TSUBAKI

EHM40M206010R4

Shock Monitor

Electric power detection type overload protector

Instruction Manual

Model No.:TSM4000M2
TSM4000M2P

Integral Power Detection Type

⚠ CAUTION

- Please read this instruction manual carefully and understand the contents before starting the installation, connection (wiring), operation, and maintenance/inspection of this product.
- Ensure that this instruction manual is delivered to the end users who will actually use this product.
- Keep this instruction manual safe from loss until this product is discarded.
- This product is subject to change without prior notice.

TSUBAKIMOTO CHAIN CO.

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Table of Contents

1. Introduction

Thank you for purchasing the Shock Monitor.
This instruction manual describes from the installation, wiring, operation, through maintenance and inspection of the Shock Monitor. Please read this manual carefully and take due caution while handling the device.

2. Safety Precautions

- Be sure to read this manual and other attached documents carefully before starting the installation, wiring, operation, and maintenance/inspection to ensure proper use.
- Familiarize yourself with all of the knowledge of the devices, safety information, and precautions before using the Shock Monitor.
- After reading this manual, be sure to keep it in a place where users can access any time.
- This instruction uses two levels of safety precautions: WARNING and CAUTION.

⚠ **WARNING**	Failure to follow instructions may lead to dangerous situations where death or severe injury can occur.
⚠ **CAUTION**	Failure to follow instructions may lead to dangerous situation where medium to light injury or property damage can occur.

Even if the instructions are followed, a serious consequence may result depending on the situation.
Be sure to exercise due caution and follow all of these important instructions.

⚠WARNING

- Use the product described in this instruction manual by observing safety-related laws and regulations such as Ordinance on Industrial Safety and Health.
- Observe the following during the installation, removal, or maintenance/inspection of the product:
  (1) Turn off the power switch.
  (2) Do not go below any equipment which may fall and drop.
  (3) Secure moving parts of the equipment so that they will not move unexpectedly.
  (4) Wear appropriate clothing and protective gear for the work.
- Before starting trial operation or regular inspection, be sure to confirm the operation so that the Shock Monitor properly works as a protection device.
- The Shock Monitor main unit is subject to conditions when it is used for a megger test. Follow the instruction in the instruction manual.
- Do not work while the line is live. Be sure to turn off the power before starting work. **Otherwise, an electric shock may result.**
- The wiring, energization/operation, and maintenance/inspection of the Shock Monitor must be done by an engineer with expert knowledge. **Otherwise, an electric shock, injury, or fire may result.**
- Be sure to ground Terminal E of the Shock Monitor. **Otherwise, an accident may result.**
- When using a 400 VAC motor power supply, ensure that the Shock Monitor unit and 400 V resistor are connected properly. **Otherwise, an electric shock or fire may result.**

⚠CAUTION

- Ensure that this instruction manual is delivered to the end users. Also, let the end users carefully read the manual before using the Shock Monitor to ensure correct use.
- If you do not have the instruction manual, contact your TC dealer or a TC sales office and request a copy by specifying the product name, model number, etc.
- Do not disassemble the product or make additional work for modification.
- This product contains **several consumable parts (electrolytic capacitor, relay, etc.)**. Check functions and operation periodically according to the instruction manual. If any malfunction is found, contact your dealer for repair.
- Do not use the Shock Monitor in an atmosphere where any corrosive gas exists. Sulfidizing gases (SO_2, H_2S), in particular, cause corrosion of copper and copper alloy used in the printed circuit boards and components, resulting in breakdowns.
- Do not allow the entry of foreign matter such as lint, paper pieces, woodchips, dust, or metal chips into the Shock Monitor.
- Clean off dirt periodically because it may cause overheating of the product or fire.
- When discarding the product, dispose it as industrial waste.

3. Usage

3.1 What is an M2 model?

The TSM4000M2 is an instrument for detecting abrasion of drill bits in drilling machines driven by 3-phase induction motors. Even when abrasion occurs in a tool, some constant-pressure type drilling machines may not cause a higher load ratio, but instead result in a longer working time. The TSM4000M2 monitors this by detecting the amount of electric power (area).

Load detection method

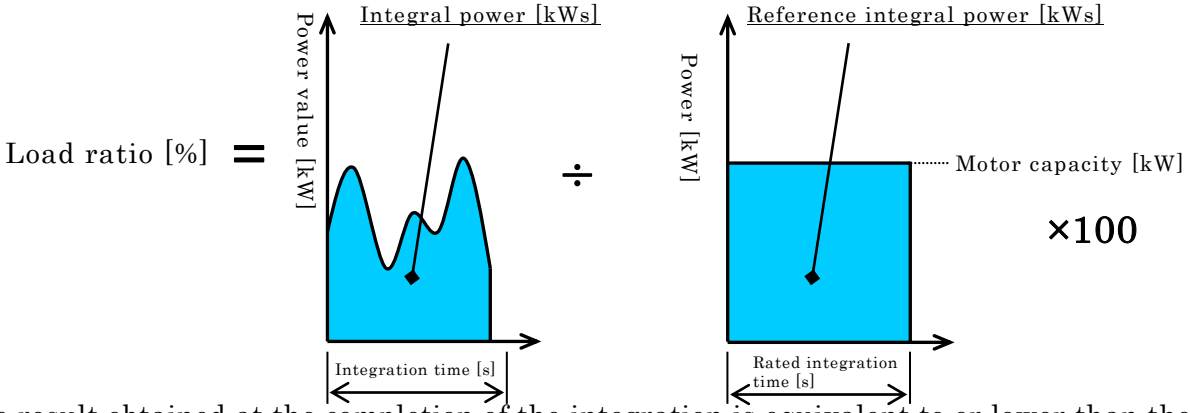
The Shock Monitor captures the voltage and current of the motor used for driving equipment and detects the power consumption of the motor.

Monitoring method

The M2 model performs monitoring by using two systems of integrated value monitoring and one system of absolute value monitoring. The integrated value monitoring totals the instantaneous electric power and assumes the area for one process as a load ratio. When the load ratio reaches or exceeds the upper limit level due to overload or other abnormalities, OUT2 is output. When the load ratio decreases to or goes below the lower limit level due to working failure caused by a broken drill bit or improper workpiece transportation, OUT1 is output. On the other hand, the absolute value monitoring activates relay OUT3 by detecting an overload when any machine trouble occurs, such as a foreign material getting stuck. This signal can be used to stop the motor for protection against overload of the equipment.

Operation of relative value monitoring relays OUT1 and OUT2

After the Start Time finishes, the power integration starts when the section between terminals X1 and CM is short-circuited. There are two integration time settings which can be set with a parameter: 1) The period while X5 is ON; and 2) the period of the parameter setting time which starts after X5 turns ON. The load ratio is calculated by dividing the obtained integral power by the product of the motor rated capacity and setting time (reference integral power) and expressing the result as a percent.



If the result obtained at the completion of the integration is equivalent to or lower than the lower limit level, the OUT1 relay provides a one-shot output for one second.
If the integration result is equivalent to or higher than the higher limit level, the OUT2 relay provides a one-shot output for one second.

Operation of absolute value monitoring relay OUT3

When the load ratio reaches or exceeds the OUT3 level (for example, an absolute value of 100%) due to machine trouble such as a foreign material getting stuck and this state continues for a specified period (Shock Time) or longer, relay OUT3 issues an output.

3.2 Other functions

Load condition recording

Detected electric power values can be output as analog voltage signals.

Power detection response setting

When the load pulsates frequently due to the resonance or jerking of the equipment, you can delay the response of the power detection. This suppresses the pulsation of the detected value and improves the accuracy of the detection of abnormal load.

Selecting detection levels

If the load condition varies for each work process of the equipment, up to eight abnormality detection levels can be set and switched.

