Oriental motor

HP-5051-4

Speed Controller
MSC-1

OPERATING MANUAL

Thank you for purchasing an Oriental Motor product.
This Manual describes product handling procedures and safety precautions.

- Please read it thoroughly to ensure safe operation.
- Always keep the manual where it is readily available.

Table of contents

1 Introduction

■ Before use

Only qualified personnel should work with the product.
Use the product correctly after thoroughly reading the section “2 Safety precautions” on p.4.
The product described in this manual has been designed and manufactured for use in general industrial equipment. Do not use for any other purpose. Oriental Motor Co., Ltd. is not responsible for any damage caused through failure to observe this warning.

■ Overview of the MSC-1

The **MSC-1** is a speed controller for velocity adjustment of AC speed control motors.

■ Applicable motors

AC speed control motor (6 to 90 W)
Also read the OPERATING MANUAL for applicable motor.

■ Standard and CE Marking

The **MSC-1** is recognized by UL, and affixed the CE Marking (Low Voltage Directive and EMC Directive) under the EN Standards.

- Applicable Standards

Applicable Standards	Cettification Body	Standards File No.	CE Marking
UL 508	UL	E91291	−
EN 50178	Conform to EN standards		Low Voltage Directive EMC Directive

- Installation conditions (EN Standard)

For use as a component within another device — Overvoltage category: Ⅱ
Protection against electric shock: Class Ⅱ — Pollution degree: 2

∗ If your equipment requires conformance to overvoltage category III, supply the power via an insulated transformer.

∗ If your equipment requires conformance to pollution degree 3, store the speed controller in an IP54-compliant enclosure.

- Low Voltage Directives

This product is designed and manufactured to be installed within another device.

- EMC Directives

Refer to “4.4 Installing and wiring in compliance with EMC Directive” on p.7.

■ Hazardous substances

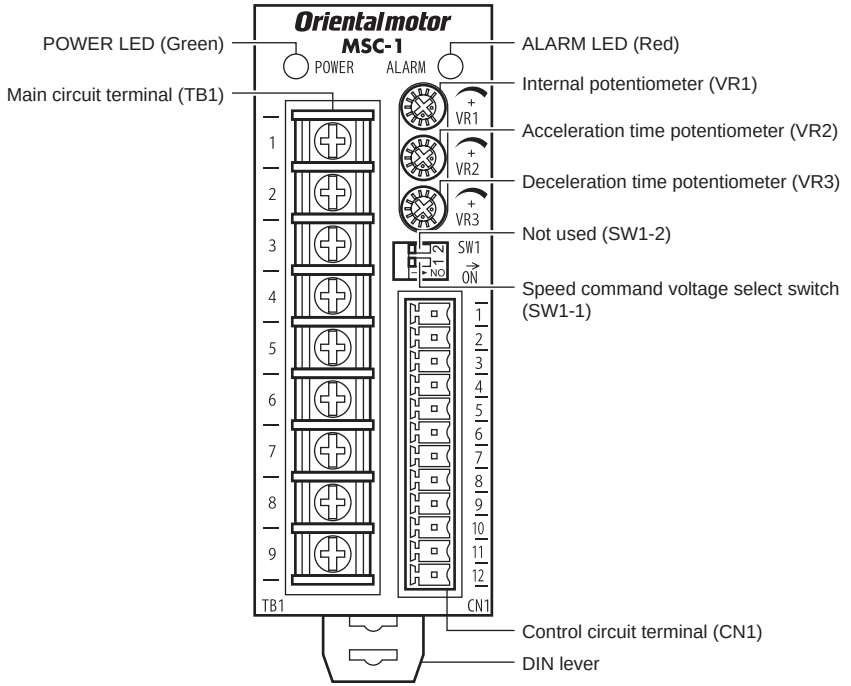
RoHS (Directive 2002/95/EC 27Jan.2003) compliant

■ Checking the product

Verify that the items listed below are included. Report any missing or damaged items to the branch or sales office from which you purchased the product.

- Speed controller ..... 1 unit
- CN1 connector ..... 1 pc.
- OPERATING MANUAL (this document) ..... 1 copy

■ Names and functions of parts



Name	Description
POWER LED (Green)	This LED lit while the AC power is input.
ALARM LED (Red)	This LED will blink when an alarm generates. The ALARM output will become OFF (H level). (P.17)
Internal potentiometer (VR1)	Sets the operating speed of the motor. (P.13)
Acceleration time potentiometer (VR2)	Sets the acceleration time for the motor. (P.14)
Deceleration time potentiometer (VR3)	Sets the deceleration time for the motor. (P.14)
Speed command voltage select switch (SW1-1)	If external DC voltage is to be used to set the operating speed, set this switch according to the applicable external DC voltage. Select 5 V or 10 V. (P.13)
Control circuit terminal (CN1)	Connects the control DC power supply (24 V) and I/O signals. (P.9)
Main circuit terminal (TB1)	Connects the AC power supply, motor, rate generator and capacitor. (P.9)
DIN lever	Mounts the speed controller to a DIN rail. (P.6)

2 Safety precautions

The precautions described below are intended to prevent danger or injury to the user and other personnel through safe, correct use of the product. Use the product only after carefully reading and fully understanding these instructions.

⚠Warning	Handling the product without observing the instructions that accompany a “Warning” symbol may result in serious injury or death.
⚠Caution	Handling the product without observing the instructions that accompany a “Caution” symbol may result in injury or property damage.

