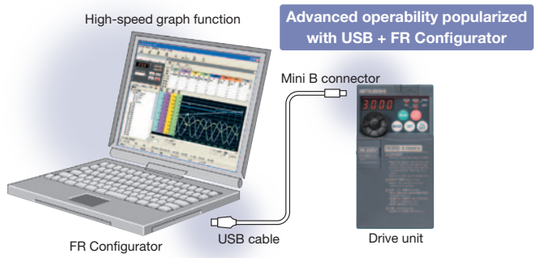
Outstanding operability

•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.

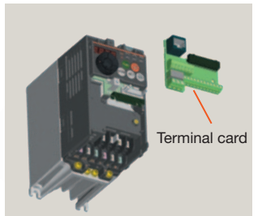
*2: Surrounding air temperature: annual average 40°C (there should be no corrosive gas, flammable gas, oil mist, or dust)
Output current: motor rated current
The design life is a calculated value, not a guaranteed value.

•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



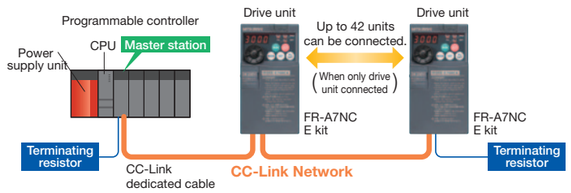
Side-by-side space saving installation

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)

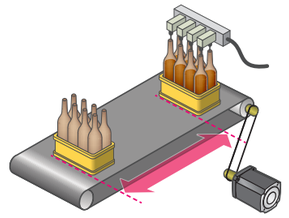
• Mitsubishi programmable controllers (Q, FX, L Series, etc.) can be connected via CC-Link. Drive units can be operated, operation monitored, and parameters changed from the programmable controller.



Application examples

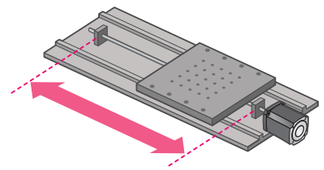
•Filling machines (transfer conveyor) — Position control

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.



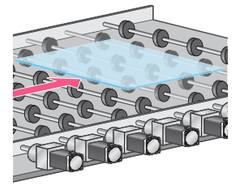
•Conveyors (ball screw) — Position control

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.



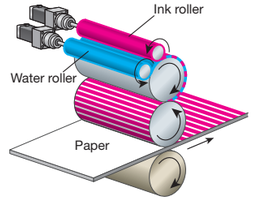
•Glass substrate conveyance — Speed control

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.



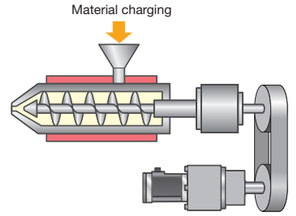
•Printing machines — Speed control

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.



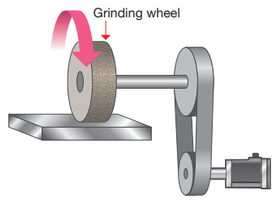
•Raw material supply machines, extruders — Speed control

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

AC power supply
Use within the permissible power supply specifications of the drive unit.

Moulded case circuit breaker (MCCB) or earth leakage circuit breaker (ELB), fuse
The breaker must be selected carefully since an inrush current flows in the drive unit at power on.
Refer to page 43

Magnetic contactor (MC)
Install the magnetic contactor to ensure safety. Do not use this magnetic contactor to start and stop the drive unit. Doing so will cause the drive unit life to be shorten.
Refer to page 43

AC reactor (FR-HAL)
Refer to page 37

DC reactor (FR-HEL)*
Refer to page 38

Noise filter (ferrite core)* (FR-BSF01, FR-BLF)
Refer to page 39

Noise filter (capacitor)* (FR-BIF)
Refer to page 38

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

Parameter unit (FR-PU07)
Refer to page 25

Enclosure surface operation panel (FR-PA07)
Refer to page 37

USB connector
A personal computer and a drive unit can be connected with a USB (Ver1. 1) cable. Parameter setting and monitoring can be performed by FR Configurator (FR-SW3-SETUP-W□) (will be supported soon).
Refer to page 26

Drive unit (FR-E700EX)

P/+ P1
R/L1 S/L2 T/L3
P/+ N/-
Earth (Ground)

Brake resistor (FR-ABR, MRS type)
Refer to page 40

P/+
PR

U V W

Noise filter (ferrite core) (FR-BSF01, FR-BLF)
Refer to page 39

Magnetic motor starter Example) No-fuse switch (DSN type)
Install a contactor in an application where the PM motor is driven by the load even at power-OFF of the drive unit. Do not open or close the magnetic motor starter while the drive unit is running (outputting).
Refer to page 46

Power supply cable (Servo motor power supply cable (option))
Refer to page 42

Motor (MM-GKR)

High power factor converter (FR-HC2)
Refer to page 41

Power regeneration common converter (FR-CV)
Refer to page 41

Brake unit (FR-BU2)
Refer to page 40

: 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

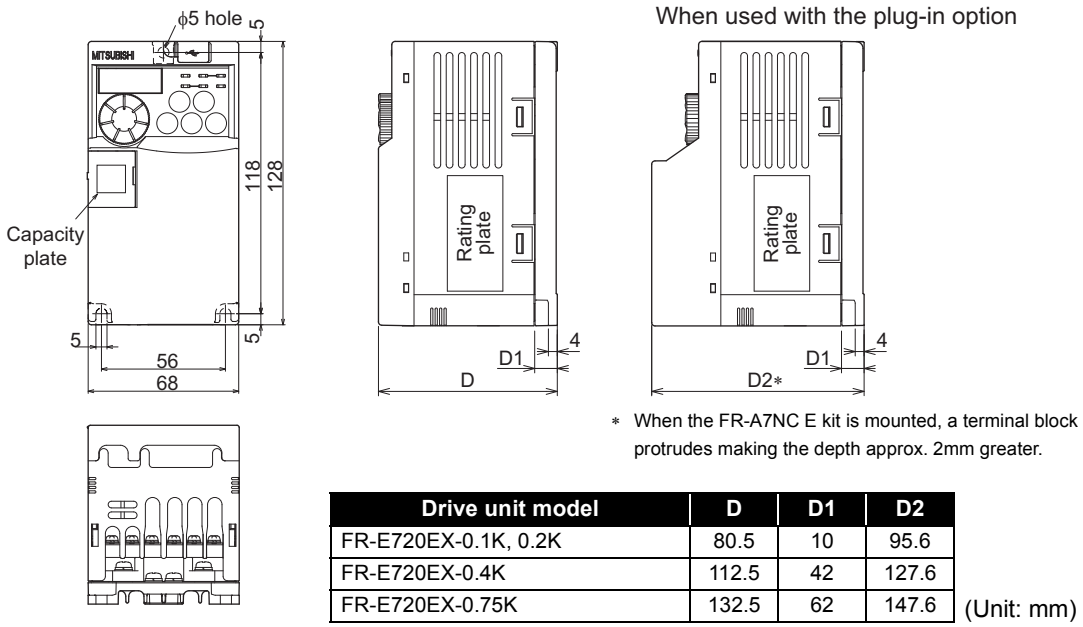
●Three-phase 200V power supply

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



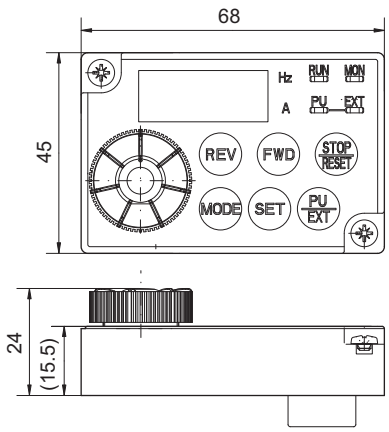
* When the FR-A7NC E kit is mounted, a terminal block protrudes making the depth approx. 2mm greater.

