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VECTOR-CONTROLLED INVERTER DRIVES WITH
POWER REGENERATIVE FUNCTION FOR MACHINE TOOLS

VARISPEED-626M5/656MR5

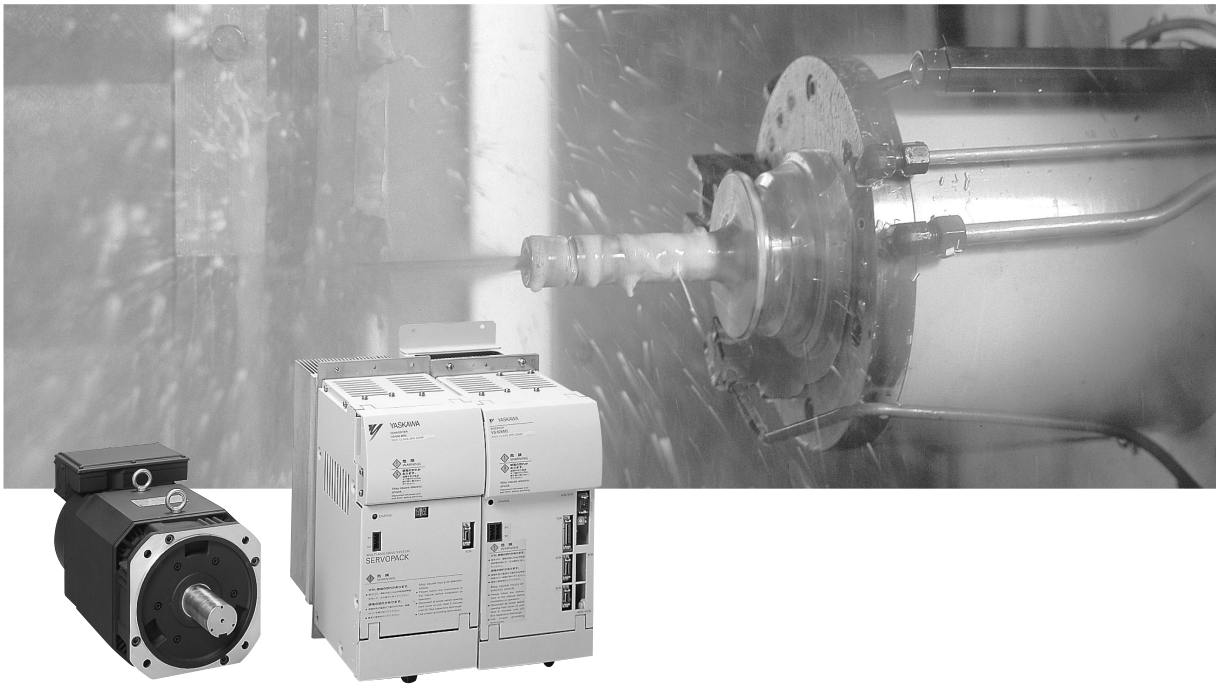
USER'S MANUAL

INVERTER (VS-626M5) MODEL : CIMR-M5 ☐

200V CLASS 3.7/2.2 TO 37/30kW(5/3 TO 50/40HP) 400V CLASS 5.5/3.7 TO 45/37kW(7.5/5 TO 60/50HP)

CONVERTER (VS-656MR5) MODEL : CIMR-MR5 ☐

200V CLASS 3.7/2.2 TO 37/30kW (5/3 TO 50/40HP, 7 TO 30kVA) 400V CLASS 5.5/3.7 TO 45/37kW (7.5/5 TO 60/50HP, 9 TO 70kVA)



YASKAWA

MANUAL NO. SIE-S626-7.5B

PREFACE

This instruction manual describes installation, maintenance and inspection, troubleshooting, and specifications of the VS-626M5 and the VS-656MR5. Read this instruction manual thoroughly before operation.

YASKAWA ELECTRIC CORPORATION

General Precautions

- The diagrams in this manual may be indicated without covers or safety shields to show details.
  Be sure to restore covers or shields before operating the Units and run the Units according to the instructions described in this manual.
- Any illustrations, photographs, or examples used in this manual are provided as examples only and may not apply to all products to which this manual is applicable.
- The products and specifications described in this manual or the content and presentation of the manual may be changed without notice to improve the product and/or the manual.
- When ordering a new copy of the manual due to damage or loss, contact your Yaskawa representatives or the nearest Yaskawa sales office and provide the manual number shown on the front cover.
- If nameplates become warn or damaged, order new ones from your Yaskawa representatives or the nearest Yaskawa sales office.

Notes for Safe Operation

Read this instruction manual thoroughly before installation, operation, maintenance or inspection of the VS-626M5. In this manual, Notes for Safe Operation are classified as “WARNING” or “CAUTION.”

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury to personnel.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury to personnel and damage to equipment.
It may also be used to alert against unsafe practices.

Even items described in ⚠ CAUTION may result in a vital accident in some situations. In either case, follow these important notes.

The warning symbols for ISO and JIS standards are different, as shown below.

ISO	JIS
	

The ISO symbol is used in this manual.

Both of these symbols appear on warning labels on Yaskawa products. Please abide by these warning labels regardless of which symbol is used.

The following shows the symbols of prohibition and mandatory action.

PROHIBITED

Specifies prohibited handling.

MANDATORY

Specifies actions that must be taken.

Notes for Inverter and Converter

■ Confirmation upon Delivery

⚠ CAUTION

	Page
● Do not install any Inverter or Converter that is damaged or has missing parts. Failure to observe this caution may result in personal injury or equipment damage.	2 -2

■ Installation

⚠ CAUTION

	Page
● Always hold the case when carrying the Inverter. If the Inverter is held by the front cover, the main body of the Inverter may fall, possibly resulting in injury.	2 -5
● Mount the Inverter and the Converter on nonflammable material (i.e. metal). Failure to observe this caution may result in a fire.	2 -5
● Install a fan or other cooling device to keep the ambient temperature of Inverter and Converter below 55°C (131°F) and the intake air temperature to heatsink below 45°C (113°F). Overheating may cause a fire or damage to the unit.	2 -5

■ Disconnecting the Digital Operator

⚠ WARNING

	Page
● Disconnect all power before removing Digital Operator (JVOP-132). Then wait for the time described on warning labels after the main circuit power supply and control power supply are disconnected and all indicators on the Inverter and the Converter have gone out. Failure to observe this warning may result in an electric shock.	2 -9

⚠ CAUTION

	Page
● Use only the screws provided with the cable bracket when installing the cable. Improper installation may result.	2 -9

■ Wiring

⚠ WARNING

	Page
● Always turn OFF the input power supply before wiring terminals. Otherwise, an electric shock or fire may occur.	3 -2
● Wiring should be performed only by qualified personnel. Failure to observe this warning may result in an electric shock or a fire.	3 -2
● Make sure to ground the ground terminal . (200V class: Ground to 100Ω or less, 400V class: Ground to 10Ω or less) Failure to observe this warning may result in an electric shock or a fire.	3 -2
● Always check the operation of any emergency stop circuits after they are wired. Otherwise, there is the possibility of injury. (Wiring is the responsibility of the user.)	3 -2
● Never touch the output terminals directly with your hands or allow the output lines to come into contact with the Inverter case. Never short the output circuits. Otherwise, electrical shock or grounding may occur.	3 -2

⚠ CAUTION

	Page
● Verify that the rated voltage of the Converter coincides with the AC power supply voltage. Failure to observe this caution may result in personal injury or a fire.	3 -2
● Do not perform a withstand voltage test of the Inverter and the Converter. It may cause semi-conductor elements to be damaged.	3 -2
● Make sure to connect the Inverter and the Converter as shown in the connection diagrams. The Inverter or Converter may be damaged.	3 -2
● Tighten terminal screws to the specified tightening torque. Failure to observe this caution may result in a fire.	3 -2
● Never connect the power supply to output terminals U/T1, V/T2, and W/T3. The Inverter may be damaged.	3 -2
● Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits. The Inverter may be damaged or internal parts burnt if these devices are connected.	3 -2
● Do not connect electromagnetic switches or contactors to the output circuits. If a load is connected while the Inverter is operating, surge current will cause the overcurrent protection circuit inside the Inverter to operate.	3 -2

■ Trial Operation

⚠ WARNING

	Page
● Only turn ON the input power supply after closing the upper and lower cover. Do not open the covers while current is flowing. Failure to observe this warning may result in an electric shock.	6 -3
● Since the stop button can be disabled by a function setting, install a separate emergency stop switch. Failure to observe this warning may result in personal injury.	6 -3

⚠ CAUTION

	Page
● Never touch the heatsink since the temperature is very high. Failure to observe this caution may result in harmful burns to the body.	6 -3
● Since it is easy to change operation speed from low to high speed, verify the safe working range of the Motor and machine before operation. Failure to observe this caution may result in personal injury.	6 -3
● Do not check signals during operation. The machine or the unit may be damaged.	6 -3
● Do not change the settings of the Inverter unnecessarily. All the constants of the Inverter have been preset at the factory. The machine or the unit may be damaged.	6 -3

■ Maintenance and Inspection

⚠ WARNING

	Page
● Never touch high-voltage terminals in the Inverter and the Converter. Failure to observe this warning may result in an electric shock.	13 -2
● Close upper and lower covers before powering up the Inverter or the Converter. To open the covers, make sure to shut OFF the molded-case circuit breaker. Failure to observe this warning may result in an electric shock.	13 -2
● Perform maintenance or inspection only after verifying that the CHARGE LED indicator and 7-segment display go OFF, after the main circuit power supply and control power supply are turned OFF. The capacitors are still charged and may be dangerous.	13 -2
● Only authorized personnel should be permitted to perform maintenance, inspections or parts replacement. Remove all metal objects, such as watches and rings, before starting work. Always use grounded tools. Failure to observe this warning may result in an electric shock.	13 -2

⚠ CAUTION

	Page
● The control PC board employs CMOS ICs. Do not touch the CMOS elements. They are easily damaged by static electricity.	13 -2
● Do not connect or disconnect wires or connectors while power is applied to the circuit. Failure to observe this caution may result in personal injury.	13 -2

■ Others

⚠ WARNING

- Never modify the product.
  Failure to observe this warning may result in an electric shock or personal injury and will invalidate the warranty.

⚠ CAUTION

- Do not store or transport the equipment in locations where halogen, fluorine, chlorine, bromine, or iodine is present.
  Failure to observe this caution may result in damage to the machine or burnout of the parts.

Notes for Motor

■ Notes on Use

⚠ WARNING

Observe the following precautions to avoid electrical shock or injury.

- Ground the ground terminals of the Inverter and the Motor (or ground a metallic part, such as the frame, if there is no ground terminal, according to local and/or national electrical codes.
  Failure to observe this warning may result in electrical shock.
- Use grounding wires of a size complying with relevant international or local standards.
- Make wiring lengths as short as possible. Separate power cables from signal lines.
  Noise on signal lines may cause vibration or malfunctions.
- Perform wiring or inspection only after verifying that the CHARGE indicator and the 7-segment display of the Inverter go OFF after the power supply is turned OFF.
  Failure to observe this warning may result in electrical shock.
- Do not damage the cables or apply excess stress to them; do not place heavy objects on the cables or clamp the cables.
  Failure to observe this warning may result in electrical shock.

⚠ CAUTION

- Use only a specified combination of Inverter and Motor.
  Failure to observe this caution may result in fire or malfunctions.
- Never use at locations exposed to water splashes, corrosive, or inflammable gases, or near combustible substances.
  Failure to observe this caution may result in fire or malfunctions.
- Use under the following environmental conditions.
  (1) Indoors where no corrosive or explosive gas exists
  (2) Well-ventilated without dust or metallic particles
  (3) Easy to check, clean, and maintain
  For use at locations where excessive water or oil splashes exist, use a cover or other protection.
  It is recommended to place the terminal box upward.
- Do not touch the Motor while the power is ON or immediately after turning the power OFF.
  Failure to observe this caution may cause harmful burn.

■ Storage

⃠ PROHIBITED

- Do not store the equipment in locations where water splashes are present or where there are corrosive gases or liquids.

❗ MANDATORY

- Store the equipment protected from direct sunlight in the specified ranges of temperature and humidity. (0°C to 60°C (32°F to 140°F), 5% to 95%)
- After long-term storage, contact your YASKAWA representative before using the Motor.

■ Transportation

⚠ CAUTION

- Do not lift the Motor by the cables or the motor shaft when carrying the Motor.
  Failure to observe this caution may result in product malfunctions or personal injury.
- Do not overload the products.
  Failure to observe this caution may result in collapse of cargo and personal injury.

❗ MANDATORY

- Use the motor eyebolts when lifting and transporting the Motor.
  Do not attempt to move a Motor when other equipment is attached to it.

■ Installation

⚠ CAUTION

- Do not climb on the Motor or place heavy objects on it.
  Failure to observe this caution may result in personal injury.
- Do not block the air inlet and outlet, and do not let foreign materials enter.
  Failure to observe this caution may result in fire.
- Do not apply heavy shock.
  Failure to observe this caution may result in a malfunction.
- When unpacking, be careful of the nails in the wood frame.
  Failure to observe this caution may result in personal injury.
- Cover the rotary parts to prevent them from being touched.
  Failure to observe this warning may result in personal injury.
- The motor shaft extension is coated with anticorrosive paint. Before installation, wipe off the paint with a cloth soaked in detergent liquid.
- When connecting the Motor to a load machine, be careful of centering, belt tension, and pulley parallelism.
- Use a flexible coupling for coupling with the load machine.
- The motor system is a high-precision device. Do not apply shock to the Motor or the motor output shaft. Design machines so that the thrust load and radial load applied to the motor shaft extension during operation are within the allowable ranges specified in the manual for each model. With a thrust load, the allowable load is 0 N in the direction where the output shaft is pressed into the motor.
- Never perform any additional machining on the Motor.
- Flange-mounted types must be installed with the load motor output shaft either horizontally, or vertically with the shaft down. If the output shaft is to be placed horizontally, place the terminal box upward. Foot-mounted Motors must be installed on the floor with the feet down. For details, refer to the manual for each model.

■ Wiring

⚠ CAUTION

- Perform wiring securely according to the connection diagrams.
  Failure to observe this caution may cause Motor overrun and personal injury.
- Verify that the input power is OFF before wiring.
- Perform proper grounding and noise control.
- Make wiring length as short as possible. Separate the power cables from the signal lines. Do not run power cables and signal lines in the same duct or bundle. Noise on signal lines may cause vibration or malfunctions.
- Never connect a commercial power supply directly to the Motor.
- Use Yaskawa-specified cables. To use other cables, check the rated current of your equipment, and consider the operating environment to select correct cables. If a cable not specified by Yaskawa is to be used for the Encoder, select a twisted-pair shielded cable.
- The terminal block, connectors, or connector pin layout differ according to the model. Refer to the manuals for your model before wiring.
- If no terminal block is used, protect lead joints with insulating tubes or tapes.
  Failure to observe this caution may result in electrical shock or fire.

■ Operation

⚠ WARNING

- Do not operate the equipment with the terminal box cover removed. After wiring, replace the terminal box cover.
  Failure to observe this warning may result in electrical shock.

⚠ CAUTION

- Perform trial operation as follows: Secure the Motor and disconnect it from load machine system, check operations, then reconnect the Motor to the load machine.
  Failure to observe this caution may result in personal injury.
- If an alarm is issued, correct the cause, verify safety, then reset the alarm and resume operation.
  Failure to observe this caution may result in personal injury.
- If momentary power loss occurs, turn OFF the power supply.
  The machine may resume operation suddenly and may result in personal injury.
- Before starting a liquid-cooled Motor, verify that cooling oil is properly supplied to the Motor.
- For oil mist lubrication Motors, verify that the lubrication is properly performed before starting operation.
- Build an emergency stop circuit or a device that protects the Motor by immediately stopping operation in case of malfunctions of cooling oil supply or oil mist lubrication.
  After emergency stop, restart operation using the following procedure.
  (1) Recover cooling oil supply or oil mist lubrication.
  (2) Cool the Motor sufficiently (for one hour or longer), then restart operation from low speed.
  (3) Gradually increase rotation speed while verifying that there is no abnormal noise, increase of vibration or rise in temperatures.

⃠ PROHIBITED

- Do not operate liquid-cooled Motors without supplying cooling oil.
- Do not operate oil mist lubrication Motors without supplying proper lubricant.

MANDATORY

- Build an external emergency stop circuit that immediately stops operation and shuts OFF power in an emergency.

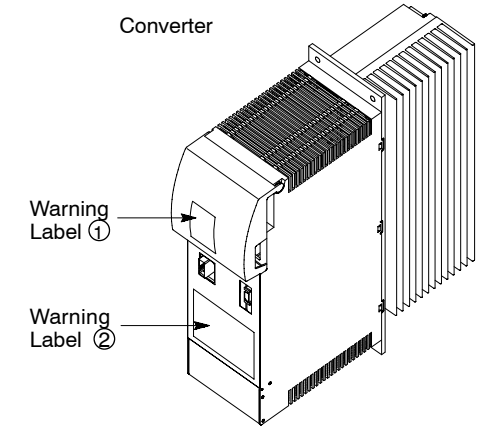
■ Maintenance and Inspection

PROHIBITED

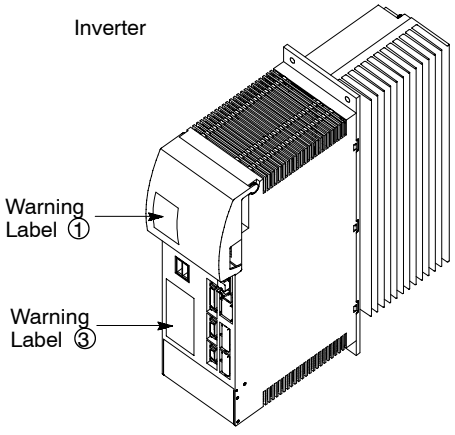
- Only authorized personnel should be permitted to disassemble or repair the equipment.
- If it becomes necessary to disassemble the Motor, contact your YASKAWA representative.

■ Warning Label

Warning labels are displayed on the upper cover and the front cover of the Inverter and the Converter, as shown below. Follow these instructions when handling the Inverter and the Converter.



Model CIMR-MR5A27P5 [200V 10HP (7.5KW)]



Model CIMR-M5A27P5 [200V 10HP (7.5KW)]

Warning Label ①

危　険
WARNING

感電の恐れが
あります。

通電中及び電源
オフ後５分以内は、
端子部に触らない
でください。

May cause electric shock.

Disconnect all power and wait 5 min. before servicing.

Warning Label ②

危　険
WARNING

けが、感電の恐れがあります。

・据え付け、運転の前には必ず取扱説明書を読んで、その指示に従ってください。

感電の恐れがあります。

・通電中及び電源オフ後５分以内は、表面カバーを開けないでください。
・確実に接地を行ってください。

May cause injury or electric shock.

- Please follow the instructions in the manual before installation or operation.
- Disconnect all power before opening front cover of unit. Wait 5 minutes until DC Bus capacitors discharge.
- Use proper grounding techniques.
- Make sure to ground the supply neutral (TÜV approval).

Warning Label ③

危　険
WARNING

けが、感電の恐れがあります。

・据え付け、運転の前には必ず取扱説明書を読んで、その指示に従ってください。

感電の恐れがあります。

・通電中及び電源オフ後５分以内は、表面カバーを開けないでください。
・確実に接地を行ってください。

May cause injury or electric shock.

- Please follow the instructions in the manual before installation or operation.
- Disconnect all power before opening front cover of unit. Wait 5 minutes until DC Bus capacitors discharge.
- Use proper grounding techniques.

Warranty Information

■ Free Warranty Period and Scope

Warranty Period

This product is warranted for twelve months after being delivered to Yaskawa's customer or if applicable eighteen months from the date of shipment from Yaskawa's factory whichever comes first.

Scope of Warranty

Inspections

Periodic inspections must be conducted by the customer. However, upon request, Yaskawa or one of Yaskawa's Service Centers can inspect the product for a fee. In this case, if after conferring with the customer, a Yaskawa product is found to be defective due to Yaskawa workmanship or materials and the defect occurs during the warranty period, then this fee will be waived and the problem remedied free of charge.

Repairs

If a Yaskawa product is found to be defective due to Yaskawa workmanship or materials and the defect occurs during the warranty period, Yaskawa will provide a replacement, repair the defective product, and provide shipping to and from the site free of charge.

However, if the Yaskawa Authorized Service Center determines that the problem with a Yaskawa product is not due to defects in Yaskawa's workmanship or materials, then the customer will be responsible for the cost of any necessary repairs. Some problems that are outside the scope of this warranty are:

- Problems due to improper maintenance or handling, carelessness, or other reasons where the customer is determined to be responsible.
- Problems due to additions or modifications made to a Yaskawa product without Yaskawa's understanding.
- Problems due to the use of a Yaskawa product under conditions that do not meet the recommended specifications.
- Problems caused by natural disaster or fire.
- Or other problems not due to defects in Yaskawa workmanship or materials.

Warranty service is only applicable within Japan.
However, after-sales service is available for customers outside of Japan for a reasonable fee.
Contact your local Yaskawa representative for more information.

■ Exceptions

Any inconvenience to the customer or damage to non-Yaskawa products due to Yaskawa's defective products whether within or outside the warranty period are NOT covered by this warranty.

■ Restrictions

- The Varispeed 626M5/656MR5 was not designed or manufactured for use in devices or systems that may directly affect or threaten human lives or health.
- Customers who intend to use the product described in this manual for devices or systems relating to transportation, health care, space aviation, atomic or electric power, or underwater use must contact their Yaskawa representatives or the nearest Yaskawa sales office beforehand.
- This product has been manufactured under strict quality-control guidelines. However, if this product is to be installed in any location where failure of this product could involve or result in a life-and-death situation or loss of human life or in a facility where failure may cause a serious accident or physical injury, safety devices must be installed to minimize the likelihood of any accident.

Visual Aids

The following aids are used to indicate certain types of information for easier reference.

◀EXAMPLE▶ Indicates application examples.



Indicates supplemental information.

IMPORTANT Indicates important information that should be memorized.

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1

Introduction

This chapter provides an overview of the VS-626M5 Inverter and VS-656MR5 Converter and describes their functions and components.

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1.1 Overview

The VS-625M5 Inverter and VS-656MR5 Converter form a highly reliable, high-performance AC drive system in which an AC spindle motor is controlled by the Inverter using vector control with a regenerative function. The system ensures stable drive control of machine tools, such as machining centers and lathes, and industrial machines, such as transfer machines and testing machines, while providing high speed and the ability to handle tough environmental conditions.

1.1.1 Features

The system has the following features.

■ Multi-axis Driving

The Inverter and Converter are separate units of highly reliable, compact book-type construction. The Converter incorporates a power regeneration function and multi-axis driving configuration, providing power to the spindle drive and servo drive with easy control through the control panel.

■ Compact

The Inverter and Converter are more compact and ensure higher precision than conventional models. This was enabled by the development of a compact, high-precision detector, improvement in output voltage under optimal vector control, and the selection of an optimum cooling construction as a result of thermal analysis.

■ Compatible with Yaskawa's YENET1200 Standard Network

The Inverter and Converter are available in models that are compatible with Yaskawa's YENET1200 standard high-speed serial network, making it possible to reduce the number of wires for CNC connections. The Inverter and Converter are also available in models that are compatible with analog I/O interfaces as well so that the Inverter and Converter can be used with the VS-626 Series for conventional spindle driving. Sequence I/O can be connected to 0- and 24-V common terminals.

■ Compact, Lightweight Spindle Motor

The downsizing of the spindle motor was enabled by the optimum electromagnetic design of the system ensuring ideal heat distribution, improvements in the core and cooling construction of the system, and changes in the circuit design of the encoder. The system ensures higher reliability under tough environmental conditions than any conventional system.

■ High-precision, High Servo Performance

The system employs a high-speed IGBT (insulated gate bipolar transistor) power element for high–precision, high-frequency PWM control at high speeds, suppressing current distortion that may cause torque ripples and reducing rotational fluctuations. The system employs a DSP (digital signal processor) as well to improve the servo performance of the system.

■ Improved Orientation Function

The system performs orientation control to a fixed position using the motor encoder. This function is used when the motor shaft is connected to the load shaft at a ratio of one to one. For orientation control with a magnetic sensor, the detected signal of the motor encoder will be used for orientation control to desired position.

■ Expanded Fixed Output Range via Winding Selection

If a winding selection motor is used, a dedicated electromagnetic contactor will select the winding, making it possible to expand the fixed output range without an increase in the capacity of the Inverter. This will eliminate the speed change mechanism of the machinery to enable downsizing.

■ Continuous Regenerative Operation

The Converter and Inverter employ an IGBT so that the Converter will respond to frequent accelerations and decelerations, suppress temperature rises, and save energy consumption, improving the rate of power supply regeneration and enabling regenerative control at high speeds.

■ Construction

Inverter and Converter models with external heatsink cooling are available and panel-mounting construction with an integral cooling fan are provided for ease of panel mounting and maintenance.

■ International Standards

The Inverter and Converter meet EMC and low-voltage directive requirements, allowing machinery manufacturers to easily acquire CE marking certification.

1.1.2 Inverter Models

Inverter models are offered in both 200 and 400 V classes. Both M5A models for independent drive with analog speed references and M5N models for NC systems using YENET1200 serial communications are available in both classes. M5A and M5N models differ from each other in the host control device and in connection methods.

Table 1.1 Inverter Models

Type	Voltage Class	VS-626M5		Inverter Model Numbers *	
		30-minute Rated Output (kW)	Model Number	Open Chassis CIMR-M5□□□□□5	Enclosed Wall-mounted CIMR-M5□□□□□0
M5A	200 V class	3.7	CIMR-M5A23P7	CIMR-M5A23P75	CIMR-M5A23P70
		5.5	CIMR-M5A25P5	CIMR-M5A25P55	CIMR-M5A25P50
		7.5	CIMR-M5A27P5	CIMR-M5A27P55	CIMR-M5A27P50
		11	CIMR-M5A2011	CIMR-M5A20115	CIMR-M5A20110
		15	CIMR-M5A2015	CIMR-M5A20155	CIMR-M5A20150
		18.5	CIMR-M5A2018	CIMR-M5A20185	CIMR-M5A20180
		22	CIMR-M5A2022	CIMR-M5A20225	CIMR-M5A20220
		30	CIMR-M5A2030	CIMR-M5A20305	CIMR-M5A20300
		37	CIMR-M5A2037	CIMR-M5A20375	CIMR-M5A20370
	400 V class	5.5	CIMR-M5A45P5	CIMR-M5A45P55	CIMR-M5A45P50
		7.5	CIMR-M5A47P5	CIMR-M5A47P55	CIMR-M5A47P50
		11	CIMR-M5A4011	CIMR-M5A40115	CIMR-M5A40110
		15	CIMR-M5A4015	CIMR-M5A40155	CIMR-M5A40150
		18.5	CIMR-M5A4018	CIMR-M5A40185	CIMR-M5A40180
		22	CIMR-M5A4022	CIMR-M5A40225	CIMR-M5A40220
		30	CIMR-M5A4030	CIMR-M5A40305	CIMR-M5A40300
		37	CIMR-M5A4037	CIMR-M5A40375	CIMR-M5A40370
		45	CIMR-M5A4045	CIMR-M5A40455	CIMR-M5A40450
M5N	200 V class	3.7	CIMR-M5N23P7	CIMR-M5N23P75	CIMR-M5N23P70
		5.5	CIMR-M5N25P5	CIMR-M5N25P55	CIMR-M5N25P50
		7.5	CIMR-M5N27P5	CIMR-M5N27P55	CIMR-M5N27P50
		11	CIMR-M5N2011	CIMR-M5N20115	CIMR-M5N20110
		15	CIMR-M5N2015	CIMR-M5N20155	CIMR-M5N20150
		18.5	CIMR-M5N2018	CIMR-M5N20185	CIMR-M5N20180
		22	CIMR-M5N2022	CIMR-M5N20225	CIMR-M5N20220
		30	CIMR-M5N2030	CIMR-M5N20305	CIMR-M5N20300
		37	CIMR-M5N2037	CIMR-M5N20375	CIMR-M5N20370
	400 V class	5.5	CIMR-M5N45P5	CIMR-M5N45P55	CIMR-M5N45P50
		7.5	CIMR-M5N47P5	CIMR-M5N47P55	CIMR-M5N47P50
		11	CIMR-M5N4011	CIMR-M5N40115	CIMR-M5N40110
		15	CIMR-M5N4015	CIMR-M5N40155	CIMR-M5N40150
		18.5	CIMR-M5N4018	CIMR-M5N40185	CIMR-M5N40180
		22	CIMR-M5N4022	CIMR-M5N40225	CIMR-M5N40220
		30	CIMR-M5N4030	CIMR-M5N40305	CIMR-M5N40300
		37	CIMR-M5N4037	CIMR-M5N40375	CIMR-M5N40370
		45	CIMR-M5N4045	CIMR-M5N40455	CIMR-M5N40450

* Specify all standards through the construction when ordering.

1

1.1.3 Converter Models

Converter models are offered in both into 200 and 400 V classes. Both MR5A models for independent drives with no 24-V control power supply and MR5N models for NC systems with a 24-V control power supply are available.

Table 1.2 Converter Models

Type	Voltage Class	VS-656MR5		Inverter Mode Numbers *	
		30-minute Rated Output (kW)	Model Number	Open Chassis CIMR-MR5□□□□□5	Enclosed Wall-mounted CIMR-MR5□□□□□0
MR5A	200 V class	3.7	CIMR-MR5A23P7	CIMR-MR5A23P75	CIMR-MR5A23P70
		5.5	CIMR-MR5A25P5	CIMR-MR5A25P55	CIMR-MR5A25P50
		7.5	CIMR-MR5A27P5	CIMR-MR5A27P55	CIMR-MR5A27P50
		11	CIMR-MR5A2011	CIMR-MR5A20115	CIMR-MR5A20110
		15	CIMR-MR5A2015	CIMR-MR5A20155	CIMR-MR5A20150
		18.5	CIMR-MR5A2018	CIMR-MR5A20185	CIMR-MR5A20180
		22	CIMR-MR5A2022	CIMR-MR5A20225	CIMR-MR5A20220
		30	CIMR-MR5A2030	CIMR-MR5A20305	CIMR-MR5A20300
		37	CIMR-MR5A2037	CIMR-MR5A20375	CIMR-MR5A20370
	400 V class	5.5	CIMR-MR5A45P5	CIMR-MR5A45P55	CIMR-MR5A45P50
		7.5	CIMR-MR5A47P5	CIMR-MR5A47P55	CIMR-MR5A47P50
		11	CIMR-MR5A4011	CIMR-MR5A40115	CIMR-MR5A40110
		15	CIMR-MR5A4015	CIMR-MR5A40155	CIMR-MR5A40150
		18.5	CIMR-MR5A4018	CIMR-MR5A40185	CIMR-MR5A40180
		22	CIMR-MR5A4022	CIMR-MR5A40225	CIMR-MR5A40220
		30	CIMR-MR5A4030	CIMR-MR5A40305	CIMR-MR5A40300
		37	CIMR-MR5A4037	CIMR-MR5A40375	CIMR-MR5A40370
		45	CIMR-MR5A4045	CIMR-MR5A40455	CIMR-MR5A40450
MR5N	200 V class	3.7	CIMR-MR5N23P7	CIMR-MR5N23P75	CIMR-MR5N23P70
		5.5	CIMR-MR5N25P5	CIMR-MR5N25P55	CIMR-MR5N25P50
		7.5	CIMR-MR5N27P5	CIMR-MR5N27P55	CIMR-MR5N27P50
		11	CIMR-MR5N2011	CIMR-MR5N20115	CIMR-MR5N20110
		15	CIMR-MR5N2015	CIMR-MR5N20155	CIMR-MR5N20150
		18.5	CIMR-MR5N2018	CIMR-MR5N20185	CIMR-MR5N20180
		22	CIMR-MR5N2022	CIMR-MR5N20225	CIMR-MR5N20220
		30	CIMR-MR5N2030	CIMR-MR5N20305	CIMR-MR5N20300
		37	CIMR-MR5N2037	CIMR-MR5N20375	CIMR-MR5N20370
	400 V class	5.5	CIMR-MR5N45P5	CIMR-MR5N45P55	CIMR-MR5N45P50
		7.5	CIMR-MR5N47P5	CIMR-MR5N47P55	CIMR-MR5N47P50
		11	CIMR-MR5N4011	CIMR-MR5N40115	CIMR-MR5N40110
		15	CIMR-MR5N4015	CIMR-MR5N40155	CIMR-MR5N40150
		18.5	CIMR-MR5N4018	CIMR-MR5N40185	CIMR-MR5N40180
		22	CIMR-MR5N4022	CIMR-MR5N40225	CIMR-MR5N40220
		30	CIMR-MR5N4030	CIMR-MR5N40305	CIMR-MR5N40300
		37	CIMR-MR5N4037	CIMR-MR5N40375	CIMR-MR5N40370
		45	CIMR-MR5N4045	CIMR-MR5N40455	CIMR-MR5N40450

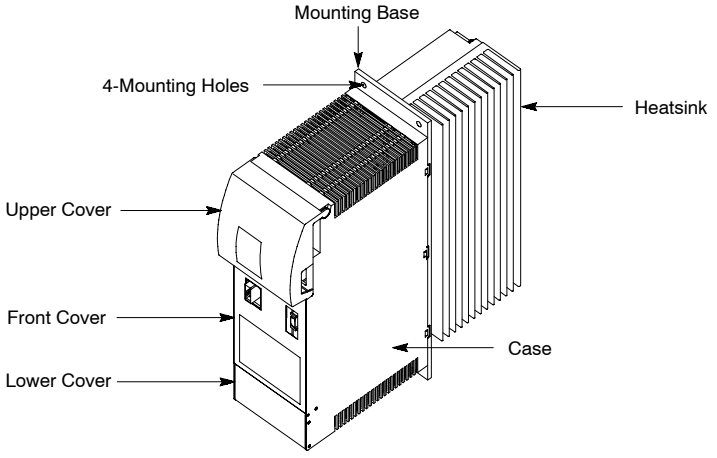
* Specify all standards through the construction when ordering.

1.2 Identifying Components

This section provides the names of Converter and Inverter components.

1.2.1 Converter

The appearance of the Converter and the names of its components are shown below.



Upper and Lower Covers Opened

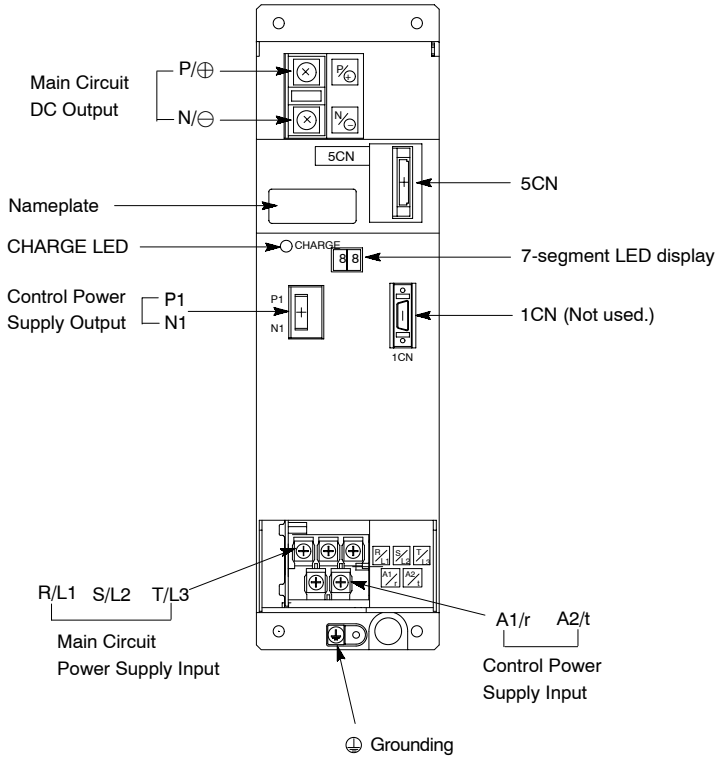
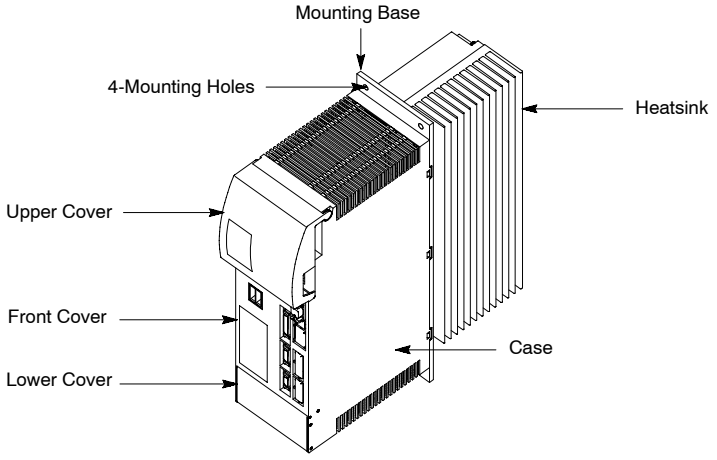


Fig 1.1 Appearance of Converter, Model CIMR-MR5A27P55 (200 V, 7.5 kW)

1

1.2.2 Inverter

The appearance of the Inverter and the names of its components are shown below.



Upper and Lower Covers Opened

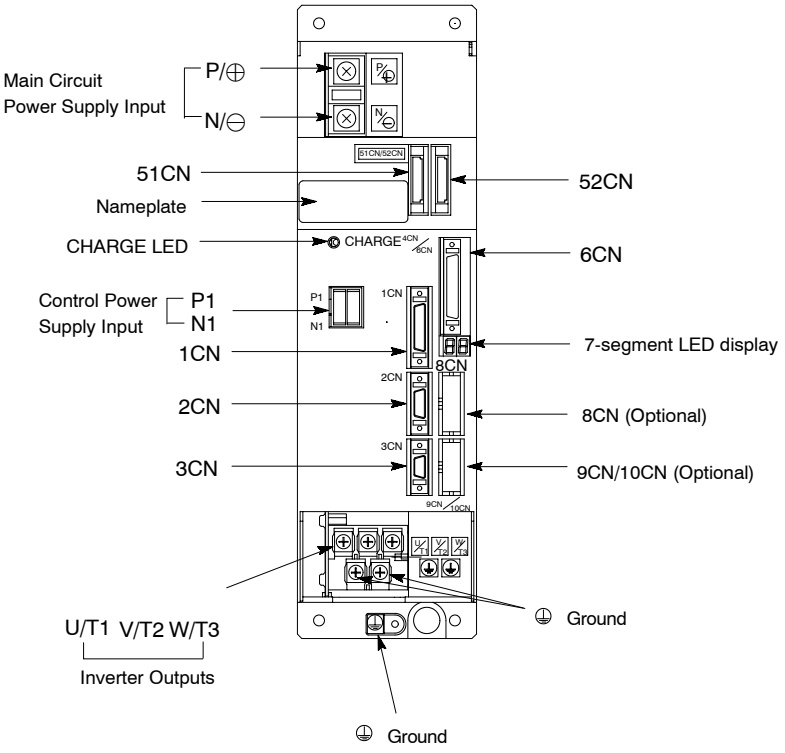


Fig 1.2 Appearance of Inverter, Model CIMR-M5A27P55 (200 V, 7.5 kW)

2

Handling

This chapter describes the checks required upon receiving an Inverter and Converter and describes installation methods.

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2.1 Confirmation upon Delivery

> **⚠ CAUTION**
>
> - Do not install any Inverter or Converter which is damaged or has missing parts.
>
> Failure to observe this caution may result in personal injury or equipment damage.

Check the following items as soon as the Inverter and Converter are delivered.

Table 2.1 Checks

Check points	Description
Does the Inverter model number correspond with the purchase order?	Check the model number on the name plate on the side of the Inverter and that of the Converter. (See 2.1.1).
Are any parts damaged?	Visually check the exterior and verify that there was no damage during transport.
Are any screws or other components loose?	Use a screwdriver or other tools to check for tightness.

If any of the above checkpoints are not satisfactory, contact your Yaskawa representative.

2.1.1 Inverter Nameplate Information

■ Nameplate Information

Example of a Model for 200 VAC, 10HP (7.5 kW)

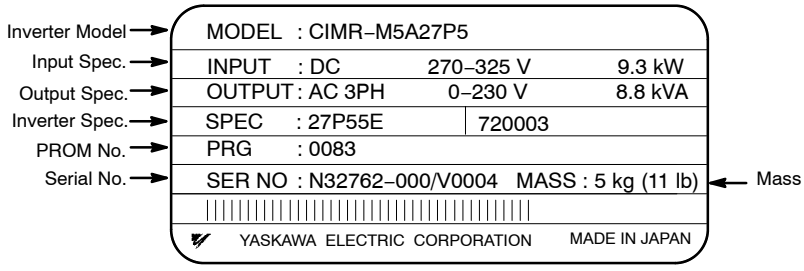


Fig 2.1 Inverter Nameplate

■ Model Designations

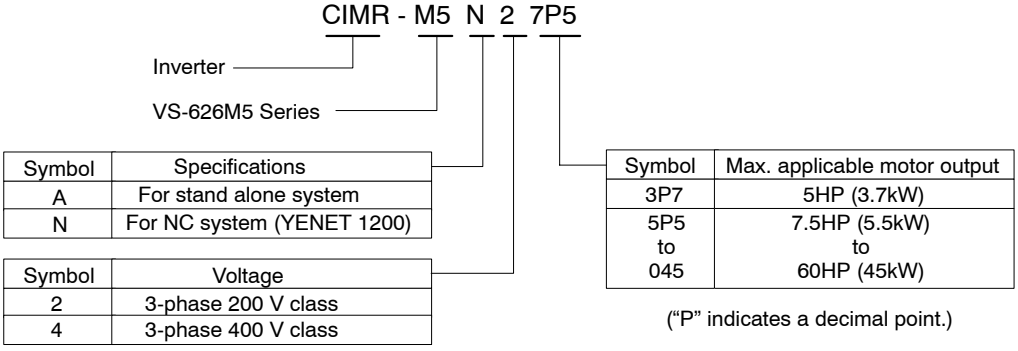
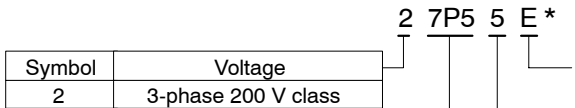


Fig 2.2 Inverter Model Numbers

■ Inverter Specification Designation



Symbol	Voltage
2	3-phase 200 V class
4	3-phase 400 V class

Symbol	Max. applicable motor output
3P7	5HP (3.7kW)
5P5 to 045	7.5HP (5.5kW) to 60HP (45kW)

("P" indicates a decimal point.)

Symbol	Enclosure
0	Open chassis type
5	External heatsink cooling type

* For special specifications, a spec. sheet No. appears on the nameplate.

Fig 2.3 Inverter Specifications

2

2.1.2 Converter Nameplate Information

■ Nameplate Information

Example of a Model for 200 VAC, 15 HP (11 kW)

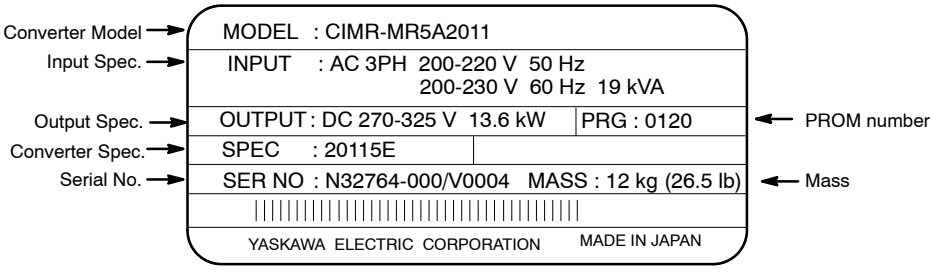
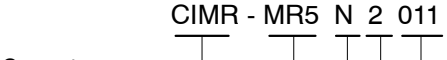


Fig 2.4 Converter Nameplate

■ Model Designations



Symbol	Specifications
A	For stand alone system
N	For NC or stand-alone system

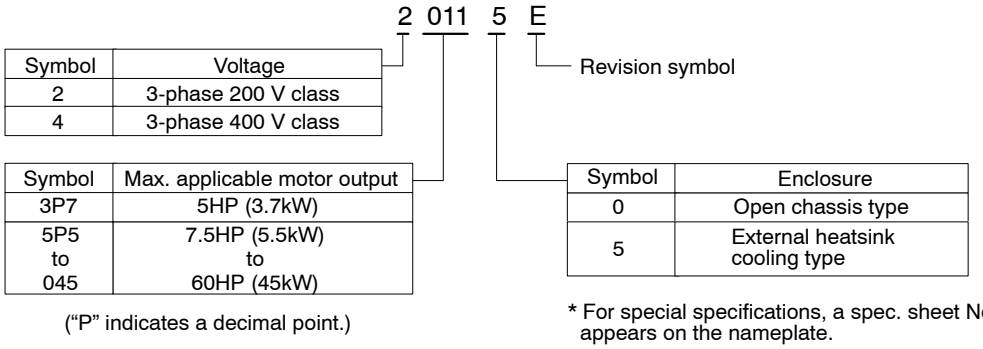
Symbol	Voltage
2	3-phase 200 V class
4	3-phase 400 V class

Symbol	Max. applicable motor output
3P7	5HP (3.7kW)
5P5 to 045	7.5HP (5.5kW) to 60HP (45kW)

("P" indicates a decimal point.)

Fig 2.5 Converter Model Numbers

■ Converter Specification Designation



Symbol	Voltage
2	3-phase 200 V class
4	3-phase 400 V class

Symbol	Max. applicable motor output
3P7	5HP (3.7kW)
5P5 to 045	7.5HP (5.5kW) to 60HP (45kW)

("P" indicates a decimal point.)

Symbol	Enclosure
0	Open chassis type
5	External heatsink cooling type

* For special specifications, a spec. sheet No. appears on the nameplate.

Fig 2.6 Converter Model Numbers

2.1.3 Motor Nameplate Information

■ Nameplate Information

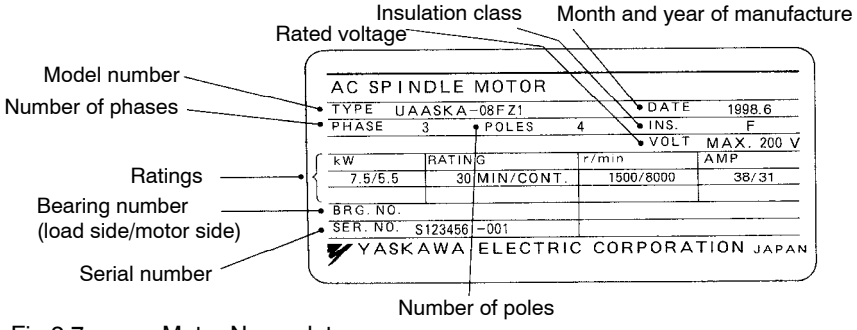
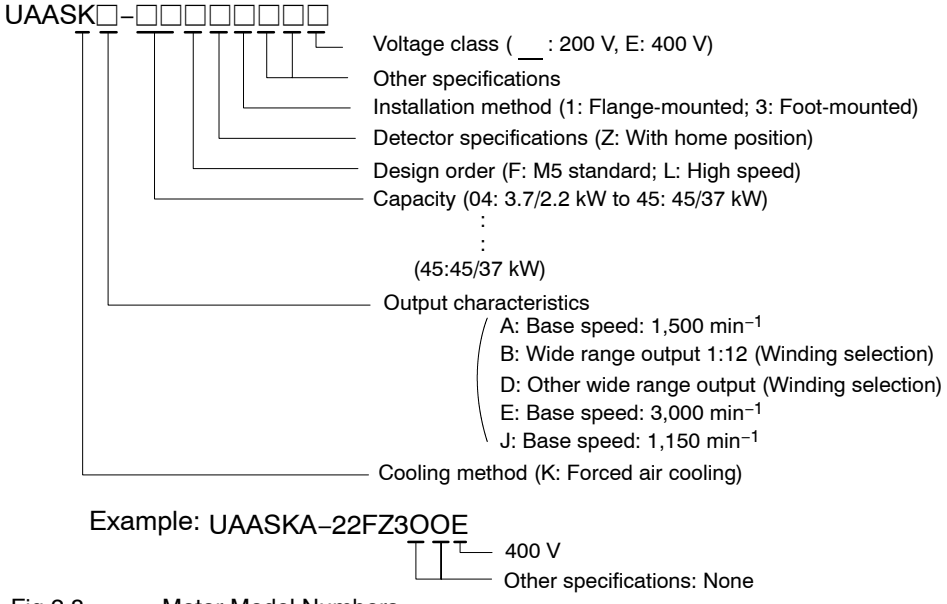


Fig 2.7 Motor Nameplate

■ Motor Model Designations



Example: UAASKA-22FZ3OOE

- 400 V
- Other specifications: None

Fig 2.8 Motor Model Numbers

2.2 Checking and Controlling the Installation Site

> **⚠ CAUTION**
>
> - Always hold the case when carrying the Inverter.
> If the Inverter is held by the front cover, the main body of the Inverter may fall, possibly resulting in injury.
> - Mount the Inverter and the Converter on nonflammable material (i.e. metal).
> Failure to observe this caution can result in a fire.
> - Install a fan or other cooling device to keep the ambient temperature of Inverter and Converter below 55°C (131°F) and the intake air temperature to heatsink below 45°C (113°F).
> Overheating may cause a fire or damage to the unit.

Install the VS-626M5 Inverter and VS-656MR5 Converter in the installation site described below. Maintain optimum conditions.

2.2.1 Installation Site

Install the Inverter and Converter under the following conditions.

- Install the Inverter and Converter in a clean location free from oil mist and water drops. Water or dirty oil inside the Inverter or Converter will decrease the insulation resistance, which may result in a ground fault. Also, any oil on the electronic components may result in an unforeseeable accident.
- Install the Inverter and Converter in a location not in direct sunlight. The interior temperature of the Inverter or Converter exposed to sunlight will increase and exceed the operating ambient temperature, which may reduce the service life of internal electronic components.
- Install the Inverter and Converter in a location free from harmful gasses, liquids, excessive dust, and excessive metal powder. Harmful gasses, corrosion of the electronic or conductive parts, and/or dust on the Inverter or Converter will decrease the insulation resistance, which may result in a ground fault.
- Do not install the Inverter and Converter on combustible material, such as wood.
- If the Inverter or Converter is installed in a location where the operation conditions are less than ideal because the occurrence of oil mist, install the Inverter or Converter in the oilproof-control panel.
  Oil mist in the Inverter or Converter may cause the corrosion of electronic or conductive part, that may then decrease the insulation resistance, which may result in a ground fault.
  If installing the Inverter or Converter in the control panel, care must be taken when planning this installation to prevent oil mist from entering the panel thorough gaps in the welded sections.
- Install the Inverter and Converter in a location free from radioactive materials and combustible materials.
- Install the Inverter and Converter in a location without excessive vibration.
- Install the Inverter and Converter in a location free from chlorides.
- Design the ventilation or heat exchanger considering the heat radiation of the Inverter and Converter. Refer to *Tables 14.9* to *14.12* for the heat radiation of each Inverter and Converter model. If the ventilation is improper, the heatsink temperature fault protective function will work regardless of whether or not the output is above the rated value.
- To cool the Inverter and Converter efficiently, install them vertically. Considering the maintainability and ventilation of the Inverter and Converter, provide sufficient space on the left, right, top, and bottom of the Inverter and Converter. Refer to *2.3 Clearance* for details. If the ventilation is improper, the heatsink temperature fault protective function will work regardless of whether or not the output is above the rated value.
- Although the Inverter and Converter operate between 05C and 555C (325F and 1315F), install the Inverter and Converter so that the maximum temperature of the heatsink inlet air will be 455C (1135F). If the temperature of the inlet air is excessively high, the heatsink temperature fault protective function will work regardless of whether or not the output is less than the rated value.
- Install the Inverter and Converter in a location where the maximum ambient humidity is 90% with no condensation.
- The heat dissipation in the control panel can be reduced if the control panel has a ventilation duct and the heatsink of the Inverter and that of the Converter are exposed in the duct to the cooling air. In this case, the capacity of the heat exchanger, if required, can be reduced. Refer to *15.5 Inverter/Converter Cooling Design* for details.
- If the Inverter is installed in a panel, the air in the box can be mixed to cool the Inverter. The Inverter must not be installed outside an enclosure. Although the surface of the PCB is coated with varnish, the Inverter may fail to operate or result in accidents if the PCB comes in contact with moisture or dust.

- Observe these additional cautions if taking the heatsink out of the panel from the opening in the control panel to cool outside.
  - Install an oil-proof gasket on the fitting to prevent oil and dust from entering the unit.
    Without a gasket, oil and iron particles may enter the control panel, corrosion of the electronic parts and conductive parts may occur, and the resulting decrease of the insulation resistance may result in a ground fault.
  - If oil is on the external cooling fan, decrease in the insulation resistance and in the life of the rotating section may occur over time.
    Also, if oil and dust are on the heatsink, cooling efficiency may decrease due to the clogging of the fins. Attach a filter onto the cooling-air intake and avoid taking in air in locations where the oil mist is present.

2.2.2 Operating Ambient Temperature

To enhance the reliability of operation, the Inverter and Converter should be installed in an environment free from extreme temperature increases. If the Inverter or Converter is installed in an enclosed environment, such as a panel, use a cooling fan or air conditioner to maintain the internal air temperature below 45°C (113°F).

2.2.3 Protecting the Inverter and Converter from Foreign Matter

Place a cover over the Inverter and Converter during installation to shield them from metal power produced by drilling.

Always remove the covers from the Inverters and Converters after completing installation. Otherwise, ventilation will be reduced, causing the Inverter and Converter to overheat.

2.2.4 Storage

The Inverter, Converter, and Motor must be stored under the following conditions.

Table 2.2 Storage Conditions

Temperature	0°C to 60°C (32°F to 140°F)
Humidity	5% to 95% with no condensation The air at 40°C (104°F) with 50% humidity will condensate if the temperature drops to 28°C (82.4°F). Be sure that the place of storage does not have radical temperature changes.
Environment	Indoors with no corrosive gas, mist, or dust.

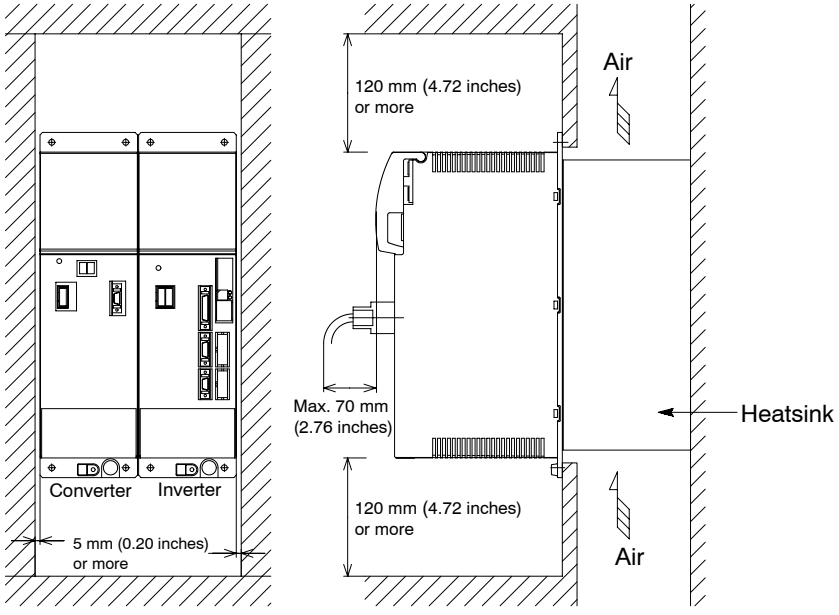
2.3 CLEARANCES

Install the Inverter and Converter vertically and allow sufficient clearances for effective cooling as shown in Fig. 2.9 and Fig. 2.10.

IMPORTANT

1. For the external dimensions and mounting dimensions, refer to *14.1.3 Dimensions*.
2. Allowable intake air temperature to the Inverter and the Converter:
   • Open chassis type: 0°C to +45°C (32°F to 113°F)
   • External heatsink cooling type
   Inside of heatsink : 0°C to +45°C (32°F to 113°F)
   Inside of unit : 0°C to +55°C (32°F to 131°F)
3. Near the heatsink, cooling air speed should be 2.5 m/s for effective cooling (for external heatsink cooling).

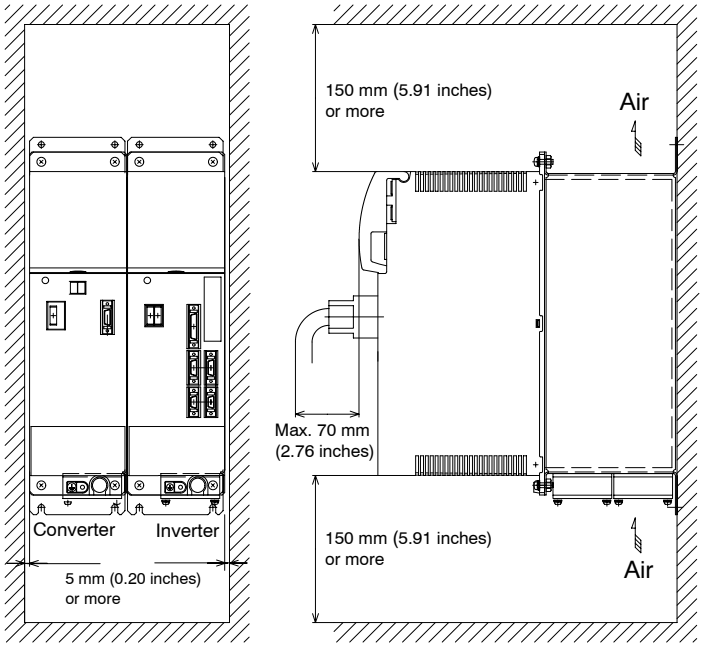
2.3.1 External Heatsink Cooling Type



(a) Front View (b) Side View

Fig 2.9 Installation Orientation and Space of Models with External Heatsink Cooling

2.3.2 Open Chassis Type



(a) Front View (b) Side View

Fig 2.10 Clearances for Open Chassis Type

When using an Open-chassis Converter (11 kW or more) in combination with an Inverter (7.5 kW or less), follow the installation procedure shown below.

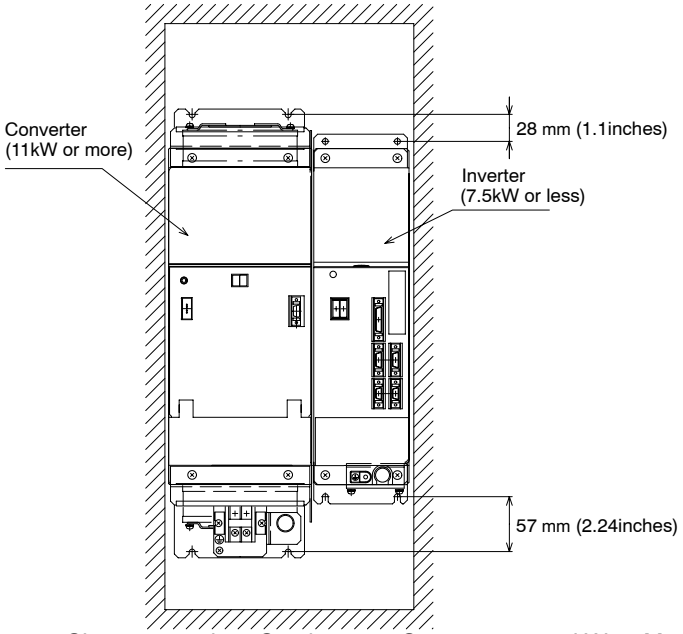


Fig 2.11 Clearances when Combining a Converter or 11 kW or More with an Inverter of 7.5 kW or Less

2.4 Attaching the Digital Operator

⚠ WARNING

- Disconnect all power before removing Digital Operator (JVOP-132). Then wait for the time described on warning labels after main circuit power supply and control power supply are disconnected, and all LEDs of the Inverter and the Converter are extinguished.
  Failure to observe this warning can result in an electric shock.

⚠ CAUTION

- Do not use any screws other than the ones provided to mount the cable holder.
  Otherwise, the cable holder will not be attached securely.

The VS-626M5 can support the Multi-functional Display Digital Operator (JVOP-132) as an option. The Exclusive-use Extension Cable (72616-W5301 or 72616-W5303) is required when connecting the Digital Operator with the Inverter. Use 3CN to attach the digital operator firmly as follows.

- Turn OFF the Inverter power supply.
- Connect the extension cable on both Inverter and Digital Operator. (See Fig. 2.12.)
- After inserting the connector into the Inverter, tighten two connector screws to prevent the connector from being removed.
- Install the cable holder on the Digital Operator with the provided tapping screws to prevent the cable from dropping.

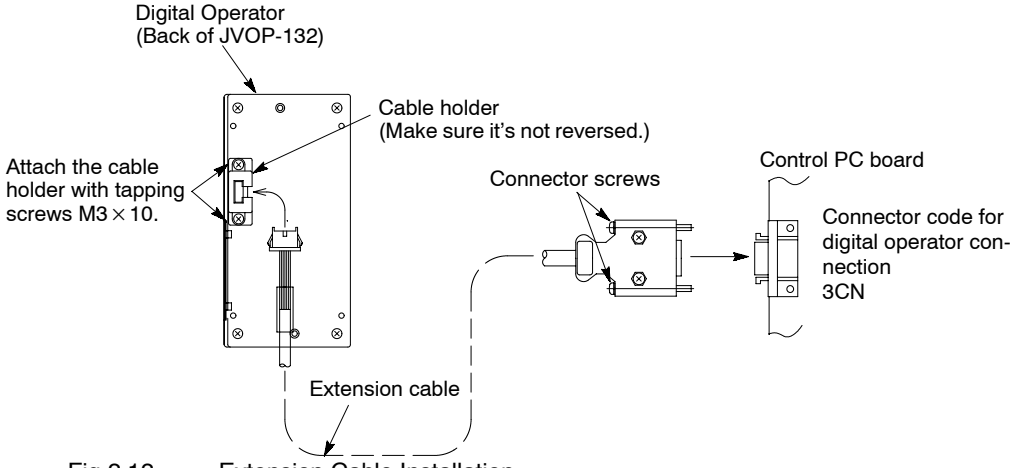


Fig 2.12 Extension Cable Installation

2.5 Motor Installation Precautions

This section provides precautions for mechanical designing around the Motor to be installed.

IMPORTANT

The motor flange and shaft are coated with anti-corrosive paint or grease. Clean the flange, shaft, and key groove with paint thinner before installing the motor.

2.5.1 Installation Site

Install the Motor under the following conditions.

- Provide sufficient space so that cooling air will be provided to the cooling fan. Keep a space of at least 100 mm (3.94 inches) between the machine and the ventilation outlet of the Motor. If ventilation is not proper, the motor temperature fault protective function will work regardless of whether or not the load is at the rated value or not.
- Install the motor in a clean location free from oil mist and water drops. If the motor is likely to come in contact with water or oil, protect the motor with a cover. The intrusion of water or dirty oil into the interior of the motor will decrease the insulation resistance, which may result in a ground fault.
- Check that the mounting bed, base, or stand of the Motor is of robust construction because the weight of the motor as well as the dynamic load of the motor in operation will be imposed on it, possibly causing vibration. Use the Motor with a maximum vibration acceleration of 2.5 G if it is a Standard Motor with a maximum capacity of 22/18.5 kW or a Winding Selection Motor with a maximum capacity of 11/7.5 kW or 18.5/15 or 22/18.5 kW and the external diameter is 260 mm (10.2 inches) or less. Use the Motor with a maximum vibration acceleration of 2 G if it is a Standard Motor with a maximum capacity of 37/30 kW or a Winding Selection Motor with a maximum capacity of 15/11 kW and the external diameter is 260 mm (10.2 inches) or less.
  Frequency of vibration acceleration is 10 to 60 Hz (constant amplitude) or 60 to 2,500 Hz (constant acceleration).
- Install the motor in a location free from excessive dust, metal powder, or mist. The motor has a built-in fan that provides cooling air to the core. If the passage of cooling air is blocked with dust or other foreign matter, the cooling efficiency will drop. As a result, the motor temperature fault protective function will work regardless of whether or not the load is the rated value or not.
  Use a motor with oil seal in the case, such as gear coupling, where the motor shaft is likely to come into contact with oil. For gear coupling, check that the surface of lubricating oil is under the oil seal lip.

2.5.2 Installation Orientation

Consider the following conditions for the installation direction of the Motor.

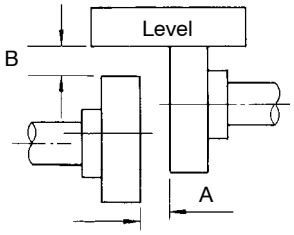
- The Flange-type Motor can be mounted with the motor shaft on the load side at any angle between horizontal and the downward vertical direction. If the motor shaft is facing up, excessive force will be imposed on the motor shaft. As a result, the service life of the Motor will be adversely affected.
- If the Motor is mounted on legs, mount the legs on the floor. If the legs are installed upward, excessive force will be imposed on the legs. As a result, the service life of the Motor will be adversely affected.
- Use the Motor of outer diameter □380 with the terminal box facing upward and the motor shaft facing horizontal if it is a Standard Motor with a minimum capacity of 45/37 kW or a Winding Selection Motor with a minimum capacity of 18.5/15 kW. If the terminal box is in the horizontal or downward direction, dust may intrude from the ventilation mouth on the bottom of the load-side bracket. As a result, the Motor may fail to operate or unexpected accidents may occur.

2.5.3 Coupling Motor and Machinery

Consider the following conditions when coupling the Motor with the machinery.

■ Direct Coupling

Couple the Motor with the machinery so that the center of the motor shaft and that of the machinery shaft are on a straight line. Insert a liner for adjustment, if necessary. If the center of the motor shaft does not coincide with that of the machinery shaft, unnecessary torsion will be imposed on the motor shaft and machinery shaft. As a result, the bearings may wear out or break quickly.



Tolerance A: 0.03 m (0.0012 inches) max.
Surface irregularity B: 0.03 mm (0.0012 inches) max.

Fig 2.13 Direct Coupling Precision of Motor and Machinery

Use the coupling so that a axial load is not imposed on the motor shaft.

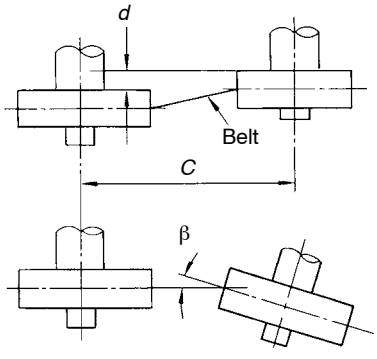
■ Belt Coupling

Check that the motor shaft is parallel to the machinery shaft and that the line connecting the centers of the pulleys and the shafts are at right angles to each other. The radial load imposed on the motor shaft edge must not exceed the permissible value specified in 14.2.5 Tolerance Radial Loads.

Be sure that no axial load is imposed on the motor shaft.

If the angularity of the belt is improper, the belt will vibrate or slip. If an excessive radial load is imposed on the motor shaft, the motor bearings will be adversely affected and the service life of the bearings will be decreased.

Check that the angle of contact of the belt and pulley will be 140° or more, or otherwise the belt may slip.



- If C is 1,000 mm (39.4 inches) or less, d < 1 mm (0.039 inches).
- If C is more than 1,000 (39.4) mm (39.4 inches), d/C < 1/1000
- β < 1/3°

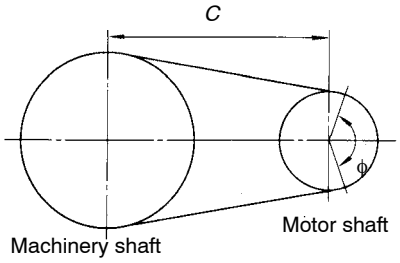


Fig 2.14 Belt Installation

■ Gear Coupling

Check that the motor shaft is parallel to the machinery shaft and that the centers of the gears are engaged properly. Refer to *14.2.6 Motor Total Indicator Readings* for the precision of the peripheral parts connecting to the motor shaft. The gears may grate if they do not engage properly.

Be sure that no axial load is imposed on the motor shaft.

■ Mounting a Pulley or Gear to the Motor Shaft

When mounting a pulley or gear to the motor shaft, consider the mounting balance of the Motor. The dynamic balance of the Motor is kept with a half key (for motors with a key way), which is a half as thick as the key (T) specified in the motor shaft dimensional drawing. The Motor rotates at high speed and a little imbalance in the mechanism may cause the motor to vibrate.

3

Wiring

This chapter provides typical connection examples of the Inverter and Converter to peripheral units, main circuit wiring specifications, and control circuit wiring.

3.1 Connection with Peripheral Units ..... 3 -2

3.2 Connection Diagram ..... 3 -5

3.3 Wiring Main Circuit Terminals ..... 3 -7

- 3.3.1 Wires and Suitable Crimp Connectors ..... 3 -7
- 3.3.2 Functions of Main Circuit Terminals ..... 3 -13
- 3.3.3 Main Circuit Configuration ..... 3 -15
- 3.3.4 Main Circuit Connection Diagrams ..... 3 -19
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3.1 Connection with Peripheral Units

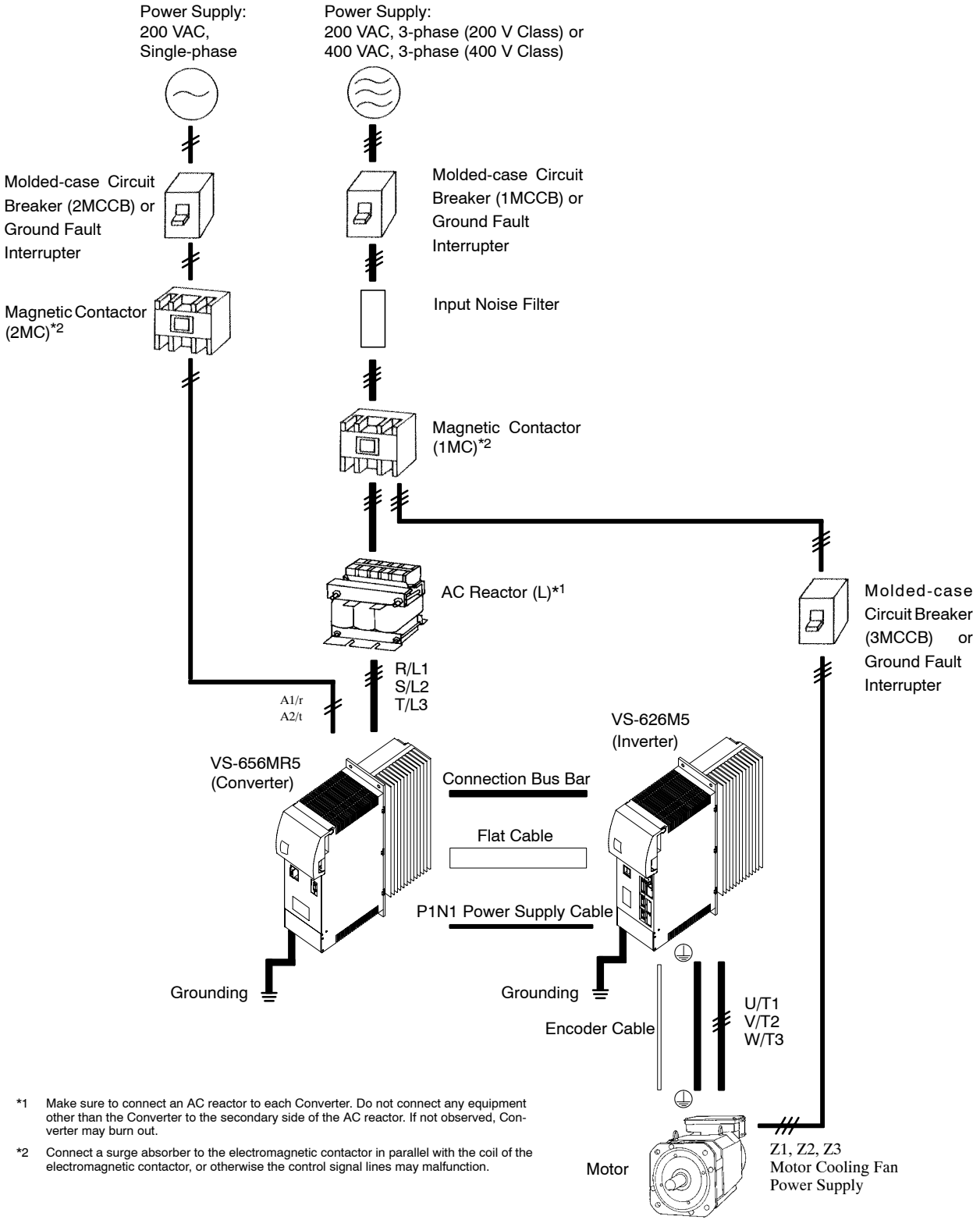
⚠ WARNING

- Always turn OFF the input power supply before wiring terminals.
  Otherwise, an electric shock or fire can occur.
- Wiring should be performed only by qualified personnel.
  Failure to observe this warning can result in an electric shock or a fire.
- Make sure to ground the ground terminal .
  (200V class: Ground to 100Ω or less, 400V class: Ground to 10Ω or less)
  Failure to observe this warning can result in an electric shock or a fire.
- Always check the operation of any emergency stop circuits after they are wired.
  Otherwise, there is the possibility of injury. (Wiring is the responsibility of the user.)
- Never touch the output terminals directly with your hands or allow the output lines to come into contact with the Inverter case. Never short the output circuits.
  Otherwise, electrical shock or grounding can occur.

⚠ CAUTION

- Verify that the rated voltage of the Converter coincides with the AC power supply voltage.
  Failure to observe this caution can result in personal injury or a fire.
- Do not perform a withstand voltage test of the Inverter and the Converter.
  It may cause semi-conductor elements to be damaged.
- Make sure to connect the Inverter and the Converter as shown in the connection diagram.
  The Inverter or the Converter may be damaged.
- Tighten terminal screws to the specified tightening torque.
  Failure to observe this caution can result in a fire.
- Do not connect the power supply to output terminals U/T1, V/T2, and W/T3.
  The interior parts of the Inverter will be damaged if voltage is applied to the output terminals.
- Do not connect phase-advancing capacitors or LC/RC noise filters to the output circuits.
  The Inverter can be damaged or internal parts burnt if these devices are connected.
- Do not connect electromagnetic switches or contactors to the output circuits.
  If a load is connected while the Inverter is operating, surge current will cause the overcurrent protection circuit inside the Inverter to operate.

The following shows standard connections of the VS-626M5 with peripheral units.



*1 Make sure to connect an AC reactor to each Converter. Do not connect any equipment other than the Converter to the secondary side of the AC reactor. If not observed, Converter may burn out.

*2 Connect a surge absorber to the electromagnetic contactor in parallel with the coil of the electromagnetic contactor, or otherwise the control signal lines may malfunction.

Fig 3.1 Connection with Peripheral Units for External Heatsink Cooling Type

The following figure shows the system configuration of the Inverter compatible with YENET1200 communications. For details on the connections of an NC machine and servo units, refer to the manual for the NC machine.

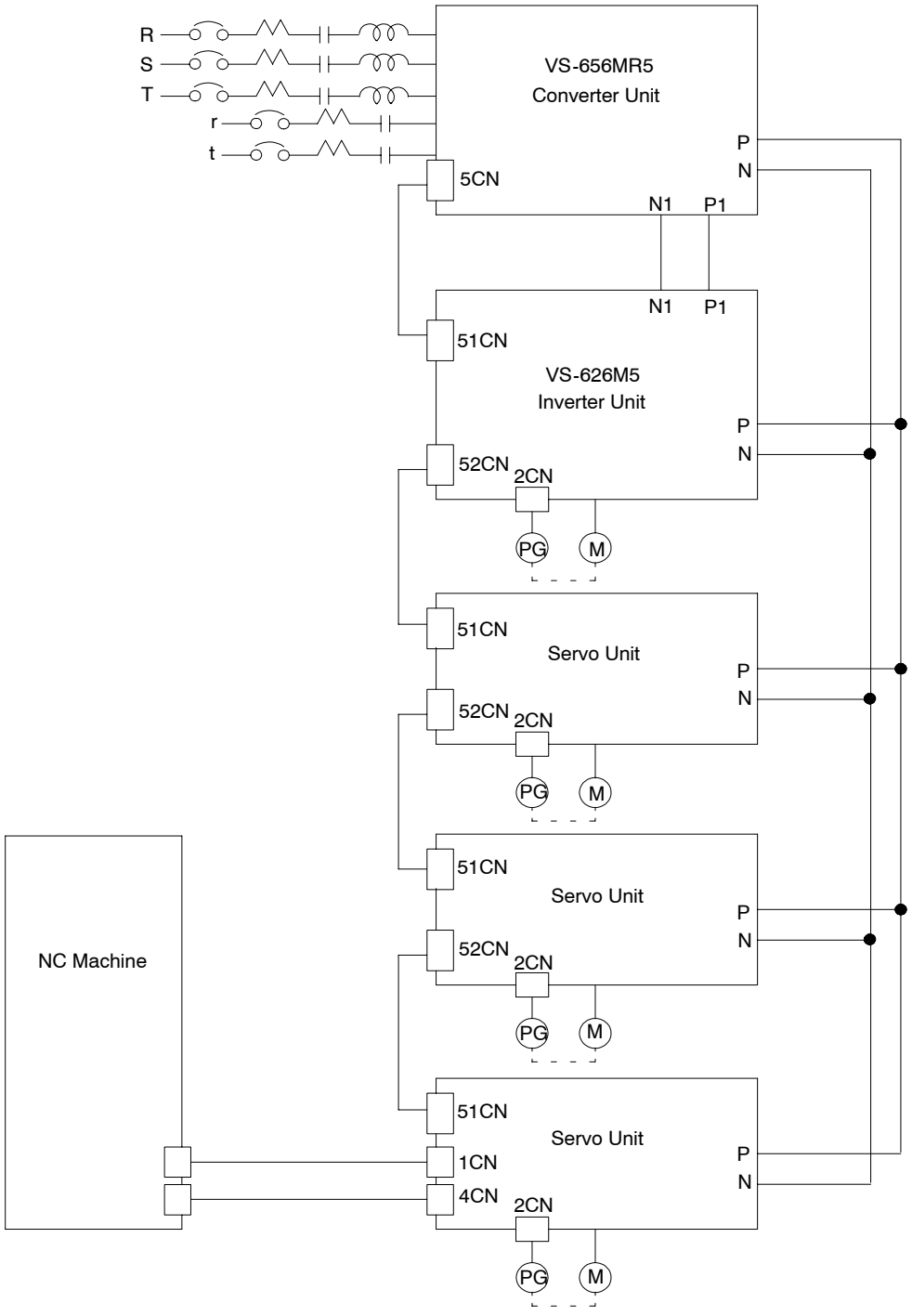
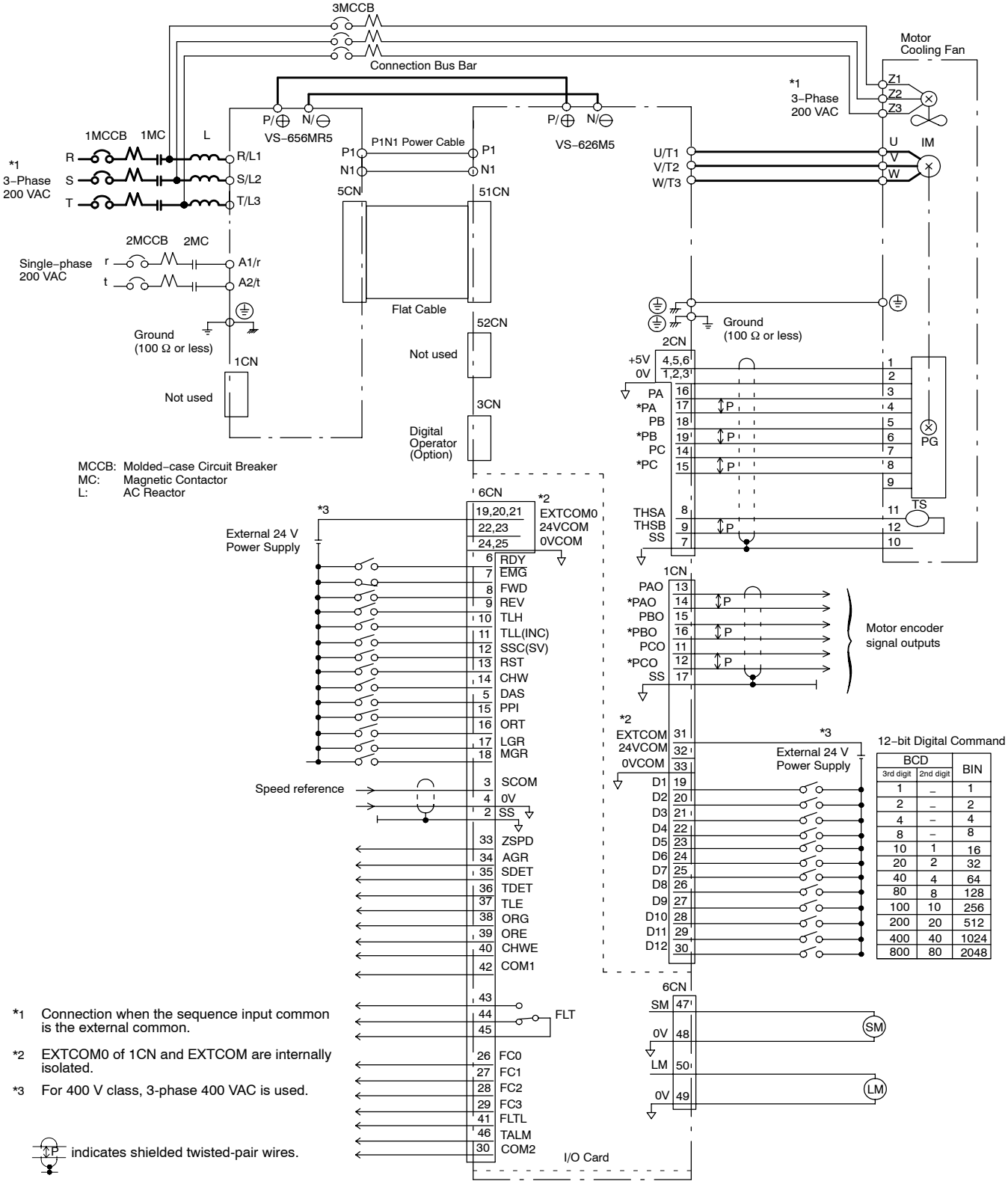


Fig 3.2 Connection Diagram for Inverter Compatible with YNET1200 Communications

3.2 Connection Diagram

The connection diagram of the Inverter and Converter is shown in Figures 3.3 and 3.4. Figure 3.3 is for a M5A Inverter model for stand-alone drives and Figure 3.4 is for a M5N model for NC systems.



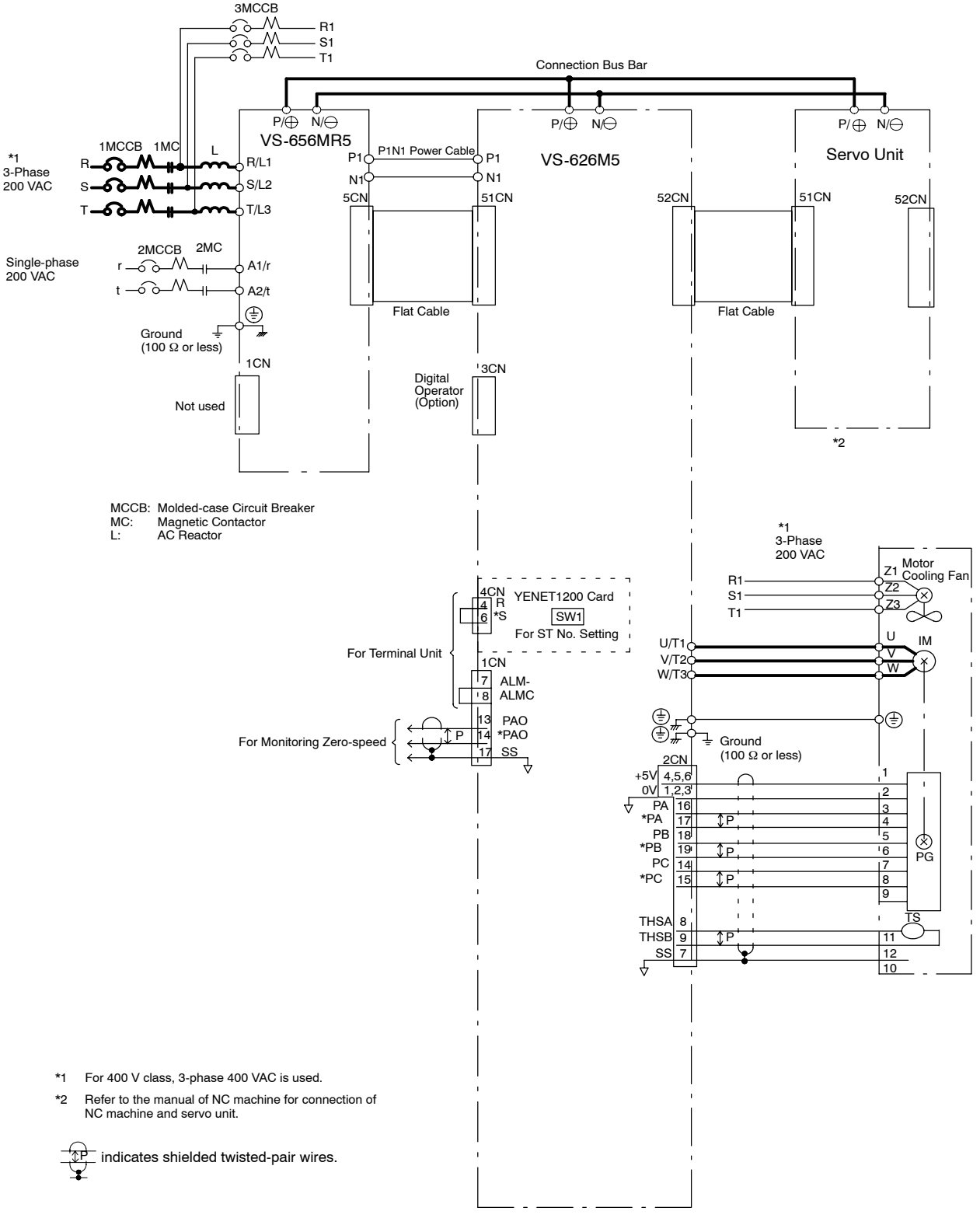
*1 Connection when the sequence input common is the external common.

*2 EXTCOM0 of 1CN and EXTCOM are internally isolated.

*3 For 400 V class, 3-phase 400 VAC is used.

indicates shielded twisted-pair wires.

Fig 3.3 Connection Diagram for Stand-alone Drive, 200 V Class External Heatsink Cooling Type



*1 For 400 V class, 3-phase 400 VAC is used.

*2 Refer to the manual of NC machine for connection of NC machine and servo unit.

indicates shielded twisted-pair wires.

Fig 3.4 Connection Diagram for NC System, 200 V Class External Heatsink Cooling Type

3.3 Wiring Main Circuit Terminals

This section provides information on the specifications, functions, configuration, and wiring of main circuit terminals.

3.3.1 Wires and Suitable Crimp Connectors

Select wires or crimp connectors to be used from the following table.

Table 3.1 200 V Class Converter Power Cable Specifications

Model CIMR-MR5□ □	Terminal Symbols	Terminal Screw	Tightening Torque (N • m)	Wire Sizes			
				UL-approved 75°C (167°F) Temperature-rated Copper Wire [AWG (mm²)]	600 V Vinyl-sheath Insulated Wire (IV, VV) 60°C (140°F) (mm²)	600 V Cross-linked Polyethylene Wire (IC) 90°C (194°F) (mm²)	600 V Rubber-insulated Cab-tyre Cable (CT) 60°C (140°F) (mm²)
23P7	P/⊕, N/⊖	M6	2.94	(*1)			
	R/L1, S/L2, T/L3	M5	2.35	14 (2.1)	2	2	2
	A1/r, A2/t	M5	2.35	14 (2.1)	2	2	2
	⏚	M4	1.2 – 2.0	10 (5.3)	2	2	2
25P5	P/⊕, N/⊖	M6	2.94	(*1)			
	R/L1, S/L2, T/L3	M5	2.35	12 (3.3)	3.5	2	3.5
	A1/r, A2/t	M5	2.35	14 (2.1)	2	2	2
	⏚	M4	1.2 – 2.0	10 (5.3)	3.5	2	2
27P5	P/⊕, N/⊖	M6	2.94	(*1)			
	R/L1, S/L2, T/L3	M5	2.35	10 (5.3)	3.5	2	3.5
	A1/r, A2/t	M5	2.35	14 (2.1)	2	2	2
	⏚	M4	1.2 – 2.0	10 (5.3)	3.5	2	3.5
2011	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	R/L1, S/L2, T/L3	M6	3.4 – 4.9	8 (8.4)	8	3.5	8
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M6	3.4 – 4.9	8 (8.4)	5.5	3.5	5.5
2015	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	R/L1, S/L2, T/L3	M6	3.4 – 4.9	6 (13.3)	14	5.5	14
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M6	3.4 – 4.9	8 (8.4)	8	5.5	5.5
2018	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	R/L1, S/L2, T/L3	M6	3.4 – 4.9	4 (21.2)	22	8	22
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M6	3.4 – 4.9	6 (13.3)	8	5.5	8
2022	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	R/L1, S/L2, T/L3	M6	3.4 – 4.9	4 (21.2)	22	14	22
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M6	3.4 – 4.9	6 (13.3)	14	8	8
2030	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	R/L1, S/L2, T/L3	M8	7.8 – 9.8	2 (33.6)	38	2.2	38
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M8	7.8 – 9.8	6 (13.3)	14	8	14
2037	P/⊕, N/⊖	M6 × 4	2.94	(*1)			
	R/L1, S/L2, T/L3	M10	14.7 – 19.6	1/0 (53.5)	50	30	60
	A1/r, A2/t	M4	1.2 – 2.0	14 (2.1)	2	2	2
	⏚	M8	7.8 – 9.8	4 (21.2)	22	14	14
2011 to 2037	A11/r1, A21/t1 (*2)	M4	1.2 – 2.0	14 (2.1)	2	2	2

* 1. Connect using exclusive-use connection bus bar.

* 2. Provided for open chassis type with a minimum capacity of 11 kW. Not provided for external heatsink cooling type.

Notes: 1. Wire size is selected assuming external suspended wiring of single 3-core cables at an ambient temperature of 30°C (86°F).
2. If ambient temperature exceeds 30°C (86°F), the allowable current of wire may be lowered.
3. Temperature for each wire indicates the maximum allowable conductor temperature.

Table 3.2 400 V Class Converter Power Cable Specifications

Model CIMR-MR5□ □	Terminal Symbols	Terminal Screw	Tightening Torque (N • m)	Wire Sizes			
				UL-approved 75°C (167°F) Temperature-rated Copper Wire [AWG (mm²)]	600 V Vinyl-sheath Insulated Wire (IV, VV) 60°C (140°F) (mm²)	600 V Cross-linked Polyethylene Wire (IC) 90°C (194°F) (mm²)	600 V Rubber-insulated Cabtyre Cable (CT) 60°C (140°F) (mm²)
45P5	P/⊕, N/⊖	M6	2.94		(*1)		
	R/L1, S/L2, T/L3	M5	2.35	14 (2.1)	2	2	2
	A1/r, A2/t	M5	2.35	14 (2.1)	2	2	2
	⏚	M4	1.2 to 2.0	10 (5.3)	2	2	2
47P5	P/⊕, N/⊖	M6	2.94		(*1)		
	R/L1, S/L2, T/L3	M5	2.35	14 (2.1)	2	2	2
	A1/r, A2/t	M5	2.35	14 (2.1)	2	2	2
	⏚	M4	1.2 to 2.0	10 (5.3)	2	2	2
4011	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	12 (3.3)	3.5	2	3.5
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	10 (5.3)	3.5	2	2
4015	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	10 (5.3)	3.5	2	3.5
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	10 (5.3)	3.5	2	3.5
4018	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	8 (8.4)	5.5	3.5	5.5
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	10 (5.3)	5.5	3.5	3.5
4022	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	8 (8.4)	8	3.5	8
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	8 (8.4)	5.5	3.5	5.5
4030	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	6 (13.3)	14	5.5	14
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	8 (8.4)	8	5.5	5.5
4037	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	4 (21.2)	22	8	22
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	6 (13.3)	8	5.5	8
4045	P/⊕, N/⊖	M6 × 2	2.94		(*1)		
	R/L1, S/L2, T/L3	M6	3.4 to 4.9	4 (21.2)	22	14	22
	A1/r, A2/t	M4	1.2 to 2.0	14 (2.1)	2	2	2
	⏚	M6, M6	3.4 to 4.9	6 (13.3)	14	8	8
4011 to 4045	A11/r1, A21/t1 (*2)	M4	1.2 to 2.0	14 (2.1)	2	2	2

* 1. Connect using exclusive-use connection bus bar.