⚠Warning

General

- Do not use the product in explosive or corrosive environments, in the presence of flammable gases, locations subjected to splashing water, or near combustibles. Doing so may result in fire, electric shock or injury.
- Assign qualified personnel the task of installing, wiring, operating/controlling, inspecting and troubleshooting the product. Failure to do so may result in fire, electric shock or injury.
- Do not transport, install the product, perform connections or inspections when the power is on. Always turn the power off before carrying out these operations. Failure to do so may result in electric shock.

Installation

- Install the motor and speed controller in the enclosure in order to prevent electric shock or injury.

Connection

- Use the speed controller which power supply voltage is the same as that of the motor. Failure to do so may result in fire or damage to equipment.
- The speed controller has no built-in fuse for overcurrent protection. Be sure to connect a device for overcurrent protection (e.g. fuse) in the power input line. Failure to do so may result in fire.
- Connect the cables securely according to the wiring diagram in order to prevent fire or electric shock.
- Do not forcibly bend, pull or pinch the cable. Doing so may cause fire or electric shock.
- Be sure to observe the specified cable sizes. Use of unspecified cable sizes may result in fire.

Operation

- Turn off the speed controller power in the event of a power failure. Or the motor may suddenly start when the power is restored and may cause injury or damage to equipment.

Maintenance and inspection

- Do not touch the main circuit terminal of the speed controller immediately after the power is turned off (for a period of 1 minute). The residual voltage may cause electric shock.

Repair, disassembly and modification

- Do not disassemble or modify the speed controller. This may cause electric shock or injury.

⚠Caution

General

- Do not use the speed controller beyond its specifications, or electric shock, injury or damage to equipment may result.
- When the speed controller's alarm is generated, first remove the cause and then reset the alarm. Failure to do so may result in injury or damage to equipment.

Installation

- Keep the area around the speed controller free of combustible materials in order to prevent fire or a skin burn(s).

Connection

- Do not wire the electromagnetic contactor or power relay between the motor and speed controller. To switch the rotation direction using the electromagnetic contactor may cause damage to equipment.

Operation

- Use this speed controller in combination with an Oriental Motor's speed control motor equipped with an overheat protection device. Failure to do so may result in fire.
- Provide an emergency stop device or emergency stop circuit external to the equipment so that the entire equipment will operate safely in the event of a system failure or malfunction. Failure to do so may result in injury.
- Immediately when trouble has occurred, stop running and turn off the speed controller power. Failure to do so may result in fire, electrical shock or injury.

Maintenance and inspection

- Do not conduct insulation resistance test or withstand voltage test on the speed controller. Failure not to do so may result in injury or damage to equipment.

Disposal

- To dispose of the speed controller, disassemble it into parts and components as much as possible and dispose of individual parts/components as industrial waste.

3 Precautions for use

WARNING FOR USE ON SPEED CONTROLLER (UL-certified)

- Maximum surrounding air temperature 50 °C (122 °F).
- DC voltage source shall be of Class 2 type.
- Install device in pollution degree 2 environment.
- Always use this speed controller in combination with a compatible motor by Oriental Motor. The compatible motors listed in this manual are recognized by UL and provide an overheat protection function based on thermal protection or impednce protection.
- Connect the cables securely according to the wiring diagram.

4 Installation

This chapter explains the installation location, installation methods and measures against noise of the speed controller.

4.1 Location for installation

The speed controller is designed and manufactured to be installed within another device. Install it in a well-ventilated location that provides easy access for inspection. The location must also satisfy the following conditions:

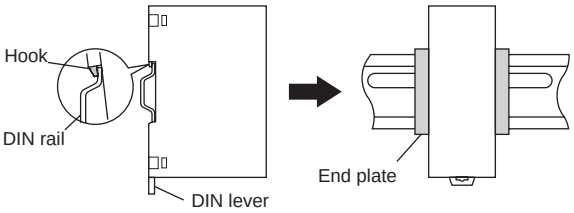
- Inside an enclosure that is installed indoors
- Operating ambient temperature 0 to +50 °C [+32 to 122 °F] (non-freezing)
- Operating ambient humidity 85% or less (non-condensing)
- Area that is free of explosive atmosphere or toxic gas (such as sulfuric gas) or liquid
- Area not stored combustible materials
- Area not exposed to direct sun
- Area free of excessive amount of dust, iron particles or the like
- Area not subject to splashing water (rain, water droplets), oil (oil droplets) or other liquids
- Area free of excessive salt
- Area not subject to continuous vibration or excessive shocks
- Area free of excessive electromagnetic noise (from welders, power machinery, etc.)
- Area free of radioactive materials, magnetic fields or vacuum
- 1000 m (3300 ft.) or lower above sea level

Note If the ambient temperature of the speed controller exceeds 50 °C (122 °F), improve the ventilation condition such as providing forced cooling by using fans or creating spaces for the speed controller.

4.2 Installation method

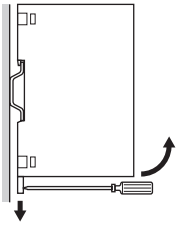
Use a DIN rail 35 mm (1.38 in.) wide to mount the speed controller.
The speed controller is designed so that heat is dissipated via air convection. Provide spaces so that the speed controller can be ventilated well through its top and bottom vent holes.

Push down the speed controller's DIN lever until it locks. Hang the hook at the rear to the DIN rail, and push in the speed controller. After installation, fix the both sides of the speed controller with the end plate.