4. Checking the Package Contents

Check the following about the product you purchased.

(1) Do the model number and specifications on the name plate match your order?

(2) Were there any damages suffered during transportation?

(3) Are the following contents included? (For their appearances, refer to the outer dimensions on page 24.)

Shock Monitor unit (including a socket): TSM4000M2

Current sensor: TSM-U*** or TSM-M***

Sensor cable: TSM4-S01

4.1 Model number meaning (Main unit + Current sensor)

● The model number of the combination of the main unit and current sensor consists of the model numbers of the main unit and sensor as follows:

TSM4000M2 - U010

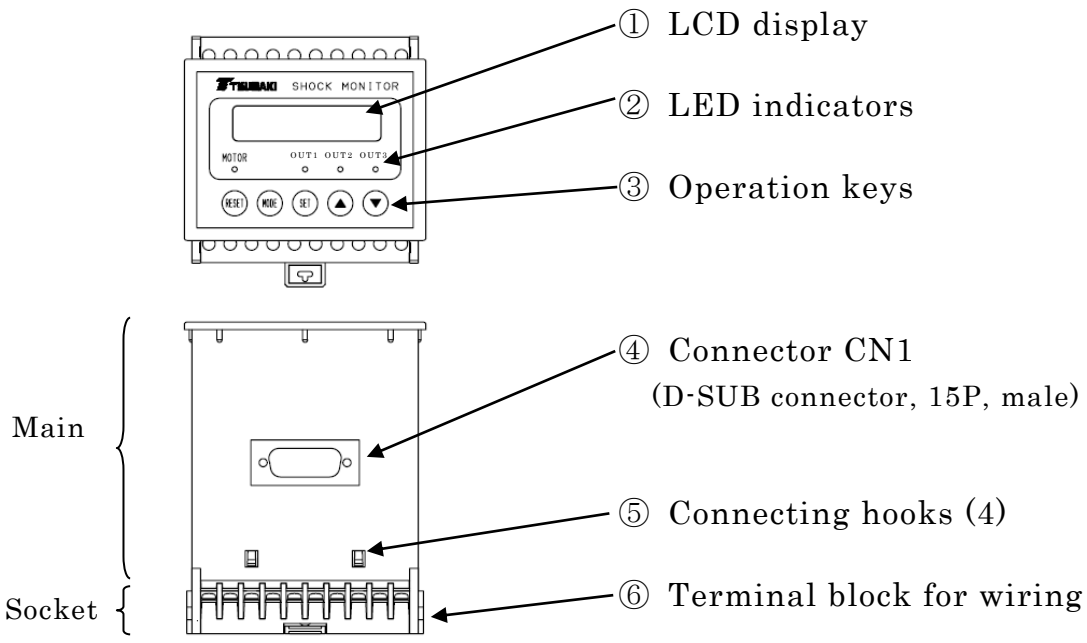
Model No. of the main unit — Model No. of the current sensor (Last 4 digits of TSM-U010)

● The model number of the sensor cable indicates the cable length as follows:

TSM-S01 ..."01" means 1 m cable

The TSM4-S01 sensor cable is included as an accessory. If this cable length is insufficient, optional cables of 3 m, 5 m, 10 m, 20 m and 30 m are available. Contact TC when necessary.

5. Part Names



① LCD display ...Shows load ratio, setting values and parameter settings.

② LED indicators ...Indicates that the motor is running and that the output relay is activated.

③ Operation keys ...Keys used for switching the displayed mode or for changing parameters.

④ Connector CN1 ...Connector for using signals such as control input or analog output.

⑤ Connecting hooks ...Used to connect/disconnect the main unit to/from the socket.
For connection, fully insert the main unit until the hooks lock securely.
For disconnection, press down the four hooks simultaneously and remove the main unit from the socket.

⑥ Terminal block for wiring...Terminals for connecting an operational power supply, motor voltage, relay output, current sensor cable, etc.

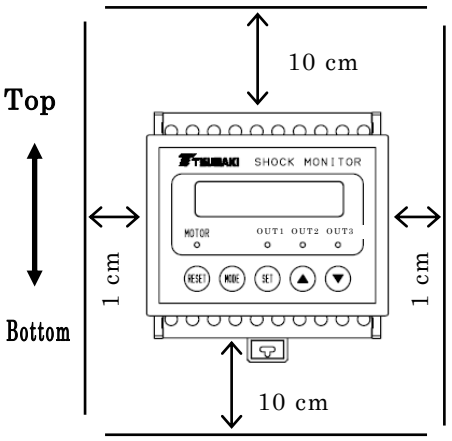
6. Installation

6.1 Installation environment

Install the Shock Monitor in a place where the following conditions are satisfied:

- Location where the ambient temperature is between 0 to 50°C and the Shock Monitor is not exposed to direct sunlight
- Location where the relative humidity is between 45 to 85%, no condensation or freezing occurs, and no water splashes onto the Shock Monitor
- Location where no dust, corrosive gases, or oil mist exist
- Location where the altitude is 1000 m or less and vibration is 4.9 m/s^2 or less

6.2 Mounting orientation and space



・ Mounting method

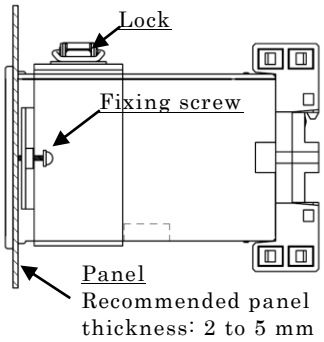
Insert M4 screws into the DIN rail or the mounting holes of the socket and attach the main unit. Mount the Shock Monitor so that its panel is oriented vertical to the ground. Mounting it upside down or horizontally may cause overheating and breakdown.

・ Space

To ensure the dissipation of the heat generated from the Shock Monitor, provide spaces as shown in the figure on the left from other equipment, walls, and wiring ducts.

・ Panel mounting type (TSM4000M2P)

Mount the Shock Monitor as shown in the figure on the right.



Tighten the fixing screw with the tightening torque of 0.12 to 0.16 N・m. Provide a space of 50 mm or more above the main unit housing to allow access to the lock.

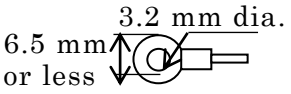
⚠CAUTION	■ Do not allow the entry of foreign matter such as lint, paper pieces, woodchips, dust, or metal chips into the Shock Monitor. **Otherwise, a fire or accident may result.**

7. Wiring

① Complete wiring by using only the socket before attaching the Shock Monitor main unit to the socket.

② Connect a commercial power supply of 90 to 250 VAC, 50/60Hz or a DC power supply of 90 to 250 VDC (no polarity) to the POWER terminals (11 and 12). Do not connect the output from an inverter or a servo driver. An erroneous connection as such may cause breakdown.

③ Use a ring type crimp terminal shown on the right to connect the power supply cable and the terminal block for wiring.
Limit the tightening torque to 0.5 to 0.6 N・m.

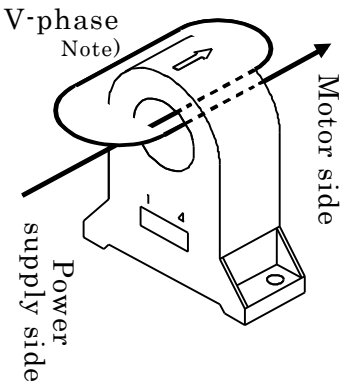


④ When the connection (wiring) is completed, check the following:
a. Are the wires connected properly?
b. Are there any remaining disconnected wires?
c. Are there any short-circuits or ground fault conditions occurring between terminals or wires?

⑤ After the connection is complete, fully insert the main unit to the socket until the hooks lock securely.