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

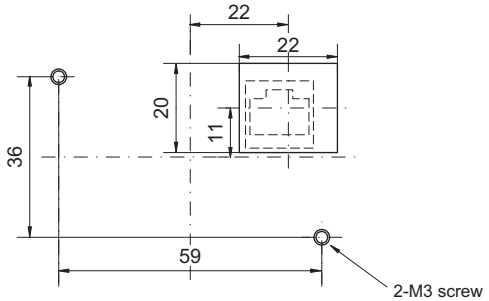
(Unit: mm)

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

<Outline drawing>



<Panel cut dimension drawing>



(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) 6r/min/3000r/min (terminal2, 4: 0 to 5V/9-bit) 3r/min/3000r/min (terminal4: 0 to 20mA/10-bit)
			Digital input	1r/min
		Analog speed command input		Two terminals Terminal 2: 0 to 10V, 0 to 5V can be selected 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) 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 Open collector output (Two terminals) 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 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. Pulse train output (1440 pulses/s/full scale).

Indication	Operation panel 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

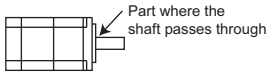
*1 The above characteristics apply when the rated AC voltage is input from the drive unit. Output and rated motor speed are not guaranteed when the power supply voltage drops.

*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).

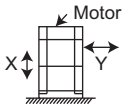
*3 When the motor is used with a machine that produces unbalanced torque such as an elevating axis, the unbalanced torque should be 70% of the rated torque or lower.

*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.

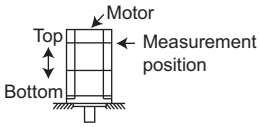


*6 X indicates the direction of the motor's output shaft, and Y indicates the direction vertical to the motor's output shaft. Usually, the indicated value is of the non-load side bracket where the vibration is the greatest.
Bearing is subject to fretting while the motor is stopped. Suppress the vibration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

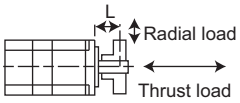


*7 The standard motor may not be used under the condition where it is constantly exposed to oil mist, oil, or water. For the details, please contact your sales representative.

*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.

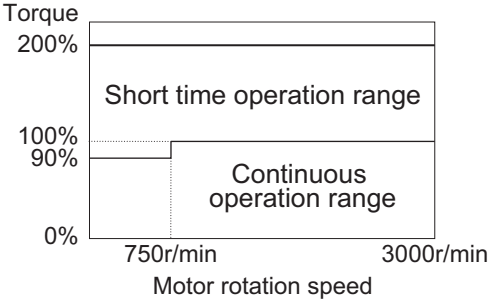
∗2 If the value exceeds the described value, please contact your sales representative.

∗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.

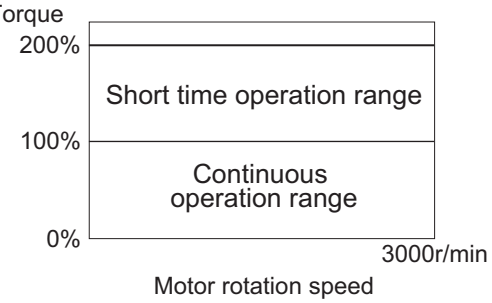
∗4 The following conversion formula is used for the unit conversion of the backlash: 1 minute = 0.0167°

Motor torque characteristic

●MM-GKR13



●MM-GKR23 to 73

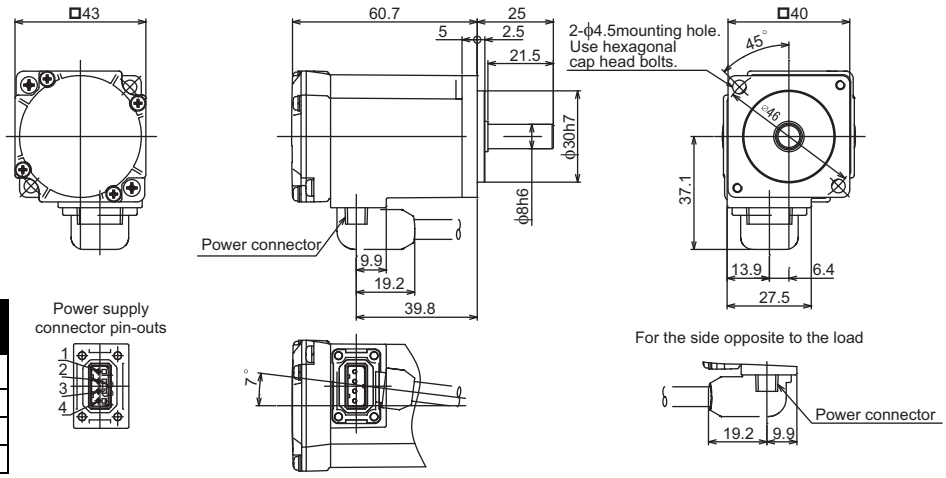


•When the input voltage is low, the torque may be reduced.

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

Outline drawing of motors

●MM-GKR13

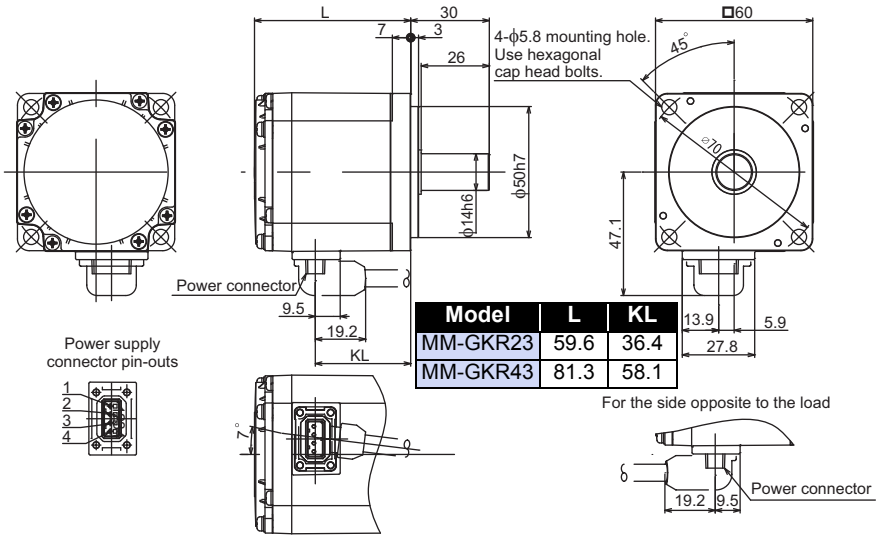


Pin No.	Signal name
1	⏚(PE)
2	U
3	V
4	W

Power supply connector pin-outs

(Unit: mm)

●MM-GKR23, 43



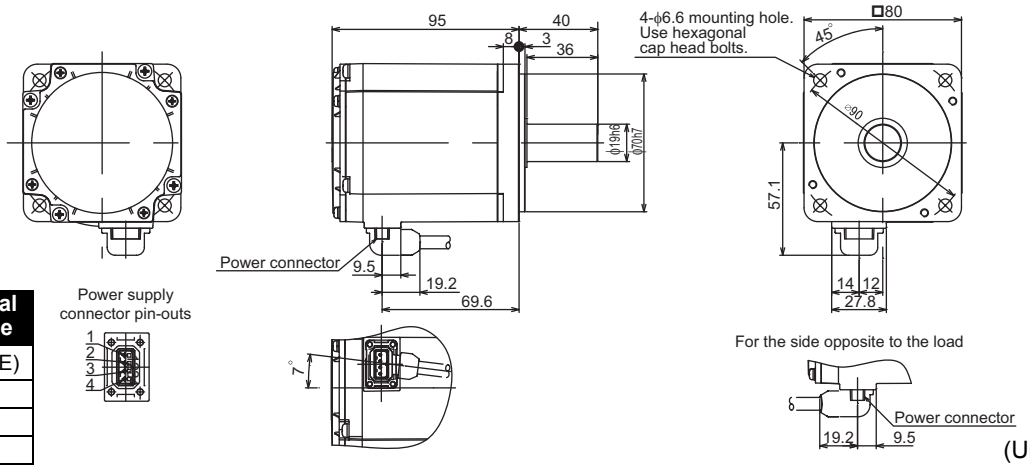
Model	L	KL
MM-GKR23	59.6	36.4
MM-GKR43	81.3	58.1