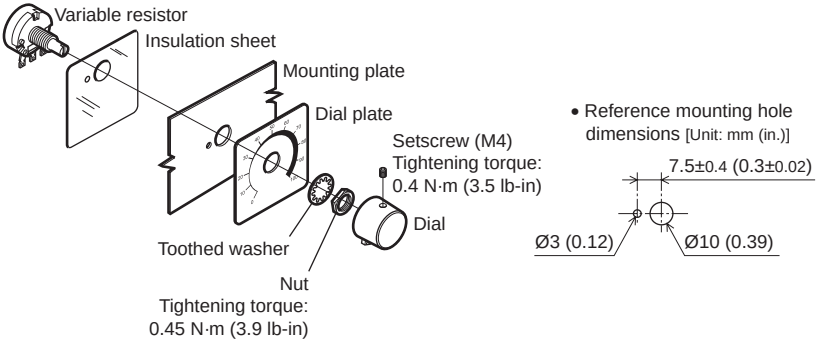
Removing from DIN rail

Pull the DIN lever down until it locks using a flat tip screwdriver, and lift the bottom of the speed controller to remove it from the rail.
Use force of about 10 to 20 N (2.2 to 4.5 lb.) to pull the DIN lever to lock it.
Excessive force may damage the DIN lever.



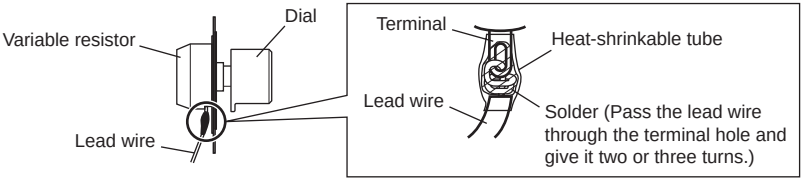
4.3 Installing an external potentiometer (Sold separately)

Install an accessory external potentiometer (sold separately) as shown below.



Soldering the variable resister terminals and the lead wires

Cover a heat-shrinkable tube over the soldered part to insulate.
235 °C (455 °F), less than 5 sec.



4.4 Installing and wiring in compliance with EMC Directive

■ EMC Directives

The speed controller is designed and manufactured as a component to be installed within another device. The EMC Directives require that your mechanical equipment in which the speed controller is installed satisfy the applicable requirements. The installation/wiring methods of the speed controller explained here represent the basic methods that are effective in helping your mechanical equipment conform to the EMC Directives.
The final level of conformance of your mechanical equipment to the EMC Directives will vary depending on the control system equipment used with the speed controller, configuration of electrical parts, wiring, layout, hazard level, and the like. Therefore, you must conduct the EMC tests on your mechanical equipment to confirm compliance.

■ Applicable Standards

EMI	Emission Tests	EN 61000-6-4
	Harmonics Current Test	EN 61000-3-2
	Voltage Fluctuations Test	EN 61000-3-3
EMS	Immunity Tests	EN 61000-6-2

Effective measures must be taken against the EMI that the speed controller may give to adjacent control-system equipment, as well as the EMS of the speed controller itself, in order to prevent a serious functional impediment in the machinery. The use of the following installation and wiring methods will enable the speed controller to be compliant with the EMC Directive.

■ Connecting mains filter for power supply line

- Connect a mains filter in the AC power supply input to prevent the noise generated in the speed controller from propagating externally through the power supply line. For a mains filter, use MC1210 (TDK-Lambda Corporation) or equivalent product.
- Install the mains filter as close to the speed controller as possible. Use cable clamps and other means to secure the input cables and output cables firmly to the surface of the enclosure. Connect the ground terminal of the mains filter to the grounding point, using as thick and short a wire as possible.
- Do not place the input cable parallel with the output cable. Parallel placement will reduce mains filter effectiveness if the enclosure's internal noise is directly coupled to the power supply cable by means of stray capacitance.

■ Connecting motor cable

When the motor cable is extended, use a cable of AWG18 (0.75 mm^2) or more with a length of 10 m (32.8 ft.) or less. When extending the rate generator lead wires, use a shielded cable.

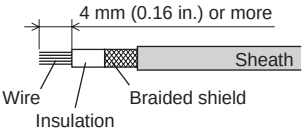
■ Ferrite core

Install a ferrite core in the power line and motor cable line to eliminate external electrical noise.
Use a ferrite core of 7427122 (Würth Elektronik GmbH & Co. KG), ZCAT3035-1330 (TDK Corporation) or equivalent.
Install the ferrite core as close to the speed controller as possible.

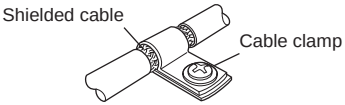
■ Wiring the control cable

Use a braided shielded cable of AWG24 (0.2 mm^2) or more for control cable, and keep the wiring distance as short as possible [less than 2 m (6.6 ft.)].

