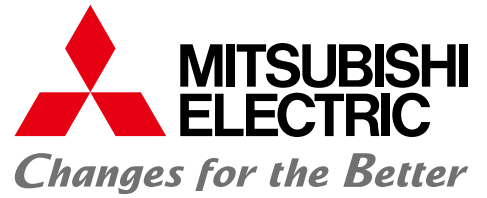




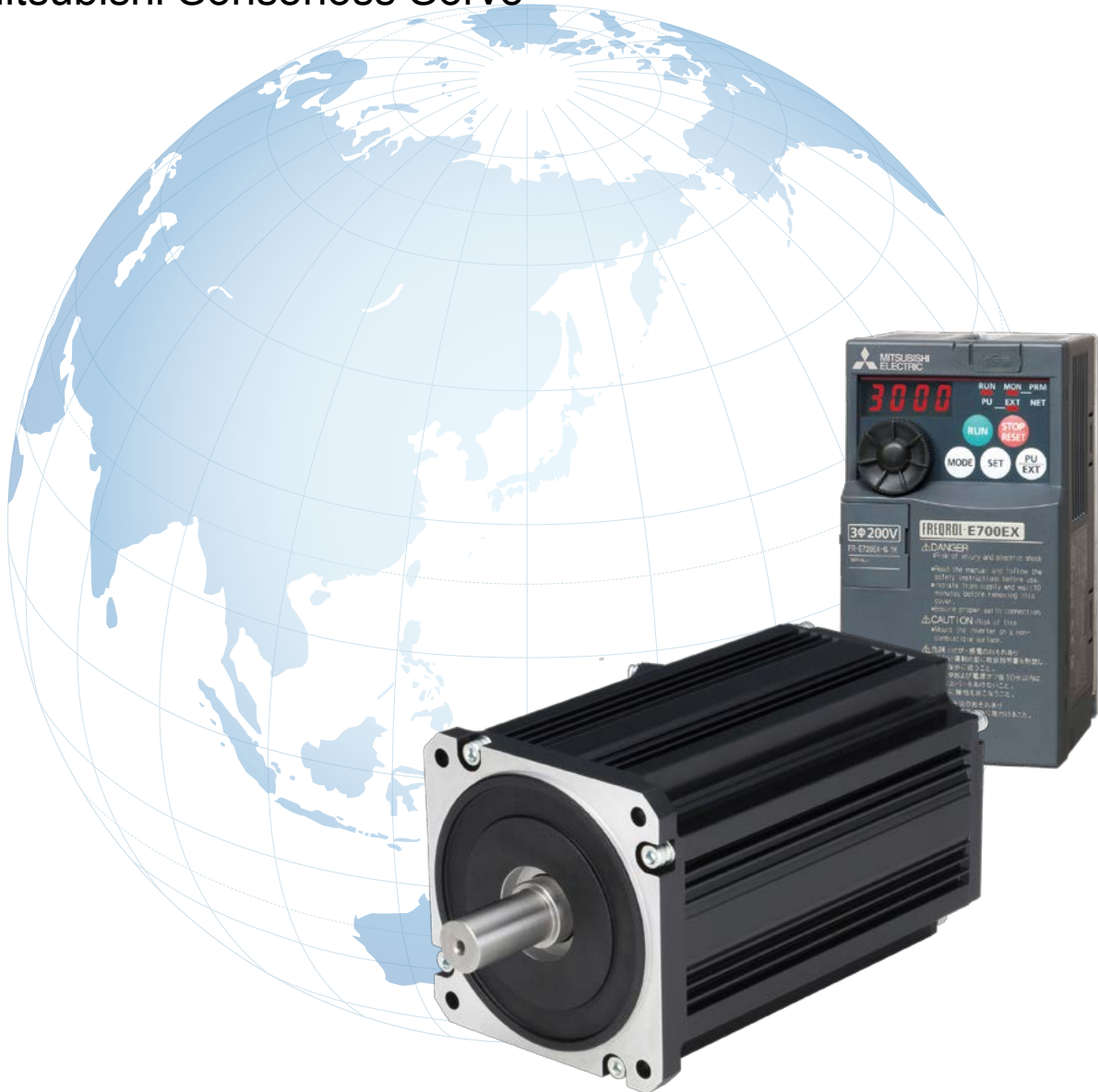
for a greener tomorrow



FACTORY AUTOMATION

# Global PM Motors EM-A Series

Mitsubishi Sensorless Servo



Mitsubishi Sensorless Servo Global PM Motors

# EM-A series



**For EM-A Series, Mitsubishi has developed a unique salient-pole core\* to realize high-performance magnetic motors that can ensure positioning and speed control without a sensor.**

\*Patent No.: 5646119

**Downsizing  
and  
energy saving**

**Globalization**

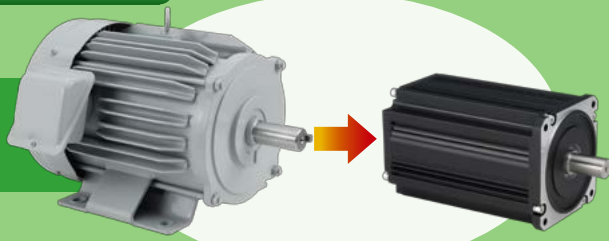
**High  
performance**



## Downsizing and energy saving

### Problems

- Downsizing of equipment
- Energy saving



### Solutions

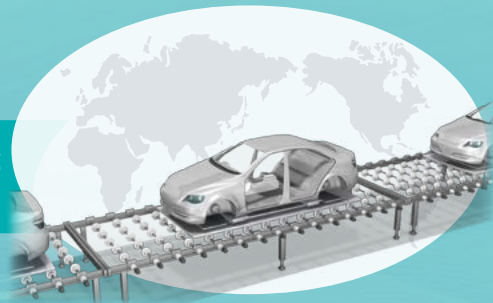
- The motors use cores with optimum shapes for sensorless control, and the motor frame numbers are lower by 1 or 2 compared to induction motors. Then, the equipment can be downsized.
- The use of the magnetic motors meeting the efficiency class\* IE5 for variable speed motors can promote energy saving.

\* According to the efficiency reference values (%) for variable speed motors (rated speed 1801 to 6000 r/min) based on IEC60034-30-2.