⚠WARNING	● Be sure to ground the grounding wire. **Otherwise, an electric shock or fire may result.** ● The wiring must be done by an electric work specialist. ● Confirm that the power is turned off before start wiring work. **Otherwise, an electric shock may result.**

⑥ Current sensor



To detect motor current, pass the V-phase motor wire through the sensor in the direction from the power supply side to motor side as shown by the arrow. Make sure that the direction of the wire matches with the arrow on the top of the current sensor. The number of times to pass the wire through the sensor depends on the motor capacity and voltage. Refer to the following table for the specified number.
The figure on the left shows the case where the number of times to pass the wire through the sensor is two (2).

(Note) Refer to the connection diagrams on pages 10 and 11 for the current sensor wiring and be sure to pass through the motor wire of the correct phase which is connected with the voltage input terminal V[2] of the TSM4000. If the wire of the other phase is connected, or the wire is passed through in the opposite direction, the electric power cannot be detected properly. This wiring is unrelated to the positive/reverse phase of the power supply or of the forward/reverse rotation switching of the motor.

■ Number of times to pass the wire through the sensor

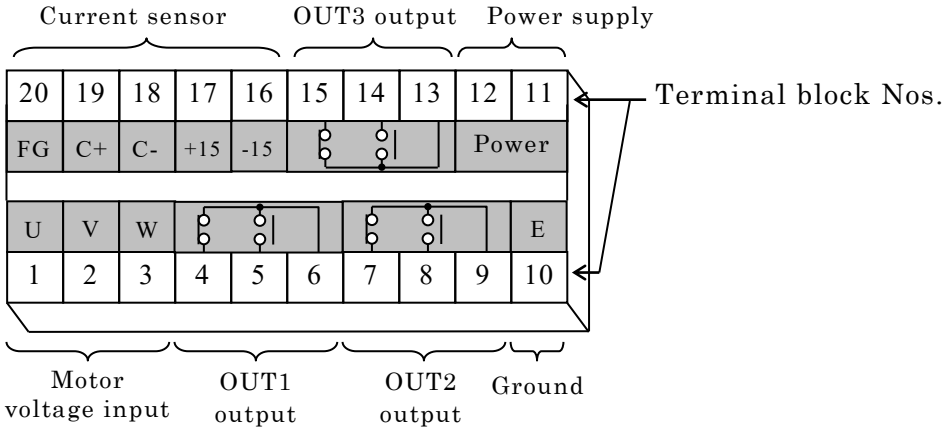
Motor capacity (kW)	200/220 VAC motor			400/440 VAC motor		
	Motor rated current (A)	Sensor model No.	No. of times to pass wire through sensor	Motor rated current (A)	Sensor model No.	No. of times to pass wire through sensor
0.1	0.71	TSM-U010	6	0.36	TSM-U010	12
0.2	1.4	TSM-U010	3	0.70	TSM-U010	6
0.4	2.3	TSM-U010	2	1.2	TSM-U010	3
0.75	3.6	TSM-U050	6	1.8	TSM-U010	2
1.5	6.6	TSM-U050	3	3.3	TSM-U050	6
2.2	9.2	TSM-U050	2	4.6	TSM-U050	5
3.7	15	TSM-U050	1	7.5	TSM-U050	3
5.5	22	TSM-U050	1	11	TSM-U050	2
7.5	29	TSM-U100	1	15	TSM-U050	1
11	42	TSM-U100	1	21	TSM-U050	1
15	55	TSM-U150	1	28	TSM-U100	1
18.5	67	TSM-U150	1	34	TSM-U100	1
22	78	TSM-U200	1	39	TSM-U100	1
30	107	TSM-M300	1	54	TSM-U150	1
37	132	TSM-M300	1	66	TSM-U150	1
45	160	TSM-M400	1	80	TSM-U200	1
55	198	TSM-M600	1	99	TSM-M300	1
75	270	TSM-M600	1	135	TSM-M300	1
90	320	TSM-M800	1	160	TSM-M400	1
110	384	TSM-M800	1	192	TSM-M400	1

The motor rated current values in the table are for reference only.

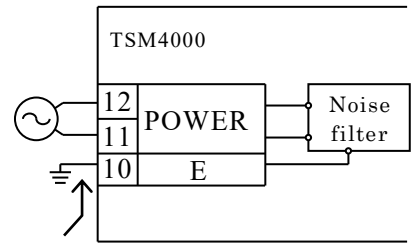
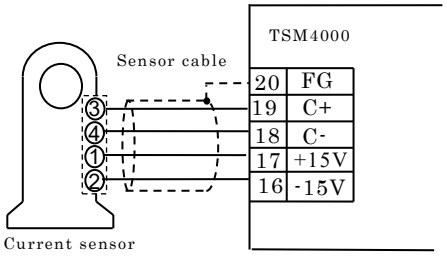
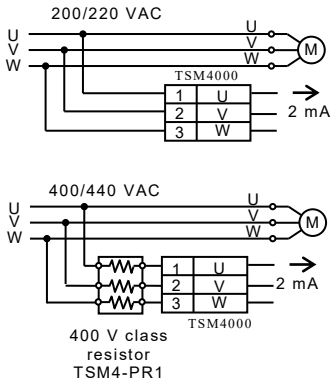
■ Connecting the sensor cable to the main unit

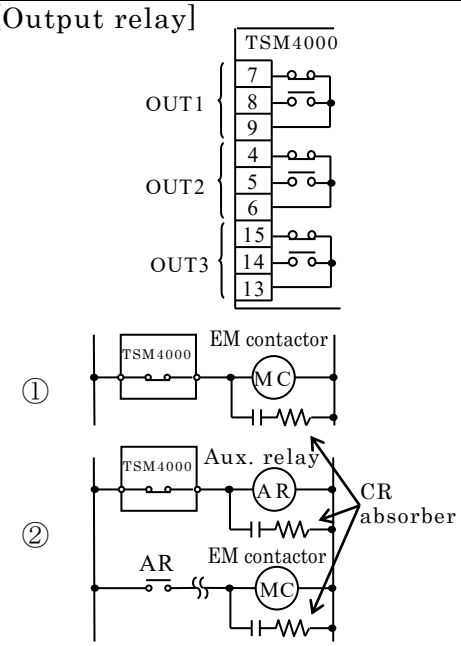
Connect the sensor cable TSM4-S01 included in the package properly to the current sensor and Shock Monitor main unit respectively. If the cable length is insufficient, longer cables are optionally available. Refer to page 4 for the model number of the sensor cable and contact TC for ordering.

8. Terminal Functions

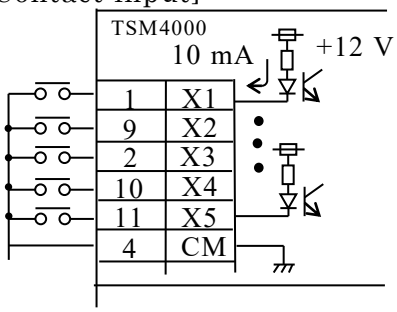
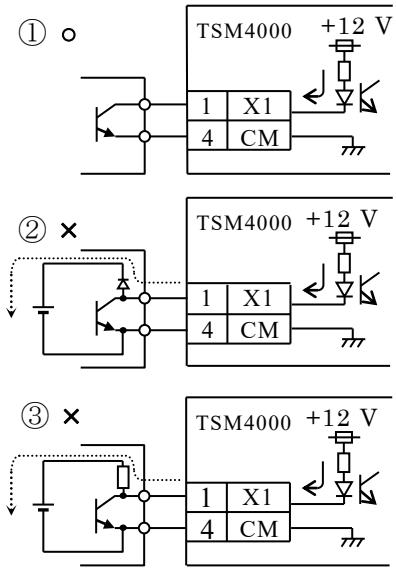