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)

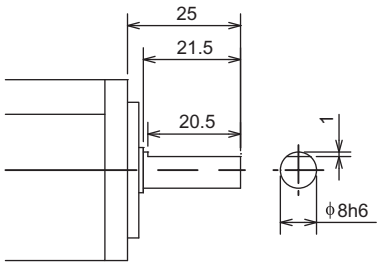
NOTE

- **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

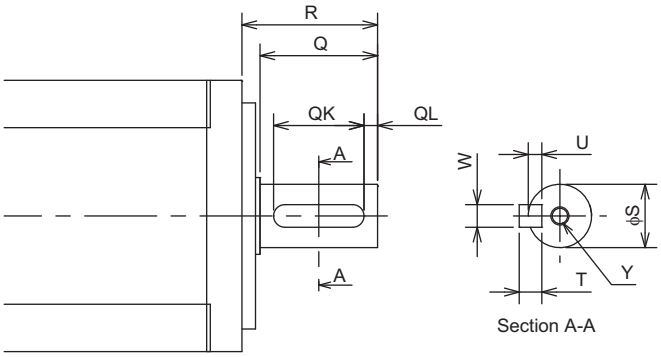
Motors with the following specifications (with dedicated shaft end) are available by request.

D-cut shaft ∗1 ...100W



(Unit: mm)

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



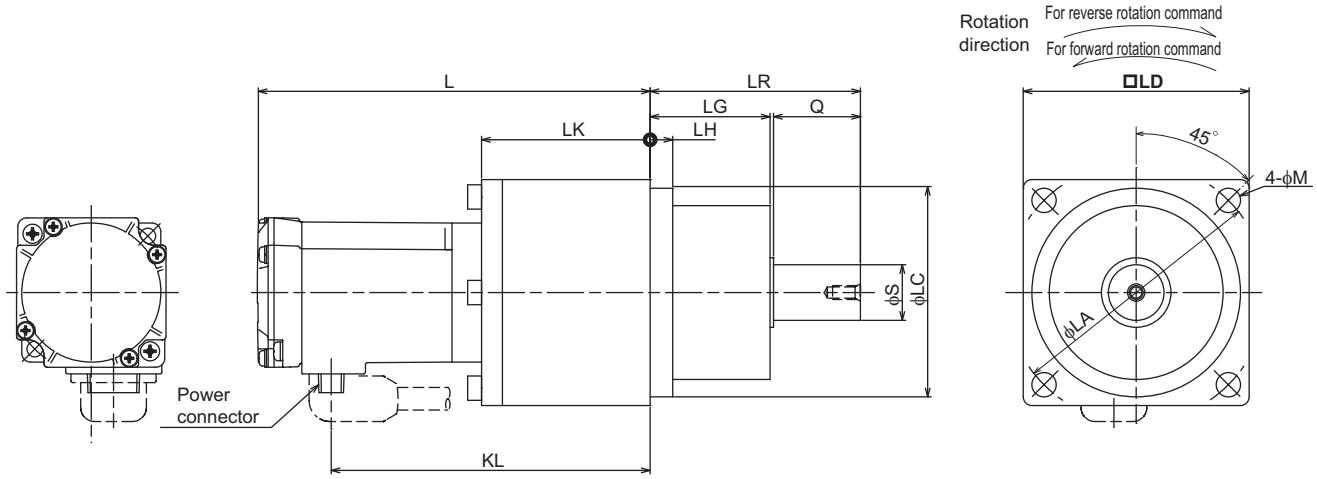
(Unit: mm)

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

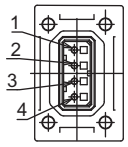
∗1 The motors with dedicated shaft end are not suitable for frequent start/stop applications. Such an operation may result in a fracture of the shaft due to rattling of the key.

∗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.

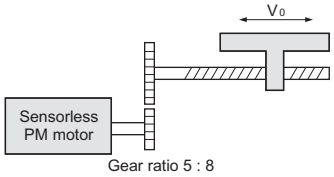
●Dedicated specifications for the reduction-gear-equipped MM-GKR series motor

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	ℓ = 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

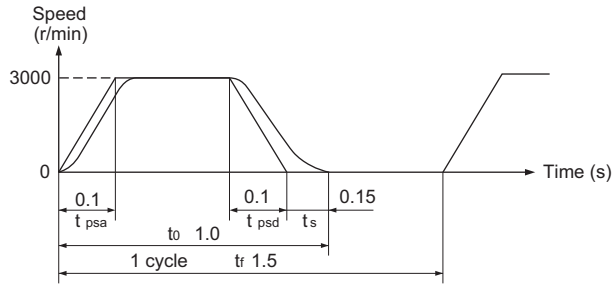
$$N_0 = \frac{V_0}{P_B} \times \frac{1}{1/n} = \frac{30000}{16} \times \frac{8}{5} = 3000 \text{ (r/min)}$$

- 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



(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)

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

- 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 ($\times 10^{-4}$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.

- Continuous effective load torque

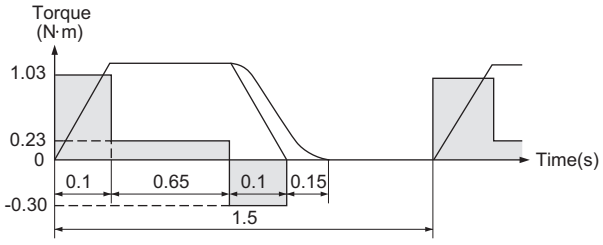
$$T_{rms} = \sqrt{\frac{T_{Ma}^2 \times t_{psa} + T_L^2 \times t_c + T_{Md}^2 \times t_{psd}}{t_f}} = 0.32 \text{ (N·m)}$$

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

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.