## Globalization

### Problems

- Use of the same motor in the equipment exported to various countries



### Solutions

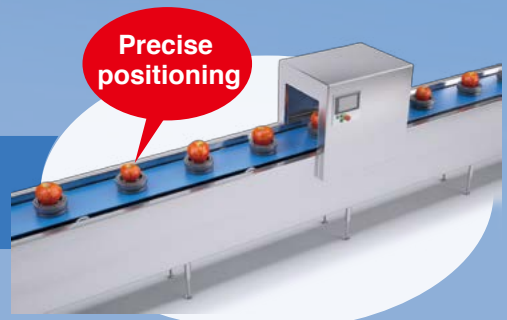
- Since the magnetic motors do not require\* the high efficiency certification in each country, they can be easily used in the equipment to be exported.
- We will receive foreign safety standard certifications (UL and CE).

\* As of March, 2019

## High performance

### Problems

- Improvement of equipment performance and cost reduction



### Solutions

- Mitsubishi's unique sensorless control realizes precise speed control comparable to that by servo motors.
- Positioning control can be achieved without a sensor (encoder).

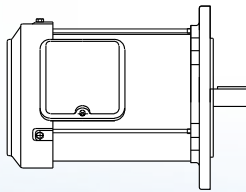
# Downsizing and energy saving

## Downsizing

- The motor core shape optimum for sensorless control realizes 50 to 60% reduction of volume and 30 to 50% reduction of mass compared to induction motors.

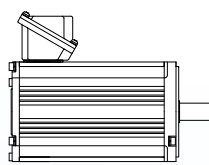
### [Comparison of volume]

Induction motor (SF-PRF, 2P, 0.75 kW)

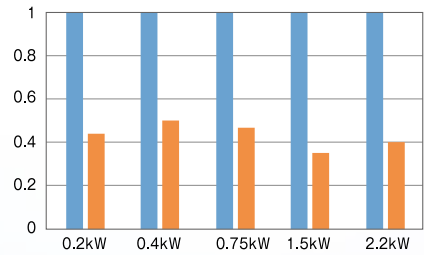


Volume ratio reduced by about 50%

EM-AMF, 0.75 kW



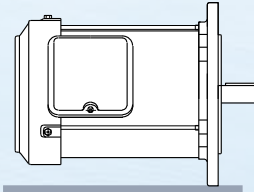
### [Volume] When the volume of induction motors is 1



Reduction of about 50% to 60%

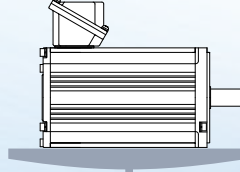
### [Comparison of mass]

Induction motor (SF-PRF, 2P, 0.75 kW)

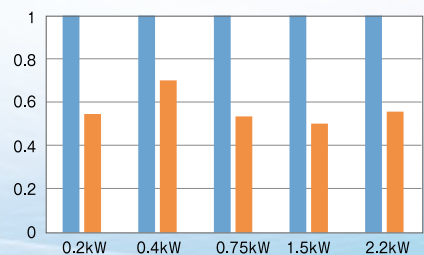


Mass ratio reduced by about 50%

EM-AMF, 0.75 kW



### [Mass] When the mass of induction motors is 1



Reduction of about 30% to 50%

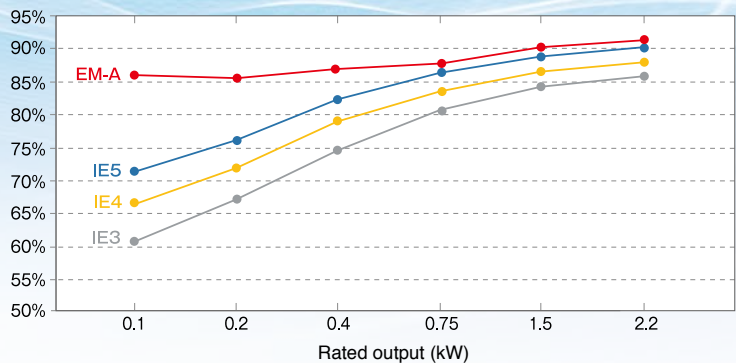
■ Induction motor ■ EM-A

## Energy saving

- Energy-saving motors meeting the efficiency class\* IE5 for variable speed motors.

\* According to the efficiency reference values (%) of variable speed motors based on IEC60034-30-2 (at the rated speed of 1801 to 6000 r/min).

Meeting the IE5 efficiency standard



- The motors consume lower electric power and contribute to the reduction of energy charge. In addition, they emit less CO<sub>2</sub> and contribute to the prevention of global warming.

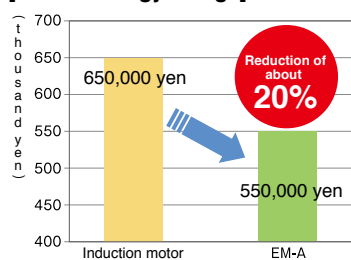
<Estimation conditions>

Efficiency value when 10 motors are operated at the rated load for 8760 hr/year (= 24 hr/day × 365 days/year), the electricity rate is 14 yen/kWh, and the CO<sub>2</sub> emissions are 0.555 kg/kWh

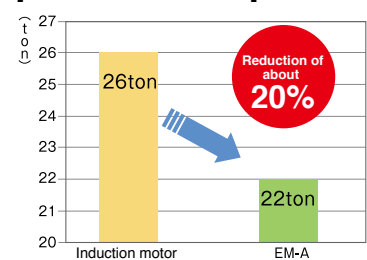
\* These data are for your reference.

For example, when 10 0.4-kW motors are used, the energy-saving efficiency is:

### [Annual energy charge]



### [Annual CO<sub>2</sub> emissions]















# Globalization

EM-A Series magnetic motors do not require\* the high efficiency certification in each country and can be easily applied to equipment to be exported.



## High efficiency regulations in each country

In 2008, the efficiency classification for induction motors (IEC60034-30) was established as an international standard, and the certification system for high efficiency regulations has been set up in each country. In the future, the high efficiency regulations will be globally applied, and it will be required to acquire the certification.