* 2. Provided for open chassis type with a minimum capacity of 11 kW. Not provided for external heatsink cooling type.

Notes: 1. Wire size is selected assuming external suspended wiring of single 3-core cables at an ambient temperature of 30°C (86°F).

2. If ambient temperature exceeds 30°C (86°F), the allowable current of wire may be lowered.
3. Temperature for each wire indicates the maximum allowable conductor temperature.

Table 3.3 200 V Class Inverter Power Cable Specifications

Model CIMR-M5 □ □□□	Terminal Symbols	Terminal Screw	Tightening Torque (N • m)	Wire Sizes			
				UL-approved 75°C (167°F) Temperature-rated Copper Wire [AWG (mm²)]	600 V Vinyl-sheath Insulated Wire (IV, VV) 60°C (140°F) (mm²)	600 V Cross-linked Polyethylene Wire (IC) 90°C (194°F) (mm²)	600 V Rubber-insulated Cabtyre Cable (CT) 60°C (140°F) (mm²)
23P7	P/⊕, N/⊖	M6	2.94	(*1)			
	U/T1, V/T2, W/T3	M5	2.35	8 (8.4)	5.5	3.5	5.5
	⏚	M5 × 2	2.35	10 (5.3)	3.5	2	3.5
25P5	P/⊕, N/⊖	M6	2.94	(*1)			
	U/T1, V/T2, W/T3	M5	2.35	8 (8.4)	5.5	3.5	5.5
	⏚	M5 × 2	2.35	10 (5.3)	3.5	2	3.5
27P5	P/⊕, N/⊖	M6	2.94	(*1)			
	U/T1, V/T2, W/T3	M5	2.35	8 (8.4)	8	3.5	8
	⏚	M5 × 2	2.35	8 (8.4)	5.5	3.5	5.5
2011	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	6.47	6 (13.3)	14	8	14
	⏚	M6 × 2	3.4 to 4.9	8 (8.4)	8	5.5	5.5
2015	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	6.47	4 (21.2)	22	14	22
	⏚	M6 × 2	3.4 to 4.9	6 (13.3)	14	8	8
2018	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	6.47	3 (26.7)	30	14	30
	⏚	M6 × 2	3.4 to 4.9	6 (13.3)	14	8	14
2022	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	6.47	2 (33.6)	50	22	38
	⏚	M6 × 2	3.4 to 4.9	6 (13.3)	14	8	14
2030	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	7.8 to 9.8	2/0 (67.4)	80	38	80
	⏚	M6 × 2	3.4 to 4.9	4 (21.2)	22	14	14
2037	P/⊕, N/⊖	M6 × 4	2.94	(*1)			
	U/T1, V/T2, W/T3	M10	14.7 to 19.6	3/0 (85.0)	100	50	100
	⏚	M8 × 2, M6	7.8 to 9.8 3.4 to 4.9	3 (26.7)	22	14	22
2011 to 2037	A12/r2, A22/t2 (*2)	M4	1.2 to 2.0	14 (2.1)	2	2	2

* 1. Connect using exclusive-use connection bus bar.

* 2. Provided for open chassis type with a minimum capacity of 11 kW. Not provided for external heatsink cooling type.

Notes: 1. Wire size is selected assuming external suspended wiring of single 3-core cables at an ambient temperature of 30°C (86°F).
2. If ambient temperature exceeds 30°C (86°F), the allowable current of wire may be lowered.
3. Temperature for each wire indicates the maximum allowable conductor temperature.

Table 3.4 400 V Class Inverter Power Cable Specifications

Model CIMR-M5 □ □□□	Terminal Symbols	Terminal Screw	Tightening Torque (N • m)	Wire Sizes			
				UL-approved 75°C (167°F) Temperature-rated Copper Wire [AWG (mm²)]	600 V Vinyl-sheath Insulated Wire (IV, VV) 60°C (140°F) (mm²)	600 V Cross-linked Polyethylene Wire (IC) 90°C (194°F) (mm²)	600 V Rubber-insulated Cabtyre Cable (CT) 60°C (140°F) (mm²)
45P5	P/⊕, N/⊖	M6	2.94	(*1)			
	U/T1, V/T2, W/T3	M5	2.35	12 (3.3)	2	2	2
	⏚	M5 × 2	2.35	10 (5.3)	3.5	2	3.5
47P5	P/⊕, N/⊖	M6	2.94	(*1)			
	U/T1, V/T2, W/T3	M5	2.35	12 (3.3)	3.5	2	3.5
	⏚	M5 × 2	2.35	10 (5.3)	3.5	2	3.5
4011	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M6	3.4 to 4.9	10 (5.3)	5.5	2	5.5
	⏚	M5 × 2, M6	2.1 to 2.5 3.4 to 4.9	10 (5.3)	3.5	2	3.5
4015	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M6	3.4 to 4.9	8 (8.4)	8	3.5	8
	⏚	M5 × 2, M6	2.1 to 2.5 3.4 to 4.9	8 (8.4)	5.5	3.5	5.5
4018	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M6	3.4 to 4.9	8 (8.4)	14	5.5	14
	⏚	M5 × 2, M6	2.1 to 2.5 3.4 to 4.9	8 (8.4)	8	5.5	5.5
4022	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M6	3.4 to 4.9	6 (13.3)	14	8	14
	⏚	M5 × 2, M6	2.1 to 2.5 3.4 to 4.9	8 (8.4)	8	5.5	5.5
4030	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	7.8 to 9.8	4 (21.2)	22	14	22
	⏚	M6 × 2, M6	3.4 to 4.9 3.4 to 4.9	6 (13.3)	14	8	8
4037	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	7.8 to 9.8	3 (26.7)	30	14	30
	⏚	M6 × 2, M6	3.4 to 4.9 3.4 to 4.9	6 (13.3)	14	8	14
4045	P/⊕, N/⊖	M6 × 2	2.94	(*1)			
	U/T1, V/T2, W/T3	M8	7.8 to 9.8	1 (42.4)	60	30	50
	⏚	M6 × 2, M6	3.4 to 4.9 3.4 to 4.9	6 (13.3)	14	8	14
4011 to 4045	A12/r2, A22/t2 (*2)	M4	1.2 to 2.0	14 (2.1)	2	2	2

* 1. Connect using exclusive-use connection bus bar.

* 2. Provided for open chassis type with a minimum capacity of 11 kW. Not provided for external heatsink cooling type.

Notes: 1. Wire size is selected assuming external suspended wiring of single 3-core cables at an ambient temperature of 30°C (86°F).

2. If ambient temperature exceeds 30°C (86°F), the allowable current of wire may be lowered.

3. Temperature for each wire indicates the maximum allowable conductor temperature.

Table 3.5 Terminal Screws for 200 V Class Motors

Inverter	Standard Motor			Winding Selection Motor		
Model CIMR-M5□	Model UAASK-□-□□FZ	Terminal Screws (U, V, W,⏚)	Cooling Fan Terminals (Z1, Z2, Z3)	Model UAASK□-□□FZ	Terminal Screws (U, V, W,⏚)	Cooling Fan Terminals (Z1, Z2, Z3)
23P7	A-04	M5	M4	–	–	M4
25P5	A-06	M5	M4	B-06	M6	M4
27P5	A-08	M5	M4	B-08	M6	M4
2011	A-11	M5	M4	B-11	M6	M4
2015	A-15	M8	M4	B-15	M8	M4
2018	A-19	M8	M4	B-19	M10	M4
2022	A-22	M8	M4	B-22	M10	M4
2030	J-30	M10	M4	B-30	M10	M4
2037	J-37	M10	M4	–	–	M4

Table 3.6 Terminal Screws for 400 V Class Motors

Inverter	Standard Motor			Winding Selection Motor		
Model CIMR-M5□	Model UAASK□-□□F Z***E	Terminal Screws (U, V, W,⏚)	Cooling Fan Terminals (Z1, Z2, Z3)	Model UAASK□-□□F Z***E	Terminal Screws (U, V, W,⏚)	Cooling Fan Terminals (Z1, Z2, Z3)
45P5	A-06	M5	M4	B-06	M6	M4
47P5	A-08	M5	M4	B-08	M6	M4
4011	A-11	M5	M4	B-11	M6	M4
4015	A-15	M8	M4	B-15	M8	M4
4018	A-19	M8	M4	B-19	M10	M4
4022	A-22	M8	M4	B-22	M10	M4
4030	J-30	M10	M4	B-30	M10	M4
4037	J-37	M10	M4	–	–	M4
4045	J-45	M10	M4	–	–	M4

Table 3.7 Closed-loop Crimp Connector Sizes (JIS C 2805) (For 200 V and 400 V Classes)

Wire Sizes		Terminal Screws	Closed-loop Crimp Connectors
mm^2	AWG		
0.5	20	M3.5	1.25 to 3.5
		M4	1.25 to 4
0.75	18	M3.5	1.25 to 3.5
		M4	1.25 to 4
1.25	16	M3.5	1.25 to 3.5
		M4	1.25 to 4
2	14	M3.5	2 to 3.5
		M4	2 to 4
		M5	2 to 5
		M6	2 to 6
		M8	2 to 8
3.5 to 5.5	12 to 10	M4	5.5 to 4
		M5	5.5 to 5
		M6	5.5 to 6
		M8	5.5 to 8
8	8	M5	8 to 5
		M6	8 to 6
		M8	8 to 8
14	6	M6	14 to 6
		M8	14 to 8
22	4	M6	22 to 6
		M8	22 to 8
30 to 38	3 to 2	M8	38 to 8
50 to 60	1 to 1/0	M8	60 to 8
		M10	60 to 10
100	4/0	M10	100 to 10

3.3.2 Functions of Main Circuit Terminals

The following tables outline the functions of the main circuit terminals.

Table 3.8 Converter Main Circuit Terminals

Voltage Class	Symbol	Name	Functions
200 V class	R/L1 S/L2 T/L3	Main circuit power supply input	3-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	A1/r A2/t	Control power supply input	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	A11/r1* A21/t1	Heatsink Power supply input for cooling fan	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	P/⊕ N/⊖	Main circuit DC output	270 to 325 VDC (For inverter main circuit power supply)
	P1 N1	Control power supply output	282 to 325 VDC (For inverter control power supply)
	⏚	Grounding	Ground terminal (Ground resistance: 100 Ω or less)
400 V class	R/L1 S/L2 T/L3	Main circuit power supply input	3-phase 400 to 440 VAC 50 Hz 400 to 460 VAC 60 Hz
	A1/r A2/t	Control power supply input	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	A11/r1* A21/t1	Heatsink Power supply input for cooling fan	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	P/⊕ N/⊖	Main circuit DC output	540 to 650VDC (For inverter main circuit power supply)
	P1 N1	Control power supply output	282 to 325VDC (For inverter control power supply)
	⏚	Grounding	Ground terminal (Ground resistance: 10 Ω or less)

* Terminals on Open Chassis Converters with a minimum capacity of 11 kW.

Table 3.9 Inverter Main Circuit Terminals

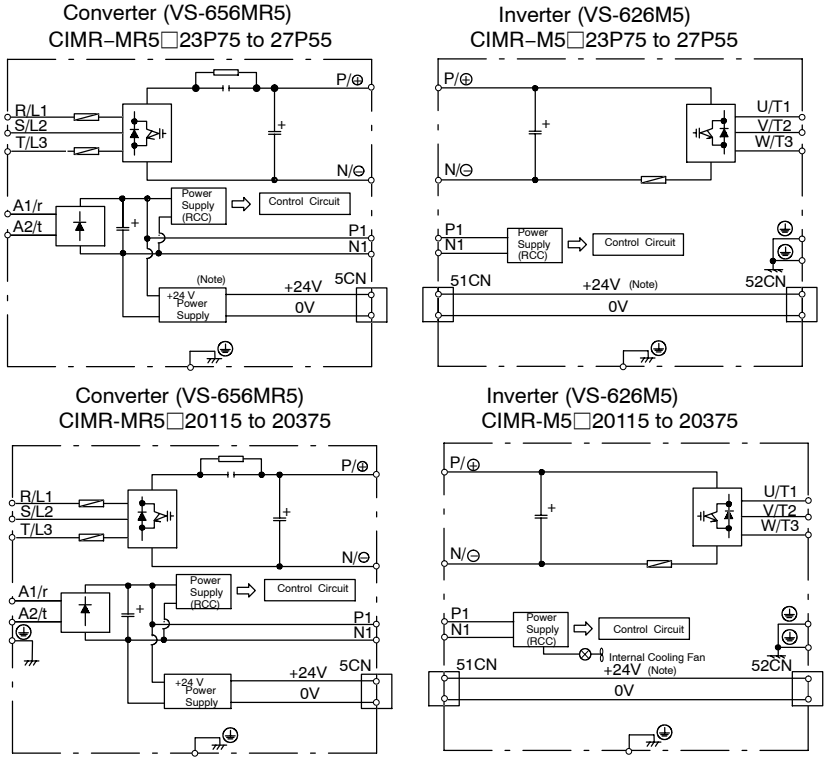
Voltage Class	Symbol	Name	Functions
200 V class	P/⊕ N/⊖	Main circuit power supply input	270 to 325 VDC (Supplied from converter)
	P1 N1	Control power supply input	282 to 325 VDC (Supplied from converter)
	A12/r2* A22/t2	Heatsink Power supply input for cooling fan	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	U/T1 V/T2 W/T3	Inverter output	Inverter output to motor
	⏚	Grounding	Ground terminal (Ground resistance: 100 Ω or less)
400 V class	P/⊕ N/⊖	Main circuit power supply input	540 to 650 VDC (Supplied from converter)
	P1 N1	Control power supply input	282 to 325 VDC (Supplied from converter)
	A12/r2* A22/t2	Heatsink Power supply input for cooling fan	Single-phase 200 to 220 VAC 50 Hz 200 to 230 VAC 60 Hz
	U/T1 V/T2 W/T3	Inverter output	Inverter output to motor
	⏚	Grounding	Ground terminal (Ground resistance: 10 Ω or less)

* Terminals on Open Chassis Inverters with a minimum capacity of 11 kW.

3.3.3 Main Circuit Configuration

The following diagrams show the main circuit configurations.

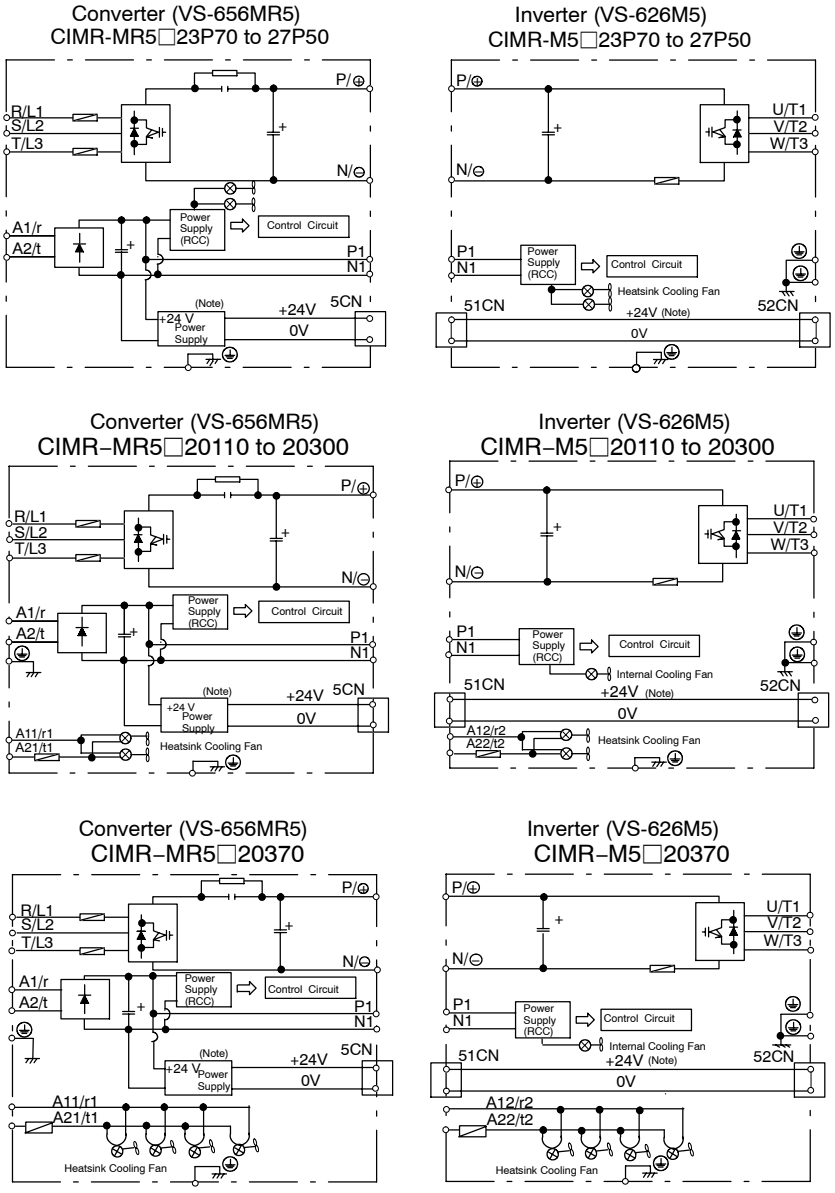
■ 200 V Class External Heatsink Cooling Type



Note: The +24-V power supply is provided to models for NC systems.

Fig 3.5 Main Circuit Configurations of 200 V Class Inverters with External Heatsink Cooling

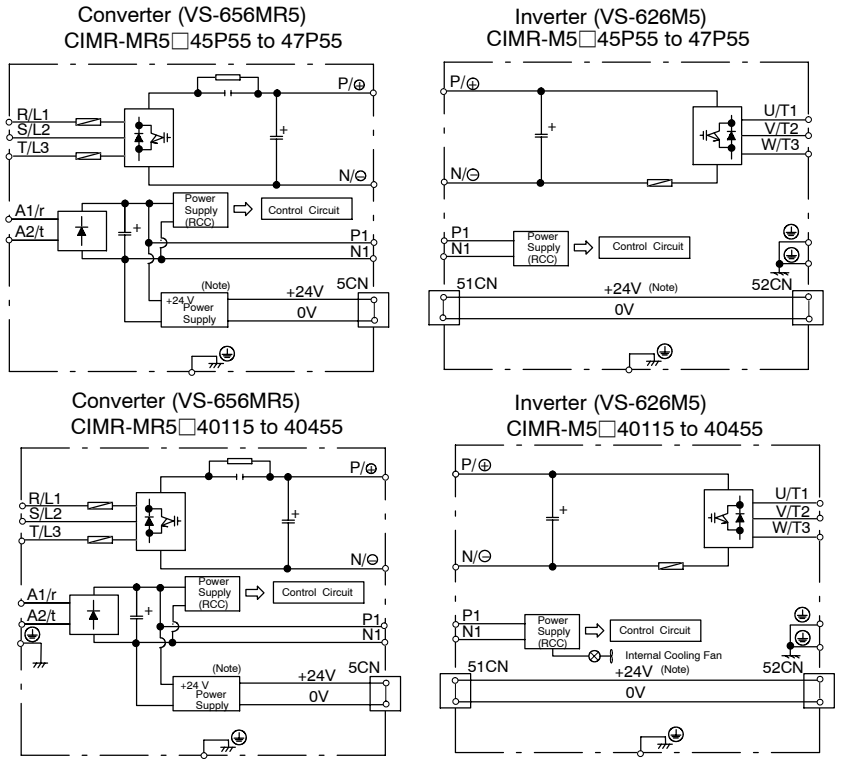
■ 200 V Class Open Chassis Type



Note: The +24-V power supply is provided to models for NC systems.

Fig 3.6 Main Circuit Configurations of 200 V Class Open Chassis Type

■ 400 V Class External Heatsink Cooling Type

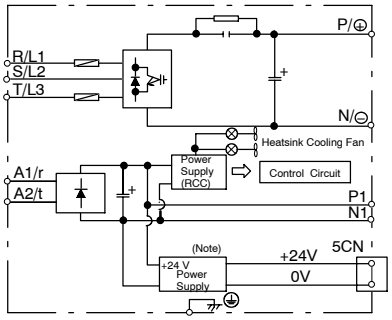


Note: The +24-V power supply is provided on models for NC systems.

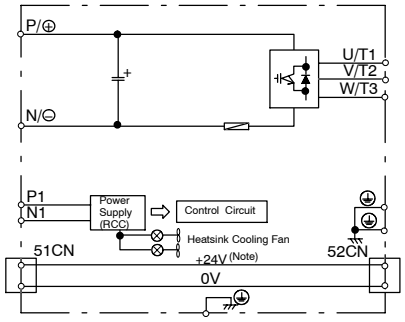
Fig 3.7 Main Circuit Configurations of 400 V Class Inverters with External Heatsink Cooling

■ 400 V Class Open Chassis Type

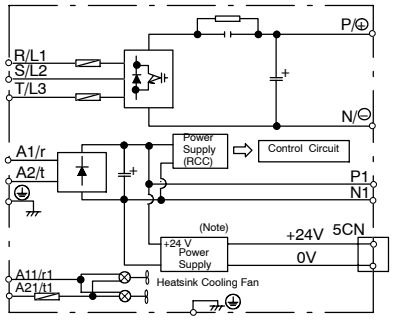
Converter (VS-656MR5)
CIMR-MR5□45P50 to 47P50



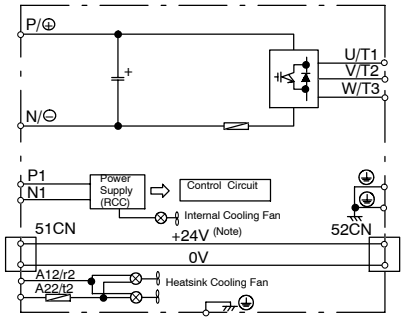
Inverter (VS-626M5)
CIMR-M5□45P50 to 47P50



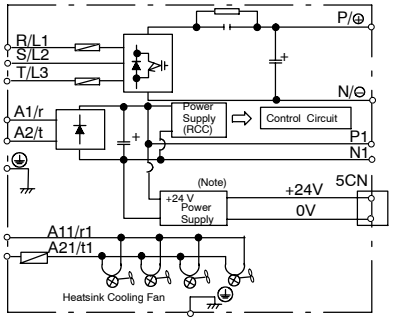
Converter (VS-656MR5)
CIMR-MR5□40110 to 40220



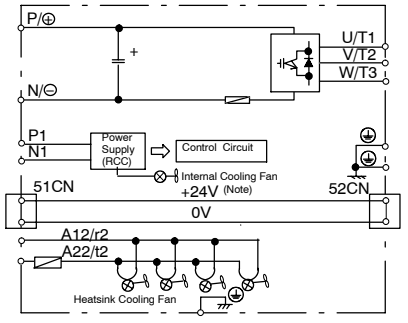
Inverter (VS-626M5)
CIMR-M5□40110 to 40220



Converter (VS-656MR5)
CIMR-MR5□40300 to 40450



Inverter (VS-626M5)
CIMR-M5□40300 to 40450



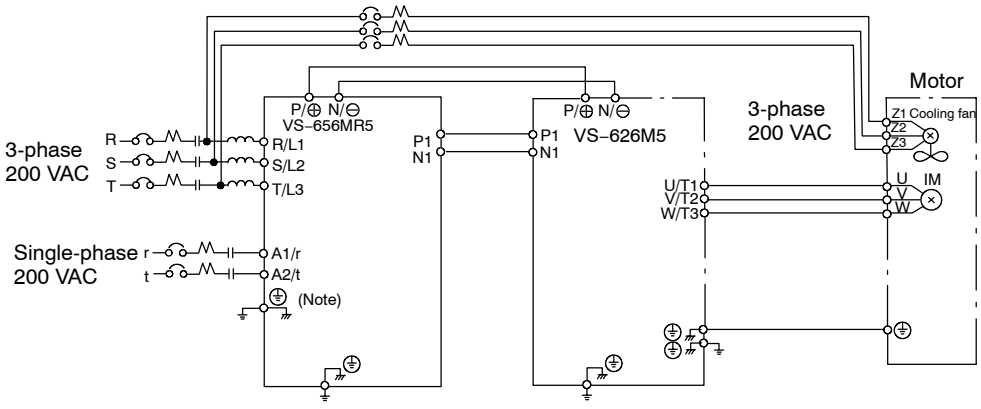
Note: The +24-V power supply is provided to models for NC systems.

Fig 3.8 Main Circuit Configurations of 200 V Class Open Chassis Type

3.3.4 Main Circuit Connection Diagrams

The following diagrams show the main circuit connections.

■ 200 V Class External Heatsink Cooling Type



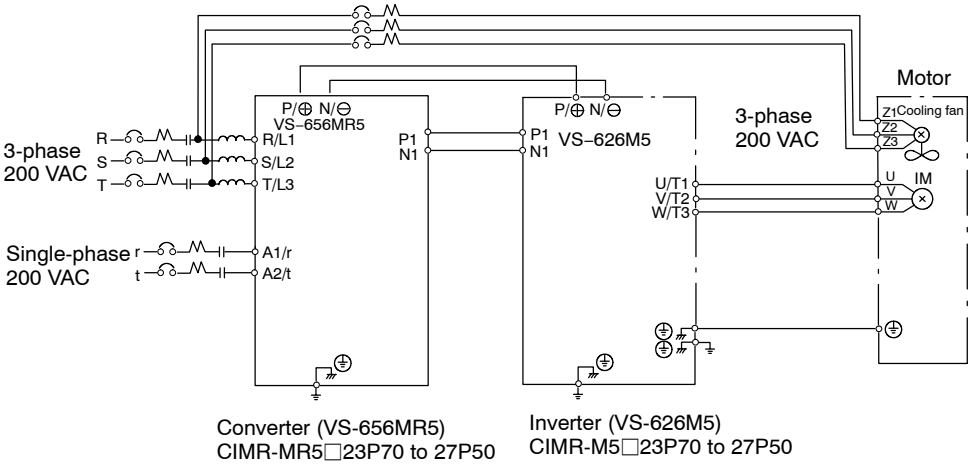
Converter (VS-656MR5) CIMR-MR5□23P75 to 20375

Inverter (VS-626M5) CIMR-M5□23P75 to 20375

Note: No ground terminals are provided on the 23P7 through 27P5 models.

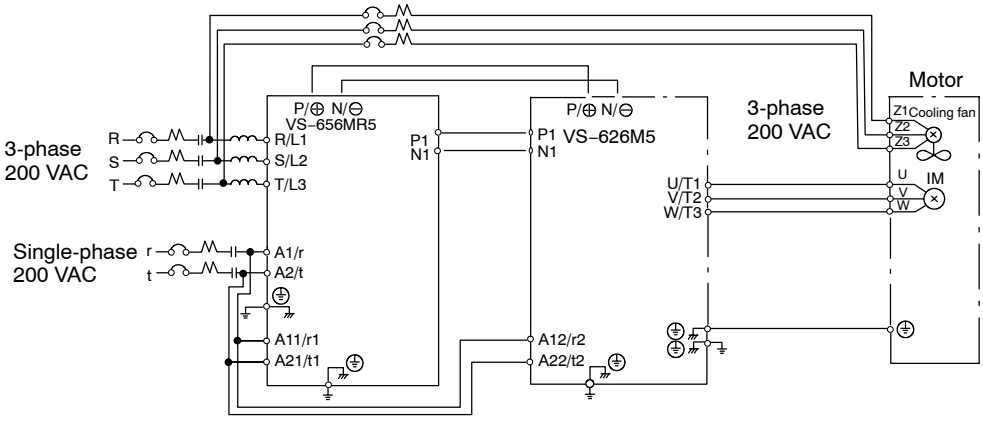
Fig 3.9 Main Circuit Connections for 200 V Class External Heatsink Cooling Type

■ 200 V Class Open Chassis Type



Converter (VS-656MR5) CIMR-MR5□23P70 to 27P50

Inverter (VS-626M5) CIMR-M5□23P70 to 27P50

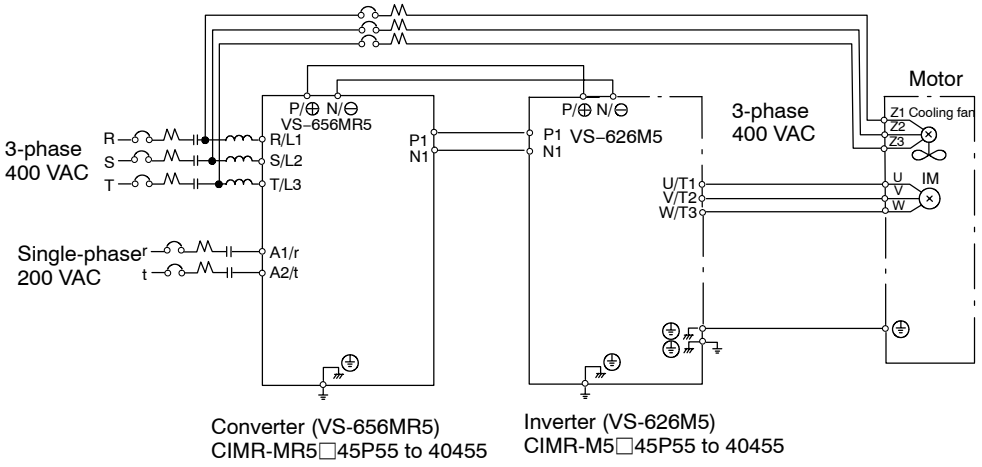


Converter (VS-656MR5) CIMR-MR5□20110 to 20370

Inverter (VS-626M5) CIMR-M5□20110 to 20370

Fig 3.10 Main Circuit Connections for 200 V Class Open Chassis Type

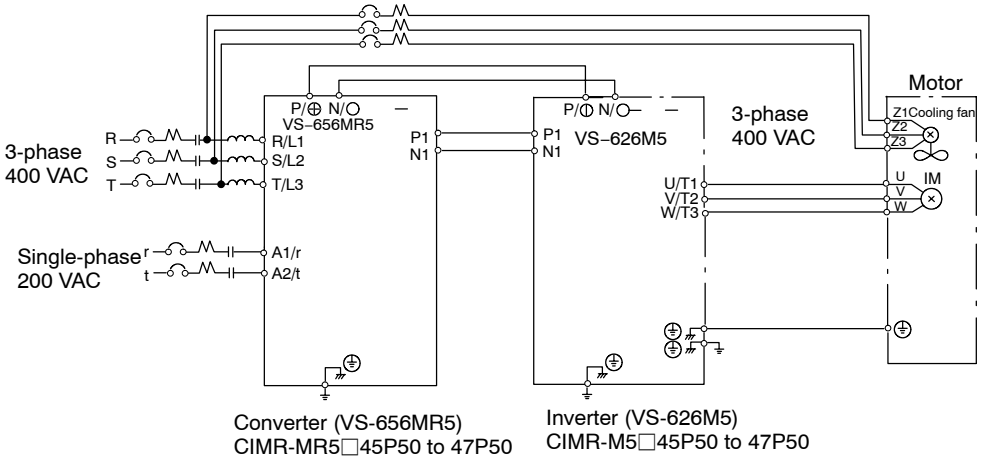
■ 400 V Class External Heatsink Cooling Type



Note: No ground terminals are provided on the 45P5 through 47P5 models.

Fig 3.11 Main Circuit Connections for 400 V Class External Heatsink Cooling Type

■ 400 V Class Open Chassis Type



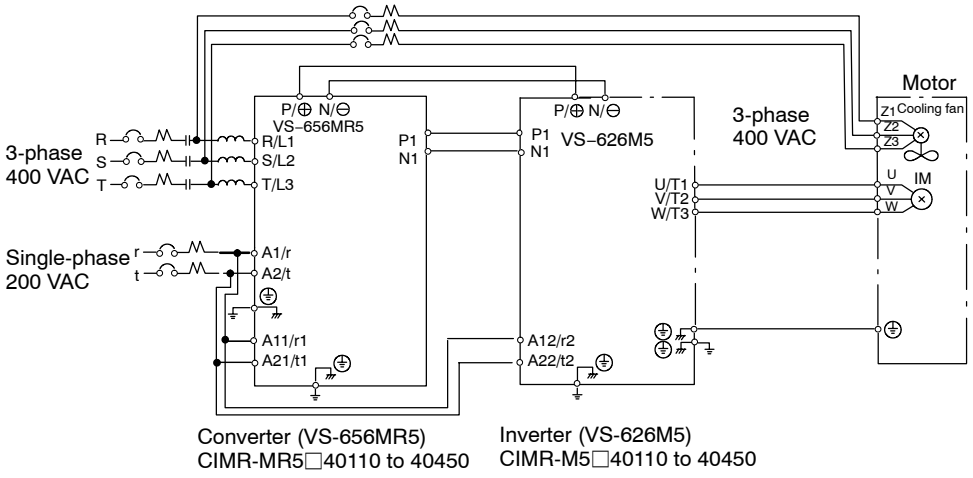


Fig 3.12 Main Circuit Connections for 400 V Class Open Chassis Type

3.3.5 Wiring the Main Circuit

This section provides information on the main circuits of the Converter and Inverter and information on wiring the ground lines.

■ Wiring Precautions for Main Circuit Input

Installation of Molded-case Circuit Breaker (MCCB)

Make sure to connect MCCB between the main circuit power supply input and VS-656MR5 input terminals R/L1, S/L2 and T/L3 to protect wiring.

Installation of Ground Fault Interrupter

The output of the Inverter is switched at high speed, which results in high-frequency leakage current. When connecting a ground fault interrupter to the input terminals of the Converter, select an one designed for inverters that eliminates the high-frequency leakage current and detects only the leakage current in frequency bands that are harmful to the human body.

- Use a ground fault interrupter designed for inverters for each Converter, with a minimum sensing current of 30 mA.
- A standard ground fault interrupter can be used for each Converter provided that it has a minimum sensing current of 200 mA with a minimum response time of 0.1 s.

Installation of Magnetic Contactor

When the main circuit power supply is shut OFF in the sequence, a magnetic contactor (MC) can be used instead of a molded-case circuit breaker (MCCB). However, when a magnetic contactor is switched OFF at the main circuit power supply input side, regenerative braking does not function and the motor coasts to a stop. (At this time, protective function activates to display a fault.)

Frequent turning ON and OFF the magnetic contactor for the main circuit power supply input may cause the Converter and Inverter to malfunction. Turn the magnetic contactor ON and OFF once every 30 minutes at most.

Terminal Block Connection Sequence

Main circuit power supply input phases can be connected to any terminal regardless of the order of R/L1, S/L2 and T/L3 on the terminal block.

Installation of AC Reactor

Make sure to install an AC reactor, which corresponds to the capacity of the individual Converter, to each Converter for the Converter's power-supply regeneration.
Do not connect any equipment other than the Converter to the secondary side of the AC reactor. If this caution is not observed, an overcurrent may occur in the Converter. An AC reactor is effective in improving the power factor of the power supply side.

Installation of Surge Suppressor

For inductive loads (magnetic contactors, magnetic relays, magnetic valves, solenoids, magnetic brakes, etc.) connected near the inverter, install a surge suppressor.

IMPORTANT

A surge absorber is used to absorb energy accumulated in the coil of an inductive load. Use a surge absorber with a capacity suitable for the coil. Do not, however, connect surge absorbers to output terminals U, V, W of the Inverter. If a surge absorber is not used, the generated surge voltage of the coil will affect the control signal line of the Inverter when the inductive load is turn ON and OFF. As a result, the control signal may malfunction.

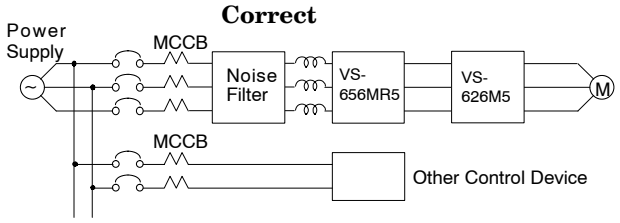
Prohibition of Installation of Phase Advancing Capacitor

Do not connect a phase advancing capacitor or surge suppressor to main circuit power supply input (R/L1, S/L2, or T/L3). The phase advancing capacitor or surge suppresser may become overheated and damaged by the harmonic components of the drive unit. Also, the drive unit may malfunction because of overcurrent.

Using Input Noise Filters

A noise filter installed on the power supply side eliminates external noise on the power line of the Inverter and suppresses harmonic noise leaking from the Inverter to the power line. Use a noise filter designed for an inverter, as shown in example 1. Refer to *14.3.7 Noise Filter* for recommended filters.

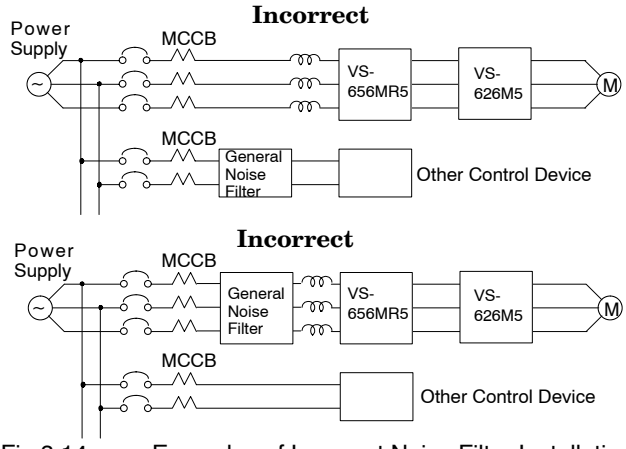
- Example 1



Use an exclusive noise filter specified for inverters.

Fig 3.13 Using Input Noise Filter

- Example 2



Do not use general-purpose filters because they are not effective.

Fig 3.14 Examples of Incorrect Noise Filter Installation

■ Wiring Precautions for Converter Control Power Supply Input

Make sure to connect MCCB with the converter control power supply input terminals A1/r and A2/t to protect wiring.

■ Wiring Precautions for Main Circuit between Converter and Inverter

Connecting the Main Circuit DC Power Supply

Connect converter main circuit DC output terminals P/⊕ and N/⊖ to inverter main circuit power supply input terminals P/⊕ and N/⊖ using exclusive-use connection bus bar. Secure bus bar using all the power terminal screws and tighten to torque value of 4 to 5 N·m.

Connecting the Converter Control Power Supply Output

Connect converter control power supply output terminals P1 and N1 to inverter left-side control power supply input terminals P1 and N1 using exclusive-use power cable.

■ Wiring Precautions for Inverter Main Circuit Output

Connecting the Inverter and Motor

Connect output terminals U/T1, V/T2 and W/T3 to motor lead wires U, V and W. Connection method is indicated on the back of the terminal cover. Verify that the motor rotates in the forward direction (CCW: counterclockwise when viewed from the motor load side) with the forward run command.

Strict Prohibition of Connecting Input Power Supply to Output Terminals

Do not connect power to the U/T1, V/T2, or W/T3 output terminals, or otherwise the internal inverter circuits will be damaged.

Strict Prohibition of Shorting or Grounding Output Terminals

Do not touch output terminals directly with your fingers or connect output lines to the Inverter's case. Electrical shock or a ground short may occur, creating an extremely dangerous situation. Never short the output lines.

Strict Prohibition of Connection of Phase Advancing Capacitor or Noise Filter

Never connect a phase advancing capacitor or LC/RC noise filter to the output circuit, or otherwise the Inverter may be destroyed or internal components damaged.

Strict Prohibition of Installation of Magnetic Starter

Do not connect a phase advancing capacitor or LC/RC noise filter to the output circuit, or otherwise the Inverter may be damaged or the internal parts of the Inverter may be damaged.

Dealing with Emission Noise

To reduce the emission noise from output side, wire the signal lines together in a grounded metallic conduit. Make the wiring distance between the power line and signal line 30 cm (11.8 inches) or longer, and the emission noise will be reduced.

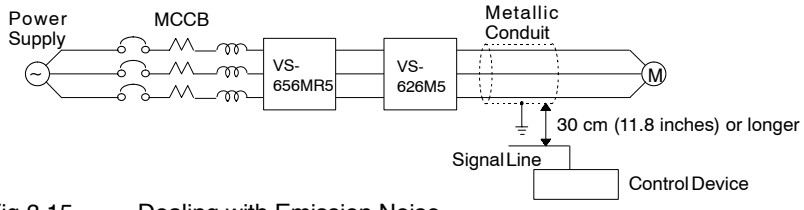


Fig 3.15 Dealing with Emission Noise

Wiring Distance between Inverter and Motor

The signal and power cables between the inverter and the motor must be separated and the cable extension must be as short as possible (20 m (65.6 ft) or less).

■ Grounding

Use the following information to ensure that the ground is sufficient.

- Make sure to ground the ground terminal (⏚).
  200 V class: Ground to 100Ω or less
  400 V class: Ground to 10Ω or less
- Never ground the inverter or the converter in common with welding machines, motors, or other large-current electrical equipment. Wiring for grounding cable must be separated from the large-current electrical equipment.
- Always use a ground wire that complies with technical standards on electrical equipment. Minimize the length of the ground wire. Leakage current flows through the Inverter. Therefore, if the distance between the ground terminal and the ground terminal is too long, the potential on the ground terminal of the Inverter will become unstable.
- Always ground converters, inverters and motors using a ground terminal even when equipment is grounded through sill channel or steel plate.
- Ground each Converter and Inverter directly to the ground as shown in figure 3.16 (a). Do not make a loop as shown in (b). Ground the Inverter and motor as shown in figure 3.17 (a). Do not ground both the Inverter and motor as shown in (b).

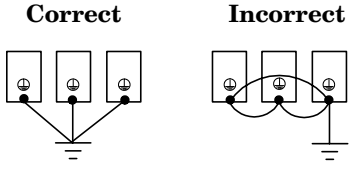


Fig 3.16 Grounding

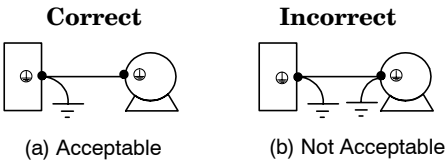


Fig 3.17 Grounding of Motor and Inverter

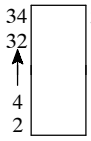
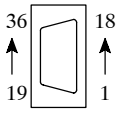
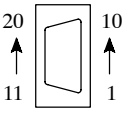
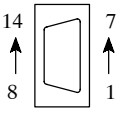
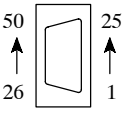
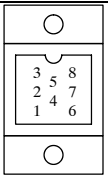
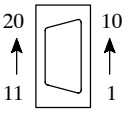
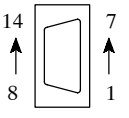
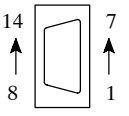
3.4 Wiring Control Circuit Signals

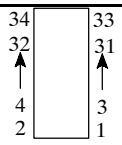
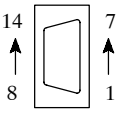
To reduce the influence of noise on control circuit signals, the control signal lines must be separated from power lines and wired at the shortest distance (20 m max.). Do not wire the control signal lines together with power lines in the same conduit or bundle them together, or otherwise the system may malfunction.

3.4.1 Control Signal Connectors and Wires

Table 3.10 outlines the relationship between control signal connectors and wires to be used in combination. Table 3.11 outlines wires that are applicable to connectors.

Table 3.10 Control Signal Connectors

	Connector No.	Function	Connector Type		Connector Pin Nos.	Applicable Max. Wire Size	Connector Manufacturer
			Inverter Side	Wiring Side			
Control PC Board (VS-626M5)	51CN (34P)	Control signal connector with converter unit	8830E-068-170LD-32	8822E-034-171D		Use a special cable.	KEL Corp.
	52CN (34P)	Control signal connector with other drive unit					
	1CN (36P)	Control signals	10236-52A2JL	• 10136-3000VE • ·10336-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.
	2CN (20P)	Encoder signal input	10220-52A2JL	• 10120-3000VE • 10320-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.
	3CN (14P)	Digital operator	10214-52A2JL	• 10114-3000VE • 10314-52A0-008 (case)		Use a special cable.	Sumitomo 3M Ltd.
I/O Card (VS-626M5) (stand-alone drives only)	6CN (50P)	Control signals	10250-52A2JL	• 10150-3000VE • 10350-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.
YENET1200 Card (VS-626M5) (NC systems only)	4CN (8P)	Control signals	MR-8RMAG	MR-8LFG		0.25 mm^2	Honda Tsushin Kogyo Co., Ltd.
Encoder Method Orientation Card (VS-626M5)	8CN (20P)	Load shaft encoder signal input	10220-52A2JL	• 10120-3000VE • 10320-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.
	9CN (14P)	Load shaft encoder signal output	10214-52A2JL	• 10114-3000VE • 10314-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.
Magnetic Sensor Method Orientation Card (VS-626M5)	10CN (14P)	Control signals	10214-52A2JL	• 10114-3000VE • 10314-52A0-008 (case)		0.2 mm^2	Sumitomo 3M Ltd.

	Connector No.	Function	Connector Type		Connector Pin Nos.	Applicable Max. Wire Size	Connector Manufacturer
			Inverter Side	Wiring Side			
Control PC Board (VS-656MR5)	5CN (34P)	Control signal connector with other drive unit	8831E-034-170LD	8822E-034-171D		Use a special cable.	KEL Corp.
	1CN (14P)	Communication cable connector (for factory test prior to shipment)	10214-52A2JL	• 10114-3000VE • 10314-52A0-008 (case)		–	Sumitomo 3M Ltd.

Note: Connectors for wires are not sold separated. Refer to *14.3.6 Connector Kit*.

IMPORTANT

Some of the connectors attached with control PC board and option cards are of the same type. Therefore, make sure to mount the cards to the correct connectors each of which is identified by device symbol. If connection is wrong, it may cause damage to the inverter.

Table 3.11 Applicable Connector Wires

Connector Number	Cable Specification	Cable External Diameter
1CN (36P) 6CN (50P)	UL2464-SB Vinyl-insulated Multi-conductor Cable (AWG24)	16 mm (0.63 inches) dia. max.
2CN, 8CN (20P)	Composite KQVV-SW Cable (AWG22 x 3 C + AWG26 x 6P)	20P: 12 mm (0.47 inches) dia. max.
9CN, 10CN (14P)	Yaskawa's drawing No.: BDP8409123 (with no connector)	14p: 8 mm (0.31 inches) dia. max.
4CN (8P)	JKEV-SB (JCS) Shielded Twisted-pair Cable (AWG18)	11 mm (0.43 inches) dia. max.

3.4.2 Terminal Arrangement of Control Signal Connector

Figures 3.18 and 3.19 show the terminal arrangements of the control signal connectors.

51CN

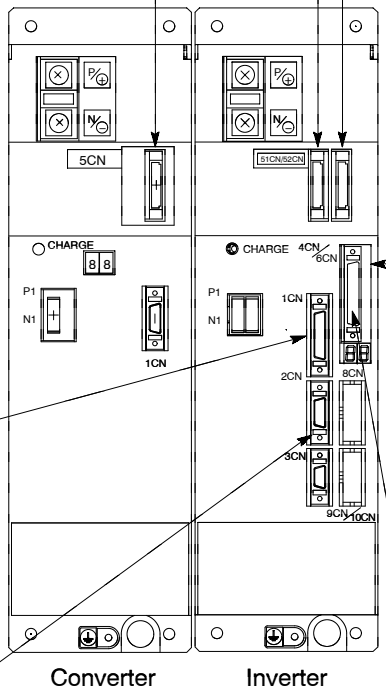
34	+24VIN	33	—
32	/EXT1	31	ESP0
30	/EXT2	29	ALM±
28	ESP1	27	ALMC
26	CONFLT	25	CONRDY
24	CONRST	23	AXRUN
22	+24V	21	+24V
20	+24V	19	+24V
18	+24V	17	+24V
16	+24V	15	+24V
14	0V	13	0V
12	0V	11	0V
10	0V	9	0V
8	0V	7	0V
6	*S	5	BAT+
4	S	3	BAT–
2	0V	1	0V

1CN

36	MNTR2	18	0V
35	MNTR1	17	SS
34	VCC	16	*PBO
33	0VCOM	15	PBO
32	24VCOM	14	*PAO
31	EXTCOM	13	PAO
30	D12	12	*PCO
29	D11	11	PCO
28	D10	10	BAT+
27	D9	9	BAT–
26	D8	8	ALMC
25	D7	7	ALM–
24	D6	6	ALM+
23	D5	5	ESP1
22	D4	4	ESP0
21	D3	3	/EXT2
20	D2	2	/EXT1
19	D1	1	+24VIN

2CN

20	—	10	+24V
19	*PB	9	THSB
18	PB	8	THSA
17	*PA	7	SS
16	PA	6	+5V
15	*PC	5	+5V
14	PC	4	+5V
13	CA2	3	0V
12	CA1	2	0V
11	CC	1	0V



5CN, 52CN

34	—	33	+24VIN
32	ESP0	31	/EXT1
30	ALM±	29	/EXT2
28	ALMC	27	ESP1
26	CONRDY	25	CONFLT
24	AXRUN	23	CONRST
22	+24V	21	+24V
20	+24V	19	+24V
18	+24V	17	+24V
16	+24V	15	+24V
14	0V	13	0V
12	0V	11	0V
10	0V	9	0V
8	0V	7	0V
6	BAT+	5	*S
4	BAT–	3	S
2	0V	1	0V

6CN (for stand-alone drives)

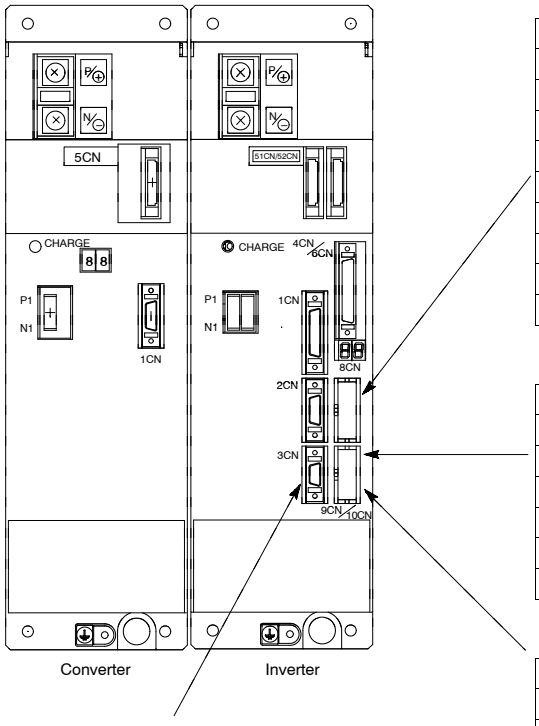
50	LM	25	0VCOM
49	0V	24	0VCOM
48	0V	23	24VCOM
47	SM	22	24VCOM
46	TALM	21	EXTCOM0
45	FLTCOM	20	EXTCOM0
44	FLTNC	19	EXTCOM0
43	FLTNO	18	MGR
42	COM1	17	LGR
41	FLTL	16	ORT
40	CHWE	15	PPI
39	ORE	14	CHW
38	ORG	13	RST
37	TLE	12	SSC(SV)
36	TDET	11	TLL(INC)
35	SDET	10	TLH
34	AGR	9	REV
33	ZSPD	8	FWD
32	—	7	EMG
31	—	6	RDY
30	COM2	5	DAS
29	FC3	4	0V
28	FC2	3	SCOM
27	FC1	2	SS
26	FC0	1	+15V

4CN (for NC systems)

3	SH	5	FG	8	SH
2	S	4	R	7	S
1	*S			6	*S

Note: Terminal arrangement is as when the connectors on the PC board are viewed from the front of the unit.

Fig 3.18 Terminal Arrangement of Control Signal Connector



8CN (Option)

20	SS	10	—
19	*SPB	9	CPA
18	SPB	8	*CPC
17	*SPA	7	CPC
16	SPA	6	+5V
15	*SPC	5	+5V
14	SPC	4	+5V
13	*CPB	3	0V
12	CPB	2	0V
11	*CPA	1	0V

Encoder Method Orientation Card

9CN (Option)

14	—	7	*SPBO
13	—	6	SPBO
12	—	5	*SPAO
11	—	4	SPAO
10	—	3	*SPCO
9	—	2	SPCO
8	—	1	SS

10CN (Option)

14	SIG–	7	—
13	SIG+	6	—
12	+15V	5	0V
11	—	4	—
10	+12V	3	0V
9	—	2	—
8	—	1	SS

Magnetic Sensor Method Orientation Card

3CN (Option)

14	—	7	+ 5 V
13	—	6	OP1
12	—	5	0 V
11	+ 5 V	4	RX
10	—	3	0 V
9	+ 5 V	2	TX
8	OP2	1	0 V

Note: Terminal arrangement is as when the connectors on the PC board are viewed from the front of the unit.

Fig 3.19 Terminal Arrangements of Control Signal Connectors (Optional)

3.4.3 Control Signal Functions

The following table outlines the functions of the control circuit signals. Use appropriate signals according to the purpose.

IMPORTANT

The12-bit digital reference signals to 1CN-19 through 1CN-30 and the sequence input signals to 6CN-5 through 6CN-18 can be 0 V, 24 V, or external common signals. The wiring of terminals varies with the input method. Refer to *3.4.4 Sequence Input Signal Circuit*s for details.

■ Control Signal Functions

Table 3.12 Control Circuit Signals (1CN to 4CN)

Connector	Signal	No.	Function	Signal Level
1CN	+24VIN	1	–	–
	/EXT1	2	–	–
	/EXT2	3	–	–
	ESP0	4	–	–
	ESP1	5	–	–
	ALM+	6	–	–
	ALM–	7	–	–
	ALMC	8	–	–
	BAT–	9	–	–
	BAT+	10	–	–
	PAO	13	Encoder phase A signal output	RS-422A specification Line driver +5 V
	*PAO	14		
	PBO	15	Encoder phase B signal output	
	*PBO	16		
	PCO	11	Encoder phase C signal output	
	*PCO	12		
	SS	17	Shield (0V)	–
	0V	18	0V	–
	D1 to D12	19 to 30	12-bit digital references 1 through 12	24 VDC Closed current: 5 mA
	EXTCOM	31	12-bit digital signal common	
	24VCOM	32	12-bit digital signal power supply +24 V	
	0VCOM	33	12-bit digital signal power supply 0 V	
	VCC	34	–	–
	MNTR1	35	–	–
	MNTR2	36	–	–
2CN	+5V	4, 5, 6	+5V power supply for encoder	+5V Load current: 350 mA or less
	0V	1, 2, 3	Encoder power supply common	
	PA	16	Encoder phase A signal input	RS-422A specification Line receiver +5 V
	*PA	17		
	PB	18	Encoder phase B signal input	
	*PB	19		
	PC	14	Encoder phase C signal input	
	*PC	15		
	THSA	8	Motor thermistor signal	–
	THSB	9		
	SS	7	Shielded wire connection (0V)	–
	+24V	10	+24V power supply for winding selection device	+24V
	CC	11	Winding selection device power supply common	
	CA1	12	Winding selection status signal	+24V Load current: 10mA or less
	CA2	13		
3CN (option)	+5 V	7, 9, 14	+5 V power supply	+5 V
	0 V	1, 3, 5	0 V	
	TX	2	Send data (Inverter to Operator)	–
	RX	4	Receive data (Operator to Inverter)	
	OP1	6	Not used.	–
	OP2	8	Not used.	–
4CN	S	2	I/O signal for YENET1200 communication	RS-422A specification Line driver/receiver +5 V
	*S	1		
	S	7	I/O signal for YENET1200 communication	
	*S	6		
	FG	5	Frame ground	–
	R	4	I/O signal for YENET1200 communication (with terminating resistance)	RS-422A specification Line driver/receiver +5 V
	SH	3, 8	Shielded wire	–

Note: The 4CN connector is for M5N models for NC systems.

Table 3.13 Control Circuit Signals (6CN)

Connector	Signal	No.	Function	Signal Level	Related Constants
6CN	+15V	1	+15V output	+15V Load current: 10mA or less	C1-26, 10, C1-38 bit 5 C1-11, 12
	SS	2	Shield (0V)	–	
	SCOM	3	Analog speed reference input	0 to ±10V (Input impedance: 50kΩ)	
	0V	4	Analog speed reference 0V	–	
	DAS	5	Digital/analog speed reference selection	24VDC Current when closed: 5mA	C1-36 bit 7
	RDY	6	Operation ready		Selected when C1-37 bit 2=0
	EMG2		Emergency stop 2		Selected when C1-37 bit 2=1
	EMG	7	Emergency stop		–
	FWD	8	Forward run		–
	REV	9	Reverse run		–
	TLH	10	Torque limit H		Selected when C1-36 bit 2=0 C1-26, C1-38 bit 2
	TLL	11	Torque limit L		Selected when C1-36 bit 1, 0=00
	INC		Incremental		Selected when C1-36 bit 1, 0=10
	SSC	12	Soft start cancel		Selected when C1-36 bit 3=0
	SV		Servo mode		Selected when C1-36 bit 3=1
	RST	13	Fault reset		–
	CHW	14	Winding selection		–
	PPI	15	P control/PI control selection		Selected when C1-36 bit 4=0
	ORT	16	Orientation		Selected when C1-40 bit 3=0 C1-39 bit 0
	NCORT		NC orientation		Selected when C1-40 bit 3=1
	LGR	17	L gear selection		C1-27, 28, 29
	MGR	18	M gear selection		
	EXT-COM0	19 to 21	Sequence input signal power supply common		–
	24VCOM	22, 23	Sequence input signal power supply 24V		–
	0VCOM	24, 25	Sequence input signal power supply 0V		–
	FC0	26	Fault code 0	Open-collector output Exclusive-use for 24VDC Load current: 50mA or less	–
	FC1	27	Fault code 1		
	FC2	28	Fault code 2		
	FC3	29	Fault code 3		
	COM2	30	Fault code signal common		
	ZSPD	33	Zero-speed	Open-collector output Exclusive-use for 24VDC Load current: 50mA or less	C1-19
	AGR	34	Speed agree		C1-20, C1-38 bit 6
	SDET	35	Speed detection		C1-21, C1-22, C1-40 bit 2
	TDET	36	Torque detection		C1-23
	TLE	37	Torque limit		–
	ORG	38	Load origin		–
	ORE	39	Orientation completion		C2-09, 10 or C3-09, 10
	CHWE	40	Winding selection completion		–
	FLTL	41	Fault (OFF at fault)		–
	TALM	46	Minor fault		–
	COM1	42	Sequence output signal common		–
	FLTNO	43	Fault contact output Closed between 43 and 45 at fault Open between 44 and 45 at fault	Relay contact output Exclusive-use for 24VDC Load current: 1A or less Minimum permissible load: 10 mA (as reference value)	–
	FLTNC	44			
	FLTCOM	45			
	SM	47	Speedometer output	0 to +10V Load current: 2mA or less	C1-16, 54
	0V	48	0V for speedometer	–	–
	LM	50	Load ratio meter output	0 to +10V Load current: 2mA or less	C1-17, 54, 18, C1-40 bit 4 C1-38 bit 1, 0 C1-38 bit 7
	0V	49	0V for load ratio meter	–	

Note: The 5CN connector is for M5A models for stand-alone drive.

Table 3.14 Control Circuit Signals (8CN, 9CN, 10CN)

Connector	Signal	No.	Function	Signal Level
8CN (option)	+5V	4, 5, 6	+5V power supply for encoder	+5V Load current: 350mA or less
	0V	1, 2, 3	Encoder power supply 0 V	
	CPA	9	–	RS-422A specification Line receiver +5 V
	*CPA	11		
	CPB	12	–	
	*CPB	13		
	CPC	7	–	
	*CPC	8		
	SPA	16	Encoder phase A signal input	RS-422A specification Line receiver +5 V
	*SPA	17		
	SPB	18	Encoder phase B signal input	
	*SPB	19		
	SPC	14	Encoder phase C signal input	
	*SPC	15		
	SS	20	Shield (0V)	–
9CN (option)	SPAO	4	Encoder phase A signal output	RS-422A specification Line driver +5 V
	*SPAO	5		
	SPBO	6	Encoder phase B signal output	
	*SPBO	7		
	SPCO	2	Encoder phase C signal output	
	*SPCO	3		
	SS	1	Shield (0V)	–
10CN (option)	SIG+	13	Magnetic sensor signal +	–
	SIG–	14	Magnetic sensor signal –	–
	+15V	12	+15V power supply for magnetic sensor	+15V Load current: 100mA or less
	+12V	10	+12V power supply for magnetic sensor	+12V Load current: 50mA or less
	0V	3, 5	Magnetic sensor power supply 0V	–
	SS	1	Shield (0V)	–

Table 3.15 Control Circuit Signals (51CN, 52CN, 5CN)

Connector	Signal	No. (51CN)	No. (52CN, 5CN)	Function
51CN 52CN 5CN	0V	1, 2	1, 2	0V
	BAT–	3	4	–
	BAT+	5	6	
	S	4	3	–
	*S	6	5	
	0V	7 to 14	7 to 14	0V
	+24V *1	15 to 22	15 to 22	+24V power supply
	AXRUN	23	24	Inverter (servo) running
	CONRST	24	23	Fault reset
	CONRDY	25	26	Converter ready
	CONFLT	26	25	Converter fault
	ALM± *2	29	30	Inverter (servo) fault
	ALMC *2	27	28	
	ESP0 *2	31	32	Inverter emergency stop
	ESP1	28	27	–
	/EXT2	30	29	–
	/EXT1	32	31	–
	+24VIN *2	34	33	+24V power supply input

* 1. The 24 V power supply is output only for M5N models for NC systems.

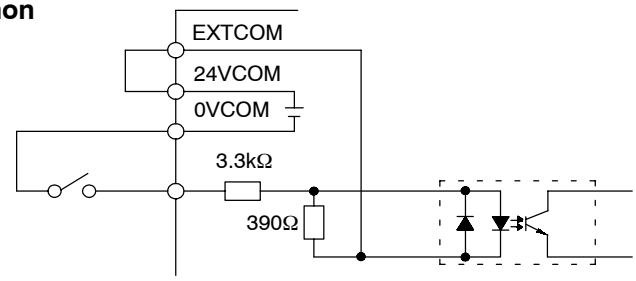
* 2. These signals are used only for M5N models for NC systems.

3.4.4 Sequence Input Signal Circuit (for Stand-alone Drive)

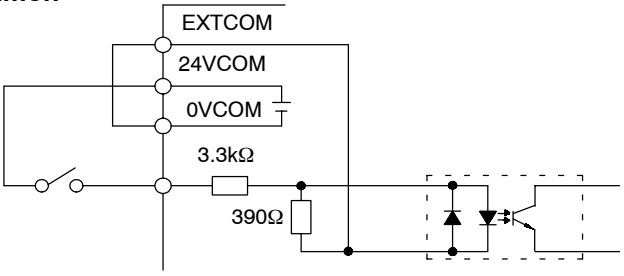
Design the input signals in consideration of the following conditions.

- The 12-bit digital reference signals into the Inverter's 1CN connectors and the sequence input signals into 6CN connectors can be 0 V, 24 V, or external common signals. The wiring of terminals varies with the input method as shown below.
- To select the external common method, prepare a 24-V (20 to 26 V) power supply for the input signal.
- The 1CN common and 6CN common terminals are insulated. Therefore, it is possible to used the common terminals individually.
- If a relay contact is used, the minimum contact capacity must be 5 mA at 30 V.
- There will be a signal delay of approximately 5 ms due to the input filter.

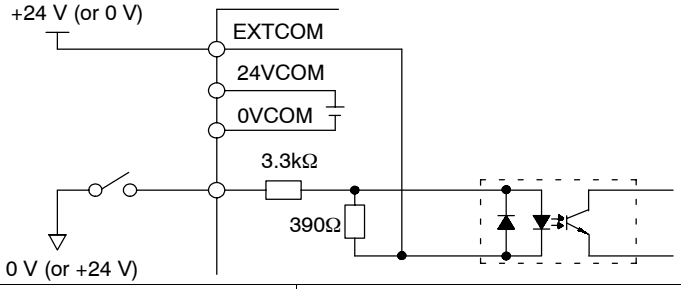
0 V Common



+24 V Common



External Common



Signal Name	Pin Number	
	1CN	6CN
EXTCOM	31	19, 20, 21
24VCOM	32	22, 23
0VCOM	33	24, 25

Fig 3.20 Input Method Selections

3.4.5 Sequence Output Signal Circuit (for Stand-alone Drive)

Design the output signals in consideration of the following conditions.

- The output method allows either a +24 V or 0 V common.
- Signal outputs are insulated with photocouplers. Prepare a +24 V power supply for the output signal.
- The output current capacity is 50 mA at 24 V.
- To turn ON and OFF an inductive load, such as an external relay, connect a surge absorber in parallel with the load. The maximum permissible voltage of the output circuit is 26 V. Do not impose a voltage exceeding the maximum permissible voltage, or otherwise the photocoupler of the output circuit may be damaged.
- If the load is capacitive, connect a protective resistor to the load in series to restrict the current, or otherwise an excessive current will flow when the photocoupler is driven, and as a result, the photocoupler may be damaged.
- The following diagram is a sequence output signal circuit.

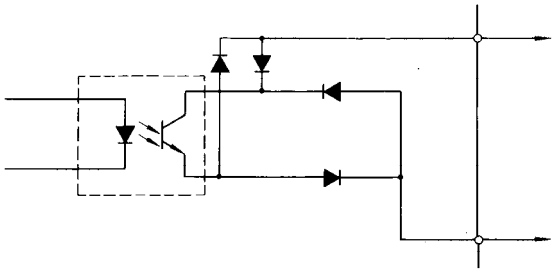


Fig 3.21 Output Interface Circuit

3.4.6 Precautions for Control Signal Wiring

For proper wiring between devices, pay attention to the following points in the design stage.

- Design the wiring for control signal lines (1, 2, 4CN) in such a way that they will be separated form the main circuit wiring (R/L1, S/L2, T/L3) or other power lines.

IMPORTANT

If the power lines are provided along with the signal lines (motor encoder signal lines), a malfunction may be caused by the affect of noise generated from the power lines.

- The length of the control signal lines (including motor encoder signal lines) must be less than 20 m (65.6 ft).

IMPORTANT

Excessively long motor encoder signal lines reduce the encoder power supply voltage because of voltage drop in the signal lines which may cause the inverter to malfunction.

- When shielded twisted-pair cables are used for control signal lines, terminate them as shown below.

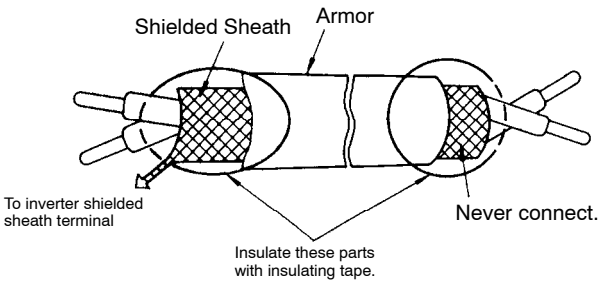


Fig 3.22 Shielded Cable Termination

- Use twisted shielded wires for motor encoder signal lines and connect both ends as shown below.

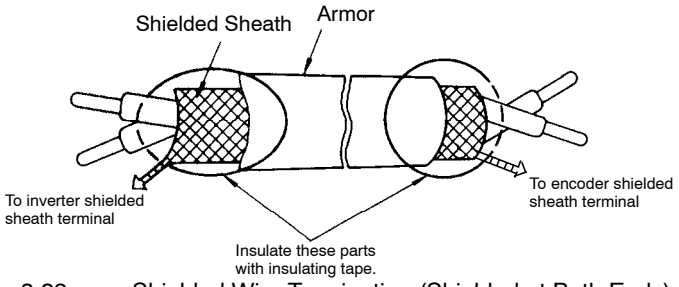


Fig 3.23 Shielded Wire Termination (Shielded at Both Ends)

3.5 Wiring Inspection

After completing installation and wiring, check for the following items. Never do a control circuit buzzer check.

- Confirm that the capacities and models of the Motor, Inverter, and Converter and the specifications of the machine are compatible. Check the nameplates on the Motor, Inverter, and Converter.
- Confirm that all devices are wired according to the connection diagram with no mistakes.
- Confirm that the following screws, bolts, and connectors are securely tightened or connected.
  The main circuit screw terminals of the Motor, Inverter, and Converter.
  The screw terminals of the motor fan power supply and the electromagnetic contactor for winding selection.
  The mounting bolts of the Motor, Inverter, and Converter.
- Confirm that the Motor, Inverter, and Converter are all securely grounded.
- Confirm that the following signal connectors are connected securely.
  The signal connectors of the Inverter, Converter, motor encoder, and magnetic sensor.
- Confirm that the conductive parts are free of any scraps of wire or metal fragments.
- Confirm that the ambient conditions of the Motor and machinery are ready for the operation of the system.
  Confirm that there are no obstacles around rotating parts.
  Confirm that the emergency stop and collision prevention functions operate normally.

4

Control Signals

This chapter provides detailed information on each control signal.

4.1 Sequence Input Signals . . . . . 4 -2
4.1.1 Connecting Sequence Input Signals . . . . . 4 -2
4.1.2 Selecting Sequence Input Signals . . . . . 4 -2
4.1.3 Status Display of Sequence Input Signals . . . . . 4 -3
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4.7 Encoder Pulse Output Circuit . . . . . 4 -20

4.1 Sequence Input Signals

This section provides information on the connections, functions, displays, and meaning of the sequence input signals.

4.1.1 Connecting Sequence Input Signals

The connections of sequence input signals vary between stand-alone drives and NC systems as described below.

■ M5A for Stand-alone Drives

Connect sequence input signals to the 6CN connector of the I/O card.

The sequence input signals can be input to the 6CN connector as 0 V, 24 V, or external common input signals. Refer to *3.4.4 Sequence Input Signal Circuit*s for details.

■ M5N for NC Systems

The Inverter performs serial transmission of sequence input signals with NC machines over YENET1200 communications. Refer to the manual for the NC machine for sequence input signals and input addresses.

4.1.2 Selecting Sequence Input Signals

Some functions of sequence input signals are selected by settings constants. Set the constants as shown in the following table for the desired functions.

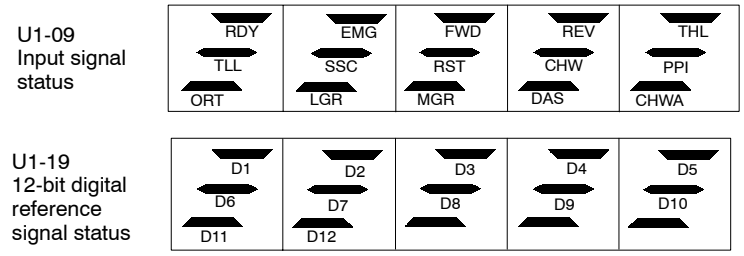
Table 4.1 Sequence Input Signals

No.	6CN Pin No.	Signal	Function	Related Constants
1	5	DAS*	Speed reference digital/analog selection	−
2	6	RDY	Operation ready	RDY selected at C1-37 bit 2 = 0.
		EMG2	Emergency stop 2	EMG2 selected at C1-37 bit 2 = 1.
3	7	EMG	Emergency stop	−
4	8	FWD	Forward run	−
5	9	REV	Reverse run	−
6	10	TLH	Torque limit H	TLH selected at C1-36 bit 2 = 0.
7	11	TLL	Torque limit L	TLL selected at C1-36 bit 1, 0 = 00.
		INC	Incremental	INC selected at C1-36 bit 1, 0 = 10.
8	12	SSC	Soft start cancel	SSC selected at C1-36 bit 3 = 0.
		SV	Servo mode	SV selected at C1-36 bit 3 = 1.
9	13	RST*	Error reset	−
10	14	CHW	Winding selection	−
11	15	PPI	P control/PI control selection	PPI selected at C1-36 bit 4 = 0.
		LM10*	Load factor meter 10x selection signal	LM10 selected at C1-36 bit 4 = 1
12	16	ORT	Orientation	−
13	17	LGR	L gear selection	−
14	18	MGR	M gear selection	−

* The M5N for NC systems does not use the RST signal.

4.1.3 Status Display of Sequence Input Signals

The ON/OFF status of input signals can be checked with the U10-09 and U1-19 operating status displays. As explained below, the LED indicators of the Digital Operator show the status of each signal. Refer to *Chapter 5. Operating the Digital Operator* for details.



Notes: 1. The LED lights to indicate that the corresponding input signal is ON.
2. CHWA indicates the status of the auxiliary bits (2CN-12 and 2CN-13) of the electromagnetic contractor for winding selection.

Fig 4.1 Display of Input Signal Status

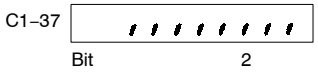
4.1.4 Details on Sequence Input Signals

This section provides information on each signal of sequence input. The description is for a stand-alone drive (M5A). Refer to the manual for the NC system (M5N) for sequence input signals and I/O addresses.

4

■ RDY (Operation Ready Signal)

RDY Function Selection: 6CN-6 will be the RDY signal if bit 2 of the C1-37 selection signals (SEL2) is turned OFF.

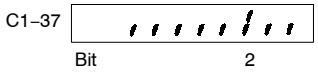


The RDY signal functions when 6CN-6 turns ON.

- When the RDY signal us turned OFF during operation, the gate will be blocked instantly and the motor current will be shut off.
- While the RDY signal is OFF, the motor will not start unless the FWD and REV signals are turned OFF together.
- Always keep the RDY signal ON if the it is not being used. If a 0 V common or 24 V common input is selected, connect pin 6 to pin 20. If the external common input is selected, turn the RDY signal ON externally.

■ EMG2 (Emergency Stop Signal 2)

EMG2 Function Selection: 6CN-6 will be the EMG2 signal if bit 2 of the C1-37 selection signals (SEL2) is turned ON.



The EMG2 signal functions when 6CN-6 turns OFF.

- The function of EMG2 is the same as the function of EMG (emergency stop signal). Refer to the description of EMG for details.
- If EMG2 is used, there will be two emergency stop signals, EMG and EMG2.
- The emergency stop operation will be performed if either EMG or EMG2 turns OFF.
- To enable operation after clearing the emergency stop operation, turn ON both EMG and EMG2.

■ FWD/REV (Forward Signal and Reverse Signal)

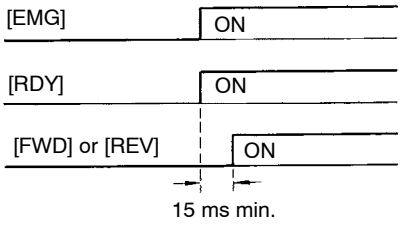
The FWD signal will function when 6CN-8 turns ON.

The REV signal will function when 6CN-9 turns ON.

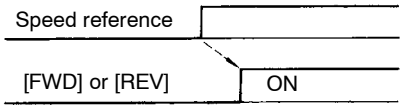
- When the FWD signal is turned ON while the RDY and EMG signals are ON and the speed reference is at a positive voltage, the motor will turn counterclockwise (motor viewed from the shaft end). When the REV signal is turned ON, the motor will turn clockwise.
  The rotation of the motor will be determined by the speed reference and operation signal in combination, as shown below.

Speed Reference		+	−
Operation signals	[FWD]	CCW (Forward)	CW (Reverse)
	[REV]	CW (Reverse)	CCW (Forward)

- When the FWD or REV signal is turned OFF while the motor is in operation, the motor will stop due to regenerative braking. When the motor speed reaches zero, the gate will be blocked and the motor current will be shut off.
- The acceleration and deceleration time between a stopped state and 100% rotation (C1-26) can be set with C1-10, the soft start time constant (T_{SFS}) between 0.1 and 180.0 s. The acceleration and deceleration time may be, however, longer than the soft start set time due to the load inertial moment.
- Turn ON the FWD or REV signal at least 15 ms after the EMG and RDY signals are turned ON. The FWD or REV signal will be unacceptable if it is turned ON before the EMG and RDY signals are turned ON.



- The motor will stop if the FWD and REV signals are turned ON simultaneously by mistake. Be aware that the motor will start operating immediately after either of the signals is turned OFF.
- When the FWD or REV signal is turned ON, the motor will rotate according to the speed reference. Set the speed reference in advance.



- If a fault occurs while the motor is in operation, the gate will be blocked immediately and the motor current will be shut off.
- Keep the FWD and REV signals turned OFF when the motor is ON. The motor will not operate while the FWD and REV signals are ON.

■ EMG (Emergency Stop Signal)

The EMG signal functions when 6CN-7 turns OFF.

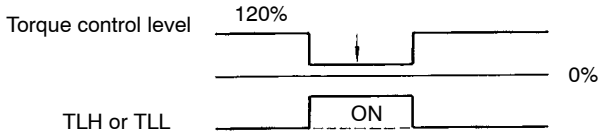
- The main circuit capacitor will be charged after the EMG signal is turned ON. The motor will be ready to operate a maximum of 2.5 s after the EMG signal is turned ON. Do not attempt to charge the capacitor repeatedly within a short period of time, or otherwise the charging circuit will deteriorate quickly. Allow a sufficient interval to charge the capacitor again.
- When the EMG signal is turned OFF, the motor will stop promptly due to regenerating braking and the current will be shut off. If the motor does not stop, the current will be shut off automatically 10 s after the EMG signal is turned OFF. At that time, the protective function will operate and “AL-21” (emergency stop failure) will be displayed.
- C1-10 (soft start time setting) will be disabled when an emergency stop failure occurs.
- If the EMG signal is turned OFF, the motor will not operate when the EMG signal turns ON again unless the FWD, REV, and ORT signals are turned OFF.
- While the motor is decelerated in emergency stop operation, the motor will coast to a stop with no regeneration breaking if the magnetic contactor on the Converter input shuts off the main circuit power supply. At that time, the main circuit low-voltage protective function will operate and a fault will be indicated.
- To prevent the motor from coasting to a stop when shutting off the main circuit power supply in emergency stop operation, use the OFF-delay circuit to delay the timing of shutting off the main circuit power supply.
- Always turn ON the EMG signal if it is not used. If the 0 V common or 24 V common input method is selected, connect 6CN-7 to 6CN-19. If the external common input method is selected, always turn the EMG signal ON externally.

■ TLH/TLL (Torque Control Signal H/L)

The TLH signal functions when 6CN-10 turns ON.

The TLL signal functions when 6CN-11 turns ON.

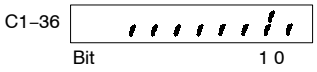
- The TLH and TLL signals are used to temporarily control the torque of the motor in operation.
- When the TLH or TLL signal is turned ON, the torque will be controlled and the TLE torque control signal will be output.
- The torque control level with the TLH signal input will be set between 5% and 120% of the 30-minute rating in C1-24 (TLEXT), the external control torque limit level constant.
- The TLL operation level will be 1/2 of the TLH operation level.
- The TLL signal will take precedence over the TLH signal if both TLH and TLL signals are turned ON simultaneously.



- The TLL control function will be enabled while the emergency stop is operating.
- When the TLH or TLL signal is not used, turn 6CN-10 and 6CN-11 OFF.

■ INC (Incremental Signal)

INC Function Selection: 6CN-11 will be the INC signal if bit 0 of the C1-36 selection signals (SEL1) is turned OFF and bit 1 is turned ON.

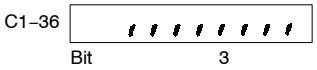


The INC signal functions when 6CN-11 turns ON.

- Used for incremental operation under orientation control.
- The INC signal will be enabled if it is input earlier than or simultaneously with the ORT signal.
- If the INC signal is input when the system is turned ON or during absolute positioning, an INC signal fault (AL-65 or AL-75) will result.
- The INC signal will start incremental operation from the stop position when the ORG signal input turns ON. If positional precision of the system is required, execute absolute positioning first.

■ SSC (Soft Start Cancel Signal)

SSC Function Selection: 6CN-12 will be the SSC signal if bit 03 of the C1-36 selection signals (SEL1) is turned OFF.

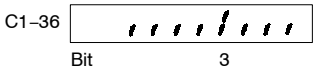


The SSC signal functions when 6CN-12 turns ON.

- The SSC signal cancels the soft start function (C1-10) so that the speed standard will catch up with the speed reference for inching.
- When the SSC signal is turned ON, the motor will be accelerated or decelerated within the shortest period in current-limited acceleration or deceleration regardless of the acceleration or deceleration time set in the C1-10 constant.
- Turn pin 12 OFF when SSC is not being used.

■ SV (Servo Mode Signal)

SV Function Selection: 6CN-12 will be the SV signal if bit 03 of the C1-36 selection signals (SEL1) is turned ON.

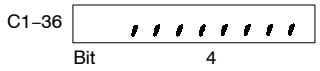


The servo mode for a solid tap or similar device will be switched to when 6CN-12 turns ON.

- In the servo mode, the speed loop gain and other control constants for servo mode will be used.
- The following control constants will be enabled in servo mode.
  Speed control proportional gain (C1-05 and C1-07)
  Speed control integral time constant (C1-06 and C1-08)
  Servo mode magnetic flux level (C1-31 and C1-33)
  Servo mode base speed ratio (C1-32 and C1-34)

■ PPI (P/PI Control Selection Signal)

PPI Function Selection: 6CN-15 will be the PPI signal if bit 04 of the C1-36 selection signals (SEL1) is turned OFF.



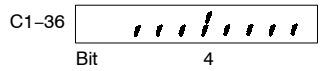
P control functions when 6CN-15 turns ON.

PI control functions when 6CN-15 turns OFF.

- The PPI signal is used to select the P or PI control of the speed controller.
- When the PPI signal is turned ON, the speed controller will be in P control regardless of the operating status of the system.
- Turn pin 15 OFF when P control is not to be performed.

■ LM10 (Load Factor Meter ×10 Selection Signal)

LM10 Function Selection: 6CN-15 will be the LM10 signal if bit 04 of the C1-36 selection signals (SEL1) is turned ON.



The LM10 signal functions when 6CN-15 turns ON.

(Not used for NC system (M5N).)

- The LM10 signal is used to improve the signal-noise ratio of the system with light loads by increasing the sensitivity of the load factor meter by 10 times.

■ DAS (Speed Reference Digital/Analog Selection Signal)

Analog input will be selected when 6CN-5 is turned OFF.

Digital input will be selected when 6CN-5 is turned ON.

(Not used for NC system (M5N).)

- The DAS signal is used to select an analog input (10 V/100%) or digital input for the speed reference.
- The analog speed reference is selected when the DAS signal is turned OFF, and the digital speed reference is selected when the DAS signal is turned ON.
- The DAS signal can be turned ON or OFF only when the system is not operating.
- The following four types of digital speed reference can be selected.
  12-bit binary (factory setting)
  3-digit BCD
  2-digit BCD
  Internal speed setting
- The digital speed reference is selected with bits 7 and 6 of selection signal C1-37.

Refer to *4.3 Using a 12-bit Digital Speed Reference.*

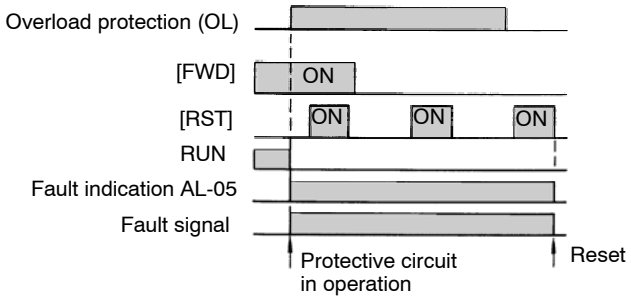
■ RST (Fault Reset Signal)

The RST signal functions when 6CN-13 turns OFF.

(Not used for NC system (M5N).)

- The RST signal is used to reset the system after the protective circuit operates for overcurrent or overload protection and the probable cause is eliminated.

- The RST signal is enabled only after the protective circuit operates.
- The system cannot be reset while the FWD , REV, or ORT signal is ON.
- The RESET switch of the Digital Operator has the same function as the RST signal.
- The system is reset on the rising edge of the RST signal. Therefore, turn the RST signal ON and then OFF.
- Faults take precedence in the sequence of the protective circuit. The following timing chart is an example of resetting.

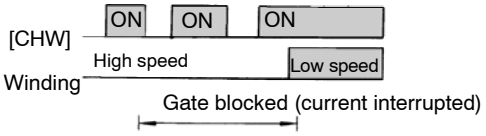


■ CHW (Winding Selection Signal)

Low speed winding will be selected when 6CN-14 is turned ON.

High speed winding will be selected when 6CN-14 is turned OFF.

- The CHW signal is a reference signal for motor winding selection control.
- The high-speed winding will be selected when the CHW signal is turned OFF. The low-speed winding will be selected when the CHW signal is turned ON.
- Winding selection is possible while the system is in operation.
- When the CHW signal is turned ON for winding selection, the gate will be blocked until the actual winding is switched over. If this status continues for the preset time, a winding selection fault (AL-20) will result and the system will stop.

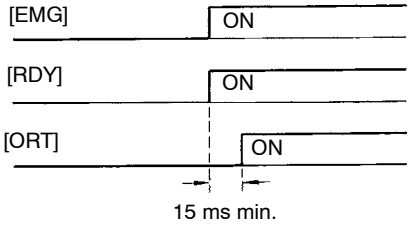


- If the winding does not coincide with the CHW reference when the system is turned ON, the winding will be switched so that is coincides with the reference.

■ ORT (Orientation Signal)

The ORT signal functions when 6CN-16 turns ON.

- The ORT signal is a reference signal for electrical orientation.
- When the ORT signal is turned ON, the load shaft will be promptly moved to the preset position.
- Turn the ORT signal OFF after completing tool or workpiece replacement for positioning.
- The system will not restart unless the ORT signal is turned OFF if an emergency stop is performed during orientation.
- Keep the ORT signal OFF when the system is turned ON, or otherwise the system will not operate.
- Turn ON the ORT signal at least 15 ms after the EMG or RDY signal is turned ON. The ORT signal will not be accepted if it is turned ON before the EMG or RDY signal is turned ON.



- Use the motor encoder signal for positioning if the optional orientation card is not used.
- Turn 6CN-16 OFF if the ORT signal is not used.

■ MGR/LGR (M Gear/L Gear Selection Signal)

The MGR signal will be selected when 6CN-18 is turned ON.

The LGR signal will be selected when 6CN-17 is turned ON.

- The MGR and LGR signals are used to change parameters, such as the gear ratio and gain, to ensure the optimum control of the load according to the gear selection of the load shaft.
- Use the gear selection signals as shown below.

MGR	LGR	Description
OFF	OFF	H gear selected
ON	---	M gear selected
OFF	ON	L gear selected

4.2 Analog Speed Reference

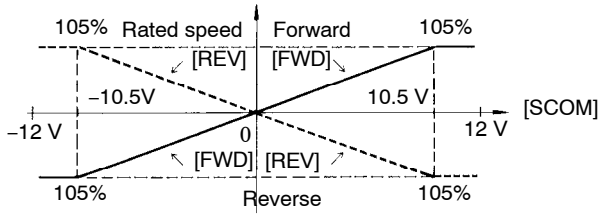
This section proves detailed information on the analog speed reference signal for stand-alone drives M5A.

■ SCOM (Analog Speed Reference Input)

Connector number: 6CN

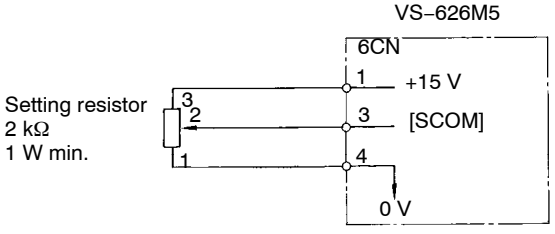
Pin number: 3

- The rated input voltage is ±10 VDC. Set the motor speed at the rated input voltage (i.e., a 100% speed reference) in C1-26 (S100), the rated speed setting constant.
- If the motor speed at the rated input voltage does not reach the maximum speed, adjust the motor speed in C1-12 (S_{ADJ}), the motor speed adjustment constant.
- The maximum permissible input voltage is ±12 VDC. The voltage is, however, limited to a maximum of 105% or 110% reference in the Controller. Therefore, the speed of the motor will reach 105% or 110% of the rated speed. The speed limit level is selected with bit 5 of selection signal C1-38 (SEL3). The level is set to 105% when bit 5 is turned OFF and 110% when bit 5 is turned ON.
- The SCOM signal has an input impedance of 50 kΩ.
- The speed together with the rotating direction is determined by the SCOM signal and operation signal as shown below.



Speed Reference		+	−
Operation signal	[FWD]	CCW (Forward)	CW (Reverse)
	[REV]	CW (Reverse)	CCW (Forward)

- The SCOM signal will be enabled and the motor will rotate when the FWD or REV signal is turned ON.
- The motor may not come to a stop with the SCOM signal set to 0 V while the FWD or REV signal is being input. To stop the motor, turn OFF both the FWD and REV signals. The motor current will flow while the FWD or REV signal is ON.
- Use a shielded cable to wire the SCROM signal to improve noise immunity.
- The SCOM signal can be manually set to the reference voltage (+15 V) of the Controller provided that the current flow is 10 mA or less.



4.3 Using a 12-bit Digital Speed Reference

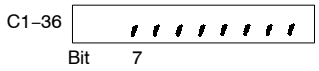
This section provides information on using a 12-bit digital speed reference input (for stand-alone drive systems M5A only).

■ D1 through D12 (12-bit Digital References 1 through 12)

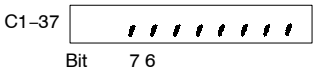
Connector number: 1CN

Pin numbers: 19 through 30

12-bit Digital Reference Signal Function Selection: 1CN-19 to 1CN-30 will be the 12-bit Digital Reference if bit 07 of the C1-36 selection signals (SEL1) is turned OFF.



- Bit 7 is used for internal speed or digital speed settings.
- It is possible to select 12-bit binary, 2-digit BCD, 3-digit BCD, or internal speed setting for digital speed references. Speed references are factory-set to 12-bit binary.
- The setting method can be selected using bits 6 and 7 of selection signal C1-37 (SEL2).



- Selecting the Speed Setting

6CN-5, 19	C1-37 (SEL2)		Speed Selection
DAS	Bit 7	Bit 6	
OFF	---	---	Analog speed
ON	OFF	OFF	2-digit BCD
	OFF	ON	Binary
	ON	OFF	3-digit BCD
	ON	ON	Internal speed

- The DAS signal can be switched only when the system is not in operation.
- If the binary, BCD, or internal speed setting method is selected, the forward or reverse rotation of the motor is selected with the external FWD or REV relay signal.

Internal Speed Setting

Number of speed settings: 8
Speed set value: Input into C1-41 through C1-48 the percentages based on the rated speed set for C1-26 (S100). Set range: 0.00 to 100.00

Control Constant	Signal	Name	1CN Input	Pin Number
C1-41	SPD1	Internal speed setting 1	D1	19
C1-42	SPD2	Internal speed setting 2	D2	20
C1-43	SPD3	Internal speed setting 3	D3	21
C1-44	SPD4	Internal speed setting 4	D4	22
C1-45	SPD5	Internal speed setting 5	D5	23
C1-46	SPD6	Internal speed setting 6	D6	24
C1-47	SPD7	Internal speed setting 7	D7	25
C1-48	SPD8	Internal speed setting 8	D8	26

- If two or more speed selection signals (D1 through D8) are turned ON at the same time, the smaller selection signal number will be enabled. (For example, if D2 and D5 are turned ON simultaneously, D2 will be enabled.)
- If all speed selection signals are OFF, the speed references are treated as 0.
- No speed reference values in C1-41 through C1-48 can be changed while the system is in operation.

Digital Speed Settings

Signal	1CN Pin Number	12-bit Binary	3-digit BCD	2-digit BCD
D1	19	1	1	---
D2	20	2	2	---
D3	21	4	4	---
D4	22	8	8	---
D5	23	16	10	1
D6	24	32	20	2
D7	25	64	40	4
D8	26	128	80	8
D9	27	256	100	10
D10	28	512	200	20
D11	29	1024	400	40
D12	30	2048	800	80

- All signals will be ON with the rated speed reference set in C1-26 if the 12-bit binary setting is selected.
- If the 3- or 2-digit BCD setting is selected, a rated speed reference of 999 or 99 will be set in C1-26 respectively.

The input signal circuit for digital speed references is the same as the sequence input signal circuit explained in *3.4.4 Sequence Input Signal Circuit (for Stand-alone Drive).*

4.4 Sequence Output Signals

This section provides information on the connections, functions, displays, and meanings of the sequence output signals.