8.1 Terminal block

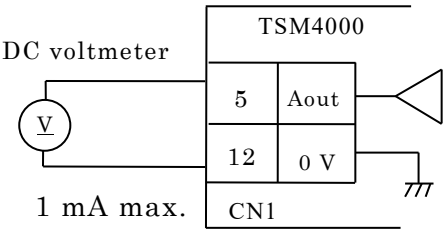
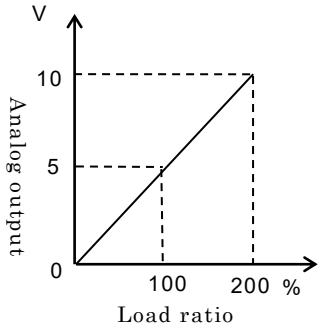
Terminal	Description
[Power supply/ground]  Leakage current 0.5 mA max.	● Power supply (Terminals 11 and 12) ・ Terminals used to connect the power supply for the Shock Monitor. Connect a commercial power supply of 90 to 250 VAC or a DC power supply of 90 to 250 VDC (no polarity). Never connect the output of an inverter or a servo driver (which may cause breakdown). ● E (Terminal 10) ・ A noise filter is connected. **This terminal must be grounded.** ・ Leakage current of 0.5 mA at maximum will flow the grounding wire from the power supply through the capacitor inside the noise filter.
[Sensor cable connection]  	・ Connector used to input the signals from the current sensor. **⚠ CAUTION** **To prevent noises, route the sensor cable at least 15 cm away from an inverter, a servo driver unit, and their output lines.**
[Voltage input]  	●U, V, W (Terminals 1, 2, 3) ・Terminals used to input the voltage applied to the motor into the Shock Monitor. When a 400 V class motor is connected, be sure to connect the 400 V class resistor as shown on the left. Direct connection of a 400 V class motor may cause breakdown. A current of about 2 mA (AC) will flow through each terminal.

Terminal	Description
[Output relay] 	● Output relay OUT1 (Terminals 4, 5, 6), OUT2 (Terminals 7, 8, 9), OUT3 (Terminals 13, 14, 15) ・Output terminals used to notify external devices of an alarm or overload condition. Three relay signals, OUT1, OUT2, and OUT3 will be output. **Contact specification: 1c contact: 250 VAC, 0.5A (Inductive load cosφ = 0.4)** Notes: ・When an electromagnetic contactor is connected as shown in the left figure ①, limit the operating coil capacity to less than 100 VA at power-on and to less than 10 VA during retention. If an electromagnetic contactor with larger capacity is connected, activate an auxiliary relay with the output of the Shock Monitor as shown in the left figure ②, and then open/close the electromagnetic contactor with the contact of the auxiliary relay. ・As shown in the left figure, mount a CR absorber to the coils of the electromagnetic contactor and auxiliary relay to prevent noise generation. ・When a sequencer photocoupler input which operates with minute current (10 mA or less) is connected, activate a relay for minute current with a relay output, and then connect the contact of the relay for minute current to a sequencer photocoupler input.

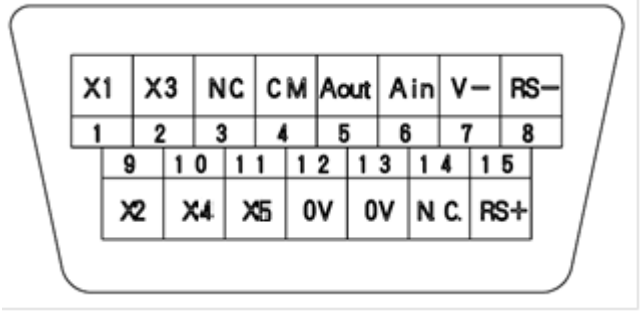
8.2 Connector CN1

Terminal	Description
[Contact input]  [Non-contact input] 	● X1, X2, X3 (CN1 pin Nos. 1, 9, 2) These terminals are used to externally switch preset overload detection levels according to the load condition of the equipment. The level can be switched according to the load condition which varies depending on the selected motor speed, material, process, etc. Up to eight detection levels can be selected by using the combination of the ON (short-circuit) and OFF (open) statuses of terminals X1 to X3. Three individual settings for OUT1 - OUT3 can be set for each selection No. If a number larger than the value set for parameter "5: Process" (No. of selected levels, refer to page 16) is chosen, the selection will be [1]. ● X4 (CN1 pin No. 10) While the section between X4 and CM is short-circuited, the load detection is stopped. ● X5 (CN1 pin No. 11) When the section between X1 and CM is short-circuited (turned ON), the integration of the power starts. Two integration methods are available: To integrate the power while the section is turned ON; or to integrate the power for the setting time after the section is turned ON. This can be set with parameter 3: Integration Time. Note: When setting [Non-contact input], be sure to use an open collector signal shown in the left figure ①. Using ② or ③ may cause malfunction due to a detour circuit which may be created depending on the condition of the power supply.

Process No.	X1 - CM	X2 - CM	X3 - CM
Process [1]	OFF	OFF	OFF
Process [2]	ON	OFF	OFF
Process [3]	OFF	ON	OFF
Process [4]	ON	ON	OFF
Process [5]	OFF	OFF	ON
Process [6]	ON	OFF	ON
Process [7]	OFF	ON	ON
Process [8]	ON	ON	ON

Terminal	Description
Analog output  	・ During the monitoring in the Monitor mode, the load ratio is output as DC voltage signals. The maximum output current is 1 mA. 

● Connector CN1 pin layout and I/O cable color

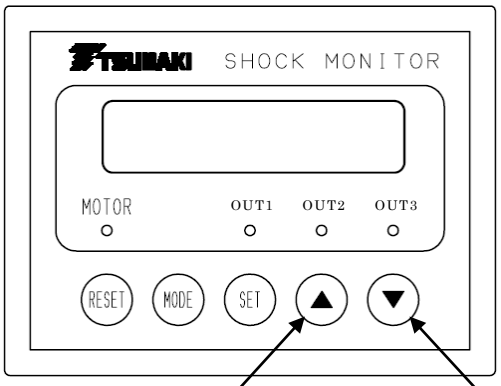


Color	Pin No.	Signal name
Black	1	X1
White	2	X3
	3	N.C.
Red	4	CM
Green	5	Aout
Yellow	6	Ain
Brown	7	V−
Blue	8	RS−
Purple	9	X2
Gray	10	X4
Pink	11	X5
Sky blue	12	0V
	13	0V
	14	N.C.
Orange	15	RS+

● LCD contrast adjustment

If the LCD display is difficult to read, adjust it with the ▲ or ▼ key while holding down the SET key.

(Note that setting the display too dark shortens the life of the LCD.)