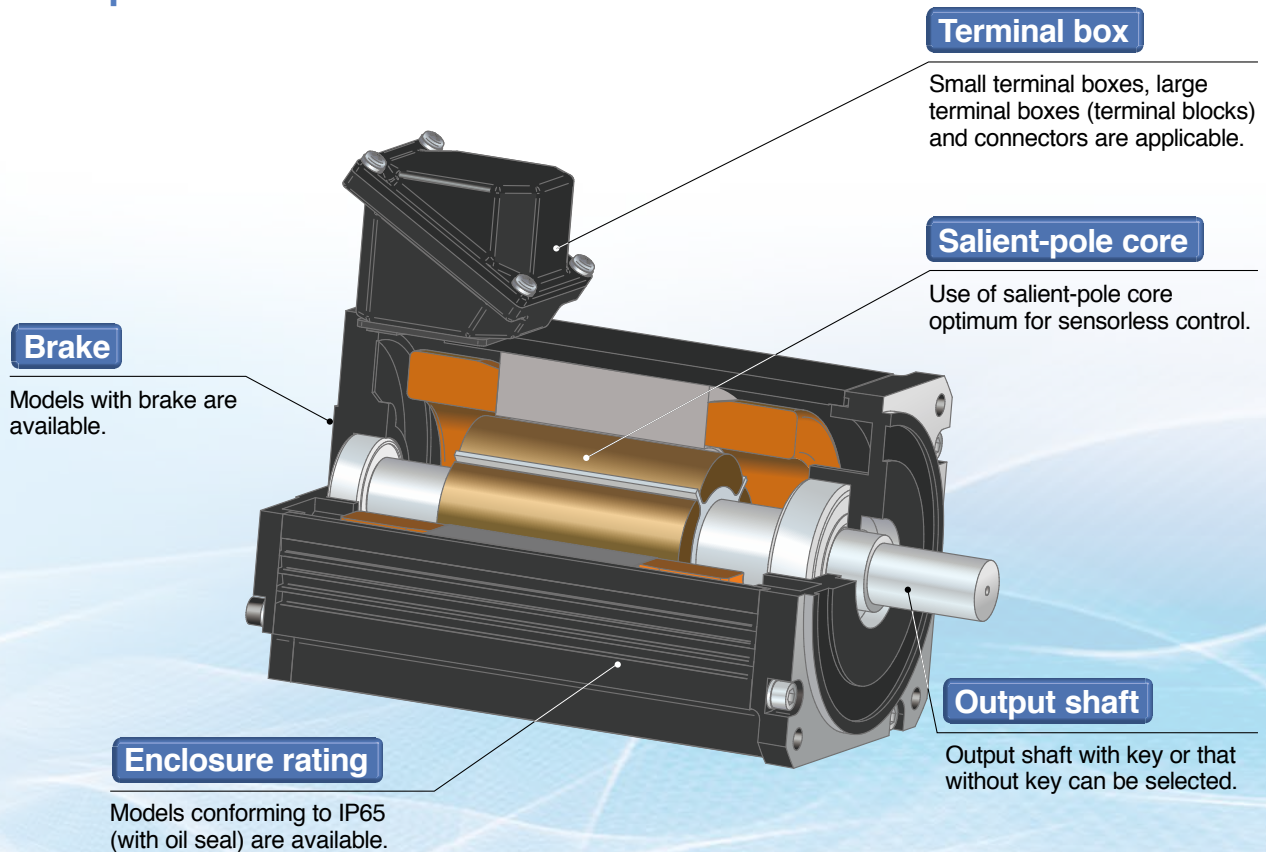
| Country/region   | Standard  | Induction motor efficiency class | EM-A Series    |
|--|---|----------------------------------|----------------|
| US            | NEMA MG1-12-12  | IE3                              | Not applicable |
| Canada        | CSA C390  | IE3                              |                |
| EU            | IEC60034-30-1(2014)   | IE3                              |                |
| Australia     | AS/NZ1359.5:2004  | IE2                              |                |
| New Zealand   |   |                                  |                |
| China         | GB18613-2012  | IE3                              |                |
| Taiwan        | Chinese National Standard (CNS) 14400   | IE3                              |                |
| Korea         | KSC 4202  | IE3                              |                |
| Brazil        | ABNT NBR 17094-1  | IE2                              |                |
| Vietnam       | TCVN 6627-30:2011<br>TCVN 7540-1:2013   | IE1                              |                |
| Mexico        | NOM-016-ENER-2010   | IE3                              |                |
| Saudi Arabia  | SASO IEC 60034-30:2013<br>(IEC 60034-30 Ed.1.0:2008)                          | IE3                              |                |
| Russia        | Unknown   | IE3                              |                |
| India         | IS 12615:2011<br>Energy Efficient Induction Motors- Three Phase Squirrel Cage | IE2                              |                |
| Singapore     | IEC 60034-2-1:2014(method 2-1-1B)<br>or IEC 112:2004(method B)                | IE3                              |                |

\* For the compliance with foreign standards, contact us.

\* Information as of March, 2019

# High performance

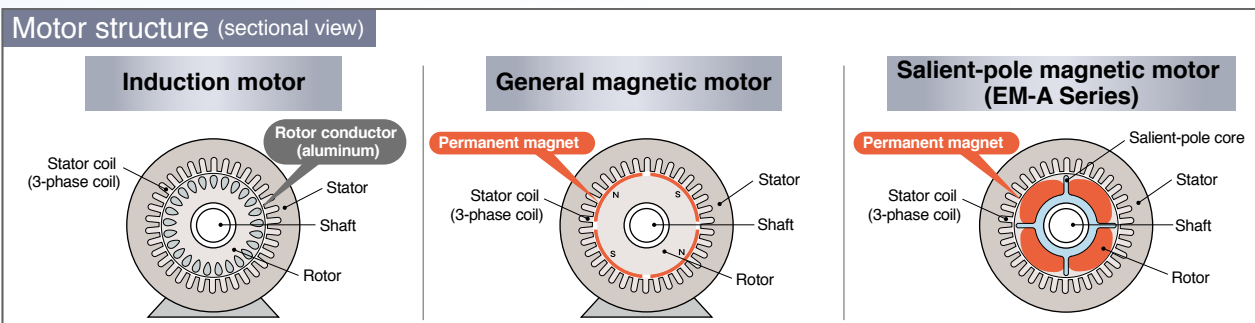
Mitsubishi has developed a unique salient-pole core to realize high-performance magnetic motors that can ensure positioning and speed control without a sensor.



## Newly developed salient-pole magnetic motors

EM-A Series include newly developed magnetic motors using the patented salient-pole core<sup>\*1</sup>. The rotor consists of the salient-pole core and surface-mounted permanent magnet, and therefore the motor inductance changes depending on the rotational position. This change in inductance is applied to the sensorless control.