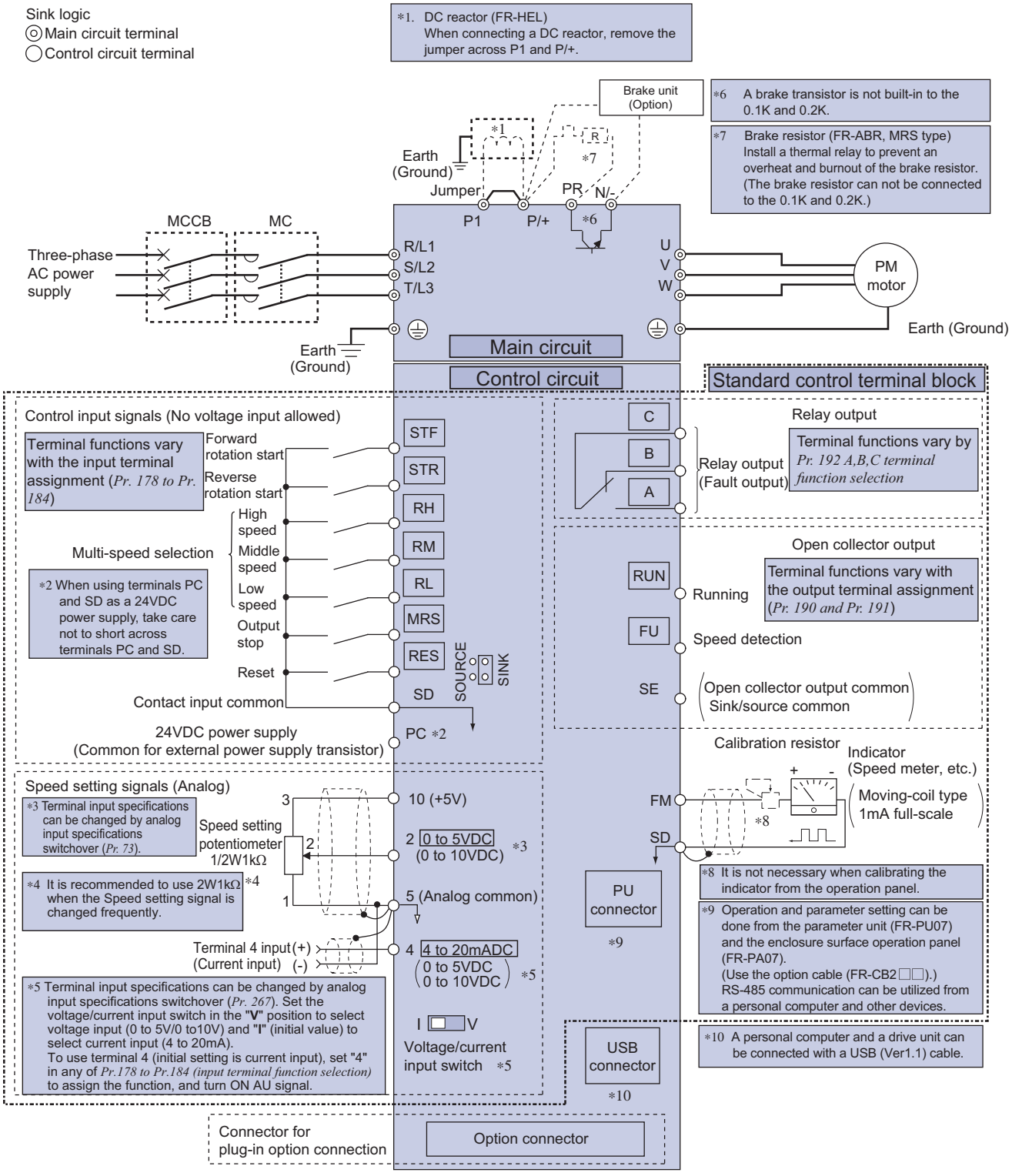
- Torque pattern



- Result

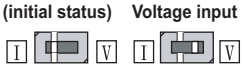
Based on the above, select the following.
Sensorless PM motor MM-GKR23
Drive unit FR-E720EX-0.2K
(The software for capacity selection will be provided at free of charge.)(To be available soon.)

●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.

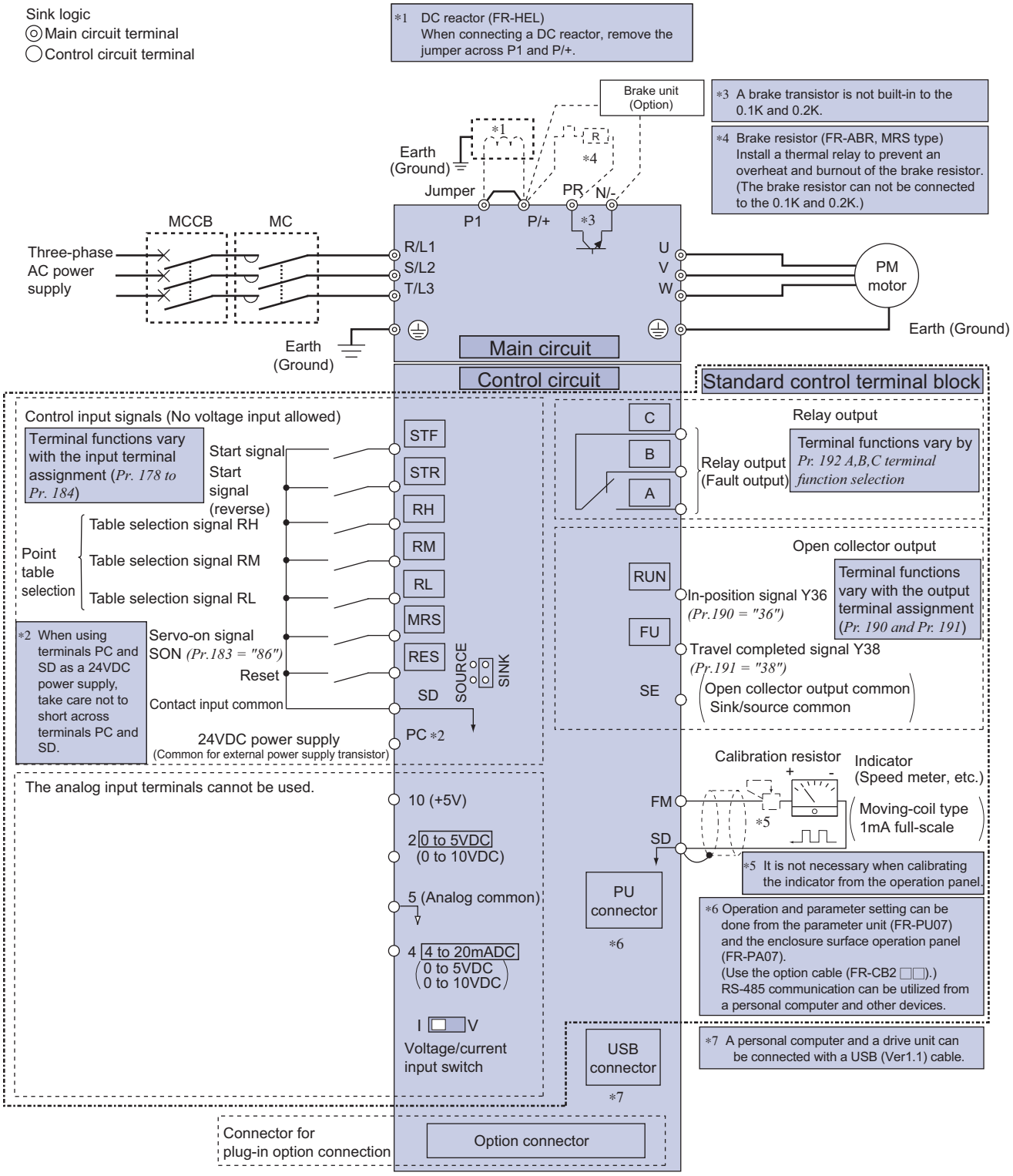
Type		Terminal Symbol	Terminal Name	Description	
Main circuit		R/L1, S/L2, T/L3	AC power input	Connect to the commercial power supply. Keep these terminals open when using the high power factor converter (FR-HC2) or power regeneration common converter (FR-CV).	
		U, V, W	Drive unit output	Connect a PM motor.	
		P/+, PR	Brake resistor connection	Connect a brake resistor (MRS type, FR-ABR) across terminals P/+ and PR. (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. 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 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 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). **Current input (initial status)** **Voltage input** 	Voltage input: Input resistance 10kΩ ± 1kΩ Permissible maximum voltage 20VDC Current input: Input resistance 233Ω ± 5Ω 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. 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) * 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 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. · Conforming standard: EIA-485 (RS-485) · Transmission format: Multi-drop link · 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. · Interface: conforms to USB1.1 · Transmission Speed: 12Mbps · 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.