4.4.1 Connecting Sequence Output Signals

The connection of sequence output signals varies between stand-alone drives and NC systems as described below.

■ M5A for Independent Drives

Connect sequence output signals to the 6CN connector of the I/O card. Refer to *3.4.5 Sequence Output Signal Circuit*s for details.

■ M5N for NC Systems

The Inverter performs serial transmission of sequence output signals with NC machines over YENET1200 communications. Refer to the manual of the NC machine for sequence output signals and output addresses.

4.4.2 Setting Sequence Output Signals

Level changes in the following sequence output signals are possible with constant settings. For details, refer to *4.4.4 Details on Sequence Output Signals*.

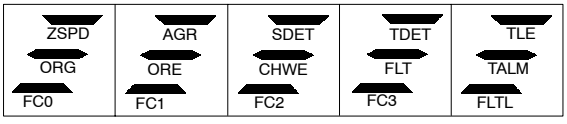
Table 4.2 Constants of Sequence Output Signals

No.	6CN Pin No.	Signal (M5)	Function	Related Constants
1	33	ZSPD	Zero-speed	C1-19 (Zero-speed detection level)
2	34	AGR	Speed agree	C1-20 (Speed agree detection width) C1-38 Bit 6 (AGR output condition selection)
3	35	SDET	Speed detection	C1-21 (Speed detection signal level) C1-22 (Speed detection signal detection width)
4	36	TDET	Torque detection	C1-23 (Torque detection signal operation level C1-40 Bit 2 (TDET output method selection)
5	37	TLE	Torque limit	–
6	38	ORG	Load shaft origin	–
7	39	ORE	Orientation completion	C2-09 or C3-09 (Positioning completion detection width) C2-10 or C3-10 (Positioning completion cancel width)
8	40	CHWE	Winding selection completion	–
9	43, 44	FLT	Fault signal	–
10	46	TALM	Minor fault signal	–

4.4.3 Status Display of Sequence Output Signals

The ON/OFF status of output signals can be checked with the U1-10 operation status display. The LED indicators on the Digital Operator will light as shown below to indicate signal status. Refer to *Section 5 Operating the Digital Operator* for operating procedures.

UI-10 Output signal status



Note: The LED indicator lights to indicate that the corresponding input signal is ON.

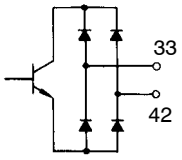
Fig 4.2 Display of Output Signal Status

4.4.4 Details on Sequence Output Signals

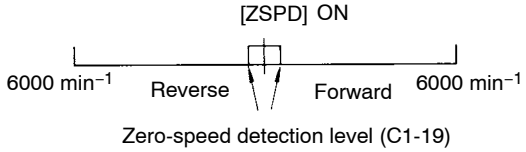
This section provides information on each of sequence output signal. Pin numbers are given for independent drive operation (M5A). Refer to the manual for the NC machine for sequence output signals and output addresses.

■ ZSPD (Zero-speed Signal)

Connector number: 6CN
Pin numbers:



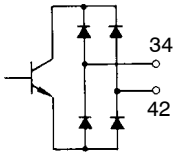
- The ZPSD signal will turn ON when the motor speed drops to the set speed or less. Once the ZPSD signal turns ON, it will be kept on hold for 50 ms.



- The C1-19 (ZS_{LVL}) can be set to a zero-speed detection level between 3 and 60 min^{-1}.
- The ZSPD signal is output regardless of the status of the FWD or REV output. Therefore, the ZSPD signal can be used as an interlock signal for hazard prevention.

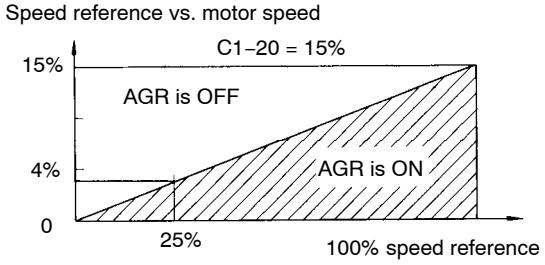
■ AGR (Speed Agree Signal)

Connector number: 6CN
Pin numbers:



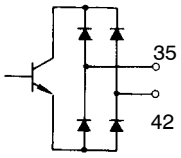
- The AGR signal will turn ON when the motor speed reaches the range set by the SCOM signal. The AGR signal will not, however, turn ON while the gate is blocked or the motor winding is selected.
- Once the AGR signal turns ON, it will be kept on hold for 50 ms.
- The AGR signal can be used in response to the S reference for NC machines in program operation to go to the next step.
- The C1-20 (AGR_{BD}) can be set to a speed agree signal detection width between ±10% and ±50%.

Operation Example of Speed Agree Signal

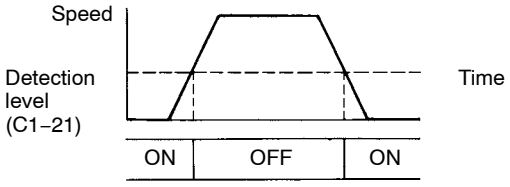


■ SDET (Speed Detection Signal)

Connector number: 6CN
Pin numbers:



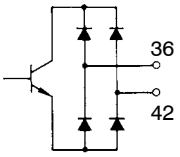
- The SDET signal will turn ON when the motor speed reaches the preset value or less.
- The speed detection level is set between 0% and 100% in the C1-21 (SD_{LVL}) control constant.



- Set the hysteresis width of the SDET signal in the C1-22 (SD_{HYS}) control constant.
- The SDET operates regardless of the operation signal.

■ TDET (Torque Detection Signal)

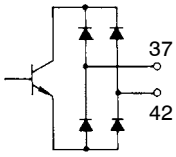
Connector number: 6CN
Pin numbers:



- The TDET signal will turn ON when the torque reference reaches the preset value or less.
- Once TDET turns OFF, the status is held for 50 ms.
- The torque detection level is set between 5% and 120% of the 30-minute rating for the C1-23 (TD_{LVL}) time constant. There is an hysteresis of ±10% of the set value for the operation point.
- Bit 2 of selection signals C1-40 (SEL5) can be turned ON to prevent TDET from turning OFF even if the torque references exceeds the set value during acceleration and deceleration.
- The TDET signal can be used to check the operation of the torque limit or load.

■ TLE (Torque Control Signal)

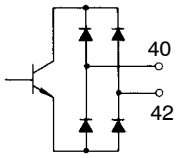
Connector number: 6CN
Pin numbers:



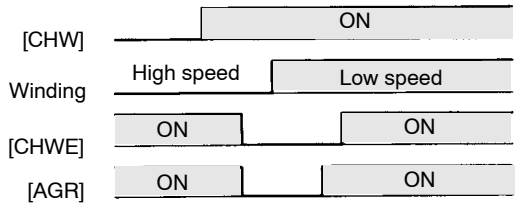
- The TLE signal turns ON when the TLL or TLH torque control signal turns ON.
- The TLE signal can be used to check the TLL or TLH signal.

■ CHWE (Winding Selection Completion Signal)

Connector number: 6CN
Pin numbers:

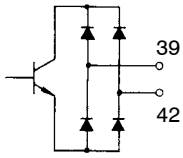


- CHWE signals completion of motor winding selection.
- The CHWE signal is usually ON when the motor is in operation. When the CHW signal is ON, the CHWE signal will turn OFF until the winding is switched. The CHWE signal will turn ON again on completion of the winding selection.
- If the CHWE signal is not output within a preset time after the CHW signal is input, the AL-20 fault (winding selection fault) will result and the system will stop the motor.
- While the winding is selected, the AGR signal will turn OFF if the winding selection is implemented while the motor is rotating at constant speed.



■ ORE (Orientation Completion Signal)

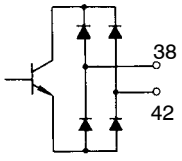
Connector number: 6CN
Pin number:



- The ORE signal will turn ON when the ORT signal input turns ON and when the load shaft is close to the specified stop position.
- While the ORE signal is ON, the deviation of the position will be compensated with countertorque is generated to offset external force. Make tool or workpiece changes while the ORE signal is ON.
- The ORE signal will turn OFF if the external force is high and the deviation of the position is excessive. In that case, arrange a sequence to result an orientation fault.

■ ORG (Load Shaft Origin) Signal

Connector number: 6CN
Pin numbers:



- A single pulse is output per load shaft rotation by using the magnetic sensor signal.
- The ORG signal will turn ON when the load shaft is rotating at the rate of 1000 min^{-1} or less.

■ FLT (Fault Bit Signal)

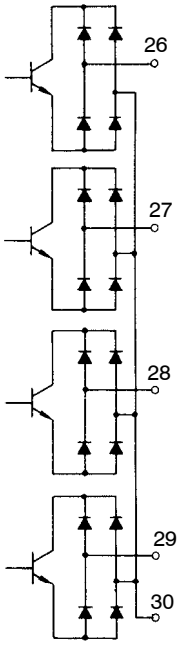
Connector number: 6CN
Pin numbers:



- The motor current will be shut off instantly when the protective circuit operates for overcurrent or overload protection and the motor will coast to a stop. The FLT signal will be output when the current is shut off.
- The FLT relay is of SPDT contact construction and operates together with the protective circuit.
- Turn OFF the FWD, REV or ORT signal while the FLT signal is output and then display the fault at the host system.
- The fault number is displayed when the FLTL is output. Refer to the fault number.
- For the relationship between the FLT and RST signals, refer to the RST signal in *4.1.4 Details on Sequence Input Signals*.

■ FC0 to FC3 (Fault Code Signals 0 to 3)

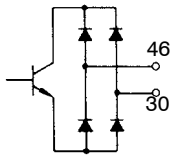
Connector number: 6CN
Pin numbers:



- A fault code signal is output to provide the details of the operation of the protective function.
- Refer to tables 12.1 and 12.2 for the details of fault codes.

■ TALM (Minor Fault Signal)

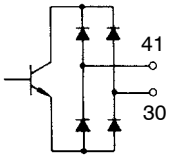
Connector number: 6CN
Pin numbers:



- The TALM signal turns ON when a motor overheat alarm 1, heatsink overheat alarm 1, or control card temperature alarm 1 is detected. The system will continue operating.
- The FLTL signal will turn ON if any of the following conditions continues while the TALM signal is ON, the current will be shut off, and the system will stop.
  Motor overheat alarm 1 continues one minute (AL-40 will change to AL-41)
  Heatsink overheat alarm continues one minute (AL-43 will change to AL-44)
  Control card temperature exceeds 85°C (185°F) (AL-46 will change to AL-47)
  The TALM signal will be output if there is a minor fault in an optional function, such as an orientation fault.

■ FLTL (Fault Signal)

Connector number: 6CN
Pin numbers:



- The FLTL signal will turn OFF if a fault occurs. The FLTL signal is ON while the system is in normal operation.
- The output conditions for the FLTL signal are the same as those for the FLT signal.
- The motor current will be shut off instantly when the protective circuit operates for overcurrent or overload protection and the motor will coast to a stop. The FLTL signal will be output when the current is shut off.
- Turn OFF the FWD, REV and ORT signal OFF while the FLT signal is being output, and then display the fault at the host system.
- The fault number is displayed when the FLTL is output. Refer to the fault number.
- For the relationship between the FLT and RST signals, refer to the RST signal in *4.1.4 Details on Sequence Input Signals*.

4.5 Analog Monitor Signals

The following conditions and specifications apply to analog output signals (for stand-alone drive systems M5A only).

■ SM (Speed Meter Signal)

Connector number: 6CN
Pin number: 47

- The motor speed can be monitored with an external speed meter connected.
- The SM signal is a DC voltage signal that is output in proportion to the speed regardless of the direction of rotation.
- Use a voltmeter as the speed meter with the following specifications.

Item	Specification
Item	Voltmeter
Operation principle	Moving coil
Rating	10 V full scale
Internal resistance	10 kΩ
Grade	2.5 or over

- The rated SM signal output (10 V) will turn ON when the motor is rotating at the speed set in C1-26 (S_{100}), the rated speed set constant.
- The SM signal level can be adjusted with C1-16 (SM_{ADJ}), the control constant.
- The C1-16 (SM_{ADJ}) control constant is for speed adjustment. The actual motor speed will not be affected by changing the set value of C1-16.
- The SM signal precision is less than 3% of the rated value when the motor is in reverse operation.

■ LM (Load Rate Signal)

Connector number: 6CN
Pin number: 50

- The load rate signal indicates the load rate based on the rated output.
- The meter used must have the same specifications as the one for the speed meter.
- The load rate signal level can be adjusted with C1-17 (LM_{ADJ}) for control and C1-18 (L_{MFS}) for full-scale setting.



Use 6CN pin 48 and 6CN pin 49 for the 0 V on the meter.

4.6 Encoder Pulse Input Circuit

Phase A, B, and C (origin) signals [PA, *PA, PB, *PB, PC, *PC] are input into the 2CN connector from the 1024 P/R motor encoder.
An asterisk indicates a reversed signal. The input signals have the following specifications.

■ Signal Configuration

90° phase-difference, two-phase pulse (A and B), and marker pulse (C)

■ Input Circuit Configuration

The input circuit is a line receiver with RS-422-A specifications.

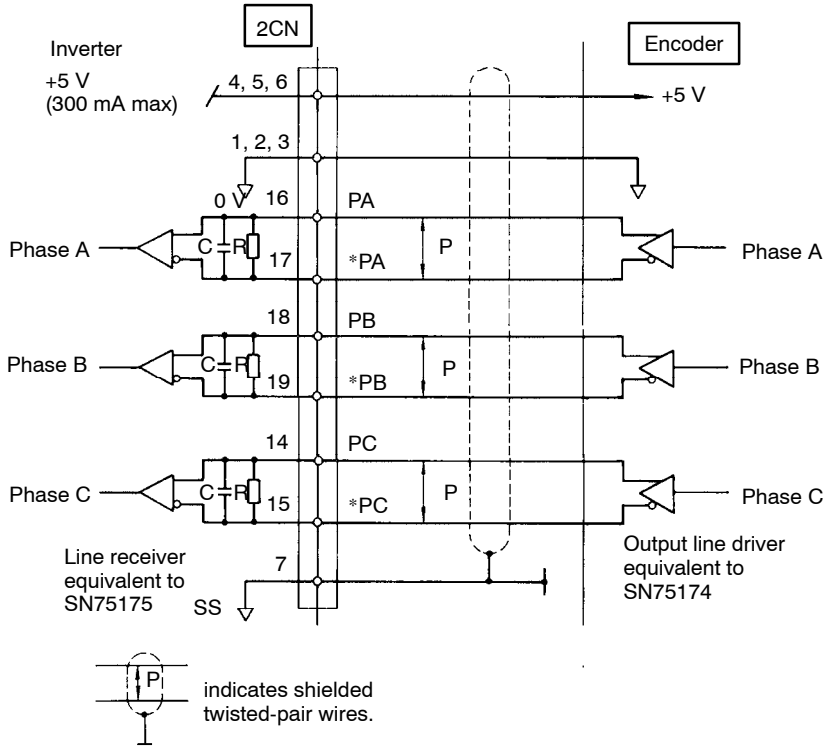


Fig 4.3 Encoder Pulse Input Circuit

■ Input Phase

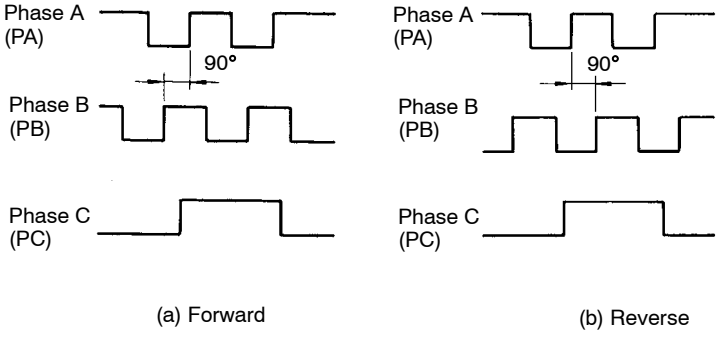


Fig 4.4 Input Phase

4.7 Encoder Pulse Output Circuit

Phase A, B, and C (origin) signals are output from the motor encoder.

An asterisk indicates a reversed signal.

The output signals have the following specifications and can be used for position feedback.

■ Signal Configuration

90° phase-difference, two-phase pulse (A and B), and marker pulse (C)

■ Output Circuit Configuration

The output circuit is a line receiver with RS-422A specifications. Use a line receiver with specifications matching the RS-422A specifications for signal exchange as shown in the following connection example.

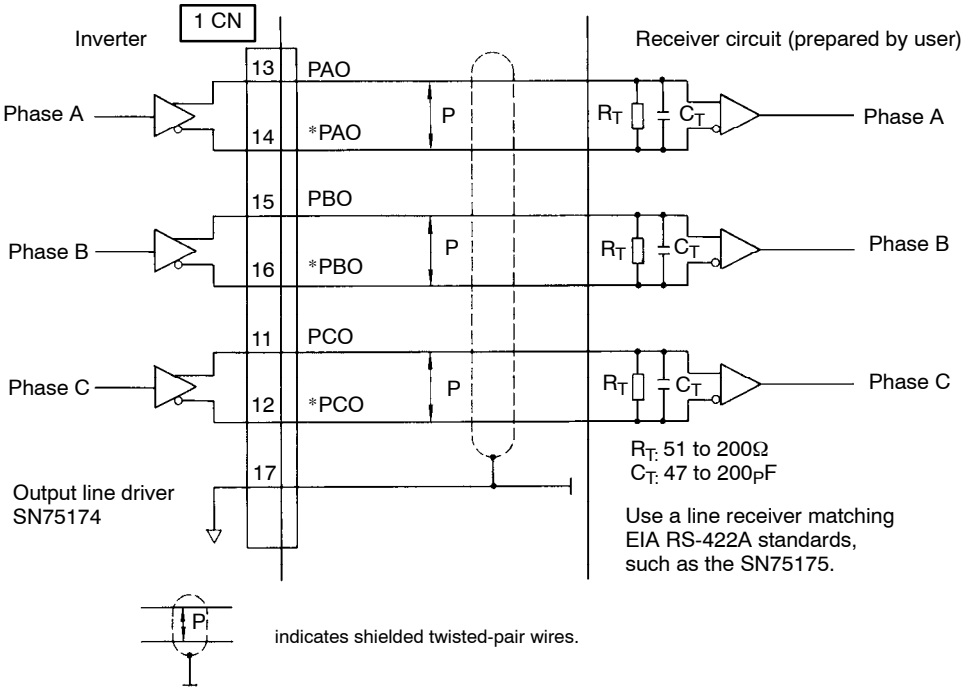


Fig 4.5 Encoder Pulse Output Circuit

■ Output Phase

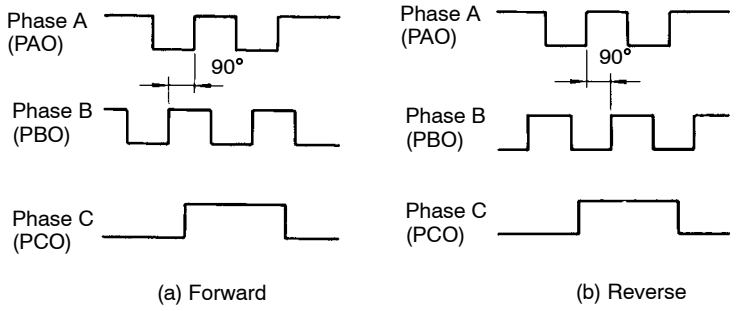


Fig 4.6 Output Phase

5

Operating the Digital Operator

This chapter explains the functions, operating methods, details on control constants for the Digital Operator.

5.1 Function of the Digital Operator . . . . . 5 -2
5.2 Display Mode Configuration . . . . . 5 -5
5.3 Key Operations and Display . . . . . 5 -6
5.3.1 Indication at Power-ON . . . . . 5 -6
5.3.2 Switching Display Functions . . . . . 5 -6
5.3.3 Operation Status Display Mode . . . . . 5 -7
5.3.4 Control Constant Display Mode . . . . . 5 -7
5.3.5 Digital Operator Operation Mode . . . . . 5 -8
5.3.6 Fault Display Mode . . . . . 5 -10
5.3.7 Fault Record Display Mode . . . . . 5 -11

5.1 Function of the Digital Operator

The Digital Operator enables the following:

■ Display of Control Signal Status

Status of control signals of each unit is displayed by monitoring the status of operation. For the display items, see *Chapter 11 Operating Status Displays.*

■ Display and Setup of Control Constants

Control constants must be set up for normal operation in compliance with the specifications. *Chapter 10 Control Constants* lists the control constants.

■ Display of Protective Functions

If an error occurs during operation, protective functions are displayed. *12.2 Converter Faults* and *12.3 Inverter Faults* list the protective functions. These are not displayed when operation is normal.

■ Functions Using the Digital Operator

Stand-alone operation without sequence input signals or speed reference is possible by using the Digital Operator. This function is effective for test run of inverter/converter connected only to motor. For the details of the operation, see Par. 5.3 (5) “Digital Operator Operation Mode.”

Fig. 5.1 shows the display section and operation keys of the Digital Operator, and Fig. 5.2 shows the LED display status of the RUN and STOP keys. Table 5.1 shows the displayed characters and the corresponding alphabets and numbers, and Fig. 5.3 shows the display of bit selection signal.

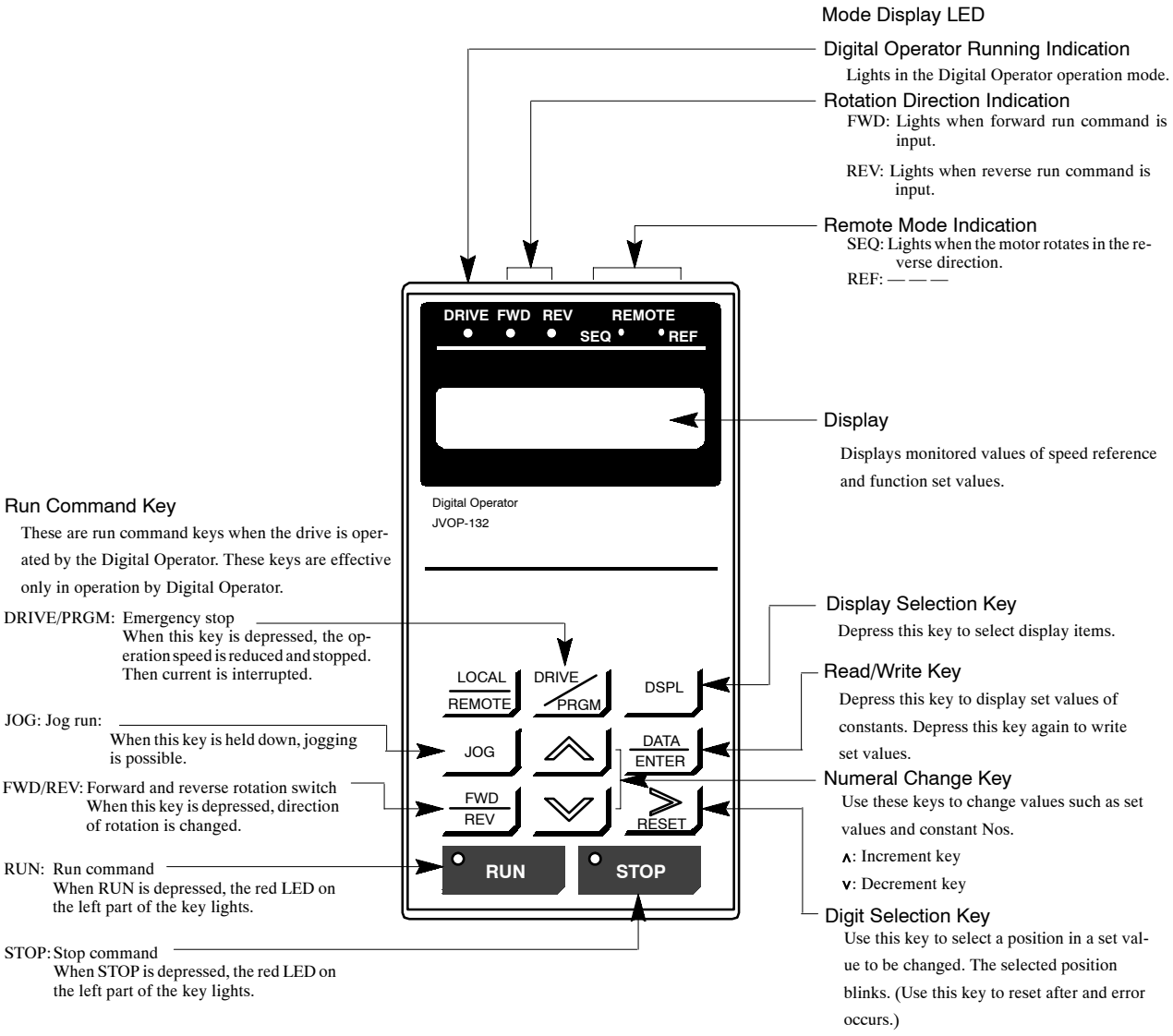


Fig 5.1 Display Unit and Operation Keys of the Digital Operator

RUN and STOP LEDs light, blink, and go OFF depending on the status of operation.

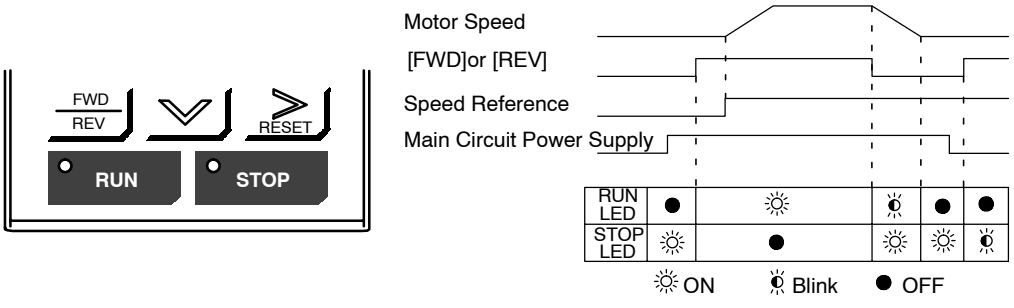


Fig 5.2 LED Display of RUN and STOP Keys

Table 5.1 Indication of Numbers and Letters by 7-segment LED

Numbers		Letters			
0	0	A	A	N	–
1	1	B	b	O	–
2	2	C	C	P	P
3	3	D	d	Q	–
4	4	E	E	R	r
5	5	F	F	S	–
6	6	G	–	T	–
7	7	H	–	U	U
8	8	I	–	V	–
9	9	J	–	W	–
.	.	K	–	X	–
–	-	L	L	Y	–
		M	–	Z	–

Note: "—" is not displayed.

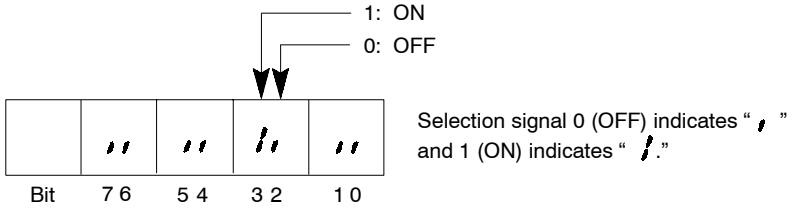
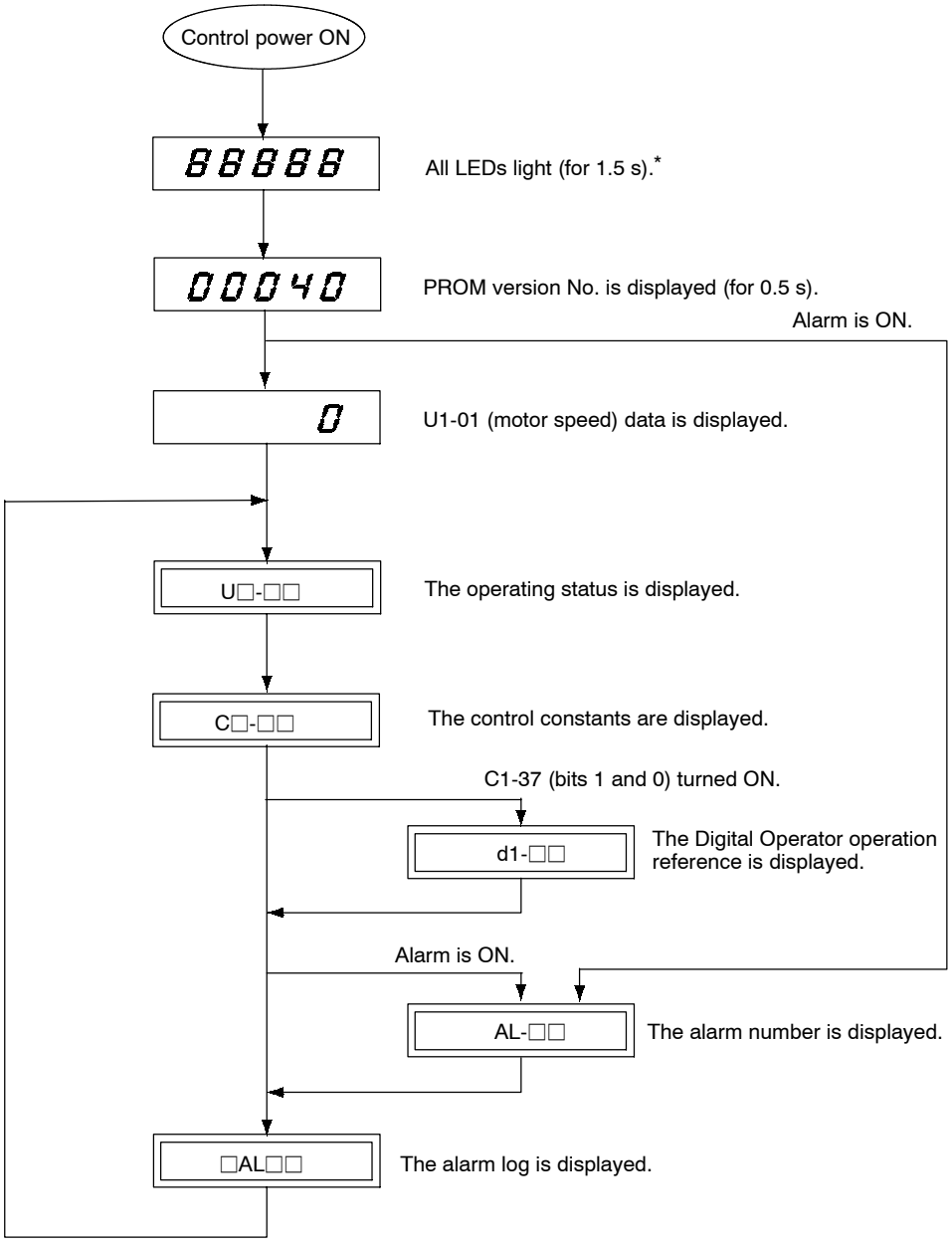


Fig 5.3 Display of Bit Selection Signal

5.2 Display Mode Configuration

The following figure shows the displays of the Digital Operator. Whenever the DSPL (display selection) key is pressed, the display mode will change.



* "88888" will be display if the model is the M5N for NC systems until communications with the NC machine are established.

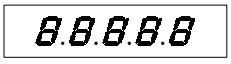
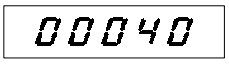
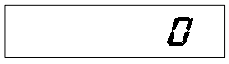
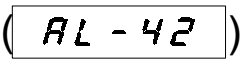
Fig 5.4 Display Order of Digital Operator

5.3 Key Operations and Display

This paragraph describes how to operate the Digital Operator keys and display.

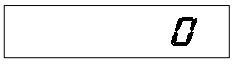
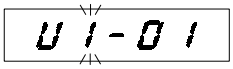
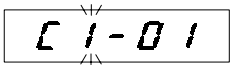
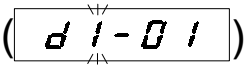
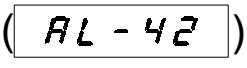
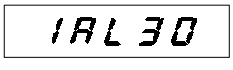
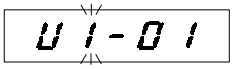
5.3.1 Indication at Power-ON

Digital Operator display at control power supply ON is shown below.

Description	Digital Operator Display	Remarks
• Turn ON control power supply.		
• All LEDs light.		Displayed for 1.5 sec.
• PROM number is displayed.		Displayed for 0.5 sec. The lower 5 digits of PROM No. are displayed. The example uses PROM No. "VSM200040."
• U1-01 (motor speed) data is displayed.		Because the motor does not rotate when power supply is turned ON, "0" is displayed.
• The fault No. is displayed. (Displayed when a protective function is activated.)		AL-42 indicates motor thermistor is disconnected when motor encoder signal 2CN is disconnected.

5.3.2 Switching Display Functions

Depress [DSPL] key on the Digital Operator to change the mode of display.

Description	Key Sequence	Digital Operator Display	Remarks
• Motor speed (U1-01) data is displayed.			
• Motor speed data No. is displayed. (Operation status display has been selected.)	DSPL		Control signal status of each unit can be monitored.
• Control constants display is selected.	DSPL		Control constants are displayed/set.
• Digital Operator run command display is selected. (Displayed when bits 0 and 1 of control constant C1-37 are set ON.)	DSPL		Use when operating by Digital Operator.
• The fault No. display is selected. (Displayed when a protective function is activated.)	DSPL		Contents of currently occurring fault are displayed. AL-42 indicates motor thermistor disconnection is detected.
• Fault record display is selected.	DSPL		Contents of past faults are displayed. 1AL30 indicates the last fault is encoder signal disconnection.
• Returns to operation status display.	DSPL		

5.3.3 Operation Status Display Mode

To check data in operation status display mode, do as follows. The following shows the example where U1-09 (sequence input signal status) is to be changed.

Description	Key Sequence	Digital Operator Display	Remarks
• U1-01 is displayed.		U1-01	
• Move blinking cursor to the data No.	RESET	U1-01	Depress [>] key once more to return the blinking cursor.
• Select U1-09.	∧ ∨	U1-09	
• Display U1-09 data contents.	DATA ENTER	- -	The display example is the status when [RDY] and [EMG] signals are ON.
• Return to operation status No. display	DSPL	U1-09	

For explanations of operation status display, refer to *Chapter 11 Operating Status Displays.*

5.3.4 Control Constant Display Mode

To check data or set/change a constant in control constant display mode, do as follow. The following shows the example where C1-10 (soft-start time) is to be changed.

Description	Key Sequence	Digital Operator Display	Remarks
• C1-01 is displayed.		C1-01	
• Move blinking cursor to the data No.	RESET	C1-01	Depress [>] key once more to return the blinking cursor.
• Select C1-10.	∧ ∨	C1-10	
• Display C1-10 data contents.	DATA ENTER	000.1	
• Select data line to be changed.	RESET	000.1	
• Change set value. (1→5)	∧ ∨	000.5	
• Write-in set value.	DATA ENTER	End	Displayed for 0.5 sec.*
• Press DATA/ENTER Key until "End" is displayed.		000.5	Returns to previous display before write-in.
• Return to control constant No. display.	DSPL	C1-10	

Note: When data outside the input range are set, "End" will not appear on the display and all data lines will continue blinking even when the [DATA/ENTER] is held down. To correct this condition, depress [DSPL] key returning to the data number display and correct the settings.

Refer to *Chapter 10 Control Constants* for contents of control constants.

IMPORTANT

The following are constants that cannot be changed during operation:
C1-25 to 59, C2-09 to 27, C3-09 to 25: Cannot be changed during operation. Change when stopped.
C1-01 to 24, C2-01 to 08, C3-01 to 08: Can be changed during operation or when stopped.

5.3.5 Digital Operator Operation Mode

In Digital Operator operation mode, operation is enabled by commands from the Digital Operator. The following table shows the operation. Change the lower 2 bits of C1-37 from "00" to "11" to turn ON the operation mode.

Description	Key Sequence	Digital Operator Display	Remarks
• C1-37 is selected.		C 1-37	
• Display C1-37 data contents.	DATA ENTER	00000000	
• Select the digit of bit 1 (second place from the right).	RESET	00000000	
• Change set value. (Turn ON lower two bits.)	∧ RESET	00000011	
• Write-in set value.	DATA ENTER	End	Displayed for 0.5 sec.
• Press DATA/ENTER Key until "End" is displayed.		00000011	Returns to previous display before write-in.
• Return to control constants display.	DSPL	C 1-37	Effective for Digital Operator operation mode.

The following table shows the reference list in Digital Operator operation. Operation control signals (sequence input) and speed references displayed among reference display are handled similar to constant set-up.

Table 5.2 Parameters for Digital Operator Operations

Constants No.	Name	Unit	Contents
d1-01	Operation signal (Sequence input)	Binary	Bit 9 8 7 6 5 4 3 2 1 0 TLH TLL SSC – – – CHW PPI ORT LGR MGR – – –
d1-02	Speed reference	%	Displayed in % for rated speed setting (C1-26)

Set the speed reference in Digital Operator operation to d1-02.

Description	Key Sequence	Digital Operator Display	Remarks
• Select d1-01.	DSPL	d1-01	
• Select d1-02.	∧	d1-02	
• Display d1-02 data contents.	DATA/ENTER	000.00	
• Set speed reference (25%).	RESET ∧ ∨	025.00	Speed reference is displayed as a percentage of rated speed settings (C1-26). For rated speed of 6000 min^{-1}, 25% reference will become 1500 min^{-1} reference.
• Write-in set value.	DATA/ENTER	End	Displayed for 0.5 sec.
• Press DATA/ENTER Key until "End" is displayed.		025.00	Returns to previous display before write-in.

The following table shows the keys used in the Digital Operator operation mode. Rotating direction is selected by [FWD/REV] key and run/stop by [RUN] or [STOP] key.

Table 5.3 Key Operations in Digital Operator Operation Mode

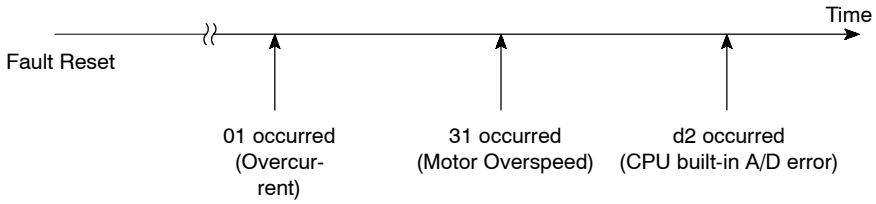
Key	Name	Function
DRIVE/PRGM	Emergency stop key	When the key is depressed, current is shut off after deceleration to stop.
JOG	Jog run key	Jog run can be performed when the key is held down. [Runs at 5% reference of rated speed setting (C1-26).]
FWD/REV	FWD/REV run key	FWD/REV run is switched when the key is depressed. (FWD/REV LED lights alternately.)
RUN	Run command key	Depress the key to start operation. (Red LED on the left lights during run.)
STOP	Stop command key	Depress the key to stop operation. (Red LED on the left lights during stop.)

To return to operation mode using a regular external run command, change the lower 2 bits of C1-37 from "11" to "01."

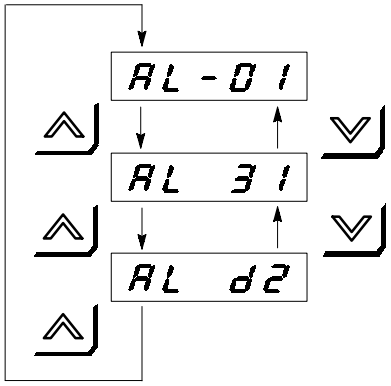
5.3.6 Fault Display Mode

If a protective function is activated because of a fault, the fault code is displayed. Up to six faults are recorded to view the order of a series of faults.

Display Example



- Displays the first fault No.
- Displays the second fault No.
- Displays the third fault No.



5

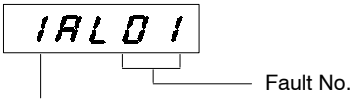
IMPORTANT

Notes on resetting faults

- To reset a fault by the Digital Operator after removing the cause, press [RESET] key in fault display mode. In other modes, [RESET] key cannot reset the fault.
- Before resetting, turn OFF the run command signals (FWD, REV, ORT) that are externally input. The reset operation will not be possible if a run command signal is ON.

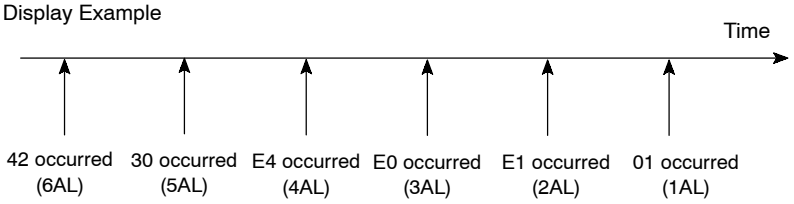
5.3.7 Fault Record Display Mode

Up to six faults can be displayed in order from most recent to oldest.

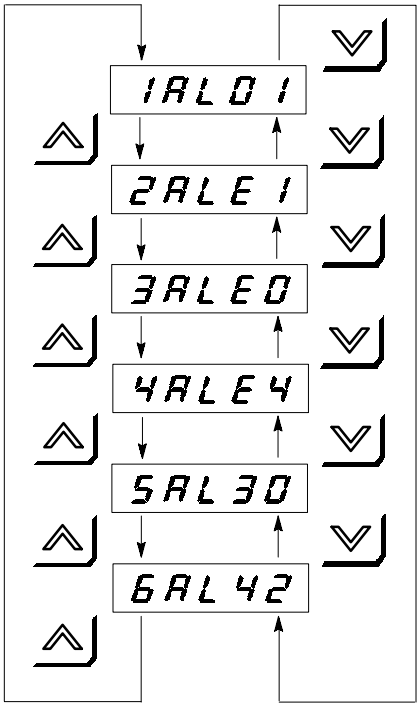


Fault Occurrence No. (1 to 6)
The larger the number, the older the fault data.

Display Example



- Displays the last fault No.
- Displays the second most recent fault No.
- Displays the third most recent fault No.
- Displays the fourth most recent fault No.
- Displays the fifth most recent fault No.
- Displays the sixth most recent fault No.



IMPORTANT

- Fault record data are not erased by fault reset or turning OFF power supply. (The data will not affect the operation.)
- To erase fault record data, turn ON bit 0 of C1-57 (right end) and turn OFF the control power supply. When power is turned ON again, data will be erased and bit 0 of C1-57 will automatically be turned OFF.

6

Trial Operation

This chapter explains the setup for trial operation, and gives examples of Digital Operator operations and trial operation.

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⚠ WARNING

- Turn ON the power supply only after closing the upper and lower covers. Do not open the covers while current is flowing.
  Failure to observe this warning can result in an electric shock.
- The Digital Operator stop button can be disabled by a function setting; you must install a separate emergency stop switch.
  Failure to observe this warning can result in personal injury.

⚠ CAUTION

- Never touch the heatsink because the temperature is very high.
  Failure to observe this caution can result in harmful burns to the body.
- Verify the safe working range of the Motor and machine before operation.
  Failure to observe this caution can result in personal injury.
- Do not check signals during operation.
  The machine or the Unit may be damaged.
- Do not change the settings of the inverter unnecessarily. All the constants of the Inverter have been preset at the factory.
  The machine or the Unit may be damaged.

6.1 Procedure

Perform trial operation according to the following flowchart.

Item	Details	Reference Page
Installation and Mounting	Install the Inverter and Converter according to the installation conditions. • Check that the installation conditions are satisfied.	1 -5
Wiring	Connect the power supply and peripheral devices. • Select peripheral devices that meet the specifications, and wire them firmly. • Be sure to check that the main circuit power supply input terminals (R/L1, S/L2, and T/L3) and control power supply input terminals (A1/r and A/2t) are wired firmly. • Check that the Motor output terminals (U/T1, V/T2, and W/T3) and the Motor are connected firmly. • Check that the ground terminal is connected firmly. • Check that the wiring between the Converter and Inverter (main circuit DC (P/+ and N/–), control power supply (P1 and N1), and control signal (5CN and 51CN)) is connected firmly. • If using a Unit mounted inside of a panel (11 kW min.), check that the power supply terminals (A1□/r□ and A2□/r□) for the cooling fan are connected firmly. • Check that the control circuit signal and Control Unit are wired firmly and be sure that all control circuit signals are OFF. • If using an Orientation Card, check that the Card is wired firmly. • If using a magnetic contactor for switching windings, check that the contactor is wired firmly.	2 -3
Check Power Supply Voltage	Check that the power supply voltage is correct before turning ON the power supply. • Main circuit power supply voltage 200 V class: 3-phase 200 to 230 VAC, 50/60 Hz 400 V class: 3-phase 400 to 460 VAC, 50/60 Hz • Control power supply voltage 1-phase 200 to 230 V, 50/60 Hz	5 -5
Set YENET1200 Node Address	If using an NC Drive (M5N), set the Inverter YENET1200 node address correctly using rotary switch SW1.	5 -5
Turn ON Control Power Supply	Turn ON the control power supply, and check that there are no abnormalities with the Inverter and Converter. • If the 7-segment LED display is normal when the power supply is turned ON, it will read as follows: Converter LED display: "– U" Inverter LED display: "– b" • If an error occurs, details of the error will be displayed on the LED display (or on the Digital Operator data display). Refer to *Chapter 12 Troubleshooting*, and perform the appropriate remedy.	5 -5
Turn ON Main Circuit Power Supply	Turn ON the main circuit power supply, and check that the 7-segment LED display on the Converter has changed to "– b" . • If the Converter LED display continues to display "– U", the main circuit input voltage is too low, or the phase has been interrupted. Check the input power supply voltage.	5 -5
Check Motor Cooling Fan	When the main circuit power supply is turned ON, the Motor cooling fan will start to rotate. Check that the direction of the Motor air flow is correct as shown in Fig 6.1.	5 -6
Check Motor Code	Check that the Motor code selection (C1-25) is set correctly. (Check the Motor model and Motor code using the factory settings table enclosed with the Inverter.) • If changing the Motor code (C1-25) set value, be sure to turn OFF the control power supply for three seconds and then turn it ON again to enable the changed settings.	5 -11
Perform Trial Operation	Send the RUN signal to start trial operation. (If using a Digital Operator for the trial operation, refer to *5.3.5 Digital Operator Operation Mode*.) • When the RUN signal is sent, check that the 7-segment LED display on the Inverter and Converter changes to "– r". • Check that the direction of Motor rotation is correct. • Check that there is no abnormal vibration or noise coming from the Motor.	5 -5

6.2 Trial Operation Procedure

This section explains in detail the procedure shown in the flowchart on the preceding page for the trial operation.

6.2.1 Checking the Power Supply Voltage

Turn OFF the MCCB on the Converter power supply, and check the power supply input voltage supplied to the Converter on the primary side of the MCCB. Use a voltmeter or rotation tester that can measure input voltage for the measurement. The input voltage tolerance range is shown in the following table.

Table 6.1 Power Supply Voltage Tolerance Range

Converter	Nominal Voltage/Frequency	Voltage Fluctuation Toleration Range
200 V Series	200 V/50 to 60 Hz	170 to 242 V
	220 V/50 to 60 Hz	
	230 V/60 Hz	170 to 253 V
400 V Series	380 V	340 to 484 V
	400 V/50 to 60 Hz	
	440 V/50 to 60 Hz	
	460 V/60 Hz	340 to 506 V

Note: The Inverter can operate within the voltage fluctuation range shown in the table above, but make the following settings for optimum characteristics. 200-V series: 200 to 240 V, and 400-V series: 400 to 480 V. If the voltage falls below 200 V or 400 V, lower outputs may not be possible in the high-speed range as specified. Therefore, if the input voltage can be converted to within these ranges using transformer tap conversion or other method,optimum operation according to the characteristics can be achieved.

6.2.2 Setting the YENET1200 Node Address

Before turning ON the control power supply, set the YENET1200 node address using rotary switch SW1 on the Inverter Unit. The node address must agree with the NC Unit node address parameter settings.

6.2.3 Turning ON the Control Power Supply

When the control power supply is turned ON, " - U " will be displayed on the 7-segment LED display on the Converter, and " - b " will be displayed on the 7-segment LED display on the Inverter. If the display differs from this, refer to *Chapter 12 Troubleshooting* for details.

IMPORTANT

Turn ON the control power supply before (or at the same time as) turning ON the main control circuit power supply. Also, turn OFF the main power supply before (or at the same time as) turning OFF the control power supply. Failure to observe this precaution can result in the Converter and Inverter malfunctioning.

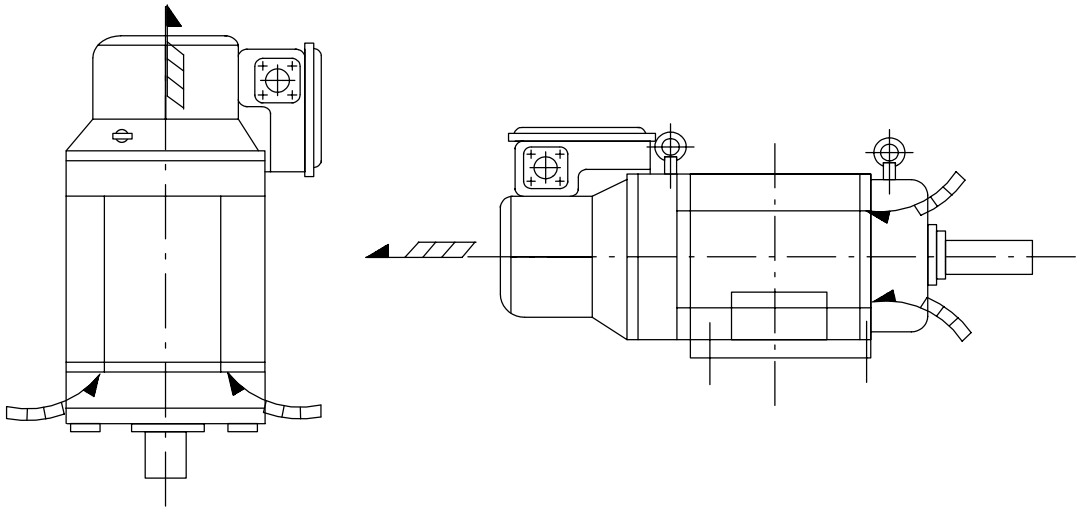
6.2.4 Turning ON the Main Circuit Power Supply

When the main circuit power supply is turned ON, the 7-segment LED display on the Converter will change to " - b ". At the same time, the CHARGE indicators on both the Inverter and Converter will light red. At this time, if an error is displayed and the above display does not appear, refer to *12.3 Inverter Fault Table* for details.

If the 7-segment LED display continues to display " - U ", the main circuit input voltage is too low or the phase has been interrupted. Check the input power supply voltage.

6.2.5 Checking the Motor Cooling Fan

When the main circuit power supply is turned ON, the Motor cooling fan will start to rotate. Check that the direction of the Motor cooling flow is as shown in the Fig.6.1 . With the standard specifications configuration, the cooling flow enters from the load side, and is vented on the side away from the load.



(a) Flange-mounted Motor (b) Foot-mounted Motor

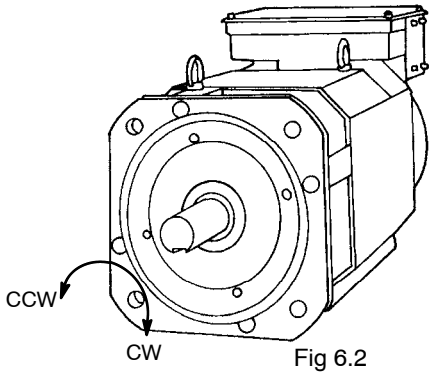
Fig 6.1 Direction of Motor Cooling Flow

6.2.6 Starting Trial Operation

When the checks after the power supply has been turned ON have been completed, send a RUN signal to start the trial operation. When the RUN signal is sent, the 7-segment LED display on the Inverter and Converter will change to " ". Gradually increase the speed reference from 0% to start the Motor.

At this time, check whether the direction of Motor rotation is correct. If the rotation direction is forward (FWD) and the speed reference is positive, rotation should be counterclockwise seen from the load end of the Motor shaft. If the rotation direction is reversed or if the Motor vibrates but does not rotate even when a RUN signal is sent, the phase sequence of the power supply cable and the encoder signal wire is incorrect. Turn OFF the power supply, check that the CHARGE indicator and the 7-segment LED displays are no longer lit, and then check the wiring.

If the Motor rotation direction is normal, change the speed reference or switch the forward and reverse rotation references, and check that Motor acceleration and deceleration is smooth in both the forwards and reverse directions. At the same time, check that there is no abnormal vibration or sound coming from the Motor. (A sound of several kHz occurring periodically from the Motor is caused by the control system, and is not an error.)



Operation Reference		+	−
RUN Signal	FWD	CCW	CW
	REV	CW	CCW

Fig 6.2 Direction of Motor Rotation

IMPORTANT

Operating Precautions

- Check that the Motor is stopped before starting an operation. If the Motor is started while it is coasting, the protective functions, such as main circuit overvoltage (AL-11) and overcurrent (AL-01), may operate.
- Do not change the wiring or insert or remove connectors while the power supply is turned ON.

6.3 Converter and Inverter LED Displays

This section explains the Converter and Inverter LED displays.

6.3.1 Display Details Tables

Details on the 7-segment LED displays on the Inverter and Converter are shown in the following tables.

Table 6.2 Seven-segment LED Display Details

■ Converter

Display	Explanation
- U	Indicates that the main circuit power supply is turned OFF, or the Unit is operating below specifications.
- b	Indicates that the Inverter is not operating.
- r	Indicates that the Inverter is operating.
2 - (Error number) 0 1 (Error details)	Indicates an error. Alternately displays the error number and the error details. (This example shows that the error, which is the 2nd to occur, is an overcurrent. For other errors, refer to *Table 12.1*.) If only one error has occurred, only the error details are displayed.
• •	Indicates that the WDT is working correctly (Exchange the control card).

■ Inverter

Display	Explanation
- b	Indicates that the Inverter is not operating (baseblock condition).
- r	Indicates that the Inverter is operating.
2 - (Error number) 4 2 (Error details)	Indicates an error. Alternately displays the error number and the error details. (This example shows that the error, which is the 2nd to occur, is a broken Motor thermistor wire. For other errors, refer to *Table 12.2*.) If only one error has occurred, only the error details are displayed.
• •	Indicates that the WDT is working correctly (Exchange the control card).

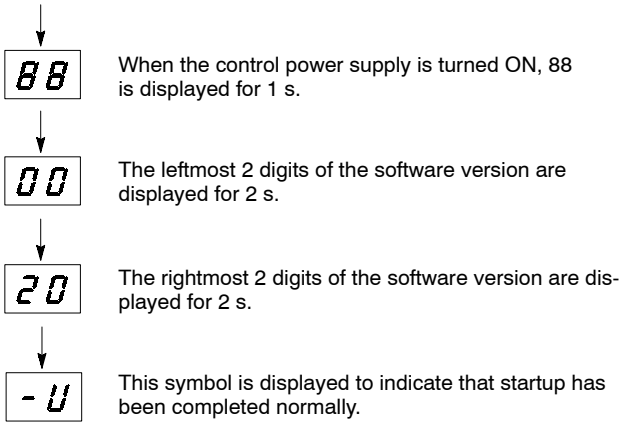
Note: The M5N (for NC systems) does not have a 7-segment display for the Inverter.

6.3.2 Display when the Converter Control Power Supply Is Turned ON

When the control power supply is turned ON, the 2-digit 7-segment LED display will display the software version of the Converter control card (with software version 0□20 or later).

Example: Software version is 0020.

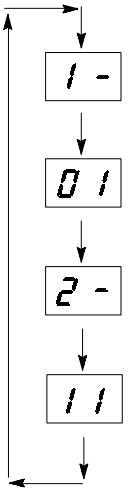
Control power supply is turned ON



6.3.3 Display when an Error Occurs

If multiple errors are detected in the Inverter and Converter, the details for a maximum of four Converter errors and six Inverter errors will be saved. Consequently, the order in which the errors occurred can be viewed. (The display switches automatically.)

Example: Overcurrent (error number 01) and main circuit overvoltage (error number 11) have occurred in the Inverter.



Displays the error that occurred first for 1 s.

Displays overcurrent error for 2 s.

Indicates that the error was the second to occur.
(Displayed for 1 s.)

Displays main circuit overvoltage error for 2 s.

6.4 Constant Settings

This section explains the user constant functions and settings.

6.4.1 User Constant Functions Table

A table of user constant functions is shown below. Change the constant set values depending on the operating specifications. Refer to *5.3.4 Control Constant Display Mode* for setting methods.

Check that the following constant set values match the operating specifications.

- Inverter settings
- Machine specification settings
- Sequence input signal settings

Table 6.3 User Constant Functions

No.	Item	Details	Related Constants	M5A	M5N
1	Inverter settings	Inverter Capacity Selection	C1-56	ON	ON
		Motor Code Selection	C1-25	ON	ON
		Orientation Control Method Selection	C1-39 bit 0	ON	ON
		YENET1200 Card Encoder Selection	C1-58 bit 0	OFF	ON
		RUN Mode Selection	C1-37 bits 1 and 0	ON	ON
2	Machine specification settings	Rated Speed	C1-26	ON	ON
		Gear Ratio Settings	C1-27 to 29	ON	ON
3	Sequence input signal settings	Sequence Input Signal Selections	C1-36 bits 1 and 0 (TLL/INC) C1-36 bit 3 (SSC/SV) C1-36 bit 4 (PPI/LM10) C1-37 bit 2 (RDY/EMG2) C1-40 bit 3 (ORT/NCORT)	ON	ON
		Torque Limit Signal	C1-24 and C1-38, bit 2	ON	ON
		12-bit Digital Reference Signal Selection	C1-36 bit 7 (Speed/position reference)	ON	OFF
4	Sequence output signal settings	Zero-speed Detection Level (ZSPD)	C1-19	ON	ON
		Speed-agree Signal (AGR)	C1-20 and C1-38 bit 6	ON	ON
		Speed Detection Signal (SDET)	C1-21 and C1-22	ON	ON
		Torque Detection Signal (TDET)	C1-23 and C1-40 bit 2	ON	ON
5	Speed reference settings	Soft Start Time Setting	C1-10	ON	ON
		Analog Speed Reference Adjustments	C1-11, C1-12, and C1-38 bit 5	ON	OFF
		Digital Speed Reference Settings	C1-37 bits 7 and 6, and C1-41 to 48	ON	OFF
6	Analog output signal settings	Speedometer Signal Adjustments	C1-16 and C1-54	ON	OFF
		Load Factor Meter Signal Adjustments	C1-17, C1-55, C1-18, C1-38 bits 1 and 0, C1-38 bit 7, and C1-40 bit 4	ON	OFF
7	Speed control system adjustments	Speed Control Gain Adjustments	C1-01 to 04	ON	ON
		Motor Flux Lower Limit Level	C1-30	ON	ON
		Torque Reference Filter Time Constant	C1-09	ON	ON
8	Servo mode settings	Analog Speed Reference Gain in Servo Mode	C1-38 bit 3, C1-40 bit 5, C1-49, and C1-50	ON	OFF
		Servo Mode Flux and Base Speed Ratio	C1-31 to 34	ON	ON
		Speed System Adjustment in Servo Mode	C1-05 to 08	ON	ON
9	Other settings	Zero-speed Braking Time	C1-35	ON	ON
		Excessive Speed Deviation Protection Operation Adjustments	C1-38 bit 4, and C1-40 bits 1 and 0	ON	ON
		Load Fault Detection Selection	C1-40 bit 7	ON	ON
		Fault Record Clear Selection	C1-57 bit 0	ON	ON

M5A: Stand-alone drive (analog speed reference settings); M5N: NC system (YENET1200 serial communications)
ON: Constant valid; OFF: Constant not valid (Not used.)

6.4.2 Soft Start Time Setting (T_{SFS}: C1-10)

The Inverter speed base is the time set to be taken from 0 min^{-1}. to the rated speed (C1-26), or from the rated speed setting to 0 rotations/min. The reference/time relationship is shown in the following diagram. The soft start time can be set between 0.1 and 180.0 s.

The acceleration and deceleration times may be longer than the soft start time setting due to load inertia.

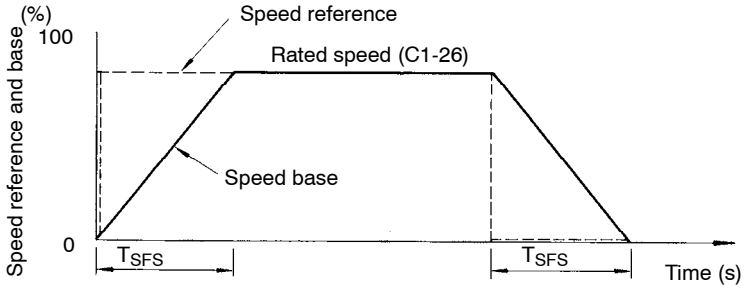


Fig 6.3 Soft Start Time Setting

6.4.3 Load Factor Meter Full Scale (LM_{FS}: C1-18)

The load factor meter displays the output ratio (in %) over the Motor rated output while the Motor is operating. Set the full scale value (i.e., the percentage value over the Motor continuous rating) of the load factor meter using control constant C1-18. The setting can be between 120% and 500%.

6.4.4 Zero Speed Detection Level (ZS_{LVL}: C1-19)

Use this constant to set the detection level for the zero speed signal. The standard setting is 30 min^{-1}. The setting can be between 3 and 60 min^{-1}. As shown in the following diagram, the operation point has an hysterisis of ± 2 min^{-1}.

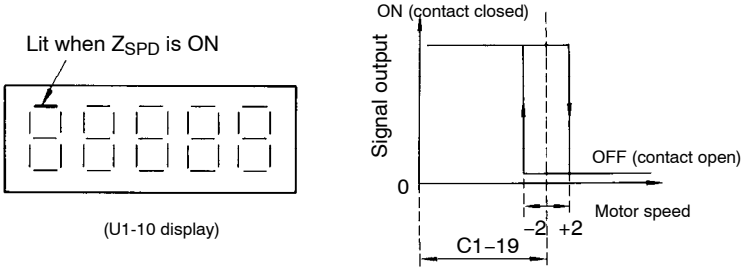
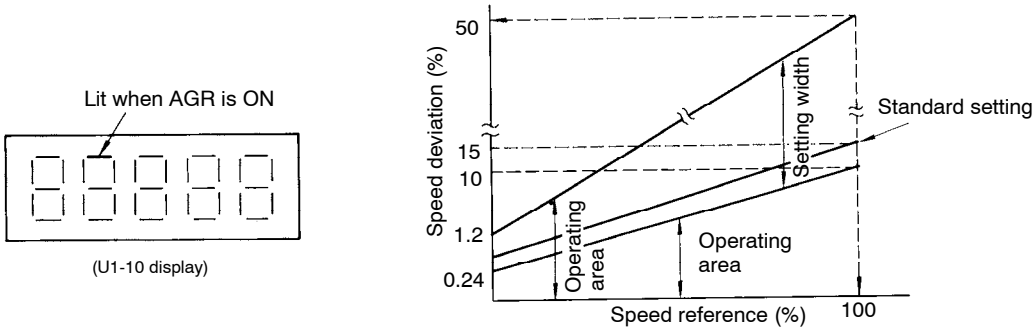


Fig 6.4 Zero Speed Signal Detection Level and Operation Display

6.4.5 Speed Agree Width (AGR_{BD}: C1-20)

Use this constant to set the operation level of the speed agree signal (AGR) (ON when the speed agrees). The speed agree width can be set between 10% and 50%. The standard setting is 15%.



Note: The speed deviation shows the % value when S_{100} (C1-26) is taken to be 100%.

Fig 6.5 Speed Agree Width Settings and Operation Display

6.4.6 Speed Detection Level and Detection Width (SD_{LVL}: C1-21, SD_{HYS}: C1-22)

When the Motor speed is below the set value, the output signal (SDET) turns ON. At this time, the U1-10 operating status display on the Digital Operator is as shown below. The speed detection signal level (C1-21) can be set between 0% and 100%, and the speed detection signal detection width (C1-22) can be set between 0% and 10%. (The percentage of the rated speed (C1-26) is displayed.)

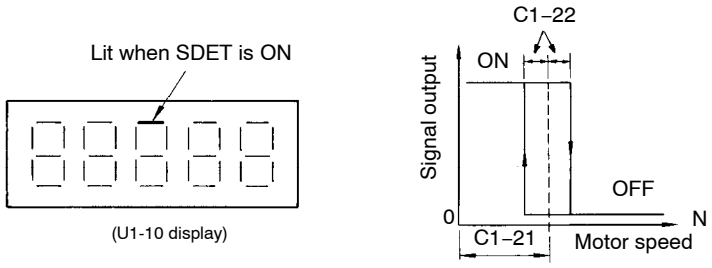


Fig 6.6 Speed Detection Signal Level and Operating Status Display

6.4.7 Torque Detection Signal Operation Level (TD_{LVL}: C1-23)

This constant is the set value for the torque detection signal (TDET) operation level. (The signal turns ON when the torque is below the set value.) When TDET is ON, the U1-10 operating status display on the Digital Operator is as shown below. The torque detection signal operation level can be set between 5% and 120%, taking 30 minutes rated torque to be 100%. As shown in the following diagram, the operation point has an hysterisis of ±10%.

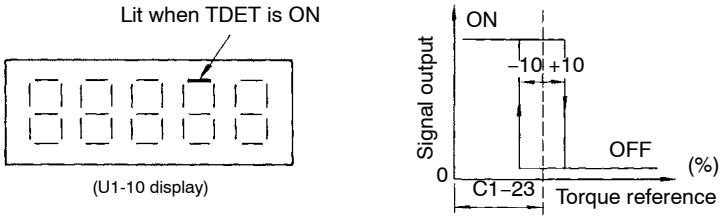


Fig 6.7 Torque Detection Signal Operation Level and Operation Display

6.4.8 External Control Torque Limit Level (TL_{EXT}: C1-24)

This control constant is used when limiting the torque externally. The limit can be set between 5% and 120%, taking the rated torque for 30 minutes as 100%.

6.4.9 Motor Code Selection (MTR: C1-25)

The Motor code sets the level of Motor control constants stored in the Inverter memory. The Motor codes are shown in the table *6.4*. When changing the Motor code settings, check that the new value matches the Inverter Unit capacity. If the selected Motor code and the Inverter capacity do not agree, error code AL-E0 (Motor Code Selection Error) will be displayed. Also, if no Motor code has been registered, error code AL-E1 (Motor Code Not Registered) will be displayed.
If the motor being used is not listed in the following table, please contact your Yaskawa representative for motor code information.

IMPORTANT

Precautions when Changing the Motor Code
After changing the Motor code, be sure to turn OFF the control power supply. Next, check that the Digital Operator display is no longer lit, and then turn ON the power supply again. This operation will enable the new Motor code.

Table 6.4 Motor Codes for Standard Spindle Motors

Voltage Class	Motor	Inverter Capacity	Inverter Capacity Selection (C1-56)	Motor Model	Motor Code (C1-25)	Motor Max. Speed (min^{-1})	30 min./ Continuous Rated Output (kW)	Load Factor Meter Max. Value (%)
200 V	Standard	23P7	04	UAASKA-04FZ□	001	8,000	3.7/2.2	202
		25P5	05	UAASKA-06FZ□	002	8,000	5.5/3.7	178
		27P5	06	UAASKA-08FZ□	003	8,000	7.5/5.5	164
		2011	07	UAASKA-11FZ□	004	6,000	11/7.5	176
		2015	08	UAASKA-15FZ□	005	6,000	15/11	164
		2018	09	UAASKA-19FZ□	006	6,000	18.5/15	148
		2022	0A	UAASKA-22FZ□	007	6,000	22/18.5	143
		2030	0B	UAASKJ-30FZ□	008	4,500	30/22	164
		2037	0C	UAASKJ-37FZ□	009	4,500	37/30	148
	Winding selection	25P5	05	UAASKB-06FZ□	062	6,000 (1,500)	5.5/3.7	178
		27P5	06	UAASKB-08FZ□	063	6,000 (1,500)	7.5/5.5	164
		2011	07	UAASKB-11FZ□	064	6,000 (1,500)	11/7.5	176
		2015	08	UAASKB-15FZ□	065	4,800 (1,000)	15/11	164
		2018	09	UAASKB-19FZ□	066	4,800 (1,000)	18.5/15	148
		2022	0A	UAASKB-22FZ□	067	4,800 (1,000)	22/18.5	143
		2030	0B	UAASKB-30FZ□	068	4,800 (1,000)	30/20	180
400 V	Standard	45P5	25	UAASKA-06FZ□OOE	102	8,000	5.5/3.7	178
		47P5	26	UAASKA-08FZ□OOE	103	8,000	7.5/5.5	164
		4011	27	UAASKA-11FZ□OOE	104	6,000	11/7.5	176
		4015	28	UAASKA-15FZ□OOE	105	6,000	15/11	164
		4018	29	UAASKA-19FZ□OOE	106	6,000	18.5/15	148
		4022	2A	UAASKA-22FZ□OOE	107	6,000	22/18.5	143
		4030	2B	UAASKJ-30FZ□OOE	108	4,500	30/22	164
		4037	2C	UAASKJ-37FZ□OOE	109	4,500	37/30	148
		4045	2D	UAASKJ-45FZ□OOE	10A	4,500	45/37	146
	Winding selection	45P5	25	UAASKB-06FZ□OOE	162	6,000 (1,500)	5.5/3.7	178
		47P5	26	UAASKB-08FZ□OOE	163	6,000 (1,500)	7.5/5.5	164
		4011	27	UAASKB-11FZ□OOE	164	6,000 (1,500)	11/7.5	176
		4015	28	UAASKB-15FZ□OOE	165	4,800 (1,000)	15/11	164
		4018	29	UAASKB-19FZ□OOE	166	4,800 (1,000)	18.5/15	148
		4022	2A	UAASKB-22FZ□OOE	167	4,800 (1,000)	22/18.5	143
		4030	2B	UAASKB-30FZ□OOE	168	4,800 (1,000)	30/20	180

Note: Values in parentheses are the maximum speed (min^{-1}) of the low-speed windings.
The maximum value of the load factor meter = (30-min rated output x 120%)/(continuous rated output) (%)

6.4.10 Rated Speed (S_{100}: C1-26)

Set the rated speed to match the machine specifications. The Motor will operate at this rated speed when the speed reference value input is 100%. The rated speed can be set between 100 min^{-1} and the maximum Motor speed.

6.4.11 Gear Ratios (R_{HGR}: C1-27, R_{MGR}: C1-28, R_{LGR}: C1-29)

Use these constants to set the gear ratio of the Motor shaft and the load shaft according to the machine specifications. The gear ratio (= load shaft speed/Motor speed) can be set to between 0.0400 and 2.5000. The set value affects the characteristics during orientation control, so set the accuracy to four decimal places.

6.4.12 Servo Mode Flux and Base Speed Ratio (Φ_{SVH}: C1-31, R_{BSH}: C1-32, Φ_{SVL}: C1-33, R_{SBL}: C1-34)

Use these control constants when increasing the rated torque control range, such as for a solid tap. As shown in the following diagram, set the flux level (C1-31 and C1-33) and the base speed ratio (C1-32 and C1-34) in relation to each other.

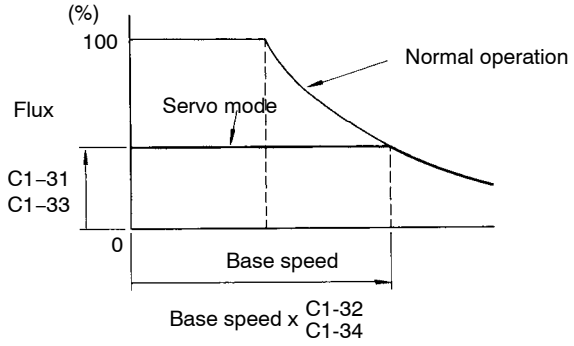
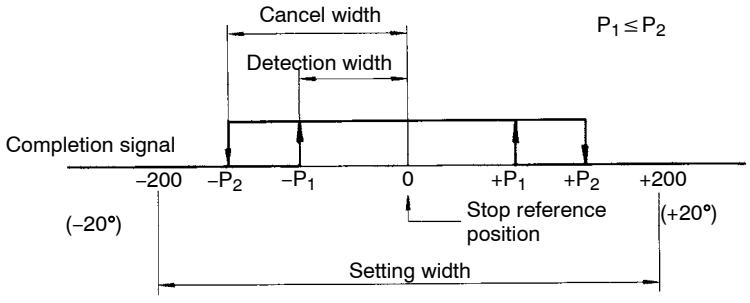


Fig 6.8 Servo Mode Flux Level

6.4.13 Positioning Completion Detection Width (Z_{FIN}: C2-09 and C3-09) and Positioning Completion Cancel Width (Z_{CAN}: C2-10 and C3-10)

Make sure the Motor is stopped before setting the Positioning Completion Detection Width and Positioning Completion Cancel Width. The orientation completion signal turns ON when the deviation between the stop position reference and the stop position is below the completion detection width for 60 ms or longer. Also, after the completion signal has been output once, if the deviation is greater than the completion cancel width, the completion signal will immediately turn OFF.

The encoder orientation control for both the completion detection width and completion cancel width can be set between 0 (0°) and 200 (17.6°), and the magnetic sensor orientation control for both the completion detection width and completion cancel width can be set between 0.0 and 20.0°, but the completion cancel width cannot be set to a smaller value than the completion detection width. Also if after setting the completion cancel width, the completion detection width is set to a greater value than the completion cancel width, the completion cancel width will automatically be set to the same value as the completion detection width.



Note: Values in parentheses are when using magnetic sensor orientation control.

Fig 6.9 Completion Signal Detection Position

6.4.14 Orientation Speed (S_{ORT} : C2-11 and C3-11)

Make sure the Motor has stopped before setting the orientation speed.

The orientation speed settings are determined by the moment of inertia (including the Motor shaft), and the torque. Consequently, calculate the load shaft moment of inertia and the load shaft torque when using the H gear for each machine separately, and then determine the orientation speed by referring to the diagram below. This speed is the upper limit, so the orientation speed can be set to a lower value than this one.

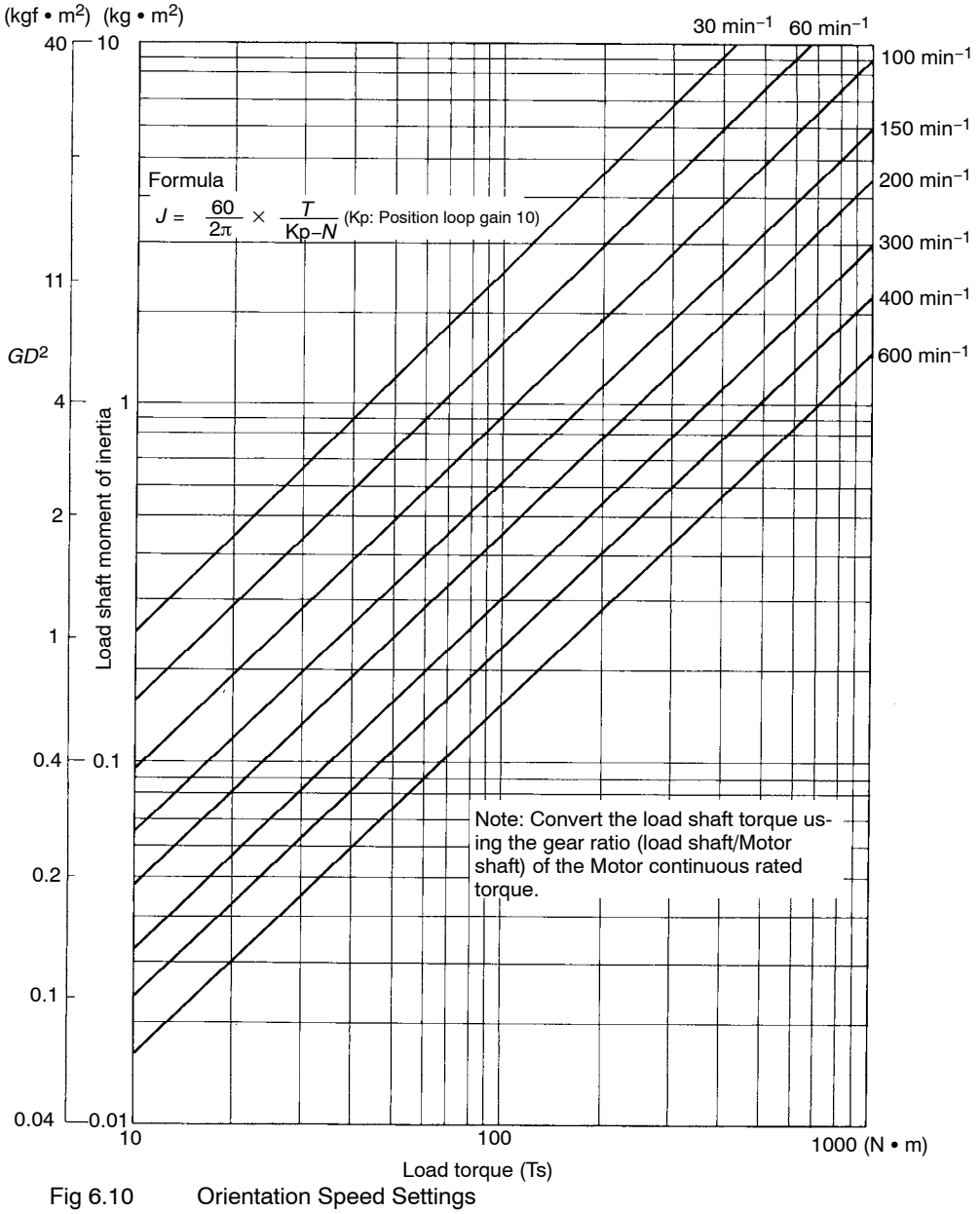


Fig 6.10 Orientation Speed Settings

6.4.15 BCD Stop Position Reference Resolution (P_{BCD}: C2-12 and C3-12)

Make sure the Motor has stopped before setting the BCD stop position reference resolution.

The BCD stop position reference resolution can be set between 0.5° and 180.0°, but the stop position reference must be within ±360°. For example, when the set value = 90°, the resolution will be 90° with a stop position reference of 1, 180° with a stop position reference of 2, 0° with a stop position reference of 4, and 90° with a stop position reference of 5.

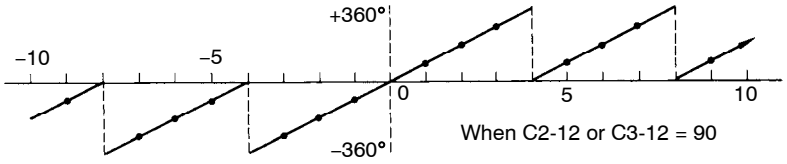
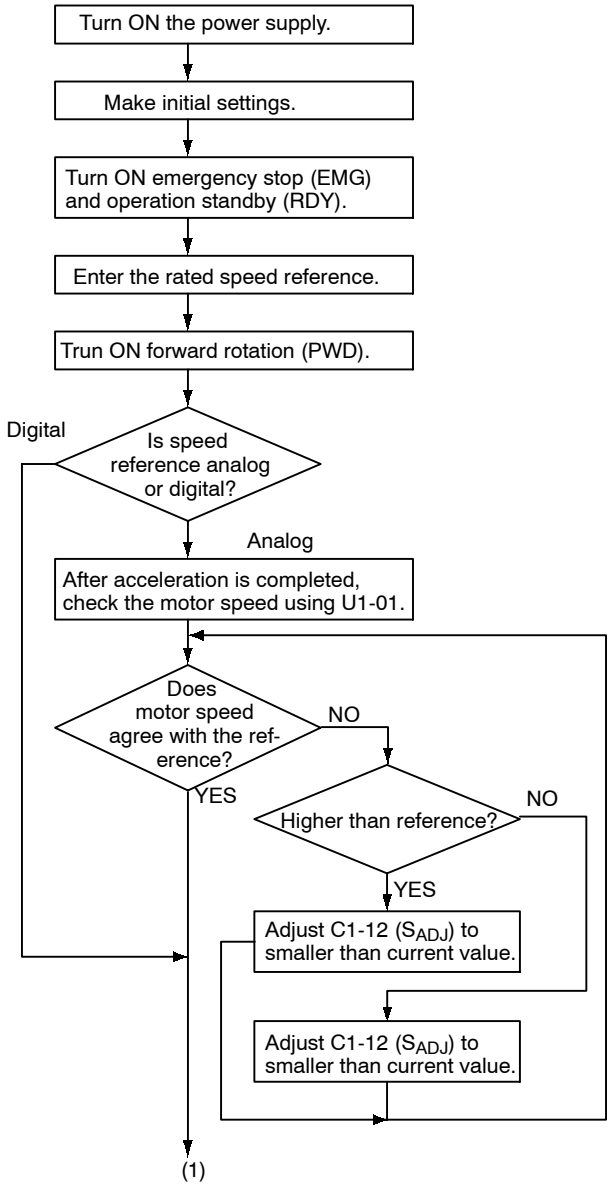
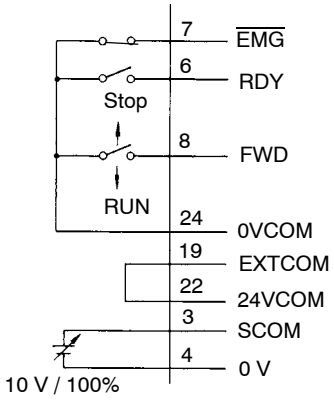
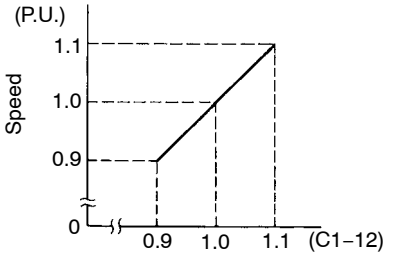


Fig 6.11 Stop Position Reference and Stop Position

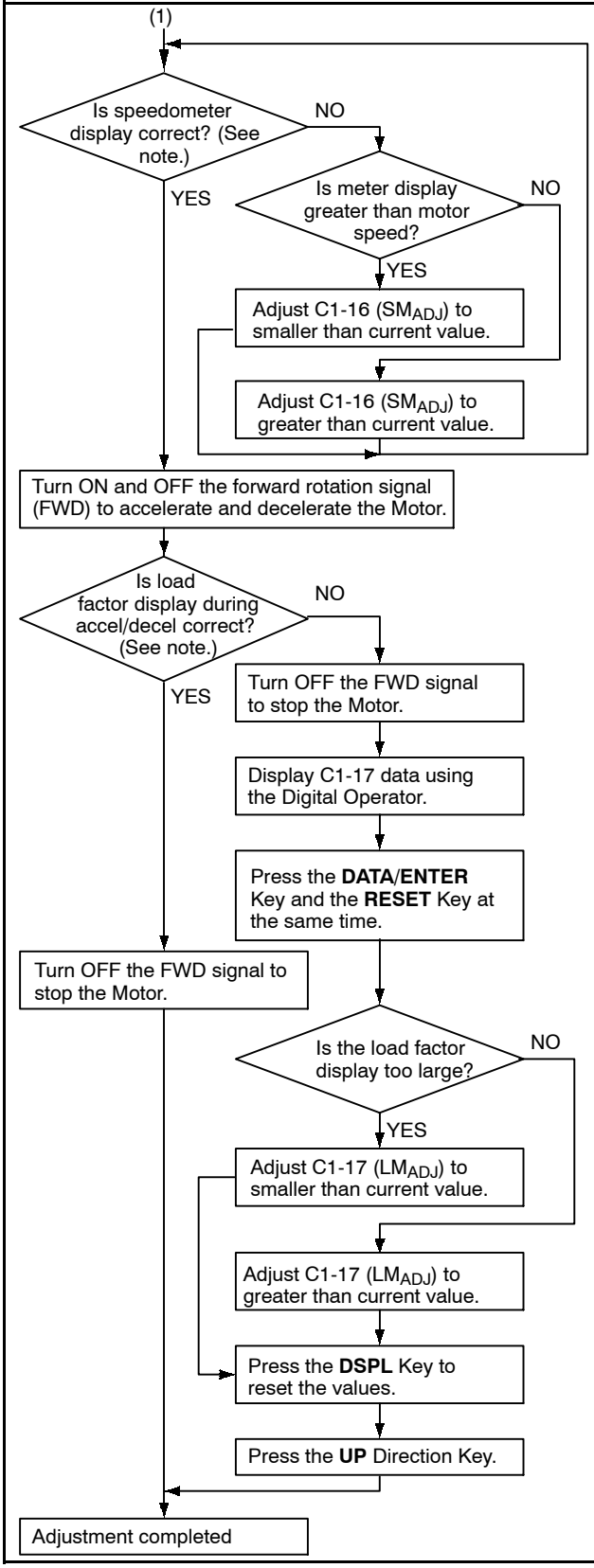
6.5 Speed Control Mode Adjustment Procedure

First check that the Motor is operating normally, and then adjust the speed control mode according to the adjustment procedure shown below. Also, if replacing the Motor or Inverter, be sure to perform the adjustments shown below.

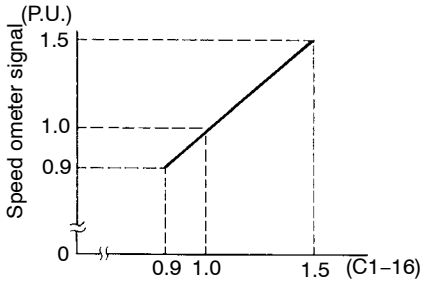
Adjustment Item and Procedure	Details
	Initial Settings • Check the settings according to the factory settings table. RUN Operation (0 V Common)  Check input signal. • Input signal status (U1-09)  RDY, EMG, and FWD are lit. Motor speed adjustment value (C1-12)  C1-12 = Reference speed/Actual motor speed Example: When reference speed = 6,000 min^{-1} and actual speed = 6,060 min^{-1}., C1-12 = 6,000/6,060 = 0.99

(Continued on next page.)

Adjustment Item and Procedure	Details



Speedometer signal adjustment value (C1-16)



C1-16 = Actual measured motor speed/Speedometer display value

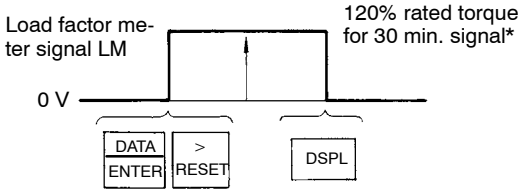
Example: When motor speed = 6,000 min^{-1} and speedometer display value = 5,940 min^{-1}, C1-16 = 6,000/5,940 = 1.01

Load factor meter display maximum value (120% of rated torque for 30 min.)

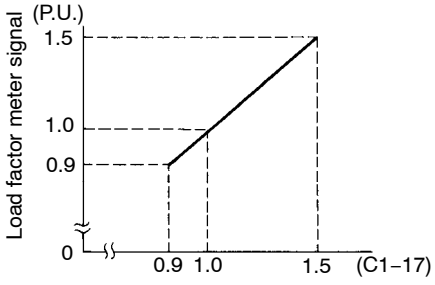
Load factor meter display maximum value

Capacity	LM	Capacity	LM
3.7/2.2	202%	18.5/15	148%
5.5/3.7	178%	22/18.5	143%
7.5/5.5	164%	30/22	164%
11/7.5	176%	37/30	148%
15/11	164%	45/37	146%

Signal output for load factor meter adjustment



Load factor meter signal adjustment value (C1-17)



C1-17 = (120% of rated torque for 30 min.)/Load factor meter display value

Example: When load factor meter display value = 150% at 7.5 kW/5.5 kW, C1-17 = 164/150 = 1.09

* When CI-38 bit 7 is ON, a 100% continuous rating signal is output.

Note: Analog monitor signal (speedometer and load factor meter) adjustment is not necessary when using the NC system (M5N).

7

Wide Constant Power Control Using Winding Selection

This chapter explains the features, connections, operations, switching methods, and precautions for wide constant power control using winding selection.

7.1 Features of the Winding Selection Wide Constant Power Drive . . . . . 7 -2

7.2 Winding Selection Motor Standard Connections . . . . . 7 -3

7.3 Motor Characteristics . . . . . 7 -4

7.4 Winding Selection Operation . . . . . 7 -5

7.5 Winding Selection Methods . . . . . 7 -6

7.5.1 M Code Winding Selection Method . . . . . 7 -6

7.5.2 Automatic Winding Selection methods . . . . . 7 -8

7.6 Winding Selection Control Precautions . . . . . 7 -11

7.1 Features of the Winding Selection Wide Constant Power Drive

The AC main shaft Motor winding selection function is provided as an effective method of increasing the constant power control range of the machine-tool main shaft drive. The features of the function are shown below.

■ Wide Constant Power Control Range

A constant power range of 1:12 can be obtained using the Motor drive without using a gearbox.

■ Small Controller Capacity

When expanding the constant power control range using the AC main shaft drive, the Motor current must also be expanded in the low-speed area, and the controller capacity must also be increased. When using winding selection, a constant power control of 1:12 can be obtained using a standard controller capacity, simply by changing the Motor winding connections.

■ Good Control Stability

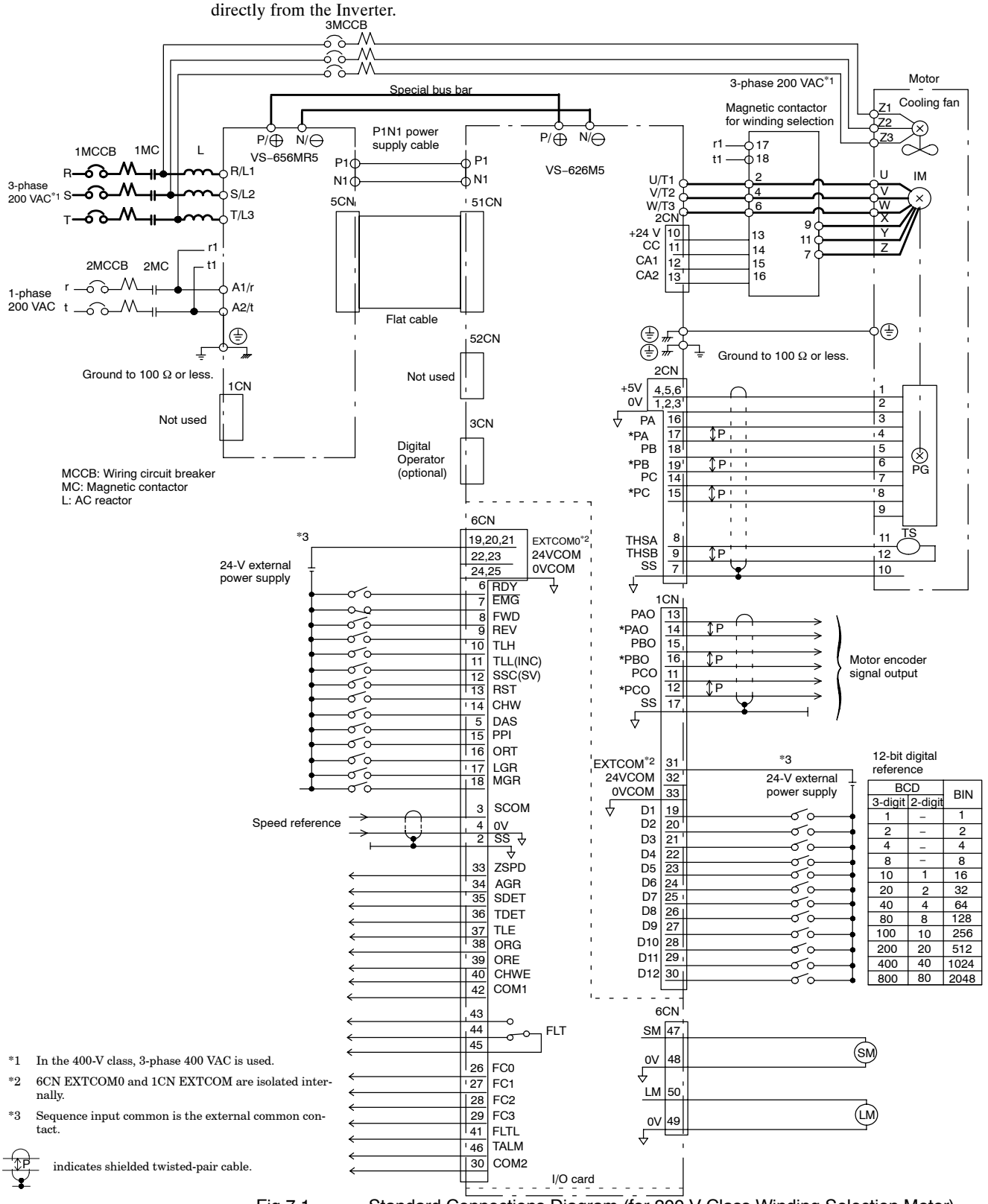
Winding selection enables optimum control by dividing the constant power control range into low-speed coils and high-speed coils. Consequently, stable control can be obtained by increasing the loop gain as well.