The combination of the newly developed salient-pole magnetic motor and Mitsubishi's unique high-performance sensorless control technique realizes high precision speed control and positioning control without a sensor (encoder). <sup>\*1 Patent No. 5646119</sup>



## Speed control

Speed control comparable to that by servo motors is realized without a sensor.

Speed variation rate:  
**±0.05%**

\* In the case of digital input

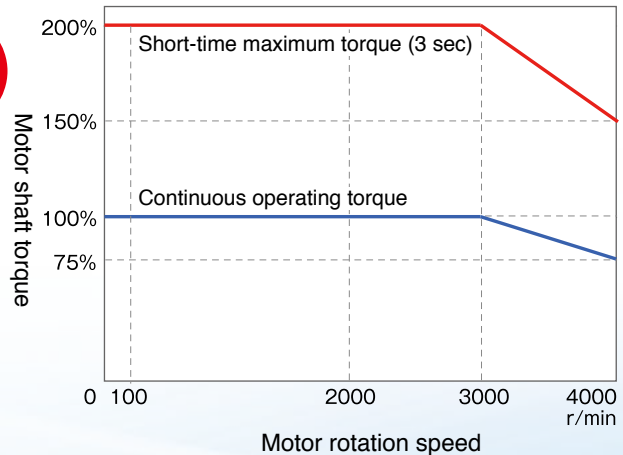
Max. torque:  
**200%**

- EM-A Series realize high precision speed control by using Mitsubishi's unique PM sensorless vector control that does not cause significant speed variation even under changing load.
- The series can be applied to high precision transfer systems of semiconductor and liquid crystal manufacturing lines.
- Operation resistant to load fluctuation at stable speed.  
Speed variation: ±0.05% \*1  
Speed control range: 1:1300
- The servo lock function generates holding torque when the motor stops and can prevent movement by external force.

\*1: When load changes between 0 and 100%

$$\text{Speed variation} = \frac{\text{Actual rotation speed} - \text{command rotation speed}}{\text{Rated speed}} \times 100(\%)$$

[Operating torque characteristics]



\*1: The continuous operating torque in the low speed area (15 r/min or less) is 80%.

\*2: In the case of high-load operation in the low speed area (15 r/min or less), the electronic thermal protector (E.THT or E.THM) operates, and the torque in the short-time operating area may not be attained.

## Positioning control

Positioning can be performed without an encoder.

- The combination of the newly developed salient-pole magnetic motor and Mitsubishi's unique high-performance sensorless control technique realizes high precision speed control and positioning control without a sensor (encoder).
- The combination with FR-E700EX enables to use the positioning function (point table method) through contact signals and CC-Link communication (option). \*1  
The use of the pulse-train input option realizes positioning by using a programmable controller positioning module.

Positioning accuracy:  
**200p/rev**

Positioning accuracy: 200 p/rev \*2

Drive module position command resolution: 4096 p/rev

\*1: The function is not applicable to absolute position detection systems.

\*2: When the input voltage is 200 to 220 V AC and the wiring length is 5 m or less.

# EM-A Series lineup

## Series name

### Motor only

| EM                  | A           | M             | F              | B                                    | K                                |                       |
|---------------------|-------------|---------------|----------------|--------------------------------------|----------------------------------|-----------------------|
| EM: Global PM motor | A: A series | M: Motor only | F: Flange type | None: Without brake<br>B: With brake | None: Without key<br>K: With key | None: IP44<br>W: IP65 |

| 0.1kW                    | 3000r/min      | 200V                    | Special specification                             |
|--------------------------|----------------|-------------------------|---|
| Output:<br>0.1 to 2.2 kW | Rotation speed | Voltage class:<br>200 V | Terminal box socket<br>direction<br>Brake 24 V DC |