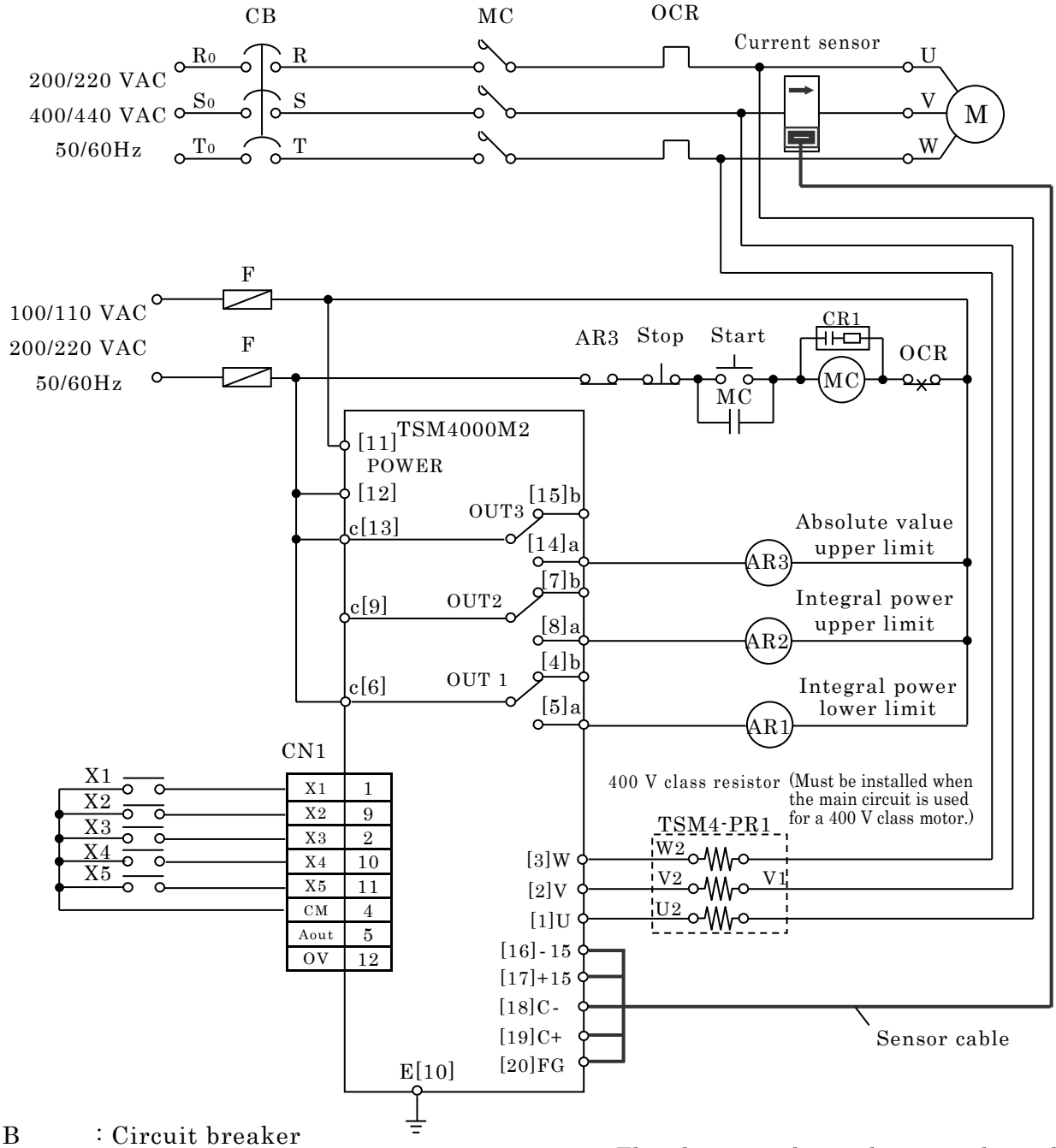


Hold down the SET key and press ▲ to make the display darker.

Hold down the SET key and press ▼ to make the display lighter.

9. Connection Diagram

9.1 Basic connection (Driven by commercial power supply)

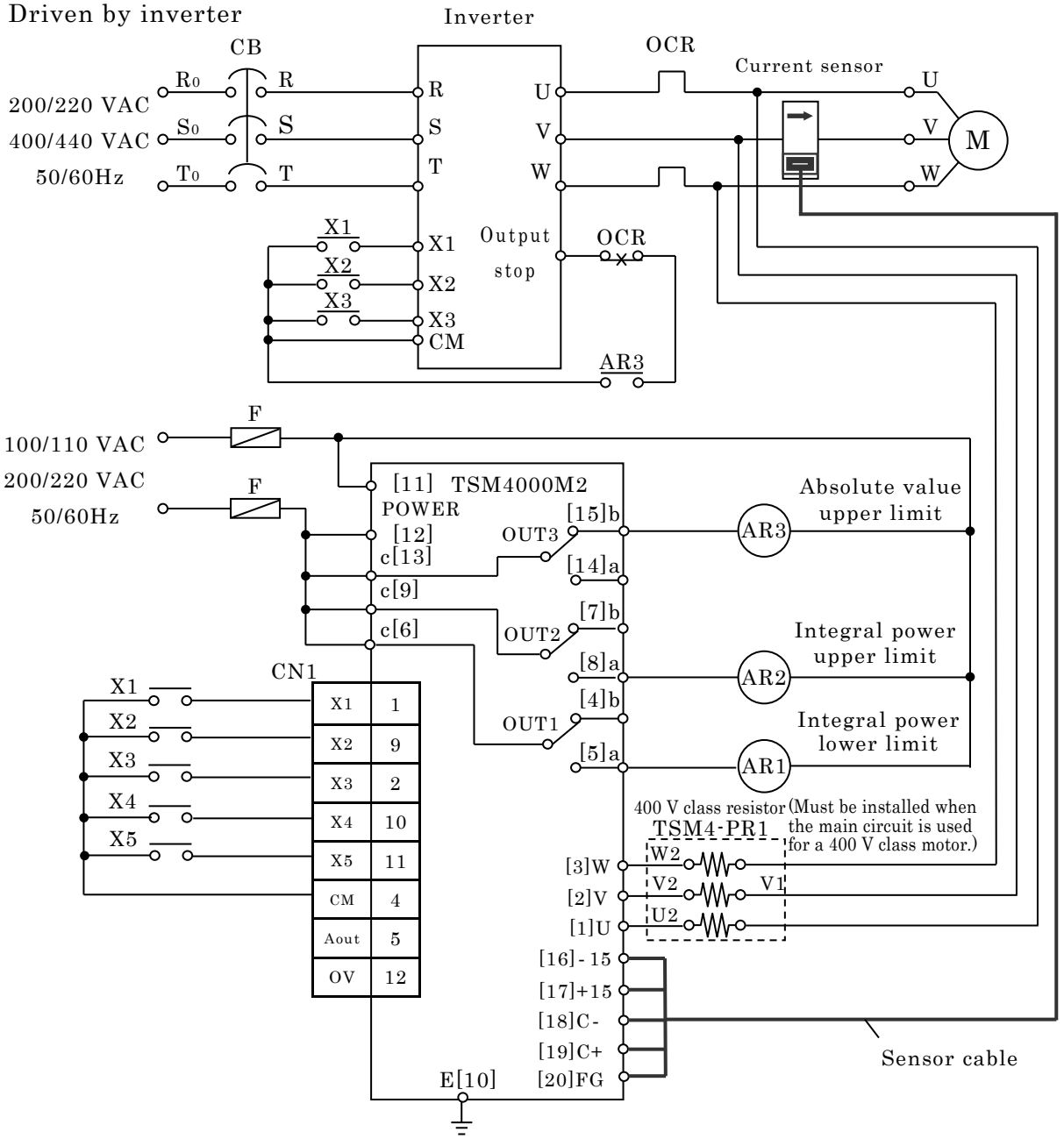


CB : Circuit breaker
F : Fuse
MC : Electromagnetic contactor for motor
OCR : Overcurrent relay
CR1 : CR absorber (surge absorbing element)

This diagram shows the case where the electromagnetic coil capacity of the electromagnetic contactor for motor [MC] is less than 100 VA at power-on and less than 10 VA during retention.

Notes:
(1) Use a current sensor which satisfies the requirement for motor capacity and voltage, and pass the motor wire through the sensor in the specified direction for the specified number of times.
(2) Set the current sensor on the phase connected to the voltage detection terminal [2] (V-phase) of the Shock Monitor.
(3) To monitor a 400V class motor, install the optional 400 V class resistor TSM4-PR1.
(4) Use relays for minute current for the contacts used for the input to [X1], [X2], [X3], [X4], and [X5]
(5) Connect a commercial power supply to the operational power supply. (Do not connect the secondary side of the inverter.)