■ Special Magnetic Contactor for Winding Selection

The magnetic contactor is a compact model developed for winding selection. The contactor has a mechanical life of 5 million operations minimum.

7.2 Winding Selection Motor Standard Connections

As shown in the following diagram, this system requires winding selection signals in addition to speed reference signals such as FWD and REV. In winding selection, a special magnetic contactor is used that can operate directly from the Inverter.



BCD		BIN
3-digit	2-digit	
1	–	1
2	–	2
4	–	4
8	–	8
10	1	16
20	2	32
40	4	64
80	8	128
100	10	256
200	20	512
400	40	1024
800	80	2048

*1 In the 400-V class, 3-phase 400 VAC is used.

*2 6CN EXTCOM0 and 1CN EXTCOM are isolated internally.

*3 Sequence input common is the external common contact.

P indicates shielded twisted-pair cable.

Fig 7.1 Standard Connections Diagram (for 200 V Class Winding Selection Motor)

7.3 Motor Characteristics

Motors with switchable windings with a 1:12 constant power range have a 1:4 constant power range for both the low-speed and high-speed windings, as shown in the following diagram.

This can be written as $S_{ML}/S_{BL} = S_{MH}/S_{BH} = 4$. Also, the base speed ratio and maximum speed ratio are set to $S_{BH}/S_{BL} = S_{MH}/S_{ML} = 3$ to optimize the motor characteristics.

Consequently, the rated output will occur for both the low-speed and high-speed windings between S_{BH} and S_{ML}, so winding selection is performed within this speed range.

(If the same output occurs in both the low-speed and high-speed coils between S_{BH} and S_{ML}, the load factor meter signal may be off by approximately ±10%.)

IMPORTANT

Low-speed Winding Application Precautions
The characteristics cannot be assured if the low-speed winding speed range exceeds S_{ML}, so avoid excessive use.

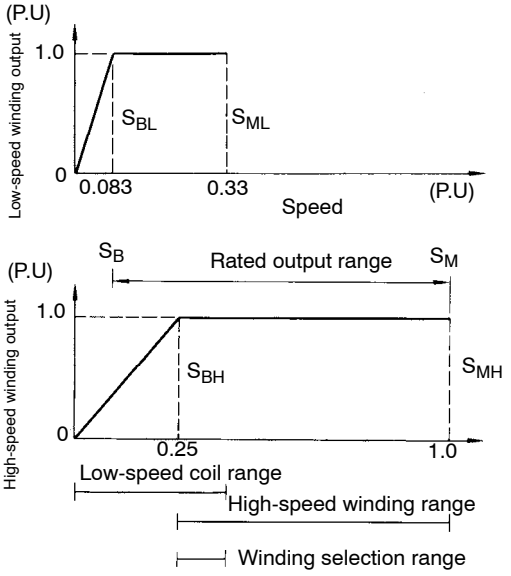
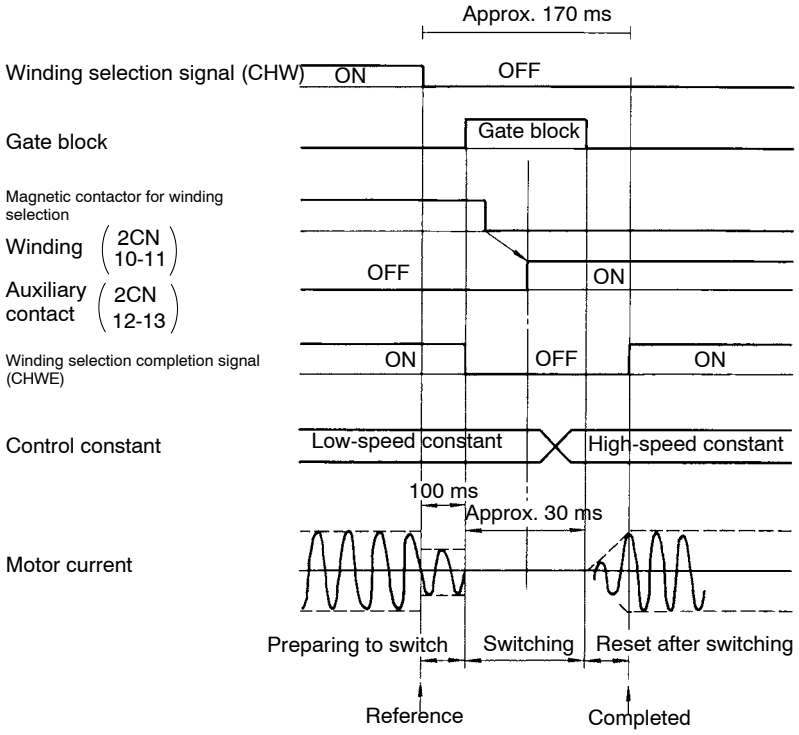


Fig 7.2 Motor Output Characteristics

7

7.4 Winding Selection Operation

The timing chart for switching from low-speed to high-speed windings is shown in the following diagram.



Note: The auxiliary contact (2CN terminals 12-13) of the magnetic contactor for winding selection can be checked using control signal U1-09. When the auxiliary contact is ON, CHWA of U1-09 is lit.

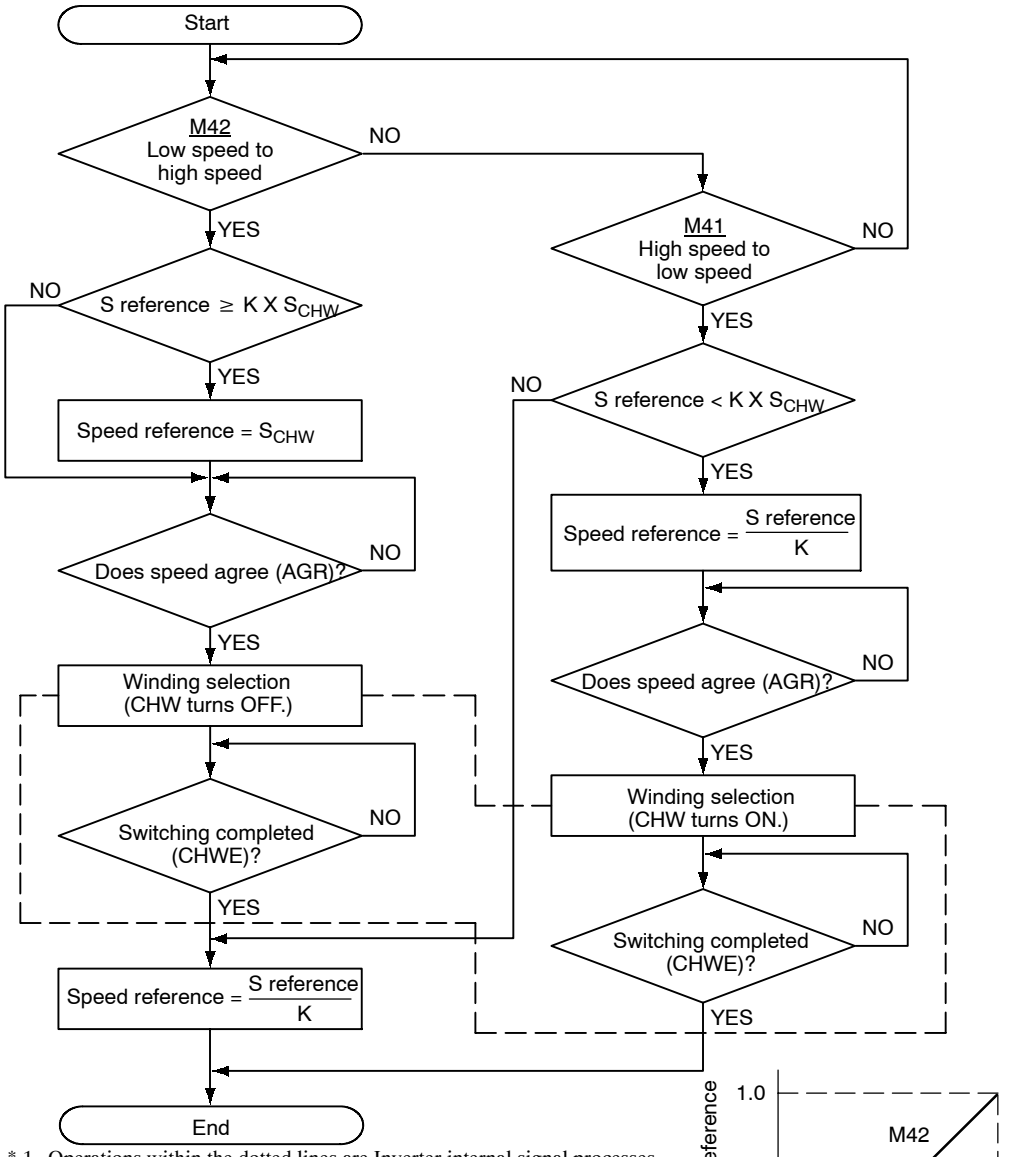
Fig 7.3 Winding Selection Timing Chart

7.5 Winding Selection Methods

When performing winding selection, design the reference circuits referring to the following three methods, to make sufficient use of the motor characteristics.

7.5.1 M Code Winding Selection Method

For the main shaft drive of the machine-tool, view the winding selection as an electric gear, and use the numeric control M codes (M41: Low-speed winding, M42: High-speed winding) as shown in the flow-chart and timing chart below.



* 1. Operations within the dotted lines are Inverter internal signal processes.

* 2. M41: Low-speed winding selection
M42: High-speed winding selection
S reference: Main shaft rotation speed reference (main shaft)
S_{CHW}: Winding selection speed (Motor)
(In the diagram, $S_{BH} \geq S_{CHW} \leq S_{ML}$)
K: Gearbox ratio (When main shaft is traveling at 4,000 min^{-1}, if the Motor is operating at 5,000 min^{-1}, K = 0.8.)
Speed reference: Motor speed reference.
The relationship between the speed reference and S reference for M41 and M42 is shown in the diagram on the right.

Fig 7.4 Flowchart

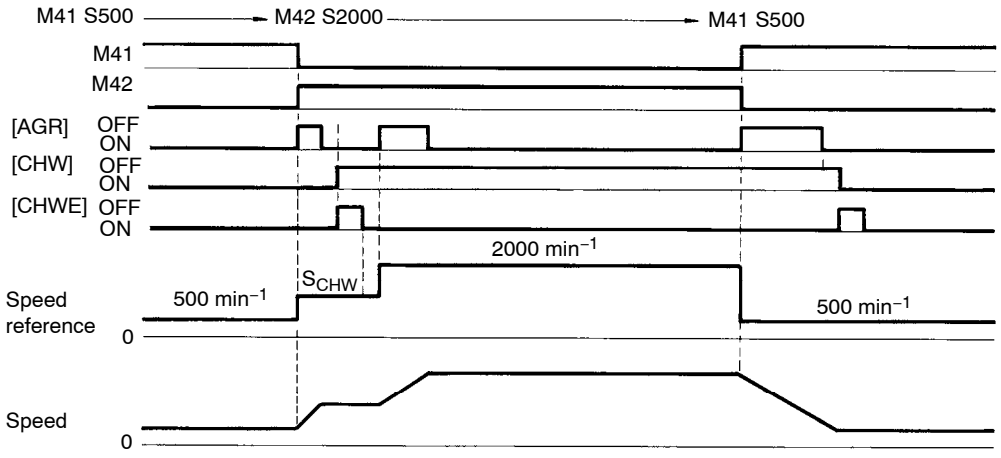


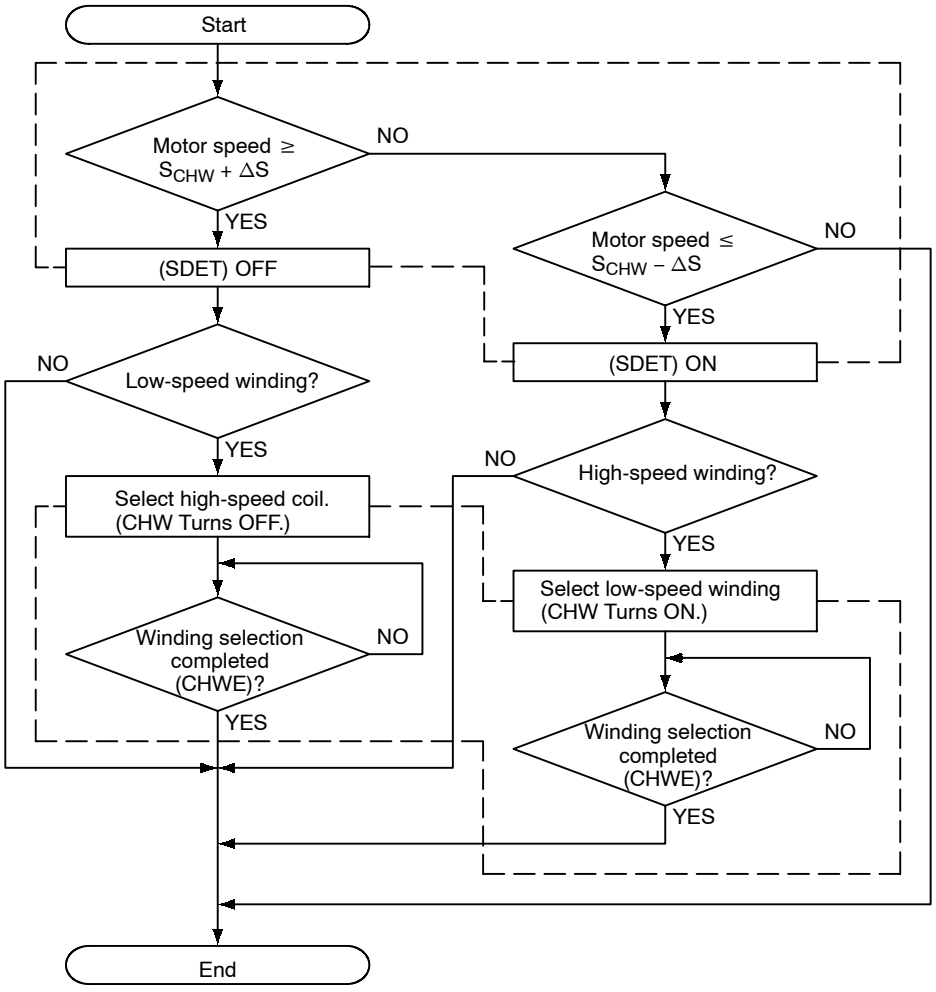
Fig 7.5 Timing Chart

7.5.2 Automatic Winding Selection methods

This section explains the automatic winding selection methods. There are two methods.

■ Using the Inverter Speed Detection Signal

The flowchart and timing chart for performing automatic winding selection judging from the actual motor speed alone using the Inverter speed detection signal (SDET) are shown below.



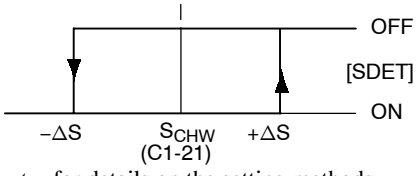
* 1. Operations within the dotted lines are Inverter internal signal processes.

* 2. S_{CHW}: Winding selection speed (Motor) (Set using control constant C1-21 (SD_{LVL}).)
ΔS: Switching speed hysterisis width (Set using control constant C1-22 (SD_{HYS}).)
Set S_{CHW} and ΔS as shown below.
Within the diagram,
$S_{CHW} - \Delta S \geqq S_{BH}$
$S_{CHW} + \Delta S \leqq S_{BH}$

$$C1-21 = \frac{S_{CHW}}{S100\ (C1\text{-}26)} \times 100(\%)$$

$$C1-22 = \frac{\Delta S}{S100\ (C1\text{-}26)} \times 100(\%)$$

(Where ΔS = 100 to 200 min^{-1})



Refer to *Chapter 5 Operating the Digital Operator* for details on the setting methods.

Fig 7.6 Flowchart

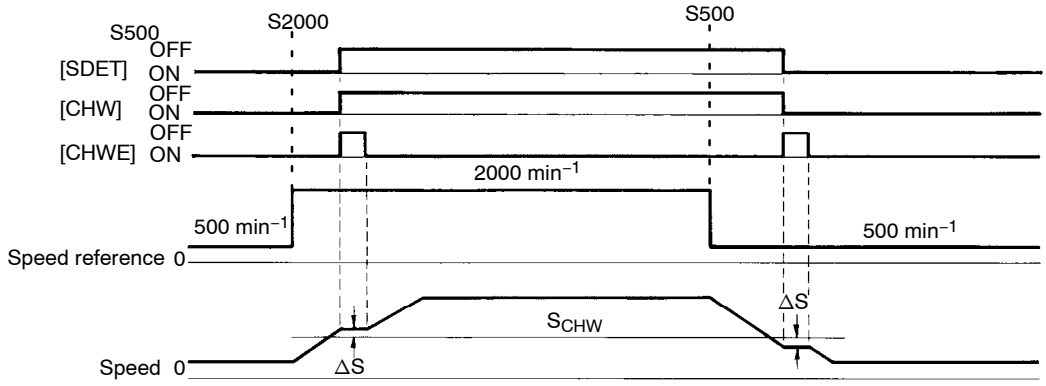
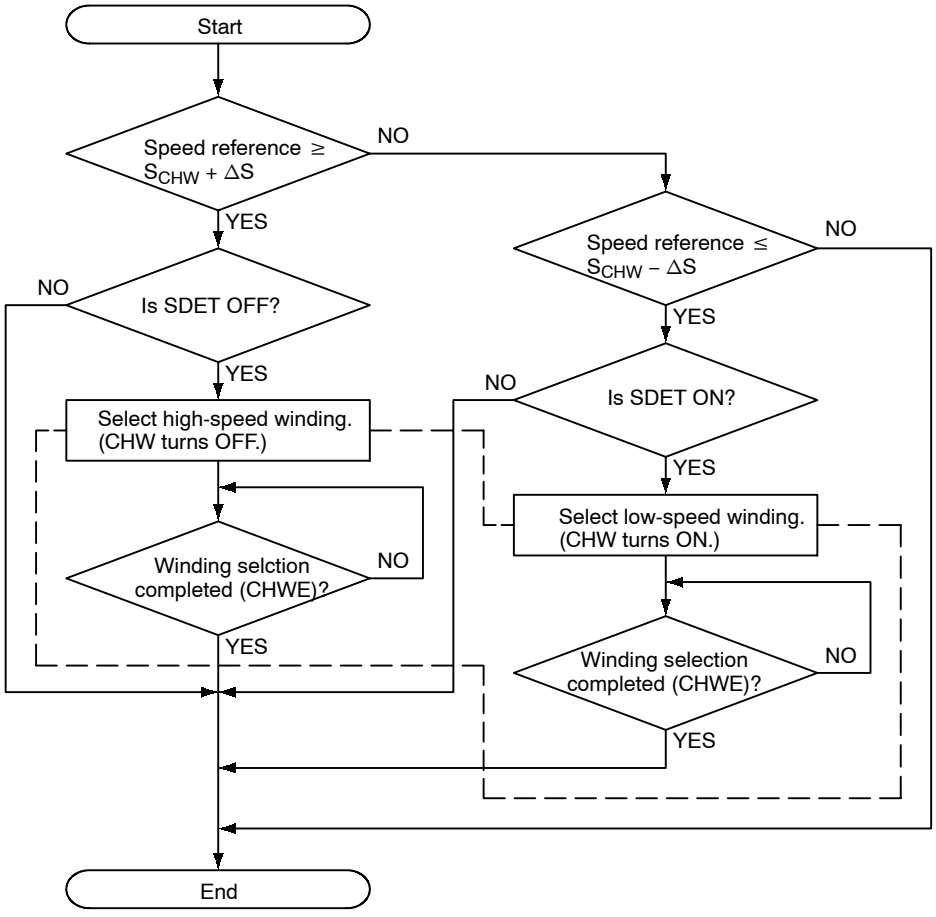


Fig 7.7 Timing Chart

■ Using Speed Reference and the Inverter Speed Detection Signal

This method performs winding selection by judging whether the speed reference and actual motor speed are within the high-speed winding selection range or the low-speed winding selection range, using the speed reference and the Inverter speed detection signal (SDET). (Refer to the table below.) Compared with the changing method that uses only the speed detection signal, signal processing is increased, but the frequency of magnetic contactor changing can be reduced. The flowchart and timing chart are shown below.



* Operations within the dotted lines are Inverter internal signal processes.

Fig 7.8 Flowchart

Set the host controller speed reference judgment level S_{CHW} and the hysterisis level ΔS to the same values as the Inverter speed detection signal level C1-21 (SD_{LVL}) and the speed detection signal detection width C1-22 (SD_{HYS}).

Table 7.1 Winding Selection Conditions

Speed	Speed Reference	
	≧ S_{CHW} − ΔS	≦ S_{CHW} − ΔS
Speed ≧ S_{CHW} − ΔS (SDET OFF)	High-speed winding selected	Winding selection not performed
Speed ≦ S_{CHW} − ΔS (SDET ON)	Winding selection not performed	Low-speed winding selected

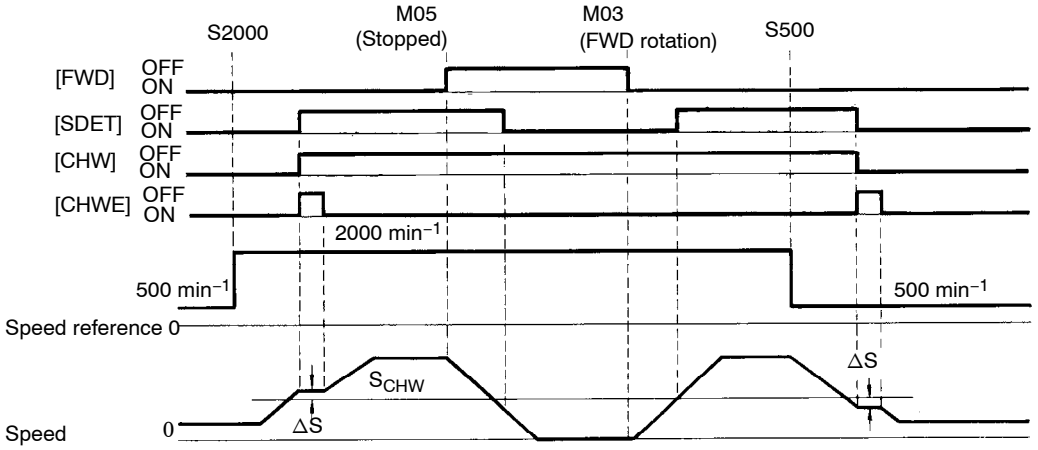
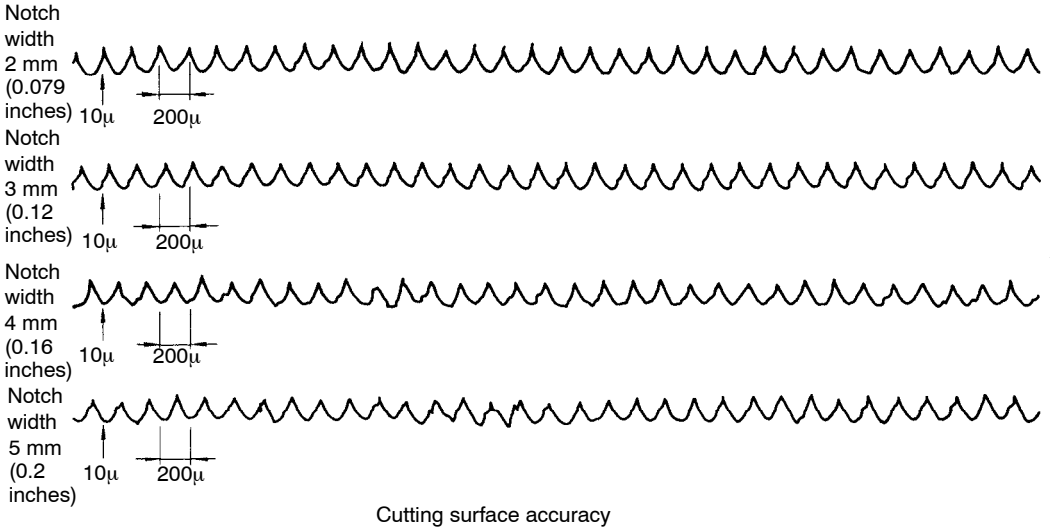


Fig 7.9 Timing Chart

7.6 Winding Selection Control Precautions

Refer to the following precautions when designing winding selection control.

- If the signal wire breaks or the magnetic contactor for winding selection malfunctions, the Motor will stop, and the operation program will not proceed. At this time, perform an overtime check after the set time, notify the operators immediately, and stop the winding selection operation by judging it to be defective (AL-20).
- For automatic changing using motor speed detection, winding selection will be performed whenever the changing speed S_{CHW} is passed, so the frequency of magnetic contactor operations will be high.
- If using the main shaft drive on the lathe, automatic winding selection will be performed when changing speed is reached even during cutting. As shown in the following diagram, during rough cutting, considerable roughness will occur during changing, but as the cutting approaches completion, the difference will be lost. As this data also makes clear, there are several characteristics in actual use, but if accuracy in particular is essential, check the accuracy of the cut surface.



Cutting surface accuracy

* Test conditions
Cut object: S45C (ϕ100 round bar)
Cutting tool: Ultra-hard cutting tool
Cutting speed: 150 m/min
Cutting feed: 0.2 mm (0.0079 inches)/revolution

Fig 7.10 Surface Accuracy Data During End Face Cutting Using a Lathe

8

Orientation Control Using an Encoder

This chapter explains methods of control using the Encoder Orientation Card.

8.1 Device Configuration . . . . . 8 -2
8.2 Standard Connection Diagram . . . . . 8 -3
8.3 Orientation Specifications . . . . . 8 -5
8.3.1 Standard Specifications . . . . . 8 -5
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8.9 Encoder Orientation Control Mode Adjustment Procedure . . . . . 8 -14

8.1 Device Configuration

Orientation control with an Encoder is used for positioning based on dividing 1 rotation into 4,096 steps (i.e., a resolution of 0.088°), 12-bit binary, or 3-digit BCD stop angle references using the load shaft (machine-tool main shaft, etc.) Encoder, and the Encoder Orientation Card. Positioning can be performed using the motor encoder signal if the load shaft and motor shaft are coupled 1:1 and there is no play.

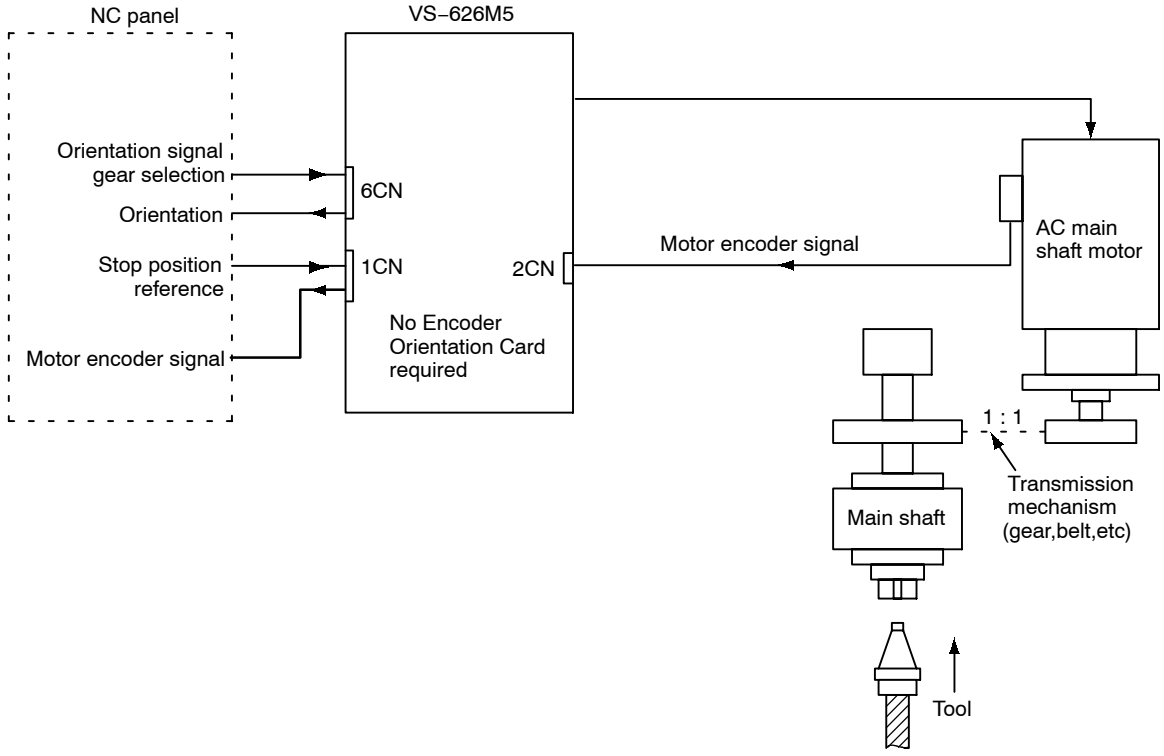


Fig 8.1 Main Shaft Orientation Device Configuration for Motor Encoder Method

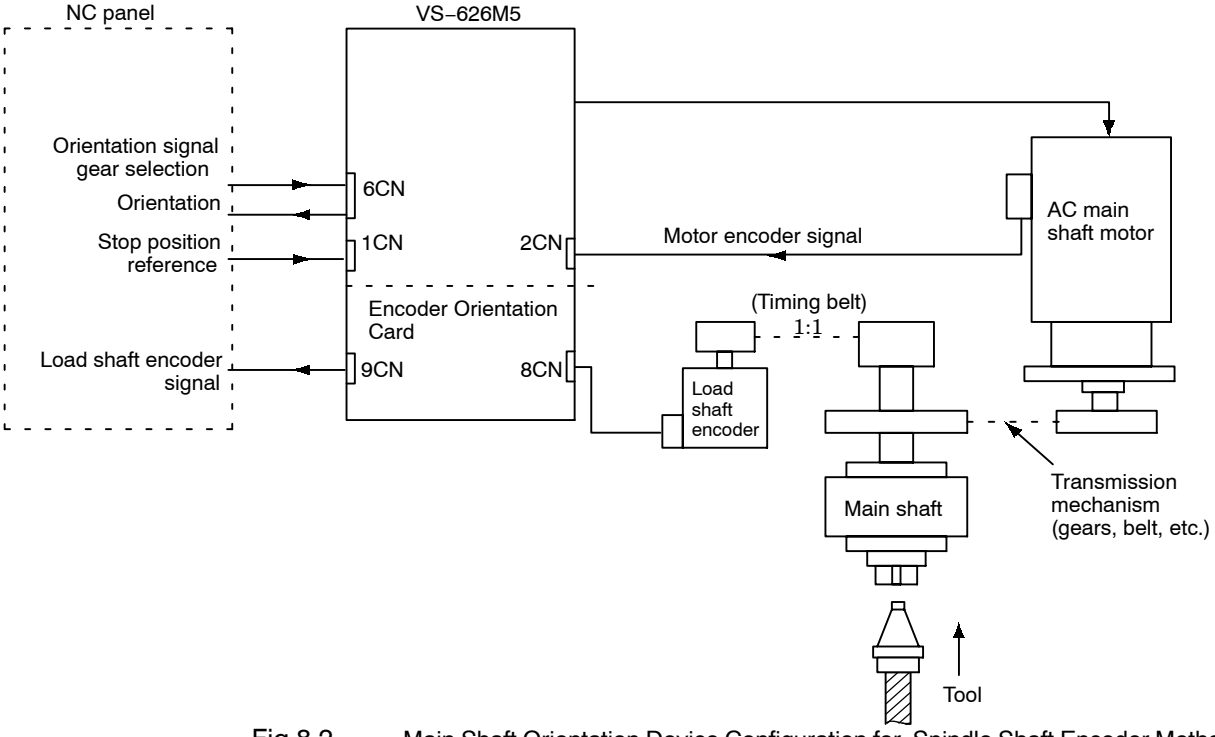
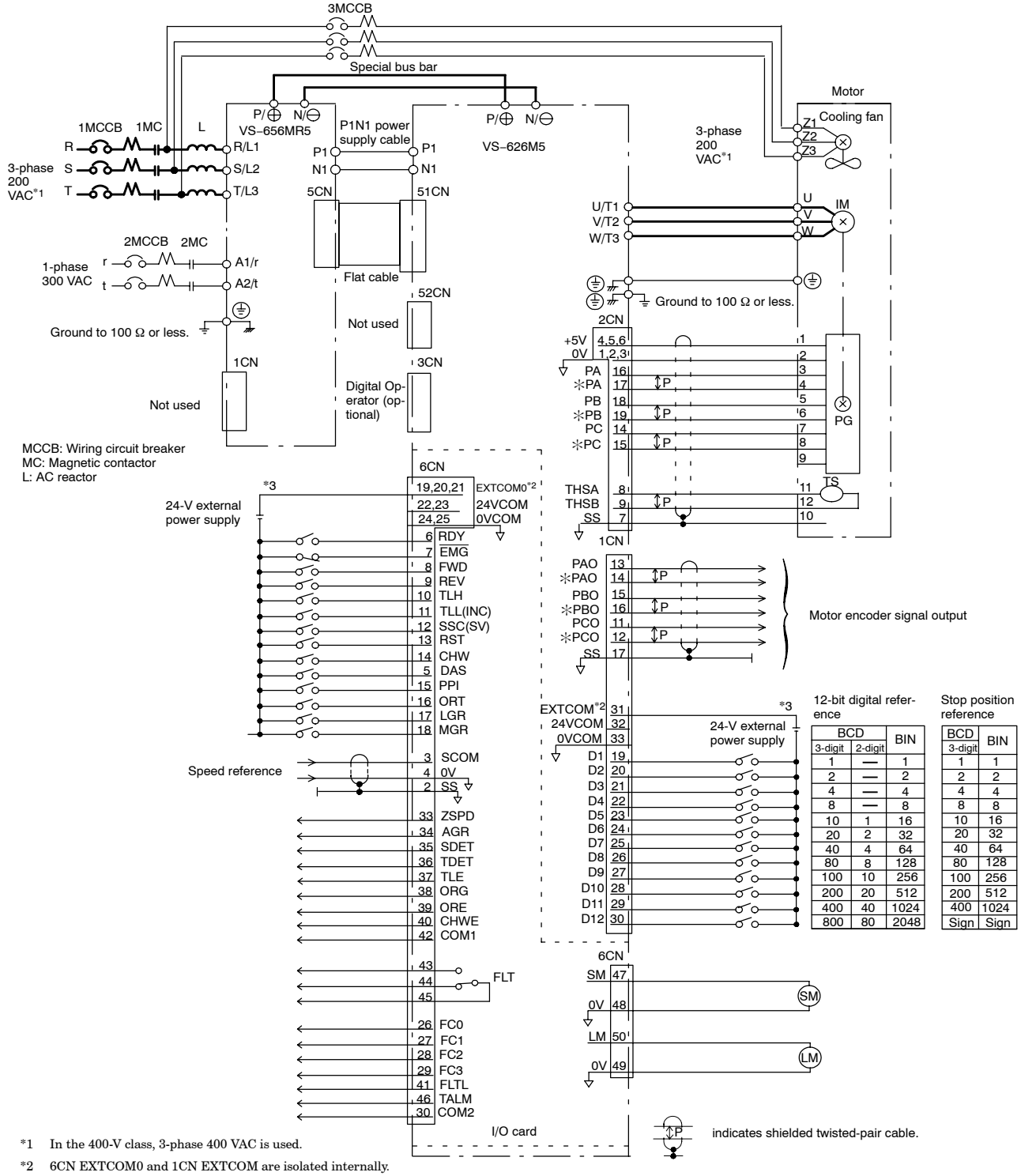


Fig 8.2 Main Shaft Orientation Device Configuration for Spindle Shaft Encoder Method

8.2 Standard Connection Diagram

Figure 8.2 shows the standard connections to use a motor encoder signal with the load shaft and motor shaft linked in a 1:1 configuration. Figure 8.3 shows the standard connections to use the load shaft encoder signal. In both cases, the example shows an stand-alone drive (CIMR-M5A□□□□).



12-bit digital reference		
BCD 3-digit	BCD 2-digit	BIN
1	—	1
2	—	2
4	—	4
8	—	8
10	1	16
20	2	32
40	4	64
80	8	128
100	10	256
200	20	512
400	40	1024
800	80	2048

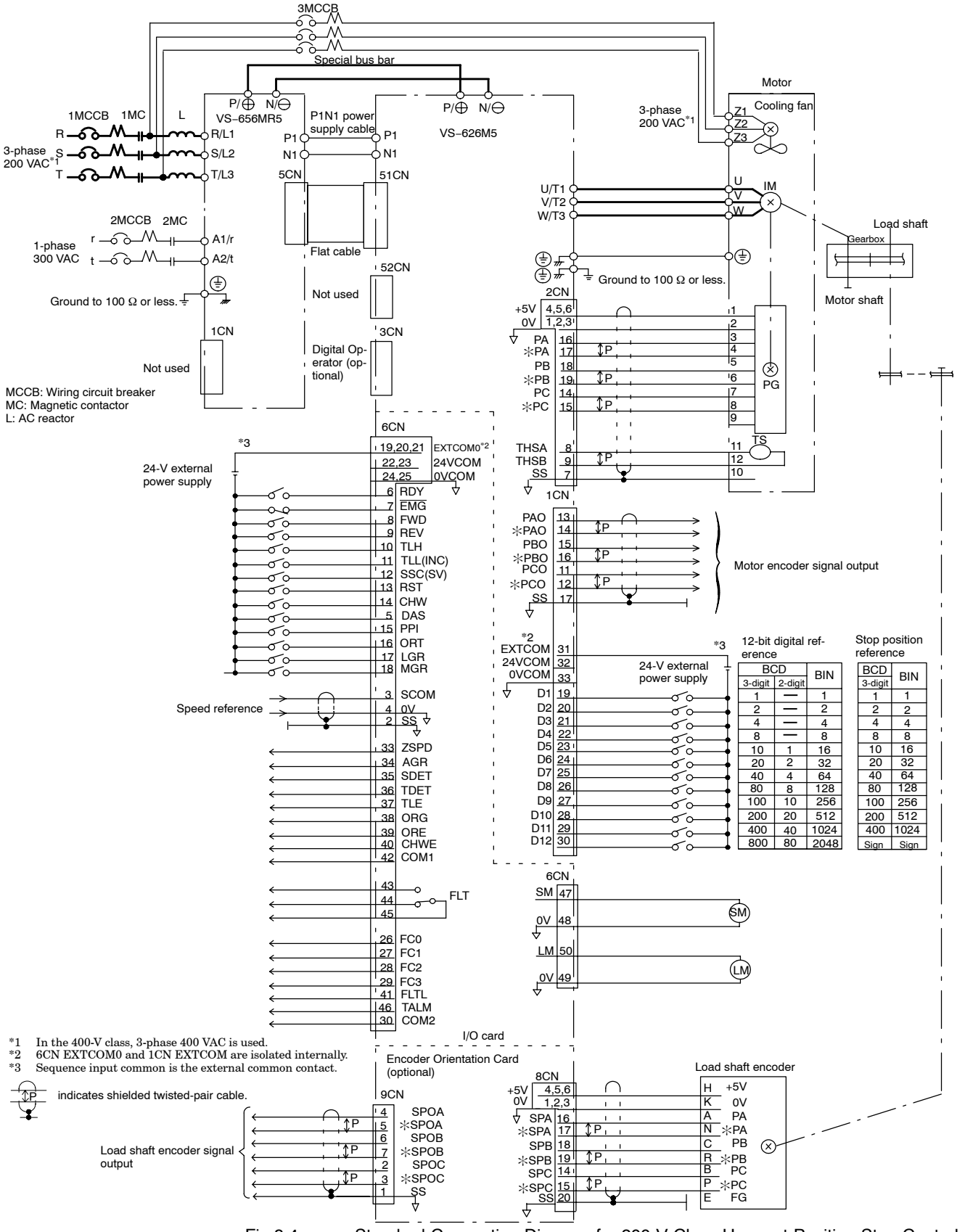
Stop position reference	
BCD 3-digit	BIN
1	1
2	2
4	4
8	8
10	16
20	32
40	64
80	128
100	256
200	512
400	1024
Sign	Sign

*1 In the 400-V class, 3-phase 400 VAC is used.

*2 6CN EXTCOM0 and 1CN EXTCOM are isolated internally.

*3 Sequence input common is the external common contact.

Fig 8.3 Standard Connection Diagram for 200-V Class User-set Position Stop Control Using a Motor Encoder



*1 In the 400-V class, 3-phase 400 VAC is used.
*2 6CN EXTCOM0 and 1CN EXTCOM are isolated internally.
*3 Sequence input common is the external common contact.

P indicates shielded twisted-pair cable.

Fig 8.4 Standard Connection Diagram for 200-V Class User-set Position Stop Control Using a Load Shaft Encoder

8.3 Orientation Specifications

This section explains the specifications for devices required for encoder orientation.

8.3.1 Standard Specifications

The following table shows the standard specifications for encoder orientation.

Table 8.1 Standard Specifications

Item	Load Shaft Encoder	Motor Encoder
Positioning Method	Absolute or incremental	
Positioning Detection Method	Main shaft angle detection using a load shaft or motor encoder phase-A, -B, and -C pulses	
Stop Position (See *1.)	Positioning to the position set internally or via external reference, using the load shaft origin (see *2) as standard. Angle resolution is 0.088° (= 360°/4096)	
Stop Position Repeat Accuracy (See *1.)	±0.2° Max.	
Resistance Torque (See *1.)	Continuous rated torque/±0.1° displacement (See *3.)	
Orientation Card	Code number: ETC62613X	Not used
Encoder Model	NE-1024-2MDF-068 (Load shaft mounted)	UTMSI-10AAG (Built-in motor encoder)

* 1. Excludes functional deviation, such as backlash and eccentricity.
* 2. The origin is obtained using the number of offset pulses set in constant memory from the rising edge of the Encoder phase-C pulse during forward rotation.
* 3. The continuous rated torque may not be output depending on the gain setting. Also, displacement may be larger for rapid load variations.

8.3.2 Load Shaft Encoder Specifications

The load shaft encoder specifications are shown in the following table.

Table 8.2 Load Shaft Encoder Specifications

Item	Details		
Model	NE-1024-2MDF-068-11	NE-1024-2MDF-068-12	UTMSI-10AAG
Maximum Speed (min^{-1}) (See note.)	6,000	8,000	10,000
Power Supply	5 VDC ±5%, 350 mA		
Number of Pulses	Phases A and B: 1,024 pulses/rotation		
	Phase C: 1 pulse/rotation		
Output	Symmetrical output using a line driver for all phases in common		
	AM26LS31		SN75158
Maximum Response Frequency	200 kHz		Phases A and B: 188 kHz Phase C: 183 kHz (11,000 min^{-1})
Accumulative Pitch Error	Within 20% of phase-A and phase-B signal cycle		Within 50% of phase-A and phase-B signal cycle
Pitch Error	Within 10% of phase-A and phase-B signal cycle		Within 12.5% of phase-A and phase-B signal cycle
Input Shaft Inertia	170 x 10^{-3} kgf•cm•s^2 max.		58.7 x 10^{-3} kgf•cm•s^2
Input Shaft Torque	1 kgf•cm max.		---
Input Shaft Tolerance Load	Thrust: 5 kg (11 lb) max (stopped), 10 kg (22 lb) max. (operating) Radial: 10 kg (22 lb) max (stopped), 20 kg (44.1 lb) max. (operating)		---
Construction	IP = 54 (connectors facing downwards)		Main shaft mounted
Output Connectors	Main Unit: 97F3102E20-29P Cable: MS3106A20-295 Manufactured by DDK		Main Unit: MLR-12 model Cable: MLP-12 model Manufactured by Nihon Crimp (KK)
Weight	1 kg (2.2lb)		0.33 kg (0.728 lb) (Encoder disk)
Operating Temperature Range	0 to 60°C (32 to 140°F)		
Humidity	85% max. (with no condensation)		10% to 95% (with no condensation)

8.4 Dimensions

The dimensions of the Orientation Card and Encoder are shown in the following diagrams.

8.4.1 Encoder Orientation Card (ETC62613X)

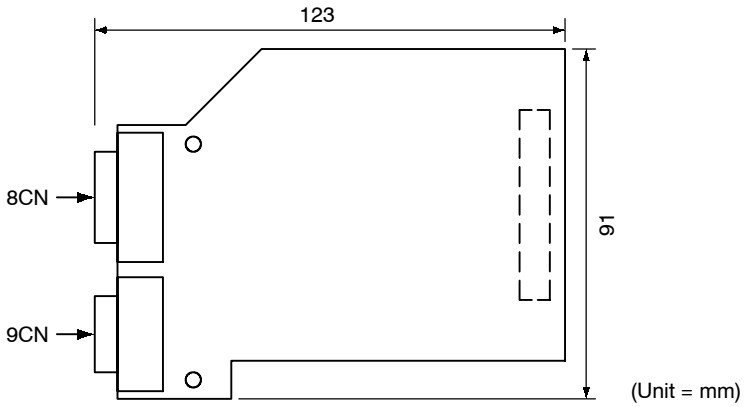
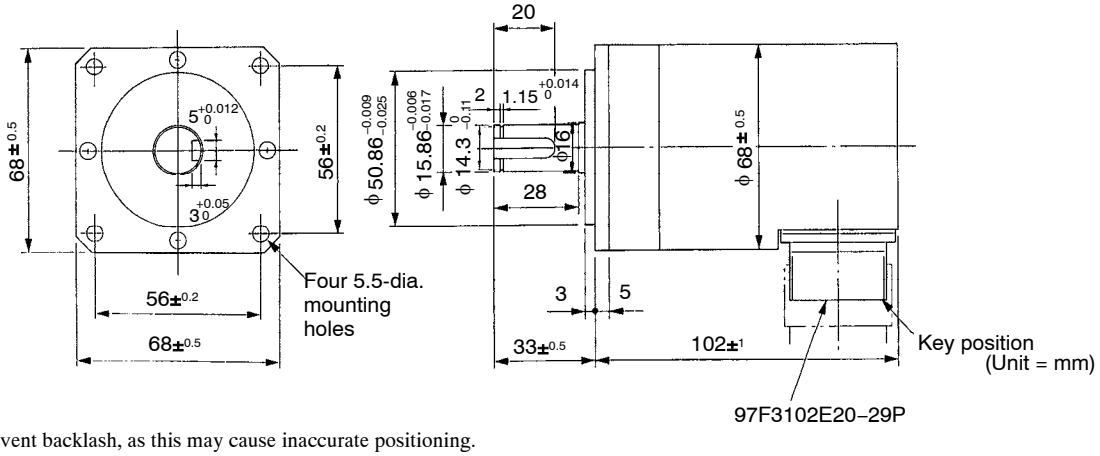


Fig 8.5 Dimensions of Encoder Orientation Card

8.4.2 Load Shaft Mounted Encoder (NE-1024-2MDF-068)

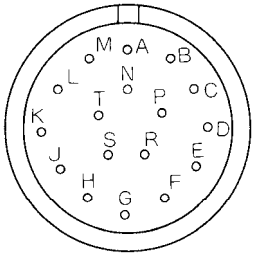


* 1. Mount to prevent backlash, as this may cause inaccurate positioning.
* 2. A Shaft Load Encoder without a flange is also available.
* 3. Ask your Yaskawa representative for Load Shaft Encoders for built-in motors.

Fig 8.6 Dimensions of Load Shaft Mounted Encoder

8.5 Load Shaft Encoder Connector Terminal Arrangement

The connector terminal arrangement for the Load Shaft Encoder is shown in the following diagram.



Encoder: MS3102A20-29P
Cables: MS3106A20-29S (Straight plug, solid shell)
MS3106B20-29S (Straight plug, 2-piece shell)
MS-3108B20-29S (L–plug, 2-piece)
MS3057-12A (Cable Clamp)

A	B	C	D	E	F	G	H	I
PA	PC	PB	---	FG	---	---	5 V	---
K	L	M	N	P	R	S	T	---
0 V	---	---	*PA	*PC	*PB	---	---	---

Notes: 1. The asterisk (*) for signals *PA, *PB, and *PC indicates reverse rotation signals.

2. The connectors are manufactured by Nihon Koku Denshi Kogyo (KK).

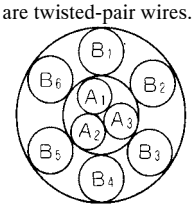
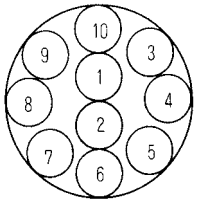
Fig 8.7 Load Shaft Encoder Connector Terminal Arrangement

8.6 Important Points for Encoder Mounting and Wiring

Pay attention to the following points when mounting and wiring the Encoder.

- Make sure the signal cable between the Orientation Card and the Load Shaft Encoder is 20 m maximum.
- Yaskawa has prepared signal cables to the specifications shown in the following table. Purchase signal cables in the standard length required for your applications.

Table 8.3 Signal Cable Specifications

Model Number	Yaskawa Number BDP8409123	Yaskawa Number DE8400093
Manufacturer	Hitachi Cable, Ltd.	Fujikura Densen (KK)
Outline of Specifications	Composite KQVV-SW AWG22 x 3C AWG26 x 6P	KVV-SB AWG26 x 10P
Internal Configuration and Lead Colors	B1 to B6 are twisted-pair wires.  A1: Red A2: Black A3: Yellow-green B1: Blue and white-blue B2: Yellow and white-yellow B3: Green and white-green B4: Orange and white-orange B5: Purple and white-purple B6: Gray and white-gray	All wires are twisted-pair wires.  1: Blue and white 2: Yellow and white 3: Green and white 4: Red and white 5: Purple and white 6: Blue and brown 7: Yellow and brown 8: Green and brown 9: Red and brown 10: Purple and brown
Standard Specifications	Standard lengths: 5 m, 10 m, and 20 m No terminal processing (Connectors are not supplied.)	

Note: The composite KQVV-SW (BDP8409123) is the standard product for the internal configuration and lead colors.

- Multiple volt signals pass through the signal cable, so arrange the wiring by separating the signal cables from power cables.
- If rotation is clockwise as seen from the end of the Encoder shaft during forward rotation of the load shaft, reverse phase A and phase B as shown in the following diagram.

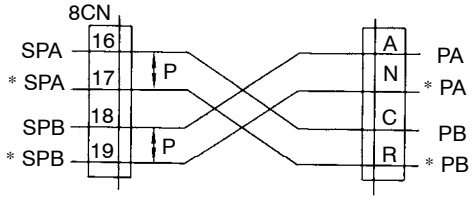


Fig 8.8 Reversing Signal Wiring

8.7 Stop Position Reference Signals

This section explains the stop position reference signal connections, status displays, and signal details.

8.7.1 Stop Position Reference Signal Connections

Connections for the stop position reference signal differ for stand-alone drive use and NC system use, as shown below.

■ Stand-alone Drives (M5A)

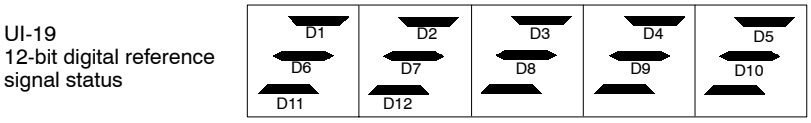
Connect the stop position reference signal to connector 1CN on the Inverter. Any of the following inputs can be used for the signal circuit common: 0 V common, 24 V common, or external common. For details, refer to *3.4.4 Sequence Input Signal Circuits*.

■ NC Systems (M5N)

The Inverter performs serial communications for the stop position reference signal using NC Unit and YE-NET1200 communications. For the NC Unit stop position reference address, refer to the NC Unit user's manual.

8.7.2 Stop Position Reference Signal Status Display

The ON/OFF status of the stop position reference signal can be checked using control signal U1-19. As shown in the following diagram, the display details are displayed using the LED display on the Digital Operator. (For operation details, refer to *Chapter 5 Operating the Digital Operator.*)



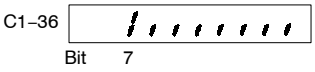
Note: When the input signal is ON, the indicator is lit.

Fig 8.9 Stop Position Reference Signal Status Display.

8.7.3 Details of the Stop Position Reference Signal

This section explains the stop position reference signals.

■ D1 to D12 (Stop Position Reference Signals)



12-bit Digital Reference Signal Function Selection: 1CN-19 to 1CN-30 will be the 12-bit Digital Reference if bit 07 of the C1-36 selection signals (SEL1) is turned OFF.

Operation is performed when pins 19 to 30 on connector 1CN are turned ON. Pins 19 to 30 correspond to signals D1 to D12.

- Signals D1 to D12 are stop position reference signals when performing user-set position stop control using a motor encoder or load shaft encoder.
- Stop position references are sent externally, taking the load shaft origin to be 0.
- The position reference can be selected using 12-bit binary or 3-digit BCD.

Absolute	Binary	Data 12 bits	0° to 359.9° (000 to FFF Hex)
	BCD	Sign: 1 bit Data 3 digits (11 bits)	–θ to θ (–799 to 799 decimal)
Incremental	Binary	Sign: 1 bit Data: 11 digits	–2,047 to 2,047 pulses (–000 to 7FF Hex)
	BCD	Sign: 1 bit Data: 3 digits (11 bits)	–θ to θ (–799 to 799 decimal)

- When the sign bit is ON, the sign is negative, and when the sign bit is OFF, the sign is positive.
- θ is determined by adding the 3-digit BCD data and the BCD stop position reference resolution C2-12 (P_{BCD}) of the control constant. The following equation must be satisfied: $\theta < 360°$
- The relationship between the reference signals and the number of pulses is shown in the following table.

Signal	Pin Number	Binary		BCD
		Without Sign	With Sign	With Sign
D1	19	1	1	1
D2	20	2	2	2
D3	21	4	4	4
D4	22	8	8	8
D5	23	16	16	10
D6	24	32	32	20
D7	25	64	64	40
D8	26	128	128	80
D9	27	256	256	100
D10	28	512	512	200
D11	29	1024	1024	400
D12	30	2048	Sign	Sign

- When using signed binary data, the meaning of the signal will depend on the sign (+ or –).
  If the sign is positive, the total number of bit pulses input is added:

  0 0 1 0 1 0 0 1 0 0 1
  : : : :
  256+ 64 + 8 + 1 = 329

  If the sign is negative, the negative of sum of the number of bit pulses input is used:
  – (256 + 64 + 3 + 1) = –329
- For incremental operations, binary references cannot be above 180°. For BCD references, references above 180° are possible depending on the setting of the BCD stop position reference resolution C2-12 (P_{BCD}) to a maximum of ±360°.

INFO

The input signal circuit for the stop position reference for the Encoder orientation is the same as that shown in *3.4.4 Sequence Input Signal Circuits.*

8.8 Functions

This section explains in detail the Encoder orientation control code functions.

IMPORTANT

Orientation Control Application Precautions

In the following cases, be sure to adjust the tuneup and parameters before using the orientation function.

- When using the orientation function for the first time after mounting the M5 to the machine
- When replacing the Motor or Encoder
- When changing the wiring between devices

For details on the tuneup, refer to the adjustment procedure.

There are two types of user-set positioning operations. This section explains them both.

- Absolute positioning
- Incremental positioning

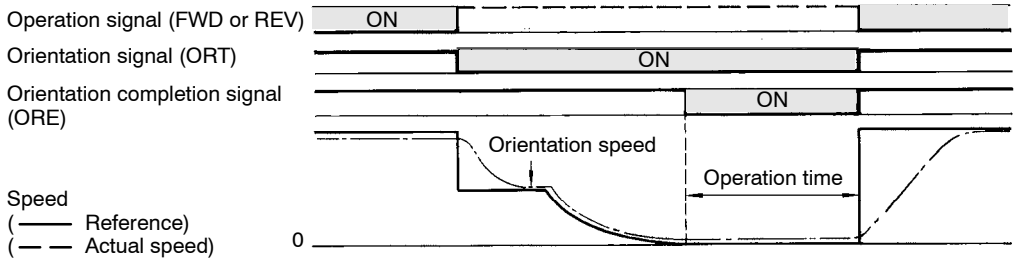
8.8.1 Absolute Positioning

Absolute positioning is used when performing positioning to the specified stop position based on the load shaft origin. Consequently, if the specified stop position is 0°, the shaft will stop at the load shaft origin, and if the specified stop position is 90°, the shaft will advance 90° clockwise before stopping.

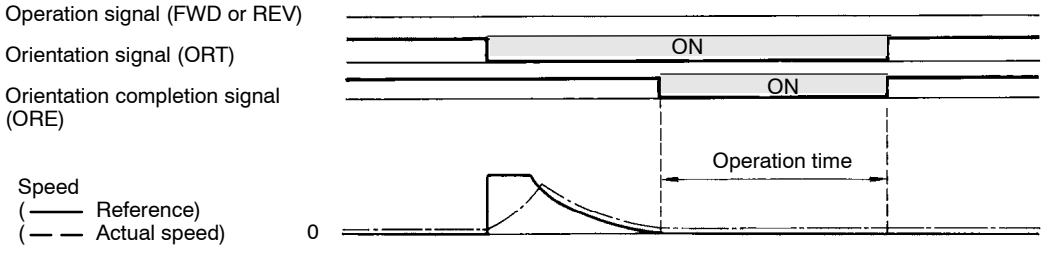
When the orientation signal is input while the motor is rotating (or while the motor is stopped), the load shaft immediately decelerates (or accelerates) to the orientation speed that has been set. After attaining the set speed, the Encoder phase-C signal is checked, and then the shaft stops at the position specified by the servo loop, and an orientation completion signal (ORE) is output at the same time.

After orientation has been completed, the servo loop will still continue to operate unless the orientation completion signal is turned OFF, so even if external force is applied to the load shaft, the shaft will not slip easily from the positioning point.

The timing chart for the absolute positioning operation is shown in the following diagram.



(a) Stopping at Specified Position when Motor is Rotating



(b) Stopping at Specified Position when Motor is Stopped

Fig 8.10 Absolute Positioning Operation

8.8.2 Incremental Positioning

Incremental positioning is used when positioning to a new stop position that adds to the current stop position a specified amount of travel (i.e., angle).

If an incremental signal is input and an orientation signal is input again after absolute positioning has been completed, the shaft stops at the new stop position according to the servo loop, and a completion signal is output at the same time.

In this mode, the shaft advances by the specified rotation travel amount only whenever an orientation signal is input.

The timing chart for the incremental positioning operation is shown in the following diagram.

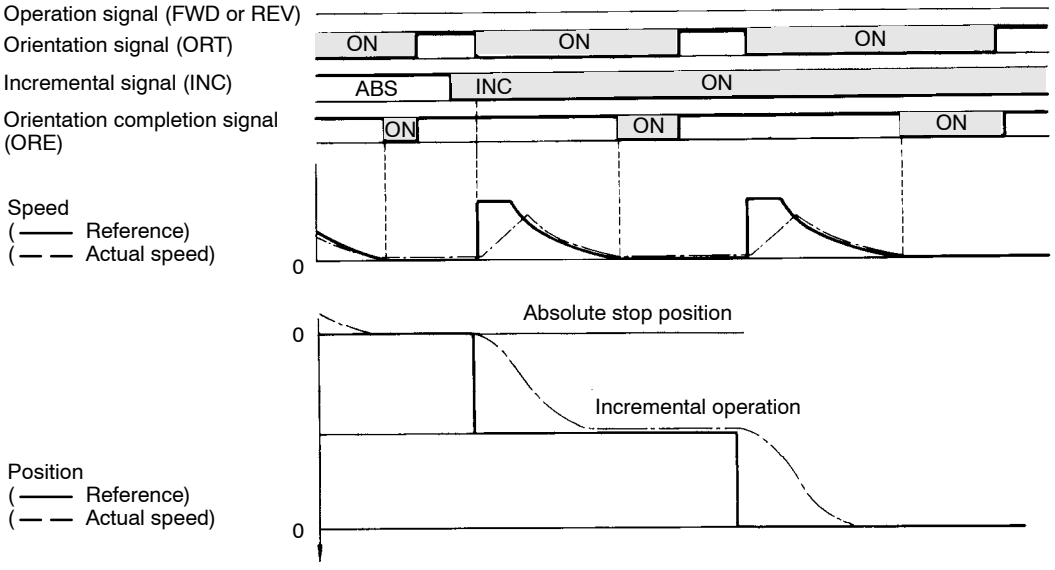


Fig 8.11 Incremental Positioning

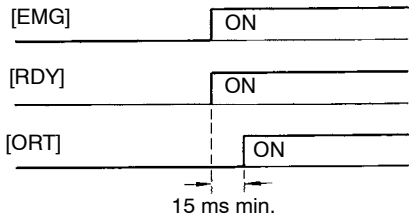
When performing incremental positioning, make sure that the position does not slip while the orientation signal is turned OFF. If the position slips, stop position accuracy will be lost.

8

8.8.3 Precautions on Orientation Control

Design the sequence considering the following points when using the orientation function.

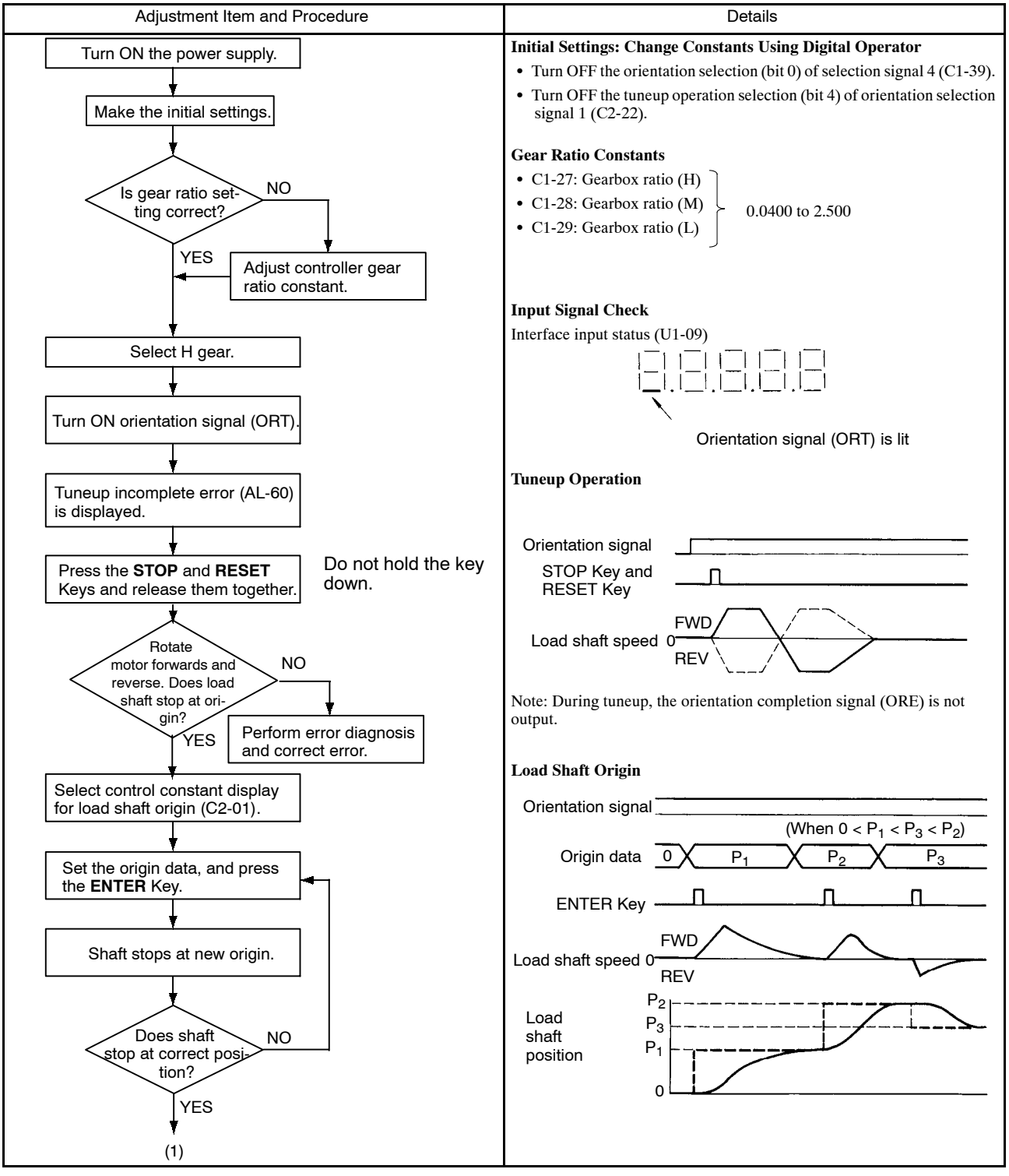
- The system will not restart unless the ORT signal is turned OFF if an emergency stop is performed during orientation.
- Keep the ORT signal OFF when the system is turned ON, or otherwise the system will not operate.
- Turn ON the ORT signal at least 15 ms after the EMG or RDY signal is turned ON. The ORT signal will not be accepted if it is turned ON before the EMG or RDY signal is turned ON.

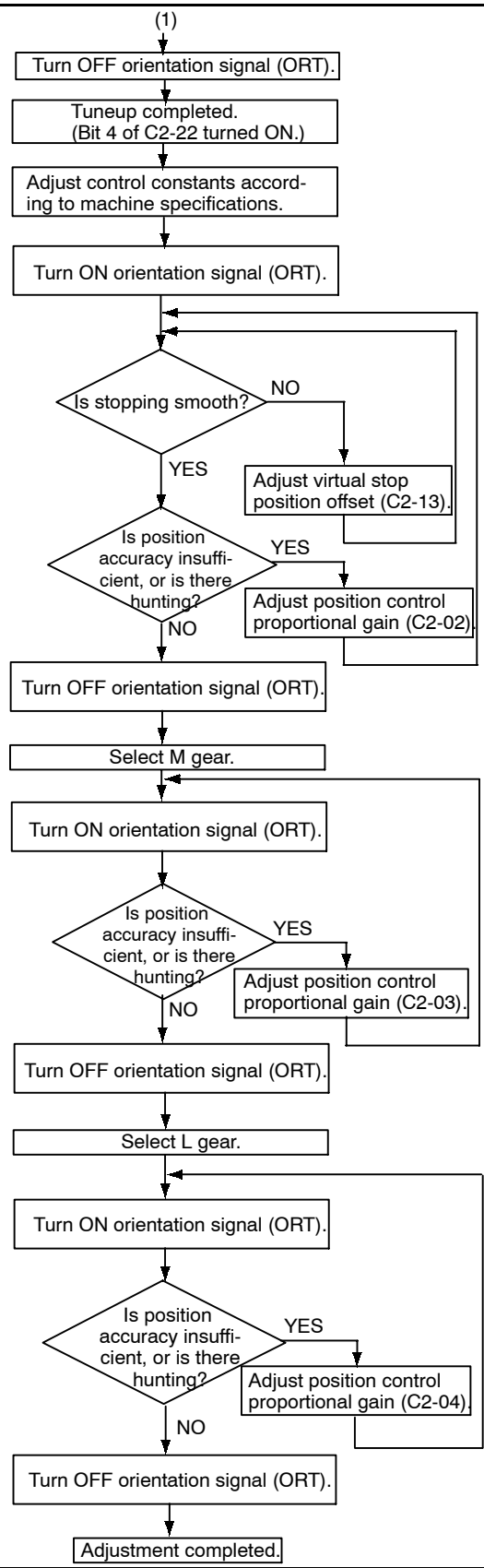
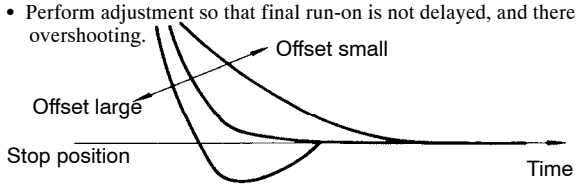
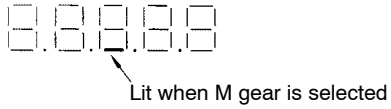
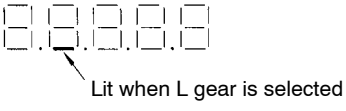


- In the orientation control, after the Encoder phase–C signal is checked, the shaft stops at the specified position, and an orientation completion signal (ORE) is output. The detected position of the origin signal is cleared when the motor speed exceeds 50 min^{-1} after the shaft has stopped. (it is also cleared if the motor is rotated by external force.) If the ORT signal is input when the detected position of the origin signal is cleared, the motor will rotate to detect the origin signal.
- If the ORT signal is input when the detected position of the origin signal is being held, the motor does not rotate because the origin signal does not have to be detected. Therefore, if the ORT signal to the current position is input, an orientation completion signal (ORE) is immediately output without rotating the motor.
- Assume the motor may rotate after the ORT signal is input because it is impossible to check if the origin signal is detected externally. Therefore, design the sequence for checking that an orientation completion signal (ORE) has turned ON after the ORT signal is input.
- The positioning rotation direction is described below.
  Before the origin signal is detected: the set value in the Positioning rotation direction constant (C2-22, bit 1 and 0)
  When the origin signal is being held: If the ORT signal is input again, the rotation direction is automatically detected, and shortcut control is carried out. The rotation direction cannot be specified.

8.9 Encoder Orientation Control Mode Adjustment Procedure

Adjust the encoder orientation according to the following flowchart. Be sure to perform the following adjustments if the Motor, Inverter, or Encoder are replaced.



Adjustment Item and Procedure	Details
	If a malfunction occurs during tuneup, reset the system, and then perform the tuneup operation again. **Tuneup completed** **Turn ON tuneup operation selection (Bit 4 of C2-22 turned ON).** **Adjust Control Constants** **Adjust Virtual Stop Position Offset (C2-13)** • Perform adjustment so that final run-on is not delayed, and there is no overshooting.  • If the load inertia changes, the characteristics will also change. Check the characteristics for the H, M, and L gears individually. **H Gear Selection** **Adjust Proportional Gain (C2-02)** • If the ORE signal is not output close to the stop position, the gain will increase. • Even if the ORE signal is output, if the shaft load is unsteady, the gain will be reduced. **Check M Gear Selection** Interface input status (U1-09)  **Adjust Proportional Gain (C2-03)** • If the ORE signal is not output close to the stop position, the gain will increase. • Even if the ORE signal is output, if the shaft load is unsteady, the gain will be reduced. Note: If there is no L gear selection in the machine specifications, omit the following L gear adjustment procedure. **Check L Gear Selection** Interface input status (U1-09)  **Adjust Proportional Gain (C2-04)** • If the ORE signal is not output close to the stop position, the gain will increase. • Even if the ORE signal is output, if the shaft load is unsteady, the gain will be reduced.

8

9

Magnetic Sensor Orientation Control

This chapter explains control methods using a Magnetic Sensor Orientation Card.

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9.1 Device Configuration

This configuration performs positioning to a fixed angle by detecting the position using a Magnetic Sensor mounted on a fixed part and a Magnet mounted to the rotating part of the load shaft. For this method of control, the following devices are required in addition to signals and speed references for forward and reverse rotation: Orientation signals and a Magnet for positioning references, a Magnetic Sensor, and a Magnetic Sensor Orientation Card.

In addition, after performing positioning using the Magnetic Sensor, user-set position stop control can be performed using an incremental operation. For this operation, stop position references are required.

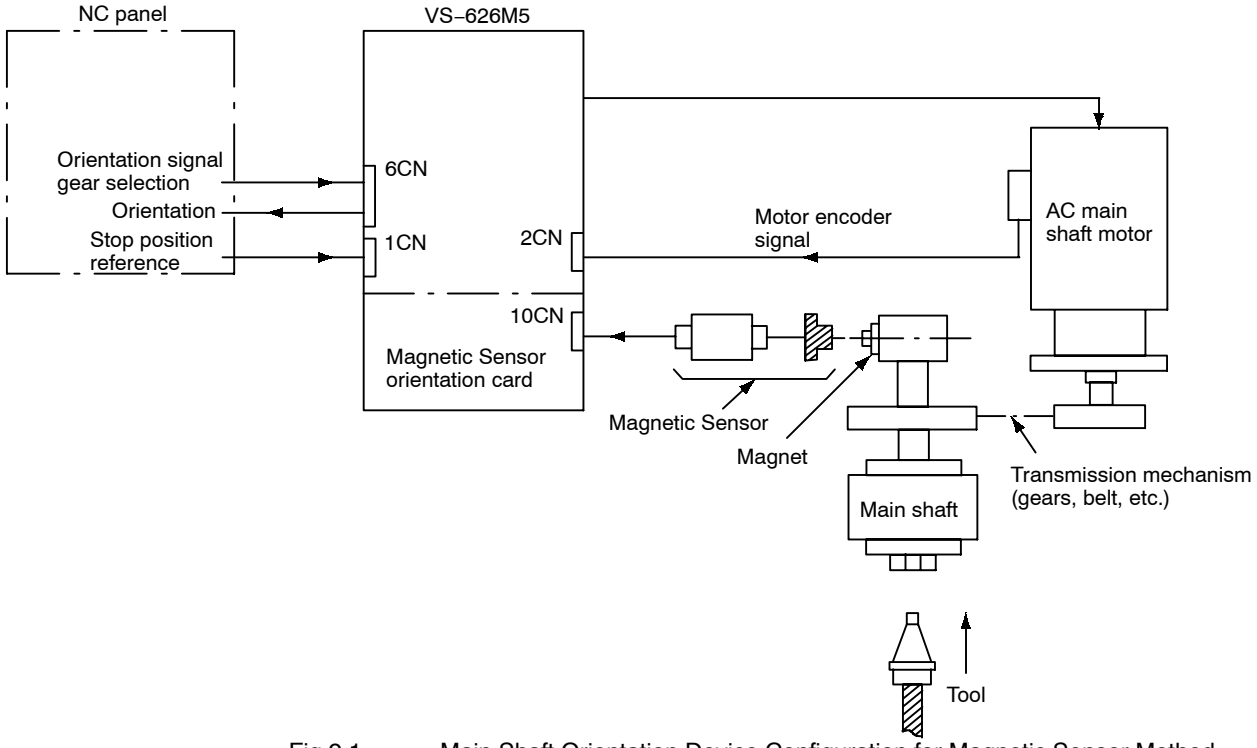
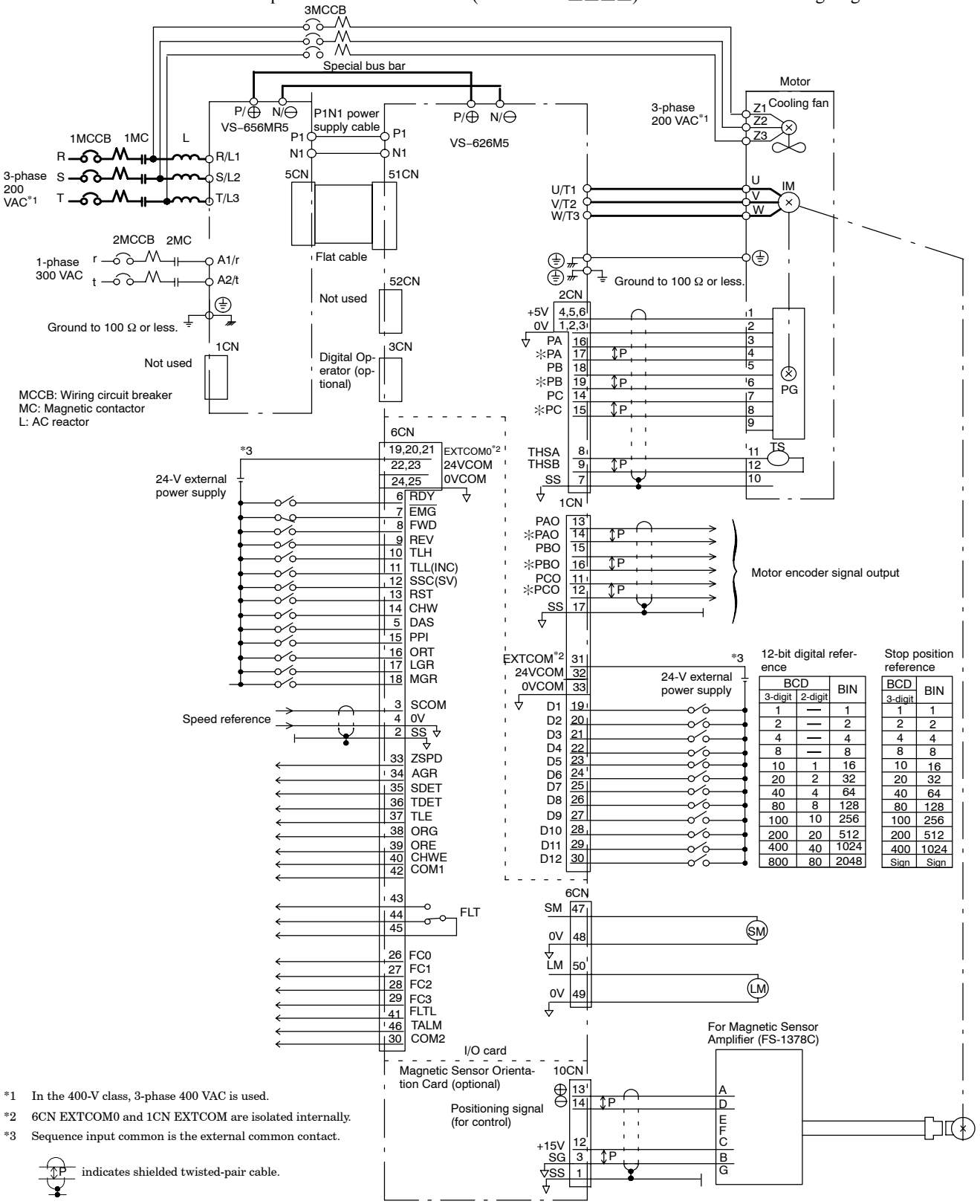


Fig 9.1 Main Shaft Orientation Device Configuration for Magnetic Sensor Method

9.2 Standard Connections

An example for an stand-alone drive (CIMR-M5A□□□□) is shown in the following diagram.



*1 In the 400-V class, 3-phase 400 VAC is used.

*2 6CN EXTCOM0 and 1CN EXTCOM are isolated internally.

*3 Sequence input common is the external common contact.

P indicates shielded twisted-pair cable.

Fig 9.2 Standard Connections for 200 V Class User-set Position Stop Control and Magnetic Sensor Positioning

9.3 Orientation Specifications

This section explains the specifications for devices required for Magnetic Sensor orientation.

9.3.1 Standard Specifications

The following table shows the standard specifications for Magnetic Sensor orientation.

Table 9.1 Standard Specifications

Item	Details
Position Detection Method	Position change detection by magnetic flux using a Magnet and a Magnetic Sensor.
Stop Position*1	Stops in the position where the center of the Magnetic Sensor head and the Magnet are aligned. Can be adjusted within the range ±2° using control constants.
Stop Position Repeat Accuracy*1	±0.2° max.
Resistance Torque*1	Continuous rated torque/±0.1° displacement*2
Orientation Card	Code number: ETC62614X
Magnet	Model: MG-1378BS or MG-1444S
Magnetic Sensor	Model: FS-1378C or FS-200A

* 1. When the Magnet is mounted on the circumference of the ϕ120 load shaft. Excludes deviation due to mechanical deviation and external magnetic fields.

* 2. Output may not reach continuous rated torque depending on the gain setting.

9.3.2 Magnet Specifications

The Magnet specifications are shown in the following table.

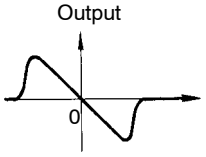
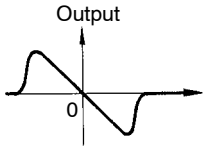
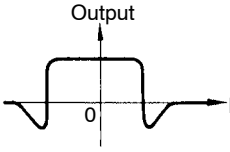
Table 9.2 Magnet Specifications

Item	Details	
	MG-1378BS	MG-1444S
Detection Range (mm)	±15	±7
Speed Tolerance (rotations/min.) (Mounted on a 200-diameter circumference)	6,700	10,000
Weight (g)	33	15
Manufacturer	(KK) Makome Research Center	

9.3.3 Magnetic Sensor Specifications

The specifications for the Magnetic Sensor are shown in the following table.

Table 9.3 Magnetic Sensor Specifications

Item	Details	
	FS-1378C	FS-200A
Power Supply Voltage	15 VDC ±5%	12 VDC ±10%
Consumption Current	100 mA max.	50 mA max.
Position Signal for Control Level Offset Output Impedance	 ±4 V min. ±0.2 V max. 1.5 kΩ	 ±8 V min. ±0.2 V max. 1.5 kΩ
Position Signal for Monitor Range Offset	 30° min.*1 (+24 V max.) ±0.5 V max.	---
Ambient Operating Temperature	–10 to 50°C	
Output Terminals	Supplied with round connectors Manufacturer: Tajimi Musen Denki (KK) A: Position signal + B: SG C: 15 V D: Position signal – E: Range signal –*2 F: Range signal +*2	Supplied with 5-m 6-mm-diameter, 4-core cabtire cable Wiring: Red: 12 V Black: SG Green: + output White: – output
Manufacturer	(KK) Makome Research Center	

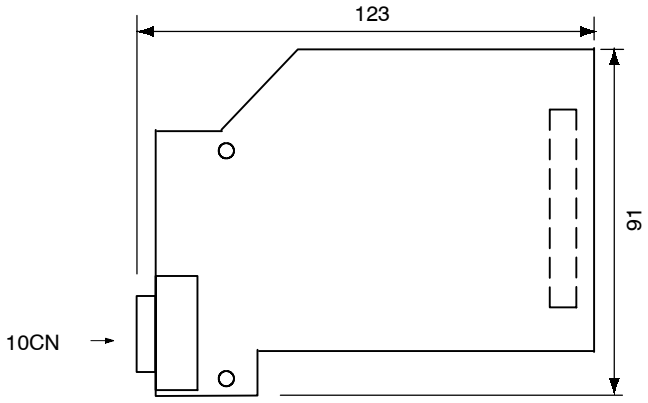
* 1. When Magnet is mounted on 120-mm-diameter load shaft rotating part.

* 2. The range signals on terminals E and F can be used for monitoring.

9.4 Dimensions

The dimensions for the Orientation Card, Magnet, and Magnetic Sensor are shown in the following diagrams.

9.4.1 Magnetic Sensor Orientation Card (ETC62614X)



Note: The Magnetic Sensor Orientation Card can be shipped after being mounted to the Unit at the factory.

Fig 9.3 Dimensions of Magnetic Sensor Orientation Card

9.4.2 Magnet

■ MG-1378BS

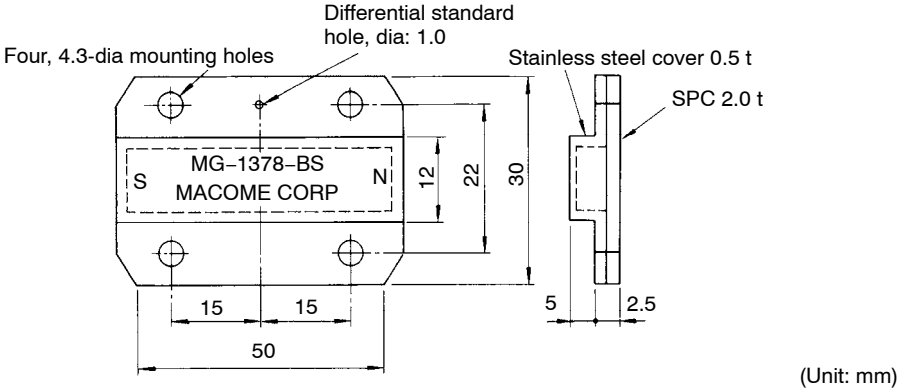


Fig 9.4 Dimensions of MG-1378BS Magnet

■ MG-1444S

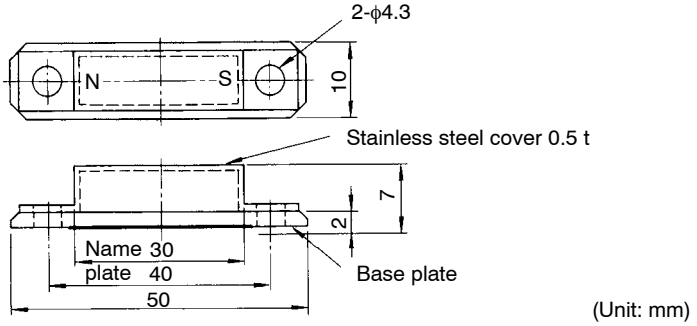
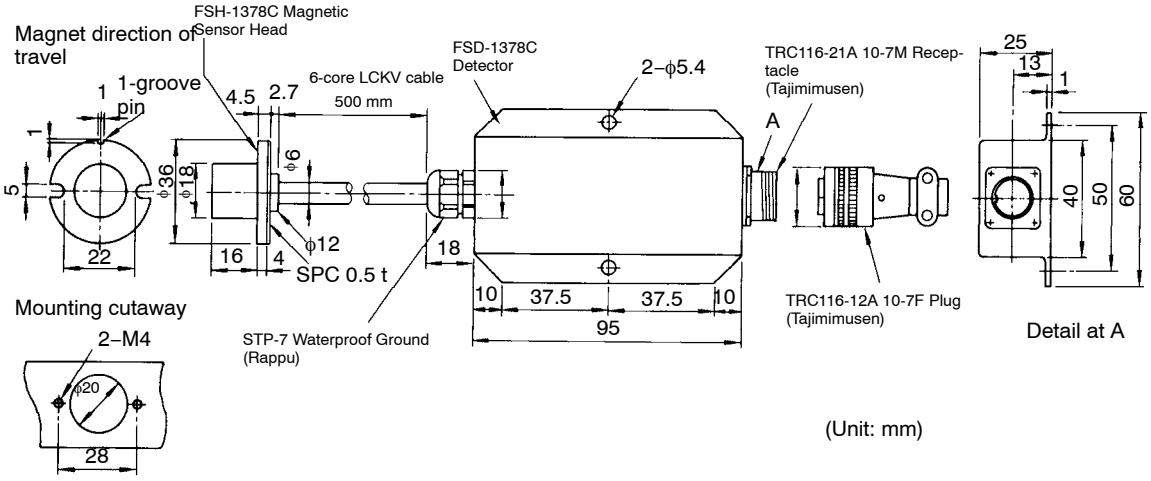


Fig 9.5 Dimensions of MG-1444S Magnet

9.4.3 Magnetic Sensor

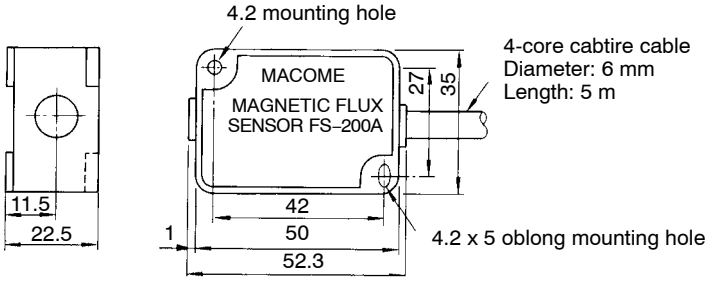
■ FS-1378C



(Unit: mm)

Fig 9.6 Dimensions of FS-1378C Magnetic Sensor

■ FS-200A



(Unit: mm)

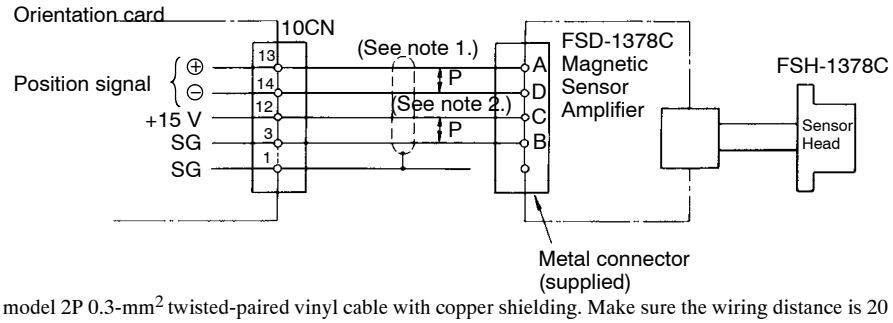
Fig 9.7 Dimensions of FS-200A Magnetic Sensor

9.5 Connections between Devices

This section explains the connections between the devices used for Magnetic Sensor orientation control.

9.5.1 Magnetic Sensor Signal

■ Using the FS-1378C



Notes: 1. Use a model 2P 0.3-mm^2 twisted-paired vinyl cable with copper shielding. Make sure the wiring distance is 20 m maximum.

2. P indicates twisted-pair cable.

Fig 9.8 Connection between Devices for FS-1378C

■ Using the FS-200A

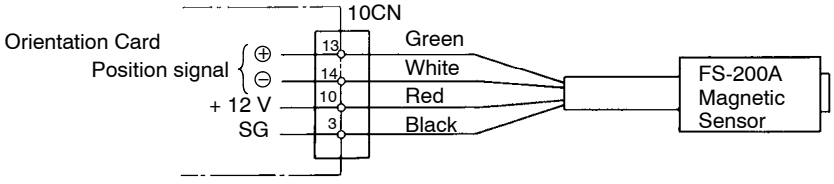
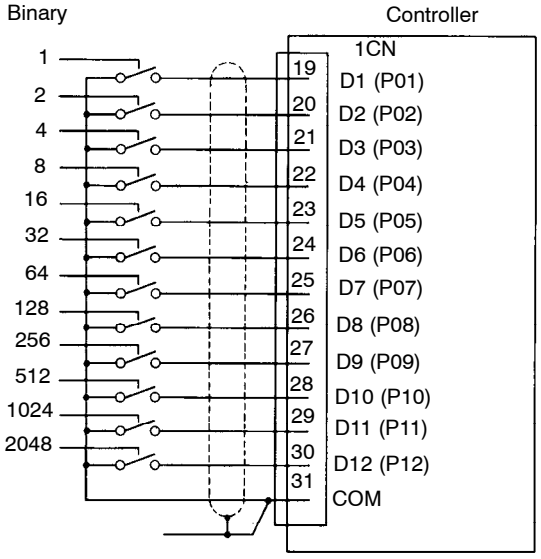


Fig 9.9 Connection between Devices for FS-200A

9.5.2 Stop Position References

Stop position references stop the motor at a user-set position using Magnetic Sensor orientation.



Note: For the connector terminal arrangement, refer to *3.4 Wiring Control Circuit Signals.*

Fig 9.10 Connection between Devices

9.6 Control Signal Connector Terminal Arrangement

The terminal arrangement of the control signal connectors is shown below.

■ 10CN Orientation Card

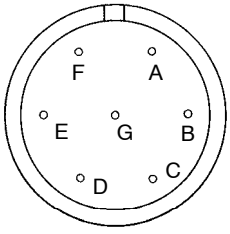
14	SIG−	7	---
13	SIG+	6	---
12	+15 V	5	0 V
11	---	4	---
10	+12 V	3	0 V
9	---	2	---
8	---	1	SS

PCB connector: 10214-52A2JL
Cable connector: 10114-3000VE
10314-52A0-008 (case)

Notes: 1. The terminal arrangement is viewed from the PCB connector.

2. Connectors are manufactured by Sumitomo 3M Corporation.

■ FS-1378C Magnetic Sensor



TRC116-21A10-7M Magnetic Sensor Connectors
TRC116-12A10-7F Cable Connectors

Notes: 1. The pin arrangement is viewed from the sensor connector.

2. The cable connectors are included in the Magnetic Sensor.

3. Connectors are manufactured by Tajimi Musen Denki (KK).

Fig 9.11 Connector Terminal Arrangement

9.7 Magnet and Magnetic Sensor Mountings

The Magnet is mounted directly to the load shaft as shown in the following diagram. The Magnetic Sensor is mounted to a part of the load shaft that does not rotate, but must be mounted so that the positioning of the center of the Magnet agrees exactly with the center of the Magnetic Sensor.