Recommended strip length for braided shielded cable



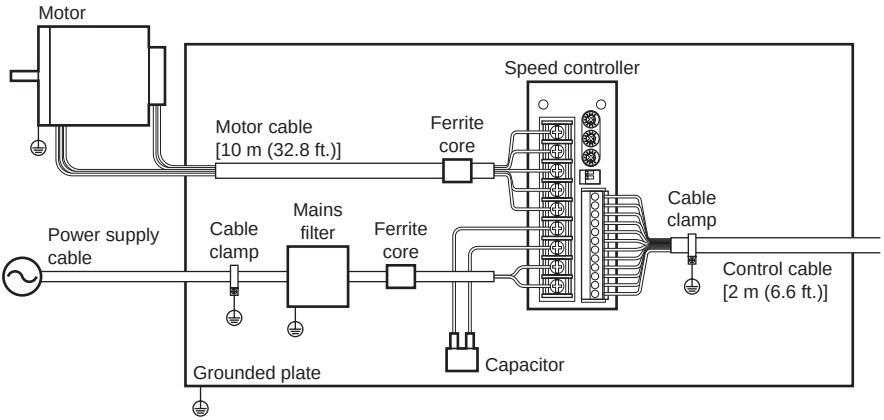
To ground a shielded cable, use a metal that will maintain contact with the entire circumference of the cable. Attach a cable clamp as close to the end of the cable as possible, and connect it as shown in the figure.



■ Notes about installation and wiring

- Connect the motor, speed controller and other peripheral control equipment directly to the grounding point so as to prevent a potential difference from developing between grounds.
- When relays or electromagnetic switches are used together with the system, use mains filters and CR circuits to suppress surges generated by them.
- Keep cables as short as possible without coiling and bundling extra lengths.
- Wire the power cables away from the control cables by providing a minimum clearance of 100 mm (3.94 in.) between them. If they have to cross, cross them at a right angle. Place the input cable and output cable of a mains filter separately from each other.

■ **Example of motor and speed controller installation and wiring**

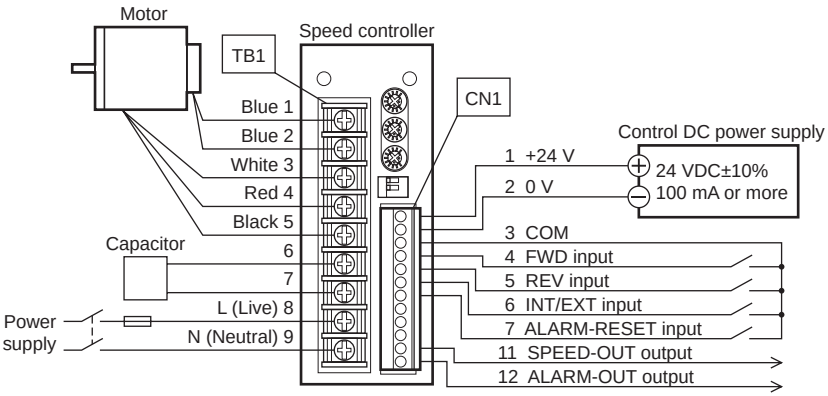


5 Connection

This chapter explains how to connect the speed controller and power supply, motor and I/O signals.

5.1 Connection example

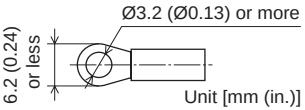
The following figure is an example when connecting the motor of World **K** Series, and the motor is operated with relays, switches and other contact switches. To operate the motor, be sure to connect control DC power supply.
A 60 W type motor or larger is equipped with a built-in cooling fan. Connect two lead wires (orange color) of the cooling fan to the AC power supply connection terminals (pin no. 8 and 9 of the TB1).



■ Connecting the main circuit terminal (TB1)

- Applicable cable size: AWG18 (0.75 mm^2) or more
- Terminal block screw size: M3
- Tightening torque: 0.8 N·m (7.0 lb-in)

Applicable crimp terminal



- TB1 pin assignments

Pin No.	Terminal name
1	Rate generator connection terminals
2	
3	Motor connection terminals
4	
5	

Pin No.	Terminal name
6	Capacitor connection terminals
7	
8	AC power supply connection terminals
9	

■ Connecting the control circuit terminal (CN1)

- Applicable cable size: AWG24 to 16 (0.2 to 1.25 mm^2)
- Lead wire strip length eled: 7 mm (0.28 in.)
- Terminal block screw size: M2
- Tightening torque: 0.33 N·m (2.9 lb-in)
- The length of the cable should be less than 2 m (6.6 ft.) and wire the cable away from the power lines.
- Use a shielded cable or twisted pair shielded cable when setting the rotation speed externally.

- CN1 pin assignments

Pin No.	Signal type	Signal name	Description
1	Control power supply	+24 V	Connect the 24 VDC for control circuit.
2		0 V (GND)	
3	Common	COM (GND)	I/O signals common
4	Input	FWD	The motor turns in the clockwise direction.
5		REV	The motor turns in the counterclockwise direction.
6		INT/EXT	Select the internal potentiometer or external potentiometer (external DC voltage).
7		ALARM-RESET	Alarms are reset.
8		VH	Connect when setting the speed externally.
9		VM	
10		VL (GND)	
11	Output	SPEED-OUT	12 pulses are output with each revolution of the motor output shaft.
12		ALARM-OUT	This signal is output when an alarm generates (normally closed).