9.2 Driven by inverter



X1-CM	X2-CM	X3-CM	Inverter	Shock Monitor Process No.
OFF	OFF	OFF	Frequency [1]	Process [1]
ON	OFF	OFF	Frequency [2]	Process [2]
OFF	ON	OFF	Frequency [3]	Process [3]
ON	ON	OFF	Frequency [4]	Process [4]
OFF	OFF	ON	Frequency [5]	Process [5]
ON	OFF	ON	Frequency [6]	Process [6]
OFF	ON	ON	Frequency [7]	Process [7]
ON	ON	ON	Frequency [8]	Process [8]

CB : Circuit breaker
F : Fuse
OCR: Overcurrent relay

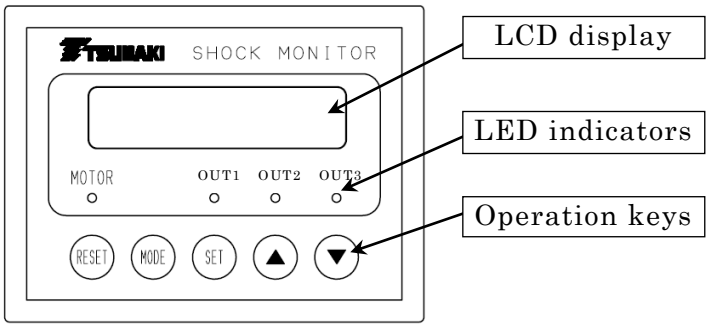
ON : Short-circuit
OFF : Open

Notes:

(1) Use a current sensor which satisfies the requirement for motor capacity and voltage, and pass the motor wire through the sensor in the specified direction for the specified number of times.
(2) Set the current sensor on the phase connected to the voltage detection terminal [2] (V-phase) of the Shock Monitor.
(3) To monitor a 400V class motor, install the optional 400 V class resistor TSM4-PR1.
(4) Use relays for minute current for the contacts used for the input to [X1], [X2], [X3], [X4], and [X5]
(5) Connect a commercial power supply to the operational power supply. (Do not connect the secondary side of the inverter.)

10 Operation

The Shock Monitor TSM4000M2 provides Monitor mode, Test mode, and Program mode, which can be selected with the MODE key.



10.1 LED indicators and operation keys

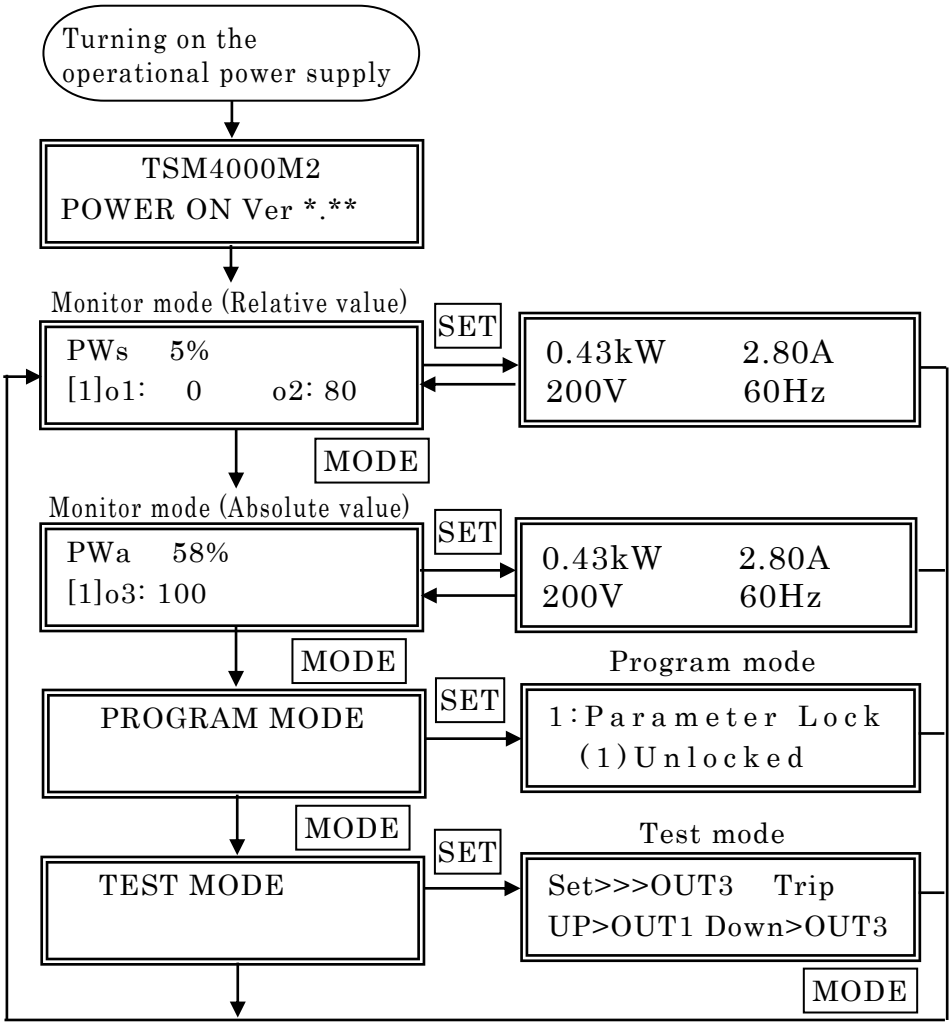
		Monitor mode	Test mode (LCD shows "TEST MODE".)	Program mode
LED indicator	MOTOR	・Illuminates when the input power of the motor exceeds 5% or the current exceeds 10% (flashes within the Start Time).		
	OUT1	・Illuminates when the load becomes equivalent to or lower than the OUT1 level. ・Flashes when relay output OUT1 is activated.	・Flashes when relay output OUT1 is activated.	
	OUT2	・Illuminates when the load reaches or exceeds the OUT2 level. ・Flashes when relay output OUT2 is activated.	・Flashes when relay output OUT2 is activated.	
	OUT3	・Illuminates when the load reaches or exceeds the OUT3 level. ・Flashes when relay output OUT3 is activated.	・Flashes when relay output OUT3 is activated.	
Operation key	RESET	・Reset the self-holding status of the output relay.	・Reset the self-holding status of the output relay.	・Return to parameter 1.
	MODE	・Show the Test/Program mode switching screen.	・Change to the Monitor mode.	・Change to the Monitor mode.
	SET	・Change the monitor screen.	・Conduct the operation test of the relays. (Relay output, LED indicator) *1	・Save the parameter and move to the next parameter.
	▲	Hold down SET and press ▲ to make the LCD contrast darker.	・Select the relay to activate. (OUT1⇒OUT2⇒OUT3)	・Select data or increment a setting value.
	▼	Hold down SET and press ▼ to make the LCD contrast lighter.	・Select the relay to activate. (OUT3⇒OUT2⇒OUT1)	・Select data or decrement a setting value.

*1 While the motor is stopped, the relay output is activated after the Start Time or Shock Time whichever is longer elapses; while the motor is running, the relay output is activated after the Shock Time elapses.