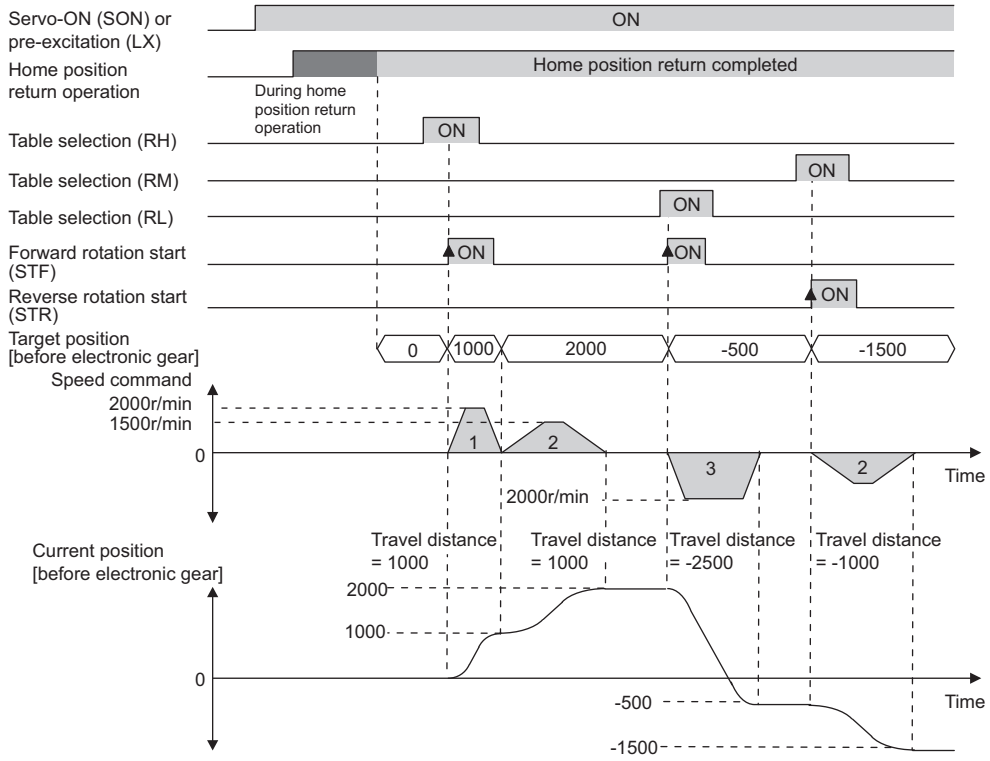
Setting value		Signal name	Function	Operation
Positive logic	Negative logic			
24	124	LP	Stroke limit warning	The stroke limit warning signal (LP signal) is output when the LSP or LSN signal is OFF (normally closed input).
36	136	Y36	In-position signal	This signal is output when the number of droop pulses 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	O	×	×
2	1000	1500r/min	2s	2s	Plus	Increment	Independent	×	O	×
3	500	2000r/min	1s	1s	Minus	Absolute position	Independent	×	×	O

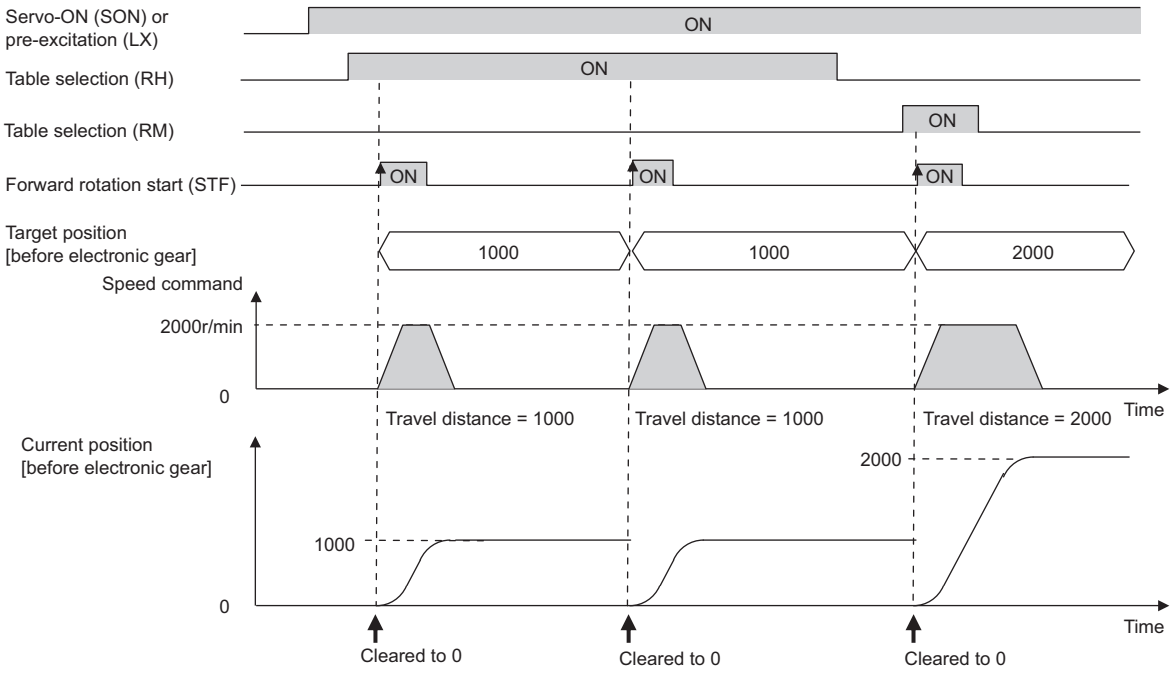
(O: ON, ×: OFF)



- 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.

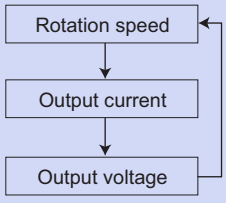
Unit indicator
• Hz: ON to indicate frequency.
(Flickers when the set frequency monitor is displayed.)
• A: ON to indicate current.
(Both "Hz" and "A" turn OFF when other than the above is displayed.)

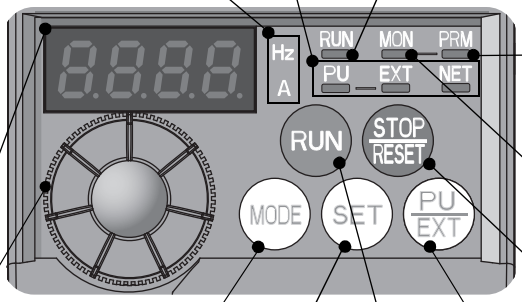
Monitor (4-digit LED)
Shows the speed, parameter number, etc.

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.