■ Connecting the fuse

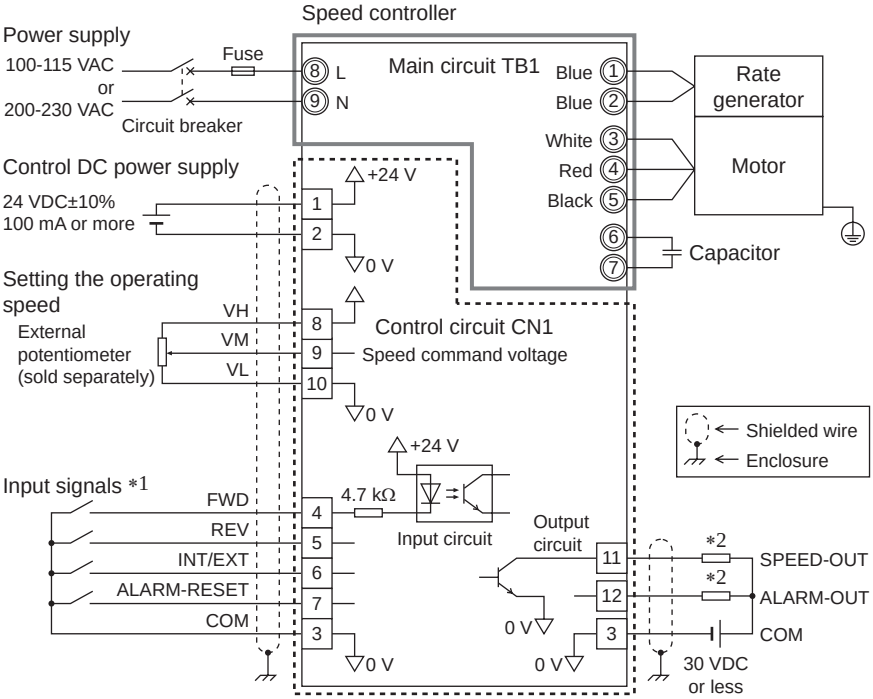
Be sure to connect a fuse or similar device in the power line to protect against overcurrent.

Fuse rating	Single-phase 100/110/115 V	216 Series (Littelfuse,Inc.) 10 A or equivalent
	Single-phase 200/220/230 V	216 Series (Littelfuse,Inc.) 6.3 A or equivalent

Note Use the speed controller which power supply voltage is the same as that of the motor.

■ Connection diagram

The connection diagram shown here is an example that the operating speed is set using an external speed potentiometer.



∗1 For relays or transistors connecting to the input signals, use those of leakage current 1 mA or less.

∗2 Connect external resistors so that the SPEED-OUT output and ALARM-OUT output are kept below 10 mA and 40 mA respectively.

5.2 I/O signals

■ Input signals

The speed controller input signals are photocoupler inputs.

■ Output signals

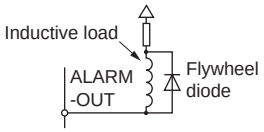
The speed controller output signals are transistor/open-collector output. Connect the current-limiting resistor to keep the SPEED-OUT output and ALARM-OUT output at maximum 10 mA and 40 mA, respectively.

- Recommended current-limiting resistor

Input power supply voltage	For SPEED-OUT output	For ALARM-OUT output
24 VDC	2.7 kΩ or more (2 W)	680 Ω or more (2 W)
5 VDC	560 Ω or more (0.5 W)	150 Ω or more (0.5 W)

Note

- Always connect a current-limiting resistor. If the power supply voltage is connected to the output circuit directly without connecting a current-limiting resistor in between, the speed controller will be damaged.
- When connecting a relay (inductive load), etc., to detect alarm outputs, use a relay with built-in flywheel diode, or provide a fly-back voltage control measure based on diode, etc., for the inductive load.



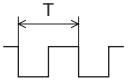
- SPEED-OUT output

12 pulses are output with each revolution of the motor output shaft synchronously with the motor operation (pulse duty: approx. 50%). The motor operating speed can be calculated by checking the SPEED-OUT output frequency.

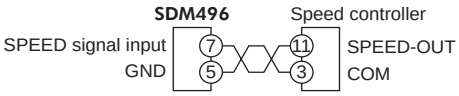
$$\text{Motor operating speed [r/min]} = \frac{\text{SPEED-OUT output frequency [Hz]}}{12} \times 60$$

$$\text{SPEED-OUT output frequency} = \frac{1}{T}$$

$$\text{When a gearhead is used: Motor operating speed} \times \frac{1}{\text{Gear ratio}}$$



To display/monitor the speed of the motor output shaft or reduced speed of the gearhead output shaft, connect an accessory digital speed indicator **SDM496** (sold separately).

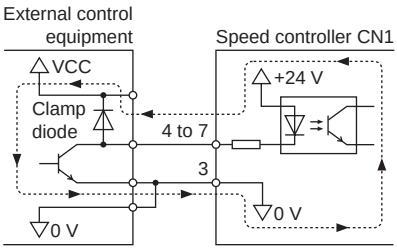


Note

The **SDM496** is not certified under safety standards. If the **SDM496** is combined with a speed controller, the speed controller does not conform to safety standards, either.

■ Using a external control equipment with a built-in clamp diode

If a external control equipment with a built-in clamp diode is used, a leakage path may form and cause the motor to operate even when the external control equipment power is off, as long as the speed controller power is on. Since the power capacity of the external control equipment is different from that of the speed controller, the motor may operate when the external control equipment and speed controller powers are turned on or off simultaneously. When powering down, turn off the speed controller power first, followed by the external control equipment power. When powering up, turn on the external control equipment power first, followed by the speed controller power.



6 Basic operations

This chapter explains the basic operations of the speed controller.

6.1 Run/stop

When turning the FWD input or REV input ON, the motor will rotate at the set speed.
When turning the FWD input or REV input OFF while the motor operates, the motor will coast to a stop.
When turning the FWD input and REV input ON simultaneously, the motor will stop instantaneously.