■ Mounting Diagram

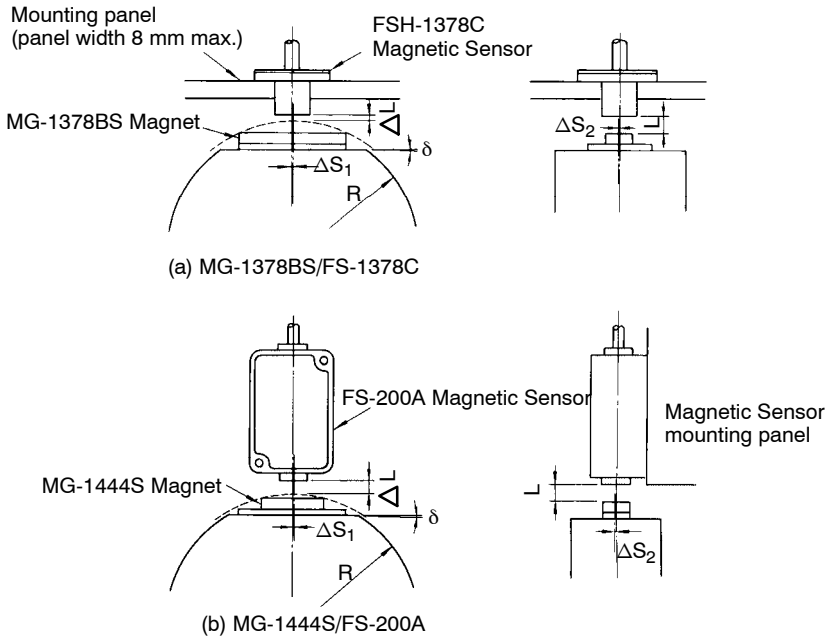


Fig 9.12 Magnet and Magnetic Sensor Mounting Diagram 1

■ Mounting Dimensions

The mounting dimensions for the above diagram are shown in the following table.

Sign	Name	MG-1378BS/FS-1378C	MG-1444S/FS-200A
R	Radius of rotating part mounted to the Magnet*1	60 to 70 mm	60 to 70 mm
L	Gap (between center of Magnet and Magnetic Sensor)*2	6 mm (6 to 8 mm)	5 mm (3 to 7 mm)
ΔL	Gap (between tip of Magnet and Magnetic Sensor)*2	1 to 2 mm	1 to 2 mm
ΔS_1 and ΔS_2	Magnet and center of Magnetic Sensor are no longer aligned.*3	0.5 mm max.	0.5 mm max.
δ	Angle of misalignment from base surface.*3	0.2° max.	0.2° max.

* 1. When specifying the radius of the rotating part mounted to the Magnet, consider the maximum speed tolerance of the Magnet.

* 2. The value of L is the recommended value. Adjust the gap to satisfy the value of ΔL.

* 3. When the mechanical central shaft (e.g., the spindle nose key in the machining center) has been matched, make sure that the center misalignment of the Magnet and Magnetic Sensor, as well as the standard of accuracy of the emitter mounting, have been satisfied. Make sure the base surface is parallel to the tangent at the point where it crosses the circumference of the rotating part mounted to the Magnet and the Magnet centerline.

Fig 9.13 Magnet and Magnetic Sensor Mounting Diagram 2

9.8 Mounting Precautions

Pay attention to the following precautions when mounting the Magnet and Magnetic Sensor.

■ Mount the Magnet to the Load Shaft

The position control loop is configured using the detection magnetic field of the Magnet. Mount the Magnet on the load shaft (e.g., the main shaft of the machine-tool). If using a belt gear transmission mechanism between the shaft to which the Magnet is mounted and the load shaft, there is a risk that the stop position will be out of alignment due to the load shaft belt slipping or gear backlash.

■ Do Not Install a Magnetic Body Near the Magnet

Use non-magnetic materials for the rotator to which the Magnet is mounted. Also make sure that there are no iron particles sticking to the Magnet. The presence of a magnetic body near the Magnet may warp the magnetic field, resulting in incorrect position detection and preventing the shaft from stopping in the correct stop position. Do not place devices that emit magnetic fields (solenoids, magnetos, etc.) near the Magnet and Magnetic Sensor, as the presence of another magnetic field near the Magnet may warp the magnetic field, resulting in incorrect position detection and preventing the shaft from stopping in the correct stop position.

■ Take Care When Handling the Magnet and Magnetic Sensor

When mounting the Magnet and Magnetic Sensor, do not damage them. The Magnet rotates at high speed, so damage can result in unexpected accidents. Also, the Magnetic Sensor is a high-precision device, so if external force is applied resulting in internal distortion, detection accuracy will be reduced.

■ Do Not Subject the Magnetic Sensor Amplifier or Connector Cables to Oil or Water

Do not allow oil or water to come into contact with the Magnetic Sensor amplifier or connector cables. If water or oil comes into frequent contact with the sensor head in particular, perform waterproof countermeasures on the bushings using additional materials, as shown in figure 9.14. If dirty oil or water permeates the Magnetic Sensor or connector cables, there is a risk that insulation will be reduced, resulting in abnormal signal detection and abnormal control operations.

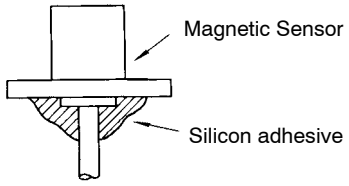


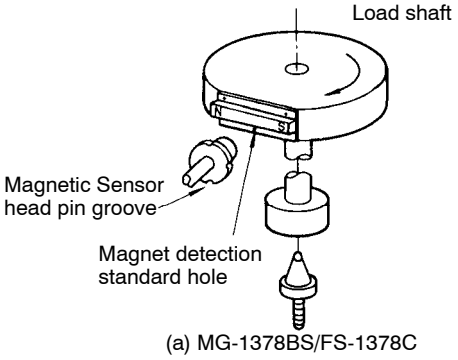
Fig 9.14 Magnetic Sensor Bushing Waterproofing Method

■ The Wiring Distance: 20 m. Max.

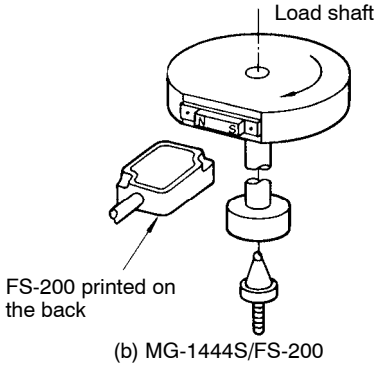
Make sure that the wiring distance between the Magnetic Sensor Amplifier and the Orientation Card is 20 m maximum. The Magnetic Sensor detection signal is low-voltage, so if the wiring is too long, the sensor will be easily affected by differential voltages and noise voltages, resulting in inaccurate positioning.

■ Be Careful of Polarity

When mounting the Magnet and Magnetic Sensor, pay attention to the polarity, and mount the devices correctly as shown in the Fig 9.15. Even if the devices are mounted with the polarity mistakenly reversed, the Orientation Card will still respond to signals, so control will be possible.



(a) MG-1378BS/FS-1378C



(b) MG-1444S/FS-200

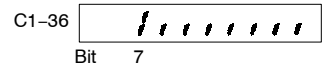
Fig 9.15 Magnet and Magnetic Sensor Mounting Directions

9.9 Stop Position Reference Signal Details

The stop position reference input signal circuit, which controls the direction of the Magnetic Sensor orientation, is the same as for the sequence input signal.

■ D1 to D12 (Stop Position Reference Signal)

12-bit Digital Reference Signal Function Selection: 1CN-19 to 1CN-30 will be the 12-bit Digital Reference if bit 07 of the C1-36 selection signals (SEL1) is turned OFF.



The circuit operates when pins 19 to 30 of 1CN are turned ON.

- Use these stop position reference signals when performing user-set position stop control (incremental operation) using Magnetic Sensor orientation.
- Stop position references are sent externally, taking the load shaft external home position to be 0.
- Select the position references as either 12-bit binary or 3-digit BCD.

Incremental	Binary	Sign: 1 bit Data: 11 bits	–2047 pulses to 2047 pulses (–000 to 7FF hexadecimal)
	BCD	Sign: 1 bit Data: 3 digits (11 bits)	–θ to +θ (–799 to 799 decimal)

- When the sign bit is ON, the sign is negative, and when the sign bit is OFF, the sign is positive.
- θ is determined using the sum of the 3-digit BCD data and the BCD stop position reference resolution C3-12 (P_{BCD}). The following equation must be satisfied, $\theta < 360°$.
- The relationship between the reference signals and the number of pulses is shown in the following table.

Signal	1CN Pin Number	Binary	BCD
		With Sign	With Sign
D1	19	1	1
D2	20	2	2
D3	21	4	4
D4	22	8	8
D5	23	16	10
D6	24	32	20
D7	25	64	40
D8	26	128	80
D9	27	256	100
D10	28	512	200
D11	29	1024	400
D12	30	Sign	Sign

- If using signed binary, the meaning of the signal will depend on the sign (+ or –). If the sign is positive, the total number of bit pulses input is added:

  0 0 1 0 1 0 0 1 0 0 1
  : : : :
  256+ 64 + 8 + 1 = 329

  If the sign is negative, the negative of sum of the number of bit pulses input is used:
  – (256 + 64 + 3 + 1) = –329

- Binary references cannot be made above 180°. For BCD references, references above 180° are possible, depending on the setting in BCD stop position reference resolution C2-12 (P_{BCD}), to a maximum of ±360°.

9.10 Functions

This section explains in detail the Magnetic Sensor orientation control mode functions.

IMPORTANT

Orientation Control Application Precautions

In the following cases, be sure to adjust the tuneup and parameters before using the orientation function.

- When using the orientation function for the first time after mounting the inverter to the machine
- When replacing the Motor or Encoder
- When changing the wiring between devices

For details on the tuneup, refer to the adjustment procedure.

This section explains the Magnetic Sensor system fixed position stopping operation and user-set position stopping operation.

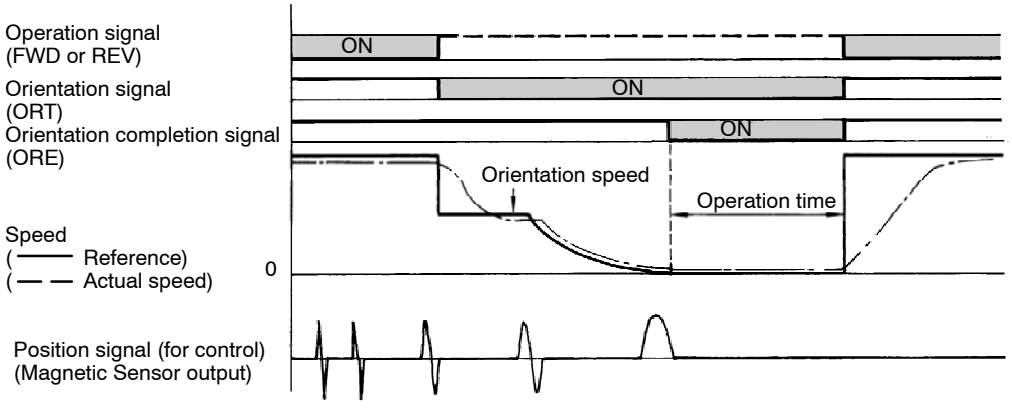
9.10.1 Fixed Position Stopping Operation Using the Magnetic Sensor

When the orientation signal is input while the motor is rotating (or while the motor is stopped), the load shaft immediately decelerates (or accelerates) to the orientation speed that has been set.

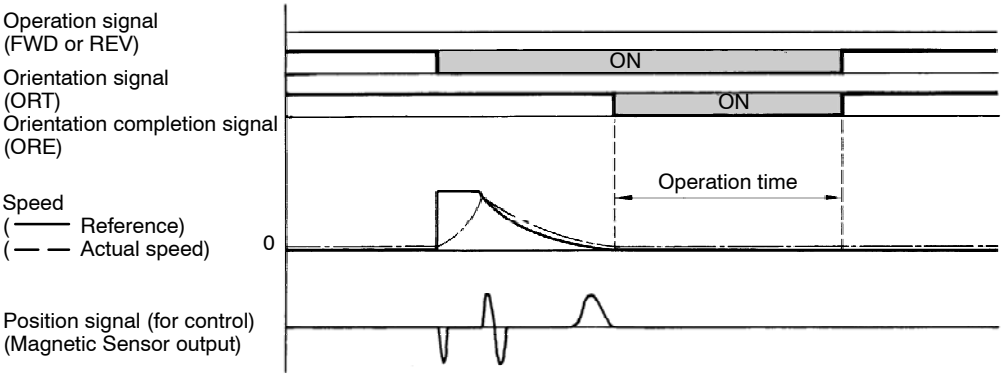
After attaining the set speed, the motor rotates until the Magnet and the center of the Magnetic Sensor are aligned according to the servo loop, which uses the motor encoder signal from the point that the load shaft Magnet passes the stop position, and stops at the fixed position using the Magnetic Sensor signal. The orientation completion signal (ORE) is output at the same time.

After orientation has been completed, the servo loop will still continue to operate unless the orientation completion signal is turned OFF, so even if external force is applied to the load shaft, the shaft will not slip easily from the positioning point.

The timing chart for the positioning operation is shown in the following diagram.



(a) Stopping at Specified Position when Motor is Rotating



(b) Stopping at Specified Position when Motor is Stopped

Note: If there is no slip in the gear mechanism and the parameters have been set correctly, the motor will stop smoothly using the servo loop.

Fig 9.16 Positioning Operation

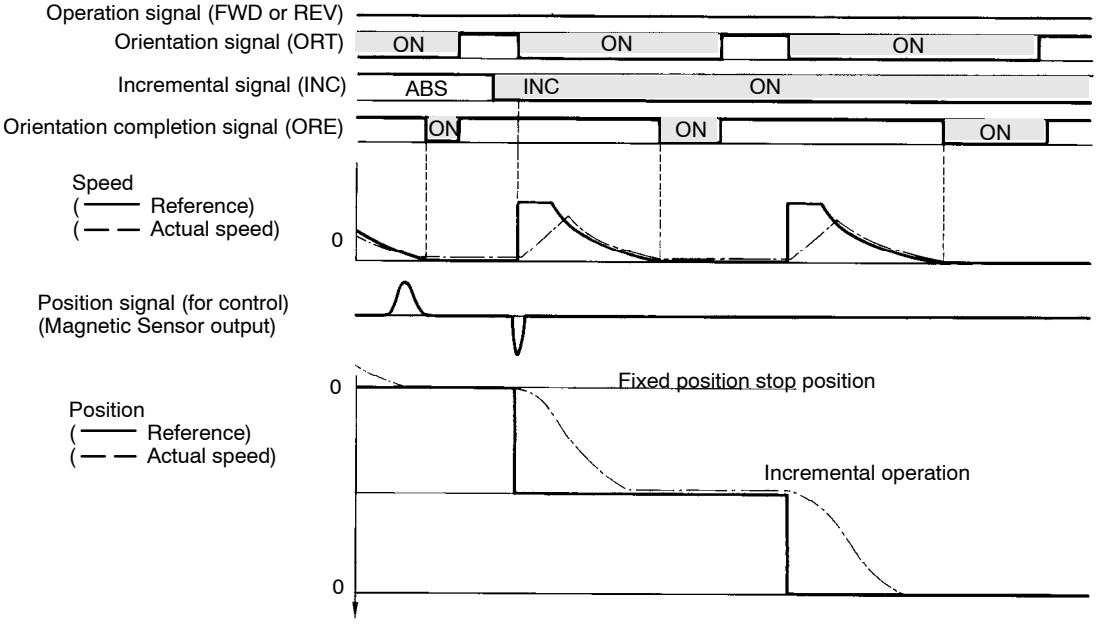
9.10.2 User-set Position Stop Control Using Incremental Operations

Incremental positioning is used when positioning to a new stop position that adds to the current stop position a specified amount of travel rotation (i.e., angle).

If an incremental signal is input and an orientation signal is input again after fixed positioning has been completed, the shaft stops at the new stop position according to the servo loop and a completion signal is output at the same time.

In this mode, the shaft advances by the specified rotation travel amount only whenever an orientation signal is input.

The timing chart for the incremental positioning operation is shown in the following diagram.

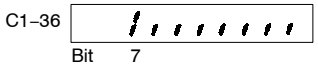


Note: If performing incremental positioning, make sure that the position does not slip while the orientation signal is turned OFF. If the position slips, stop position accuracy may be lost.

Fig 9.17 Incremental Positioning

To use user-set position stop control, select the stop position reference using control constant bit 7 of C1-36 (SEL1).

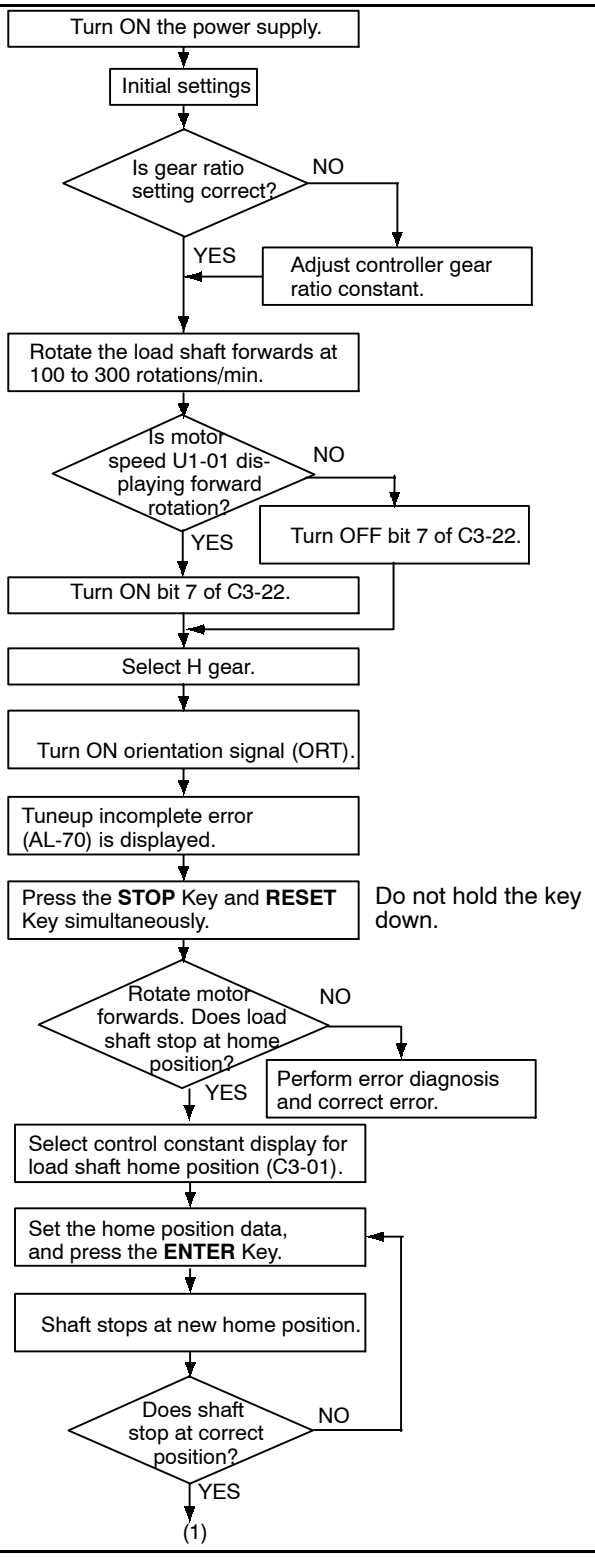
When bit 7 of C1-36 is set to ON, the stop position reference is enabled and user-set position stop can be used during orientation control. Normally, user-set position stop is used as a digital speed reference, so the standard setting is OFF. When bit 7 is OFF, fixed position stop control is used.



9.11 Magnetic Sensor Orientation Control Mode Adjustment Procedure

Adjust the Magnetic Sensor orientation according to the following flowchart. Be sure to perform the following adjustments if the Motor, Inverter, or Encoder is replaced.

Adjustment Item and Procedure	Details



Initial Settings: Change Constants Using Digital Operator

- Turn OFF the orientation selection (bit 0) of selection signal 4 (C1-39).
- Set the sensor signal standardization angle (C3-20).
- Turn OFF the tuneup operation selection (bit 4) of orientation selection signal 1 (C3-22).

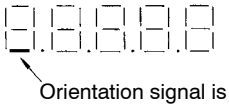
Gear Ratio Constants

- C1-27: Gearbox ratio (H)
- C1-28: Gearbox ratio (M)
- C1-29: Gearbox ratio (L)

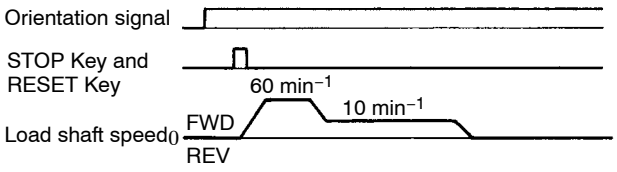
} 0.0400 to 2.5000

Input Signal Check

Interface input status (U1-09)

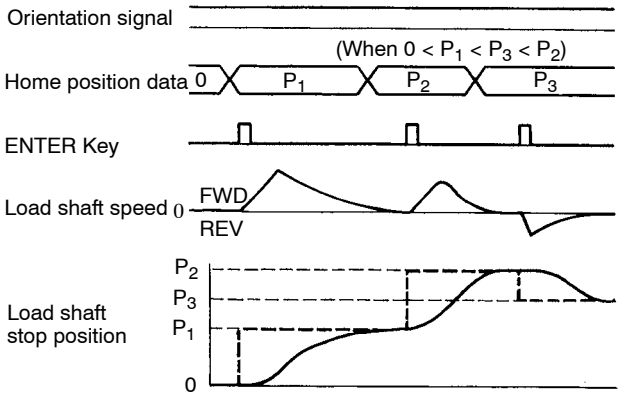


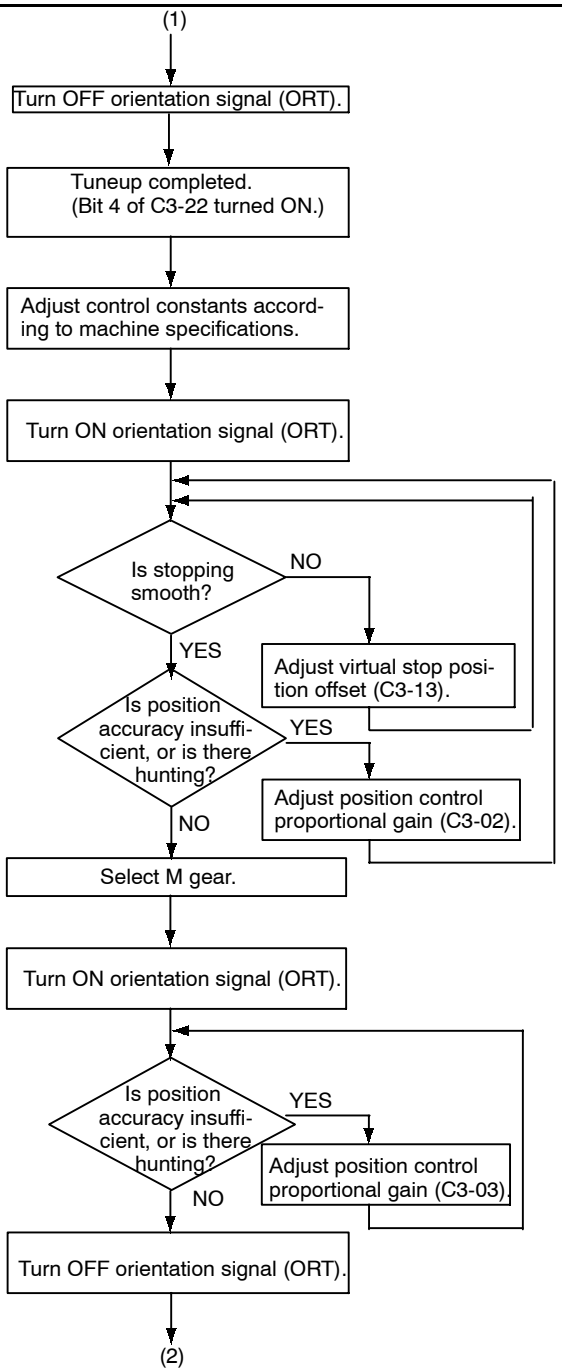
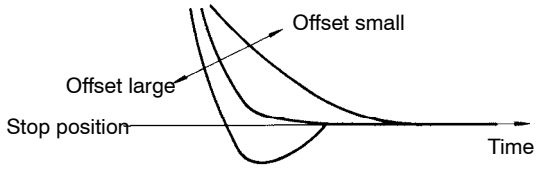
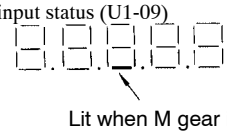
Tuneup Operation



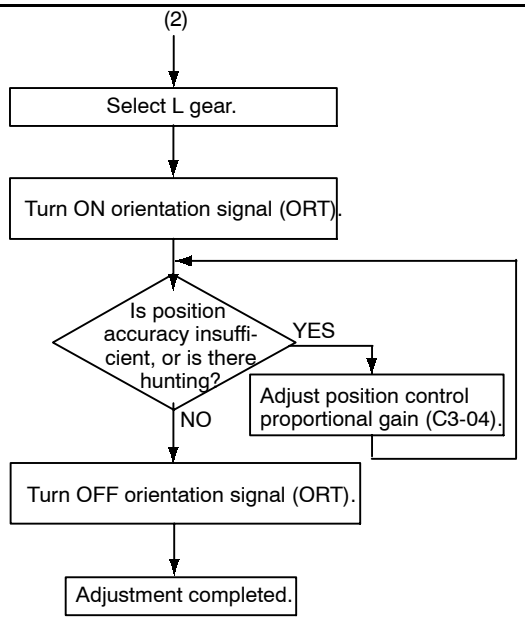
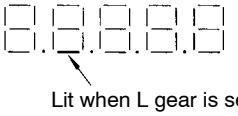
Note: During tuneup, the orientation completion signal (ORE) is not output.

Load Shaft Home Position



Adjustment Item and Procedure	Details
	If a malfunction occurs during tuneup, reset the system, and them perform the tuneup operation again. **Tuneup completed. (Bit 4 of C3-22 turned ON.)** • **Turn ON tuneup operation selection (C3-22 bit 4).** **Adjust Control Constants** **Adjust Virtual Stop Position Offset (C3-13)** • Perform adjustment so that final run-on is not delayed, and there is no overshoot.  • If the load inertia changes, the characteristics will also change, so check the characteristics for the H, M, and L gears individually. **H Gear Selection** **Adjust Proportional Gain (C3-02)** • If the ORE signal is not output close to the stop position, increase the gain. • If the shaft load is unsteady even if the ORE signal is output, reduce the gain. **Check M Gear Selection** • Interface input status (U1-09)  **Adjust Proportional Gain (C3-03)** • If the ORE signal is not output close to the stop position, increase the gain. • If the shaft load is unsteady even if the ORE signal is output, reduce the gain.

9

Adjustment Item and Procedure	Details
	Note: If there is no L gear selection in the machine specifications, omit the following L gear adjustment procedure. **Check L Gear Selection** Interface input status (U1-09)  Lit when L gear is selected. **Adjust Proportional Gain (C3-04)** • If the ORE signal is not output close to the stop position, increase the gain. • If the shaft load is unsteady even if the ORE signal is output, reduce the gain.

10

Control Constants

The control constants of the VS-626M5 can be changed using the Digital Operator (option). The control constants includes user constants (C1), optional encoder orientation constants (C2), and magnetic sensor orientation constants (C3).

10.1 User Constants . . . . . 10 -2
10.2 Encoder Orientation Constants . . . . . 10 -8
10.3 Magnetic Sensor Orientation Constants . 10 -11

10.1 User Constants

The user constants are listed in the following table.

Table 10.1 User Constants

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C1-01	Speed Control Proportional Gain (H) K_{VHN}	Speed control proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF). Increasing K_{VHN} increases rigidity. Torque reference P = K_{VHN} × Speed tolerance	Yes	%/Hz	30	255 1
C1-02	Speed Control Integral Time (H) τ_{VHN}	Speed control integral time constant when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF). Reducing τ_{VHN} quickens response. Torque reference I = Torque reference P × Time/τ_{VHN}	Yes	ms	600	1000 5
C1-03	Speed Control Proportional Gain (M, L) K_{VLN}	Speed control proportional gain when low-speed is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON). Increasing K_{VLN} increases rigidity. Torque reference P = K_{VLN} × Speed tolerance	Yes	%/Hz	30	255 1
C1-04	Speed Control Integral Time Constant (M, L) τ_{VLN}	Speed control integral time constant when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON). Reducing τ_{VLN} quickens response. Torque reference I = Torque reference P × Time/τ_{VLN}	Yes	ms	600	1000 5
C1-05	Speed Control Proportional Gain (H) K_{VHS}	Speed proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in servo mode (i.e., SV is ON). Torque reference P = K_{VHS} × Speed tolerance	Yes	%/Hz	40	255 1
C1-06	Speed Control Integral Time Constant (H) τ_{VHS}	Speed control integral time constant when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in servo mode (i.e., SV is ON). Torque reference I = Torque reference P × Time/τ_{VHS}	Yes	ms	100	1000 5
C1-07	Speed Control Proportional Gain (M, L) K_{VLS}	Speed control proportional gain when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in servo mode (i.e., SV is ON). Torque reference P = K_{VLS} × Speed tolerance	Yes	%/Hz	40	255 1
C1-08	Speed Control Integral Time Constant (M, L) τ_{VLS}	Speed control integral time constant when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in servo mode (i.e., SV is ON). Torque reference I = Torque reference P × Time/τ_{VLS}	Yes	ms	100	1000 5
C1-09	Torque Reference Filter Time Constant τ_T	Time constant of low-pass filter for torque reference for gear chattering noise. Increasing the time constant may cause run-away depending on conditions.	Yes	ms	1.0	5.0 0.0
C1-10	Soft Start Time Setting T_{SFS}	Setting of time required for soft starter. Variations in speed references are suppressed according to the speed change ratio of the set time. Starting time from at rest state is obtained as follows: Starting time = T_{SFS} × Speed reference (%)/100	Yes	sec	0.1	180.0 0.1
C1-11*2	Speed Reference Offset Adjustment Value SC_{OFS}	Offset adjustment to analog reference. Set the value of U1-15 when operating using speed reference 0 in C1-11.	Yes	---	0	80 –80
C1-12*2	Motor Speed Adjustment Value S_{ADJ}	Constant to adjust motor speed over analog speed reference. When the value of S_{ADJ} increases, speed increases, and when the value of S_{ADJ} decreases, speed decreases. Disabled when using digital speed reference.	Yes	---	1.0000	1.1000 0.9000

Table 10.1 User Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C1-13 to C1-15	---	---	---	---	---	--- ---
C1-16*2	Speedometer Signal Adjustment Value SM_{ADJ}	Constant to finely adjust the speed signal so that the actual speed and speedometer display agree. When the value of SM_{ADJ} increases, speedometer indication also increases. A 10-V output is the standard value at rated speed (C1-26).	Yes	---	1.00	1.50 0.90
C1-17*2	Load Meter Signal Adjustment Value LM_{ADJ}	This constant makes fine adjustments so that the torque reference and the load meter display agree. When the value of LM_{ADJ} increases, meter needle indication also increases. A 10-V output is the standard value at 120% of rated torque for 30 min.	Yes	---	1.00	1.50 0.90
C1-18*2	Load Factor Meter Full Scale LM_{FS}	Sets the load meter full scale value when continuous torque is taken to be 100%. The full scale value depends on machine specifications.	Yes	%	200	500 120
C1-19	Zero Speed Detection Level ZS_{LVL}	Detection level of zero-speed signal (ZSPD). Standard setting is 30 min^{-1}.	Yes	min^{-1}	30	60 3
C1-20	Speed Agree Signal Detection Width AGR_{BD}	Detection width of speed-agree signal at rated speed. Standard setting is 15%.	Yes	%	15	50 10
C1-21	Speed Detection Signal Level SD_{LVL}	Speed detection signal (SDET) activation level used for winding selection. Expressed as a percent of the motor rated speed (C1-26).	Yes	%	10	100 0
C1-22	Speed Detection Signal Detection Width SD_{HYS}	Hysteresis width adjustment level of speed signal detection. During acceleration, SDLVL + SDHYS is detected. During deceleration, SDLVL – SDHYS is detected. Expressed as a percent of the motor rated speed (C1-26).	Yes	%	1.00	10.00 0.00
C1-23	Torque Detection Signal Operation Level TD_{LVL}	Torque detection signal (TDET) activation level used to detect abnormal loads. Expressed as a percent of the 30-minute rated torque. Hysteresis width is limited to ±10%.	Yes	%	10	120 5
C1-24	External Control Torque Limit Level TL_{EXT}	Torque limit using external torque limit signals (TLL and TLH). Expressed as a percent of the 30-minute rated torque.	Yes	%	10	120 5
C1-25	Motor Code Selection MTR	Select applicable motor from the motor codes stored in Inverter memory. Expressed in 3-digit hexadecimal (0 to F). When the motor code is changed, be sure to turn OFF the power once; and then turn it ON again after verifying that the Digital Operator display has gone OFF.	No	---	---	1FF 001
C1-26	Rated Speed S_{100}	Rated speed set according to load machine specifications. Must not be greater than the motor maximum speed. When speed reference is 100%, this speed is applied.	No	min^{-1}	Max. speed	Max. speed 100
C1-27	Gear Ratio 1 (H) R_{HGR}	Gear ratio determined by mechanical specifications. This parameter is valid when H gear is selected (i.e., HGR and MGR are OFF). Gear ratio = Load shaft speed ÷ Motor speed	No	---	1.0000	2.5000 0.0400
C1-28	Gear Ratio 2 (M) R_{MGR}	Gear ratio determined by mechanical specifications. This parameter is valid when M gear is selected (i.e., MGR is ON). Gear ratio = Load shaft speed ÷ Motor speed	No	---	1.0000	2.5000 0.0400
C1-29	Gear Ratio 3 (L) R_{LGR}	Gear ratio determined by mechanical specifications. This parameter is valid when L gear is selected (i.e., LGR is ON). Gear ratio = Load shaft speed ÷ Motor speed	No	---	1.0000	2.5000 0.0400
C1-30	Motor Flux Lower Limit Level ϕ_{WL}	Set value of motor flux lower limit level at reduction control	No	%	15	100 15

Table 10.1 User Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C1-31	Servo Mode Flux Level (H) ϕ_{SVH}	Motor flux level when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in servo mode (i.e., SV is OFF).	No	%	70	100 30
C1-32	Servo Mode Base Speed Ratio (H) R_{BSH}	Base speed ratio when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in servo mode (i.e., SV is ON). Base speed (Servo) = R_{BSH} × Base speed (Motor)	No	---	1.00	5.00 1.00
C1-33	Servo Mode Flux Level (M, L) ϕ_{SVL}	Motor flux level when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in servo mode (i.e., SV is ON).	No	%	70	100 30
C1-34	Servo Mode Base Speed Ratio (M, L) R_{BSL}	Base speed ratio when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in servo mode (i.e., SV is ON). Base speed (Servo) = R_{BSL} × Base speed (Motor)	No	---	1.00	5.00 1.00
C1-35	Zero-speed Braking Time T_{BLK}	Time for generating braking force after deceleration and zero-speed is reached to stop.	No	sec	0	100 0
C1-36	Signal Selections 1 SEL1*4	Selections for multi-functional signals and other selections.*3 • Bits 1 and 0: 6CN pin 11 00: TLL 01: --- 10: INC 11: --- • Bit 2: 6CN pin 10 0: TLH 1: --- • Bit 3: 6CN pin 12 0: SSC 1: SV • Bit 4: 6CN pin 15*2 0: PPI 1: LM10 • Bit 7: 1CN 12-bit digital reference signal selection*2 0: Digital speed reference 1: Orientation control stop position reference	No	---	00000000	---
C1-37	Signal Selections 2 SEL2*4	Selections for multi-functional signals and other selections.*3 • Bits 1 and 0: RUN mode selection 00: Operation by speed reference 11: Operation by Digital Operator • Bit 2: 6CN pin 6 0: RDY 1: EMG2 • Bits 7 and 6: Digital speed reference selection*2 00: 2-digit BCD 01: 12-bit binary 10: 3-digit BCD 11: Internal speed setting	No	---	01000000	---

Table 10.1 User Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C1-38	Signal Selections 3 SEL3*4	Signal selections for control mode and level • Bits 1 and 0: Load meter filter selection*2 00: 2-ms filter 01: 10-ms filter 10: 100-ms filter 11: 500-ms filter • Bit 2: Torque limit auto judgement 0: Speed reference gain switching OFF 1: Speed reference gain switching ON • Bit 3: Sensitivity switching selection when using servo mode*2 0: Not judged 1: Judged • Bit 4: Excessive speed deviation protection (AL-32) operation threshold 0: 1/2 or less of speed reference 1: 1/4 or less of speed reference • Bit 5: Speed limiting level*2 0: 105% of rated reference 1: 110% of rated reference • Bit 6: Speed agree signal (AGR) output at zero speed 0: Output (AGR: closed) 1: Not output (AGR: open) • Bit 7: Load meter adjustment selection*2 0: 120% of rated output signal for 30 min. 1: 100% of continuous rated output signal	No	---	00000000	---
C1-39	Signal Selections 4 SEL4*4	Signal selections for control mode and level • Bit 0: Orientation control method 0: Encoder 1: Magnetic sensor When the setting has changed, turn the control power supply OFF then ON again.	No	---	00000000	---
C1-40	Signal Selections 5 SEL5*4	Control mode signal selections • Bit 1 and 0: Operation delay time for excessive speed deviation protection (AL-32) 00: 0 s 01: 0.3 s 10: 0.4 s 11: 0.5 s • Bit 2: Torque detection signal (TDET) output 0: Standard output 1: ON for acceleration/deceleration • Bit 3: NC orientation 0: Disabled. 1: Enabled. Even if orientation signal (ORT) is input, the Inverter will not perform orientation. The rotating direction of motor is determined according to the polarity of speed reference. • Bit 4: Load meter output standard selection*2 0: Continuous rated output 1: 30 min. rated output • Bit 5: Servo mode speed reference gain selection (Enabled when bit 3 of C1-38 is ON.)*2 0: Analog speed reference, 10 V/5,000 rotations/min. 1: Set the read gain of the analog speed reference using C1-49 or C1-50. • Bit 7: Load fault detection selection (AL-33) 0: Disabled 1: Enabled	No	---	00000000	---

<table>
<tr><th>Constant No.</th><th>Name</th><th>Explanation</th><th>Change *1</th><th>Unit</th><th>Standard Setting</th><th>Upper Limit/ Lower Limit</th></tr>
<tr><td>C1-41 to C1-48*2</td><td>Internal Speed Reference Set Values SPD1 to SPD8</td><td>Set values when using internal speed references using digital speed references. The correspondence with reference inputs (1CN) are as shown below, and are given as percentages over the rated speed (C1-26).
Pin 19: SPD1 Pin 23: SPD5
Pin 20: SPD2 Pin 24: SPD6
Pin 21: SPD3 Pin 25: SPD7
Pin 22: SPD4 Pin 26: SPD8</td><td>No</td><td>%</td><td>0.00</td><td>100.00
0.00</td></tr>
<tr><td>C1-49 to C1-50*2</td><td>Servo Mode Speed Reference Gain SVGAIN1 and SVGAIN2</td><td>Set value of the analog speed reference read gain in servo mode. (Enabled when C1-38 bit 3 is ON and C1-40 bit 5 is ON.) Set the ratio of the number of rotations when the analog speed reference is 10 V over the rated speed (C1-26).
Analog speed reference 10 V/(S100 x SVGAIN/100) min^{-1}.
Select C1-49 and C1-50 using the DAS signal (C6N-5).
DAS = OFF: C1-49 (SVGAIN1)
DAS = ON: C1-50 (SVGAIN2)</td><td>No</td><td>%</td><td>100.00</td><td>100.00
0.00</td></tr>
<tr><td>C1-51 to C1-53</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>C1-54*2</td><td>Speedmeter Signal Offset Adjustment Value SM_{OFS}</td><td>Offset adjustment value for speedometer signal. Outputs speedometer signal after subtracting from SM_{OFS}.</td><td>Yes</td><td>5.4 mV</td><td>0</td><td>200
–200</td></tr>
<tr><td>C1-55*2</td><td>Load Meter Signal Offset Adjustment Value LM_{OFS}</td><td>Offset adjustment value for load meter signal. Outputs speedometer signal after subtracting from LM_{OFS}.</td><td>Yes</td><td>5.4 mV</td><td>0</td><td>200
–200</td></tr>
<tr><td>C1-56</td><td>Inverter Capacity Selection UNITNO</td><td>Inverter capacity setting. (The setting is already made at factory prior to shipment.)
200 V class
<table>
<tr><td>CIMR –M5 □</td><td>23P7</td><td>25P5</td><td>27P5</td><td>2011</td><td>2015</td><td>2018</td><td>2022</td><td>2030</td><td>2037</td></tr>
<tr><td>Set value</td><td>04</td><td>05</td><td>06</td><td>07</td><td>08</td><td>09</td><td>0A</td><td>0B</td><td>0C</td></tr>
</table>
400 V class
<table>
<tr><td>CIMR –M5 □</td><td>45P5</td><td>47P5</td><td>4011</td><td>4015</td><td>4018</td><td>4022</td><td>4030</td><td>4037</td><td>4045</td></tr>
<tr><td>Set value</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>2A</td><td>2B</td><td>2C</td><td>2D</td></tr>
</table>
When the setting has changed, turn the control power supply OFF for 3 seconds or longer then ON again.</td><td>No</td><td>---</td><td>---</td><td>---</td></tr>
<tr><td>C1-57</td><td>Signal Selections 6 SEL6*4</td><td>Control mode signal selections
• Bit 0: Fault record clear selection
0: Disabled
1: Clears next time control power is turned ON.
(Automatically returns to 0.)
• Bit 4 and 5: Emergency stop fault (AL-21) detection time selection *5
00: 10 sec
01: 20 sec
10: 40 sec
11: Disabled</td><td>No</td><td>---</td><td>00000000</td><td>---</td></tr>
<tr><td>C1-58</td><td>Signal Selections 7 SEL7*4</td><td>Control mode signal selections
• Bit 0: YENET1200 card encoder selection
0: Motor encoder (2CN)
1: Load shaft encoder (8CN)
When the setting has changed, turn the control power supply OFF then ON again.</td><td>No</td><td>---</td><td>00000000</td><td>---</td></tr>
<tr><td>C1-59</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td><td>---</td></tr>
</table>

Table 10.1 User Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C1-60	Magnetic Pole Positioning Value*6	Adjusts the position of the magnetic pole. Sets the difference between the magnetic position and the encoder origin signal using the electrical angle (360° el = 8192). Set the C1-60 value on the terminal box. When the setting has changed, turn the control power supply OFF then ON again.	No	---	4096	8191 –8192
C1-61	Phase-C Pulse Width*6	Sets the pulse width of the motor encoder origin signal (phase C). Set the C1-61 value listed on the terminal box. When the setting has changed, turn the control power supply OFF then ON again.	No	Pulse	7	100 0

*1. *Change* (change during operation) column: Indicates whether the constant can be changed during inverter operation.
Yes: Constant can be changed during inverter operation; No: Constant cannot be changed during inverter operation

*2. This constant is enabled for stand-alone drives (M5A) only. Do not change the set value for NC system s (M5N).

*3. Connector pin numbers are for stand-alone drives.

*4. In signal selection descriptions, 0 stands for " " and 1 for " ."

*5. This function is available in the following software.
VSM200XXX: VSM200112 or later

*6. Constants only for IPM motors (with syncs using flush-type permanent magnets). C1-60 and C1-61 are not displayed when the software for controlling an induction motor is used.

10.2 Encoder Orientation Constants

The encoder orientation constants are listed in the following table.

Table 10.2 Encoder Orientation Constants

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit / Lower Limit
C2-01	Load Shaft Positioning Origin P_{ORG}	Mechanical origin of the load shaft. Set difference from encoder origin signal (phase C) pulses.	Yes	Pulse	0	4095 0
C2-02	Position Control Proportional Gain (H) K_{PH}	Position control proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF). Increasing K_{PH} increases rigidity. Speed reference (pps) = K_{PH} × Position tolerance (pulses)	Yes	1/s	15	99 1
C2-03	Position Control Proportional Gain (M) K_{PM}	Position control proportional gain when medium-speed gear is selected (i.e., MGR is ON). Increasing K_{PM} increases rigidity. Speed reference (pps) = K_{PM} × Position tolerance (pulses)	Yes	1/s	15	99 1
C2-04	Position Control Proportional Gain (L) K_{PL}	Position control proportional gain when low-speed gear is selected (i.e., LGR is ON) or when low-speed winding is selected (i.e., CHW is ON). Increasing K_{PL} increases rigidity. Speed reference (pps) = K_{PL} × Position tolerance (pulses)	Yes	1/s	15	99 1
C2-05	Speed Control Proportional Gain (H) K_{VHO}	Speed control proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in orientation control (i.e., ORT is ON). Torque reference P = K_{VHO} × Speed tolerance	Yes	%/Hz	40	255 1
C2-06	Speed Control Integral Time Constant (H) τ_{VHO}	Speed control integral time constant when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in orientation control (i.e., ORT is ON). Torque reference I = Torque reference P × Time/τ_{VHO}	Yes	ms	100	1000 5
C2-07	Speed Control Proportional Gain (M, L) K_{VLO}	Speed control proportional gain when low-speed gear is selected (i.e., MGR or LGR is ON) or when high-speed winding is selected (i.e., CHW is ON) in orientation control (i.e., ORT is ON). Torque reference P = K_{VLO} × Speed tolerance	Yes	%/Hz	40	255 1
C2-08	Speed Control Integral Time Constant (M, L) τ_{VLO}	Speed control integral time constant when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in orientation control (i.e., ORT is ON). Torque reference I = Torque reference P × Time/τ_{VLO}	Yes	ms	100	1000 5
C2-09	Positioning Completion Detection Width Z_{FIN}	Detection width for outputting completion signal when the load shaft approaches the stop reference position. Detection width is stop reference position ±Z_{FIN}.	No	Pulse	5	200 0
C2-10	Positioning Completion Cancel Width Z_{CAN}	Set value for canceling completion signal when the load shaft is moved after completion signal is output. Cancel width is stop reference position ±Z_{CAN}.	No	Pulse	10	200 Z_{FIN}
C2-11	Orientation Speed S_{ORT}	Speed applied (after detecting encoder origin) until changing to the servo loop during orientation.	No	min^{-1}	400	600 40
C2-12	BCD Stop Position Reference Resolution P_{BCD}	Angle set value per minimum increment of stop position BCD command.	No	Deg.	1.0	180.0 0.5
C2-13	Virtual Stop Position Offset P_{IMG}	Stop position offset for smoothing stop operation when the servo loop is used. When Z_{FIN} is reached, offset becomes 0.	No	Pulse	0	100 0
C2-14	Orientation Speed Changing Ratio R_{SOR}	Speed changing ratio for gradually reducing orientation speed to reduce gear noise when switching from orientation speed to servo loop speed.	No	---	0	100 0
C2-15	Starting Soft Start Time T_{SFO}	Soft start time for accelerating from at rest state to orientation speed. Use this parameter to reduce gear noise at starting. Acceleration rate is (500 min^{-1})/sec.	No	ms	0	50 0

Table 10.2 Encoder Orientation Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C2-16	Flux Level ϕ_{ORT}	Flux level at completion of orientation. Motor noise and torque changes in proportion to flux level.	No	%	60	100
C2-17	Orientation Speed Reduction Coefficient K_{SOR}	Reduction coefficient to set orientation speed in proportion to the traveling angle for incremental positioning.	No	---	0	32767 0
C2-18 to C2-21	---	---	---	---	---	--- ---
C2-22	Orientation Control Signal Selections 1 SEL-E1*2	Control mode setting signals, e.g., for specifying the direction of rotation in orientation control. • Bits 1 and 0: Positioning rotation direction 00: Automatically selected rotation direction 01: Same direction as the forward/reverse RUN signal 10: Fixed rotation direction 11: Automatically selected rotation direction • Bit 2: Selection for fixed rotation direction 0: Forward rotation of load shaft 1: Reverse rotation of load shaft • Bit 3: Stop position reference code 0: 12-bit binary 1: 3-digit BCD • Bit 4: Tuneup operation 0: Tuneup enabled 1: Tuneup disabled • Bit 5: Incremental positioning reference point 0: Previous stop reference position 1: Current stop position • Bit 6: Encoder selection 0: Load shaft encoder 1: Motor encoder • Bit 7: Rotation direction of motor and load shaft (automatically set at tuneup) 0: Reverse 1: Same	No	---	11000000	--- --- ---
C2-23	Orientation Control Signal Selections 2 SEL-E2*2	Dither signal pattern and gain • Bit 0: DB selection upon orientation completion 0: Disabled 1: Stops by braking torque at orientation completion • Bit 1: Dither signal pattern 0: 6 steps (83 Hz) 1: 2 steps (250 Hz) • Bits 4, 3 and 2: Dither signal level (H) (i.e., MGR and LGR are OFF) 000: 0.0% 011: 7.5% 110: 15.0% 001: 2.5% 100: 10.0% 111: 17.5% 010: 5.0% 101: 12.5% • Bits 7, 6 and 5: Dither signal level (L) (i.e., MGR or LGR is ON) 000: 0% 011: 3% 110: 6% 001: 1% 100: 4% 111: 7% 010: 2% 101: 5%	No	---	00000000	--- --- ---

Table 10.2 Encoder Orientation Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C2-24	Orientation Control Signal Selections 3 SEL-E3*2	Orientation control parameters • Bit 3: Speed control mode selection when positioning *3 0: P control 1: PI control • Bits 5 and 4: Seed reference differential compensation gain 00: 10 01: 15 10: 20 11: 30 • Bits 7 and 6: Flux level for positioning servo loop control 00: 100% 01: 80% 10: 60% 11: 40%	No	---	10000000	--- --- ---

*1. *Change* (change during operation) column: Indicates whether the constant can be changed during inverter operation.
Yes: Constant can be changed during inverter operation; No: Constant cannot be changed during inverter operation

*2. In signal selection descriptions, 0 stands for " " and 1 for " ."

*3. This function available in the following software.
VSM200XXX: VSM200095 or later
VSM2051XX: VSM205120 or later
VSM207XXX: VSM207051 or later

10.3 Magnetic Sensor Orientation Constants

The magnetic sensor orientation constants are listed in the following table.

Table 10.3 Magnetic Sensor Orientation Constants

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C3-01	Load Shaft Positioning Origin P_{ORG}	Mechanical origin of the load shaft. Set difference from magnetic sensor signal in degrees.	Yes	Deg.	0.00	2.00 –2.00
C3-02	Position Control Proportional Gain (H) K_{PH}	Position control proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF). Increasing K_{PH} increases rigidity. Speed reference (pps) = K_{PH} × Position tolerance (pulses)	Yes	1/sec	15	99 1
C3-03	Position Control Proportional Gain (M) K_{PM}	Position control proportional gain when medium-speed gear is selected (i.e., MGR is ON). Increasing K_{PM} increases rigidity. Speed reference (pps) = K_{PM} × Position tolerance (pulses)	Yes	1/sec	15	99 1
C3-04	Position Control Proportional Gain (L) K_{PL}	Position control proportional gain when low-speed gear is selected (i.e., LGR is ON) or when low-speed winding is selected (i.e., CHW is ON). Increasing K_{PL} increases rigidity. Speed reference (pps) = K_{PL} × Position tolerance (pulses)	Yes	1/sec	15	99 1
C3-05	Speed Control Proportional Gain (H) K_{VHO}	Speed control proportional gain when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in orientation control (i.e., ORT is ON). Torque reference P = K_{VHO} × Speed tolerance	Yes	%/Hz	40	255 1
C3-06	Speed Control Integral Time Constant (H) τ_{VHO}	Speed control integral time constant when high-speed gear is selected (i.e., MGR and LGR are OFF) or when high-speed winding is selected (i.e., CHW is OFF) in orientation control (i.e., ORT is ON). Torque reference I = Torque reference P × Time /τ_{VHO}	Yes	ms	100	1000 5
C3-07	Speed Control Proportional Gain (M, L) K_{VLO}	Speed control proportional gain when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in orientation control (i.e., ORT is ON). Torque reference P = K_{VLO} × Speed tolerance	Yes	%/Hz	40	255 1
C3-08	Speed Control Integral Time Constant (M, L) τ_{VLO}	Speed control integral time constant when low-speed gear is selected (i.e., MGR or LGR is ON) or when low-speed winding is selected (i.e., CHW is ON) in orientation control (i.e., ORT is ON). Torque reference I = Torque reference P × Time /τ_{VLO}	Yes	ms	100	1000 5
C3-09	Positioning Completion Detection Width Z_{FIN}	Detection width for outputting completion signal when the load shaft approaches the stop reference position. Detection width is stop reference position ±Z_{FIN}.	No	Deg.	0.5	20.0 0.0
C3-10	Positioning Completion Cancel Width Z_{CAN}	Set value for canceling completion signal when the load shaft is moved after completion signal is output. Cancel width at stop reference position ±Z_{CAN}.	No	Deg.	1.0	20.0 Z_{FIN}
C3-11	Orientation Speed S_{ORT}	Speed applied (after detecting magnetic sensor signal) until changing to the servo loop during orientation.	No	min^{-1}	400	600 40
C3-12	BCD Stop Position Reference Resolution P_{BCD}	Completion signal cancel angle per minimum increment for determining stop position for incremental positioning with BCD command after stopping at home position.	No	Deg.	1.0	180.0 0.5
C3-13	Virtual Stop Position Offset P_{IMG}	Stop position offset for smoothing stop operation when the servo loop is used. When Z_{FIN} is reached, offset becomes 0.	No	Deg.	0.0	10.0 0
C3-14	Orientation Speed Changing Ratio	Speed changing ratio for gradually reducing orientation speed to reduce gear noise when switching from orientation speed to servo loop speed.	No	---	0	100 0

Table 10.3 Magnetic Sensor Orientation Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C3-15	Starting Soft Start Time T_{SFO}	Soft start time for accelerating from stop to orientation speed. Use this parameter to reduce gear noise at starting. Acceleration rate is (500 min^{-1})/sec.	No	ms	0	50 0
C3-16	Flux Level ϕ_{ORT}	Flux level at completion of orientation. Motor noise and torque change in proportion to flux level.	No	---	60	100 15
C3-17	Orientation Speed Reduction Coefficient K_{SOR}	Reduction coefficient to set orientation speed in proportion to the traveling angle for incremental positioning.	No	---	0	32767 0
C3-18	---	---	---	---	---	---
C3-19	---	---	---	---	---	---
C3-20	Sensor Signal Standardization Angle θ_{SEN}	Angle for standardizing magnetic sensor signal detection sensitivity $\theta_{SEN} = 180° \times$ Detection range (mm (inches)) ÷ Mounting radius ÷ π Set 20.0 to θ_{SEN} when $\theta_{SEN} > 20.0$. For detection range, check the specifications of the magnetizer and apply the values below: MG-1378BS (15 mm (0.59 inches)) MG-1444S (7 mm (0.28 inches))	No	Deg.	5.0	20.0 5.0
C3-21	---	---	---	---	---	---
C3-22	Orientation Control Signal Selections 1 SEL-M1*2	Control mode setting signals, e.g., for specifying the direction of rotation in orientation control. • Bits 1 and 0: Positioning rotation direction 00: Automatically selected rotation direction 01: Same direction as the forward/reverse run signal 10: Fixed rotation direction 11: Automatically selected rotation direction • Bit 2: Selection for fixed rotation direction 0: Forward rotation of load shaft 1: Reverse rotation of load shaft • Bit 3: Stop position reference code 0: 12-bit binary 1: 3-digit BCD • Bit 4: Tuneup operation 0: Tuneup enabled 1: Tuneup disabled • Bit 5: Incremental positioning reference point 0: Previous stop reference position 1: Current stop position • Bit 6: Encoder selection 0: Load shaft encoder 1: Motor encoder • Bit 7: Rotation direction of motor and load shaft 0: Reverse 1: The same	No	---	11000000	---
C3-23	Orientation Control Signal Selections 2 SEL-M2*2	Dither signal pattern and gain • Bit 1: Dither signal pattern 0: 6 steps (83 Hz) 1: 2 steps (250 Hz) • Bits 4, 3, and 2: Dither signal level (H) (i.e., MGR and LGR are OFF) 000: 0.0% 011: 7.5% 110: 15.0% 001: 2.5% 100: 10.0% 111: 17.5% 010: 5.0% 101: 12.5% • Bit 7, 6, and 5: Dither signal level (L) (i.e., MGR or LGR is ON) 000: 0% 011: 3% 110: 6% 001: 1% 100: 4% 111: 7% 010: 2% 101: 5%	No	---	00000000	---

Table 10.3 Magnetic Sensor Orientation Constants (continued)

Constant No.	Name	Explanation	Change *1	Unit	Standard Setting	Upper Limit/ Lower Limit
C3-24	Orientation Control Signal Selections 3 SEL-M3*2	Orientation control parameters • Bits 5 and 4: Speed reference differential compensation gain 00: 10 01: 15 10: 20 11: 30 • Bits 7 and 6: Flux level for positioning servo loop control 00: 100% 01: 80% 10: 60% 11: 40%	No	---	10000000	---

*1. *Change* (change during operation) column: Indicates whether the constant can be changed during inverter operation.
Yes: Constant can be changed during inverter operation; No: Constant cannot be changed during inverter operation
*2. In signal selection descriptions, 0 stands for " " and 1 for " ."

11

Operating Status Displays

The operating status of the VS-626M5 can be monitored on the Digital Operator (option). The operating status displays include Inverter operation (U1), optional encoder orientation control (U2), and magnetic sensor orientation control (U3).

11.1 Inverter Operating Status . . . . . 11 -2

11.2 Encoder Orientation Control Status . . . . . 11 -3

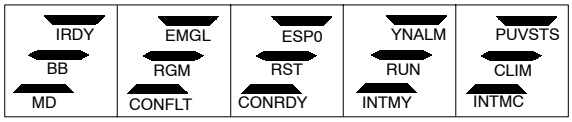
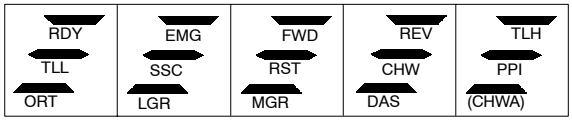
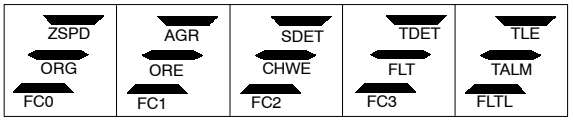
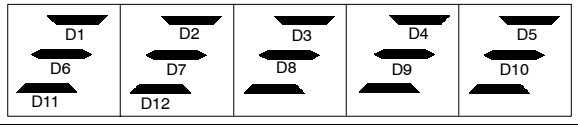
11.3 Magnetic Sensor Orientation Control Status . . . . . 11 -3

11.4 Miscellaneous Status Displays . . . . . 11 -4

11.1 Inverter Operating Status

The status displays when the Inverter is operating are listed in the following table.

Table 11.1 Operating Status Displays for Inverter Operation

No.	Signal Name	Explanation	Unit
U1-01	Motor speed	Speed detected by the motor encoder	min^{-1}
U1-02	Speed reference	Speed control reference. Percentage of the rated speed (C1-26)	%
U1-03	Load shaft speed	Product of motor speed and gear transmission ratio	min^{-1}
U1-04	Torque reference	Percentage of 30-minute rating (100%)	%
U1-05	–––	–––––––––	
U1-06	Inverter output current	Detected Inverter output current converted to amperes. Accuracy: ±3%	A
U1-07	Output frequency	Inverter output current frequency	Hz
U1-08*1	Internal status	Operating status signal (at logical level) 	
U1-09	Input signal status	Sequence input signal ON/OFF status*2 	
U1-10	Output signal status	Sequence output signal ON/OFF status*2 	
U1-11	Inverter capacity	Inverter unit 30-minute rated capacity	kW
U1-12	Inverter internal temperature	Detected Inverter internal temperature (control PC board)	°C
U1-13	Heatsink temperature	Detected heatsink temperature of Inverter. Accuracy: ±5°C (±41°F)	°C
U1-14*1	DC bus voltage	Main circuit capacitor voltage	V
U1-15*1	Analog speed reference A/D converter	Conversion value of analog reference used to adjust the speed reference offset.	
U1-16	–––	–––––––––	
U1-17*1	Phase-U current	Detected phase-U current converted from analog to digital	
U1-18*1	Phase-W current	Detected phase-W current converted from analog to digital	
U1-19*3	12-bit digital reference signal status	On/OFF status of 12-bit digital reference signal.*2 	
U1-20	LED check	All LEDs on the Digital Operator light when U1-20 is selected.	
U1-21	PROM No.	PROM software version number is displayed (lower 5 digits).	

* 1. Operating status display data for in-house adjustment.

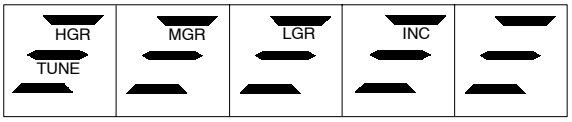
* 2. The LED segments for ON I/O signals will light.

* 3. Operating status display is enabled for independent drives (M5A) only.

11.2 Encoder Orientation Control Status

The status displays for encoder orientation control are listed in the following table.

Table 11.2 Operating Status Displays Functions for Encoder Orientation Control

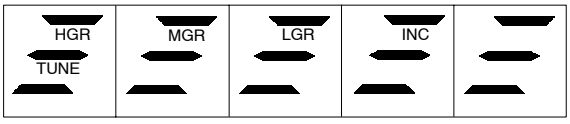
No.	Signal Name	Explanation	Unit
U2-01	I/O signal status	Orientation I/O signal status (See note.) 	
U2-02	–––	–––––––	
U2-03	Position monitor	Actual position expressed by dividing one rotation by 4096 in reference to the set origin	Pulses
U2-04	Stop reference position	Stop reference position expressed by dividing one rotation by 4096 in reference to the set origin	Pulses
U2-05	Position deviation	Difference between stop reference position and current position in pulses	Pulses
U2-06	Positioning time	Time from input of orientation command to output of completion signal	× 2 ms

Note: The LED segments for ON I/O signals will light.

11.3 Magnetic Sensor Orientation Control Status

The status displays for magnetic sensor orientation control are listed in the following table.

Table 11.3 Operating Status Displays for Magnetic Sensor Orientation Control

No.	Signal Name	Explanation	Unit
U3-01	I/O signal status	Orientation I/O signal status*1 	
U3-02*2	Magnetic sensor signal level	AD converted value of magnetic sensor signal	
U3-03	Position monitor	Actual position expressed by dividing one rotation by 4096 in reference to the set origin	Pulses
U3-04	stop reference position	stop reference position expressed in reference to the set origin	Pulses
U3-05	Speed deviation	Difference between stop reference position and current position in pulses	Pulses
U3-06	Positioning time	Time from input of orientation command to output of completion of signal	× 2 ms

* 1. Operating status display data for in-house adjustment.

* 2. The LED segments for ON I/O signals will light.

11.4 Miscellaneous Status Displays

The miscellaneous status displays are listed in the following table.

Table 11.4 Miscellaneous Operating Status Displays

No.	Signal Name	Explanation	Unit
U7-01	Motor temperature	Detected temperature for motor overheat protection	°C
U7-02	Slip frequency*	Slip frequency to be applied to the motor	Hz

* Operating status display data for in-house adjustment.

12

Troubleshooting

This chapter describes the Inverter and Converter fault displays, the faults caused by motor malfunctions, and the corrective actions to be taken.

12.1 Troubleshooting Outline . . . . . 12 -2
12.2 Converter Faults . . . . . 12 -3
12.3 Inverter Faults . . . . . 12 -5
12.4 Motor Faults and Corrective Actions . . . . 12 -13

12.1 Troubleshooting Outline

When the Inverter or Converter detects a fault, the fault number is displayed on the 7-segment display or the Digital Operator, outputs an error signal, and the motor coasts to a stop. Check the cause in tables 12.1 to 12.3 and take corrective actions.

If the inspections or corrective actions described cannot solve the problem, contact your YASKAWA representative immediately.

To restart, turn ON the reset input signal of NC machine, press the RESET Key or shut OFF the main circuit power supply once to reset the stop status.

IMPORTANT

Precautions on Resetting Faults

- To reset a fault from the Digital Operator after removing the cause, press the RESET Key in fault display mode. The RESET Key will not reset the fault in any other mode.
- Before resetting, turn OFF the RUN signals (FWD, REV, ORT) that are externally input.

12.2 Converter Faults

If a fault occurs during operation, protective functions are activated depending on the fault and operation is stopped. The contents of the faults are displayed numerically on the 7-segment display.

Table 12.1 Converter Faults

Fault No.	Name	Meaning	Corrective Actions
01	Overcurrent	Output current exceeded overcurrent detection level.	• Check the wiring. • Check the input supply voltage. • Check the AC reactor. • Check the load shaft (Inverter, Servo) capacity.
04	Main circuit fuse blown	Main circuit fuse was blown.	Check for damaged transistor, load short circuit, ground short, etc.
05	Overload	Output current exceeded overload level.	• Reduce the load. • Check the load shaft (Inverter, Servo) capacity.
11	Output overvoltage	Output voltage exceeded overvoltage level. Detection level: 200 V class: Approx. 400 V 400 V class: Approx. 800 V	• Check the input supply voltage. • Check the load shaft (Inverter, Servo) capacity.
12	Main circuit undervoltage	Main circuit output voltage became lower than undervoltage detection level.	Check the input supply voltage.
13	Control circuit undervoltage	Control circuit power supply became lower than undervoltage detection level.	Check the control supply voltage.
14	Servo unit power supply fault	Control supply voltage supplied to Servo Unit was not normal.	
15	Power supply frequency fault	Excessive power supply frequency deviation (50 Hz or 60 Hz ±5%)	Check the input power waveform.
16	Initial charging fault	Charging of main circuit capacitor was not completed within set time.	Replace the Unit.
17	Power supply open phase	An open phase occurred at input supply.	• Check the input supply voltage. • Check the wiring.
23	Built-in MC operation fault	Magnetic contactor did not function.	Replace the Unit.
43	Heatsink overheat 1	Heatsink temperature exceeded upper limit (minor fault).	Check the ambient temperature for effective cooling.
44	Heatsink overheat 2	Heatsink temperature over upper limit continued for one minute or longer.	
45	Heatsink thermistor disconnection	Thermistor for heatsink temperature detection was disconnected.	Replace the unit.
		The ambient temperature is low (–20°C (–4°F) or below).	Raise the ambient temperature to above –20°C (–4°F).
46	Control PCB temperature fault 1	Control PCB temperature exceeded 80°C (176°F) (minor fault).	Check the ambient temperature for effective cooling.
47	Control PCB temperature fault 2	Control PCB temperature exceeded 85°C (185°F).	

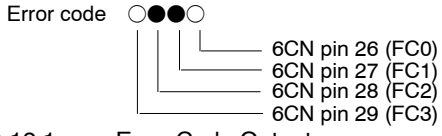
Table 12.1 Converter Faults (continued)

Fault No.	Name	Meaning	Corrective Actions
d2	CPU built-in A/D error	Built-in A/D Converter error	Replace the control PCB.
F0	ROM error	Memory (PROM) error	
F1	EEPROM error	Memory (EEPROM) error	
F5	CPU error	CPU error	
• •	Control PCB fault	WDT time exceeded.	

12.3 Inverter Faults

If a fault occurs during operation, protective functions are activated depending on the fault and operation is stopped. The contents of the faults are displayed on the Digital Operator (option) in AL code, and on the Inverter, 7-segment display display as the last two digits of the AL code.

As shown in the following diagram, the error codes (for stand-alone drives only) are shown as ○ for ON and ● for OFF, using the signals output from pins 26 to 29 on 6CN.



(6CN pin 30 is the common.)

Fig 12.1 Error Code Outputs

Table 12.2 Inverter Faults

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-01	Overcurrent	Output current exceeded overcurrent detection value, or Inverter output (load) was short-circuited.	Check the wiring for looseness, etc. Note) Before turning the power ON again, make sure that no short-circuit or ground fault occurs at the Inverter output.	●●●●
AL-02	Ground fault *	Inverter output side ground current exceeded grounding detection level.	• Check the motor for deterioration of insulation. • Check the wiring between Inverter and motor. Note) Before turning the power ON again, make sure that no short-circuit or ground fault occurs at the Inverter output.	●●●●
AL-04	Main circuit fuse blown	DC circuit fuse was blown.	• Check for damage to transistor, short-circuits on load side, ground fault, etc. • Check the Inverter output wiring.	●●●●
AL-05	Inverter output overload	Output current of 120% of 30-minute rating runs for over one minute.	• Reduce the load. • Check the load shaft (Inverter, Servo) capacity.	●●●●
AL-06	Motor overload	Motor overload capacity exceeded.	Reduce the load.	●●●●
AL-07	Motor Overload (When the motor is locked)	The motor exceeded the overload level at low speed (30 min^{-1} or less).	• Check if the load is heavy or a tool is jammed. • Make sure that the motor shaft rotates. (Check if a motor fault or a contact between the rotor and the stator occurs, or if a bearing is damaged.)	●●●●
AL-10	Converter fault	A fault occurred in Converter Unit.	Check fault contents by using Converter LED.	●●●○
AL-11	Main circuit overvoltage	Main circuit DC bus voltage exceeded the overvoltage set value.	• Check the input supply voltage. • Check the load shaft (Inverter, Servo) capacity. • Check the control constants.	●●●○

* The ground fault here is one which occurs in the motor wiring while the motor is running.
A ground fault may not be detected in the following cases.
• A ground fault with low resistance which occurs in motor cables or terminals.
• A ground fault occurs when the power is turned ON.

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL - 12	Main circuit undervoltage	Main circuit DC bus voltage became lower than undervoltage detection level during run.	Check the input supply voltage.	●●●○
AL - 13	Control circuit undervoltage	Control circuit power supply became lower than undervoltage detection level.	Check the control supply voltage.	●●●○
AL -20	Winding selection fault	Winding selection was not completed within set time.	• Check the control constant C1-25. • Check magnetic contactor wiring for winding selection.	●●○●
AL -21	Emergency stop fault	Inverter did not stop within 10 seconds after emergency stop command.	• Check control constant C1-25. • Check the setting of control constant C1-24 and whether external torque limit signals TLL and TLH are input.	●●○●
AL -30	Encoder signal cable disconnection	Motor encoder signal was disconnected or connected improperly.	Check the wiring of encoder signal lines.	●●○○
AL -31	Motor overspeed	Motor speed exceeded 120% of set rated speed.	• Confirm that encoder signal lines are separated from main circuit or other power lines. • Check the control constants.	●●○○
AL -32	Excessive speed deviation	Speed falls to less than 50% of reference value.	• Check if the load is heavy or a tool is jammed. • Check whether external torque limit signals TLL and TLH are input. • Check the control constants. • Check the wiring of encoder signal lines.	●●○○
AL -33	Load fault	Inverter output (U/T1, V/T2, W/T3) was disconnected.	Check Inverter output wiring.	●●○○
AL -34	Motor Lock Detection (For IP motors only)	The motor is locked. (The motor speed remains at 35 min^{-1} or lower for 10 seconds during the torque reference saturation.)	• Check if the load is heavy or a tool is jammed. • Check the wiring between Inverter and motor. • Check the wiring of encoder signal lines. • Make sure that the motor shaft rotates. • Check if a motor fault or a contact between rotor and stator occurs, or if a bearing is damaged.	●●○○
AL -40	Motor overheat 1	Motor temperature exceeded upper limit (minor fault).	• Check the wiring. • Confirm that motor cooling air is normal with power ON. • Confirm that the fan is not clogged with dust or oil. • Check the wiring of motor thermistor signal lines.	●○●●
AL -41	Motor overheat 2	Motor temperature over upper limit continued for over one minute.		●○●●

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-42	Motor thermistor disconnection	Motor temperature detection thermistor was disconnected.	• Check the motor thermistor signal wiring. • Check the motor ambient temperature. (Raise the temperature to above –10°C (14°F) or more.)	●○●●
AL-43	Heatsink overheat 1	Heatsink temperature exceeded upper limit (minor fault).	Check the ambient temperature for effective cooling.	●○●●
AL-44	Heatsink overheat 2	Heatsink temperature over upper limit continued for one minute or longer.		
AL-45	Heatsink thermistor disconnection	Thermistor for heatsink temperature detection was disconnected. The ambient temperature is low (–20°C (–4°F) or below).	• Replace the unit. • Raise the ambient temperature to above –20°C (–4°F).	●○●●
AL-46	Control PCB temperature fault 1	Control PCB temperature exceeded 80°C (176°F) (minor fault).	Check the ambient temperature for effective cooling.	●○●●
AL-47	Control PCB temperature fault 2	Control PCB temperature exceeded 85°C (185°F).		
AL-48	Internal cooling fan fault	Inverter internal cooling fan is stopped.	Replace the internal cooling fan.	●○●●
AL-60	tuneup incomplete (Encoder method orientation)	Orientation command was input before tuning up (minor fault).	Perform orientation tuneup.	●○○●
AL-61	Phase-C signal detection error	Phase-C signal could not be detected during tuning up.	• Check the wiring of encoder signal lines. • Confirm that encoder signal lines are separated from main circuit or other power lines. • Verify that motor and Inverter are grounded. • Replace the Orientation Card. • Replace the encoder.	●○○●
AL-62	Phase-C signal width error	Phase-C signal width exceeded 100 pulses.		
AL-63	Fault of number of pulses per rotation (Encoder method orientation)	Number of pulses per rotation exceeded 4096 ±1 during tuning up.		
AL-64	Position detection signal cable disconnection	Position detection encoder signal cable was disconnected or connected improperly.	• Check the wiring of load shaft encoder signal lines. • Replace the load shaft encoder. • Replace the Orientation Card.	●○○●
AL-65	INC signal error (Encoder method orientation)	INC signal input timing error (minor fault)	After carrying out absolute positioning, change circuit to command INC signal.	●○○●

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-70	Tuneup incomplete (magnetic sensor method orientation)	Orientation command was input before tuning up (minor fault).	Perform orientation tuneup.	●○○○
AL-71	Magnetic sensor signal detection error	Incorrect magnetic sensor signal voltage level during tuning up.	• Check the wiring of magnetic sensor signal lines. • Replace the magnetic sensor or magnetizer.	●○○○
AL-73	Fault of number of pulses per rotation (magnetic sensor method orientation)	Number of motor pulses per main axis rotation (4096 × speed gear ratio) exceeded ±6% during tuning up.	• Check control constants C1-27, 28, 29. • Check the wiring of motor encoder signal lines.	●○○○
AL-74	Magnetic sensor signal disconnection	Magnetic sensor signal cable was disconnected or connected improperly.	• Check the wiring of magnetic sensor signal lines. • Replace the magnetic sensor or magnetizer. • Perform tuneup again.	●○○○
AL-75	INC signal error (Magnetic sensor method orientation)	INC signal input timing error (minor fault)	After carrying out absolute positioning, change circuit to command INC signal.	●○○○
AL-80	YENET1200 communication error	Communication error between YENET1200 card and NC machine.	Check the wiring on communication line.	---
AL-81	Excessive position deviation	Position deviation exceeded the allowable range.	Check the main axis load.	---
AL-82	YENET1200 card ROM error	YENET1200 card memory (PROM) error	Replace YENET1200 card.	---
AL-83	YENET1200 communication WDT error 1	WDT error between YENET1200 card and NC machine.	Check the wiring on communication line.	---
AL-84	YENET1200 communication WDT error 2	WDT error between YENET1200 card and control PCB.	Replace the control PCB.	---
AL-85	YENET1200 card NMI	YENET1200 card detected NMI.	Replace YENET1200 card.	---
AL-86	YENET1200 card zero division	YENET1200 card detected division/ overflow error.		---
AL-87	Communications timeout 1	Answer to communications command between YENET1200 card and control PCB does not return.	Replace the controller PCB.	---

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-88	Communications timeout 2	YENET1200 card internal timeout error	Replace YENET1200 card.	---
AL-89	Undefined constant No. setting error	Undefined constant number is set.	Check NC machine constants.	---
AL-8A	YENET1200 undefined command error	Undefined command for YENET 1200 is specified.	Replace YENET1200 card.	---
AL-8b	Constant change disable error	I/F card constant change is disabled.		---
AL-90	Handshake error	Handshake error between YENET 1200 card and control PCB	Replace the control PCB.	---
AL-91	YENET1200 card RAM error 1	YENET1200 card memory (RAM) error	Replace YENET1200 card.	---
AL-92	YENET1200 card RAM error 2	YENET1200 card memory (IC) error		---
AL-97	Communications command error 1	YENET1200 communications command error (undefined warning occurred.)	Check software version for control PCB and NC machine.	---
AL-98	Communications command error 2	YENET1200 communications command error (orientation tuneup disabled)		---
AL-99	Communications command error 3	YENET1200 communications command error (memory access disabled)		---
AL-9A	Communications command error 4	YENET1200 communications command error (constant write-in disabled)		
AL-9b	Communications command error 5	YENET1200 communications command error (constant read-out disabled)		
AL-9C	Communications command error 6	YENET1200 communications command error (constant setting change disabled during run)		
AL-9d	Communications command error 7	YENET1200 communications command error (constant set value exceeds upper/lower limits.)		
AL-9E	Communications command error 8	YENET1200 communications command error (incorrect access number)		
AL-9F	Communications command error 9	YENET1200 communications command error (undefined command code)		

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-A0	YENET1200 card fault	YENET1200 card fault	Replace YENET1200 card.	---
AL-A1	YENET1200 card RAM error	YENET1200 card memory (common RAM) error		
AL-A2	YENET1200 card I/O fault 1	YENET1200 card data send/receive error (initial handshake error)		
AL-A3	YENET1200 card I/O fault 2	WDT error between control PCB and YENET1200 card		
AL-A4	YENET1200 card I/O fault 3	YENET1200 card interrupt signal timeout error		
AL-b0	Initial Origin Detection Error (For IPM motors only)	When the power is turned ON, a phase-C signal cannot be detected while detecting the initial origin.	• Check the wiring of the C-phase signal of the encoder. • Replace the encoder or motor. • Replace the control card.	○●○○
AL-b1	Encoder Pulse Number Error (For IPM motors only)	The encoder pulse number per rotation exceeded the correct value by ±10 pulses.	• Check the wiring of the encoder signal lines. • Check if the encoder signal line is separated from the main circuit wiring and other power cables. • Check if the motor and the Inverter are properly grounded. • Check the encoder cable specifications. (Check if a shielded twisted-pair cable is used.) • Replace the encoder.	○●○○
AL-b2	Low Speed Winding Overspeed Error (For IPM motor only)	The motor speed exceeded the max. speed for the low speed winding.	Check the external sequence to verify that the winding change point is correct.	○●○○

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
AL-d2	CPU built-in A/D Converter error	CPU built-in A/D Converter error	Replace the control PCB.	○○●○
AL-d3	Phase U A/D Converter error	Phase U current detection A/D Converter error		○○●○
AL-d4	Phase W A/D Converter error	Phase W current detection A/D Converter error		○○●○
AL-d5	Control circuit I/O fault 1	Data transmission error between CPUs.		○○●○
AL-d6	Control circuit I/O fault 2			○○●○
AL-d7	Control circuit I/O fault 3			○○●○
AL-E0	Motor code selection error	Selected motor code (C1-25) does not match Inverter capacity (C1-56).	Check motor model, motor code (C1-25), Inverter model, and Inverter capacity selection (C1-56).	○○○●
AL-E1	Motor code unrecorded	Motor code set in C1-25 is not recorded.	• Check motor model and motor code (C1-25). • Check setting list for correct PROM version of motor code (C1-25).	○○○●
AL-E2	Constant setting range error	Memory (EEPROM) data exceeded upper/lower limit.	• Confirm that rated speed (C1-26) is within setting range. • Check control constants. • Replace the control PCB.	○○○●
AL-E3	Orientation Card mismatch	Selected orientation bit does not match Orientation Card.	• Check Orientation Card model and orientation selection signal (bit 0 of C1-39). • Replace the Orientation Card.	○○○●
AL-E4	Inverter capacity selection error	Selected Inverter capacity (C1-56) does not match the Unit.	Check Inverter model and Inverter capacity selection (C1-56).	○○○●
AL-F0	ROM error	Memory (PROM) error	Replace the control PCB.	○○○○
AL-F1	EEPROM error 1	Memory (EEPROM) error		○○○○
AL-F2	EEPROM error 2			○○○○
AL-F3	EEPROM error 3			○○○○
AL-F4	EEPROM error 4			○○○○

Table 12.2 Inverter Faults (continued)

Fault No.	Name	Contents	Corrective Actions	Error Code
CPF00	Control circuit fault 1 (operator transmission error)	Transmission between the Inverter and the Digital Operator cannot be established until 5 seconds after supplying power. Built-in memory fault, WDT activated.	• Insert the Digital Operator connector again. • Check the wiring of power supply signal line of 1CN. • Replace the control PCB.	---
CPF01	Control circuit fault 2 (operator transmission error)	Transmission between the Inverter and the Digital Operator is established once after supplying power, but later transmission fault continues for more than 2 seconds. WDT time exceeded.		---
88888	YENET1200 communication signal delay	After turning control power ON, NC machine and YENET1200 communication is not established.	• Check the wiring of YENET1200 communication line. • Check NC machine power supply.	---

12.4 Motor Faults and Corrective Actions

If any of the following faults occurs in the motor, check the cause and perform the relevant corrective actions.

Table 12.3 Motor Faults and Corrective Actions

Fault	Cause	Corrective Action
Motor does not rotate.	Protective function has been activated.	Check fault number and carry out appropriate steps.
	Inverter output disconnection, improper connection	Check the wiring between Inverter and motor.
	Control signal does not function.	• Check sequence input signal on operating status display (U1-09) (RDY, EMG, FWD and REV). • Check if speed reference is input or not on operating status display (U1-02). • Check if operating signal FWD or REV is input at least 15 ms after RDY or EMG is input.
	Torque limiting	Check whether external torque limit signals TLL or TLH is input on operating status display (U1-09).
	Motor winding wire disconnection	• Check resistance between motor terminals (a circuit tester necessary). • Replace the motor.
	Motor fault (rotor and stator rub together, broken bearing)	• Check motor shaft rotation manually. • Replace the motor.
	Control PCB fault	Replace the control PCB.
Motor does not rotate. (STOP LED blinks.)	Power of Converter's main circuit is not turn ON.	• Turn ON power supply. • Check voltage.
	Flat cable is not correctly connected.	Check that flat cable is correctly installed to connectors.
	Timing of operating signal FWD, RED and EMG is incorrect. (All signals input at the same time.)	Check if operating signal FWD or REV is input at least 15 ms after RDY or EMG is input.
Motor rotates slowly or vibrates without rotation.	Inverter output disconnection, improper connection	Check the wiring between Inverter and motor.
	Encoder signal line disconnection, improper connection, loose connector (See note.)	Check the wiring of encoder signal line.
	Motor encoder fault	• Check for abnormal changes in motor speed on speedometer or operating status display (U1-01). • Replace the encoder or the motor.
	Torque limiting	Check whether external torque limit signals TLL or TLH is input on operating status display (U1-09).
	Control PCB fault	Replace the control PCB.
Motor rotates in reverse direction.	Improper connection of Inverter output or motor encoder signal line	Check the wiring according to the connection diagram.

Table 12.3 Motor Faults and Corrective Actions (continued)

Fault	Cause	Corrective Action
Motor does not rotate at commanded speed.	Speed reference signal error	• Check speed reference on operating status display (U1-02). • Readjust master speed reference function.
	Incorrect setting of motor rated speed	Check the setting of control constant C1-26.
	Incorrect adjustment of motor speed *	Check the operating status display of the motor speed (U1-01), and adjust the control constant (C1-12).
	Speed is controlled by P control.	Check if PPI signal is input or not on operating status display (U1-09).
	Torque limiting	Check whether external torque limit signals TLL or TLH is input on operating status display (U1-09).
	Control PCB fault	Replace the control PCB.
Extended acceleration/de-celeration time	Soft starter time setting error (Set time is too long.)	Check the setting of control constant C1-10.
	Motor code selection error	Check the setting of control constant C1-25 on the setting list.
	Torque limiting	Check whether external torque limit signals TLL or TLH is input on operating status display (U1-09).
	Excess load on load machine	• Check load status on the load factor meter for loss and inertia moment of the load machine. • Increase the capacity of Inverter and motor.
	Control PCB fault	Replace the control PCB.
Heavy motor noise, vibration	Inverter output disconnection	Check wiring between Inverter and motor.
	Grounding error of motor or Inverter	Check continuity of motor and Inverter to see if they are securely grounded.
	Malfunction due to noise (Poor encoder characteristics)	• Confirm that encoder signal lines are separated from Inverter output wiring or other power lines. • Check encoder cable specifications (whether the cable is a shielded twisted-pair cable).
	Control constant setting error (especially speed control proportional gain)	Check control constants on the setting list.
	Motor installation error	Check for loose mounting bolts.
	Unbalanced motor	• Check if rotor is balanced. • Replace the motor.
	Motor fault (Motor bearing fault, rotor fault)	• Run a motor alone to check if noise and vibration are within specifications. • Replace the motor.
	Defective load machine coupling or centering	Confirm that coupling and centering are appropriate according to the connection with load machine.
	Insufficient strength of load machine	Check the load machine for deformations or resonance.
	Loose foundation bolts	Check for loose foundation bolts on load machine.
	Control PCB fault	Replace the control PCB.
Motor does not stop.	Control signal does not operate.	Confirm that operation signal (FWD or REV) is open on operating status display (U1-09).
	Control PCB fault	Replace the control PCB.

* Enabled for stand-alone drives (M5A) only.

Table 12.3 Motor Faults and Corrective Actions (continued)

Fault	Cause	Corrective Action
Motor does not stop at orientation. (encoder method orientation)	Orientation signal ORT is not input.	Confirm that orientation signal ORT is closed on operating status display (U1-09).
	Encoder signal line disconnection, improper connection, loose connector	Check the wiring of encoder signal lines.
	Encoder fault	• Check for abnormal changes in motor speed on the speedometer or operating status display (U1-01). • Replace the encoder or the motor.
	Fault of Orientation Card or control PCB	Replace the Orientation Card or the control PCB.
Motor does not stop at orientation. (magnetic sensor method orientation)	Orientation signal ORT is not input.	Confirm that orientation signal ORT is closed on operating status display (U1-09).
	Incorrect transmission ratio setting	Check the machine data for transmission ratio values (C1-27 to 29).
	Magnetic sensor signal line disconnection, improper connection, loose connector	Check the wiring of magnetic sensor signal lines.
	Fault of magnetic sensor or magnetizer	Rotate the load shaft and verify that ORG signal lights once per rotation on operating status display (U1-10).
	Fault of Orientation Card or control PCB	Replace the Orientation Card or the control PCB.
Stop position differs from commanded position. (encoder method orientation)	Incorrect setting of stop position reference	Check whether the position reference is correct on operating status display (U2-04).
	Incorrect selection of binary/BCD reference or incorrect setting of BCD reference resolution	Check the setting of control constants C2-22 bit 3 and C2-12.
	Incorrect selection of reference point at incremental positioning	Check the setting of control constant C2-22 bit 5.
	Improper setting of load shaft zero-point position	• Perform positioning at zero-point to measure position accuracy. • Perform tuneup again to set the load shaft zero point.
	Encoder signal line disconnection, improper connection, loose connector	Check the wiring of encoder signal lines.
	Malfunction due to noise (Poor encoder characteristics)	• Confirm that encoder signal lines are separated from Inverter output wiring or other power lines. • Check encoder cable specifications (whether the cable is a shielded twisted-pair cable).
	Control PCB fault	Replace the control PCB.
Stop position differs from commanded position. (magnetic sensor method orientation)	Magnetic sensor signal line disconnection, loose connector	Check the wiring of magnetic sensor signal lines.
	Fault of Orientation Card or control PCB	Replace the Orientation Card or the control PCB.

Table 12.3 Motor Faults and Corrective Actions (continued)

Fault	Cause	Corrective Action
Orientation completion signal is not output.	Orientation signal ORT is not input.	Confirm that orientation signal ORT is closed on operating status display (U1-09).
	Incorrect setting of selection signal (Completion signal is not output at tuning of initial setting.)	Set tuneup operation selection signal (C2-22 or C3-22, bit 4) to "1."
	Incorrect speed changing ratio setting	Verify the machine data for transmission ratio values (C1-27 to 29).
	Position control proportional gain is high.	• Confirm that no vibration occurs in the forward and reverse directions near the stop position. • Lower position control proportional gain to reduce vibration.
	Position control proportional gain is low.	• Confirm that the load shaft has reached the stop position on operating status display (U2-03 or U3-03). • Increase position control proportional gain to reach the commanded position.
	Fault of Orientation Card or control PCB	Replace the Orientation Card or the control PCB.

13

Maintenance and Inspection

This chapter describes basic maintenance and inspection procedures for the VS-626M5 and the VS-656MR5.

13.1 Maintenance and Inspection . . . . . 13 -3
13.1.1 Daily Inspections . . . . . 13 -3
13.1.2 Periodic Inspections . . . . . 13 -3
13.1.3 Parts Replacement Schedule . . . . . 13 -4

⚠ WARNING

- Never touch high-voltage terminals in the Inverter or the Converter.
  Failure to observe this warning can result in an electric shock.
- Close the upper and lower covers before supplying power to the Inverter or the Converter. Before opening the covers, always shut OFF the molded-case circuit breaker.
  Failure to observe this warning can result in an electric shock.
- Perform maintenance or inspection only after verifying that the CHARGE LED indicator and 7-segment display go OFF after the main circuit power supply and control power supply have been turned OFF.
  The capacitors are still charged and can be dangerous.
- Only authorized personnel should be permitted to perform maintenance, inspections, or parts replacement. Remove all metal objects (watches, bracelets, etc.) before performing these operations. (Use tools which are insulated against electric shock.)
  Failure to observe this warning can result in an electric shock.

⚠ CAUTION

- The control PC board employs CMOS ICs. Do not touch the CMOS elements.
  They are easily damaged by static electricity.
- Do not connect or disconnect wires or connectors while power is applied to the circuits.
  Failure to observe this caution can result in personal injury.

13.1 Maintenance and Inspection

This section explains the maintenance and inspection methods for the Inverter and Converter.

13.1.1 Daily Inspections

Check the following items while the system is in operation.

- Are there abnormal motor noises or vibration?
- Is there any abnormal heat?
- Is the ambient temperature too high?
- Is the value displayed on the output voltage monitor higher than normal?

13.1.2 Periodic Inspections

Check the following items during periodic maintenance.

To prevent electric shock, turn OFF the power supply to the main circuit and check that the CHARGE indicator and 7-segment display have gone out before performing maintenance operations.

Table 13.1 Periodic Inspection Items

Area	Component	Check	Corrective Action
Inverter and Converter	External terminals, Unit mounting bolts, connectors, etc.	Loose screws	Tighten.
		Loose connectors	Tighten.
	Heatsink	Build-up of dust and dirt	Blow with dry compressed air of 39.2×10^4 to 58.8×10^4 Pa (4 to 6kg·cm^2) pressure.
	Printed circuit boards	Accumulation of conductive dust or oil	Blow with dry compressed air of 39.2×10^4 to 58.8×10^4 Pa (4 to 6kg·cm^2) pressure. If dust and oil cannot be removed, replace the board.
	Cooling fan	• For abnormal noise and vibration • Whether the cumulative operation time exceeds 20,000 hours or not.	Replace the cooling fan.
	Power elements	Accumulation of dust and dirt	Blow with dry compressed air of 39.2×10^4 to 58.8×10^4 Pa (4 to 6kg·cm^2) pressure.
	Smoothing capacitor	Discoloration or odor	Replace the capacitor or Unit.
Related to Bearings	Bearing noise	Abnormal noise or increase of noise level	Replace the bearings.
	Vibration	Abnormal vibration	
	Bearing temperature	Abnormal temperature rise	
	Grease	No leakage	Remove the cause.
Motor and Cooling Fan	Operating status	Normal operation	Remove the cause of fan halt or replace the fan if a fault is found.

13.1.3 Parts Replacement Schedule

The Inverter and Converter are configured using multiple parts, and these parts perform their functions as long as they are operating normally.

The electronic parts require maintenance depending on their operating conditions. To make sure that the Inverter and Converter operate normally over a long period of time, periodic maintenance and parts replacement is required depending on the service life of the relevant part.

The parts replacement schedule differs depending on the installation environment and conditions of use of the Inverter and Converter. The parts replacement schedule of the Inverter and Converter are shown in the following table. Refer to the table for parts replacement and maintenance.