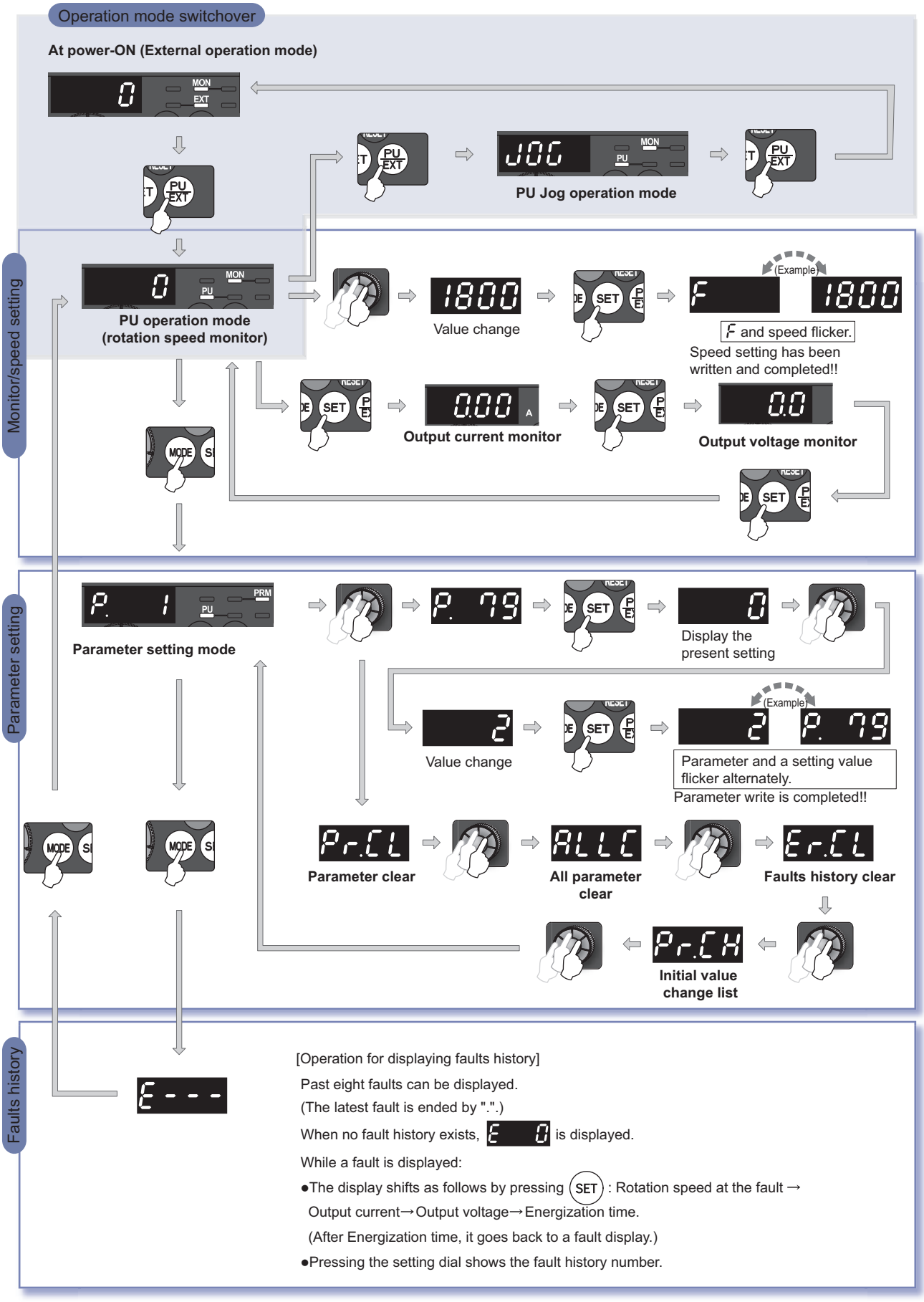
Monitor indication
ON to indicate monitoring mode.

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

Key	Description
PrSET	Used for parameter setting. Press to choose the parameter setting mode.
MON	First priority monitor is displayed. In the initial setting, the output frequency is displayed.
ESC	Operation cancel key
FUNC	Used to display the function menu. 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. · Press either of these keys on the parameter setting mode screen to change the parameter setting value sequentially. · On the setting screen, these keys are used to move the cursor. · 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. · Used to reset the drive unit when an alarm occurs.
WRITE	· Used to write a set value in the setting mode. · 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. · Used as a parameter number read key in the setting mode. · Used as an item select key on the menu screen such as parameter list or monitoring list. · Used as an alarm definition display key in the alarm history display mode. · 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. 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. 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. 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.

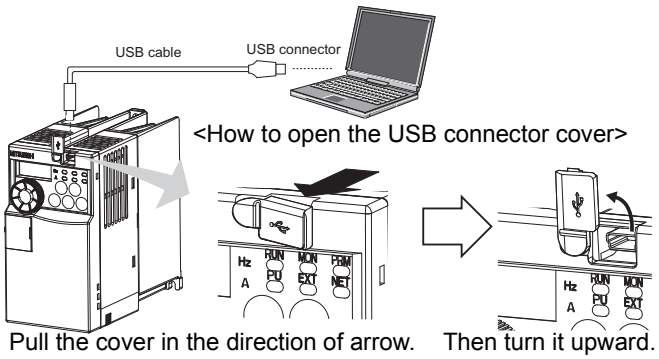
FR-SW3-SETUP-WE

(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

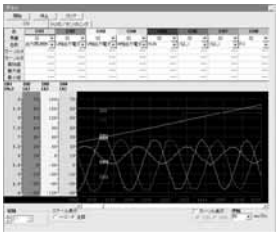
From station number to parameter setting, setting with wizard style dialog (interactive) is available.
Procedure for Easy Setup
(1) System File setting
(2) Communication setting
(3) Drive unit recognition
(4) Control method selection
(5) Motor setting
(6) Start command, frequency command setting
(7)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

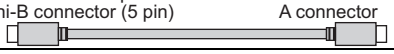
When a fault occurs, the drive unit trips and the PU display automatically changes to one of the following fault or alarm indications.
The error message shows an operational error. It does not trip the drive unit.
Warnings are messages given before faults occur. It does not trip the drive unit.
When 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.	nr
	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.	E.ILF
	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.	E.IOH
	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.AIE
	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. ☐ indicates a cable length. (1m, 3m, or 5m)	
		USB cable	MR-J3USBCBL3M 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). Brake unit, electrical-discharge resistor and resistor unit are used in combination.	0.4K or higher
		Power regeneration common converter Stand-alone reactor dedicated for the FR-CV	FR-CV 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 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

Enclosure surface operation panel FR-PA07

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

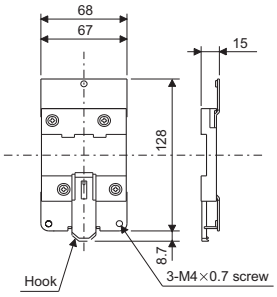
Item	Specifications
Surrounding air temperature	-10°C to +50°C (non-freezing)
Ambient humidity	90%RH or less (non-condensing)
Storage temperature	-20°C to +60°C
Atmosphere	Indoors (free from corrosive gas, flammable gas, oil mist, dust and dirt)
Altitude/vibration	Maximum 1,000m above sea level. 5.9m/s^2 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



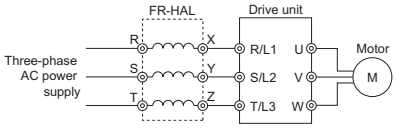
(Unit: mm)

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.

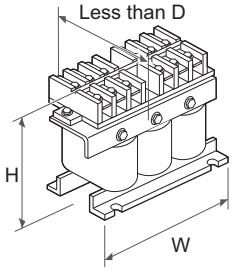
- Connection diagram



- 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.

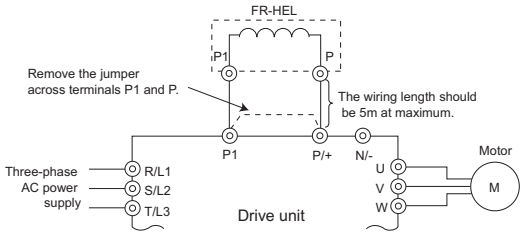
● Selection method

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.)

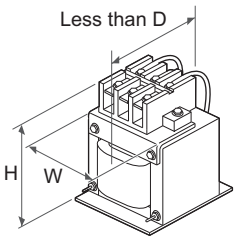
The connection cable between the reactor and the drive unit should be as short as possible (5m or less).



● 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

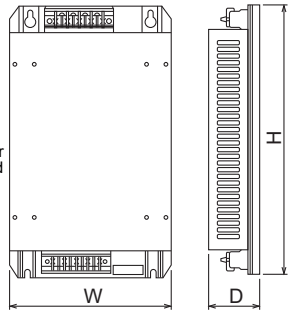


(Note)1. Be sure to remove the jumper across the drive unit terminals P/+ and P1.
(A failure to do so will produce no power factor improving effect)
2. The wiring length between the reactor and drive unit should be within 5m.
3. The size of the cables used should be equal to or larger than that of the 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) W	H	D	Mass (kg)	Leakage Current (mA) ∗2 (Reference Value)	Loss (W)
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.

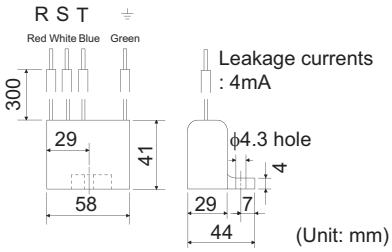
● Countermeasures for leakage current

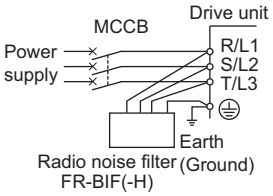
Take the following actions to prevent malfunction of peripheral devices or an electric shock caused by leakage current.