Note Do not operate the motor in vertical drive (gravitational operation).

6.2 Setting the operating speed

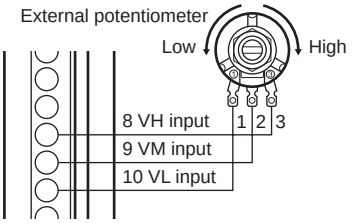
The setting range is from 90 to 1400 r/min at 50 Hz or 90 to 1600 r/min at 60 Hz.
There are three methods to set the operating speed; internal potentiometer, external potentiometer and external DC voltage.

■ Setting by internal potentiometer

Use a precision screwdriver to turn the internal potentiometer (VR1). Turn the potentiometer clockwise to increase the speed.
Factory setting: 0 r/min

■ Setting by external potentiometer (sold separately)

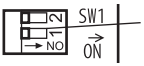
When the speed is set away from the speed controller, connect the external potentiometer (sold separately) to CN1. When the INT/EXT input is turned ON, the external potentiometer is enabled.
Turn the potentiometer clockwise to increase the speed.

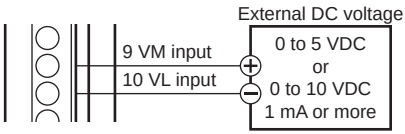


■ Setting with external DC voltage

Set either 5 or 10 VDC for the external DC voltage. Select the speed command voltage select switch (SW1-1) to set which voltage to be used. 5 VDC is set when the switch is set to the OFF position, and 10 VDC is set when the switch is set to the ON position.
Factory setting: 5 VDC (OFF)

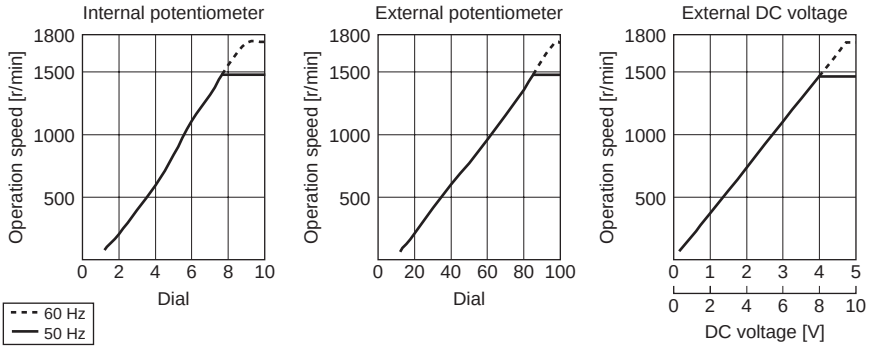
For the external voltage, use a DC power supply (0 to 5 VDC or 0 to 10 VDC) with reinforced insulation on both the primary side and secondary side, and connect it to the CN1.





Note Be sure to set the external DC voltage to either 5 VDC or less, or 10 VDC or less. When connecting the external DC power supply, make sure the polarities are correct. If the polarities are reversed, the speed controller may be damaged.

■ Operating speed characteristics (representative values)



6.3 Setting the acceleration time and deceleration time

The acceleration/deceleration time can be adjusted to prevent the load from receiving a shock upon starting, stopping or a change in speed.
The acceleration time and deceleration time are effective for all speed settings.
The setting range is approx. 0.3 to 15 seconds (at 1000 r/min, with no inertial load).

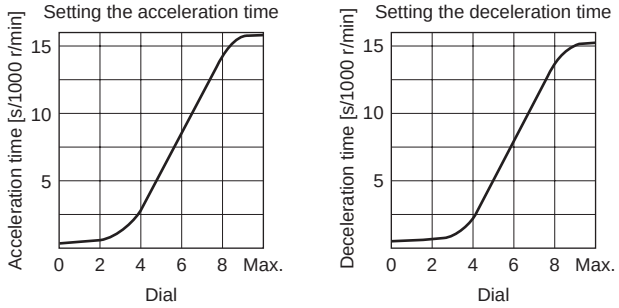
- Acceleration time

The acceleration time is actuated at start or when the speed is switched to the higher setting in a 2-speed operation. Turning the acceleration time potentiometer (VR2) clockwise increases the time.
Factory setting: Min.

- Deceleration time

The deceleration time is actuated at natural stop or when the speed is switched to the lower setting in a 2-speed operation. Turning the deceleration time potentiometer (VR3) clockwise increases the time.
Factory setting: Min.

■ Characteristics (representative values)



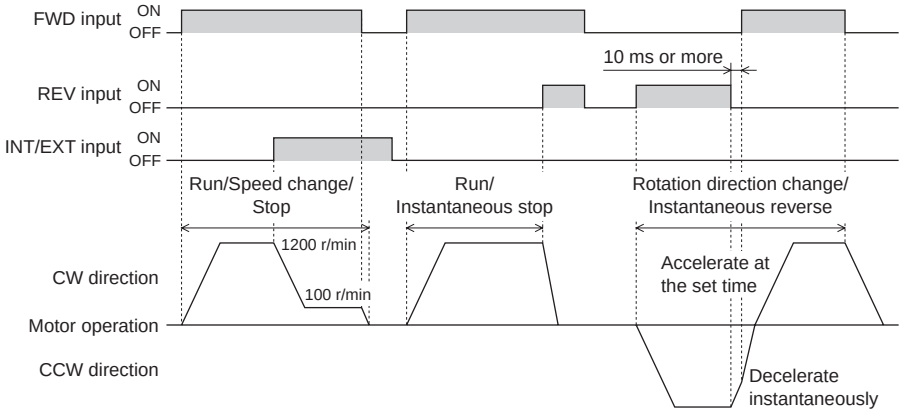
∗ However, when the load inertia is large, the deceleration time cannot be set at a shorter time than how long it takes for the motor to coast to a stop.