10.2 Switching modes

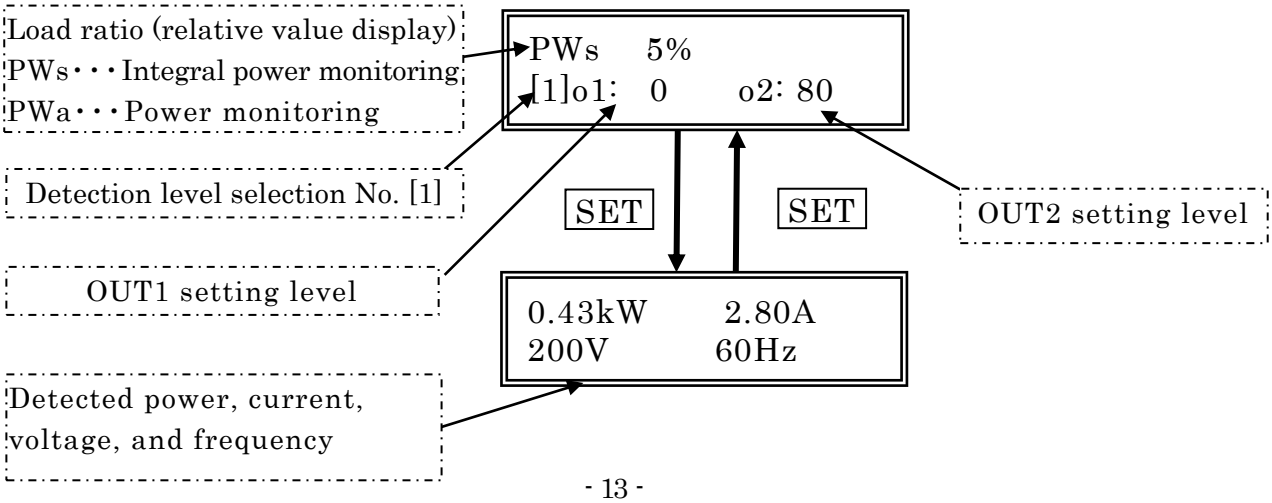
When the Shock Monitor is turned on, the initial screen is displayed for about three seconds, and then the device enters the Monitor mode.
The Monitor mode is used for load monitoring.

To change parameters, press the MODE key to go to the Program mode selection screen. Press the SET key to change to the Program mode.
On the MODE selection screen, press the MODE key again to go to the Test mode selection screen.
Press the SET key here to change to the Test mode. In the Test mode, you can activate the output relay to issue outputs.
Press the MODE key to return to the Monitor mode.



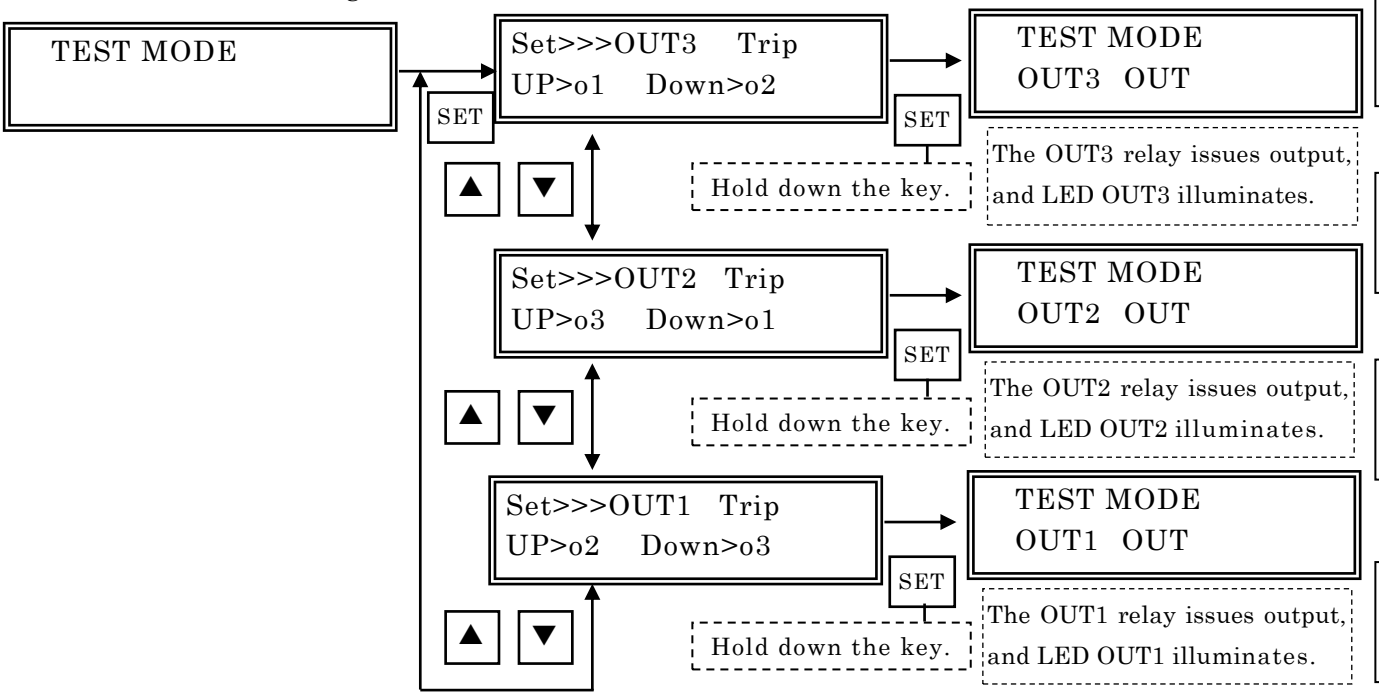
10.3 Monitor mode

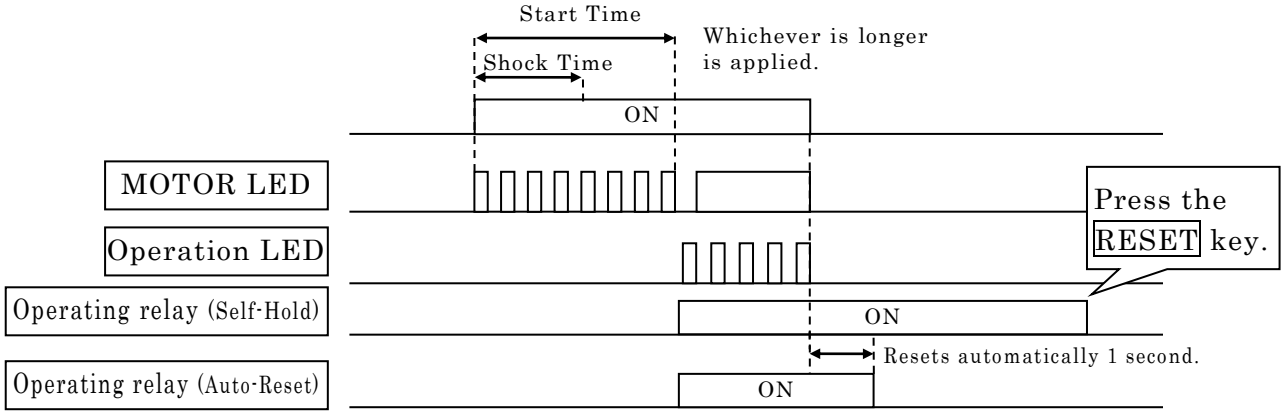
The Monitor mode is used to actually monitor the load. The LCD display shows the current load ratio or the maximum load ratio detected, current overload judgment criterion [No.], and the setting values for OUT1, OUT2 and OUT3. The display can be shown separately for relative and absolute values, which can be switched with the MODE key. The absolute value of the load ratio switches from the current value to the maximum value determined while OUT3 is illuminating and flashing. For power monitoring, the displayed load ratio is a value calculated on the assumption that the selected motor capacity is 100%. The relative value display shows the difference between reference value.