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





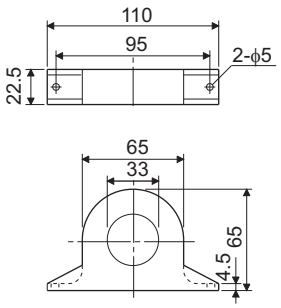
(Note) 1. Cannot be connected to the drive unit output side.
2. Wire should be cut as short as possible, and connect to the drive unit terminal block.

Name (Model)	Specifications, Structure, etc.

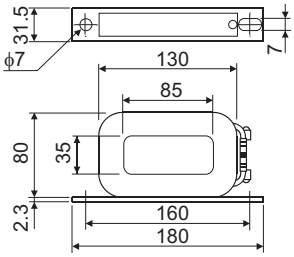
Line noise filter
FR-BSF01
(for drive units with small capacities)
FR-BLF

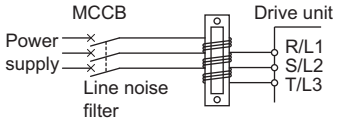
● Outline dimension

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

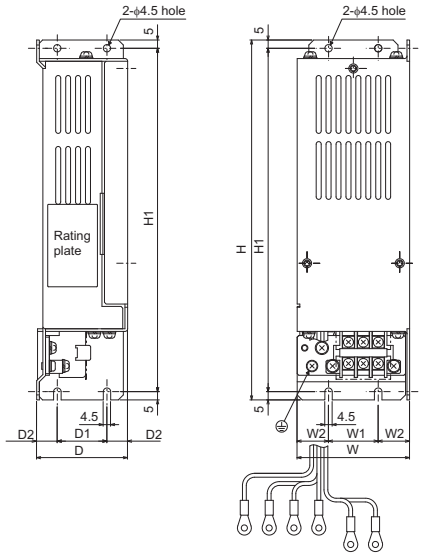
•Three-phase 200V power input model

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>



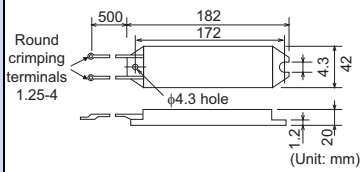
Capacity		W	W1	W2	H	H1	D	D1	D2
200V	0.4K, 0.75K	68	30	19	218	208	60	30	15

(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



(Unit: mm)

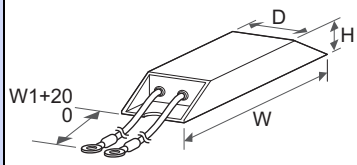
Resistor Model		Control Torque / Permissible Duty	Resistance Value (Ω)	Permissible Power (W)	Applicable Motor Capacity (kW)	Thermal RelayType (Mitsubishi Product)
200V	MRS120W200	150% torque 3%ED	200	15	0.4	TH-N20CXHZ-0.7A
	MRS120W100		100	30	0.75	TH-N20CXHZ-1.3A

(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>

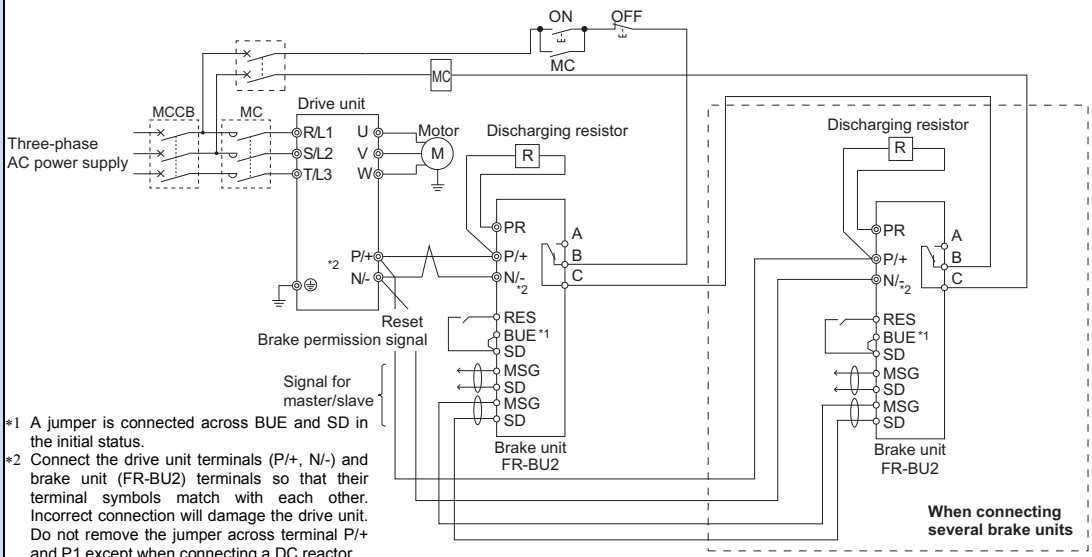
Model GRZG Type	200V GZG300W-50Ω
Number of connectable devices	one
Brake resistor total resistance value (Ω)	50
Continuous permissible power (W)	100

● 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	

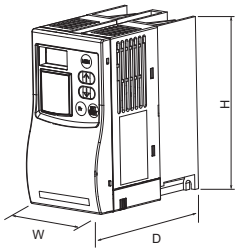
● Connection diagram



*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

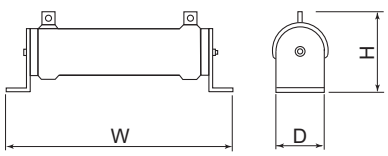
<FR-BU2>



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

(Unit: mm)

<GZG>

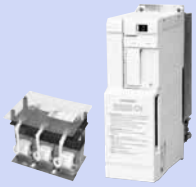


Model	W	H	D
GZG300W	335	40	78

(Unit: mm)

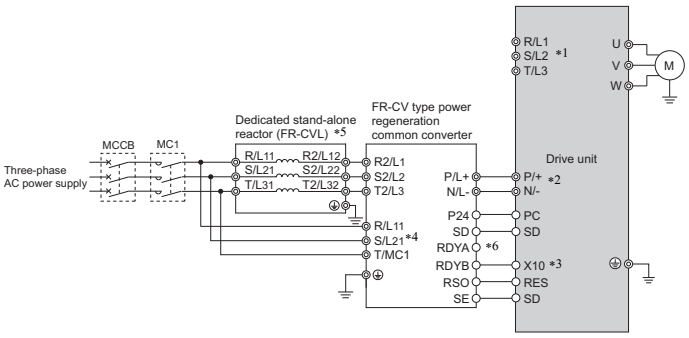
Name (Model)	Specifications, Structure, etc.

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.

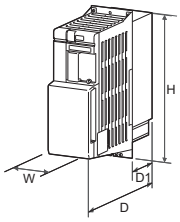
Connection diagram



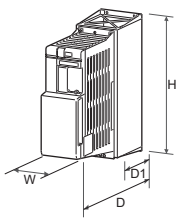
*1 Do not connect anything to the power input terminals (R/L1, S/L2, T/L3). Incorrect connection will damage the drive unit. Opposite polarity of terminals N/-, P/+ will damage the drive unit.
*2 Do not insert an MCCB between the terminals P/+-N/- (between P/L+-P/+, between N/L--N/-). Connect the drive 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>



<FR-CV-AT>



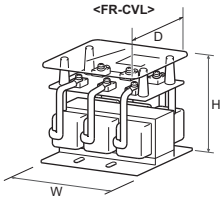
FR-CV (Unit mm)

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>



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

(FR-HCL21) (FR-HCB2) (FR-HCL22) FR-HC2 Provided appliances

- 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 200V to 230V 60Hz				
Rated input current (A)	33	61	115	215	278

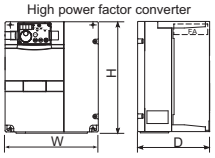
*1 The applicable capacity to the high power factor converter is the total capacity of the drive units.
*2 If a high power factor converter (FR-HC2) is purchased, it comes with reactor 1 (FR-HCL21), reactor 2 (FR-HCL22), and an outside box (FR-HCB2).