6.4 2-speed operation

Operation can be performed at two speeds through use of both the internal potentiometer and external potentiometer (external DC voltage) by switching the INT/EXT input. For details, refer to following timing chart.

6.5 Timing chart

The chart below is an example of setting the internal potentiometer to 1200 r/min and external potentiometer to 100 r/min and switching the speed between these two levels.



Note

- Make sure each signal remains ON for at least 10 ms.
- When switching the FWD input and REV input, provide an interval of at least 10 ms.
- If the power supply is turned on while the FWD input or REV input is being ON, the motor will rotate. Turn on the power supply after turning the FWD input and REV input OFF, so that the motor will not rotate suddenly when the power is turned on.
- To change rotation direction of the induction motor, wait until the motor completely stops.

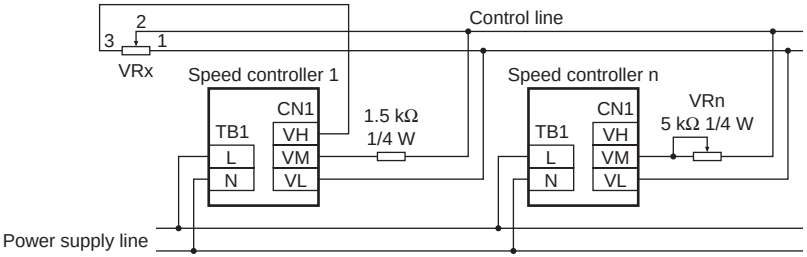
6.6 Multi-motor control

Two or more motors can be operated at the same speed by using a single external potentiometer (external DC voltage).

■ Using an external potentiometer

Connect the speed controller as shown below. When performing multi-motor control using the external potentiometer, the number of speed controllers should not exceed 20 units.

- Connect the external I/O signals to each speed controller.
- If the speed will vary among the respective motors, make adjustments as follows;
  Speed controller 1: Connect a resistor of 1.5 kΩ, 1/4 W to VM terminal
  Speed controller 2 and subsequent speed controllers: Connect a variable resistor VRn of 5 kΩ, 1/4 W



Resistance (VRx) when the number of speed controllers is n:

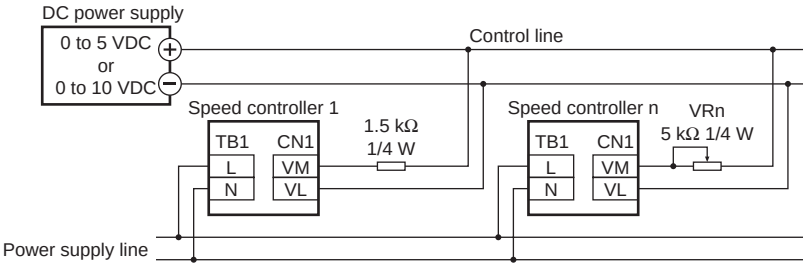
Resistance (VRx) = 20/n (kΩ), n/4 (W)

Example: If two speed controllers are used
Resistance (VRx) = 20/2 (kΩ), 2/4 (W), resistance (VRx) is calculated as 10 kΩ, 1/2 W.

■ Using external DC voltage

Connect the speed controller as shown below.

- Connect the external I/O signals to each speed controller.
- If the speed will vary among the respective motors, make adjustments as follows;
  Speed controller 1: Connect a resistor of 1.5 kΩ, 1/4 W to VM terminal
  Speed controller 2 and subsequent speed controllers: Connect a variable resistor VRn of 5 kΩ, 1/4 W



Current capacity (I) of external DC power supply when the number of speed controllers is n:

Current capacity (I) = 1 × n (mA)

Example: If two speed controllers are used
Current capacity (I) = 1 × 2 (mA), current capacity (I) is calculated as 2 mA or more.

6.7 Repeated operation/braking cycle

When operating/braking of the motor is repeated in short cycles, the rise in motor temperature will increase and the continuous-operation time will be limited.
Use the motor at the repetition cycle shown below.
6 W to 40 W: 2 seconds (running 1 second, stopping 1 second)
60 W and 90 W: 4 seconds (running 2 seconds, stopping 2 seconds)

6.8 Braking current

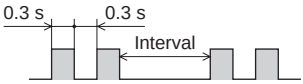
When turning the FWD input and REV input ON simultaneously, the braking current flows for 0.4 seconds and the motor stops instantaneously. Since the following current will flow when the motor stops instantaneously, use the power supply which current capacity is large enough.

Motor output power	Braking current (Peak value)	
	Single-phase 100/110/115 V	Single-phase 200/220/230 V
6 W	2 A	1 A
15 W	4 A	3 A
25 W	8 A	4 A
40 W	12 A	7 A
60 W	22 A	9 A
90 W	29 A	13 A

7 Alarms

When the protective function is actuated and an alarm generates, the ALARM-OUT output will turn OFF. The motor coasts to a stop and once the motor has stopped, the motor output shaft becomes free. At the same time, the ALARM LED will start blinking. The cause of the alarm can be checked by counting the number of times the ALARM LED blinks.
The ALARM LED will illuminate briefly when the control DC power is turned on. This is not a malfunction.