# Specifications

## ●EM-A Series (200 V class)

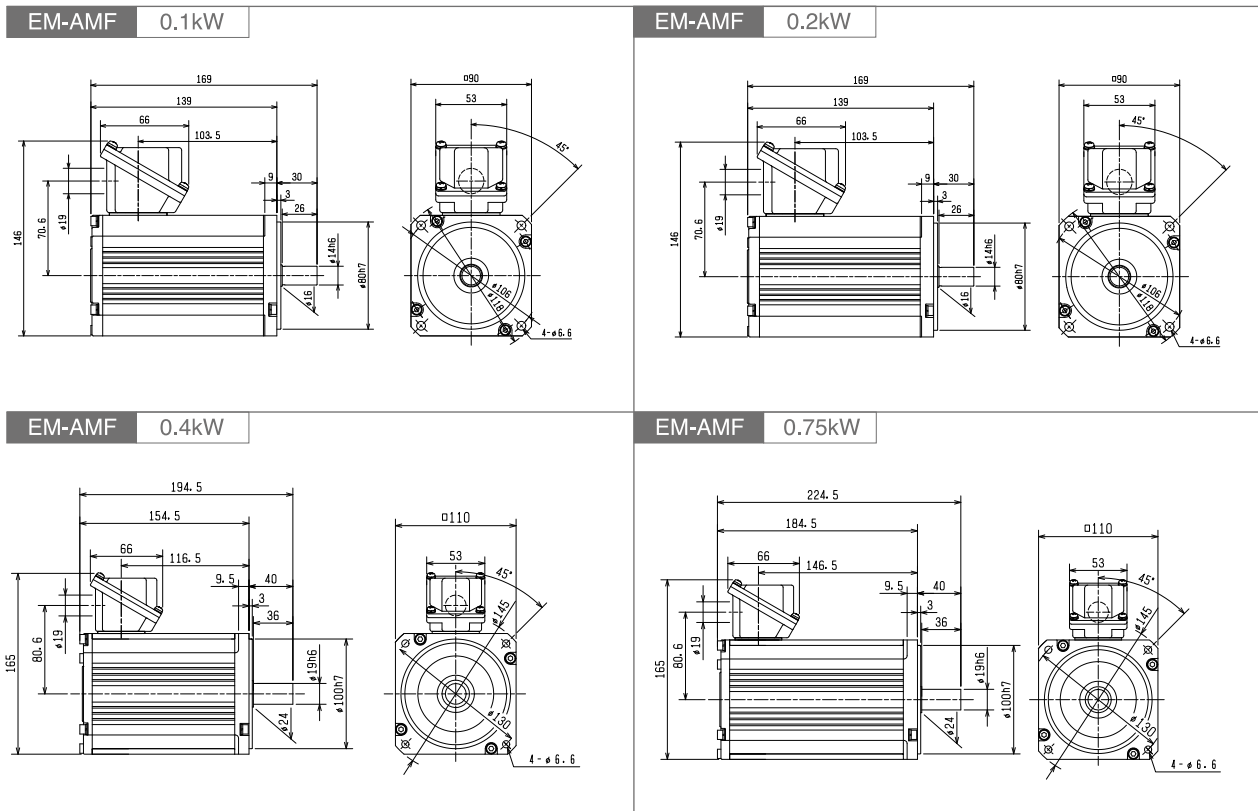
| Output (kW)                             |               | 0.1  | 0.2  | 0.4  | 0.75 | 1.5     | 2.2  |
|---|---------------|--|------|------|------|---------|------|
| Number of poles                         |               | 4P   |      |      | 6P   |         |      |
| Rated motor rotation speed(r/min)       |               | 3000   |      |      |      |         |      |
| Max. motor rotation speed(r/min)        |               | 4000   |      |      |      |         |      |
| Motor rated voltage(V)                  |               | 130  | 135  | 160  | 165  | 170     | 165  |
| Motor rated current(A)                  |               | 0.55   | 1.1  | 1.8  | 3.3  | 6.1     | 9.3  |
| Motor rated torque(Nm)                  |               | 0.32   | 0.64 | 1.27 | 2.39 | 4.78    | 7.0  |
| Motor max. torque(%)                    |               | 200  |      |      |      |         |      |
| Positioning accuracy(p/rev)             |               | 200  |      |      |      |         |      |
| Rating                                  |               | Continuous   |      |      |      |         |      |
| Allowable output shaft overhang load(N) |               | 392  |      | 490  |      | 686     |      |
| Allowable output shaft thrust load(N)   |               | 196  |      | 294  |      | 490     |      |
| Heat resistance class                   |               | 130 (B)  |      |      |      | 155 (F) |      |
| Enclosure rating                        |               | Indoor type (IP44) *1  |      |      |      |         |      |
| Shell structure                         | Without brake | Totally-enclosed self-cooling type   |      |      |      |         |      |
|   | With brake    | Totally-enclosed self-cooling type   |      |      |      |         |      |
| Ambient temperature/relative humidity   |               | 0 to +40°C / RH 90% or less  |      |      |      |         |      |
| Altitude                                |               | Up to 1000 m above sea level   |      |      |      |         |      |
| Vibration                               |               | Constant 4.9 m/s <sup>2</sup> , instantaneous 9.8 m/s <sup>2</sup> or less   |      |      |      |         |      |
| Brake type                              |               | DC spring holding, 90 V DC *2<br>(Brake torque 150% or more/allowable number of braking operations 1000 times/mechanical life 1,000,000 times) |      |      |      |         |      |
| Paint color                             |               | Black (equivalent to Munsell N1.5)   |      |      |      |         |      |
| Weight(kg)                              | Without brake | 2.9  | 2.9  | 4.9  | 6.4  | 9.5     | 11.7 |
|   | With brake    | 3.9  | 3.9  | 6.7  | 8.2  | 12.2    | 14.4 |

\*1: IP65 protection is available as semi-standard.

\*2: The brake can be used with 24 V DC (the motors conforming to UL will be supplied with brakes for 24 V DC).

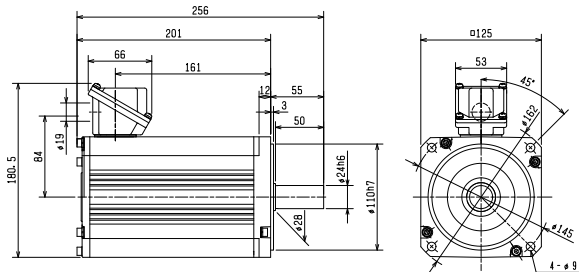
Motors with various capacities and those with reducers will be launched successively.