Table 13.2 Parts Replacement Schedule

Area	Parts	Interval (Approx.)	Remarks
Inverter and Converter	Cooling fan	2 to 3 years	Replace with new one.
	Smoothing capacitor	5 years	Replace with new one. (Decided after inspection.)
	Breakers or relays	—	Decided after inspection.
	Fuse	10 years	Replace with new one.
	Aluminum electrolytic capacitor on PCBs	5 years	Replace with new one. (Decided after inspection.)
Motor	Bearings	12000 hours or 2 years	Disassemble and replace worn items or provide necessary maintenance.
	Cooling fan	15000 hours or 2 years	Replace the fan.
	Overhaul	20000 hours or 5 years	Contact your YASKAWA representative.

Note: Operating conditions are as follows:
- Ambient temperature: 30°C (86°F) yearly average
- Load factor: 80% or below
- Operating rate: 12 hours max. per day

14

Specifications

This chapter describes the specifications for the Drives, Motors, options, and peripheral devices.

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14.1 Drives

This section provides the standard specifications of the Drives.

14.1.1 Standard Drive Series

The following table lists the specifications for the Standard Drive Series.

Table 14.1 Standard 200 V Series

Motor	Model UAASK□FZ		A-04	A-06	A-08	A-11	A-15	A-19	A-22	J-30	J-37
	Rated Output *2	30-minute Rating (S2) 50%ED Rating (S3)	5 *1 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)	50 (37)
	HP (kW)	Continuous Rating (S1)	3 (2.2)	5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)
	Rated speed (min^{-1})	Base Speed	1500							1150	
		Maximum Speed	8000			6000				4500	
	Output Torque at Base Speed Continuous Rating	N·m	14.0	23.5	35.0	47.7	70.0	95.0	117.6	182.3	249.1
		lb·ft (kgf·m)	10.4 (1.43)	17.4 (2.40)	25.8 (3.57)	35.8 (4.87)	51.7 (7.14)	70.6 (9.74)	86.9 (12.0)	134 (18.6)	183 (25.4)
	Rotor Inertia J ($GD^2/4$)	$lb·ft^2$ ($kg·m^2$)	0.209 (0.0088)	0.411 (0.0173)	0.617 (0.026)	0.759 (0.032)	1.614 (0.068)	1.970 (0.083)	2.326 (0.098)	6.122 (0.258)	8.068 (0.34)
	Overload Capacity		120%, 60s of 30-minute rating								
	Vibration	(μ·m)	V5							V10	
	Noise Level		75dB (A) or less							80dB (A) or less	
	Ambient Temperature, Humidity		0°C to +40°C (32°F to 104°F), 95% or less (non-condensing)								
	Approx. Mass	lb (kg)	71 (32)	119 (54)	130 (59)	150 (68)	207 (94)	238 (108)	269 (122)	481 (218)	580 (263)

* 1. 15-minute rating (50%ED)/continuous rating for model UAASKA-04FZ 5/3HP (3.7/2.2kW)

* 2. Rated output power is guaranteed when input voltage is three-phase, 200 V (50/60 Hz), 220 V (50/60 Hz), 230 V (60 Hz). If input voltage is lower than 200 V, rated output power is not guaranteed.

Controller	Inverter	Model CIMR-M5□*1 □		23P7	23P5	27P5	2011	2015	2018	2022	2030	2037
		Continuous Rated Input Current (A)		17.6	17.6	26.2	35.7	52.4	71.4	88.1	104.8	142.8
		Continuous Rated Output Current (A)		21	21	31	40	56	80	98	113	160
		Control Method		Sine wave PWM Inverter (Vector control)								
		Speed Control Range		40 min^{-1} to maximum motor speed								
		Speed Regulation		0.2% maximum speed or less								
		Overload Capacity		120%, 60s of 30-minute rating								
		Approx. Mass	lb (kg)	11 (5)			27 (12)				35 (16)	57 (26)
		Dimensions in inches (mm) *2	Width	3.94 (100)			5.91 (150)				7.84 (200)	11.81 (300)
			Height	13.78 (350)								
			Depth	12.60 (320)								
	Converter *3	Model CIMR-MR5□*1 □		23P7	25P5	27P5	2011	2015	2018	2022	2030	2037
		Required Power Capacity (kVA)		7	9	12	19	24	30	36	48	60
		Continuous Rated Input Current (A)		13.3	13.3	19.7	26.8	39.3	53.6	66.1	78.6	107.2
		Continuous Rated Output Current (A)		17.6	17.6	26.2	35.7	52.4	71.4	88.1	104.8	142.8
		Power Supply		Three-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%, Line-to-line voltage unbalance: 5% or less)								
		Control Power Supply		Single-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%) Required power capacity: 100 VA (for independent drive system) 250 VA (for NC system)								
		Control Method		Power regenerative control (120° current conduction)								
		Overload Capacity		120% for one minute, 200% for one second								
		Approx. Mass	lb (kg)	11 (5)			27 (12)				35 (16)	57 (26)
		Dimensions in inches (mm) *2	Width	3.94 (100)			5.91 (150)				7.84 (200)	11.81 (300)
			Height	13.78 (350)								
			Depth	12.60 (320)								
		Power Supply AC Reactor Code No.		X010057	X010058	X010059	X010060	X010061	X010062	X010063	X010064	X010120
	Common	Model CIMR-M5□*1 □ CIMR-MR5□*1 □		23P7	25P5	27P5	2011	2015	2018	2022	2030	2037
		Ambient Temperature		0°C to 55°C (32°F to 131°F) (not frozen)								
		Heatsink Intake Air Temperature		0°C to 45°C (32°F to 113°F)								
		Storage Temperature *4		–20°C to 60°C (–4°F to 140°F)								
		Humidity		90% or less (non-condensing)								
		Location		Indoor (protected from corrosive gases and dust), elevation: 1000 m (3280 ft) or less								
		Vibration		9.8 m/s^2 (1G) at 10 to less than 20 Hz, up to 2 m / s^2 (0.2G) at 20 to 50 Hz								
		Protective Structure		IEC IP00 (Protected so that parts of the human body cannot reach electrically charged parts from the front)								

* 1. A: For stand-alone drive system N: for NC system

* 2. Dimensions of External Heatsink Cooling Type. Refer to *14.1.3 Dimensions* for Open Chassis Type.

* 3. An AC reactor is required between Converter and main circuit power supply.

* 4. Temperature during shipping.

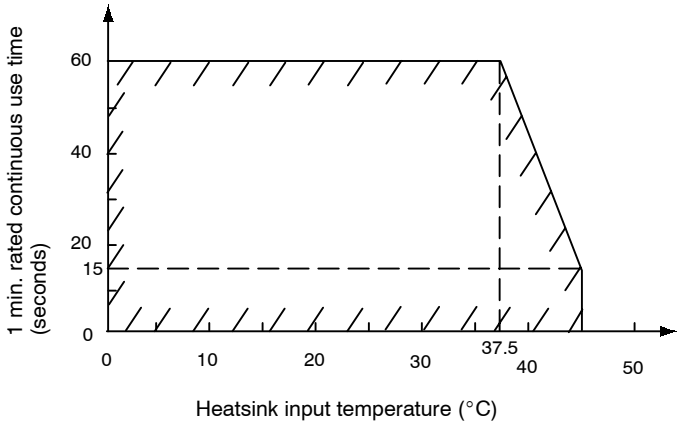
14.1.1 Standard Drive Series

Table 14.2 Standard 400 V Series

Motor	Model UAAS □FZ***E			A-06	A-08	A-11	A-15	A-19	A-22	J-30	J-37	J-45
	Rated Output *1	30-minute Rating (S2) 50%ED Rating (S3)		7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)	50 (37)	60 (45)
	HP (kW)	Continuous Rating (S1)		5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)	50 (37)
	Rated speed (min^{-1})	Base Speed		1500						1150		
		Maximum Speed		8000		6000				4500		
	Output Torque at Base Speed Continuous Rating		N·m	23.5	35.0	47.7	70.0	95.0	117.6	182.3	249.0	306.8
			lb·ft (kgf·m)	17.4 (2.40)	25.8 (3.57)	35.8 (4.87)	51.7 (7.14)	70.6 (9.74)	86.9 (12.0)	134 (18.6)	183.7 (25.4)	226.4 (31.3)
	Rotor Inertia J ($GD^2/4$)		$lb·ft^2$ ($kg·m^2$)	0.411 (0.0173)	0.617 (0.026)	0.759 (0.032)	1.614 (0.068)	1.970 (0.083)	2.326 (0.098)	6.122 (0.258)	8.068 (0.340)	11.22 (0.473)
	Overload Capacity			120%, 60s of 30-minute rating								
	Vibration (μ·m)			V5						V10		
	Noise Level			75dB (A) or less						80dB (A) or less		
	Ambient Temperature, Humidity			0°C to 40°C (32°F to 104°F), 95% or less (non-condensing)								
	Approx. Mass		lb (kg)	119 (54)	130 (59)	150 (68)	207 (94)	238 (108)	269 (122)	481 (218)	580 (263)	783 (355)
Controller	Inverter	Model CIMR-M5□*2 □		45P5	47P5	4011	4015	4018	4022	4030	4037	4045
		Continuous Rated Input Current (A)		8.8	13.1	17.9	26.2	35.7	44.1	52.4	71.4	88.2
		Continuous Rated Output Current (A)		10.4	15.5	20	28	40	49	56.5	80	98
		Control Method		Sine wave PWM Inverter (Vector control)								
		Speed Control Range		40 min^{-1} to maximum motor speed								
		Speed Regulation		0.2% maximum speed or less								
		Overload Capacity*3		120%, 60s of 30-minute rating								
		Approx. Mass	lb (kg)	11 (5)		27 (12)				35 (16)		
		Dimensions in inches (mm) *4	Width	3.94 (100)		5.91 (150)				9.84 (250)		
			Height	13.78 (350)								
			Depth	12.60 (320)								
	Converter *5	Model CIMR-MR5□*2 □		45P5	47P5	4011	4015	4018	4022	4030	4037	4045
		Required Power Capacity (kVA)		9	12	19	24	30	36	48	60	70
		Continuous Rated Input Current (A)		6.7	9.85	13.4	19.7	26.8	33.1	39.3	53.6	66.2
		Continuous Rated Output Current (A)		8.8	13.1	17.9	26.2	35.7	44.1	52.4	71.4	88.2
		Power Supply		Three-phase, 400 VAC (50/60Hz); 440 VAC (50/60Hz); 460 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%, Line-to-line voltage unbalance: 5% or less)								
		Control Power Supply		Single-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%) Required power capacity: 100 VA (for independent drive system) 250 VA (for NC system)								
		Control Method		Power regenerative control (120° current conduction)								
		Overload Capacity		120% for one minute, 200% for one second								
		Approx. Mass	lb (kg)	11 (5)		27 (12)				46 (21)		
		Dimensions in inches (mm) *4	Width	3.94 (100)		5.91 (150)				9.84 (250)		
			Height	13.78 (350)								
			Depth	12.60 (320)								
		Power Supply AC Reactor Code No.		X002501	X010099	X010100	X010101	X010102	X010103	X010104	X010105	X010106

Controller	Common	Model CIMR-M5□*2 □ CIMR-MR5□*2 □	45P5	47P5	4011	4015	4018	4022	4030	4037	4045
		Ambient Temperature	0°C to 55°C (32°F to 131°F) (not frozen)								
		Heatsink Intake Air Temperature	0°C to 45°C (32°F to 113°F)								
		Storage Temperature *6	–20°C to 60°C (–4°F to 140°F)								
		Humidity	90% or less (non-condensing)								
		Location	Indoor (protected from corrosive gases and dust), elevation: 1000 m (3280 ft) or less								
		Vibration	9.8 m/s^2 (1G) at 10 to less than 20 Hz, up to 2 m / s^2 (0.2G) at 20 to 50 Hz								
		Protective Structure	IEC IP00 (Protected so that parts of the human body cannot reach electrically charged parts from the front)								

* 1. Rated output power is guaranteed when input voltage is three-phase, 400 V (50/60 Hz), 440 V (50/60 Hz), 460 V (60Hz). If input voltage is lower than 400 V, rated output power is not guaranteed.
* 2. A: For stand-alone drive system N: for NC system
* 3. If the heatsink input temperature for the 4037 and 4045 Inverter is high, the bearable load is limited. The continuous use time at 1 minute rated value (120% of 30 minutes rated output) depending on the Unit heat limit is shown in the following diagram.
* 4. Dimensions of External Heatsink Cooling Type. Refer to *14.1.3 Dimensions* for Open Chassis Type.
* 5. An AC reactor is required between Converter and main circuit power supply.
* 6. Temperature during shipping.



1 Minute Rated Continuous Use Time for 4037 and 4045 Inverters

14.1.2 Winding Selection Drive Series

The specifications for the winding selection drive series are shown in the following table.

Table 14.3 Winding Selection 200 V Series

Motor	Model UAASK□FZ			B-06	B-08	B-11	B-15	B-19	B-22	B-30
	Rated Output *1	30-minute Rating (S2) 50%ED Rating (S3)		7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)
	HP (kW)	Continuous Rating (S1)		5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	27 (20)
	Rated speed (min^{-1})	Base Speed		500			400			
		Maximum Speed		6000			4800			
	Output Torque at Base Speed Continuous Rating		N·m	71	105	143	262	358	442	477
			lb·ft (kgf·m)	52.3 (7.21)	77.6 (10.7)	105.9 (14.5)	193.6 (26.7)	264.5 (36.5)	326.2 (45.0)	351.8 (48.7)
	Rotor Inertia J ($GD^2/4$)		$lb·ft^2$ ($kg·m^2$)	1.614 (0.068)	1.970 (0.083)	2.563 (0.108)	6.146 (0.259)	11.22 (0.473)	13.00 (0.548)	13.00 (0.548)
	Overload Capacity			120%, 60s of 30-minute rating						
	Vibration		(μ·m)	V5			V10			
	Noise Level			75dB (A) or less			80dB (A) or less			
	Ambient Temperature, Humidity			0°C to 40°C (32°F to 104°F), 95% or less (non-condensing)						
	Approx. Mass		lb (kg)	207 (94)	238 (108)	291 (132)	481 (218)	783 (355)	893 (405)	893 (405)
Controller	Model CIMR-M5□*2 □			25P5	27P5	2011	2015	2018	2022	2030
Inverter	Continuous Rated Input Current (A)			17.6	26.2	35.7	52.4	71.4	88.1	104.8
	Continuous Rated Output Current (A)			21	31	40	56	80	98	113
	Control Method			Sine wave PWM Inverter (Vector control)						
	Speed Control Range			40 min^{-1} to maximum motor speed						
	Speed Regulation			0.2% maximum speed or less						
	Overload Capacity			120%, 60s of 30-minute rating						
	Approx. Mass		lb (kg)	11 (5)		27 (12)				35 (16)
	Applicable Magnetic Contactor Model			HV-75AP4			HV-150AP4			
	Dimensions in inches (mm) *3		Width	3.94 (100)		5.91 (150)				7.84 (200)
			Height	13.78 (350)						
			Depth	12.60 (320)						

Controller	Converter *4	Model CIMR-MR5□*2 □		25P5	27P5	2011	2015	2018	2022	2030
		Required Power Capacity (kVA)		9	12	19	24	30	36	48
		Continuous Rated Input Current (A)		13.3	19.7	26.8	39.3	53.6	66.1	78.6
		Continuous Rated Output Current (A)		17.6	26.2	35.7	52.4	71.4	88.1	104.8
		Power Supply		Three-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%, Line-to-line voltage unbalance: 5% or less)						
		Control Power Supply		Single-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%) Required power capacity: 100 VA (for independent drive system) 250 VA (for NC system)						
		Control Method		Power regenerative control (120° current conduction)						
		Overload Capacity		120% for one minute, 200% for one second						
		Approx. Mass	lb (kg)	11 (5)		27 (12)				35 (16)
		Dimensions in inches (mm) *3	Width	3.94 (100)		5.91 (150)				7.84 (200)
			Height	13.78 (350)						
			Depth	12.60 (320)						
		Power Supply AC Reactor Code No.		X010058	X010059	X010060	X010061	X010062	X010063	X010064
	Common	Model CIMR-M5□*2 □ CIMR-MR5□*2 □		25P5	27P5	2011	2015	2018	2022	2030
		Ambient Temperature		0°C to 55°C (32°F to 131°F) (not frozen)						
		Heatsink Intake Air Temperature		0°C to 45°C (32°F to 113°F)						
		Storage Temperature *5		–20°C to 60°C (–4°F to 140°F)						
		Humidity		90% or less (non-condensing)						
		Location		Indoor (protected from corrosive gases and dust), elevation: 1000 m (3280 ft) or less						
		Vibration		9.8 m/s^2 (1G) at 10 to less than 20 Hz, up to 2 m / s^2 (0.2G) at 20 to 50 Hz						
		Protective Structure		IEC IP00 (Protected so that parts of the human body cannot reach electrically charged parts from the front)						

* 1. Rated output power is guaranteed when input voltage is three-phase, 200 V (50/60 Hz), 220 V (50/60 Hz), 230 V (60 Hz). If input voltage is lower than 200 V, rated output power is not guaranteed.

* 2. A: For stand-alone drive system N: for NC system

* 3. Dimensions of External Heatsink Cooling Type. Refer to *14.1.3 Dimensions* for Open Chassis Type.

* 4. An AC reactor is required between Converter and main circuit power supply.

* 5. Temperature during shipping.

Table 14.4 Winding Selection 400 V Series

Motor	Model UAASK□FZ***E		B-06	B-08	B-11	B-15	B-19	B-22	B-30*1
	Rated Output *2 HP (kW)	30-minute Rating (S2) 50%ED Rating (S3)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	30 (22)	40 (30)
		Continuous Rating (S1)	5 (3.7)	7.5 (5.5)	10 (7.5)	15 (11)	20 (15)	25 (18.5)	27 (20)
	Rated speed (min^{-1})	Base Speed	500			400			
		Maximum Speed	6000			4800			
	Output Torque at Base Speed Continuous Rating	N·m	71	105	143	262	358	442	477
		lb·ft (kgf·m)	52.3 (7.21)	77.6 (10.7)	105.9 (14.5)	193.6 (26.7)	264.5 (36.5)	326.2 (45.0)	351.8 (48.7)
	Rotor Inertia J ($GD^2/4$)	$lb·ft^2$ ($kg·m^2$)	1.614 (0.068)	1.970 (0.083)	2.563 (0.108)	6.146 (0.259)	11.22 (0.473)	13.00 (0.548)	13.00 (0.548)
	Overload Capacity		120%, 60s of 30-minute rating						
	Vibration	(μ·m)	V5			V10			
	Noise Level		75dB (A) or less			80dB (A) or less			
	Ambient Temperature, Humidity		0°C to 40°C (32°F to 104°F), 95% or less (non-condensing)						
	Approx. Mass	lb (kg)	207 (94)	238 (108)	291 (132)	481 (218)	783 (355)	893 (405)	893 (405)
Controller – Inverter	Model CIMR-M5□*3 □		45P5	47P5	4011	4015	4018	4022	4030
	Continuous Rated Input Current (A)		8.8	13.1	17.9	26.2	35.7	44.1	52.4
	Continuous Rated Output Current (A)		10.4	15.5	20	28	40	49	56.5
	Control Method		Sine wave PWM Inverter (Vector control)						
	Speed Control Range		40 min^{-1} to maximum motor speed						
	Speed Regulation		0.2% maximum speed or less						
	Overload Capacity		120%, 60s of 30-minute rating						
	Approx. Mass	lb (kg)	11 (5)		27 (12)				35 (16)
	Applicable Magnetic Contactor Model		HV-75AP4			HV-150AP4			
	Dimensions in inches (mm) *4	Width	3.94 (100)		5.91 (150)				9.84 (250)
		Height	13.78 (350)						
		Depth	12.60 (320)						
Controller – Converter *5	Model CIMR-MR5□*3 □		45P5	47P5	4011	4015	4018	4022	4030
	Required Power Capacity (kVA)		9	12	19	24	30	36	48
	Continuous Rated Input Current (A)		6.7	9.85	13.4	19.7	26.8	33.1	39.3
	Continuous Rated Output Current (A)		8.8	13.1	17.9	26.2	35.7	44.1	52.4
	Power Supply		Three-phase, 400 VAC (50/60Hz); 440 VAC (50/60Hz); 460 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%, Line-to-line voltage unbalance: 5% or less)						
	Control Power Supply		Single-phase, 200 VAC (50/60Hz); 220 VAC (50/60Hz); 230 VAC (60Hz) (Allowable voltage fluctuation: +10% to –15%, allowable frequency fluctuation: ±5%) Required power capacity: 100 VA (for independent drive system) 250 VA (for NC system)						
	Control Method		Power regenerative control (120° current conduction)						
	Overload Capacity		120% for one minute, 200% for one second						
	Approx. Mass	lb (kg)	11 (5)		27 (12)				46 (21)
	Dimensions in inches (mm) *4	Width	3.94 (100)		5.91 (150)				9.84 (250)
		Height	13.78 (350)						
		Depth	12.60 (320)						
	Power Supply AC Reactor Code No.		X002501	X010099	X010100	X010101	X010102	X010103	X010104

Controller	Common	Model CIMR-M5□*3 □ CIMR-MR5□*3 □	45P5	47P5	4011	4015	4018	4022	4030
		Ambient Temperature	0°C to 55°C (32°F to 131°F) (not frozen)						
		Heatsink Intake Air Temperature	0°C to 45°C (32°F to 113°F)						
		Storage Temperature *6	–20°C to 60°C (–4°F to 140°F)						
		Humidity	90% or less (non-condensing)						
		Location	Indoor (protected from corrosive gases and dust), elevation: 1000 m (3280 ft) or less						
		Vibration	9.8 m/s^2 (1G) at 10 to less than 20 Hz, up to 2 m / s^2 (0.2G) at 20 to 50 Hz						
		Protective Structure	IEC IP00 (Protected so that parts of the human body cannot reach electrically charged parts from the front)						

* 1. UAASKB-30FZ***E 30/20 kW is 20 minutes (50%ED)/Continuous rated value.

* 2. Rated output power is guaranteed when input voltage is three-phase, 400 V (50/60 Hz), 440 V (50/60 Hz), 460 V (60 Hz).
If input voltage is lower than 400 V, rated output power is not guaranteed.

* 3. A: For stand-alone drive system N: for NC system

* 4. Dimensions of External Heatsink Cooling Type. Refer to *14.1.3 Dimensions* for Open Chassis Type.

* 5. An AC reactor is required between Converter and main circuit power supply.

* 6. Temperature during shipping.

14.1.3 Dimensions

The Inverter and Converter dimensions are shown in the following diagrams.

■ Inverter (VS-626M5) External Heatsink Cooling Type

The figures below show a 200 V 10 HP (7.5 kW) model.

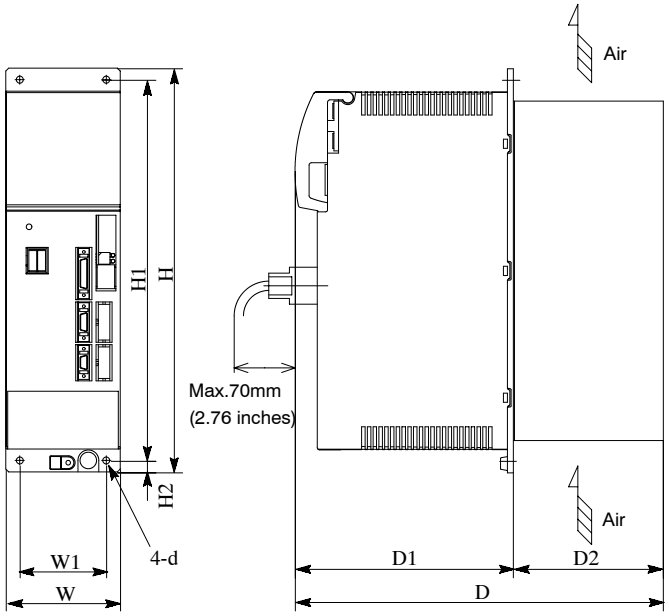


Fig 14.1 Inverter Dimensions

Table 14.5 VS-626M5 Inverter Dimensions and Approx. Mass

Voltage Class	Model CIMR-M5□*□	External Heatsink Cooling Type Dimensions in mm (inches)									
		W	H	D	W1	H1	H2	D1	D2	Approx. Mass kg (lb)	d
200 V class	23P7	100 (3.94)	350 (13.78)	320 (12.6)	75 (2.95)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	5 (11)	M5
	25P5										
	27P5										
	2011	150 (5.91)	350 (13.78)	320 (12.6)	100 (3.94)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	12 (26)	M5
	2015										
	2018										
	2022										
	2030	200 (7.87)	350 (13.78)	320 (12.6)	150 (5.91)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	16 (35)	M5
	2037	300 (11.81)	350 (13.78)	320 (12.6)	250 (9.84)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	26 (57)	M6
400 V class	45P5	100 (3.94)	350 (13.78)	320 (12.6)	75 (2.95)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	6 (13)	M5
	47P5										
	4011										
	4015	150 (5.91)	350 (13.78)	320 (12.6)	100 (3.94)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	12 (26)	M5
	4018										
	4022										
	4030	250 (9.84)	350 (13.78)	320 (12.6)	200 (7.87)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	16 (35)	M5
	4037										
	4045										

* A: For stand-alone drive system N: for NC system

■ Inverter (VS-626M5) Open Chassis Type

The figures below show a 200 V 10 HP (7.5 kW) model.

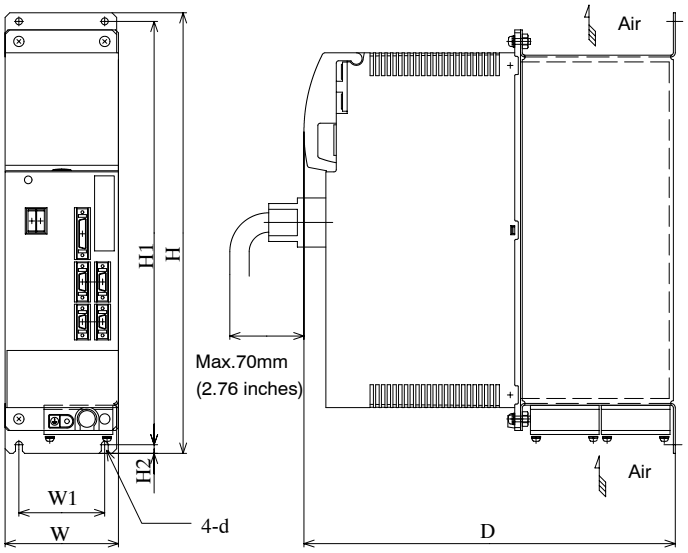


Fig 14.2 Inverter Dimensions

Table 14.6 VS-626M5 Dimensions and Approx. Mass

Voltage Class	Model CIMR-M5□*□	Open Chassis Type Dimensions in mm (inches)							
		W	H	D	W1	H1	H2	Approx. Mass kg (lb)	d
200 V class	23P7	100 (3.94)	385 (15.16)	324 (12.76)	75 (2.95)	370 (14.57)	7.5 (0.30)	6 (13)	M5
	25P5								
	27P5								
	2011	150 (5.91)	470 (18.5)	324 (12.76)	100 (3.94)	455 (17.91)	6.5 (0.26)	16 (35)	M5
	2015								
	2018							16.5 (36)	
	2022								
	2030	200 (7.87)	470 (18.5)	324 (12.76)	150 (5.91)	455 (17.91)	6.5 (0.26)	21.5 (47)	M5
	2037	300 (11.81)	470 (18.50)	324 (12.76)	250 (9.84)	455 (17.91)	7 (0.28)	35 (1.38)	M6
400 V class	45P5	100 (3.94)	385 (15.16)	324 (12.76)	75 (2.95)	370 (14.57)	7.5 (0.30)	7 (15)	M5
	47P5								
	4011	150 (5.91)	470 (18.5)	324 (12.76)	100 (3.94)	455 (17.91)	6.5 (0.26)	16 (35)	M5
	4015								
	4018							16.5 (36)	
	4022								
	4030	250 (9.84)	470 (18.50)	324 (12.76)	200 (7.87)	455 (17.91)	7 (0.28)	25 (0.98)	M6
	4037								
	4045								

Note: The 2037 and 4030 to 4045 models are in development.

* A: For stand-alone drive system N: for NC system

■ Converter (VS-656MR5) External Heatsink Cooling Type

The figures below show a 200 V 10 HP (7.5 kW) model.

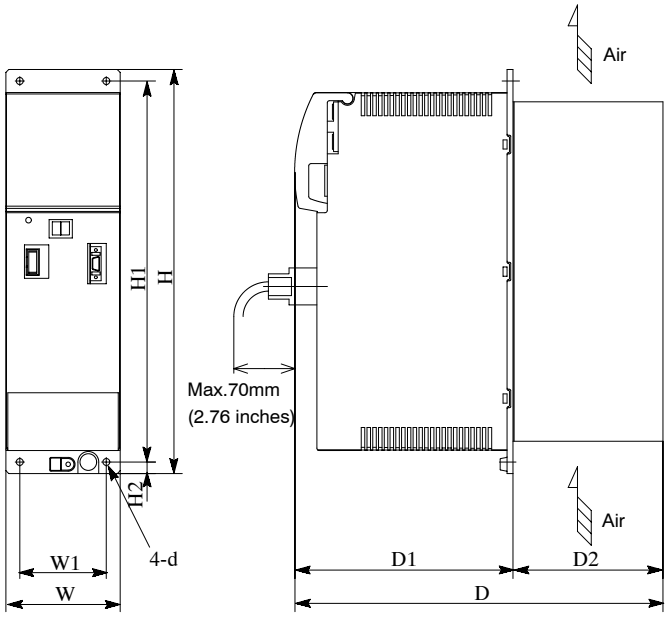


Fig 14.3 Dimensions of the Converter

Table 14.7 VS-656MR5 Dimensions and Approx. Mass

Voltage Class	Model CIMR-MR5□*	External Heatsink Cooling Type Dimensions in mm (inches)									
		W	H	D	W1	H1	H2	D1	D2	Approx. Mass kg (lb)	d
200 V class	23P7	100 (3.94)	350 (13.78)	320 (12.6)	75 (2.95)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	5 (11)	M5
	25P5										
	27P5										
	2011	150 (5.91)	350 (13.78)	320 (12.6)	100 (3.94)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	12 (26)	M5
	2015										
	2018										
	2022										
	2030	200 (7.87)	350 (13.78)	320 (12.6)	150 (5.91)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	16 (35)	M5
	2037	300 (11.8)	350 (13.78)	320 (12.6)	250 (9.84)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	26 (57.3)	M6
400 V class	45P5	100 (3.94)	350 (13.78)	320 (12.6)	75 (2.95)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	7 (15)	M5
	47P5										
	4011	150 (5.91)	350 (13.78)	320 (12.6)	100 (3.94)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	12 (26)	M5
	4015										
	4018										
	4022										
	4030	250 (9.84)	350 (13.78)	320 (12.6)	200 (7.87)	330 (12.99)	10 (0.39)	190 (7.48)	130 (5.12)	21 (46)	M5
	4037										
	4045										

* A: For stand-alone drive system N: for NC system

■ Converter (VS-656MR5) Open Chassis Type

The figures below show a 200 V 10 HP (7.5 kW) model.

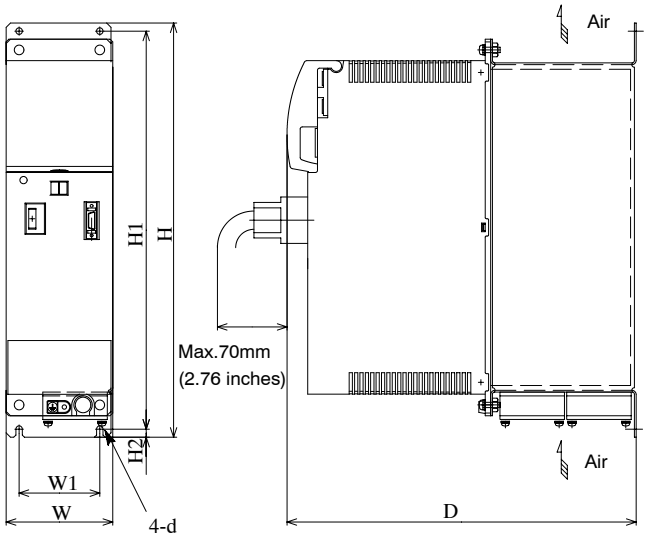


Fig 14.4 Dimensions of the Converter

Table 14.8 VS-656MR5 Dimensions and Approx. Mass

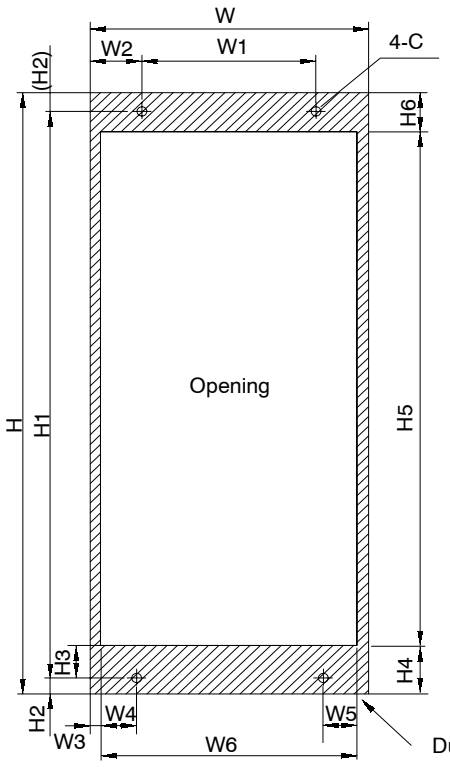
Voltage Class	Model CIMR-MR5□*□	External Heatsink Cooling Type Dimensions in mm (inches)							
		W	H	D	W1	H1	H2	Approx. Mass kg (lb)	d
200 V class	23P7	100 (3.94)	385 (15.16)	324 (12.76)	75 (2.95)	370 (14.57)	7.5 (0.30)	6 (13)	M5
	25P5								
	27P5								
	2011	150 (5.91)	470 (18.5)	324 (12.76)	100 (3.94)	455 (17.91)	6.5 (0.26)	16 (35)	M5
	2015								
	2018							16.5 (36)	
	2022								
	2030	200 (7.87)	470 (18.5)	324 (12.76)	150 (5.91)	455 (17.91)	6.5 (0.26)	21.5 (47)	M5
	2037	300 (11.81)	470 (18.50)	324 (12.76)	250 (9.84)	455 (17.91)	7 (0.28)	40 (1.57)	M6
400 V class	45P5	100 (3.94)	385 (15.16)	324 (12.76)	75 (2.95)	370 (14.57)	7.5 (0.30)	8 (18)	M5
	47P5								
	4011	150 (5.91)	470 (18.5)	324 (12.76)	100 (3.94)	455 (17.91)	6.5 (0.26)	16 (35)	M5
	4015								
	4018							16.5 (36)	
	4022								
	4030	250 (9.84)	470 (18.50)	324 (12.76)	200 (7.87)	455 (17.91)	7 (0.28)	30 (0.98)	M6
	4037								
	4045								

Note: The 2037 and 4030 to 4045 models are in development.

* A: For stand-alone drive system N: for NC system

14.1.4 Panel Cutout Dimensions for External Heatsink Cooling Type

Refer to the following diagram for panel cutout.



Note: Gasket is attached on mounting area of Converter and Inverter unit.

Voltage Class	CIMR-M5□* / CIMR-MR5□*	W	W1	W2	W3	W4	W5	W6	H	H1	H2	H3	H4	H5	H6	C
200 V class	23P7 25P5 27P5	99 (3.90)	75 (2.95)	12 (0.47)	3.5 (0.14)	8.5 (0.33)	5.5 (0.22)	89 (3.50)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)
	2011 2015 2018 2022	149 (5.87)	100 (3.94)	24.5 (0.96)	4.5 (0.18)	20 (0.79)	20 (0.79)	140 (5.51)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)
	2030	199 (7.83)	150 (5.91)	24.5 (0.96)	4.5 (0.18)	20 (0.79)	20 (0.79)	190 (7.48)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)
	2037	299 (11.78)	250 (9.84)	24.5 (0.96)	4.5 (0.18)	20 (0.79)	20 (0.79)	290 (11.42)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M6 (0.28 dia)
400 V class	45P5 47P5	99 (3.90)	75 (2.95)	12 (0.47)	3.5 (0.14)	8.5 (0.33)	5.5 (0.22)	89 (3.50)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)
	4011 4015 4018 4022	149 (5.87)	100 (3.94)	24.5 (0.96)	4.5 (0.18)	20 (0.79)	20 (0.79)	140 (5.51)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)
	2030 4037 4045	249 (9.80)	200 (7.87)	24.5 (0.96)	4.5 (0.18)	20 (0.79)	20 (0.79)	240 (9.45)	350 (13.8)	330 (13.0)	10 (0.39)	18 (0.71)	28 (1.10)	300 (11.8)	22 (0.87)	M5 (0.24 dia)

* A: For stand-alone drive system N: for NC system

Fig 14.5 Panel Cutout Dimensions in mm (inches)

14.1.5 Calorific Value and Cooling Air Speed

The following tables show the calorific value and cooling air speed of the Inverter and the Converter unit.

Table 14.9 Calorific Value and Cooling Air Speed of Inverter Unit (200 V class)

Inverter Model CIMR-M5□*1		23P7		25P5		27P5		2011		2015		2018		2022		2030		2037	
Output		Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute
Open Chassis Type Total calorific value*2 (W)		185	257	185	257	244	316	307	427	454	597	565	680	717	836	869	1147	1061	1344
External Heatsink Cooling Type	Outside of heatsink (W)	127	188	127	188	167	229	218	320	335	456	421	519	537	638	650	887	809	1029
	Inside of heatsink (W)	58	69	58	69	77	87	89	107	119	141	144	161	180	198	219	260	252	315
Cooling air speed near heatsink (m/s)		2.5																	

Table 14.10 Calorific Value and Cooling Air Speed of Inverter Unit (400 V class)

Inverter Model CIMR-M5□*1		45P5		47P5		4011		4015		4018		4022		4030		4037		4045	
Output		Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute
Open Chassis Type Total calorific value*2 (W)		117	192	170	247	273	288	354	488	512	583	630	674	759	939	934	1130	1298	1691
External Heatsink Cooling Type	Outside of heatsink (W)	56	120	94	159	146	159	207	321	328	388	419	457	488	641	612	778	910	1243
	Inside of heatsink (W)	61	72	76	88	127	129	147	167	184	195	211	217	271	298	322	352	388	448
Cooling air speed near heatsink (m/s)		2.5																	

Table 14.11 Calorific Value and Cooling Air Speed of Converter Unit (200 V class)

Inverter Model CIMR-MR5□*1		23P7		25P5		27P5		2011		2015		2018		2022		2030		2037	
Output		Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute
Open Chassis Type Total calorific value*2 (W)		84	108	84	108	119	144	152	197	204	254	273	318	335	380	392	491	524	698
External Heatsink Cooling Type	Outside of heatsink (W)	40	60	40	60	58	79	82	121	116	158	165	203	203	241	232	316	331	426
	Inside of heatsink (W)	44	48	44	48	61	65	70	76	88	96	108	115	132	139	160	175	193	272
Cooling air speed near heatsink (m/s)		2.5																	

14.1.5 Calorific Value and Cooling Air Speed

Table 14.12 Calorific Value and Cooling Air Speed of Converter Unit (400 V class)

Inverter Model CIMR-MR5□* □		45P5		47P5		4011		4015		4018		4022		4030		4037		4045	
Output		Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute	Continuous	30-minute
Open Chassis Type Total calorific value (W)		58	73	76	88	117	138	185	209	193	210	233	250	310	356	365	398	435	477
External Heatsink Cooling Type	Outside of heatsink (W)	20	32	29	39	40	58	59	79	79	93	100	115	118	157	158	186	200	236
	Inside of heatsink (W)	38	41	47	49	77	80	126	130	114	117	133	135	192	199	207	212	235	241
Cooling air speed near heatsink (m/s)		2.5																	

* A: For stand-alone drive system N: for NC system

14

14.2 Standard Motor Specifications

This section explains the standard motor specifications.

14.2.1 Outline

The AC main axis motor is a squirrel cage induction motor ideal for the main axis drive of machine-tools and high-speed drives on industrial devices. There are two series of models: Flange models for easy mounting to machinery, and foot-mounted models. The features of both are given below.

■ Wide Rated Output Ranges

The application of high-precision bearings, a high rigidity frame design, and other design elements enables using the motor within the following ranges: Maximum speed of 8,000 min^{-1} (rated output range of 1:5.3) at 7.5 kW maximum, maximum speed of 6,000 min^{-1} (rated output range of 1:4) from 11 kW to 22 kW, and maximum speed of 4,500 min^{-1} (rated output range of 1:3.9) at 30 kW minimum. The winding selection motors have even wider rated output ranges, and achieve a rated output range of 1:12 without using a speed change gear. Compact magnetic contactors having a transfer contact structure specialized for winding selection are provided. For detailed specifications of the magnetic contactor, refer to *14.3.3 Magnetic Contactor Specifications for Winding Selection*.

■ Low Vibration

Low vibration is achieved by miniaturizing the motor and adjusting the dynamic balance for high-speed drive.

■ High Reliability

The motor protection conforms to IP44, and the speed detector uses a highly reliable 1024 P/R magnetic field encoder.

■ Cooling System

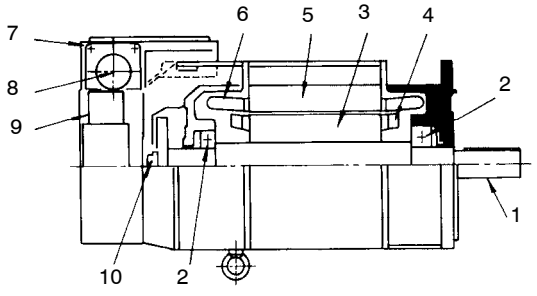
In all motors, cooling air enters from the load machine side and exits from the opposite side, avoiding exposure of the machine to the exhaust. If the opposite air direction is preferred because of the machine configuration, the cooling structure can be changed accordingly.

■ 400 V Series

The mounting dimensions and other dimensions are the same as for the Standard 200 V Series. The Motor Cooling Fan, however, is special for the 400 V Series.

14.2.2 Configuration

The motor configuration is shown in the following diagram.



Number	Name	Number	Name
1	Output shaft	6	Stator winding
2	Bearings	7	Terminal box
3	Rotor	8	Cable socket
4	Rotor short environment	9	Cooling fan
5	Stator	10	Encoder

Fig. 14.6 Motor Configuration

14.2.2 Configuration

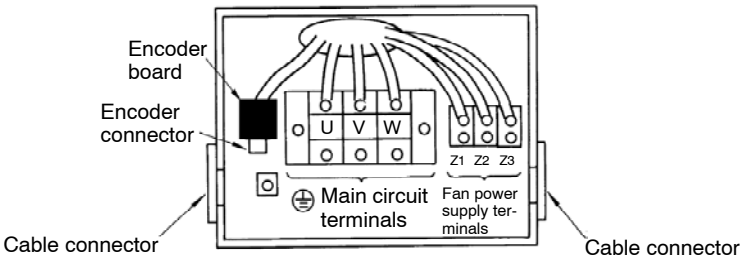
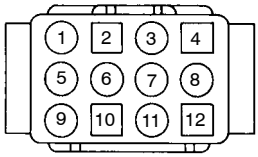


Fig. 14.7 Terminal and Connector Arrangement



EL Connector (ELR-12V)

Number	Terminal	Number	Terminal
1	5 VDC	7	PC
2	0 V	8	⁎PC
3	PA	9	FG (Frame Ground)
4	⁎PA	10	SS (Shield)
5	PB	11	TS
6	⁎PB	12	

Fig. 14.8 Encoder Connector

The common motor specifications are shown in the following table.

Table 14.13 Common Motor Specifications

Isolation	F type
Cooling Fan	Fan motor: Thermostat (auto resetting) 3-phase 200 V 50/60 Hz, 220 V 50/60 Hz, 230 V 60 Hz, 400 V 50/60 Hz, 440 V 50/60 Hz, 460 V 60 Hz
Overheating Protection	NTC Thermistor
Detector	Magnetic field encoder
Mounting Direction	Output shaft can be between horizontal to vertically down.
Bearing Lubrication	Grease
Color	Munsell N1.5
Ambient Temperature	0°C to 40°C (32°F to 104°F)
Humidity	95% max. (with no condensation)
Elevation	1000 m (3281 ft) max.
Insulation Voltage Resistance	1500 VAC for 1 min. (200 V Series) 1800 VAC for 1 min. (400 V Series)
Insulation Resistance	500 VDC, 10 MΩ min.
Conforming Standards	JIS, JEC

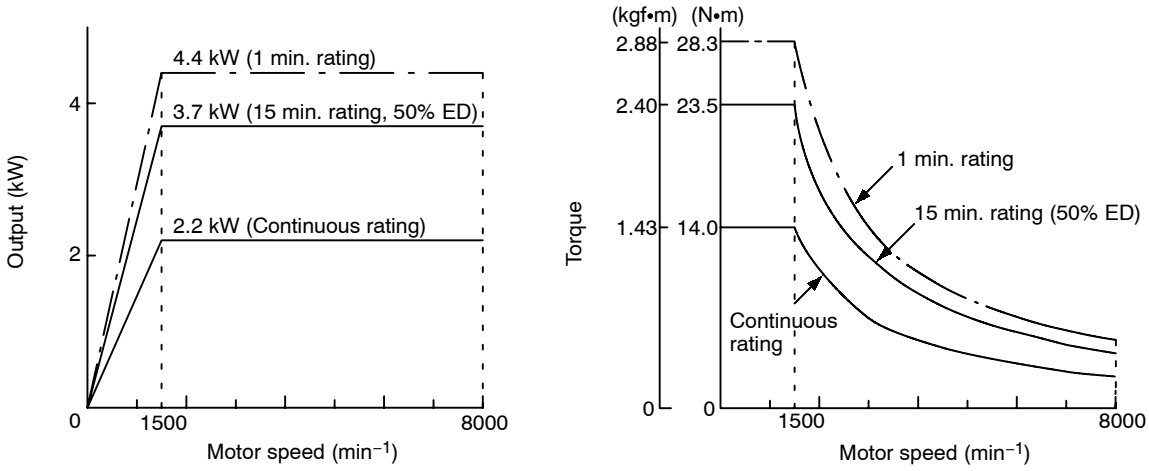
14.2.3 Output and Torque Speed Characteristics

The output and torque speed characteristics are shown in the following graphs.

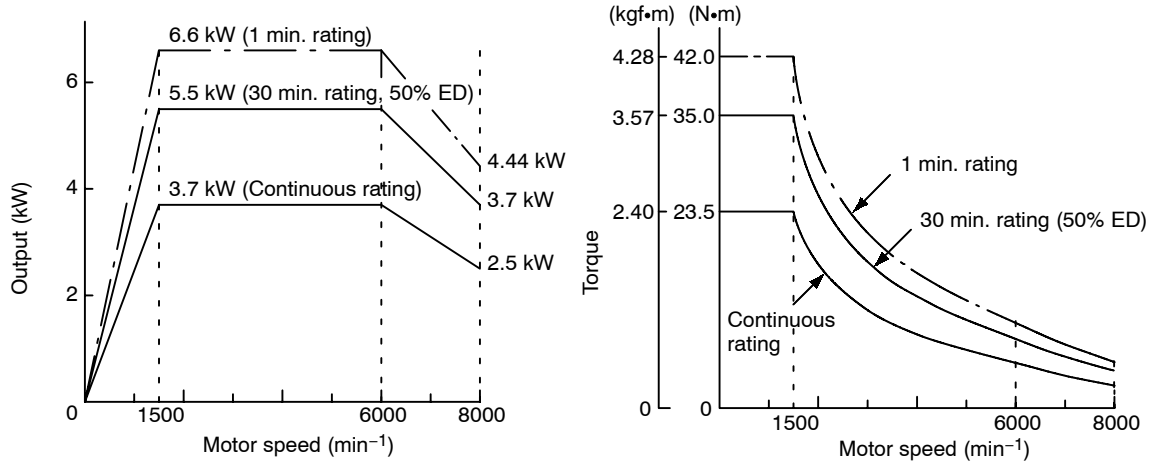
■ Standard Motors

The output characteristics are the same for both the 200 V and 400 V Series. Note that 3.7/2.2 kW is available only for the 200 V Series, and 45/37 kW is available only for the 400 V Series.

3.7/2.2 kW (200 V Series)

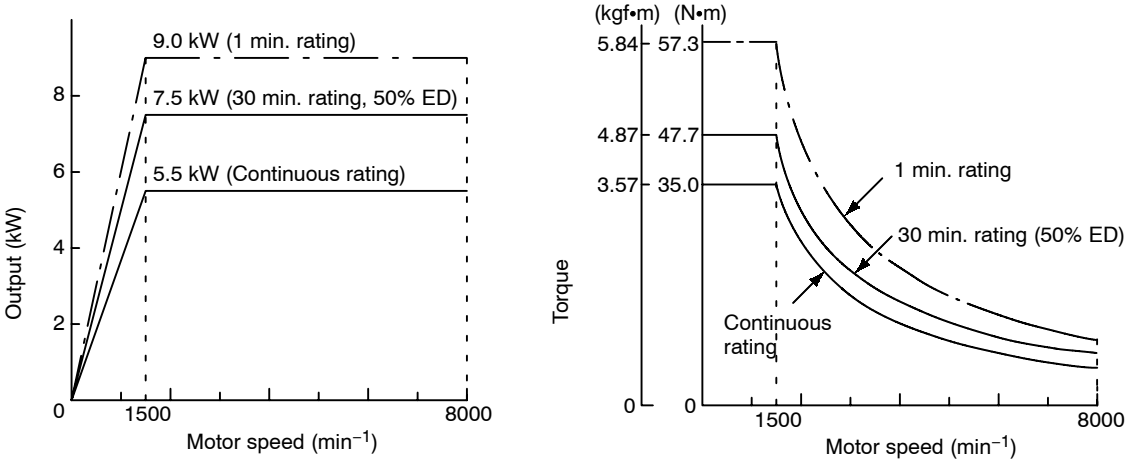


5.5/3.7 kW (200 V and 400 V Series)



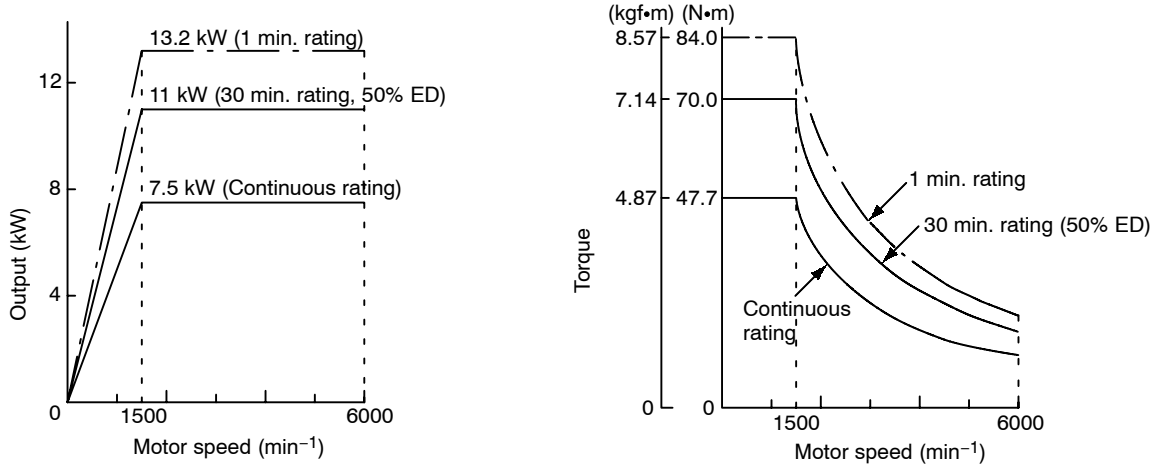
14.2.3 Output and Torque Speed Characteristics

7.5/5.5 kW (200 V and 400 V Series)

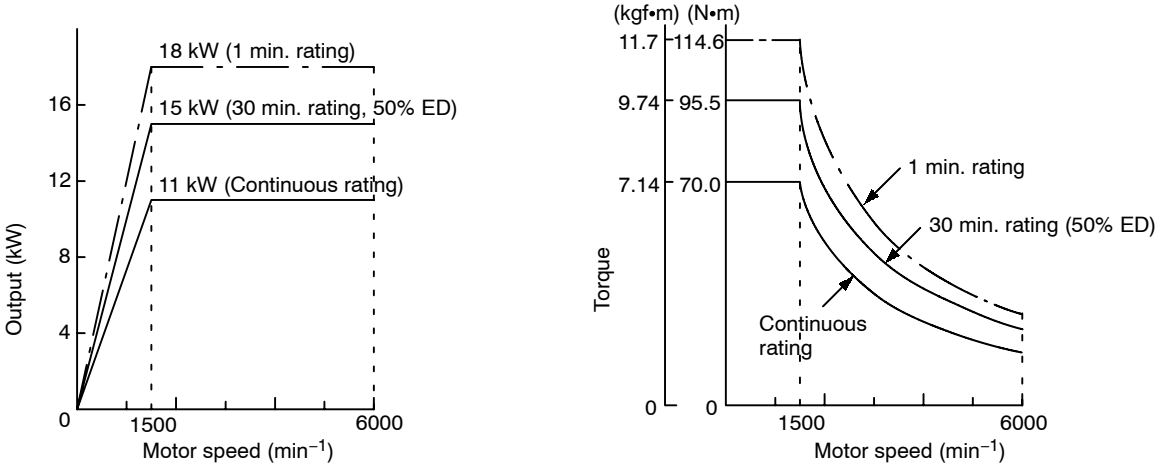


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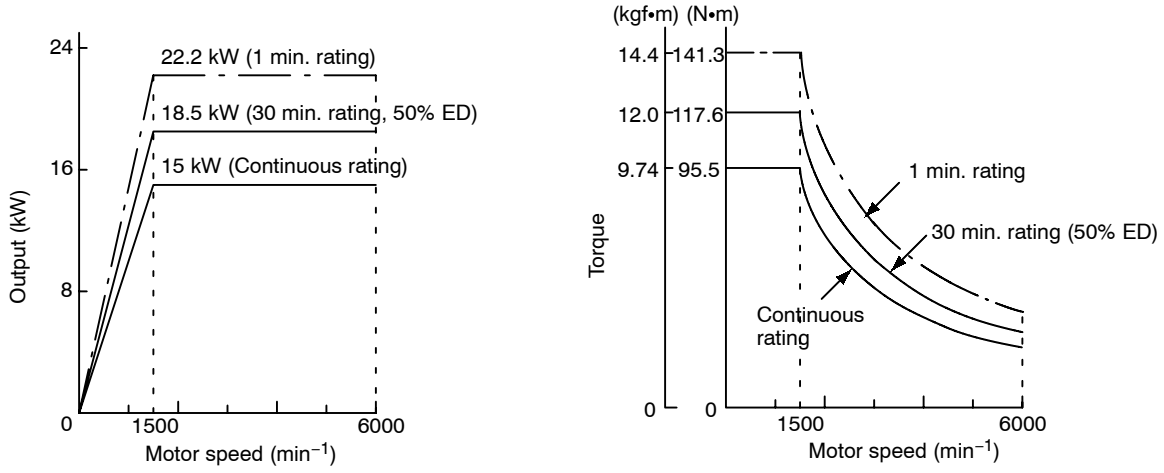
11/7.5 kW (200 V and 400 V Series)



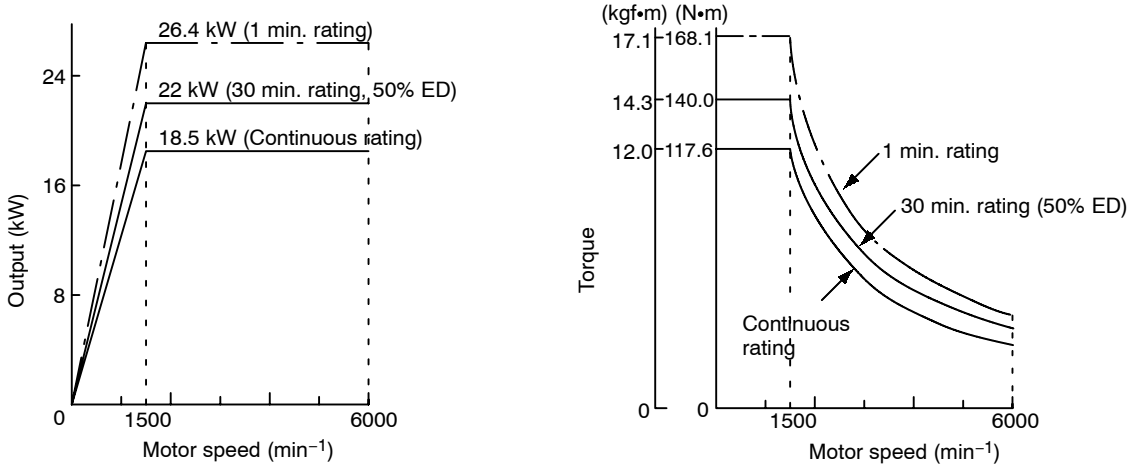
15/11 kW (200 V and 400 V Series)



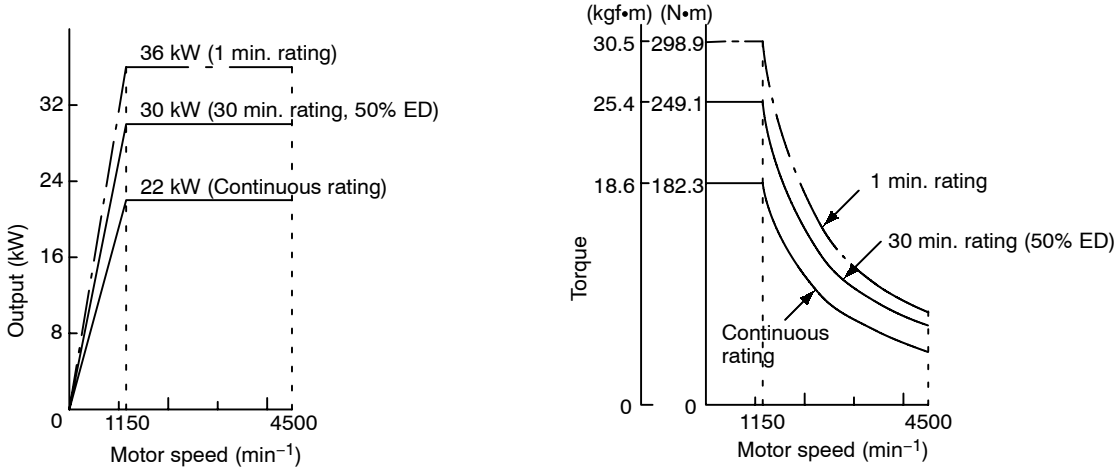
18.5/15 kW (200 V and 400 V Series)



22/18.5 kW (200 V and 400 V Series)

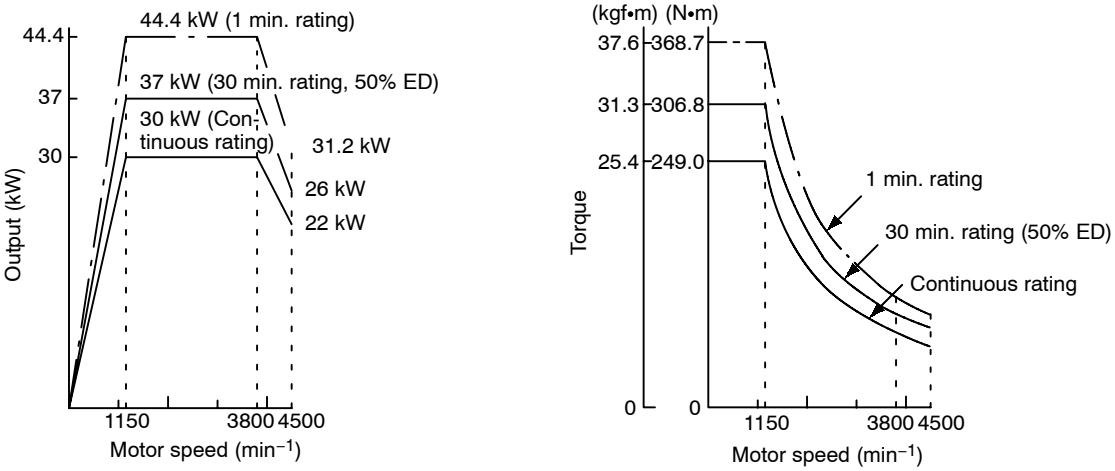


30/22 kW (200 V and 400 V Series)



14.2.3 Output and Torque Speed Characteristics

37/30 kW (200 V and 400 V Series)



45/37 kW (400 V Series)

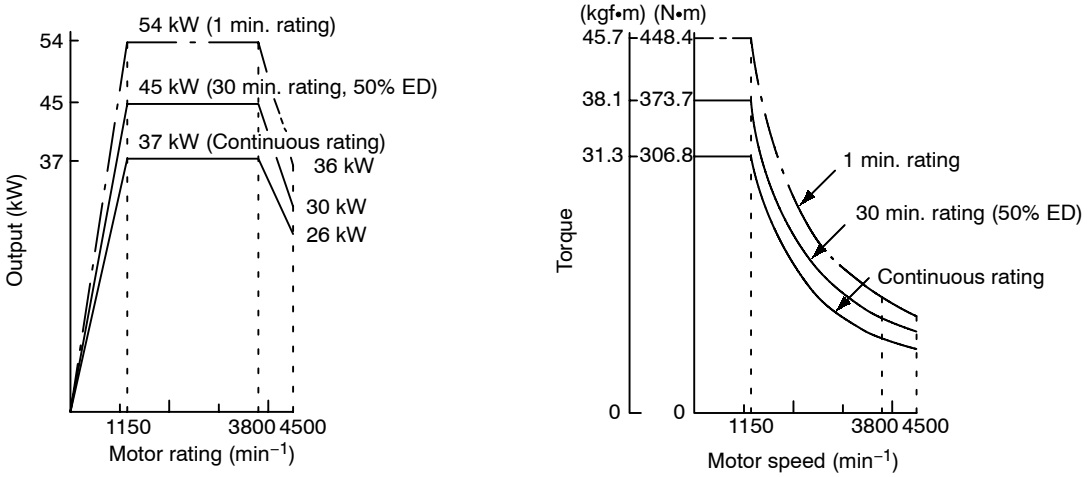
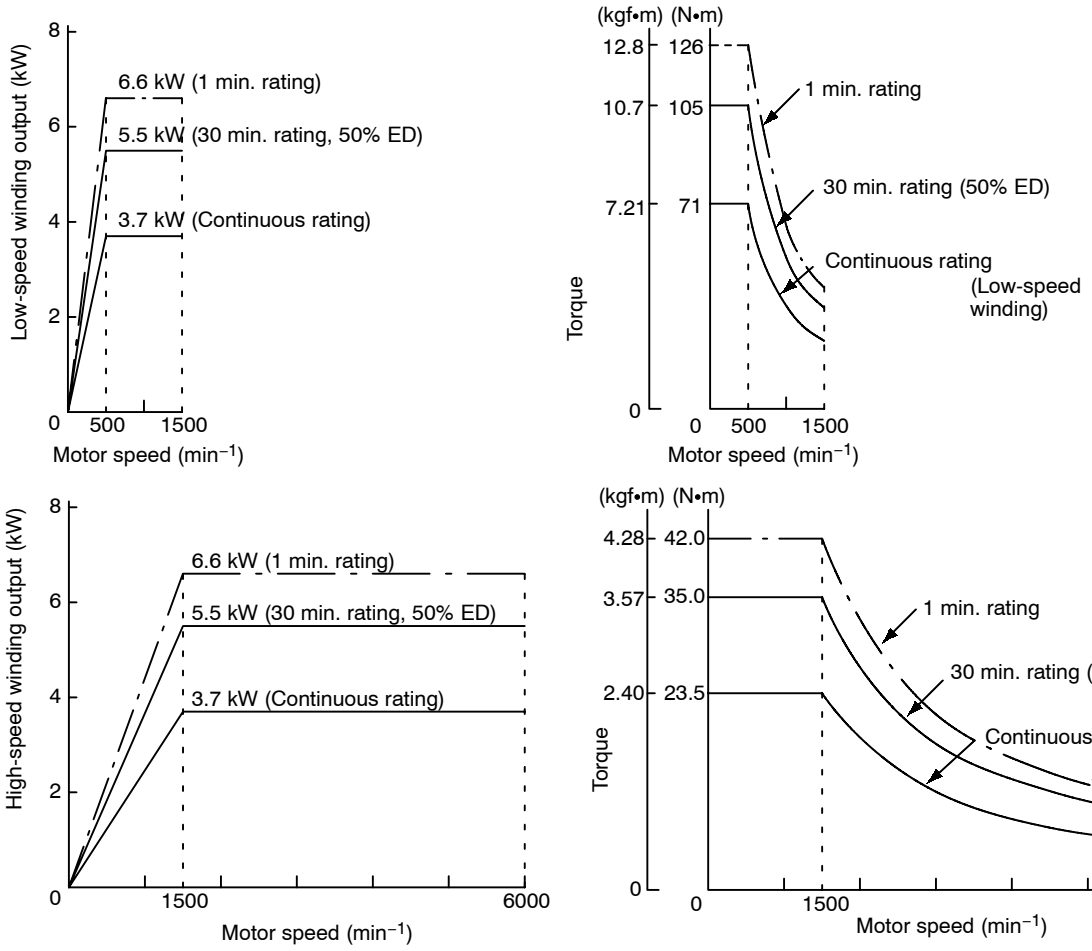


Fig. 14.9 Output and Torque Speed Characteristics for Standard Motors

■ Winding Selection Motors

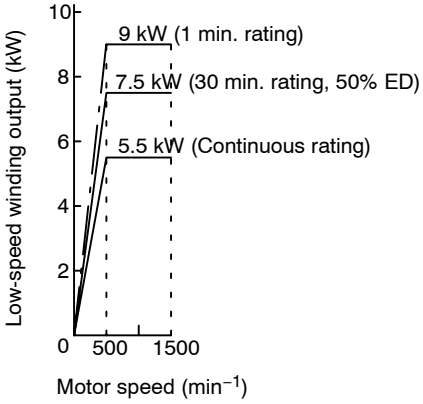
The output characteristics are the same for both the 200 V and 400 V Series.

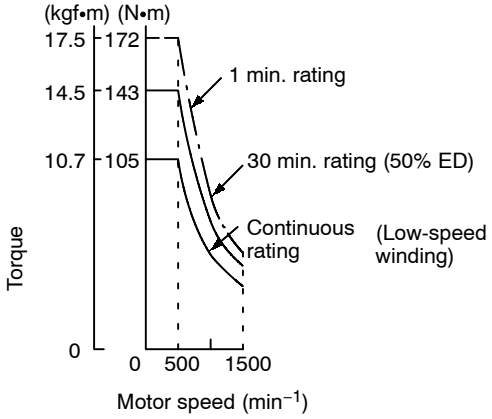
5.5/3.7 kW (200 V and 400 V Series)

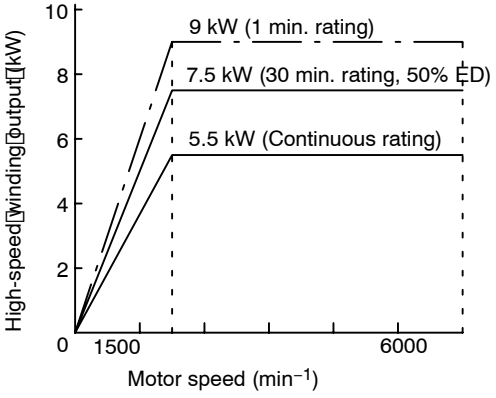


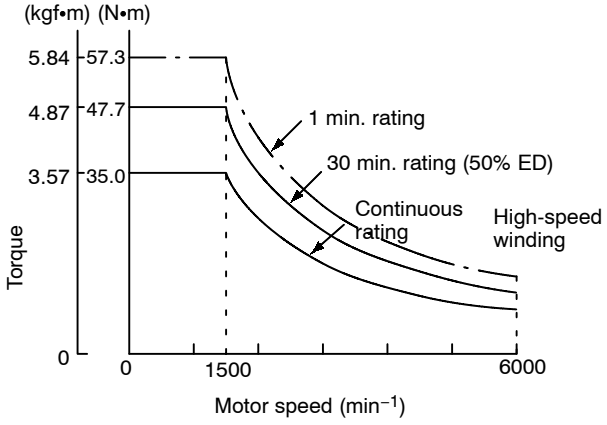
14.2.3 Output and Torque Speed Characteristics

7.5/5.5 kW (200 V and 400 V Series)

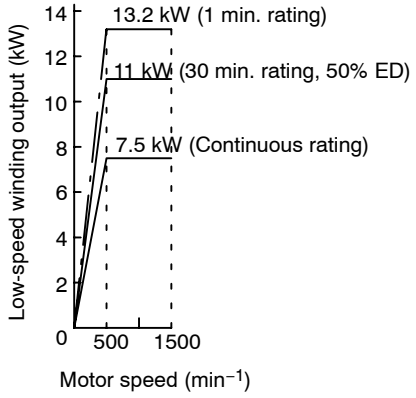


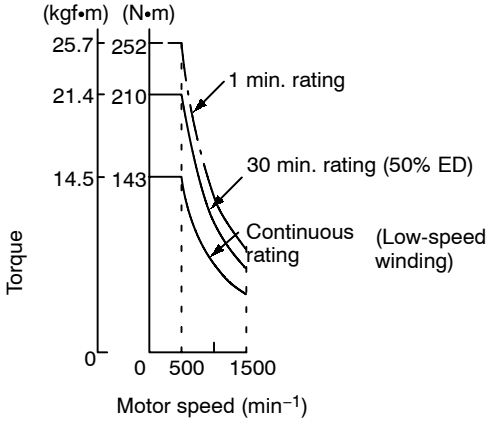


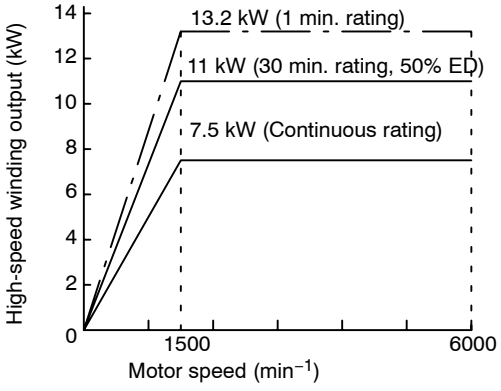


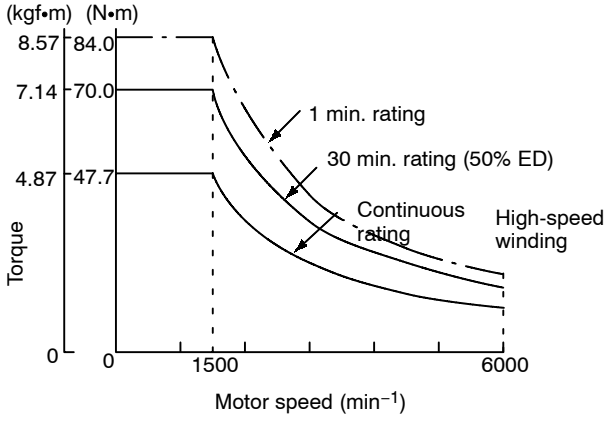


11/7.5 kW (200 V and 400 V Series)





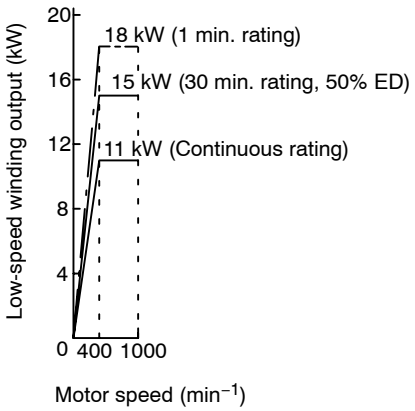


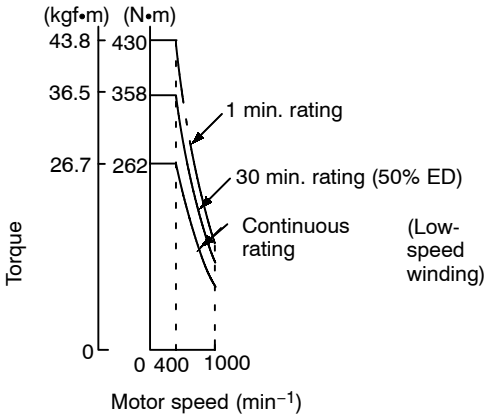


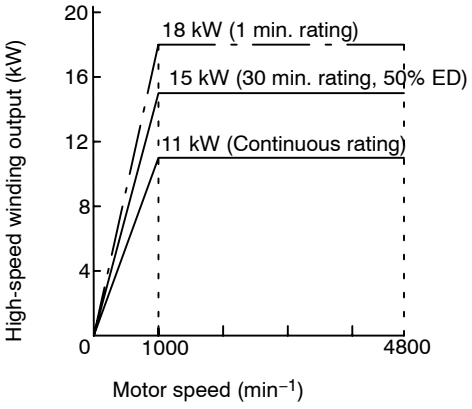
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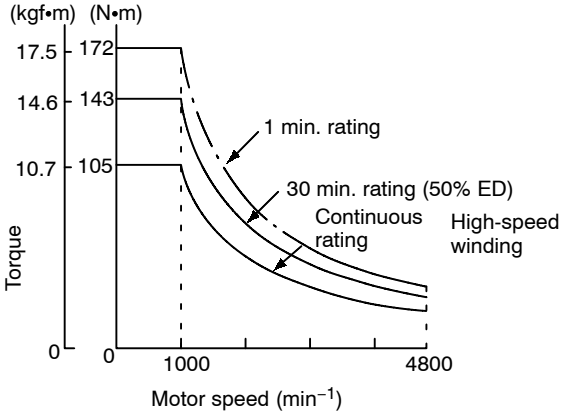
14.2.3 Output and Torque Speed Characteristics

15/11 kW (200 V and 400 V Series)

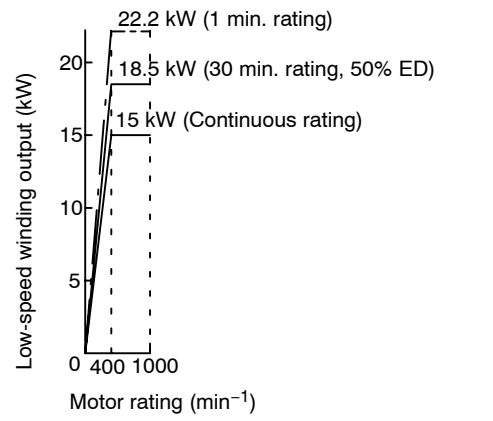


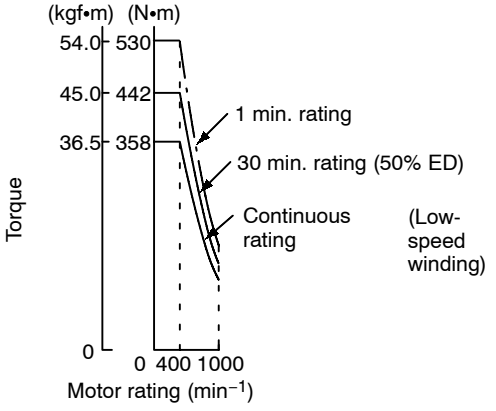


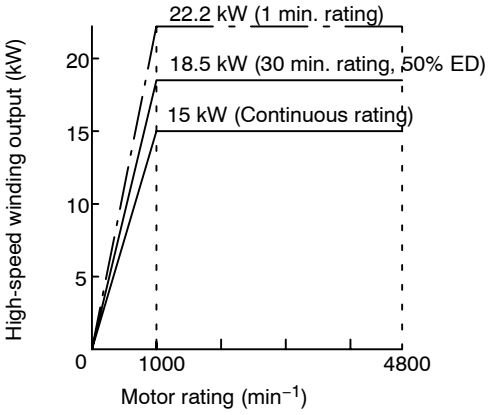


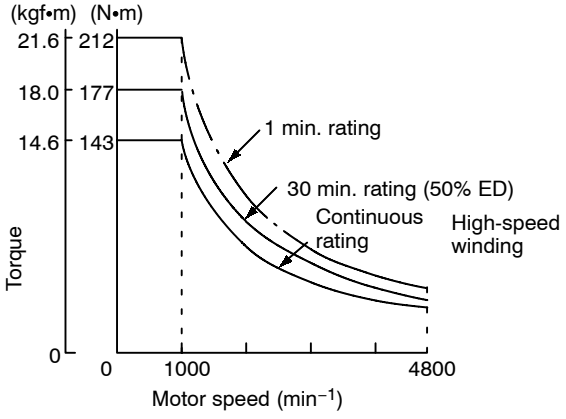


18.5/15 kW (200 V and 400 V Series)





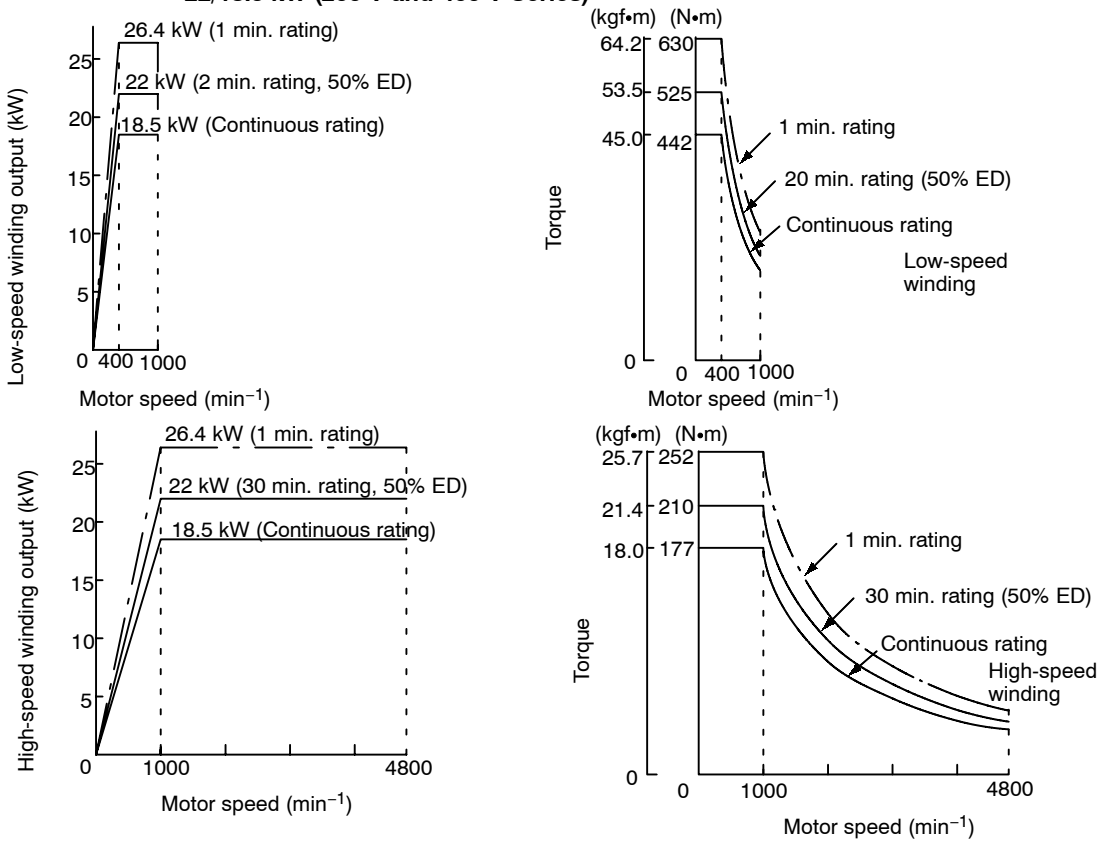




14

14.2.3 Output and Torque Speed Characteristics

22/18.5 kW (200 V and 400 V Series)



14

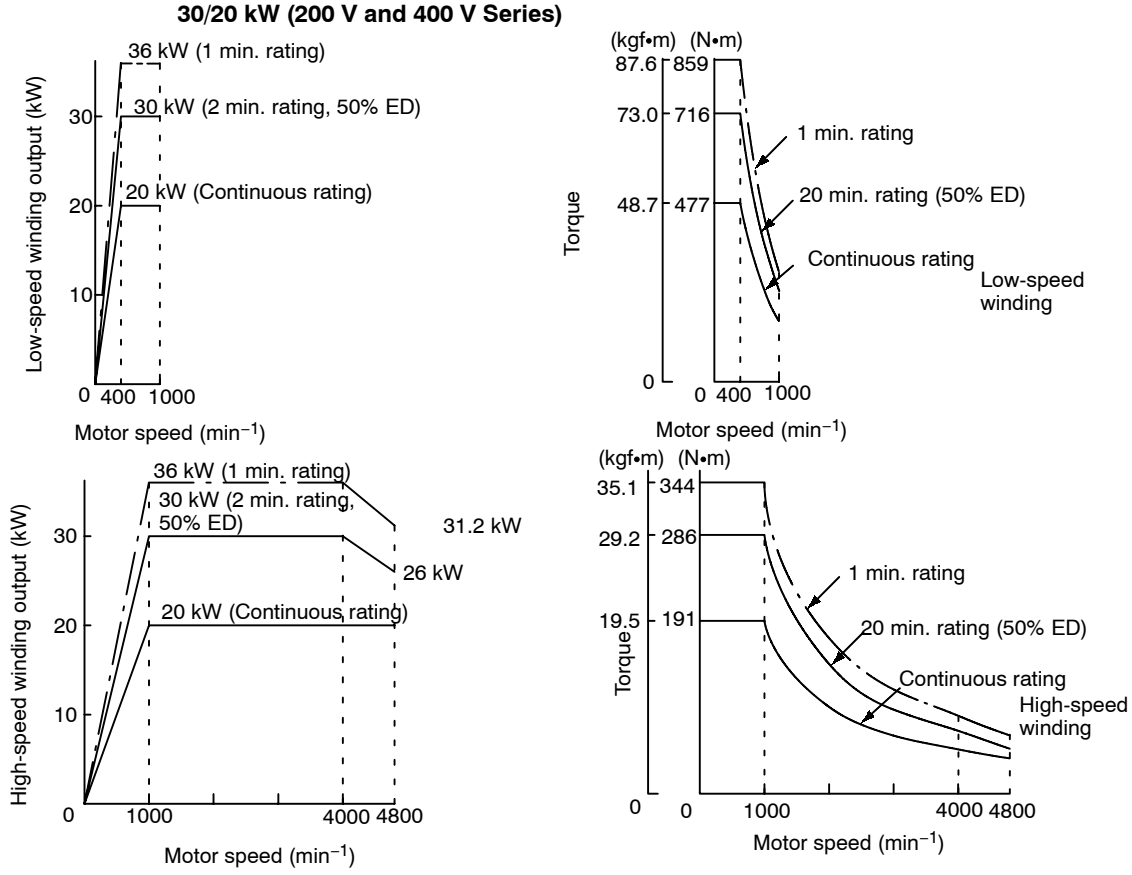
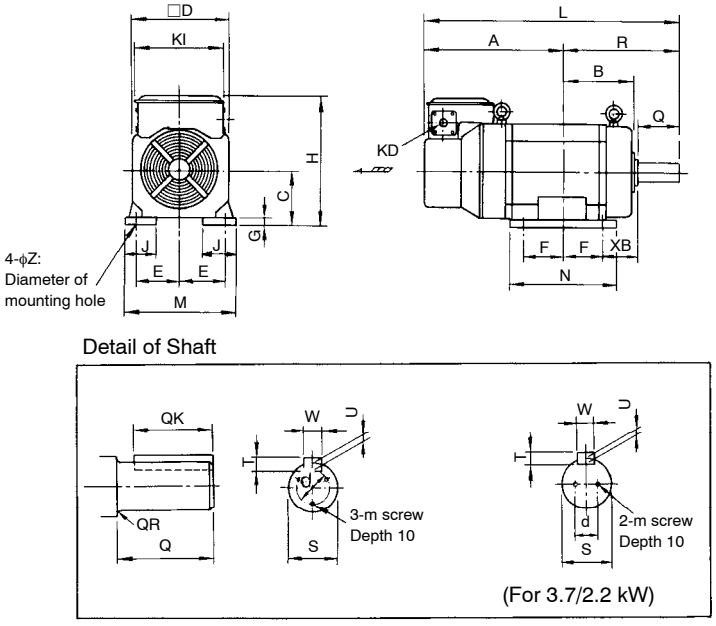


Fig. 14.10 Output and Torque Speed Characteristics (Winding Selection Motor)

14.2.4 Dimensions

The motor dimensions are shown in the following diagram. (unit: mm)

■ Standard Motors, Foot-mounted Type



Detail of Shaft

Unit: mm (inch)

Rated Output kW		A	B	0 −0.5 C	D	E	F	G	H	J	KD	L	M	N	R	XB	Z	KI
30 min. Rating	Continuous Rating																	
3.7 *1	2.2	237 (9.33)	93 (3.66)	100 (3.94)	174 (6.85)	80 (3.15)	50 (1.97)	9 (0.35)	242 (9.53)	34 (1.34)	34 (1.34)	392 (15.4)	188 (7.4)	125 (4.92)	155 (6.1)	45 (1.77)	12 (0.47)	174 (6.85)
5.5	3.7	308 (12.1)	132 (5.2)	100 (3.94)	174 (6.85)	80 (3.15)	89 (3.5)	9 (0.35)	242 (9.53)	34 (1.34)	34 (1.34)	502 (19.8)	188 (7.4)	206 (8.11)	194 (7.64)	45 (1.77)	12 (0.47)	174 (6.85)
7.5	5.5	300 (11.8)	137 (5.39)	112 (4.41)	204 (8.03)	95 (3.74)	70 (2.76)	10 (0.39)	269 (10.6)	75 (2.95)	42.5 (1.67)	520 (20.5)	220 (8.66)	177 (6.97)	220 (8.66)	70 (2.76)	12 (0.47)	204 (8.03)
11	7.5	321 (12.6)	156 (6.14)	112 (4.41)	204 (8.03)	95 (3.74)	89 (3.5)	10 (0.39)	269 (10.6)	75 (2.95)	42.5 (1.67)	590 (23.2)	220 (8.66)	215 (8.46)	269 (10.6)	70 (2.76)	12 (0.47)	204 (8.03)
15	11	261 (10.3)	196 (7.72)	160 (6.3)	260 (10.2)	127 (5)	89 (3.5)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	568 (22.4)	290 (11.4)	223 (8.78)	307 (12.1)	108 (4.25)	15 (0.59)	250 (9.84)
18.5	15	283 (11.1)	212 (8.35)	160 (6.3)	260 (10.2)	127 (5)	105 (4.13)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	606 (23.9)	290 (11.4)	255 (1)	323 (12.7)	108 (4.25)	15 (0.59)	250 (9.84)
22	18.5	297 (11.7)	234 (9.21)	160 (6.3)	260 (10.2)	127 (5)	127 (5)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	642 (25.3)	290 (11.4)	299 (11.8)	345 (13.6)	108 (4.25)	15 (0.59)	250 (9.84)
30	22	406 (16)	246 (9.69)	180 (7.09)	320 (12.6)	139.5 (5.49)	127 (5)	16 (0.63)	407 (16)	55 (2.17)	61 (2.4)	794 (31.3)	320 (12.6)	298 (11.7)	388 (15.3)	121 (4.76)	19 (0.75)	320 (12.6)
37	30	460 (18.1)	297 (11.7)	180 (7.09)	320 (12.6)	139.5 (5.49)	178 (7.01)	16 (0.63)	407 (16)	55 (2.17)	61 (2.4)	899 (35.4)	320 (12.6)	400 (15.7)	439 (17.3)	121 (4.76)	19 (0.75)	320 (12.6)
45 *2	37	378 (14.9)	302 (11.9)	225 (8.86)	380 (15)	178 (7.01)	155.5 (6.12)	21 (0.83)	505 (19.9)	75 (2.95)	61 (2.4)	822.5 (32.4)	420 (16.5)	425 (16.7)	444.5 (17.5)	149 (5.87)	24 (0.94)	385 (15.2)

Rated Output kW		Shaft Dimensions								
30 min. Rating	Continuous Rating	Q	QK	QR	S	T	U	W	d	m
3.7 *1	2.2	60 (2.36)	45 (1.77)	1 (0.039)	$28^{+0.009}_{-0.004}$	7 (0.28)	4 (0.16)	8 (0.31)	16 (0.63)	M6
5.5	3.7	60 (2.36)	45 (1.77)	1 (0.039)	$28^{0}_{-0.013}$	7 (0.28)	4 (0.16)	8 (0.31)	22 (0.87)	M4
7.5	5.5	80 (3.15)	70 (2.76)	1 (0.039)	$32^{0}_{-0.016}$	8 (0.31)	5 (0.2)	10 (0.39)	22 (0.87)	M5
11	7.5	110 (4.33)	90 (3.54)	0.5 (0.02)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
15	11	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
18.5	15	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
22	18.5	110 (4.33)	90 (3.54)	1 (0.039)	$55^{+0.030}_{+0.011}$	10 (0.39)	6 (0.24)	16 (0.63)	45 (1.77)	M5
30	22	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
37	30	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
45 *2	37	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6

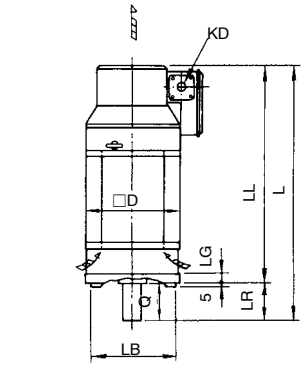
* 1. 3.7/2.2 kW is 15 min. rating (50% ED)/Continuous rating. There are no eyebolts on the 3.7/2.2 kW or 5.5/3.7 kW models.

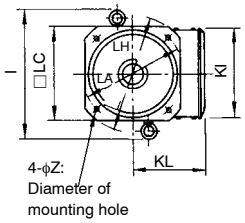
* 2. 45/37 kW is for the 400 V Series.

Notes: 1. The shaft key and the key way are standard JIS B 1301-1996 models.

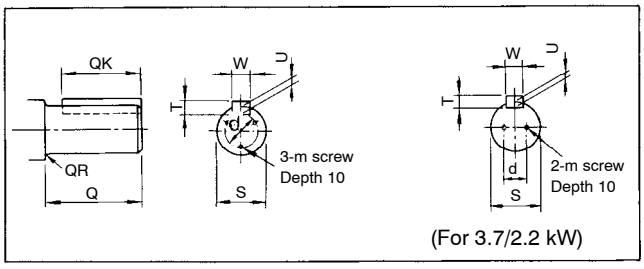
2. External dimensions are the same for both the 200 V and 400 V Series.