Outline dimension

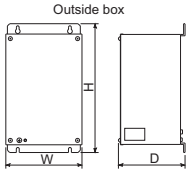
(Unit: mm)

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

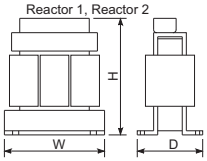
High power factor converter



Outside box

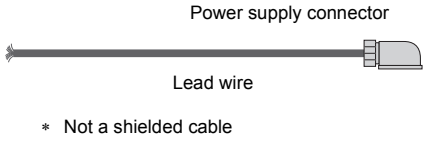
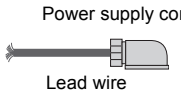


Reactor 1, Reactor 2



*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)	 ∗ 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	 ∗ 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 MR-PWS1CBL_M-A1-L MR-PWS1CBL_M-A2-H MR-PWS1CBL_M-A2-L	 Plug: KN4FT04SJ1-R Socket contact: ST-TMH-S-C1B-100-(A534G) (Japan Aviation Electronics Industry, Limited)
MR-PWS2CBL03M-A1-L MR-PWS2CBL03M-A2-L	 Plug: KN4FT04SJ2-R Socket contact: ST-TMH-S-C1B-100-(A534G) (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.

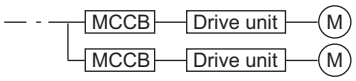
Peripheral devices/cable size list

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 0.75mm^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 (0.75mm^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 1.25mm^2 (AWG16) for extension.

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

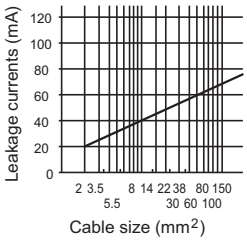
  Ig1, g2 : Leakage currents in wire path during commercial power supply operation

  Ign : Leakage current of drive unit input side noise filter

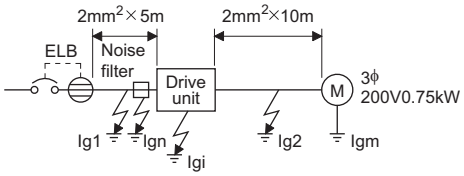
  Igm : Leakage current of motor (leakage current of MM-GKR series motor: 0mA)

  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

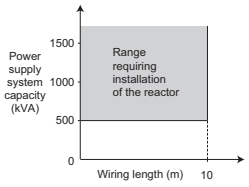
- A magnetic contactor (MC) provided on the input side should not be used to make frequent starts and stops. It could cause the drive unit to fail.
- However, at this time, the motor cannot be brought to a sudden stop. Hence, provide a mechanical stopping/holding mechanism for the machine/equipment which 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)

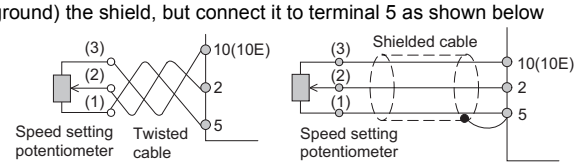
The power factor improving capacitor and surge suppressor on the drive unit output side may be overheated or damaged by the harmonic components of the drive unit output. Also, since an excessive current flows in the drive unit to activate overcurrent protection, do not install a capacitor or surge suppressor.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

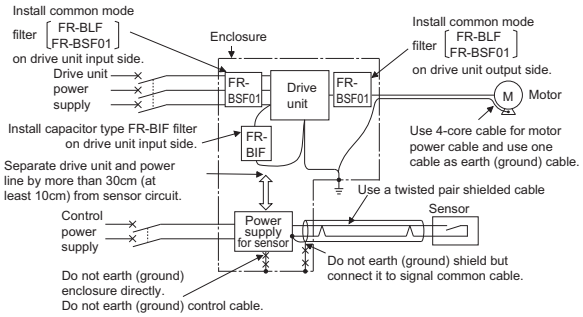
Always earth (ground) the drive unit and motor. In addition, always use the earth (ground) terminal of the drive unit to earth (ground) the drive unit. (Do not use the case and chassis)

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.

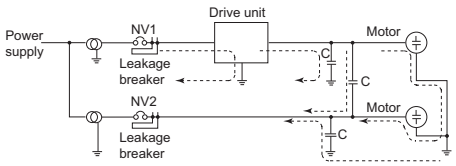
Noise reduction examples



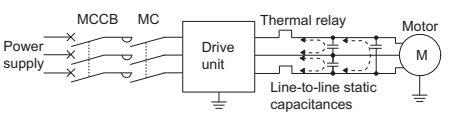
Leakage currents

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. ●Countermeasures • Use an earth leakage circuit breaker with a weak sensitivity in a high frequency range. 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. • Minimize the stray capacitance between the earth. 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. • The external thermal relay may be operated unnecessarily by the harmonics of the leakage current. ●Countermeasures • Use *Pr.9 Electronic thermal O/L relay* • 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	 **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. Reference materials • "Harmonic suppression measures of the inverter" Jan. 2004 Japan Electrical Manufacturer's Association • "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]	Fundamental Wave Current Converted from 6.6kV (mA)	Rated Capacity (kVA)	Outgoing Harmonic Current Converted from 6.6kV (mA) (No reactor, 100% operation ratio)							
	200V			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 Position control	Speed control Position control Torque control	Speed control Position control Torque control
Encoder		Without	With	With
Initial magnetic pole detection		Required (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 (internal speed command)	1: 2000 (analog speed command) 1: 5000 (internal speed command)
Command resolution/encoder resolution		5120 pulses/rev	131072 pulses/rev (Incremental)	4194304 pulses/rev (absolute)
Positioning accuracy		±1.8°	—	—
Maximum torque		200%	300%	350%
Dynamic brake		None (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 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. 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) 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.

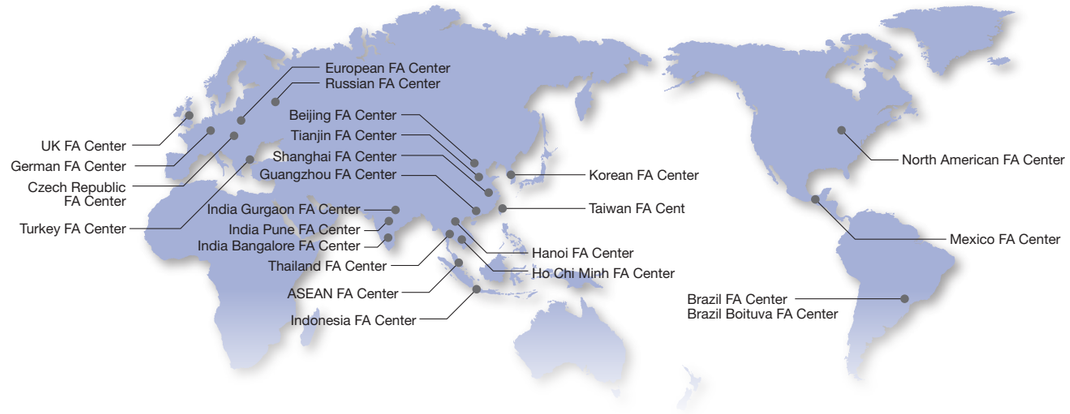
◎A CNC structured in building block method on iQ Platform.
◎High performance CNC integrated with high-speed PLC offers high-speed control to reduce cycle time.
◎A wide variety of FA products helps construct flexible lines.

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



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⚠ Safety Warning

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

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