# Outline dimensional drawings

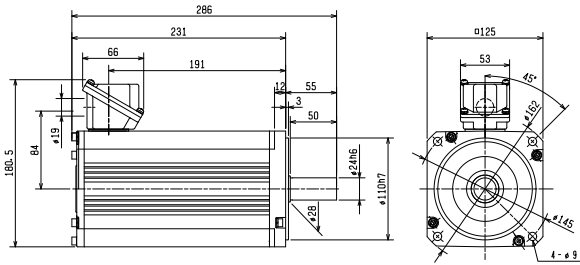


# Outline dimensional drawings

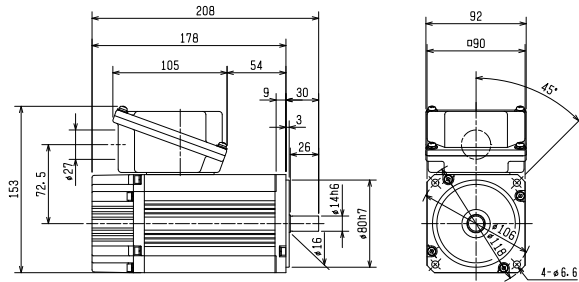
EM-AMF 1.5kW



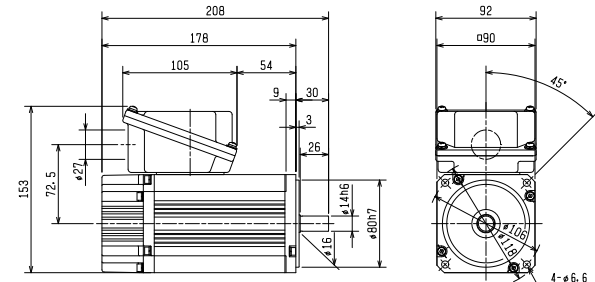
EM-AMF 2.2kW



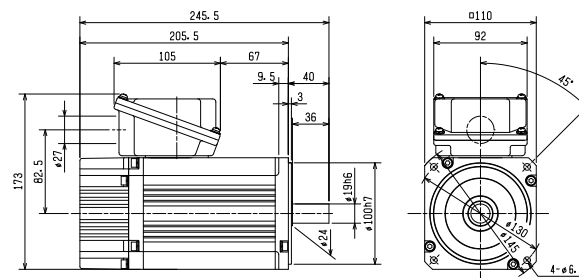
EM-AMFB 0.1kW



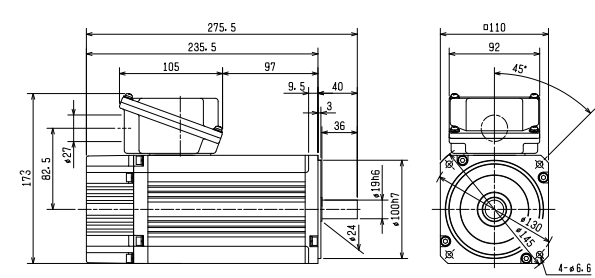
EM-AMFB 0.2kW



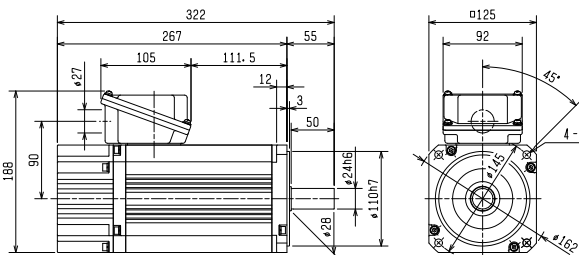
EM-AMFB 0.4kW



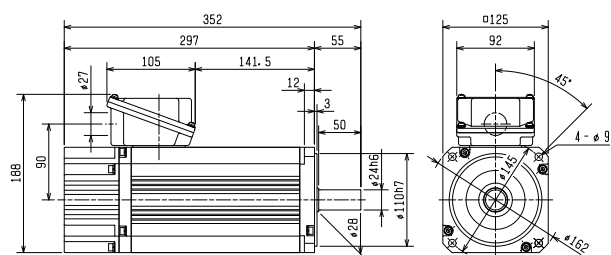
EM-AMFB 0.75kW



EM-AMFB 1.5kW



EM-AMFB 2.2kW



# FREQROL-E700EX

Small and sophisticated drive modules



Lineup

FR - [E720EX] - [0.75]K [ ]

| Symbol | Voltage class       | Symbol     | Drive module capacity        | Symbol | Specification of control circuit terminal             |
|--------|---------------------|------------|------------------------------|--------|---|
| E720EX | 3-phase 200-V class | 0.1 to 2.2 | Indicates the capacity [kW]. | None   | Standard control circuit terminal type (screwed type) |
|        |                     |            |                              | NF     | FL remote communication type                          |



Conforming to UL (UL508C), cUL (CSA C22.2 No.14), EC Directive (CE mark) and Radio Waves Act (Republic of Korea) \*1

Human- and environment-friendly drive modules conforming to RoHS Directive.

\*1 The products compatible with FL remote communication do not conform to the Radio Waves Act (Republic of Korea).

Rating

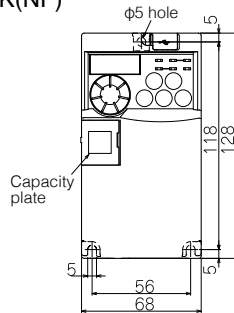
3-phase 200-V power supply

| Model name: FR-E720EX-□K (NF) |   | 0.1   | 0.2 | 0.4                | 0.75 | 1.5 | 2.2 |
|-------------------------------|---|---|-----|--------------------|------|-----|-----|
| Output                        | Rated current (A)                         | 0.8   | 1.5 | 3                  | 5    | 8   | 11  |
|                               | Overload current rating                   | 150% 60 s, 200% 3 s (based on motor rated current, inverse-time-limit characteristic) |     |                    |      |     |     |
| Power supply                  | Rated input AC voltage/frequency          | 3-phase, 200 to 240 V, 50 Hz/60 Hz  |     |                    |      |     |     |
|                               | Allowable range of AC voltage fluctuation | 170 to 264 V, 50 Hz/60 Hz   |     |                    |      |     |     |
|                               | Allowable range of frequency fluctuation  | ±5%   |     |                    |      |     |     |
|                               | Enclosure rating                          | Closed type (IP20) *1   |     |                    |      |     |     |
| Cooling method                | Self-cooling                              |   |     | Forced air cooling |      |     |     |
| Approximate weight (kg)       | 0.5                                       | 0.5   | 0.7 | 1.0                | 1.4  | 1.4 |     |

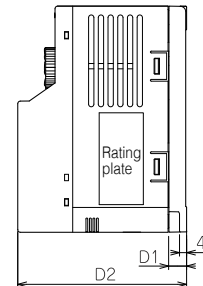
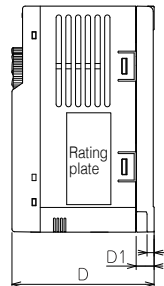
\*1 The products compatible with FL remote communication are open type (IP00).

## Outline dimensional drawings

FR-E720EX-0.1K(NF) to 0.75K(NF)



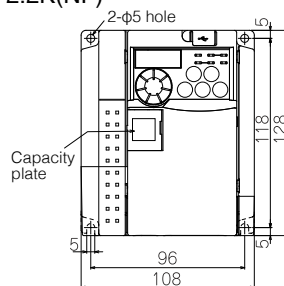
When built-in option is mounted



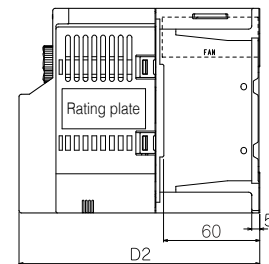
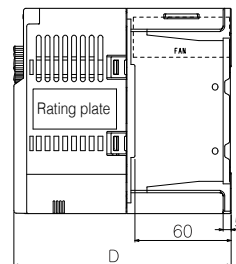
| Drive module model name      | D     | D1 | D2                            |                         |
|------------------------------|-------|----|-------------------------------|-------------------------|
|                              |       |    | When FR-A7NC E kit is mounted | When FR-E7DS is mounted |
| FR-E720EX-0.1K and -0.2K     | 80.5  | 10 | 97.6                          | 108                     |
| FR-E720EX-0.1KNF and -0.2KNF | 89.5  | -  | -                             | -                       |
| FR-E720EX-0.4K               | 112.5 | 42 | 129.6                         | 140                     |
| FR-E720EX-0.4KNF             | 121.5 | -  | -                             | -                       |
| FR-E720EX-0.75K              | 132.5 | 62 | 149.6                         | 160                     |
| FR-E720EX-0.75KNF            | 141.5 | -  | -                             | -                       |

(Unit: mm)

FR-E720EX-1.5K(NF) and -2.2K(NF)