■ Standard Motors, Flange Type





Detail of Shaft



Unit: mm (inch)

Rated Output kW		L	LA	LB	LC	LG	LH	LL	LR	Z	D	I	KD	KL	KI
30 min. Rating	Continuous Rating														
3.7 *1	2.2	392 (15.4)	185 (7.28)	150 $^{0}_{-0.04}$	174 (6.85)	12 (0.47)	220 (8.66)	332 (13.1)	60 (2.36)	11 (0.43)	174 (6.85)	---	34 (1.34)	142 (5.59)	174 (6.85)
5.5	3.7	502 (19.8)	185 (7.28)	150 $^{0}_{-0.04}$	174 (6.85)	12 (0.47)	220 (8.66)	442 (17.4)	60 (2.36)	11 (0.43)	174 (6.85)	---	34 (1.34)	142 (5.59)	174 (6.85)
7.5	5.5	526 (20.7)	215 (8.46)	180 $^{0}_{-0.04}$	204 (8.03)	16 (0.63)	250 (9.84)	446 (17.6)	80 (3.15)	15 (0.59)	204 (8.03)	270 (10.6)	42.5 (1.67)	157 (6.18)	204 (8.03)
11	7.5	596 (23.5)	215 (8.46)	180 $^{0}_{-0.04}$	204 (8.03)	16 (0.63)	250 (9.84)	486 (19.1)	110 (4.33)	15 (0.59)	204 (8.03)	270 (10.6)	42.5 (1.67)	157 (6.18)	204 (8.03)
15	11	568 (22.4)	265 (10.4)	230 $^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	458 (18)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
18.5	15	606 (23.9)	265 (10.4)	230 $^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	496 (19.5)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
22	18.5	642 (25.3)	265 (10.4)	230 $^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	532 (20.9)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
30	22	794 (31.3)	350 (13.8)	300 $^{0}_{-0.052}$	320 (12.6)	20 (0.79)	385 (15.2)	654 (25.7)	140 (5.51)	19 (0.75)	320 (12.6)	440 (17.3)	61 (2.4)	224 (8.82)	320 (12.6)
37	30	899 (35.4)	350 (13.8)	300 $^{0}_{-0.052}$	320 (12.6)	20 (0.79)	385 (15.2)	759 (29.9)	140 (5.51)	19 (0.75)	320 (12.6)	440 (17.3)	61 (2.4)	224 (8.82)	320 (12.6)
45 *2	37	827 (32.6)	400 (15.7)	350 $^{0}_{-0.057}$	370 (14.6)	22 (0.87)	450 (17.7)	687 (27)	140 (5.51)	24 (0.94)	380 (15)	505 (19.9)	61 (2.4)	280 (11)	385 (15.2)

Rated Output kW		Shaft Dimensions								
30 min. Rating	Continuous Rating	Q	QK	QR	S	T	U	W	d	m
3.7 *1	2.2	60 (2.36)	45 (1.77)	1 (0.039)	$28^{+0.009}_{-0.004}$	7 (0.28)	4 (0.16)	8 (0.31)	16 (0.63)	M6
5.5	3.7	60 (2.36)	45 (1.77)	1 (0.039)	$28^{0}_{-0.013}$	7 (0.28)	4 (0.16)	8 (0.31)	22 (0.87)	M4
7.5	5.5	80 (3.15)	70 (2.76)	1 (0.039)	$32^{0}_{-0.016}$	8 (0.31)	5 (0.2)	10 (0.39)	22 (0.87)	M5
11	7.5	110 (4.33)	90 (3.54)	0.5 (0.02)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
15	11	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
18.5	15	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
22	18.5	110 (4.33)	90 (3.54)	1 (0.039)	$55^{+0.030}_{+0.011}$	10 (0.39)	6 (0.24)	16 (0.63)	45 (1.77)	M5
30	22	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
37	30	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
45 *2	37	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6

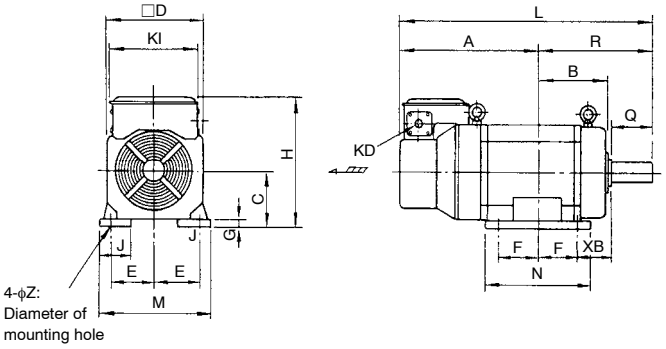
* 1. 3.7/2.2 kW is 15 min. rating (50% ED)/Continuous rating. There are no eyebolts on the 3.7/2.2 kW or 5.5/3.7 kW models.

* 2. 45/37 kW is for the 400 V Series.

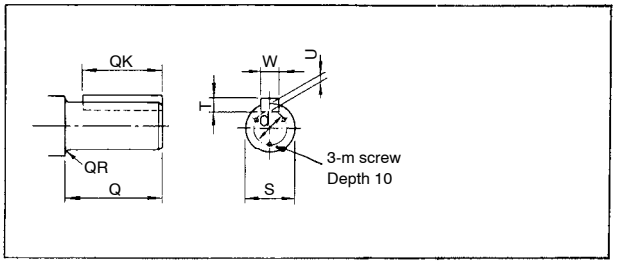
Notes: 1. The shaft key and the key way are standard JIS B 1301-1996 models.

2. External dimensions are the same for both the 200 V and 400 V Series.

■ Winding Selection Motor, Foot-mounted Type



Details of Shaft



Unit: mm (inch)

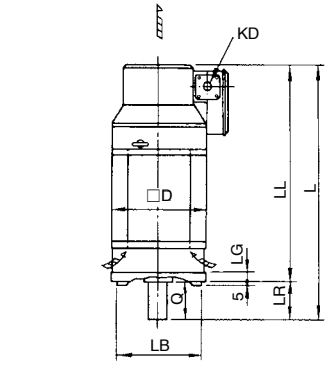
Rated Output kW		A	B	0 −0.5 C	D	E	F	G	H	J	KD	L	M	N	R	XB	Z	KI
30 min. Rating	Continuous Rating																	
5.5	3.7	261 (10.3)	196 (7.72)	160 (6.3)	260 (10.2)	127 (5)	89 (3.5)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	568 (22.4)	290 (11.4)	223 (8.78)	307 (12.1)	108 (4.25)	15 (0.59)	250 (9.84)
7.5	5.5	283 (11.1)	212 (8.35)	160 (6.3)	260 (10.2)	127 (5)	105 (4.13)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	606 (23.9)	290 (11.4)	255 (1)	323 (12.7)	108 (4.25)	15 (0.59)	250 (9.84)
11	7.5	310.5 (12.2)	246.5 (9.7)	160 (6.3)	260 (10.2)	127 (5)	139.5 (5.49)	16 (0.63)	341 (13.4)	55 (2.17)	42.5 (1.67)	668 (26.3)	290 (11.4)	324 (12.8)	357.5 (14.1)	108 (4.25)	15 (0.59)	250 (9.84)
15	11	406 (16)	246 (9.69)	180 (7.09)	320 (12.6)	139.5 (5.49)	127 (5)	16 (0.63)	407 (16)	55 (2.17)	61 (2.4)	794 (31.3)	320 (12.6)	298 (11.7)	388 (15.3)	121 (4.76)	19 (0.75)	320 (12.6)
18.5	15	378 (14.9)	302 (11.9)	225 (8.86)	380 (15)	178 (7.01)	155.5 (6.12)	21 (0.83)	505 (19.9)	75 (2.95)	61 (2.4)	822.5 (32.4)	420 (16.5)	425 (16.7)	444.5 (17.5)	149 (5.87)	24 (0.94)	385 (15.2)
22	18.5	409 (16.1)	321 (12.6)	225 (8.86)	380 (15)	178 (7.01)	174.5 (6.87)	21 (0.83)	505 (19.9)	75 (2.95)	61 (2.4)	872.5 (34.4)	420 (16.5)	465 (18.3)	463.5 (18.2)	149 (5.87)	24 (0.94)	385 (15.2)
30	20	409 (16.1)	321 (12.6)	225 (8.86)	380 (15)	178 (7.01)	174.5 (6.87)	21 (0.83)	505 (19.9)	75 (2.95)	61 (2.4)	872.5 (34.4)	420 (16.5)	465 (18.3)	463.5 (18.2)	149 (5.87)	24 (0.94)	385 (15.2)

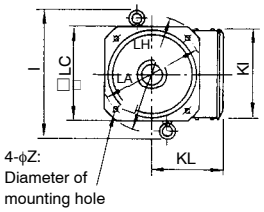
Rated Output kW		Shaft Dimensions								
30 min. Rating	Continuous Rating	Q	QK	QR	S	T	U	W	d	m
5.5	3.7	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
7.5	5.5	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
11	7.5	110 (4.33)	90 (3.54)	1 (0.039)	$55^{+0.030}_{+0.011}$	10 (0.39)	6 (0.24)	16 (0.63)	45 (1.77)	M5
15	11	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
18.5	15	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6
22	18.5	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6
30	20	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6

Notes: 1. The shaft key and the key way are standard JIS B 1301-1996 models.

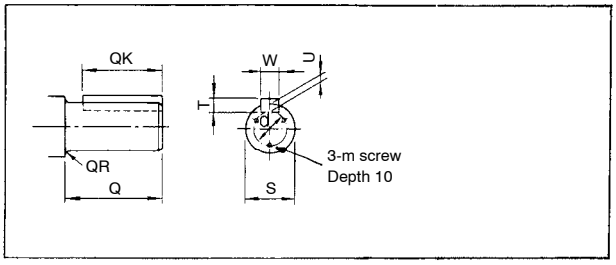
2. External dimensions are the same for both the 200 V and 400 V Series.

■ Winding Selection Motor, Flange Type





Details of Shaft



Unit: mm (inch)

Rated Output kW		L	LA	LB	LC	LG	LH	LL	LR	Z	D	I	KD	KL	KI
30 min. Rating	Continuous Rating														
5.5	3.7	568 (22.4)	265 (10.4)	$230^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	458 (18)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
7.5	5.5	606 (23.9)	265 (10.4)	$230^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	496 (19.5)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
11	7.5	668 (26.3)	265 (10.4)	$230^{0}_{-0.046}$	250 (9.84)	20 (0.79)	300 (11.8)	558 (22)	110 (4.33)	15 (0.59)	260 (10.2)	343 (13.5)	42.5 (1.67)	182.5 (7.19)	250 (9.84)
15	11	794 (31.3)	350 (13.8)	$300^{0}_{-0.052}$	320 (12.6)	20 (0.79)	385 (15.2)	654 (25.7)	140 (5.51)	19 (0.75)	320 (12.6)	440 (17.3)	61 (2.4)	224 (8.82)	320 (12.6)
18.5	15	827 (32.6)	400 (15.7)	$350^{0}_{-0.057}$	370 (14.6)	22 (0.87)	450 (17.7)	687 (27)	140 (5.51)	24 (0.94)	380 (15)	505 (19.9)	61 (2.4)	280 (11)	385 (15.2)
22	18.5	877 (34.5)	400 (15.7)	$350^{0}_{-0.057}$	370 (14.6)	22 (0.87)	450 (17.7)	737 (29)	140 (5.51)	24 (0.94)	380 (15)	505 (19.9)	61 (2.4)	280 (11)	385 (15.2)
30	20	877 (34.5)	400 (15.7)	$350^{0}_{-0.057}$	370 (14.6)	22 (0.87)	450 (17.7)	737 (29)	140 (5.51)	24 (0.94)	380 (15)	505 (19.9)	61 (2.4)	280 (11)	385 (15.2)

14.2.4 Dimensions

Rated Output kW		Shaft Dimension								
30 min. Rating	Contin-uous Rating	Q	QK	QR	S	T	U	W	d	m
5.5	3.7	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
7.5	5.5	110 (4.33)	90 (3.54)	1 (0.039)	$48^{0}_{-0.016}$	9 (0.35)	5.5 (0.22)	14 (0.55)	40 (1.57)	M5
11	7.5	110 (4.33)	90 (3.54)	1 (0.039)	$55^{+0.030}_{+0.011}$	10 (0.39)	6 (0.24)	16 (0.63)	45 (1.77)	M5
15	11	140 (5.51)	110 (4.33)	2 (0.079)	$60^{+0.030}_{+0.011}$	11 (0.43)	7 (0.28)	18 (0.71)	50 (1.97)	M6
18.5	15	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6
22	18.5	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6
30	20	140 (5.51)	110 (4.33)	1 (0.039)	$70^{+0.030}_{+0.011}$	12 (0.47)	7.5 (0.3)	20 (0.79)	60 (2.36)	M6

Notes: 1. The shaft key and the key way are standard JIS B 1301-1996 models.

2. External dimensions are the same for both the 200 V and 400 V Series.

14.2.5 Tolerance Radial Loads

The tolerance radial loads for the motor are listed in the following table.

Table 14.14 Tolerance Radial Load (Shaft Tip)

Motor Model UAASK□-□FZ	Rated Output (kW)	Tolerance Radial Load (N)	
		Standard Motor (UAASKA)	Winding Selection Motor (UAASKB)
04	3.7/2.2	1320	---
06	5.5/3.7	1470	2940
08	7.5/5.5	1765	2940
11	11/7.5	1810	3530
15	15/11	2940	4900
19	18.5/15	2940	5200
22	22/18.5	3530	5200
30 *1	30/22 *3	4900	5200
37 *2	37/30	5200	---
45	45/37	5200	---

Note: Be sure that no axial load is imposed on the motor shaft.

* 1. Model 30 is UAASKJ-30FZ.

* 2. Model 37 is UAASKJ-37FZ.

* 3. The winding selection motor is 30/20.

14.2.6 Motor Total Indicator Readings

The motor TIR (Total Indicator Reading) are listed in the following tables.

■ Foot-mounted Motors

Table 14.15 Leg-mounted Motor TIR

Item	Standard Motor	Winding Selection Motor	Accuracy
Degree of Shaft Parallax	7.5/5.5 kW max.	---	0.03
	11/7.5 to 22/18.5 kW	5.5/3.7 to 11/7.5 kW	0.033
	30/22 to 45/37 kW	15/11 to 30/20 kW	0.042
Shaft Vibration	7.5/5.5 kW max.	---	0.02
	11/7.5 to 22/18.5 kW	5.5/3.7 to 11/7.5 kW	0.022
	30/22 to 45/37 kW	15/11 to 30/20 kW	0.028

■ Flange Motors

Table 14.16 Flange Motor TIR

Item	Standard Motor	Winding Selection Motor	Accuracy
Right Angle to the Flange Output Shaft	22/18.5 kW max.	11/7.5 kW max.	0.04
	30/22 to 37/30 kW	15/11 kW	0.06
	45/37 kW	18.5/15 to 30/20 kW	0.072
Flange External Diameter Eccentricity	11/7.5 kW max.	---	0.04
	15/11 to 22/18.5 kW	5.5/3.7 to 11/7.5 kW	0.046
	30/22 to 37/30 kW	15/11 kW	0.048
	45/37 kW	18.5/15 to 30/20 kW	0.070
Shaft Vibration	7.5/5.5 kW max.	---	0.02
	11/7.5 to 22/18.5 kW	5.5/3.7 to 11/7/5 kW	0.022
	30/22 to 45/37 kW	15/11 to 30/20 kW	0.028

14.2.7 Encoders

A magnetic encoder that uses a magnetic disk is used as the motor speed detector. If there is a home position signal, three detection signals are used: Two 1024 P/R AB phase signals, and one P/R home position pulse signal. If using a main axis drive with a machine-tool, the signal resolution is the same as the main axis encoder, and in machinery where the motor axis and main axis correspond 1:1, the motor encoder can be used as the main axis encoder. The relationship between the encoder configuration and the output phase during forward rotation is shown in the following diagram.

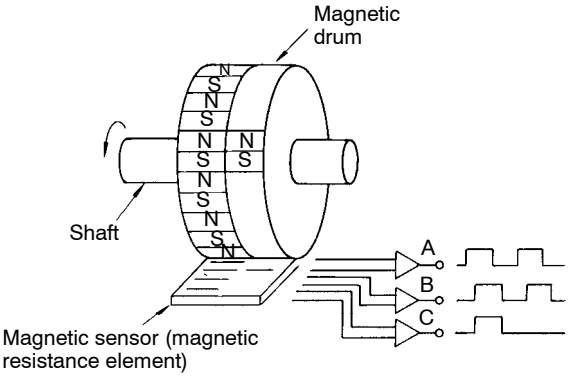


Fig. 14.11 Encoder Configuration

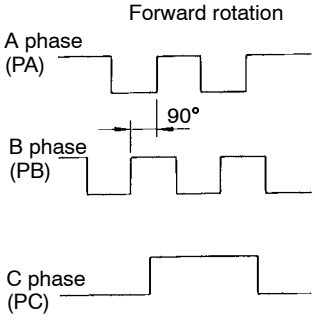
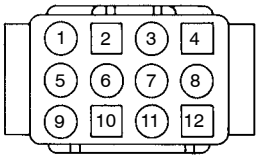


Fig. 14.12 Output Phases (Forward Rotation)

14.2.8 Encoder Connector

The terminal arrangement and dimensions of the encoder connector are given below.

■ Terminal Arrangement



EL Connector (ELR-12V)

Number	Name	Number	Name
1	5 V	7	PC
2	0 V	8	∗PC
3	PA	9	FG (Frame Ground)
4	∗PA	10	SS (Shield)
5	PB	11	TS
6	∗PB	12	

Notes: 1. Pins 11 and 12 are thermistor signal wires from the motor unit.

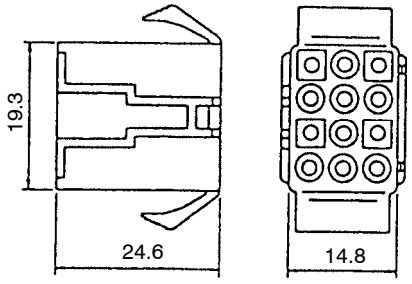
2. The asterisk (∗) before PA, PB, and PC indicate reverse rotation signals.

Fig. 14.13 Encoder Signal Connector Terminal Arrangement

■ Dimensions

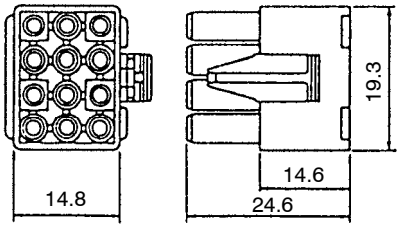
Motor (Wiring Completed)

Receptacle housing: ELR-12V

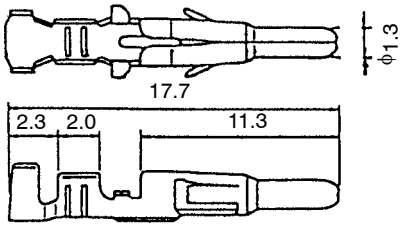


Cable (Included with Motor Terminal Box)

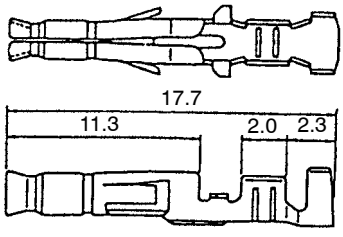
Plug housing: ELP-12V



Pin contacts
LLM-01T-1.3E × 11 pins (pins 1 to 9, 11, and 12)
LLM-41T-1.3E × 1 pin (pin 10)



Socket contacts
LLF-01T-1.3E × 11 pins (pins 1 to 9, 11, and 12)
LLF-41T-1.3E × 1 pin (pin 10)



Notes: 1. Manufacturer: JST Manufacturing Co., Ltd.

2. The cable connector housing and socket contact is built into the motor. Special tool: YC-202 and YC-203. (manufactured by JST Manufacturing Co., Ltd.)

Fig. 14.14 Encoder Signal Connector Dimensions

14.2.9 Spare Motor Parts

The model numbers of the spare parts for the motors are listed in the following tables.

Table 14.17 200V Series Spare Motor Parts

Standard Motors	Model	UAASKA-□FZ								
		04	06	08	11	15	19	22	30 *1	37 *2
	Encoder	UTMSI-10AAGAZA							UTMSI-10AAGBZA	
	Cooling Fan Motor *3	B935P4562-1		B935P7267-1		B032P0341-1			B935P4690-1	
Winding Selection Motors	Model	UAASKB-□FZ								
		---	06	08	11 *3	15	19	22	30	---
	Encoder	---	UTMSI-10AAGAZA			UTMSI-10AAGBZA				---
	Cooling Fan Motor *3	---	B032P0341-1			B935P 4690-1	B935P6539-1			---

* 1. Motor model is UAASKJ-30FZ.
* 2. Motor model is UAASKJ-37FZ.
* 3. When specifying the Cooling Fan Motor, also specify the casing. The casing must be replaced at the same time as the cooling fan motor.

Table 14.18 400V Series Spare Motor Parts

Standard Motors	Model	UAASKA-□FZ✻✻✻E									
		04	06	08	11	15	19	22	30 *1	37 *2	45 *3
	Encoder	UTMSI-10AAGAZA							UTMSI-10AAGBZA		
	Cooling Fan Motor *4	B935P5653-1		B032P0426-1		B032P0427-1			B935P5659-1		B935P6496-1
Winding Selection Motors	Model	UAASKB-□FZ✻✻✻E									
		---	06	08	11 *4	15	19	22	30	---	---
	Encoder	---	UTMSI-10AAGAZA			UTMSI-10AAGBZA				---	---
	Cooling Fan Motor *4	---	B032P0427-1			B935P 5659-1	B935P6496-1			---	---

* 1. Motor model is UAASKJ-30FZ***E.
* 2. Motor model is UAASKJ-37FZ***E.
* 3. Motor model is UAASKJ-45FZ***E.
* 4. When specifying the cooling fan motor, also specify the casing. The casing must be replaced at the same time as the cooling fan motor.

14.2.10 Replacing the Motor Cooling Fan

The AC main axis motor is cooled using a cooling fan mounted to the back of the motor. If the cooling fan malfunctions due to dirt or damage, replace the cooling fan immediately. For spare parts, refer to *14.2.9 Spare Motor Parts*.

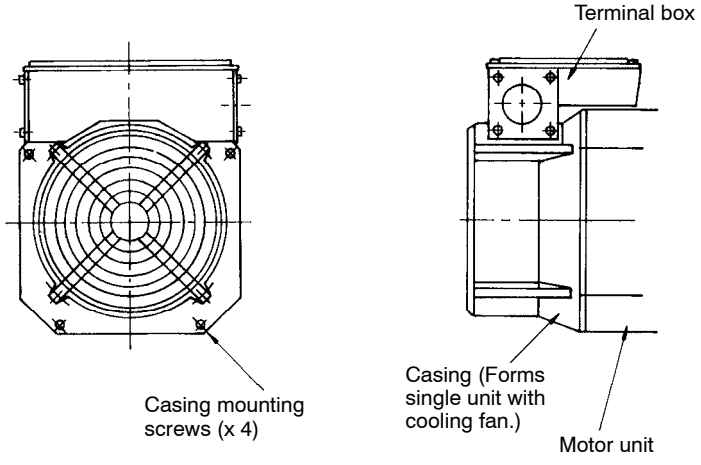
IMPORTANT

Never replace the cooling fan or insert or remove wiring while the power supply is turned ON. Also, when replacing the cooling fan or inserting or removing wiring, be sure not to drop screws or other small parts into the motor unit.

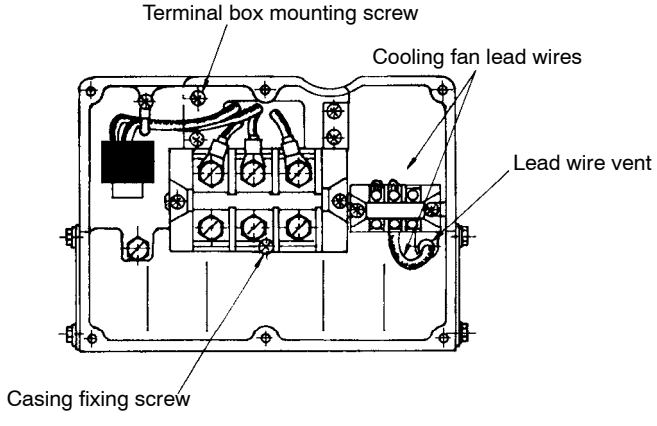
Replace the Motor Cooling Fan using the following procedure.

1. Turn OFF the power supply. Make sure the main circuit capacitor has fully discharged by confirming that the CHARGE indicator is not lit before starting work.
2. Remove the cooling fan lead cables inside the terminal box, and pull out the lead cables from the lead cable vent.
3. Remove the four screws used to mount the casing to the motor unit, and the screws within the terminal box used to fix the terminal box to the casing.
4. Remove the cooling fan and the casing as a single unit.
5. Perform steps 1. to 4. in reverse to mount the new cooling fan and the casing as a single unit to the motor unit.
6. Apply Three Bond No. 1212 to the lead cable vent on the terminal box to seal the vent.

Note: When performing step 4., if the casing and terminal box interfere with each other making it difficult to remove the casing, loosen the terminal box mounting screws.



Casing Mounting



Terminal Box Exterior

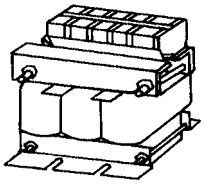
Fig. 14.15 Replacing the Motor Cooling Fan

14.3 Options and Peripheral Units

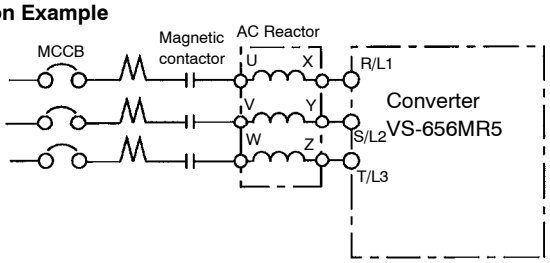
This section explains the specifications for the options and peripheral units.

14.3.1 AC Reactor

The exterior of the AC Reactor (UZBA-B: Input, 50/60 Hz) and connections examples are shown below.



Connection Example



■ With Terminal Block

Select an AC reactor from the table below according to Converter (VS-656MR5) model.

200 V Class

Model CIMR-MR5□*□	Current A	Inductance mH	Code No.	Fig. No.	Dimensions in mm (inches)															Approx. Mass kg (lb)	Heat Loss W
					A (Max.)	A1	B	B1 (Max.)	B2	C1	C2	D	E	F	I	J	K	L	M		
23P7	20	0.53	X010 057	1	130 (5.12)	—	88 (3.46)	60 (2.36)	44 (1.73)	105±5 (4.13±0.2)	25 (0.98)	50 (1.97)	70 (2.76)	130 (5.12)	3.2 (0.13)	M6	9 (0.35)	7 (0.28)	M4	3 (6.6)	35
25P5	30	0.35	X010 058	1	130 (5.12)	—	88 (3.46)	60 (2.36)	44 (1.73)	105±5 (4.13±0.2)	40 (1.57)	50 (1.97)	70 (2.76)	130 (5.12)	3.2 (0.13)	M6	9 (0.35)	7 (0.28)	M5	3 (6.6)	45
27P5	40	0.265	X010 059	2	130 (5.12)	150 (5.91)	98 (3.86)	65 (2.56)	49 (1.93)	105±5 (4.13±0.2)	40 (1.57)	50 (1.97)	80 (3.15)	130 (5.12)	3.2 (0.13)	M6	9 (0.35)	7 (0.28)	M6	4 (8.8)	50
2011	60	0.18	X010 060	1	160 (6.3)	—	105 (4.13)	75 (2.95)	52.5 (2.07)	130±5 (5.12±0.2)	40 (1.57)	75 (2.95)	85 (3.35)	160 (6.3)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M6	6 (13.2)	65
2015	80	0.13	X010 061	1	180 (7.09)	—	100 (3.94)	85 (3.35)	50 (1.97)	150±5 (5.91±0.2)	42 (1.65)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	75
2018	90	0.12	X010 062	2	180 (7.09)	190 (7.48)	100 (3.94)	90 (3.54)	50 (1.97)	150±5 (5.91±0.2)	45 (1.77)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M8	8 (17.6)	90
2022	120	0.09	X010 063	2	180 (7.09)	190 (7.48)	100 (3.94)	95 (3.74)	50 (1.97)	150±5 (5.91±0.2)	45 (1.77)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M8	8 (17.6)	90
2030	160	0.07	X010 064	3	210 (8.27)	—	100 (3.94)	210 (8.27)	—	175±5 (6.89±0.2)	110 (4.33)	75 (2.95)	80 (3.15)	205 (8.07)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M10	12 (26.5)	100
2037	200	0.05	X010 120	3	210 (8.27)	—	116 (4.57)	230 (9.06)	—	175±5 (6.89±0.2)	130 (5.12)	75 (2.95)	95 (3.74)	205 (8.07)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M10	15 (0.59)	110

400 V Class

Model CIMR-MR5□*□	Current A	Inductance mH	Code No.	Fig. No.	Dimensions in mm (inches)															Approx. Mass kg (lb)	Heat Loss W
					A (Max.)	A1	B	B1 (Max.)	B2	C1	C2	D	E	F	I	J	K	L	M		
45P5	15	1.42	X002 501	1	130 (5.12)	—	98 (3.86)	—	49 (1.93)	105±5 (4.13±0.2)	25 (0.98)	50 (1.97)	80 (3.15)	130 (5.12)	3.2 (0.13)	M6	9 (0.35)	7 (0.28)	M4	4 (8.8)	50
47P5	20	1.06	X010 099	1	160 (6.3)	—	90 (3.54)	50 (1.97)	45 (1.77)	130±5 (5.12±0.2)	25 (0.98)	75 (2.95)	70 (2.76)	160 (6.3)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M4	5 (11)	50
4011	30	0.7	X010 100	1	160 (6.3)	—	105 (4.13)	95 (3.74)	52.5 (2.07)	130±5 (5.12±0.2)	40 (1.57)	75 (2.95)	85 (3.35)	160 (6.3)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M5	6 (13.2)	65
4015	40	0.53	X010 101	1	180 (7.09)	—	100 (3.94)	85 (3.35)	50 (1.97)	150±5 (5.91±0.2)	40 (1.57)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4018	50	0.42	X010 102	1	180 (7.09)	—	100 (3.94)	85 (3.35)	50 (1.97)	150±5 (5.91±0.2)	40 (1.57)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4022	60	0.36	X010 103	1	180 (7.09)	—	100 (3.94)	85 (3.35)	50 (1.97)	150±5 (5.91±0.2)	40 (1.57)	75 (2.95)	80 (3.15)	180 (7.09)	2.3 (0.09)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4030	80	0.26	X010 104	1	210 (8.23)	—	100 (3.94)	90 (3.54)	50 (1.97)	175±5 (6.89±0.2)	45 (1.77)	75 (2.95)	80 (3.15)	205 (8.07)	3.2 (0.13)	M6	10 (0.39)	7 (0.28)	M6	12 (26.5)	95
4037	90	0.24	X010 105	1	210 (8.23)	—	116 (4.57)	110 (4.33)	58 (2.28)	175±5 (6.89±0.2)	48 (1.89)	75 (2.95)	95 (3.74)	205 (8.07)	3.2 (0.13)	M6	10 (0.39)	7 (0.28)	M8	15 (33.1)	110
4045	120	0.18	X010 106	1	240 (9.41)	—	126 (4.96)	120 (4.72)	63 (2.48)	205±5 (8.07±0.2)	48 (1.89)	150 (5.90)	110 (4.33)	240 (9.45)	3.2 (0.13)	M8	8 (0.31)	10 (0.39)	M8	23 (50.7)	130

* A: For stand-alone drive system N: for NC system

Fig. 1

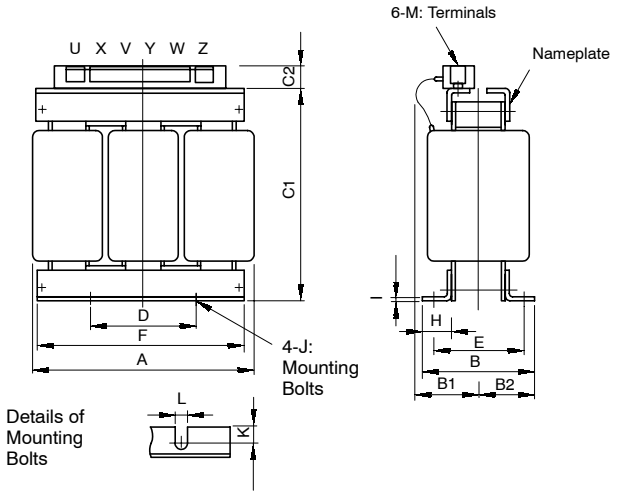


Fig. 2

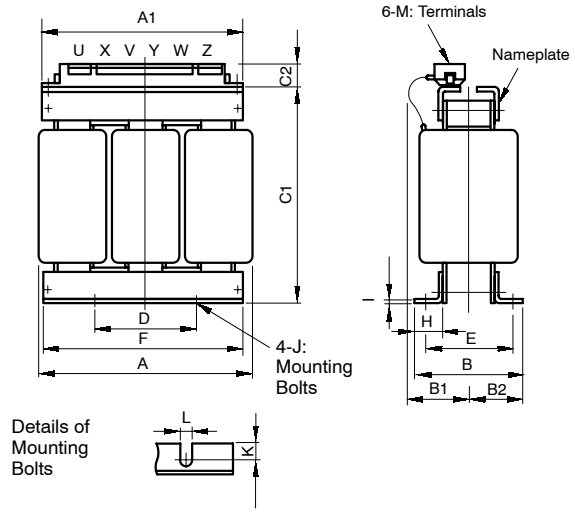
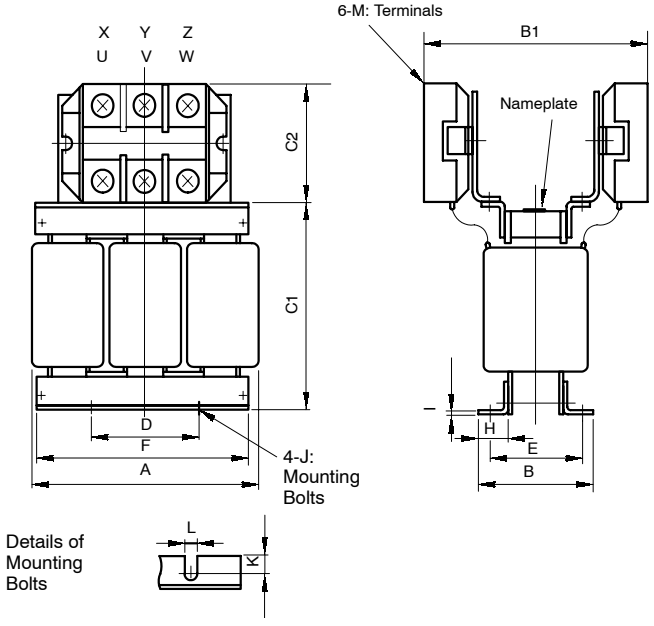


Fig. 3



■ Without Terminal Block

Select an AC reactor from the table below according to Converter (VS-656MR5) model.

200 V Class

Model CIMR-MR5□*□	Current A	Inductance mH	Code No.	Fig. No.	Dimensions in mm (inches)												Approx. Mass kg (lb)	Heat Loss W
					A (Max.)	B	B1 (Max.)	C	D	E	F	H	J	K	L	M		
23P7	20	0.53	X002491	1	130 (5.12)	88 (3.46)	114 (4.49)	105 (4.13)	50 (1.97)	65 (2.56)	130 (5.12)	22 (0.87)	M6	11.5 (0.45)	7 (0.28)	M5	3 (6.6)	35
25P5	30	0.35	X002492		130 (5.12)	88 (3.46)	119 (4.69)	105 (4.13)	50 (1.97)	70 (2.76)	130 (5.12)	22 (0.87)	M6	9 (0.35)	7 (0.28)	M5	3 (6.6)	45
27P5	40	0.265	X002493		130 (5.12)	98 (3.86)	139 (5.47)	105 (4.13)	50 (1.97)	75 (2.95)	130 (5.12)	22 (0.87)	M6	11.5 (0.35)	7 (0.28)	M6	4 (8.8)	50
2011	60	0.18	X002495		160 (6.3)	105 (4.13)	147.5 (5.81)	130 (5.12)	75 (2.95)	85 (3.35)	160 (6.3)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M6	6 (13.2)	65
2015	80	0.13	X002497		180 (7.09)	100 (3.94)	155 (6.1)	150 (5.91)	75 (2.95)	80 (3.15)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M8	8 (17.6)	75
2018	90	0.12	X002498		180 (7.09)	100 (3.94)	150 (5.91)	150 (5.91)	75 (2.95)	80 (3.15)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M8	8 (17.6)	90
2022	120	0.09	X002555		180 (7.09)	100 (3.94)	155 (6.1)	150 (5.91)	75 (2.95)	80 (3.15)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M10	8 (17.6)	90
2030	160	0.07	X002556		210 (8.27)	100 (3.94)	170 (6.69)	175 (6.89)	75 (2.95)	80 (3.15)	205 (8.07)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M10	12 (26.5)	100
2037	200	0.05	X002557		210 (8.27)	115 (4.53)	182.8 (7.2)	175 (6.89)	75 (2.95)	95 (3.74)	205 (8.07)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M10	15 (0.59)	110

400 V Class

Model CIMR-MR5□* □	Current A	Inductance mH	Code No.	Fig. No.	Dimensions in mm (inches)												Approx. Mass kg (lb)	Heat Loss W
					A (Max.)	B	B1	C	D	E	F	H	J	K	L	M		
45P5	15	1.42	X002501	2	130 (5.12)	98 (3.86)	—	130 (5.12)	50 (1.97)	75 (2.95)	130 (5.12)	22 (0.87)	M6	11.5 (0.45)	7 (0.28)	M4	4 (8.8)	50
47P5	20	1.06	X002502	1	160 (6.3)	90 (3.54)	115	130 (5.12)	75 (2.95)	70 (2.76)	160 (6.3)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M5	5 (11)	50
4011	30	0.7	X002503		160 (6.3)	105 (4.13)	132.5	130 (5.12)	75 (2.95)	85 (3.35)	160 (6.3)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M5	6 (13.2)	65
4015	40	0.53	X002504		180 (7.09)	100 (3.94)	140	150 (5.91)	75 (2.95)	80 (3.15)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4018	50	0.42	X002505		180 (7.09)	100 (3.94)	145	150 (5.91)	75 (2.95)	80 (3.15)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4022	60	0.36	X002506		180 (7.09)	100 (3.94)	150	150 (5.91)	75 (2.95)	75 (2.95)	180 (7.09)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M6	8 (17.6)	90
4030	80	0.26	X002508		210 (8.23)	100 (3.94)	150	175 (6.89)	75 (2.95)	80 (3.15)	205 (8.07)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M8	12 (26.5)	95
4037	90	0.24	X002509		210 (8.23)	115 (4.53)	177.5	175 (6.89)	75 (2.95)	95 (3.74)	205 (8.07)	25 (0.98)	M6	10 (0.39)	7 (0.28)	M8	15 (33.1)	110
4045	120	0.18	X002566		240 (9.41)	126 (4.96)	193	205±5 (8.07±0.2)	150 (5.90)	110 (4.33)	240 (9.45)	25 (0.98)	M8	8 (0.31)	10 (0.39)	M10	23 (50.7)	130

* A: For stand-alone drive system N: for NC system

Fig. 1

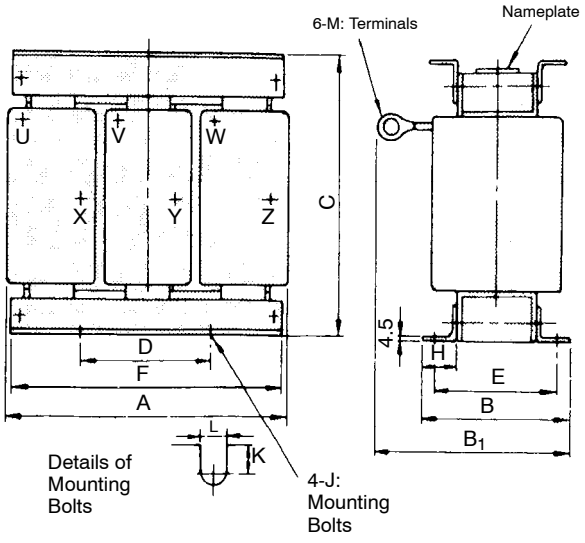
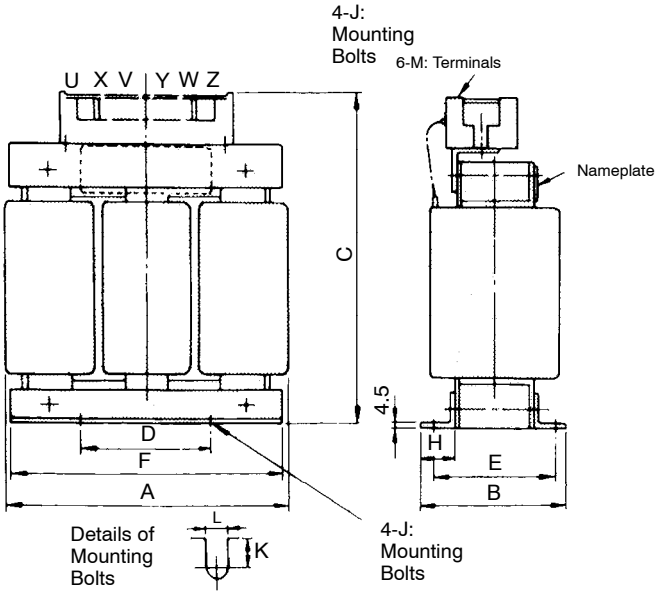
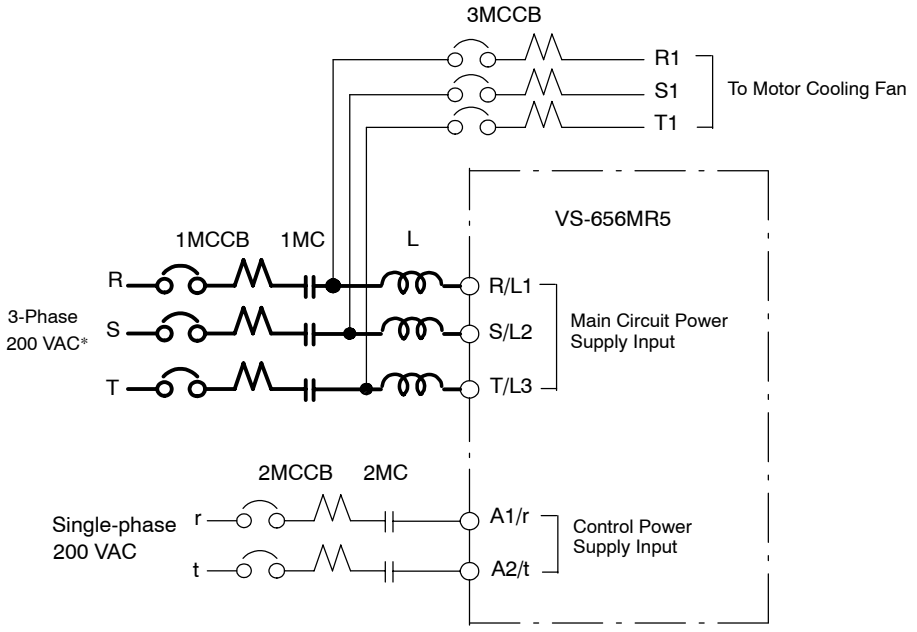

6-M: Terminals
Nameplate
U
V
W
X
Y
Z
C
4.5
H
E
B
B1
D
F
A
L
K
Details of Mounting Bolts
4-J: Mounting Bolts

Fig. 2


4-J: Mounting Bolts
6-M: Terminals
U X V Y W Z
Nameplate
C
4.5
H
E
B
D
F
A
L
K
Details of Mounting Bolts
4-J: Mounting Bolts

14.3.2 Molded Case Circuit Breaker and Magnetic Contactor

An example of the molded case circuit breaker and magnetic contactor wiring is shown below.



*: For 400 V Class, 3-phase 400 VAC.

Select MCCB and MC from the table below according to Converter (VS-656MR5) model.

Voltage Class	Converter Model CIMR-MR5□*□	Power Capacity (kVA)	MCCB Rated Current (A)			MC Rated Current (A)	
			1MCCB	2MCCB	3MCCB	1MC	2MC
200 V Class	23P7	7	30	3	3	20	3
	25P5	9	40	3	3	30	3
	27P5	12	50	3	3	40	3
	2011	19	75	3	3	60	3
	2015	24	100	3	3	75	3
	2018	30	125	3	3	100	3
	2022	36	150	3	3	125	3
	2030	48	175	3	3	150	3
	2037	60	250	3	3	200	3
400 V Class	45P5	9	20	3	2	15	3
	47P5	12	25	3	2	20	3
	4011	19	40	3	2	30	3
	4015	24	50	3	2	40	3
	4018	30	60	3	2	50	3
	4022	36	75	3	2	60	3
	4030	48	100	3	2	80	3
	4037	60	125	3	2	100	3
	4045	72	150	3	2	125	3

* A: For stand-alone drive system N: for NC system

14.3.3 Magnetic Contactor Specifications for Winding Selection

This section explains the specifications for the winding selection magnetic contactor.

■ Ratings and Specifications

The standard specifications are shown in the following table.

Table 14.19 Standard Specifications

Type*1	Standard	HV-75AP4	HV-150AP4	HV-200AP4
	IPM Motor *2	HV-75BP4	HV-150BP4	HV-200BP4
Contact		Main contact: 3NO3NC, auxiliary contact: 1NO		
Rated Insulation Voltage		600 V		
Rated Applying Current	Continuous	75A	150A	200A
	30 minutes *3	87A	175A	226A
Breaking Current Capacity	220 V	200A	400A	400A
	440 V	150A	300A	300A
Open/Close Frequency		600 times/hr		
Mechanical Duration of Life		5 million times		
Control Magnetic Coil Rating		200 V 50/60 Hz, 220 V 50/60 Hz, 230 V 60 Hz		
Mass lb (kg)		2.5 kg (5.51 lb)	5.0 kg (11 lb)	5.0 kg (11 lb)
Ambient Temperature		–10 to 55°C (14 to 131°F)		
Humidity		10 to 95% (non-condensing)		
Applicable Inverter Capacity	200 V class	5 HP to 20 HP (3.7 kW to 15 kW)	25 HP to 40 HP (18.5 kW to 30 kW)	50 HP (37 kW)
	400 V class	5 HP to 20 HP (3.7 kW to 15 kW)	25 HP to 40 HP (18.5 kW to 30 kW)	50 HP to 60 HP (37 kW to 45 kW)

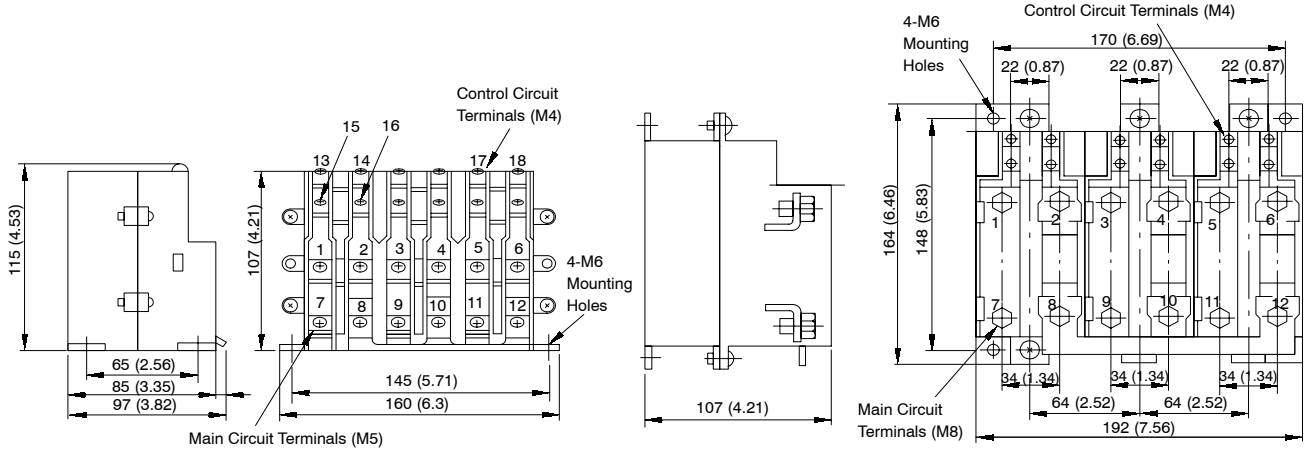
* 1. Models with safety covers are as follows: HV-□ AP4S and HV-□ BP4S.

* 2. IPM motors are the standard models with the short circuit bar removed.

* 3. A dwell time of 1 hour or more is required after applying power supply for 30 minutes.

■ Dimensions

The dimensions are shown below in mm (inches).



(a) Model HV-75□P4

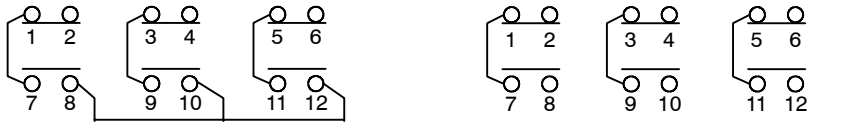
(b) Models HV-150□P4, HV-200□P4

Fig 14.16 Dimensions

■ Terminal Descriptions

Table 14.20 Terminal Name and Operation Status

Terminal	Name	Operation Status	
13–14	Selection signal	+24 V (Low-speed winding)	0 V (High-speed winding)
1–2 3–4 5–6	Main contact: 3NC	Open	Closed
7–8 9–10 11–12	Main contact: 3NO	Closed	Open
15–16	Auxiliary contact: 1NO	Open	Closed
17–18	200 V power supply	–	–

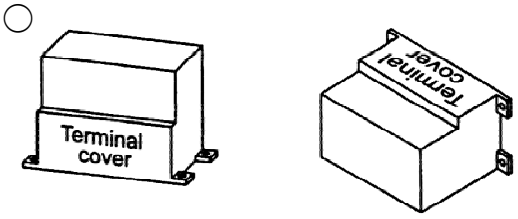
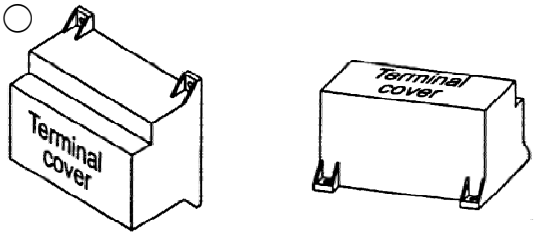
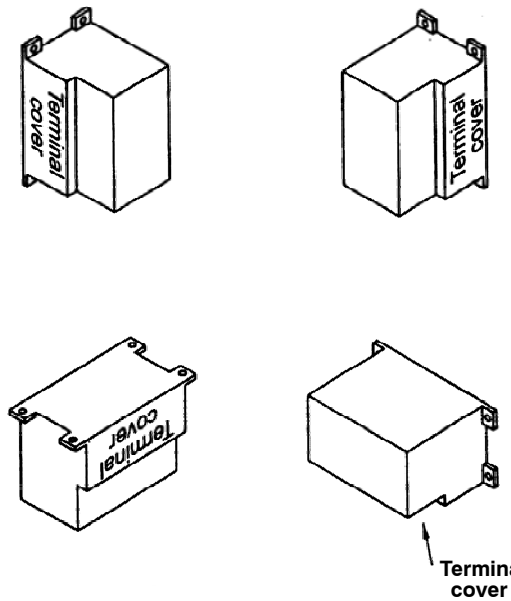
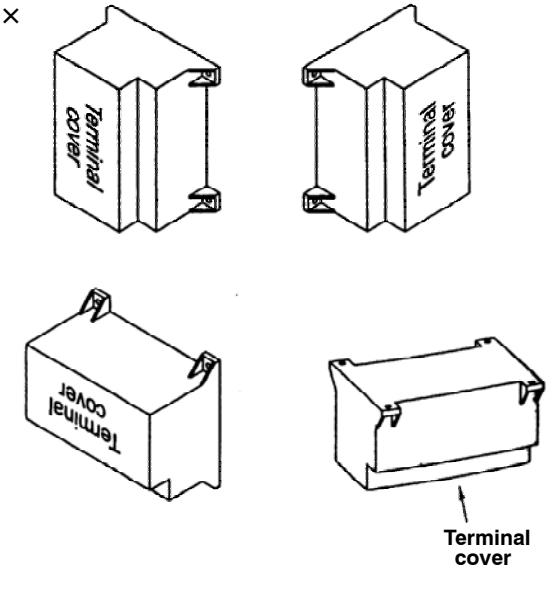


(a) HV-□AP4 (Standard) (b) HV-□BP4 (IPM Motor)

Fig 14.17 Main Circuit Contact Configuration

■ Mounting Orientations

Refer to the following table for mounting orientations.

Mounting	HV-75□P4	HV-150□P4 and HV-200□P4
Possible	○ 	○ 
Not Possible	× 	× 

14.3.4 Busbar and Cable Kits for Connecting Units

Busbar and Cables are required for connections between the Converter and Inverter. Select suitable Busbar and Cable Kit from the tables below depending on the combination of Converter and Inverter. Busbar and Cable Kit are not supplied with the Inverter, but must be purchased separately when needed.

⚠ WARNING

- Always turn OFF the input power supply before wiring terminals.
  Otherwise, an electric shock or fire can occur.

⚠ CAUTION

- When mounting the Busbar, use only the screws supplied.
  Otherwise, mounting may be incorrect.

■ Selecting Busbar and Cable Kits

Refer to the following table when selecting Busbar and Cable Kits

Table 14.21 200 V Class

Unit Combination		Busbar/Cable Kits Code Number
CIMR-MR5□*□ Converters	CIMR-M5□*□ Inverters	
23P7 25P5 27P5	23P7 25P5 27P5	72626-W100100
	2011 2015 2018 2022	72626-W100150
	2030	72626-W100200
	2037	72626-W100300
2011 2015 2018 2022 2030	23P7 25P5 27P5	72626-W150100
	2011 2015 2018 2022	72626-W150150
	2030	72626-W150200
	2037	72626-W150300
2307	23P7 25P5 27P5	72626-W300100
	2011 2015 2018 2022	72626-W300150
	2030	72626-W300200
	2037	72626-W300300

* A: For stand-alone drive system N: for NC system

Table 14.22 400 V Class

Unit Combination		Busbar/Cable Kits Code Number
CIMR-MR5□*□ Converters	CIMR-M5□*□ Inverters	
45P5 47P5	45P5 47P5	72626-W100100
	4011 4015 4018 4022	72626-W100150
	4030 4037 4045	72626-W100250
4011 4015 4018 4022	45P5 47P5	72626-W150100
	4011 4015 4018 4022	72626-W150150
	4030 4037 4045	72626-W250250
4030 4037 4045	45P5 47P5	72626-W250100
	4011 4015 4018 4022	72626-W250150
	4030 4037 4045	72626-W250250

* A: For stand-alone drive system N: for NC system

■ Dimensions

The Busbar and Cable dimensions are given in the following table.

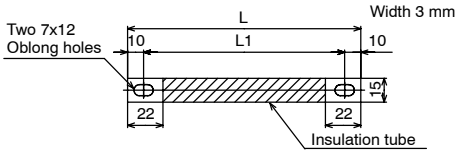
Table 14.23 Busbar and Cable Dimensions

Code Number	Special Busbar					Flat Cable		P1N1 Power Supply Cable	
	Cutaway Diagram	Dimensions (mm (inches))			No.	Dimensions L in mm (inches)	No.	Dimensions L in mm (inches)	No.
		L	L1	L2					
72626-W100100	1	120 (4.72)	100 (3.94)	---	2	100 (3.94)	1	150 (5.91)	1
72626-W100150	2	167.5 (6.59)	122.5 (4.82)	---	2	180 (7.09)	1	150 (5.91)	1
72626-W100200	2	217.5 (8.56)	172.5 (6.79)	---	2	230 (9.06)	1	150 (5.91)	1
72626-W100250	2	267.5 (10.5)	222.5 (8.76)	---	2	280 (11)	1	150 (5.91)	1
72626-W100300	4	317.5 (12.5)	122.5 (4.82)	98.5 (3.88)	2	330 (13)	1	150 (5.91)	1
72626-W150100	2	147.5 (5.81)	102.5 (4.04)	---	2	100 (3.94)	1	250 (9.84)	1
72626-W150150	3	195 (7.68)	125 (4.92)	---	2	180 (7.09)	1	250 (9.84)	1
72626-W150200	3	245 (9.65)	175 (6.89)	---	2	230 (9.06)	1	300 (11.8)	1
72626-W150300	5	345 (13.6)	125 (4.92)	101 (3.98)	2	330 (13)	1	350 (13.8)	1
72626-W250100	2	147.5 (5.81)	102.5 (4.04)	---	2	100 (3.94)	1	300 (11.8)	1
72626-W250150	3	195 (7.68)	125 (4.92)	---	2	180 (7.09)	1	300 (11.8)	1
72626-W250250	3	295 (11.6)	225 (8.86)	---	2	280 (11)	1	300 (11.8)	1
72626-W300100	4	297.5 (11.7)	102.5 (4.04)	78.5 (3.09)	2	100 (3.94)	1	350 (13.8)	1
72626-W300150	5	345 (13.6)	125 (4.92)	101 (3.98)	2	180 (7.09)	1	350 (13.8)	1
72626-W300200	5	395 (15.6)	175 (6.89)	151 (5.94)	2	230 (9.06)	1	350 (13.8)	1
72626-W300300	6	495 (19.5)	---	---	2	330 (13)	1	350 (13.8)	1

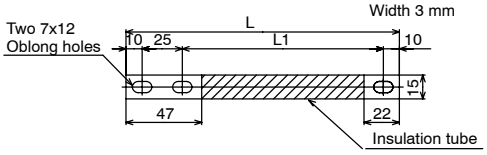
■ Cutaway Diagrams

The Busbar and cable cutaway diagrams are shown below.

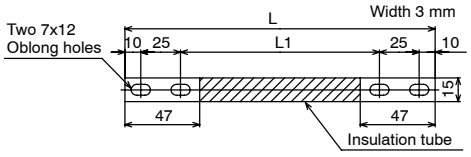
Busbar: Cutaway Diagram 1



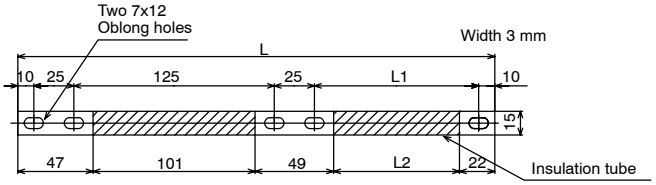
Busbar: Cutaway Diagram 2



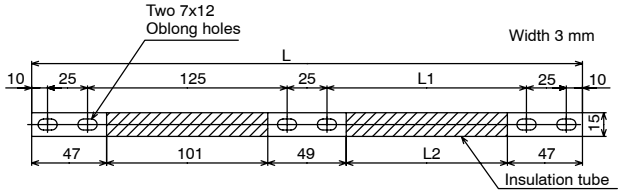
Busbar: Cutaway Diagram 3



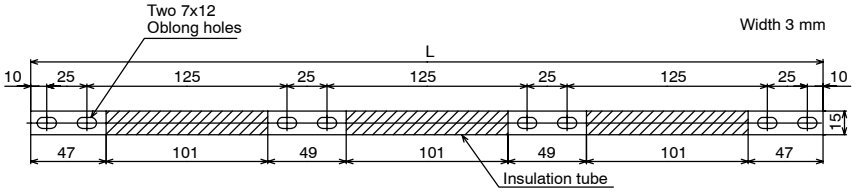
Busbar: Cutaway Diagram 4



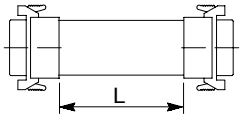
Busbar: Cutaway Diagram 5



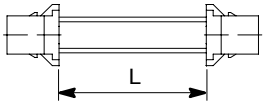
Busbar: Cutaway Diagram 6



Flat Cable



P1N1 Power Supply Cable



■ Unit Installation

An example combination of a 200-V, 22-kW Converter and a 200-V, 22-kW Inverter is shown in the following diagram. Always install the Converter on the left when viewed from the front.

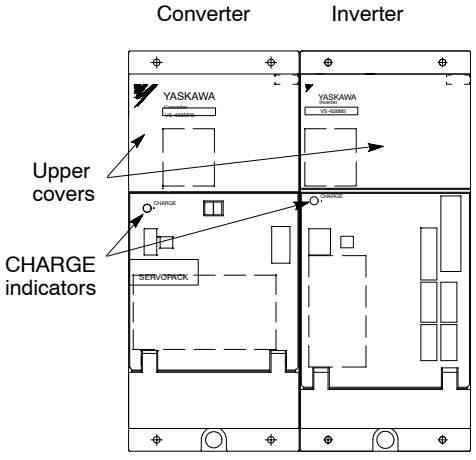


Fig 14.18 Unit Mounting

■ Busbar Mounting

Use the following procedure to mount the Busbar.

1. Turn OFF the power supply to the Converter, and wait at least 5 minutes (until the CHARGE indicator is no longer lit) before opening the upper cover.
2. Remove the Converter and Inverter power supply terminal screws, and connect the Busbar.

INFO

Be sure to use all of the power supply terminal screws supplied to mount the Busbar, and tighten the screws firmly to a torque of 4 to 5 N•m.

■ Flat Cable Mounting

Use the following procedure to mount the flat cable.

1. Connect the cable with the red line facing down.
2. Connect the Inverter using the left connector of the two connectors.

INFO

When inserting the connectors, check that the clasp locks with a snap.

■ PIN1 Power Supply Cable Mounting

Connect the P1N1 Power Supply Cable according to the following steps.

1. Turn the cable connector so that the two grooves on the tip are facing left, and then connect the cable.
2. Connect the Inverter using the left connector of the two connectors.

INFO When inserting the connectors, check that the clasp locks with a snap.

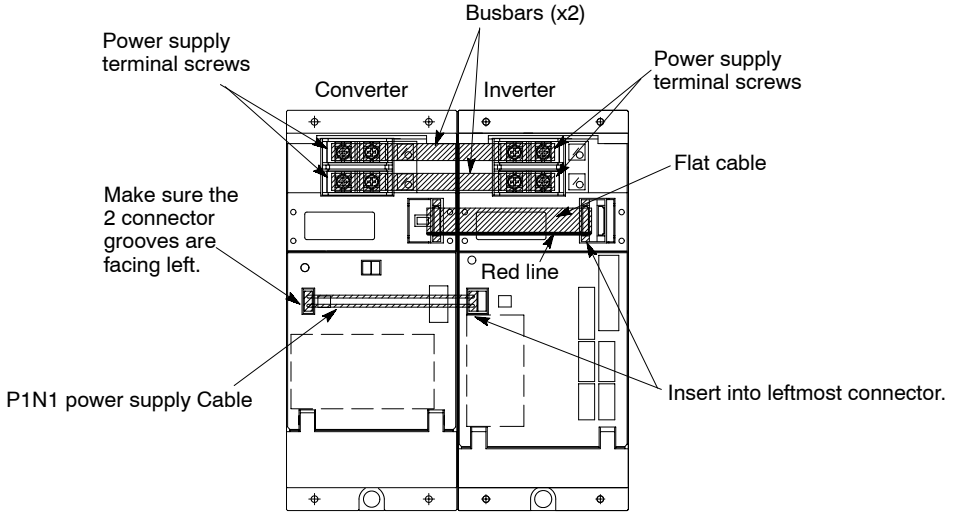


Fig. 14.19 Busbar and Cable Mounting (With Upper Cover Open)

14.3.5 Digital Operator and Connector Cables

Operations, such as displaying the status of control signals, displaying and setting control constants, and displaying protection function operations can be performed by mounting an optional JVOP-132 Digital Operator to the Inverter.

■ Digital Operator and Extension Cables

A Digital Operator Extension Cable (72616-W5301 or 72616-W5303, sold separately) is required to connect a JVOP-132 Digital Operator to the Inverter. Digital Operators and Cables are not supplied with the Inverter, but must be purchased as needed. Refer to *2.4 Mounting and Dismounting the Digital Operator* and to *Chapter 5 Operating the Digital Operator* for mounting and operating procedures.

Product	Model	Details
Digital Operator	JVOP-132	Use the Digital Operator in combination with an Extension Cable to set and reference Inverter constants.
Extension Cable (1 m (3.28 ft))	72616-W5301	Use an Extension Cable to connect the Inverter and the Digital Operator. The following are supplied with the Extension Cable: **Cable (1 m or 3 m) (3.28 ft to 9.84 ft) x 1** Cable clamp x 1 2 types of tapping screws 3 x 10 x 2
Extension Cable (3 m (9.84 ft))	72616-W5303	

■ Digital Operator Appearance

The appearance of the Digital Operator is shown in the following diagram.

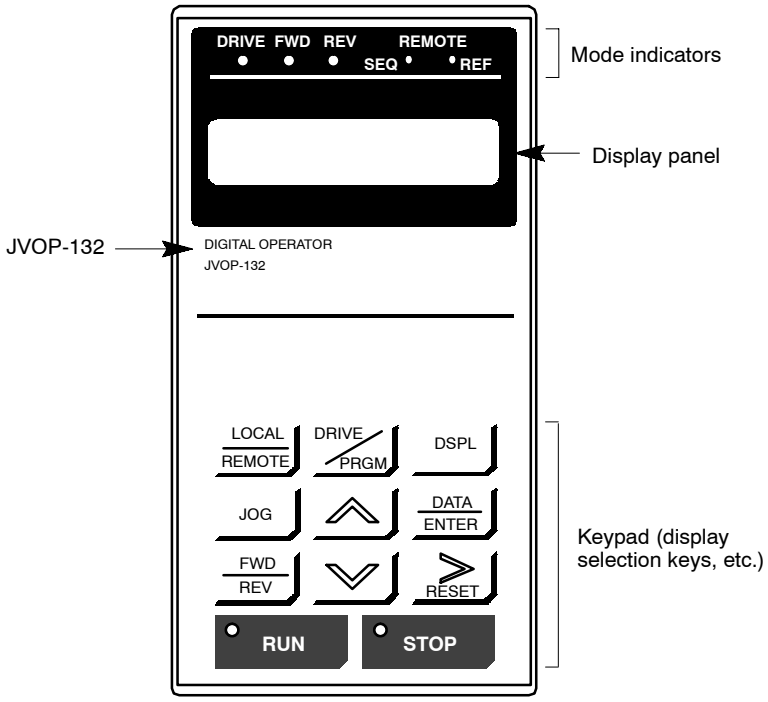


Fig 14.20 Digital Operator Display Panel and Operation Keys

■ Mounting the Digital Operator to the Panel

The following three methods can be used to mount the Digital Operator to a control panel. Mount the Digital Operator in accordance with the application.

Table 14.24 Mounting Method Features

Item	Method 1	Method 2 *1	Method 3 *1	Remarks
Ease of mounting (Extent of panel manipulation)	Excellent	Good	Some difficulty	---
	3 screw holes	3 screw holes	5 screw holes	
Ease of removal (Removal from the panel)	Some difficulty	Some difficulty	Excellent	Method 3 enables the Digital Operator to be mounted and removed freely.
	Fixed permanently	Fixed permanently	Can be mounted and removed freely	
Applicable location (Dusty locations, etc.)	Some difficulty	Good	Some difficulty	---
	---	*2	---	
Additional parts code number	---	DACT32183-AD	DACT32183-BD	---

* 1. Mounting methods 2 and 3 require additional parts such as metal plates or resin.

* 2. If mounting the Digital Operator in a dusty location or similar, mount packaging or another buffer between the panel and the Digital Operator.

■ Mounting Method 1

As shown in the following diagram, the Digital Operator can be fixed easily just by drilling holes in the panel on the side to be mounted, and fixing the Digital Operator using screws from the back of the panel. (Screws must be supplied by the customer. If the panel thickness is 1.6 mm, use Sems screws M3 x 8.)

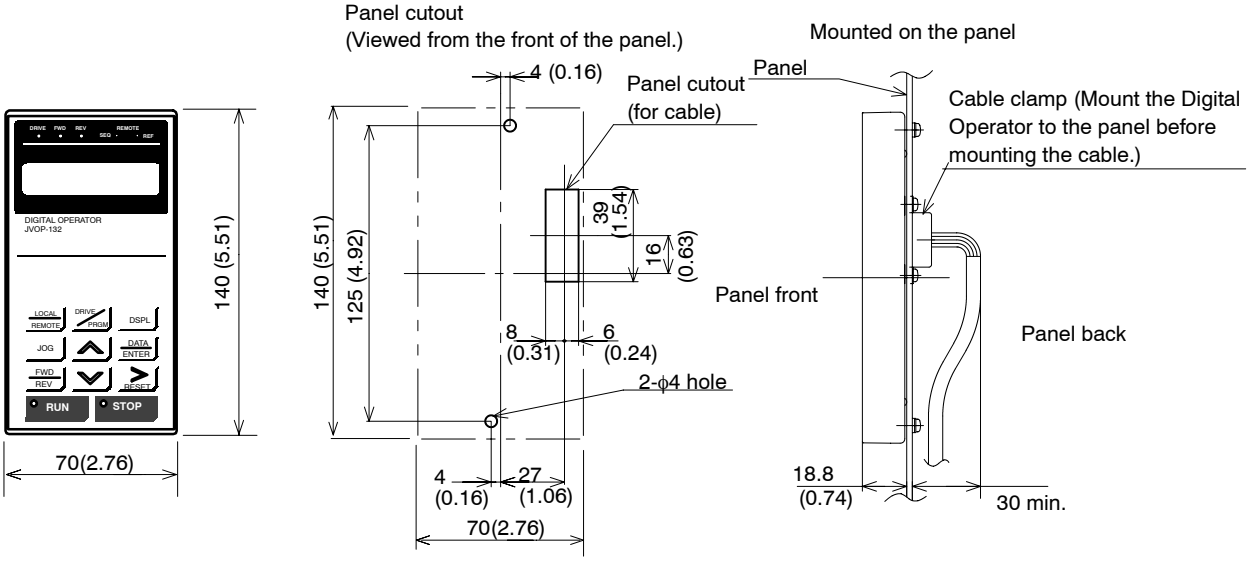


Fig. 14.21 Mounting the Digital Operator to a Panel, Method 1 (Unit: mm)

■ Mounting Method 2

Use this method to mount the Digital Operator from the back of the panel using a metal plate.

As shown in the following diagram, this method supports the Digital Operator using a metal plate from the back of the panel by drilling screw holes making a cutout in the panel.

The code number for the metal plate is DACT32183-AD.

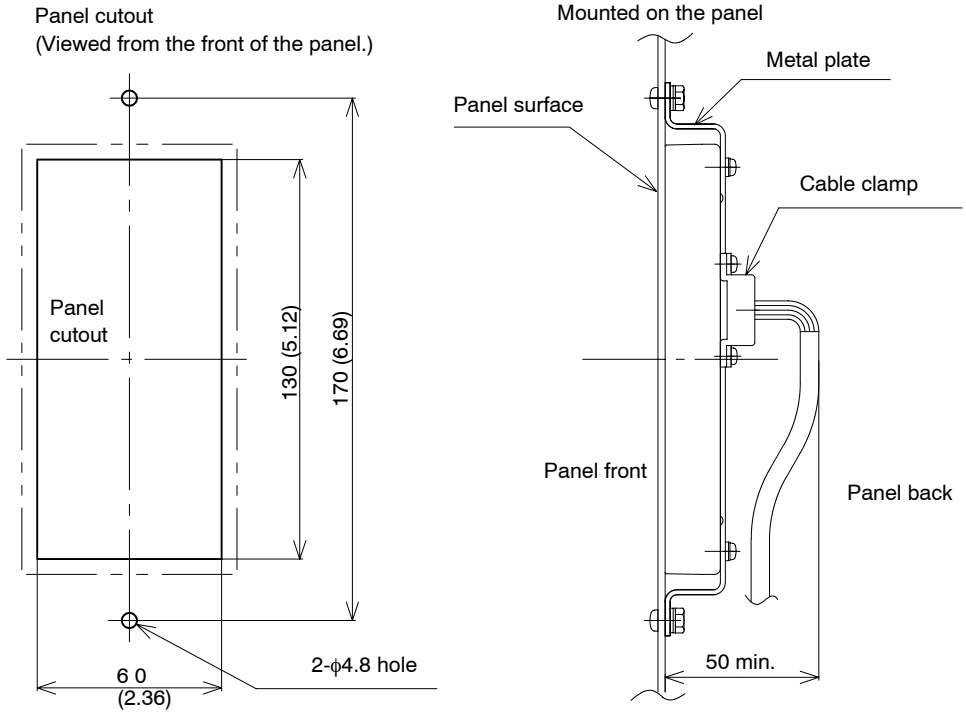


Fig. 14.22 Mounting the Digital Operator to the Panel, Method 2 (Unit: mm)

■ Mounting Method 3

Use this method to mount the Digital Operator from the front of the panel using resin parts.

The Digital Operator can be mounted and removed from the panel easily. (To fix the Digital Operator permanently, use Sems screws M3 x 8 from the back of the Operator bracket.)

As shown in the following diagram, this method mounts the Digital Operator from the front of the panel using a resin part on the back of the panel, and by drilling mounting holes and making a cutout in the panel.

When attaching the cable to the resin part, open the cable connector cover fully, and insert the connector until the cable audibly snaps into place. (If the cable is not securely mounted, the connection with the Digital Operator will be poor.)

The code number for the metal plate is DACT32183-BD.

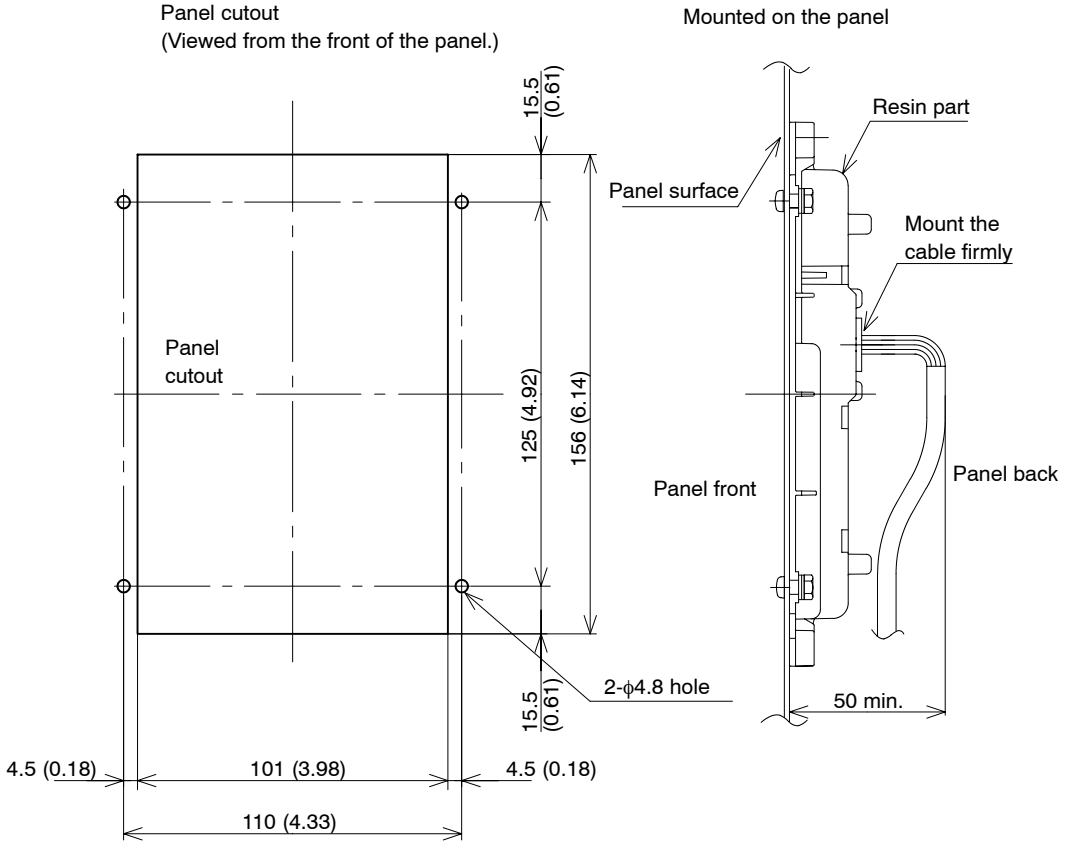


Fig 14.23 Mounting the Digital Operator to the Panel Method 3 (Unit: mm)

14.3.6 Connector Kits

The required connectors differ depending on the type of Inverter and Option Cards used. Connector Kits include one set of connectors (for the cable) required for each product combination.

The Connector Kits are not provided with the Inverter and must be purchased separately as required.

Table 14.25 Connector Kits

Code Number	Relevant Inverter*	Connector					Relevant Connector Number	Manufacturer
		Name	No. of Pins	Plug	Case	Number		
72626-CA01	CIMR-M5A□ M5A Standard	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	Sumitomo 3M LTD.
			20	10120-3000VE	10320-52A0-008	1	2CN	
			50	10150-3000VE	10350-52A0-008	1	6CN	
72626-CA02	CIMR-M5A□ M5A Encoder Orientation Card	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	
			20	10120-3000VE	10320-52A0-008	2	2CN or 8CN	
			50	10150-3000VE	10350-52A0-008	1	6CN	
			14	10114-3000VE	10314-52A0-008	1	9CN	
72626-CA03	CIMR-M5A□ M5A Magnetic Sensor Orientation Card	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	
			20	10120-3000VE	10320-52A0-008	1	2CN	
			50	10150-3000VE	10350-52A0-008	1	6CN	
			14	10114-3000VE	10314-52A0-008	1	10CN	
72626-CN01	CIMR-M5N□ M5N Standard	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	
			20	10120-3000VE	10320-52A0-008	1	2CN	
		MR	8	MR-8LFG		1	4CN	HONDA TSUSHIN KOGYO CO., LTD.
72626-CN02	CIMR-M5N□ M5N Encoder Orientation Card	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	Sumitomo 3M LTD
			20	10120-3000VE	10320-52A0-008	2	2CN or 8CN	
			14	10114-3000VE	10314-52A0-008	1	9CN	
		MR	8	MR-8LFG		1	4CN	HONDA TSUSHIN KOGYO CO., LTD.
72626-CN03	CIMR-M5N□ M5N Magnetic Sensor Orientation Card	MDR	36	10136-3000VE	10336-52A0-008	1	1CN	Sumitomo 3M LTD.
			20	10120-3000VE	10320-52A0-008	1	2CN	
			14	10114-3000VE	10314-52A0-008	1	10CN	
		MR	8	MR-8LFG		1	4CN	HONDA TSUSHIN KOGYO CO., LTD.

* M5A: For stand-alone drive system M5N: for NC system

■ Connector Attachment Positions

Use the connector code to determine the connector position for mounting to the Inverter.

Example: 22 kW Inverter

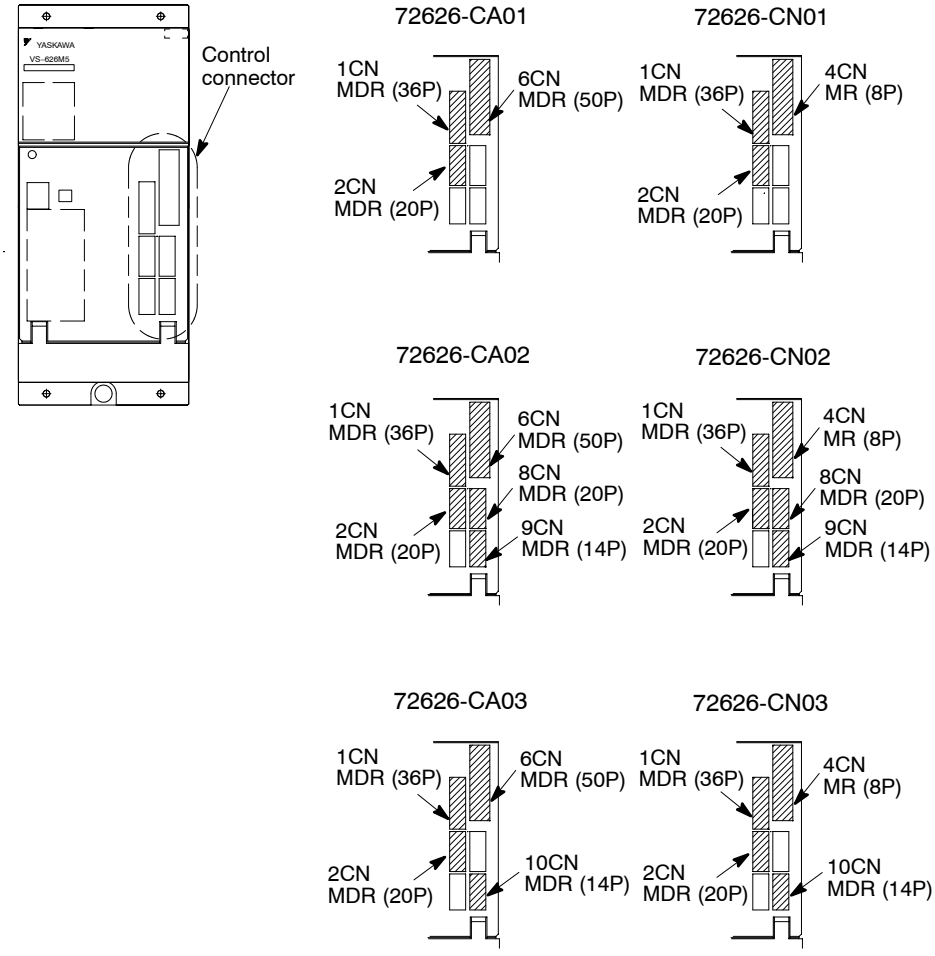
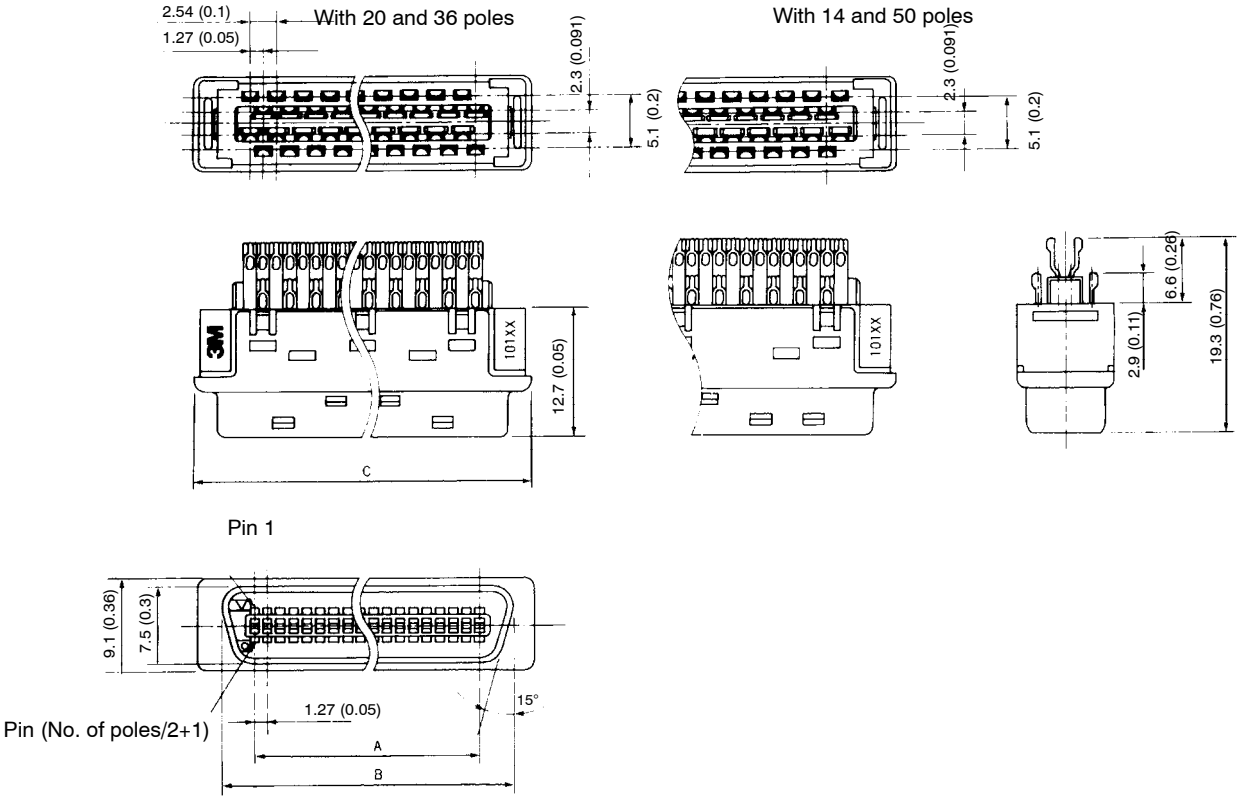


Fig 14.24 Control Connector Attachment Positions

■ MDR Connector Shapes

Plugs (Soldered)



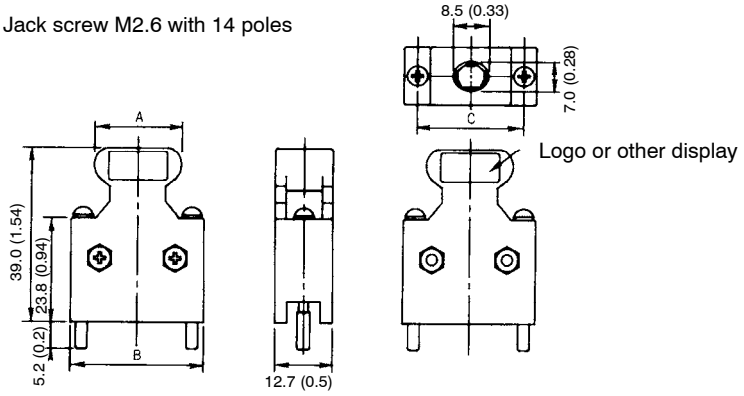
Unit: mm (inches)

No. of Poles	Product Code	A	B	C	Relevant Connector Number	Manufacturer
14	10114-3000VE	7.62 (0.3)	13.8 (0.54)	18.2 (0.72)	9CN or 10CN	Sumitomo 3M LTD.
20	10120-3000VE	11.43 (0.45)	17.6 (0.69)	22.0 (0.87)	2CN or 8CN	
36	10136-3000VE	21.59 (0.85)	27.8 (1.09)	32.2 (1.27)	1CN	
50	10150-3000VE	30.48 (1.2)	36.7 (1.44)	41.1 (1.62)	6CN	

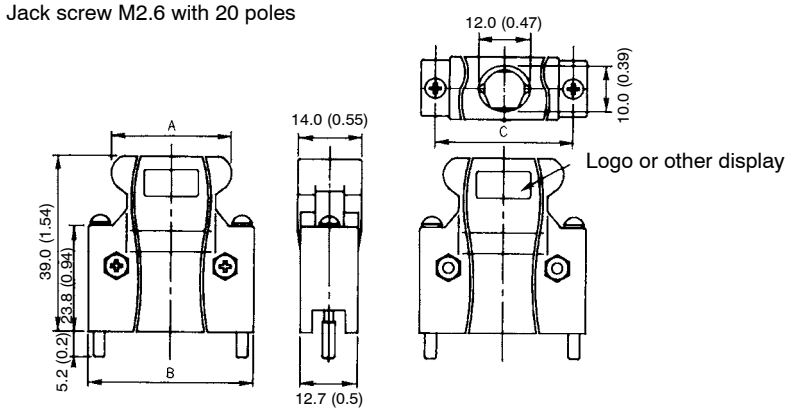
Fig. 14.25 MDR Connectors (Plugs)

Case (Unshielded)

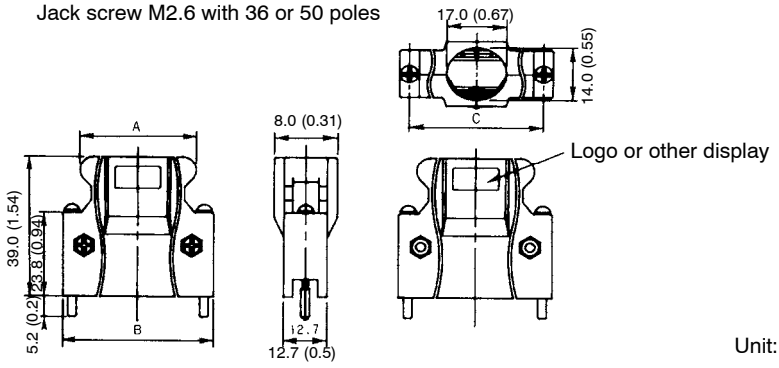
Jack screw M2.6 with 14 poles



Jack screw M2.6 with 20 poles



Jack screw M2.6 with 36 or 50 poles



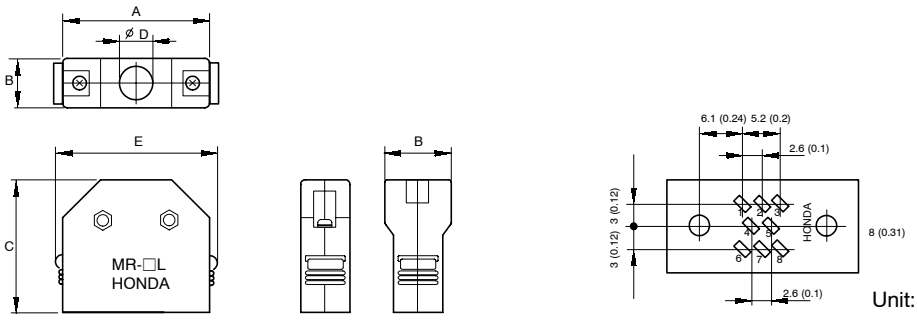
Unit: mm (inches)

No. of Poles	Product Code	A	B	C	Relevant Connector Number	Manufacturer
14	10314-□2□0-008	18.2 (0.72)	29.5 (1.16)	23.6 (0.93)	9CN or 10CN	Sumitomo 3M LTD.
20	10320-□2□0-008	22.0 (0.87)	33.3 (1.31)	27.4 (1.08)	2CN or 8CN	
36	10336-□2□0-008	32.2 (1.27)	43.5 (1.71)	37.6 (1.48)	1CN	
50	10350-□2□0-008	41.1 (1.62)	52.4 (2.06)	46.5 (1.83)	6CN	

Fig. 14.26 MDR Connectors (Case)

■ MR Connector Shapes

The MR connector shapes and specifications are shown in the following diagram.



Unit: mm (inches)

No. of Cores	Product Name	A	B	C	ϕD	E	Relevant Connector Number	Manufacturer
8	MR-8LFG	31.0 (1.22)	19 (0.75)	39.8 (1.57)	11 (0.43)	36.6 (1.44)	4CN	HONDA TSUSHIN KOGYO CO., LTD.

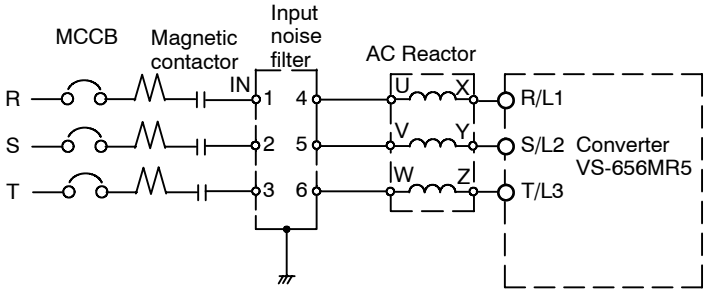
Fig□14.27□ MR□Connectors

14.3.7 Noise Filters (Input)

Reduce radio noise by using a filter that suppresses transmission of high-frequency noise generated by the Inverter to the power supply. If used in a location where magnetic field strength is weak, installing an input noise filter is effective for suppressing electrical interference of televisions and radios.

Select an appropriate input noise filter from the tables 13.28 to 13.31 depending on the Converter model (VS-656MR5).

Connection Example



Note: Do not connect the input noise filter to the Inverter outputs (U, V. and W).

■ Specifications

The (input) noise filter specifications are shown in the following table. There are two types: Standard specifications and Counter–EMC models. There are also a simplified models.

200 V Series

Standard Specifications and EMC Conformance Models (manufactured by Schaffner Electronik AG)

Table14.26 200-V Noise Filter Specifications

Converter Model CIMR-MR5□*□	Standard Specifications				EMC Conformance Models		
	Model	Code Number	No.	Current (A)	Model	No.	Current (A)
23P7	FN258L-30-07	FIL001064	1	30	FN258-30/07	1	30
25P5	FN258L-42-07	FIL001065	1	42	FN258-42/07	1	42
27P5	FN258L-55-07	FIL001066	1	55	FN258-55/07	1	55
2011	FN258L-75-34	FIL001067	1	75	FN258-75/34	1	75
2015	FN258L-100-35	FIL001068	1	100	FN258-100/35	1	100
2018	FN258L-100-35	FIL001068	1	100	FN258-100/35	1	100
2022	FN258L-130-35	FIL001069	1	130	FN258-130/35	1	130
2030	FN258L-180-07	FIL001070	1	180	FN258-180/07	1	180
2037	FN359P-250-99	FIL001071	1	250	---	---	---

* A: For stand-alone drive system N: for NC system

Simplified Models

Table14.27 200-V Simplified Noise Filter Specifications

Converter Model CIMR-MR5□*□	Model	Code Number	No.	Current (A)
23P7	LNFD-2303HY	72600-D2303HY	1	30
25P5	LNFD-2203HY	72600-D2203HY	2	40
27P5	LNFD-2303HY	72600-D2303HY	2	60
2011	LNFD-2303HY	72600-D2303HY	3	90
2015	LNFD-2303HY	72600-D2303HY	3	90
2018	LNFD-2303HY	72600-D2303HY	4	120
2022	LNFD-2303HY	72600-D2303HY	4	120
2030	---	---	---	---
2037	---	---	---	---

Note: Connect two or more noise filters in parallel.