Example: Timing chart for blinking LED when the motor lock alarm is generated



■ Alarm list

No. of ALARM LED blinks	Alarm type	Cause	Remedial action
2	Motor lock	• The motor output shaft was locked for a minimum of 5 seconds. • Disconnection or improper connection for the rate generator lead wires of the motor	• Reduce the load. • Improve the operation condition such as the acceleration time or deceleration time. • Check the motor connection.
9	Motor overheat	• A built-in overheat protection device (thermal protector) is activated (open). • Disconnection or improper connection for the motor cable	

■ How to reset the alarm

To reset an alarm, be sure to remove the cause of the alarm and then perform one of the following operations:

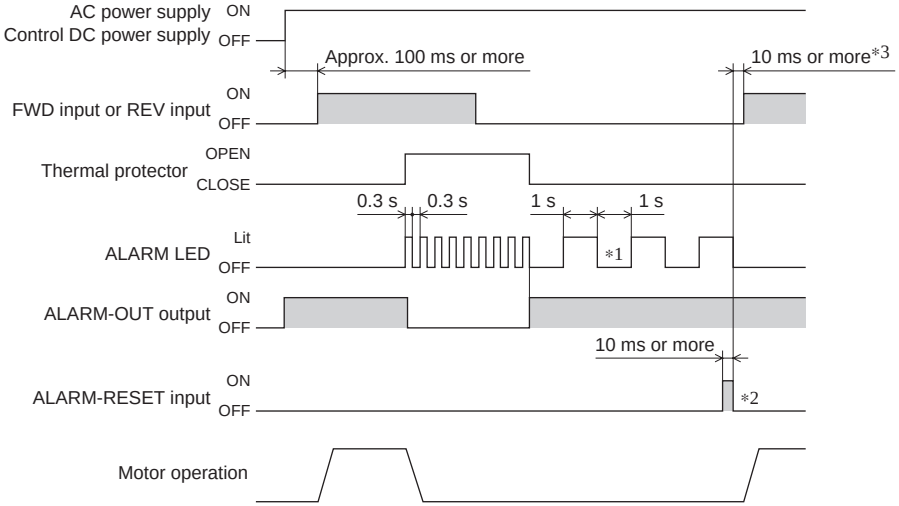
- Turn the ALARM-RESET input ON for at least 10 ms.
- Cycle the control DC power.

Note

- Be sure to remove the cause of the alarm and then reset the alarm.
- Alarms cannot be reset if the FWD input or REV input is ON.
  The ALARM-RESET input is enabled only while the motor is stopped.

■ Timing chart

The timing chart shown here is an example when the thermal protector is activated and the motor overheat alarm is generated.



∗1 When closing the thermal protector while the AC power supply has been turned ON, the blinking rate of the ALARM LED will be slower.
∗2 Although the ALARM-OUT output is turned ON if the thermal protector was closed, the operation will not restart until the alarm is cleared by the ALARM-RESET input.
∗3 To restart the motor, wait for at least 10 ms and then turn any of the input signal for operation ON.

8 Inspection

It is recommended that periodic inspections be conducted for the items listed below after each operation of the motor. If an abnormal condition is noted, discontinue any use and contact your nearest office.

■ During inspection

- Are there any scratches, signs of stress in the cable?
- The openings in the speed controller are not blocked.
- The main circuit terminal screws and control circuit terminal screws are not loose.

Note The speed controller uses semiconductor elements, so be extremely careful when handling them. Static electricity may damage the speed controller.

9 Troubleshooting and remedial actions

During motor operation, the motor or speed controller may fail to function properly due to an improper speed setting or wiring. When the motor cannot be operated correctly, refer to the contents provided in this section and take appropriate action. If the problem persists, contact your nearest office.

Note Certain items must be checked with the power on. Be careful not to touch any live connections.

Phenomenon	Possible cause	Remedial action
• The motor does not operate. • The speed doesn't change.	Both the FWD input and REV input are OFF.	Turn either FWD input or REV input ON.
	Both the FWD input and REV input are ON.	
	The internal potentiometer or external potentiometer is not adjusted.	The factory setting is 0 r/min. Turn the potentiometer clockwise.
	The INT/EXT input is ON when using the internal potentiometer.	Turn the INT/EXT input OFF.
	The external potentiometer is not connected correctly.	Check the connection.
	The INT/EXT input is OFF when using the external potentiometer.	Turn the INT/EXT input ON.
	The motor or capacitor is not connected correctly.	Check the connection.
The motor speed does not change to the set speed.	The speed command voltage select switch (SW1-1) is being ON when the external potentiometer is used.	Turn the speed command voltage select switch (SW1-1) to OFF.
	The speed command voltage select switch (SW1-1) is being ON when the speed command voltage is 0 to 5 VDC.	
The motor is rotating at the maximum speed, while the speed cannot be changed.	The rate generator is not connected correctly.	Check the connection.
• Motor operation is unstable. • Motor vibration is too great.	Effect of electrical noise.	See p.7 for measures with regard to noise.
The motor doesn't start instantaneously.	The acceleration time is too long.	Adjust the acceleration potentiometer.
	Load inertia may be excessive.	Reduce the load inertia.
The motor doesn't stop instantaneously.	Load inertia may be excessive.	Increase the frictional load or reduce the load inertia.

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