When built-in option is mounted



| Drive module model name      | D     | D2                            |                         |
|------------------------------|-------|-------------------------------|-------------------------|
|                              |       | When FR-A7NC E kit is mounted | When FR-E7DS is mounted |
| FR-E720EX-1.5K and -2.2K     | 135.5 | 152.6                         | 163                     |
| FR-E720EX-1.5KNF and -2.2KNF | 144.5 | -                             | -                       |

(Unit: mm)

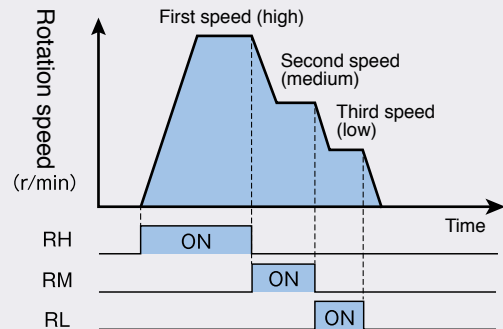
\* For the details of the drive modules, see the general catalog of sensorless servos (L(NA)06083-E(1703)MEE).

# 1

## Operating in the speed control mode

The motor speed can be controlled in the same manner as when an inverter is used, and the motor can be operated at a specified speed with an external operation switch.

**3-speed operation can be performed with an external operation switch.**



### Operation procedure

1

#### Screen displayed when power is turned on

The monitor screen appears.

2

#### Speed setting

Turn on the high speed switch (RH).

3

#### Start → Acceleration → Constant speed

Turn on the start switch (STF or STR). The speed indicated on the display area will increase with the acceleration time Pr.7 and reach “3000” (3000 r/min). The [RUN] lamp is on during normal rotation and flashing during reverse rotation.

●When RM has been turned on, 1500 r/min is displayed. When RL has been turned on, 300 r/min is displayed.

4

#### Deceleration → Stop

Turn off the start switch (STF or STR).

The speed indicated on the display area will decrease with the deceleration time Pr.8 and reach “0” (0 r/min), and the motor will stop. The [RUN] lamp will go out.

5

#### Speed setting (OFF)

Turn off the high speed switch (RH).

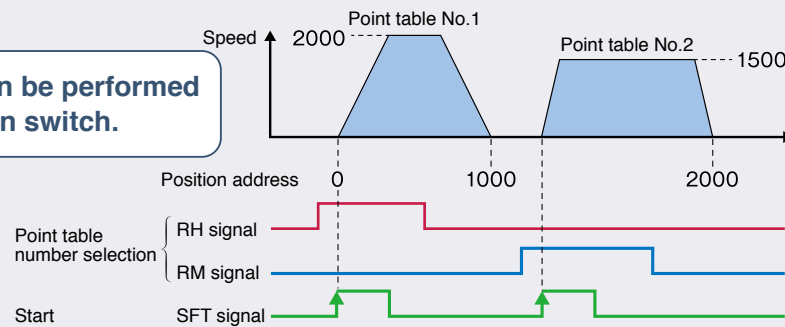
## 2

## Operating in the position control mode

Position control can be performed without a sensor, and the motor can be operated for movement to a specified position with an external operation switch.

### Operation example

Positioning operation can be performed with an external operation switch.



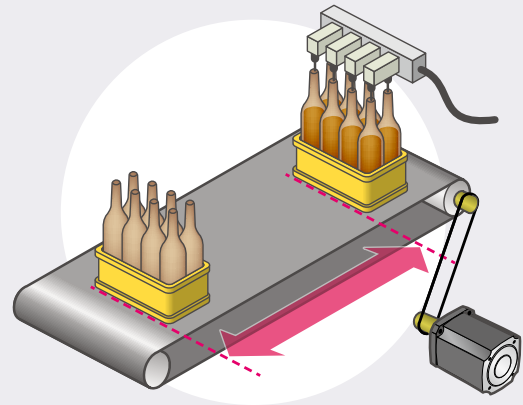
### Operation procedure

- 1 **Screen displayed when power is turned on**  
The monitor screen appears.
- 2 **Target position setting**  
Turn on the high speed switch (RH).
- 3 **Servo on**  
Turn on the low speed switch (SON).
- 4 **Positioning**  
Turn on the start switch (STF).  
The motor will run until the position specified in the point table is reached.
- 5 **Stop**  
Turn off the start switch (STF).
- 6 **Servo off**  
Turn off the low speed switch (SON).
- 7 **Target position setting (OFF)**  
Turn off the high speed switch (RH).

For position control, the speed command is calculated to zero the difference between position command and present position, and the motor is started.

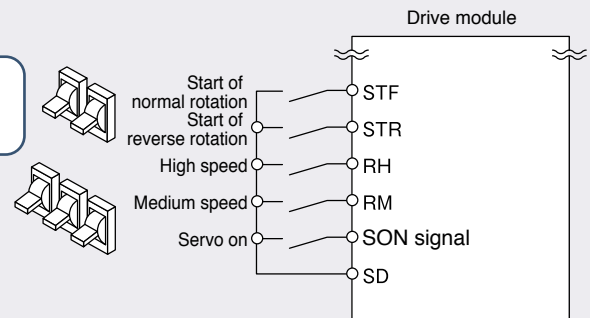
The position command can be set by the point table method.

The positioning operation can be performed by selecting a position command in the point table with an external operation switch.



### Connection example

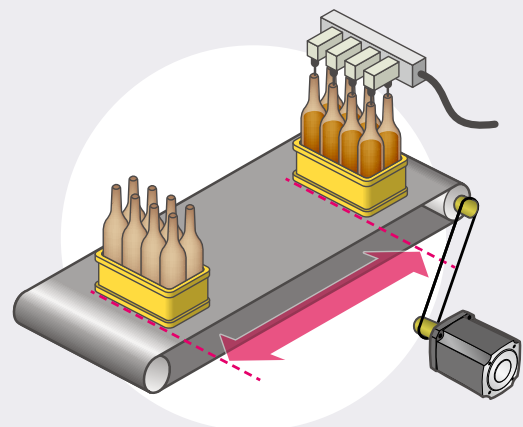
Assign the external operation switch functions for position control.