* A: For stand-alone drive system N: for NC system

400 V Series

Standard Specifications and EMC Conformance Models (manufactured by Schaffner Electronik AG)

Table14.28 400-V Noise Filter Specifications

Converter Model CIMR-MR5□*□	Standard Specifications				EMC Conformance Models		
	Model	Code Number	No.	Current (A)	Model	No.	Current (A)
45P5	FN258L-30-07	FIL001064	1	30	FN258-30/07	1	30
47P5	FN258L-30-07	FIL001064	1	30	FN258-30/07	1	30
4011	FN258L-42-07	FIL001065	1	42	FN258-42/07	1	42
4015	FN258L-55-07	FIL001066	1	55	FN258-55/07	1	55
4018	FN258L-55-07	FIL001066	1	55	FN258-55/07	1	55
4022	FN258L-75-34	FIL001067	1	75	FN258-75/34	1	75
4030	FN258L-100-35	FIL001068	1	100	FN258-100/35	1	100
4037	FN258L-130-35	FIL001069	1	130	FN258-130/35	1	130
4045	FN258L-130-35	FIL001069	1	130	FN258-130/35	1	130

* A: For stand-alone drive system N: for NC system

Simplified Models

Table14.29 400-V Simplified Noise Filter Specifications

Converter Model CIMR-MR5□*□	Model	Code Number	No.	Current (A)
45P5	LNFD-4203HY	72600-D4203HY	1	20
47P5	LNFD-4303HY	72600-D4303HY	1	30
4011	LNFD-4203HY	72600-D4203HY	1	40
4015	LNFD-4303HY	72600-D4303HY	1	60
4018	LNFD-4303HY	72600-D4303HY	1	60
4022	LNFD-4303HY	72600-D4303HY	1	90
4030	LNFD-4303HY	72600-D4303HY	1	90
4037	LNFD-4303HY	72600-D4303HY	1	120
4045	LNFD-4303HY	72600-D4303HY	1	120

Note: Connect two or more noise filters in parallel.

* A: For stand-alone drive system N: for NC system

■ Dimensions

The noise filter dimensions are shown in mm (inches) in the following table.

Table14.30 Standard Specifications and EMC Conformance Models (manufactured by Schaffner Electronik AG)

mm (inch)

Specifications	Model	External Diagram No.	A	B	C	D	E	F	G	H	J	L	O	P	Mass kg (lb)
Standard Specifications (FN258L)	FN258L-30-07	1	335 (13.2)	150 ± 1 (5.91 ± 0.039)	60 (2.36)	305 (12)	320 (12.6)	35 (1.38)	6.5 (0.26)	400 (15.7)	1 ± 0.1 (0.039 ± 0.0039)	9 (0.35)	M5	AWG10	1.8 (3.97)
	FN258L-42-07	1	329 (13)	185 ± 1 (7.28 ± 0.039)	70 (2.76)	300 (11.8)	314 (12.4)	45 (1.77)	6.5 (0.26)	500 (19.7)	1.5 (0.059)	12 (0.47)	M6	AWG8	2.8 (6.17)
	FN258L-55-07	1	329 (13)	185 ± 1 (7.28 ± 0.039)	80 (3.15)	300 (11.8)	314 (12.4)	55 (2.17)	6.5 (0.26)	500 (19.7)	1.5 (0.059)	12 (0.47)	M6	AWG6	3.1 (6.83)
	FN258L-75-34	2	329 (13)	220 (8.66)	80 (3.15)	300 (11.8)	314 (12.4)	55 (2.17)	6.5 (0.26)	---	1.5 (0.059)	---	M6	---	4.0 (8.82)
	FN258L-100-35	2	379 ± 1.5 (14.9 ± 0.059)	220 (8.66)	90 ± 0.8 (3.54 ± 0.031)	350 ± 1.2 (13.8 ± 0.047)	364 (14.3)	65 (2.56)	6.5 (0.26)	---	1.5 (0.059)	---	M10	---	5.5 (12.13)
	FN258L-130-35	2	439 ± 1.5 (17.3 ± 0.059)	240 (9.45)	110 ± 0.8 (4.33 ± 0.031)	400 ± 1.2 (15.7 ± 0.047)	414 (16.3)	80 (3.15)	6.5 (0.26)	---	3 (0.12)	---	M10	---	7.5 (16.53)
	FN258L-180-07	3	438 ± 1.5 (17.2 ± 0.059)	240 (9.45)	110 ± 0.8 (4.33 ± 0.031)	400 ± 1.2 (15.7 ± 0.047)	413 (16.3)	80 (3.15)	6.5 (0.26)	500 (19.7)	4 (0.16)	15 (0.59)	M10	50 mm^2 (0.077 $inches^2$)	11 (24.25)
	FN359P-250-99	4	See diagram for specifications.												16 (35.27)
EMC Conformance Models (FN258)	FN258-30/07	1	335 (13.2)	150 ± 1 (5.91 ± 0.039)	60 (2.36)	305 (12)	320 (12.6)	35 (1.38)	6.5 (0.26)	400 (15.7)	1 ± 0.1 (0.039 ± 0.0039)	9 (0.35)	M5	AWG10	1.8 (3.97)
	FN258-42/07	1	329 (13)	185 ± 1 (7.28 ± 0.039)	70 (2.76)	300 (11.8)	314 (12.4)	45 (1.77)	6.5 (0.26)	500 (19.7)	1.5 (0.059)	12 (0.47)	M6	AWG8	2.8 (6.17)
	FN258-55/07	1	329 (13)	185 ± 1 (7.28 ± 0.039)	80 (3.15)	300 (11.8)	314 (12.4)	55 (2.17)	6.5 (0.26)	500 (19.7)	1.5 (0.059)	12 (0.47)	M6	AWG6	3.1 (6.83)
	FN258-75/34	2	329 (13)	220 (8.66)	80 (3.15)	300 (11.8)	314 (12.4)	55 (2.17)	6.5 (0.26)	---	1.5 (0.059)	---	M6	---	4.0 (8.82)
	FN258-100/35	2	379 ± 1.5 (14.9 ± 0.059)	220 (8.66)	90 ± 0.8 (3.54 ± 0.031)	350 ± 1.2 (13.8 ± 0.047)	364 (14.3)	65 (2.56)	6.5 (0.26)	---	1.5 (0.059)	---	M10	---	5.5 (12.13)
	FN258-130/35	2	439 ± 1.5 (17.3 ± 0.059)	240 (9.45)	110 ± 0.8 (4.33 ± 0.031)	400 ± 1.2 (15.7 ± 0.047)	414 (16.3)	80 (3.15)	6.5 (0.26)	---	3 (0.12)	---	M10	---	7.5 (16.53)
	FN258-180/07	3	439 ± 1.5 (17.3 ± 0.059)	240 (9.45)	110 ± 0.8 (4.33 ± 0.031)	400 ± 1.2 (15.7 ± 0.047)	413 (16.3)	80 (3.15)	6.5 (0.26)	500 (19.7)	4 (0.16)	15 (0.59)	M10	50 mm^2(0.07 7 $inches^2$)	11 (24.25)

External Diagrams

External diagrams of the noise filters are shown below in mm (inches).

Standard Specifications and EMC Conformance Models (manufactured by Schaffner EMC (KK))

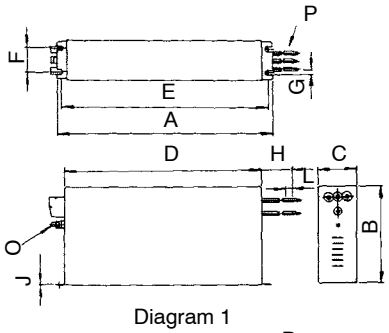


Diagram 1

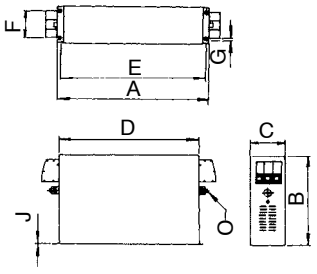


Diagram 2

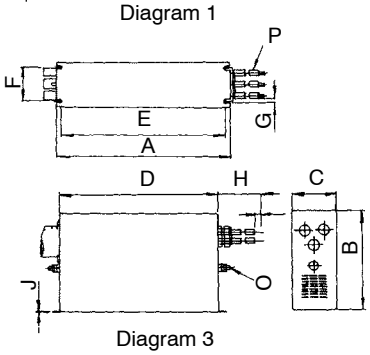


Diagram 3

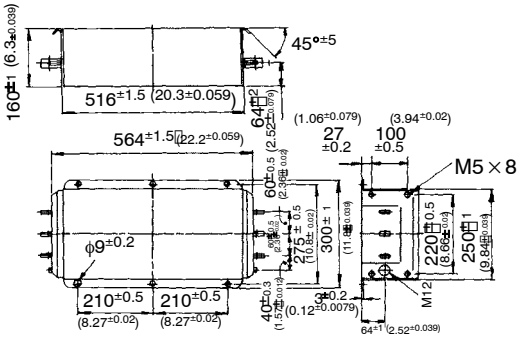
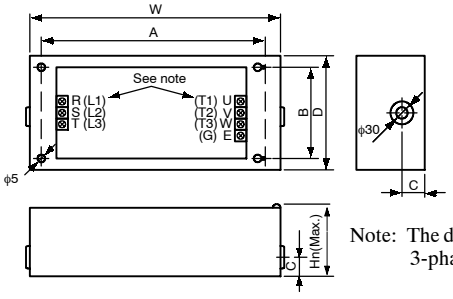


Diagram 4

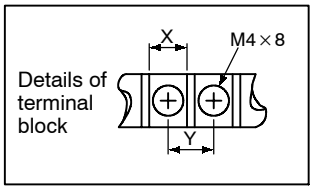
Simplified Models

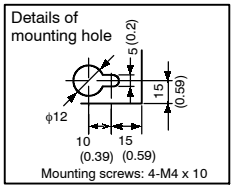
Model	Code No.	Noise Filter mm (inch)						Terminal Block		Weight (kg (lb))
		W	D	H	A	B	C	X	Y	
LNFD-2203HY	72600-D2203HY	240 (9.45)	125 (4.92)	100 (3.94)	210 (8.27)	95 (3.74)	33 (1.3)	9 (0.35)	11 (0.43)	1.5 (3.31)
LNFD-2203HY	72600-D2203HY	240 (9.45)	125 (4.92)	100 (3.94)	210 (8.27)	95 (3.74)	33 (1.3)	10 (0.39)	13 (0.51)	1.6 (3.53)
LNFD-4203HY	72600-D4203HY	270 (10.6)	155 (6.1)	125 (4.92)	240 (9.45)	125 (4.92)	43 (1.69)	9 (0.35)	11 (0.43)	2.2 (4.85)
LNFD-4303HY	72600-D4303HY	270 (10.6)	155 (6.1)	125 (4.92)	240 (9.45)	125 (4.92)	43 (1.69)	10 (0.39)	13 (0.51)	2.2 (4.85)

External Diagrams



Note: The diagram shows a 3-phase model.





14.3.8 Surge Absorbers

Always use a surge absorber (recommneded manufacturer: Marcon Electronics) with inductive loads, such as magnetic contactors, magnetic relays, magnetic valves, solenoids, and magnetic brakes, that are connected near the Inverter.

The surge absorber absorbs energy accumulated in the coils of the magnetic contactor, and so requires a capacity equal to that of the coils. Never connect the surge absorber to the Inverter output terminals (U, V, and W).

IMPORTANT

Failure to connect a surge absorber means that there is a risk of signal failure because the surge voltage generated by the coils when the magnetic contactor is turned ON and OFF can affect the Inverter control signal wires.

■ Specifications and Model Numbers

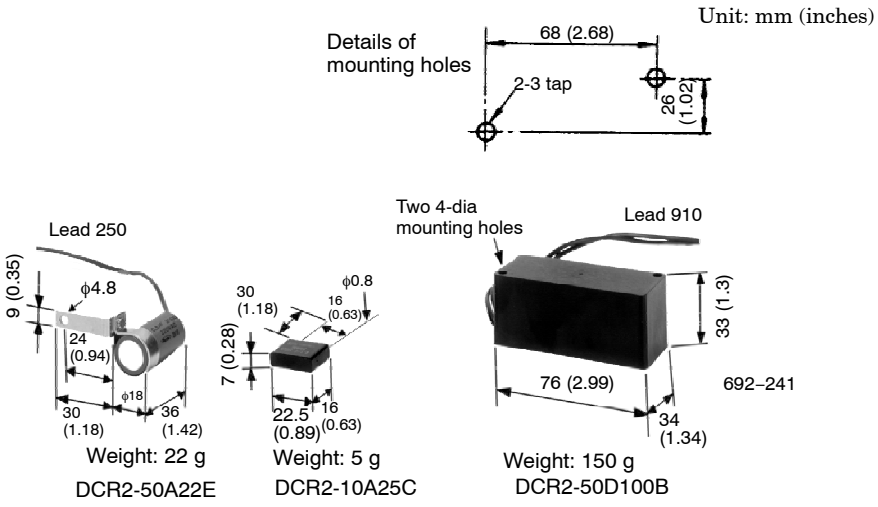
The surge absorber specifications and model numbers are shown in the following table.

Device			Surge Absorbers		
			Model	Specifications	Code Number
200 to 230 V	Large-capacity coil other than a relay		DCR2-50A22E	220 VAC 0.5 μF + 200 Ω	C002417
	Control relay	LY-2, LY-3, HH-22, HH-23, MM2, MM4	DCR2-10A25C	250 VAC 0.1 μF + 100 Ω	C002482
380 to 460 V device			DCR2-50D100B	1000 VDC 0.5 μF + 220 Ω	C002630

■ Dimensions

The surge absorber dimensions are shown in the following diagram.

Unit: mm (inches)



15

Appendix

This appendix explains the Inverter drive basics, how to select the drive capacity, designing an interface and cooling configuration, wiring, and the VS-626M5 drive specifications.

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15.1 Inverter Drive Basics

This section explains the basics of an inverter drive.

15.1.1 Principle of an Inverter Drive

An inverter is a frequency conversion device that converts a commercial frequency power supply to a variable frequency power supply. Fig. 15.1 shows an operation diagram for a 3-phase voltage inverter consisting of switches, such as relay contacts. S_1 and S_4, S_3 and S_6, and S_5 and S_2 work as pairs to repeatedly turn ON and OFF each half-cycle. Their ON/OFF timing is staggered by one-third of a cycle, so a square wave AC voltage can be obtained as the output, as shown in Fig. 15.2. The frequency of the AC output voltage is proportional to the speed at which the switches are turned ON and OFF; in other words, inversely proportional to the cycle. This is the basic operating principle of an inverter.

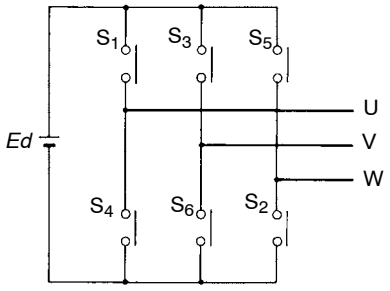


Fig. 15.1 Inverter Operating Principle

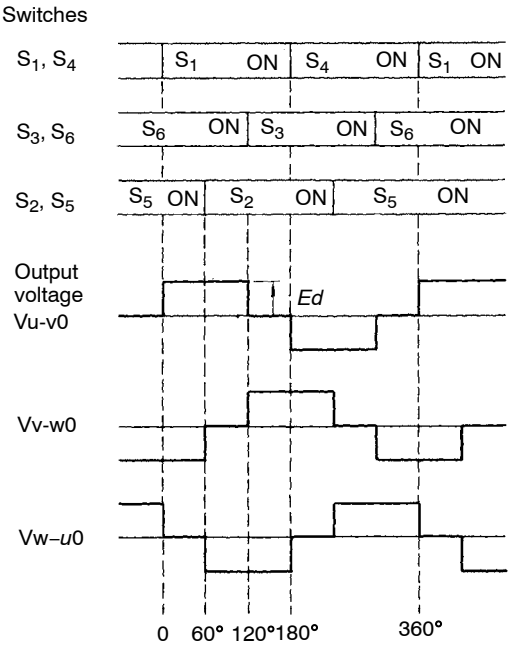
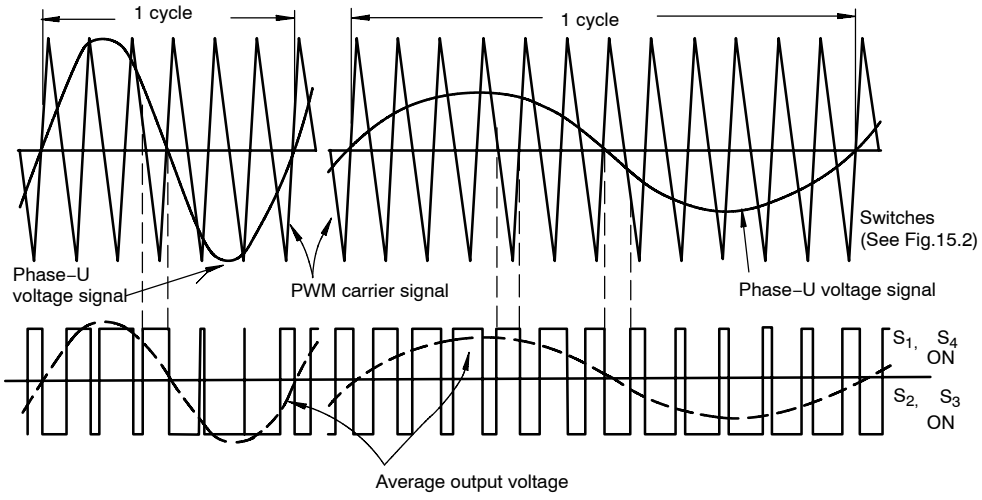


Fig. 15.2 Switch Operation and Output Voltage

In reality, a motor drive inverter requires a variable voltage and variable frequency (VVVF), so sine wave pulse width modulation (PWM) control is used, as shown in Fig. 15.3. When the carrier frequency is increased, sine wave current flows through the motor.



(a) Output frequenncy: High
Output voltage: High

(b) Output frequenncy: Low
Output voltage: Low

Fig. 15.3 Sine Wave PWM Control

15.1.2 Inverter and Converter Configuration

As shown in Fig. 15.4, the configuration consists of a VS-656MR5 Converter, which rectifies a commercial power supply and converts it to direct current, a main circuit capacitor, which smooths the rectified voltage, and a VS-626M5 Inverter, which converts the direct current to the required AC frequency. The converter switching element uses IGBT as used by the Inverter.

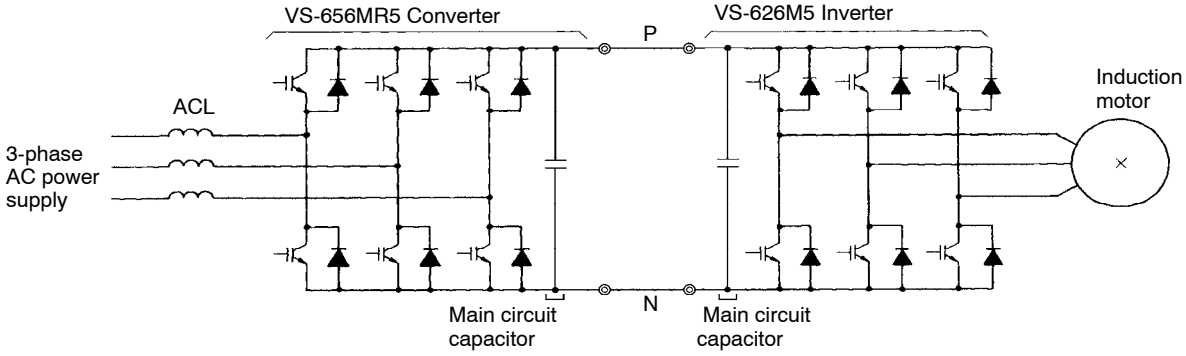


Fig. 15.4 Inverter and Converter Configuration

15.1.3 Squirrel Cage Induction Motor Characteristics

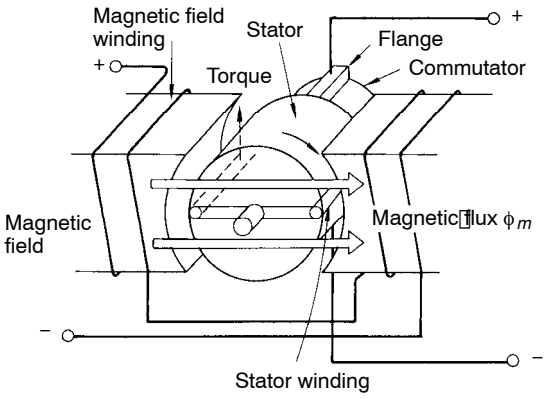
The squirrel cage induction motor characteristics are contrasted with the DC motor and the principle of torque generation is explained below. Fig. 15.5 shows the model diagrams for each from the direction of the axis.

Torque occurs in the DC motor using electromagnetic force proportional to the accumulated current that flows in the armature winding, and the magnetic flux created by the magnetic field current. The torque generated in this way is easy to control because the magnetic field windings from which the magnetic current flows and the armature windings are independent.

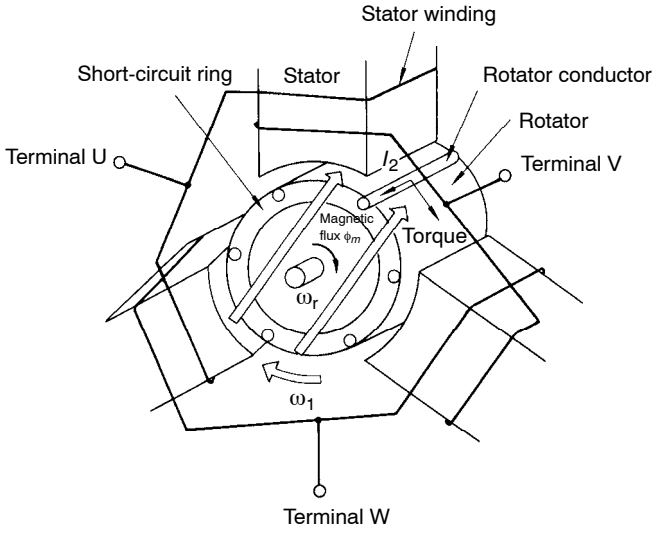
On the other hand, the squirrel cage induction motor consists of a rotator with a so-called “squirrel-cage” construction, and a stator with stator windings. When 3-phase alternating current flows through the stator windings, a magnetic field of magnetic flux ϕ_m is generated. This is equivalent to the magnetic flux generated by the DC motor magnetic field current.

Magnetic flux ϕ_m can be expressed using the following formula. This current is called magnetized current I_m, and is almost equivalent to the unladen current of the squirrel-cage induction motor.

Formula: $\phi_m = MI_m$



(a) DC Motor



(b) Squirrel Cage Induction Motor

Fig. 15.5 Motor Model Diagrams

As shown in Fig. 15.5, the rotator is positioned inside the stator; i.e., within the rotation magnetic field. When there is a difference between the angular velocity ω_r of the rotator and the angular velocity ω_1 of the rotation magnetic field, the rotator conductor cuts the alternating magnetic field of the differential angular velocity. Consequently, secondary induction electromotive force E_2 is generated in the rotator conductor due to the effect of magnetic field induction. Also, counterelectromotive force E_1 is generated in the stator due to the effects of electromagnetic induction, and interlinkage between the magnetic flux of the rotation magnetic field and the stator winding.

$E_1 = k\omega_1 \phi_m = 2\pi k f_1 \phi_m$

Both tips of the rotator conductor are connected to the short-circuit ring, hence the name "squirrel cage." The secondary current I_2 thus flows due to the secondary induction electromotive force E_2. This is equivalent to the armature current of the DC motor.

Torque is generated using electromagnetic force proportional to the accumulation of secondary current I_2 and magnetic flux ϕ_m in the same way as the DC motor, causing the rotator to rotate. The ratio of the rotator to the speed differential of the rotator magnetic field is called the induction motor "slip." If the rotator is rotating at the same speed as the rotation magnetic field, the relative position of both will not change, so the electromagnetic induction effect does not occur, and torque will not be generated. This is called synchronous speed. Synchronous speed and slip are expressed using the following formulas.

Synchronous speed $N = \dfrac{120f}{P}$ (min^{-1})

Slip $S = \dfrac{N - N_r}{N}$

N_r: Rotator speed (min^{-1}), f: Power supply frequency (Hz), P: No. of motor poles

Also, switching to 3-phase alternating current will reverse the order of the phases, causing the rotation magnetic field to rotate in reverse, so the motor will rotate in reverse.

In this way, the squirrel cage induction motor changes slip to meet the required torque, generates the required primary current, and functions as an energy converter that converts electric power (electrical energy) to to torque and speed (mechanical energy). Differing from the DC motor, however, there is the problem that the magnetic flux of the rotation magnetic field and the secondary current cannot be controlled directly, so careful planning for the control is required.

15.1.4 Controlling an Induction Motor Using Vector Control

Vector control permits controls equivalent to the DC motor in a squirrel cage induction motor. This control method is called slip frequency control, it requires a speed detector, and it performs control taking the detected speed as a standard. Nearly all vector control inverters in use employ this method.

Vector control uses applies the torque generation principle of the squirrel cage induction motor to inverter control. Primary current I_1, which is supplied to the induction motor in line with the torque references, is distributed to secondary current I_2 and magnetized current I_m as per the set value inside the motor, and performs control so that the required torque is generated.

The VS-626M5 control block is shown in Fig. 15.6.

The speed controller performs control so that there is no difference in speed reference value ω_{r*} and speed detection value ω_r according to the speed detector signal, and outputs secondary current reference value I_2* using a secondary current reference limiter. Rated speed settings and speed adjustment parameters are used to standardize the signals. The speed controller gain and integral time can be selected to suit the control mode.

The magnetic flux reference part inputs the speed detection value ω_r and outputs the magnetic flux reference value ϕ* to control fixed outputs.

The vector controller develops the torque generation principle. Primary current reference value I_1*, and its frequency and phases, are generated from secondary current reference value I_2*, magnetic flux reference value ϕ*, and speed detection value ω_r. Use the motor codes to select the parameters depending upon the motor model.

Current flows through the current controller according to primary current reference vector $\dot{I}_1^*$, and performs control to generate the required torque.

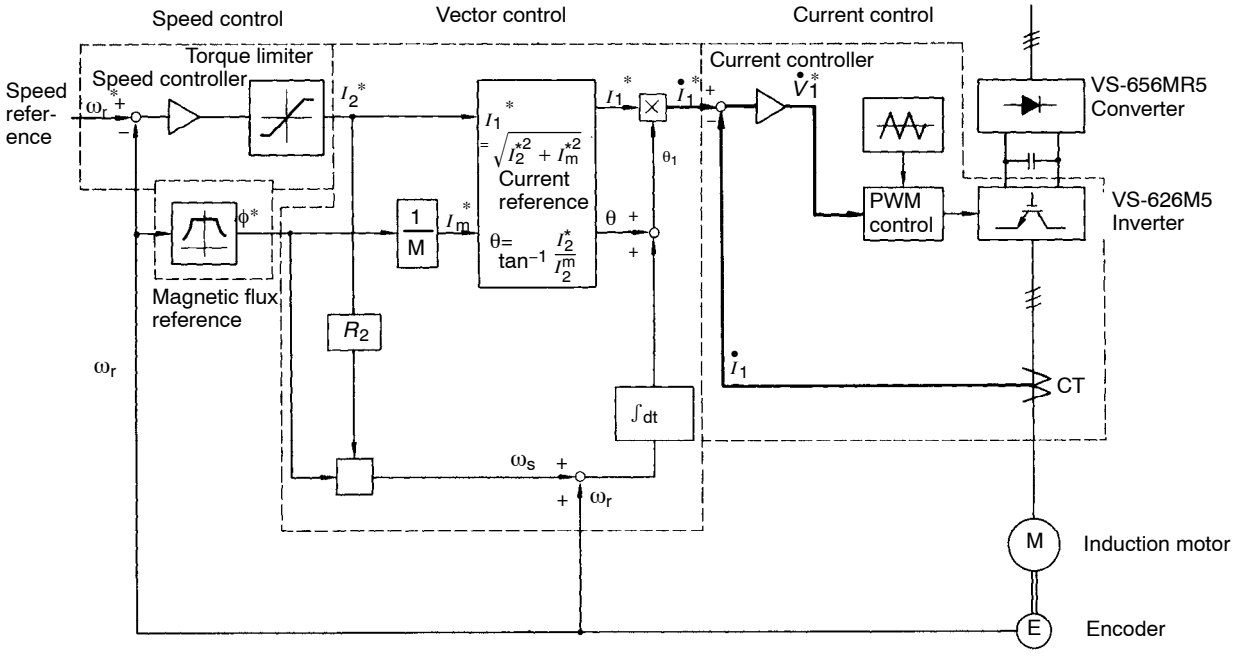


Fig 15.6 VS-626M5 Control Block

15.2 Basic Inverter Drive mechanics

This section explains the torque, motive power, and inertial moment that are the basis of selecting motor and inverter capacities.

15.2.1 Torque

Torque is a moment of force that causes the rotation axis on the rotator to rotate about a center. As shown in Fig. 15.7, when external force f (N) is used in a tangential direction at point P, which is separated by the distance r (m) only from the center of rotation O, the torque T can be expressed using the following formula.

$$T = f \cdot r \,(\mathrm{N \cdot m})$$

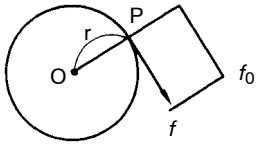


Fig. 15.7 Torque Definition

Also, as shown in Fig. 15.8, if a gearbox is used, the torque increases and decreases proportional to the shifting gears, so taking motor axis speed N_M (min^{-1}) and load axis speed N_L (min^{-1}), the motor axis calculated torque T_M (N•m) can be expressed using the following formula.

$$T_M = \frac{N_L T_L}{N_M} = \frac{T_L}{a} \,(\mathrm{N \cdot m})$$

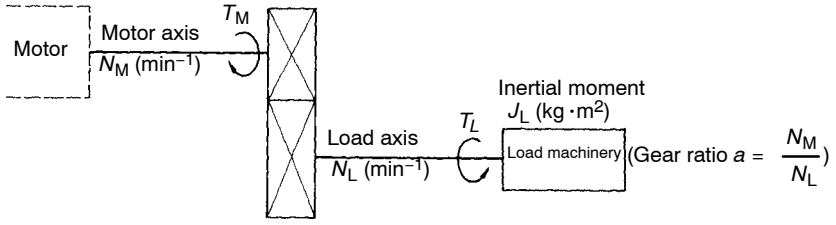


Fig. 15.8 Torque when a Gearbox Is Used

15.2.2 Rotator and Linear Operator Outputs

Using torque T (N•m) on the rotator, the output P_R during rotation at speed N (min^{-1}) can be expressed using the following formula.

$$P_R = \frac{2\pi NT}{60} = 0.1048NT \,(\mathrm{W})$$

As shown in Fig. 15.9, taking the force F (N), which is used on the speed V (m/min.) and the load, the output P_L when performing linear operations can be expressed using the following formula.

$$P_L = \frac{FV}{60} = 0.0167FV \,(\mathrm{W})$$

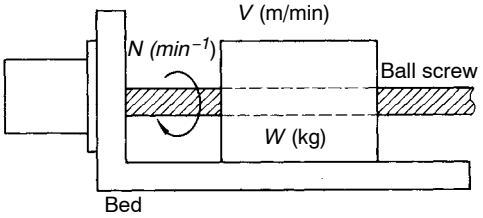


Fig. 15.9 Linear Operation Output

15.2.3 Inertial Moment and GD²

Inertial moment is a measure of the ease of the rotation operation of the rotator. Taking the total mass m (kg) of the rotator, and the rotation radius r (m), the inertial moment J can be expressed using the following formula.

$$J = mr^2 \ (\mathrm{kg \cdot m^2})$$

The relationship to the flywheel effect GD^2 that has been used until now can be expressed using the following formula.

$$J = \frac{GD^2}{4} \ (\mathrm{kg \cdot m^2})$$

The various inertial moment shapes are summarized below. Friction and other losses, however, have not been considered, and the efficiency is taken to be 1.

■ Cylindrical Inertial Moment

Inertial moment J_1 during rotation along an axis centered on the mass m_1 (kg) and radius r_1 (m) of a cylinder can be expressed using the following formula.

$$J_1 = \frac{m_1 r_1^{\ 2}}{2} \ (\mathrm{kg \cdot m^2})$$

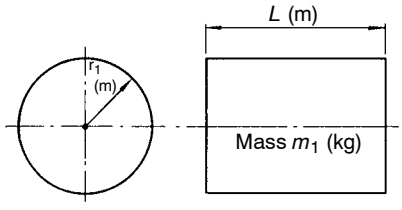


Fig 15.10 Cylindrical Inertial Moment

■ Tubular Inertial Moment

Inertial moment J_2 during rotation along an axis centered on the mass m_2 (kg), outer radius r_1 (m), and inner radius r_2 (m) of a cylinder can be expressed using the following formula.

$$J_2 = \frac{m_2(r_1^{\ 2} + r_2^{\ 2})}{2} \ (\mathrm{kg \cdot m^2})$$

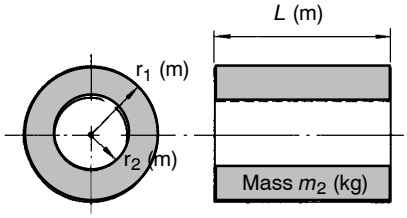


Fig 15.11 Tubular Inertial Moment

■ Load Reel Inertial Moment

Inertial moment J_3 of a load reel, as shown in Fig. 15.12, concentrates the entire load on the contact point between a rope and pulley, and can be expressed using the following formula.

$$J_3 = m_3 r_1^{\ 2} \ (\mathrm{kg \cdot m^2})$$

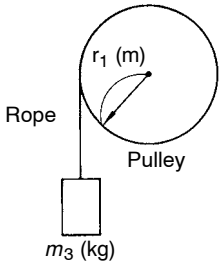


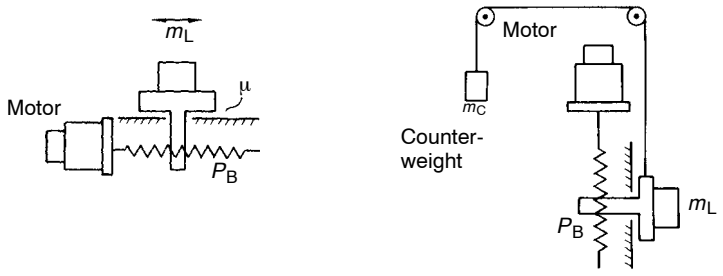
Fig 15.12 Load Reel Inertial Moment

■ Linear Operator Inertial Moment

Fig. 15.3 shows linear operation such as a motor turning a ball screw to drive a table. Example (a) shows horizontal operation, and example (b) shows vertical operation. Both horizontal and vertical inertial moments J_H and J_V take the full load mass m_L (kg), counterweight mass m_C (kg), and ball screw reed P_B, and can be expressed using the following formula.

$$J_H = \frac{m_L P_B^{\ 2}}{4\pi^2} \ (\mathrm{kg \cdot m^2})$$

$$J_V = \frac{(m_L + m_C)\, P_B^{\ 2}}{4\pi^2} \ (\mathrm{kg \cdot m^2})$$



(a) Horizontal Operation (b) Vertical Operation

Fig. 15.13 Linear Operator Inertial Moment

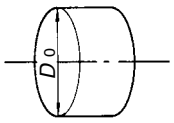
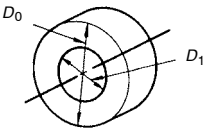
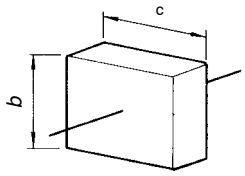
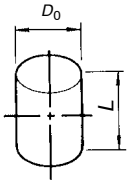
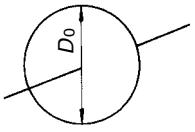
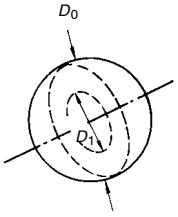
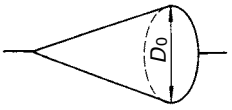
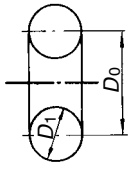
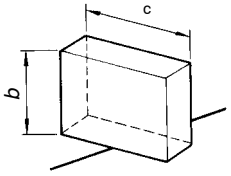
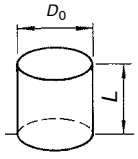
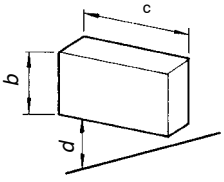
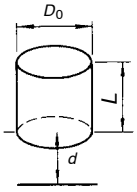
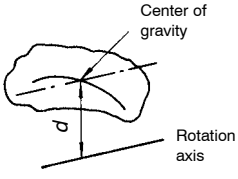
■ Inertial Moment Converted on a Motor Axis with a Gearbox

To obtain the required mechanical speed, a pulley and gears that can accelerate and decelerate are sometimes used. In Fig. 15.8, the load inertial moment converted to the motor axis as gear ratio a can be expressed using the following formula.

$$J_M = \frac{N_M{}^2 J_L}{N_L{}^2} = \frac{J_L}{a^2} (\text{kg} \cdot \text{m}^2)$$

A simplified diagram of the rotation circumference is shown in Table 15.1.

Table 15.1 Simplified Diagram of the Rotation Circumference

Rotation axis is the same as the cylinder centerline	Solid cylinder $(D^2 = D_0{}^2/2)$ 	Hollow cylinder $D^2 = (D_0{}^2 + D_1{}^2)/2$ 
Rotation axis passes through the center of gravity	Right-angle box $D^2 = (b^2 + c^2)/3$ 	Cylinder $D^2 = L^2/3 + D_0{}^2/4$ 
	Sphere $D^2 = \frac{2}{5} D_0{}^2$ 	Hollow sphere $D^2 = \frac{2}{5} \cdot \frac{D_0{}^5 - D_1{}^5}{D_0{}^3 - D_1{}^3}$ 
	Cone $D^2 = \frac{3}{10} D_0{}^2$ 	Circle $D^2 = D_0{}^2 + \frac{3}{4} D_1{}^2$ 
Rotation axis is at one tip	Right-angle box $D^2 = (4b^2 + c^2)/3$ 	Cylinder $D^2 = \frac{4}{3} L^2 + \frac{D_0{}^2}{4}$ 
Rotation axis is outside rotator	Right-angled box $D^2 = \frac{4b^2 + c^2}{3} + 4(bd + d^2)$ 	Cylinder $D^2 = \frac{4}{3} L^2 + \frac{D_0{}^2}{4} + 4(dL + d^2)$ 
General equation when rotation axis is outside rotator	The general equation for the rotation circumference when the rotation axis is outside the rotator is shown below. $D_2{}^2 = D_1{}^2 + 4d^2$ D_1: Rotation circumference when the axis parallel to the rotation axis and whose center of gravity passes through the rotation axis is hypothetically the rotation axis.	

15.2.4 Converting Metric Units and SI Units

This manual uses SI units. SI units differ from the metric units for gravity used to date, so conversion is necessary. Table 15.2 shows how to convert the main units of gravity and force to SI units.

Table 15.2 Metric Units and SI Units Conversion Table

Quantity	Metric Unit	SI Unit	Conversion
Force and Load	kgf	N	1 kgf = 9.80665 N
Weight	kgf	---	The metric unit for weight and the SI unit for mass are the same. (Mass expressed using SI units for bodies in the metric measurement for weight *W*kgf are expressed as *W*kg.
Mass	kgf·s^2/m	kg	
Torque	kgf·m	N·m	1 kgf·m = 9.80665 N·m
Inertial Moment	gf·cm·s^2	kg·m^2	1 gf·cm·s^2 = 9.80665 x 10^{-5} kg·m^2
Speed (Revolutions)	rpm	min^{-1}	1 rpm = 1 min^{-1}
Vibration	G	m/s^2	1 G = 9.80665 m/s^2

Note: The relationship between the metric GD^2 and the SI unit for inertial moment is as follows: $GD^2 = 4J$.

15

15.3 Determining Drive Capacity

When controlling machine speed, an inverter drive must supply torque to accelerate and decelerate the drive system (couplings, machine, and motor), as well as torque to match the characteristics of the machine that makes up the motor load. Consider the following points when determining drive capacity.

- Make clear the ratings to be used (continuous rating, short-time rating, and repetitive rating) to suit the load characteristics.
- Consider the efficiency of the motive force transmission mechanism and the load dispersion, and select a drive capacity greater than the motive force required by the load.
- Select a capacity that can sufficiently provide the startup torque and maximum torque required by the load. Use the following equation to select the drive capacity.

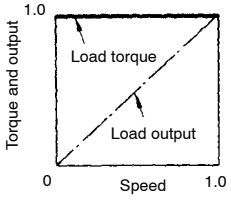
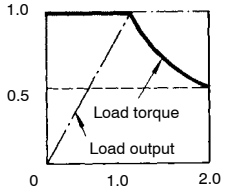
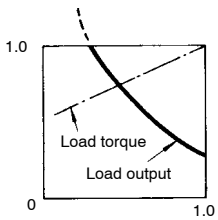
  Drive load ≧ Motive force to drive the load mechanism + Motive force to accelerate and decelerate the load mechanism to the required speed

The above equation shows the method for calculating load drive force and acceleration/deceleration motive force.

15.3.1 Load Drive Capacity

The torque-speed characteristics of the load mechanism that uses the VS-626M5 are classified as listed in Table 15.3. The methods of calculating load drive capacity that are described are typical examples.

Table 15.3 Typical Load Torque-Speed Characteristics

Load Characteristics		Load Examples	Speed-Torque Characteristics	Motor Capacity
Fixed Torque Load	Load torque over speed is a fixed load. Usually a friction load.	Conveyers Cranes Winches Other friction loads and gravity loads	Load torque is fixed regardless of speed. Output is proportional to speed. 	Motor capacity is the same as the maximum speed load capacity.
Fixed Output Load	Required output over speed is a fixed load.	Center drive low tension winders Main axis of machine-tool Veneer rotor relays	Within fixed torque range: Load torque is fixed regardless of speed. Output is proportional to speed. Within fixed output range: Output required by load is fixed. Load torque is inversely proportional to speed. 	Required rated output when using a drive with fixed torque characteristics is as follows: Required output = Load output x Fixed output control ratio$^{1/2}$
Reduced Output Load	Load torque over-speed is a variable load. Load has the intermediate characteristics of fixed output load and fixed torque load.		Intermediate speed-torque and output characteristics of fixed torque load and fixed output load 	Motor capacity is the same as the maximum speed load capacity.

■ Machine-tool Main Axis Drive

The motive force required for the main axis drive, such as a lathe or machining center, is determined using the cutting motive force. The cutting process requires fixed output characteristics, and the fixed output control range requires a ratio of 1: 10 to 30. The methods of calculating the required motive force shown are examples of lathe cutting processing, machining center milling processing, and drill processing. (To accurately calculate the required force, the condition of the cutting oil, the material of the cutting tools, the shape, and the hardness of the material being cut all affect the cutting resistance, so these must also be considered.)

As shown in Fig. 15.14, when using a lathe cutting processing, the object to be cut is rotated, and the blade is pressed against it to perform the cutting operation, so the motive force *PLC* required to cut can be expressed using the following equation.

$$P_C = \frac{K_S\, dLV}{60 \times 1000 \times \eta_C} = \frac{dLV}{S_C \cdot \eta_C} \text{(kW)}$$

$$V = \frac{\pi DNs}{1000} \text{(m/min)}$$

K_S: Cutting resistance (N/mm2)
d: Cutting depth (mm)
L: Length of blade actually performing cutting (i.e., amount of feed per rotation) (mm)
D: Diameter of object being processed (mm)
N_S: Main axis speed (min^{-1})
η_C: Machine efficiency 0.7 to 0.85
S_C: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)

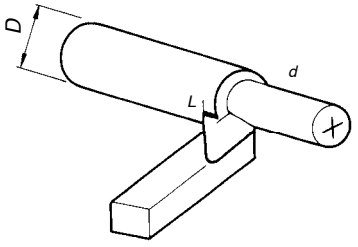
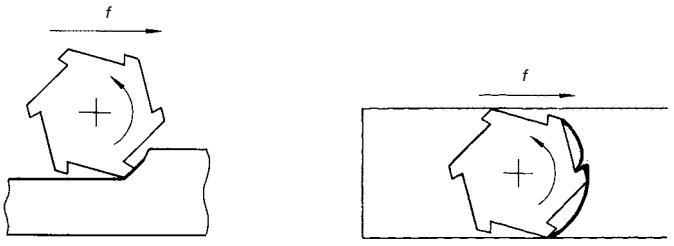


Fig. 15.14 Example of Lathe Cutting Process

As shown in Fig. 15.15, if using milling processing, the blade is mounted to the main axis and rotated to cut the object being processed, so the motive force P_F required can be expressed using the following formula.

$$P_F = \frac{K_S\, \delta Wf}{60 \times 1000^2 \times \eta_F} = \frac{\delta Wf}{1000^2\, S_F \eta_F} \text{ (kW)}$$

K_S: Cutting resistance (N/mm2)
δ: Cutting depth (mm)
W: Cutting width (mm)
f: Feed speed (mm/min.)
S_F: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)
η_F: Machine efficiency 0.7 to 0.85



(a) Side Milling (b) Front Milling

Fig. 15.15 Example of Milling Processing

As shown in Fig. 15.16, when performing drill processing, the blade is mounted to the main axis and rotated, opening a hole in the material being processed, so the motive force P_D required can be expressed using the following formula. The load torque M differs depending on the material, and the ratio of the drill radius D: Feed speed f, so care must be applied.

$$P_D = \frac{M \cdot 2\pi n}{60 \times 100 \times 1000 \times \eta_D} = \frac{\pi D^2 f}{4 \times 1000 \times S_D \eta_D} \text{ (kW)}$$

M: Drill load torque (N · cm)

n: Main axis speed (min^{-1})

η_D: Machine efficiency 0.7 to 0.85

D: Drill radius (mm)

f: Feed speed (mm/min.)

S_D: Cutting efficiency (i.e., cutting amount per 1 kW per minute) (CC/kW/min.)

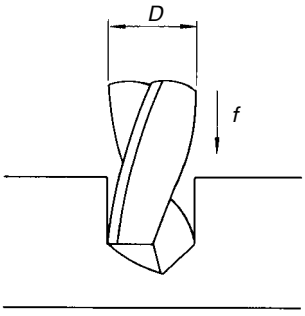


Fig. 15.16 Example of Drill Processing

■ Gravity Load Drive

The motive force required to move a load such as a crane or loader vertically differs greatly depending on whether or not a counterweight is used. The motive force in each case can be expressed using the following formulas.

Without counterweight $P_{GL} = \frac{m_L V}{6120\eta}$ (kW)

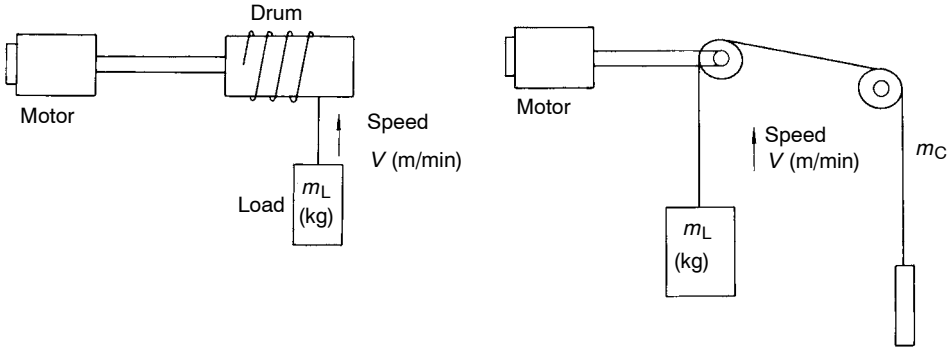
With counterweight $P_{GLC} = \frac{(m_L - m_C)V}{6120\eta}$ (kW)

V: Vertical travel speed (m/min.)

η: Machine efficiency

m_L: Load mass (kg)

m_C: Counterweight mass (kg)



(a) Without Counterweight (b) With Counterweight

Fig. 15.17 Gravity Loads

■ Friction Load Drive

The horizontal movements of conveyers such as crane movement and table drives are friction loads. The motive force P_F required taking the friction coefficient to be μ can be expressed using the following formula.

$$P_F = \frac{um_L V}{6120\eta} \text{ (kW)}$$

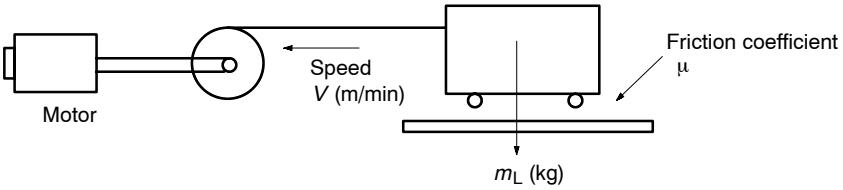


Fig. 15.18 Friction Loads

15.3.2 Acceleration/deceleration Capacity

When stopping machinery operation, the acceleration method can be selected from rapid acceleration/deceleration to smooth acceleration/deceleration, depending on the application. A comparison of these acceleration methods is shown in Table 15.4. Calculate the acceleration/deceleration capacity using the severest current-limiting acceleration according to capacity. The formula for calculating the drive capacity required from the acceleration time t (s) is shown below.

- Required drive capacity of the fixed torque characteristics range ($0 \leqq N_M \leqq N_B$)

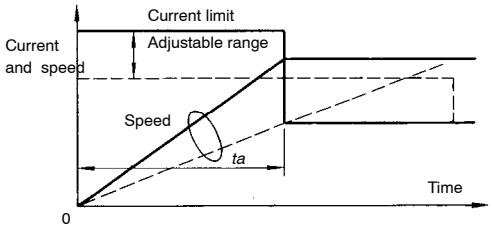
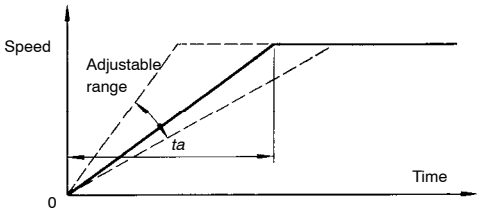
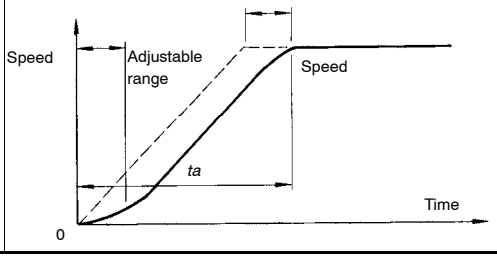
$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{J_M N_M{}^2}{1000\, t} \text{ (kW)}$$

- Required drive capacity of the fixed torque characteristics + the fixed output characteristics range ($0 \leqq N_M \leqq N_{MAX}$)

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{J_M (N_M{}^2 + N_B{}^2)}{2000\, t} \text{ (kW)}$$

J_M: Motor axis conversion inertial moment (kg · m^2)
P_M: Basic low-speed motor output (kW)
N_M: Operation speed (min^{-1})
N_B: Basic low speed (min^{-1})
N_{MAX}: Maximum speed (min^{-1})

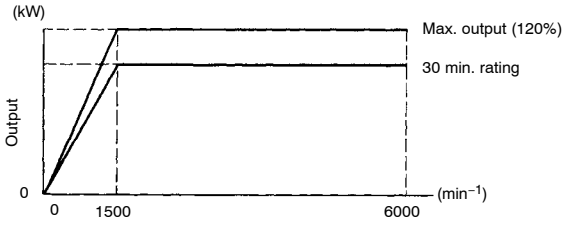
Table 15.4 Acceleration Formulas

Acceleration Method	Control Method	Explanatory Diagram	Remarks
Current-limited Acceleration	This method suppresses the current during acceleration to a fixed value to protect the drive unit and machinery.		Fixes the torque generated by the motor during acceleration.
Time-limited Acceleration	This method suppresses the acceleration rate so that there is linear acceleration change over time, against rapid speed reference changes.		Fixes the acceleration torque.
S-curve Acceleration	This method further suppresses torque over the above method, to perform smooth acceleration.		Suppresses the rate of variation in the torque at the start and end points during acceleration.

An example of calculations based on standard drive and machinery specifications is shown below. With actual machinery, the calculated values may vary slightly due to mechanical loss, fluctuations in the power supply voltage, and machine noise and motor magnetic field noise countermeasures.

■ Calculation Conditions

Table 15.5 Calculation Conditions

Item	Value
Acceleration Time	2.5 s (0 to 6,000 min^{-1}) 0.5 s (0 to 1,500 min^{-1})
Inertial Moment J_M	0.13 kg • m^2 Load: 0.10 kg • m^2 Motor: 0.03 kg • m^2 (assuming load to be x 0.3)
Output Characteristics (30 min. Rating)	Basic low speed N_B: 1,500 min^{-1} 
Maximum Output During Acceleration/deceleration	120% of 30 min. rated output

■ Calculations

In the example shown in Table 15.5, as a result of performing the calculations, the motive force required from the acceleration/deceleration time is as follows: Upper formula: 30 min. rated 7.5 kW (47.7 N•m); Lower formula: 15 kW (95.0 N · m).

- At 0 to 1,500 min^{-1}

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{0.13 \times 1500^2}{1000 \times 0.5} = 6.41 \text{ (kW)}$$

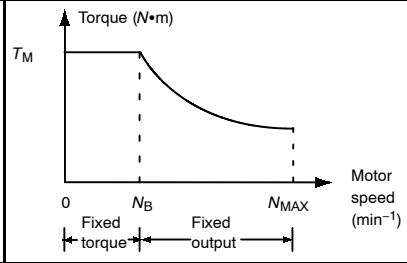
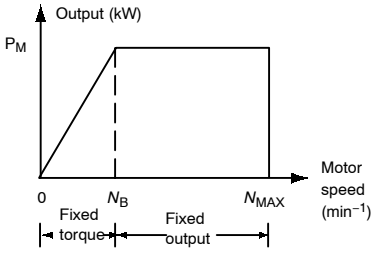
- At 0 to 6,000 min^{-1}

$$P_M = \left(\frac{2\pi}{60}\right)^2 \frac{0.13 \times (6000^2 + 1500^2)}{2000 \times 2.5} = 10.89 \text{ (kW)}$$

15.3.3 Calculating Start and Stop Times

After selecting the machine characteristics and Inverter capacity, the start and stop times can be calculated using Table 15.6. For the motor characteristics, refer to *14.1 Drives*.

Table 15.6 Formulas for Calculating Start and Stop Times

Item	Calculating from Torque	Calculating from Output
Motor Characteristics		
Fixed Torque Characteristics ($0 \leqq N_M \leqq N_B$) $0 \leftrightarrow N_M$ Acceleration/deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot N_M \cdot \frac{1}{T_M}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000\,P_M} \cdot N_B \cdot N_M$
Fixed Output Characteristics ($N_B \leqq N_M \leqq N_{MAX}$) $N_B \leftrightarrow N_M$ Acceleration/deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot \frac{1}{T_M} \cdot \frac{N_M^2 - N_B^2}{2N_B}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000\,P_M} \cdot \frac{N_M^2 - N_B^2}{2}$
Fixed Torque + Fixed Output Characteristics ($N_B \leqq N_M \leqq N_{MAX}$) $0 \leftrightarrow N_M$ Acceleration/deceleration Time	$t = \frac{2\pi}{60} \cdot J_M \cdot \frac{1}{T_M} \cdot \frac{N_M^2 + N_B^2}{2N_B}$	$t = \left(\frac{2\pi}{60}\right)^2 \cdot \frac{J_M}{1000\,P_M} \cdot \frac{N_M^2 + N_B^2}{2}$

N_M: Operation speed (min^{-1})
N_B: Basic low speed (min^{-1})
M_{MAX}: Maximum speed (min^{-1})
J_M: Motor axis conversion inertial moment (kg・m2) (= Motor inertial moment + motor axis conversion load inertial moment)
T_M: Motor maximum torque at basic low speed (N・m) (For a standard motor, max. torque = 30 min. rated torque x 1.2)
P_M: Motor maximum output at basic low speed (kW) (For a standard motor, max. output = 30 min. rated output x 1.2)

Note: The values obtained from actual units may differe from calculated values due to mechanical losses, fluctuation in supply voltages, mechanical noise, and measures taken for motor's magnetic noise.

15.3.4 Intermittent Load Operating Capacity

If operations, such as tapping a machine-tool or driving a conveyer table, are frequently reversed, care must be taken in selecting the capacity. When using an operation cycle that includes acceleration/deceleration operations such as those shown in Fig. 15.19, make a selection so that the motor equivalence efficiency torque T_R is less than the inverter continuous rated torque. (The maximum value of T_P will be 120% of the Inverter 30 min. rating.)

$$T_R = \sqrt{\frac{T_P^2 (t_r + t_f) + T_L^2 t_s}{t_C}} \text{ (N•m)}$$

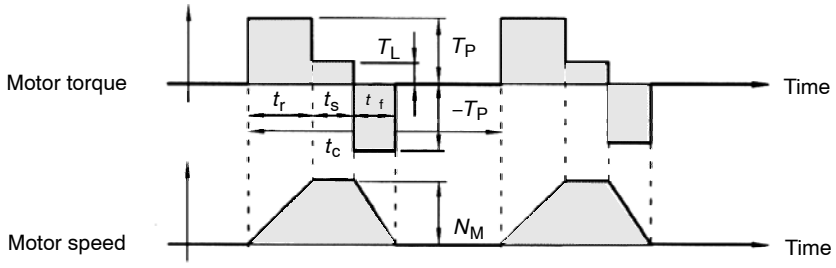


Fig. 15.19 Motor Torque and Speed Timechart

The motor reverse rating is the rating over the load where the motor load changes cyclically. When the reverse rated output is taken to be t_1, and with no load is taken to be t_2, a as expressed in the following formula is called %ED (Einschalt Dauer). $t_1 + t_2$ is regulated to 10 minutes.

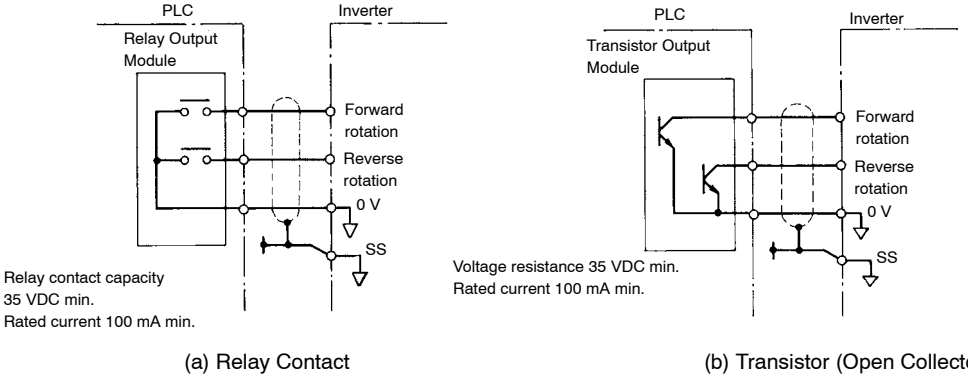
$$\alpha = \frac{t_1}{t_1 + t_2} \times 100 \ (\%)$$

15.4 Interface Design

This section explains the interface design for the signals.

15.4.1 Sequence Input Signals

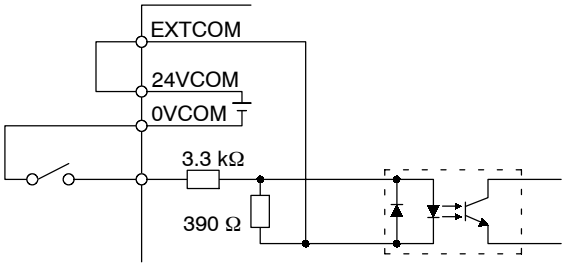
Among the input signals, 12-bit digital references (1CN) and sequence input signals (6CN), which control the operation status of forward rotations, reverse rotations, and torque limits, etc., can be used in common with the relay contacts and transistor switches, as shown in Fig. 15.20. Also, the signal circuit common can be selected from the 0 V common, which uses the Inverter power supply, the 24-V common, or the external common, which uses a separate 24-V power supply (20 to 26 V). The wiring differs depending on the input method, so refer to Fig. 15.21 to perform the wiring correctly. Also, the 1CN common and 6CN common are isolated, so each common can be selected independently. For signal details, refer to *4.1.4 Details on Sequence Input Signals*.



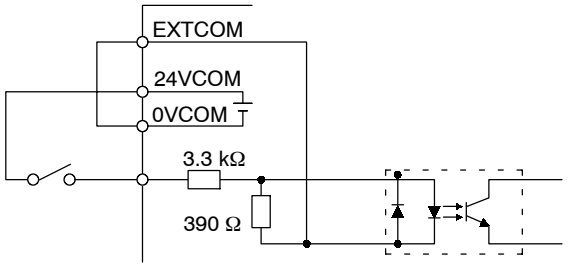
(a) Relay Contact (b) Transistor (Open Collector)

Fig 15.20 Operation Signals Connection Examples

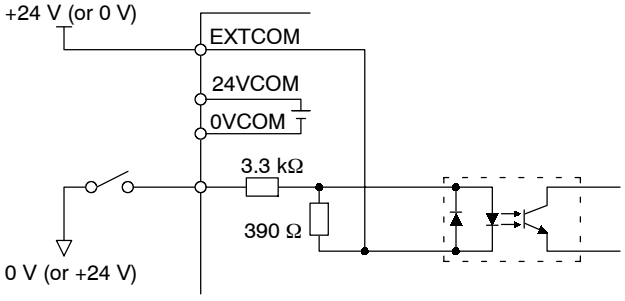
15.4.1 Sequence Input Signals



(a) 0 V Common



(b) 24 V Common



(c) External Common

Signal Name	Pin Number	
	1CN	6CN
EXTCOM	31	19, 20, 21
24VCOM	32	22, 23
0VCOM	33	24, 25

Fig 15.21 Input Method Selection

15.4.2 Speed Reference Signals (M5A Stand-alone Drive)

As shown in Fig. 15.22 and Fig. 15.23, the speed reference signals can be used as either analog or digital signals. Analog signals have a rated speed reference of ± 10 V. Voltage drop due to wiring impedance and drift due to temperature variations and wear and tear can be adjusted using the control parameters in the Inverter, and the control parameters and adjustment resistors at PLC and NC.

The digital speed references (1CN) uses both BCD and binary signals. In this case, reference errors due to temperature drift and voltage drop do not occur, unlike with analog signals. Also, if speed variation is not continuous, the speed setting parameters within the Inverter are switched externally so that multi-step speed operations can also be used. The digital speed reference (1CN) input circuit is the same as the sequence input signal (6CN). The signal circuit common can be selected independently of the sequence input signals (refer to Fig. 15.21).

For the signal details, refer to *4.2 Analog Speed References (Stand-alone Drive)*, and *4.3 Using a 12-bit Digital Speed Reference.*

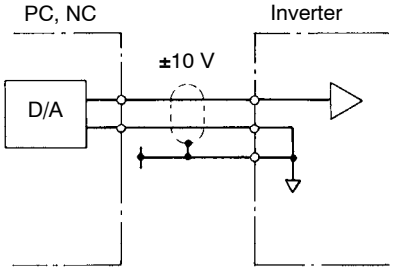


Fig 15.22 Example of Analog Speed Reference Signals

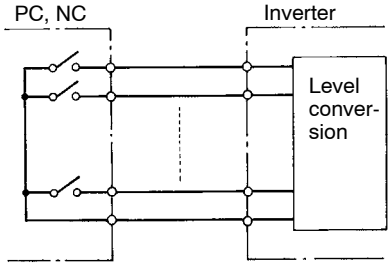


Fig 15.23 Example of Digital Speed Reference Signals

15.4.3 Sequence Output Signals (M5A Stand-alone Drive)

Sequence signals such as zero speed and malfunction signals, which notify externally the Inverter operation status, use the relay contacts and transistor switches. The transistor switch output circuit is bi-directional, as shown in Fig. 15.24, so both the 0-V common and +24-V common can be used, in the same way as for the relay outputs.

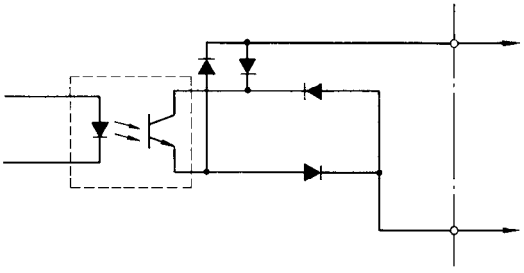


Fig 15.24 Output Interface Circuit

15.4.4 Analog Monitor Signals (M5A Stand-alone Drive)

The monitor signals output from the Inverter are speedometer signals and load rate meter signals. Use a 10 V full-scale voltmeter or a PLC Analog Input Module. Use the monitor signal wires at 20 m max. If the length of the wires exceeds 20 m, or noise is superimposed on the signal wires, install an isolation amplifier midway along the line to good effect.

For signal details, refer to *4.5 Analog Monitor Signals (for Stand-alone Drives).*

15.4.5 YENET1200 Signals (M5N NC Drive)

The YENET1200 communications system for Yaskawa NC Units sends and receives data such as speed references, sequence I/O signals, motor speed, and failure information using serial communications. These serial communications signals are connected to 4CN on the YENET1200 Card. If an Inverter is installed at the terminal, connections must be made to 4CN and 1CN for terminal processing.

For details of YENET1200 communications, refer to the Yaskawa NC Unit operation manuals.

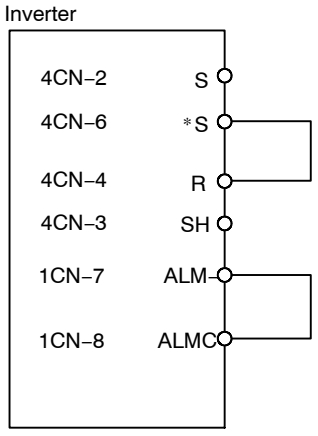


Fig 15.25 Connection when the Inverter is the Terminal Unit

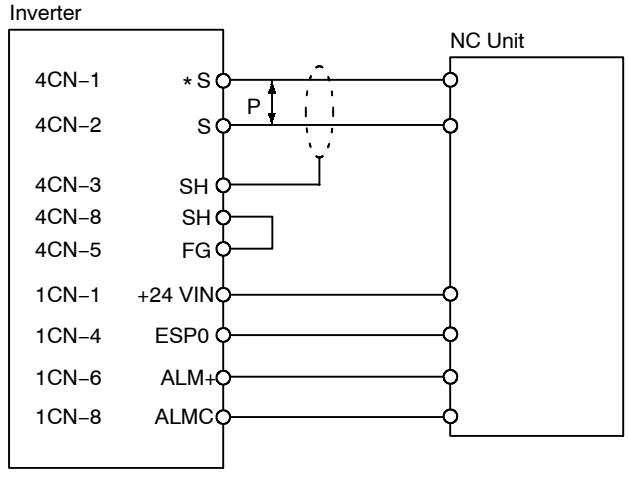


Fig 15.26 Connection between NC Unit and Inverter

15.5 Inverter/Converter Cooling Design

If the Inverter/Converter is built into the panel, be sure to mount it vertically for effective cooling, and make sure there is sufficient space to both the sides, and top and bottom, in consideration of maintenance and ventilation, as shown in Fig. 2.9 and Fig. 2.10. (Refer to *2.3 CLEARANCES* for details.) There are two Inverter/Converter models: External heatsink cooling models for the fully-enclosed control board mounting, and models mounted inside the panel, which house the whole unit in the control panel. The external heatsink cooling model cools the majority of generated loss from the unit using external air directly, so the generated loss in the control panel is reduced.

The maximum operating temperature of the Inverter/Converter is 55°C. Design the cooling system so that the average temperature rise within the control panel is 10 K (10°C (50°F)) max., taking the maximum control panel ambient temperature to be 40°C (103°F). Consequently, heat caused by the generated loss of the Inverter must be discharged using forced air currents and a heat exchanger. For the calorific value and cooling air speed of each Inverter/converter by capacity, refer to *14.1.5 Calorific Value and Cooling Air Speed*.

15.5.1 Temperature Rise within the Control Panel

Taking the calorific value within the panel P (W), rate of heat conduction of the metal plate k (W/m^2 · °C), and control panel surface area in contact directly with the external air A (m^2), temperature rise within the control panel ΔT (K) can be expressed using the following formula.

$$\Delta T = \frac{P}{k \times A} \text{ (K)}$$

The value of k changes according to the conditions as shown below.

- With no internal circulation fan: 4 (W/m^2 · °C)
- With internal circulation fan: 6 (W/m^2 · °C)
- Cooling air duct with forced air current (with internal circulation fan): 9 (W/m^2 · °C)

The internal temperature rise ΔT (K) when using a heat exchanger can be expressed using the following formula.

$$\Delta T = \frac{P}{k \times (A - B) + qh}$$

qh: Heat exchanger cooling ability (W/°C)
B: Heat exchanger surface area (m^2)

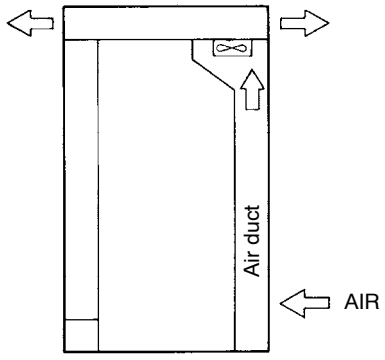


Fig. 15.27 Configuration of Control Panel with Air Duct

15.5.2 Heat Exchanger Specifications

To improve the cooling abilities of the control panel, install one of the Heat Exchangers (manufactured by Yaskawa) shown in Table 15.8.

Table 15.7 Heat Exchanger Specifications

Heat Exchanger	Cooling Ability	Dimensions (mm (inches))	Mounting Surface (m^2)
REX1550	110 W/10°C (50°F)	295 x 890 x 50 (11.6 x 35 x 1.97) (W x H x D)	0.31
HEATEX02	250 W/10°C (50°F)	440 x 924 x 50 (17.3 x 36.4 x 1.97) (W x H x D)	0.45

The calorific content of the *Cooling Ability* column is the calorific tolerance when the internal air temperature rise within the unit is suppressed to 10 K (10 °C (50°F)) max.

Mount the heat exchanger internally as shown in Fig. 15.28 so that the internal air is drawn in from the top and expelled through the bottom, and so that the external air is drawn in from the bottom and expelled from the top.

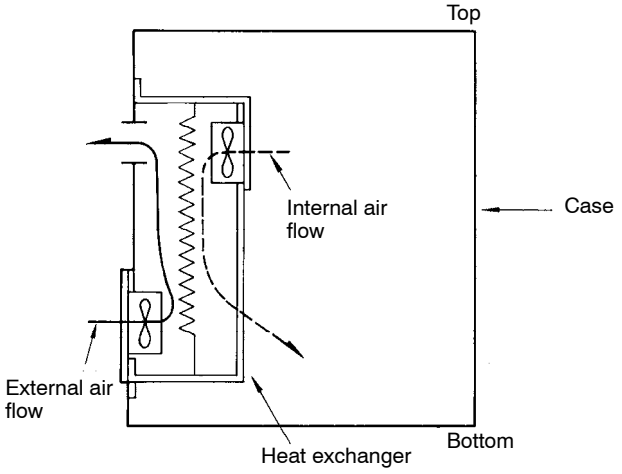


Fig 15.28 Example of Heat Exchanger Mounting

15.6 Wiring Examples

Several examples of wiring diagrams are given below.

15.6.1 Independent Operation for Speed Control Using a Digital Operator

The following example shows independent operation using a Digital Operator. Fixed-position stop control using RUN, stop, and a motor encoder is possible, so this operation is useful for test operations. As shown in Fig. 15.29, operation is possible by wiring the motor encoder and connecting the main circuit only. For Digital Operator operations, refer to *Chapter 5 Operating the Digital Operator*.

15.6.1 Independent Operation for Speed Control Using a Digital Operator

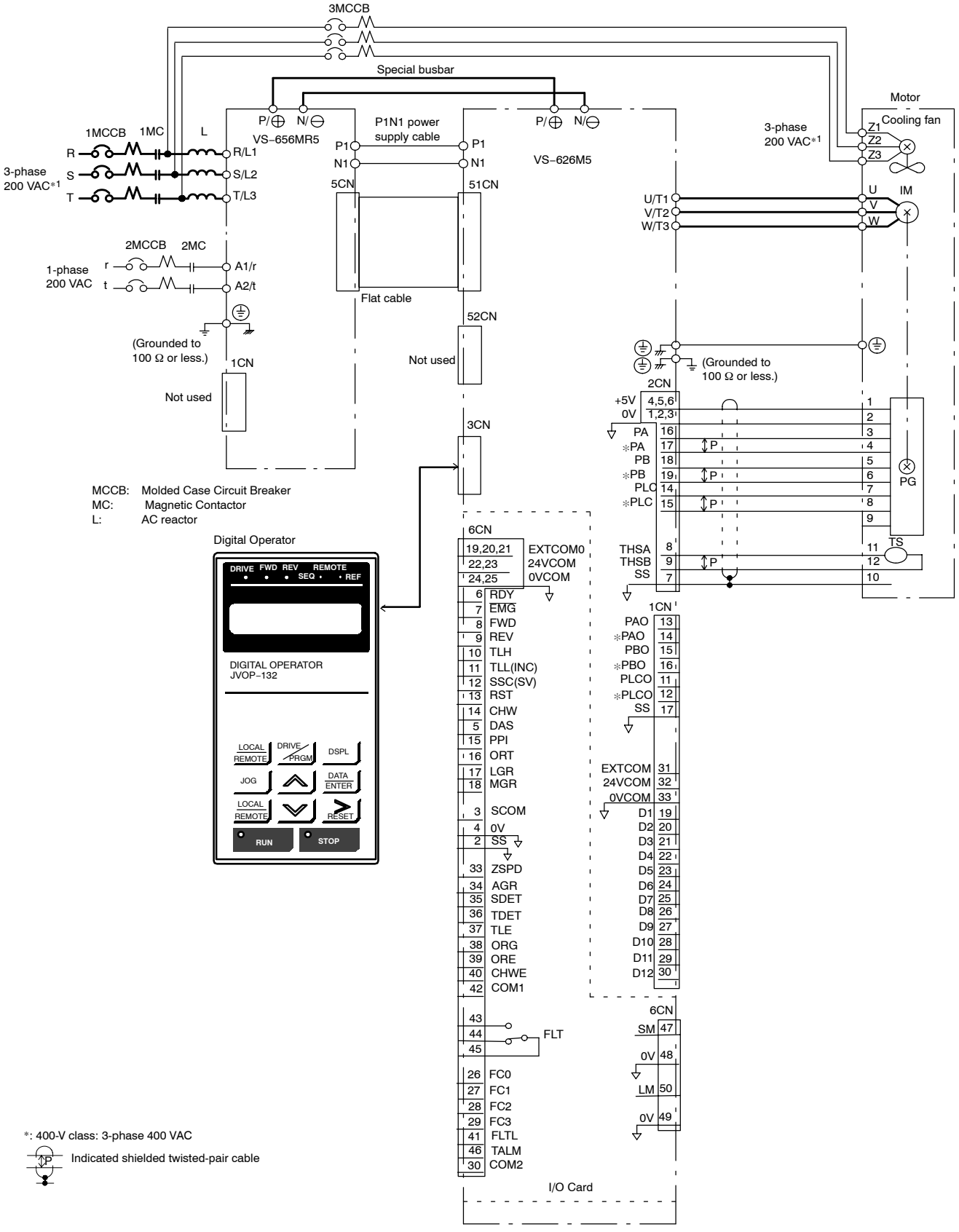


Fig 15.29 Stand-alone Operation Using Digital Operator

15.6.2 Speed Control Operation Combined with NC

This is the most popular operation using a main axis drive for a machine-tool. Sequence input signals such as forward rotation and reverse rotation, and output signals such as zero speed and speed matching, are connected to the I/O Module in the sequencer, and the speed references are connected to the axis control module in the CPU. A basic connection example is shown in Fig. 15.30.

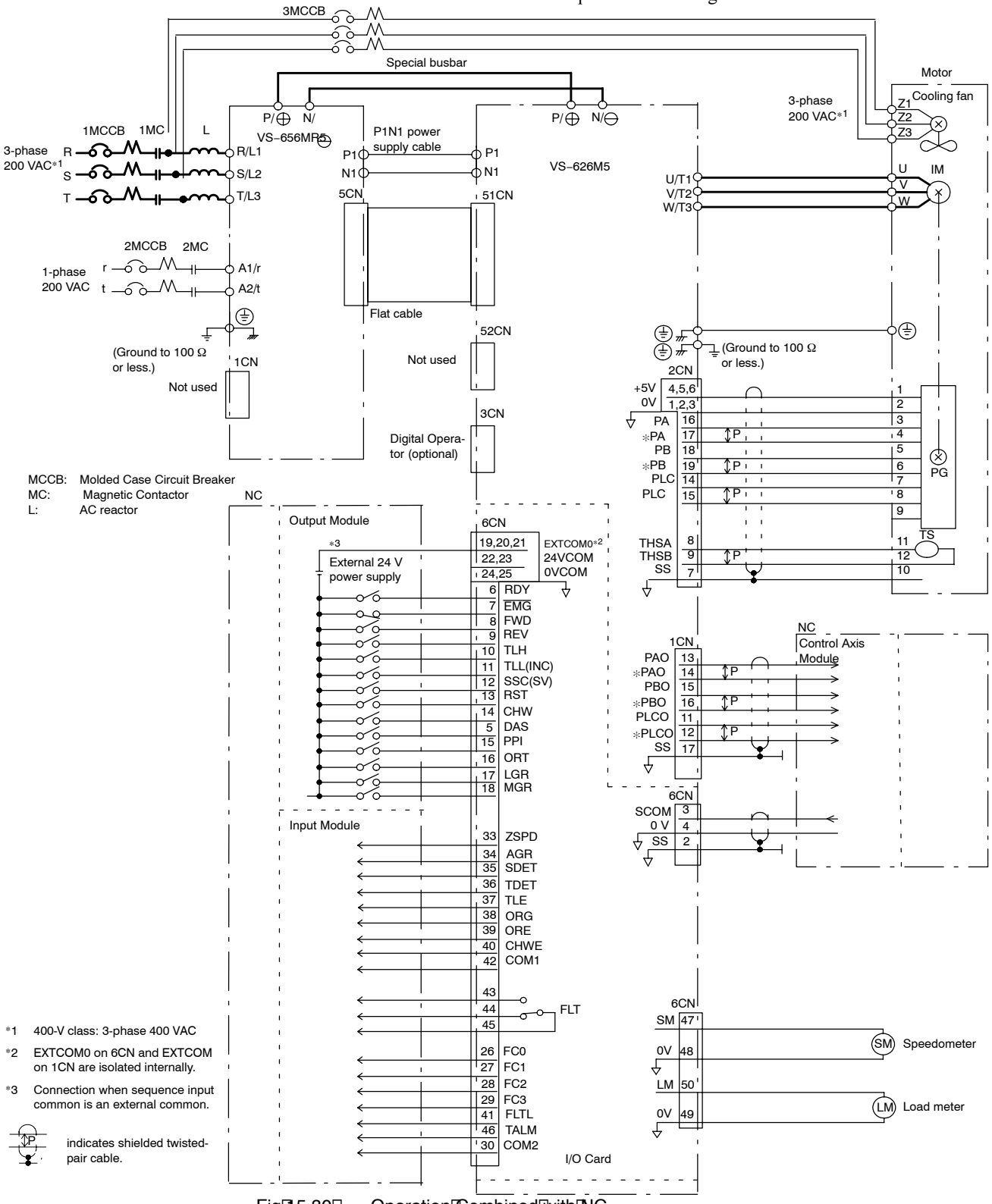


Fig 15.30 Operation Combined with NC

15.6.3 Multi-step Speed Operation Combined with PLC

As shown in Fig. 15.31, this is a multi-step speed operation to a maximum of eight speeds using internal speed settings by changing the digital speed reference settings. This method is effective when performing operations by repeating speed patterns that have been set beforehand, such as transfer machines and other special hole-boring equipment. The speed references are set internally, so there is no effect from speed reference offset and noise. For multi-step speed operations, select internal speed settings using the control constant C1-37 (SEL2) settings. For details, refer to *4.3 Using a 12-bit Digital Speed Reference*.

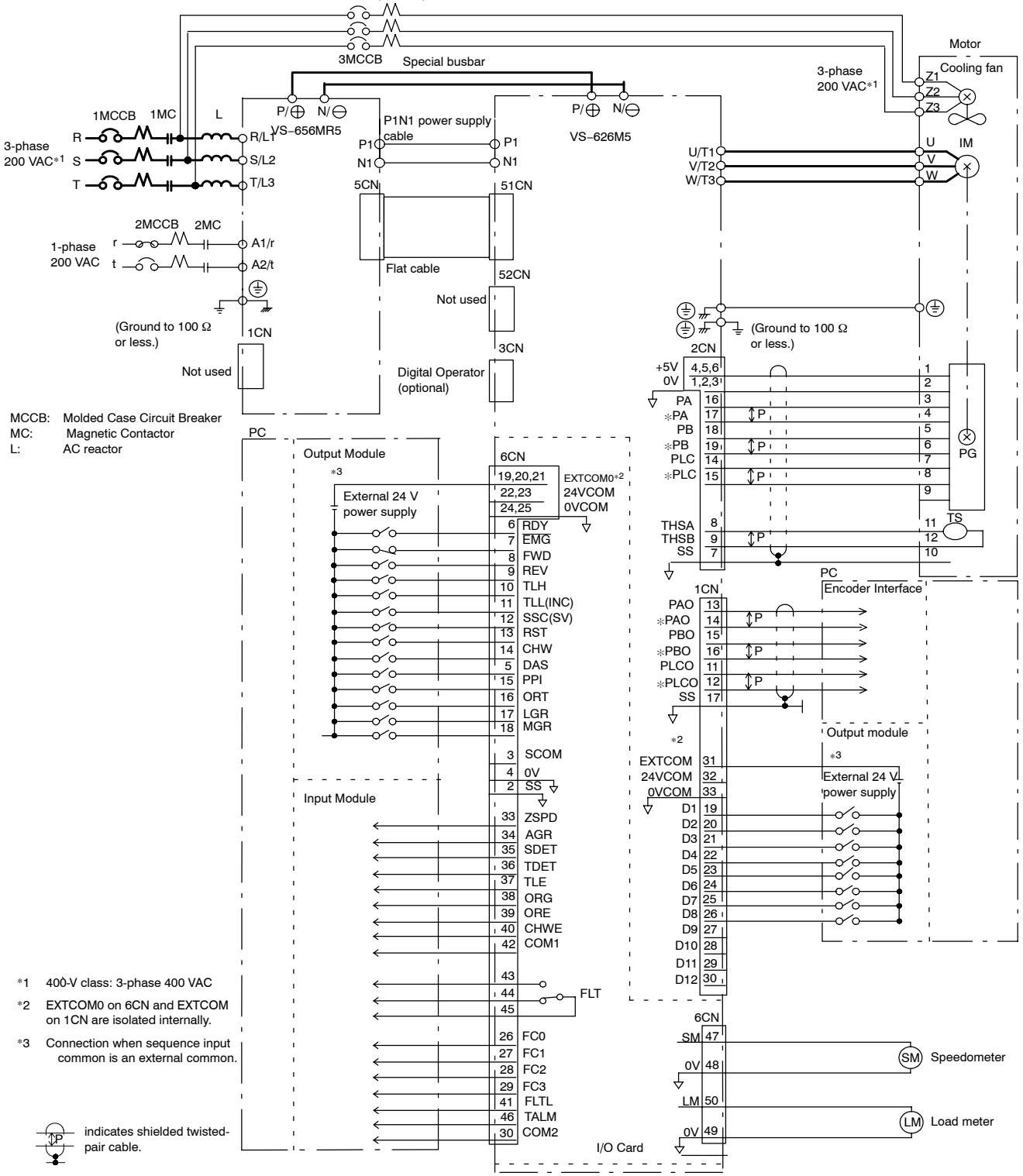
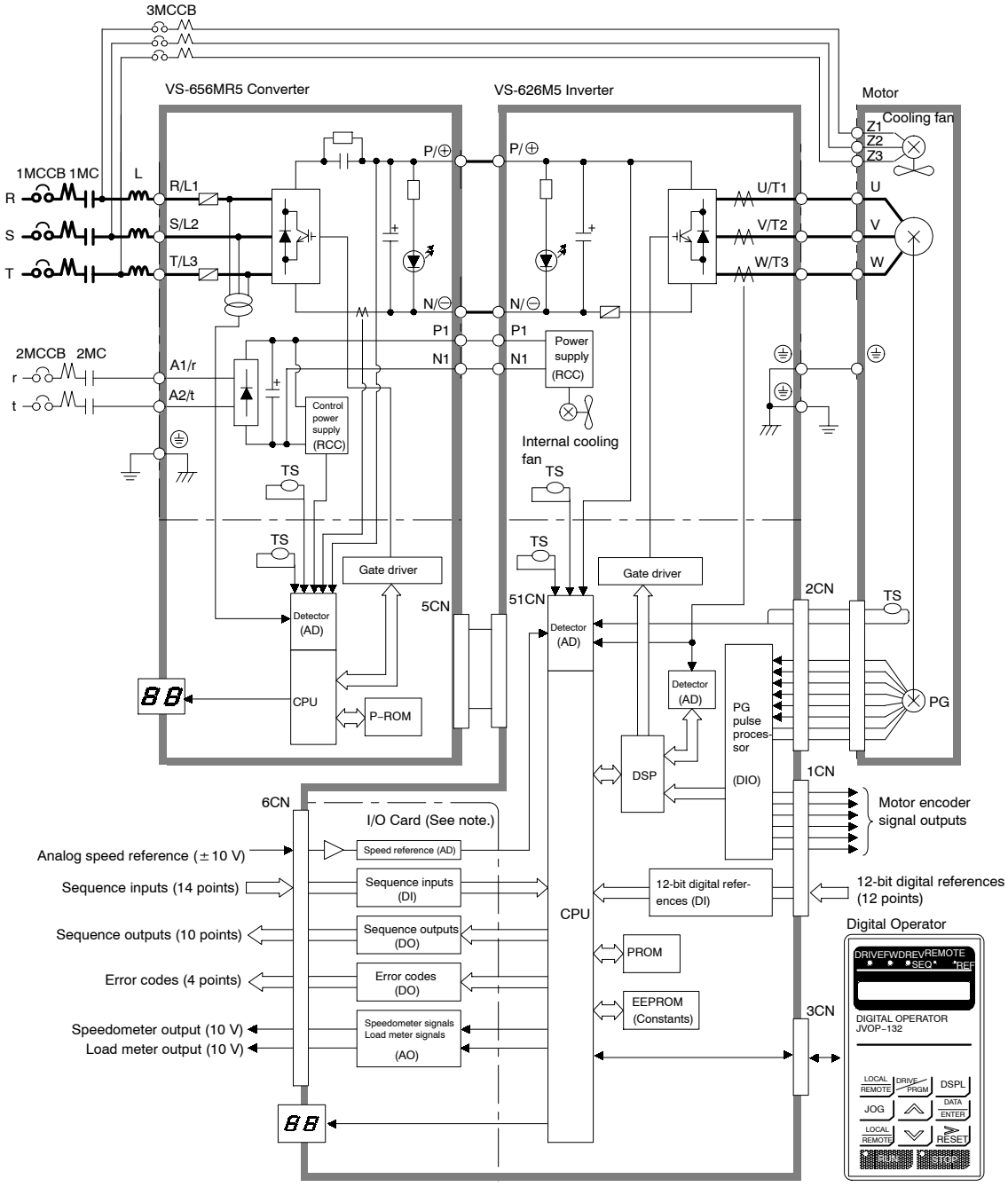


Fig 15.31 Multi-step Speed Operation Using Internal Speed Settings

15.7 Internal Block Diagram

The M5 Drive internal block diagram is shown below.



* An I/O Card is mounted when using an M5A Independent Drive

Fig 13.59 Internal Block Diagram

15.8 VS-626M5 Specifications Entry Tables

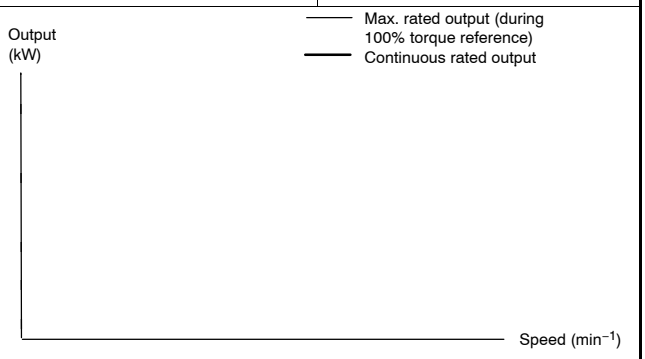
Enter the specifications according to the configuration in use. Uncompleted items will be taken to be Yaskawa standard settings, as indicated by numbers in dotted-line boxes.

Customer Name	Model	Device Name	Application
		Machining center, lathe ( )	Main axis drive/Other ( )

■ Machine Specifications

Power Required	Short-time rating kW (min., %ED) Continuous rating kW					
Power Transmission Method	1. Gear 2. Belt 3. Direct connection 4. Built-in motor	---	High speed (H)	Medium speed (M)		Low speed (L)
		Speed control range (min^{-1})				
		Gear ratio Load axis/Motor axis				
		Motor axis conversion inertial moment (kg • m^2: $GD^2/4$)				
Acceleration/deceleration Frequency	times/min.	Acceleration/deceleration time (0 ↔ Top) (s)				
Speedometer	1. Not used 2. Used: Speedometer full scale ( ) min^{-1}					
Load Meter	1. Not used 2. Used: Load meter full scale ( )% (Over continuous rating)					
Orientation Control Method	1. Not used (No Orientation Card) 2. Motor encoder (No Orientation Card) 3. Load axis encoder (with ETC62613X) 4. Magnetic sensor (with ETC62614X) 5. NC orientation (No Orientation Card)					
Solid Tap	1. Not used	---	Speed (H)	Speed (L)	Tap size	
	2. Used	Max. speed (min^{-1})			ϕ to ϕ	
		Acceleration/deceleration time (s)				
Speed Reference	1. Analog					
	2. Digital	2-1 Binary 2-2 2-digit BCD 2-3 3-digit BCD 2-4 Internal speed settings				
	3. Serial communications	3-1 YENET1200				
Input Common Method (M5A Type Only)	1. Sequence input signals	1-1 0 V common 1-2 +24 V common 1-3 External common				
	2. 12-bit digital input signals	2-1 0 V common 2-2 +24 V common 2-3 External common				
Remarks						

■ Motor Specifications

Model		Output characteristics	Characteristic drawing number
Winding Selection	1. Single winding 2. Winding selection		
Continuous Rated Torque	N • m (Basic low speed)		
Shape	1. Motor with frame 2. Built-in motor		
Mounting Method	1. Leg mounted 2. Flange mounted		
Motor Inertial Moment	kg•m^2 (GD^2/4)		
Dimensions No.			
Remarks			

■ Inverter Specifications

Model	CIMR-M5	
Reference Card	1. I/O Card (ETC62612X) (M5A) 2. YENET1200 Card (ETC62611X-SXXXX) (M5N)	
Mounting Configuration	1. Mounted in the panel (with fan) 2. External heatsink cooling (without fan)	
Connection Diagram		
Remarks		

■ Converter Specifications

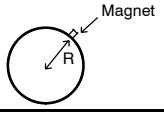
Model	CIMR-MR5	
Servo Control Power Supply	1. Without power supply (MR5A) 2. With power supply (MR5N)	
Mounting Configuration	1. Mounted in the panel (with fan) 2. External heatsink cooling (without fan)	
Remarks		

■ Power Supply and Environmental Specifications

Power Supply Voltage	1. 3-phase 200 V (50/60 Hz), 220 V (50/60 Hz), 230 V (60 Hz) 2. 3-phase 400 V (50/60 Hz), 440 V (50/60 Hz), 460 V (60 Hz)
	Tolerable voltage fluctuation 10% to 15% Tolerable frequency fluctuation ±5% Voltage unbalance between wires 5% max.
Ambient Temperature and Humidity	Inverter and Converter: 0% to 55% (internal air temperature 45°C (113°F) max.) 5% to 95% (with no condensation) Motor: 0 to 40°C (32 to 104°F) 95% max. (with no condensation)
Location for Use	Indoors (with no corrosive gas or dust), or as per other standard specifications.

■ Remarks

If using magnetic sensor orientation, enter the mounting radius of the magnetic.



R = _____ mm

Magnetic emitter: 1. MG-1378BS 2. MG1444S)
Magnetic sensor: 1. FS-1378C 2. FS-200A)

VECTOR-CONTROLLED INVERTER DRIVES WITH
POWER REGENERATIVE FUNCTION FOR MACHINE TOOLS

VARISPEED-626M5/656MR5

USER'S MANUAL

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