Create the point table.

| Item                               | First positioning   | Second positioning   |
|------------------------------------|---|--|
| Operating speed                    | 2000r/min(Pr.4)   | 1500r/min(Pr.5)  |
| Acceleration time                  | 1.0s(Pr.578)  | 0.5s(Pr.580)   |
| Deceleration time                  | 1.0s(Pr.579)  | 0.5s(Pr.581)   |
| Target position                    | 1000(Pr.465)  | 2000(Pr.467)   |
| Auxiliary function for positioning | 10: Forward direction<br>Incremental value command<br>Independent<br>(Pr.525) | 11: Backward direction<br>Incremental value command<br>Independent<br>(Pr.526) |

| Item                               | Setting              |
|------------------------------------|----------------------|
| Pr.800 Control method selection    | 13: Position control |
| Pr.532 Home position return method | 2: Data set method   |
| Pr.537 Roll feed mode selection    | 1                    |



\* For details, see the instruction manual for the drive module.

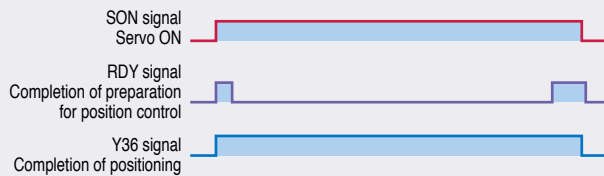
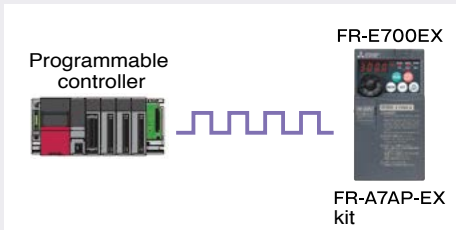
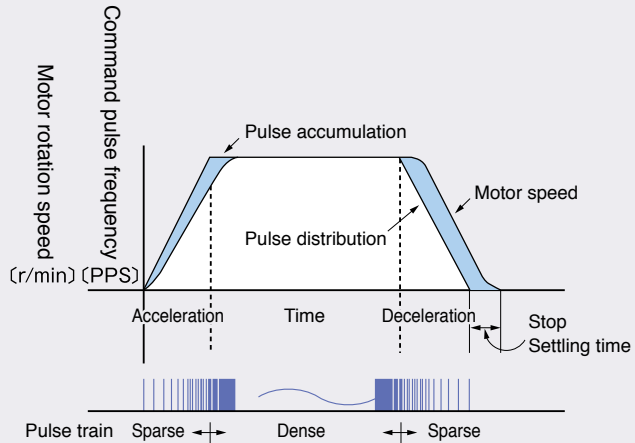
# 3

## Introduction of positioning modules

An example of combination with a positioning module is introduced.

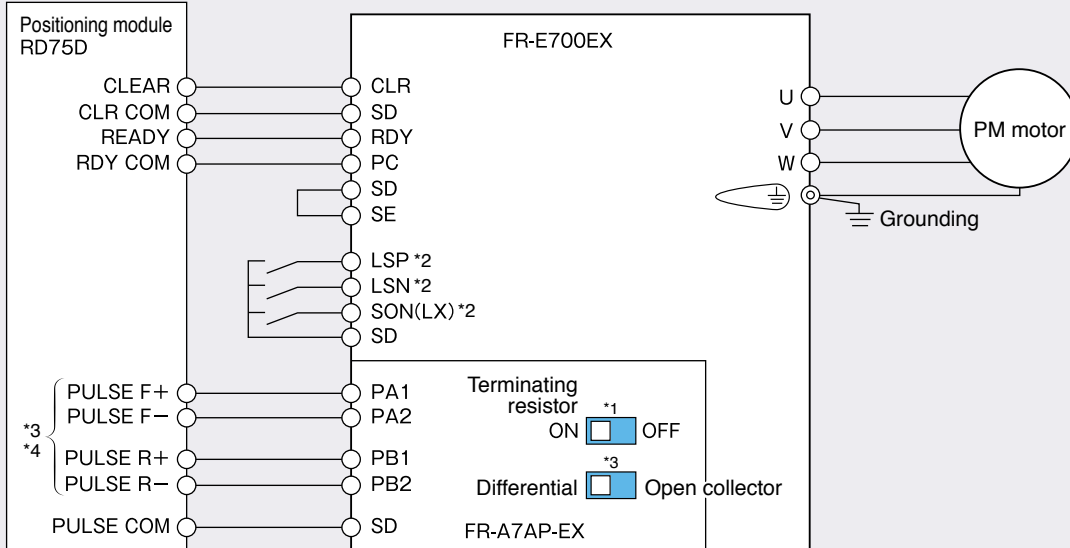
### Operation example

Positioning by pulse-train input can be performed by combining FR-A7AP-EX (built-in option) and a programmable controller positioning module.



### Wiring example Example of wiring of FR-A7AP-EX (built-in option) and positioning module

Connection with MELSEC iQ-R Series RD75D positioning module



\*1 When an open collector is used, set the terminating resistor selector switch to OFF (default).  
 \*2 Assign the functions with Pr.178 to Pr.184 (input terminal function selection).  
 \*3 The connection varies depending on the specifications for the pulse signals input from the positioning module. (This figure gives an example of connection with a differential line driver.)  
 \*4 When Pr.428 (command selection) is not set to "1,4," connect the positioning module terminals (PULSE F+, PULSE F-, PULSE R+ and PULSE R-) and the terminals of FR-A7AP-EX (PA1, PA2, PB1 and PB2) as shown in the wiring example. When Pr.428 is set to "1,4," connect the terminals PULSE R+ and PA1, PULSE R- and PA2, PULSE F+ and PB1, and PULSE F- and PB2.

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## Safety Precautions

- To ensure proper use of the products listed in this catalog, please read the instruction manual carefully prior to use.
- Make sure to connect the grounding wire and install the dedicated earth leakage circuit breaker. Electric shock may be caused by machine failure or electricity leakage.
- Install an appropriate motor protective device for each unit of the product to prevent fires caused by machine trouble.
- Make sure that electrical wiring works are conducted safely according to the electric installation engineering standards and the indoor wiring regulations of the power company.
- Do not exceed the rotation speed specified in the outline drawings, specifications, and catalogs, etc. Failure to do so may cause the product to explode or be damaged.
- Select a model appropriate to the operating environment and the purpose of use. Use in an inappropriate environment or for an unintended purpose will result in accidents.
- When using the product for a lift, install safety devices on the machine side to prevent the lift from falling in case of product trouble.
- Do not use the product for passenger lifts. This is prescribed in the Building Standards Act.

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