10.4 Test mode

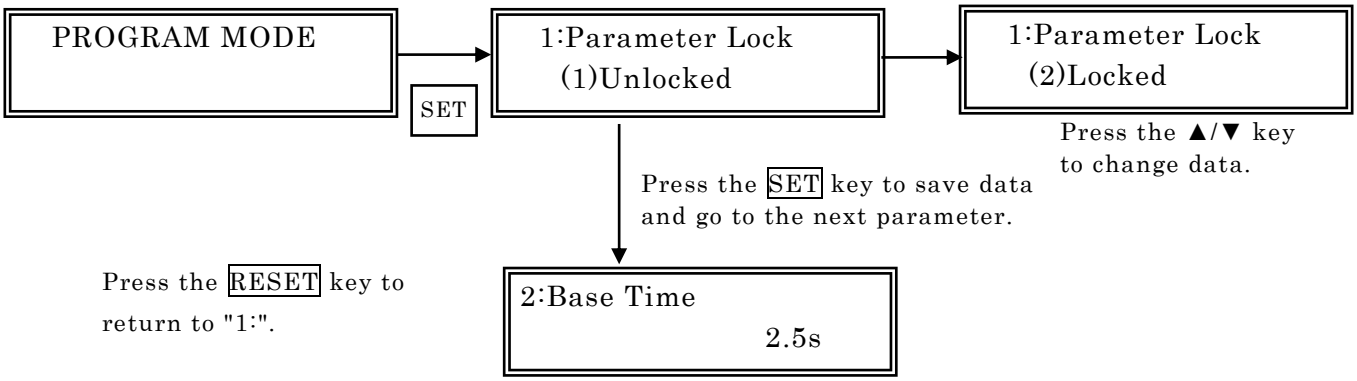
In the Test mode, you can check the operation of the output relays and LED indicators. Since load monitoring is disabled in the Test mode, be sure to return to the Monitor mode after the operation (or after pressing RESET when the relay output is in the self-holding status).





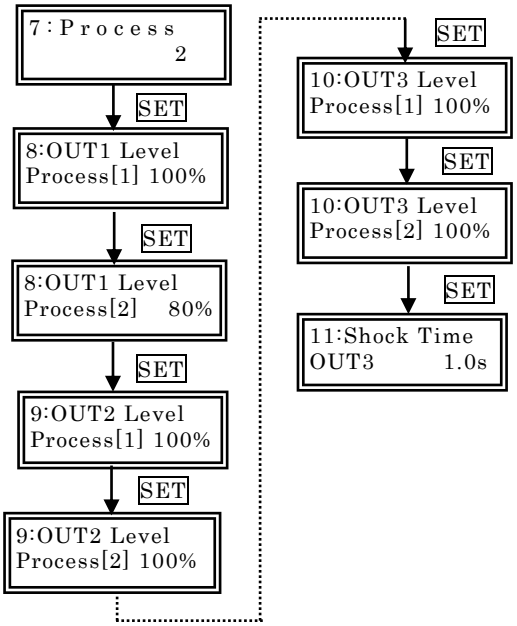
10.5 Program mode

The Program mode is used for changing and checking parameters.



■ Parameter description and setting procedure

Parameter (Default data is shown.)	Data		Description
1:Parameter Lock (1)Unlocked ▲ ...Select data. ▼ SET…Make the set data effective.	(1)Unlocked		・All parameters can be changed.
	(2)Locked		・Parameters other than the current parameter cannot be changed.
Base time 2:Base Time 2.5s ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	0.1 to 25s		・Set the time to calculate the rating (100%) to express the integral power as a percent. ・Calculate the percent value by dividing the integrated value of the detected power by the product of this setting time and the rated capacity (100%). $\text{Load ratio}[\%] = \frac{\text{Integral power}[\text{kW}\cdot\text{s}]}{\text{Motor capacity}[\text{kW}] \times \text{Base time}[\text{s}]} \times 100$
Integration time 3:Integration Time 5.0s ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	X5		・The power is totalized while the section between control input terminal X5 and CM is turned ON (short-circuited).
	0.1 to 25s		・The power is totalized for the setting time after the section between control input terminal X5 and CM is turned ON (short-circuited).
Motor voltage setting 4: Motor Voltage (1)200-230V ▲ ...Select data. ▼ SET…Make the set data effective.	(1)200-230V		・Select (1) to monitor a 200 V class motor. The allowable maximum voltage is 250 VAC.
	(2)380-460V		・Select (2) to monitor a 400 V class motor. The allowable maximum voltage is 500 VAC. Monitoring a 400 V class motor requires the installation of the optional 400 V class resistor.
Motor capacity setting 5:Motor kW (4) 0.75kW ▲ ...Select data. ▼ SET…Make the set data effective.	(1)0.1kW	(11)15kW	Set the capacity of the motor to be monitored. The load ratio display of the Shock Monitor shows 100% when this motor capacity is detected. When a motor other than listed is used, select the nearest capacity.
	(2)0.2kW	(12)18.5kW	
	(3)0.4kW	(13)22kW	
	(4)0.75kW	(14)30kW	
	(5)1.5kW	(15)37kW	
	(6)2.2kW	(16)45kW	
	(7)3.7kW	(17)55kW	
	(8)5.5kW	(18)75kW	
	(9)7.5kW	(19)90kW	
	(10)11kW	(20)110kW	

Parameter (Default data is shown.)	Data	Description
Start Time setting 6:Start Time 3.0s ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	0.1 to 20.0 s (Minimum setting increment: 0.1 s)	・To prevent unnecessary operation during the startup period of the motor, the Shock Monitor disables the relay output function for a specified period after it is started, even in the Monitor mode. ・Counting starts when the detected electric power reaches 5% or the current reaches 10% of the rated current. ・Set the period as short as possible based on the startup time of the motor. ・The Start Time starts when the Shock Monitor returns from the Test mode or Program mode to the Monitor mode.
No. of selected detection levels 7:Process 1 ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	1 to 8	There are up to eight possible combinations of the statuses of 8:OUT1 Level, 9:OUT2 Level, and 10:OUT3 Level. Select how many combinations to use. When 2 is selected 
Integral power lower limit level setting 8:OUT1 Level Process[1] 0% ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	OUT1 0 to 99%	Set the level to activate the OUT1 lower limit output. Output is activated when the integral power value becomes equal to or less than the setting value.
Integral power upper limit level setting 9:OUT2 Level Process[1] 80% ▲…Increment the setting value. ▼…Decrement the setting value. SET…Make the set data effective.	OUT2 5 to 200%	Set the level to activate the OUT2 upper limit output. Output is activated when the integral power value reaches or exceeds the setting value.

Parameter (Default data is shown.)	Data	Description

Absolute value upper limit level setting
`10:OUT3 Level`
`Process[1] 100%`
▲…Increment the setting value.
▼…Decrement the setting value.
SET…Make the set data effective.
	OUT3
	5 to 200%
		Set the level to activate the OUT3 output. Output is activated when the load ratio reaches or exceeds this setting value for the setting time of 11: Shock Time or longer. When "0%" is specified, the OUT3 output is disabled.

Shock Time setting
`11:Shock Time`
`OUT3 1.0s`
▲…Increment the setting value.
▼…Decrement the setting value.
SET…Make the set data effective.
	MIN
	(Shock Time: Minimum)
		[Time required for detection and output]
		・Motor power supply frequency: 50 Hz or more
		… Approx. 50 ms
		・Motor power supply frequency: Less than 50 Hz
		… 2 cycles + Approx. 10 ms
		(Example: 40 Hz・・・・・60 ms)

	0.1 to 10.0 s (Minimum setting increment: 0.1 s)	・Period between the instant when the load ratio reaches or exceeds the setting value and the instant when the relay output is activated. ・If the load ratio goes below the value of 10:OUT3 Level within the specified period, the relay output is not activated.

Relay output mode setting
`12:Output Relay`
`O3 (2)Auto-Reset`
▲ ▼ …Select data.
SET…Make the set data effective.
	(1)Self-Hold
	(Self holding)
		The status of the relay output is retained. The status is reset by pressing the RESET key or by an input to the [RST] terminal.

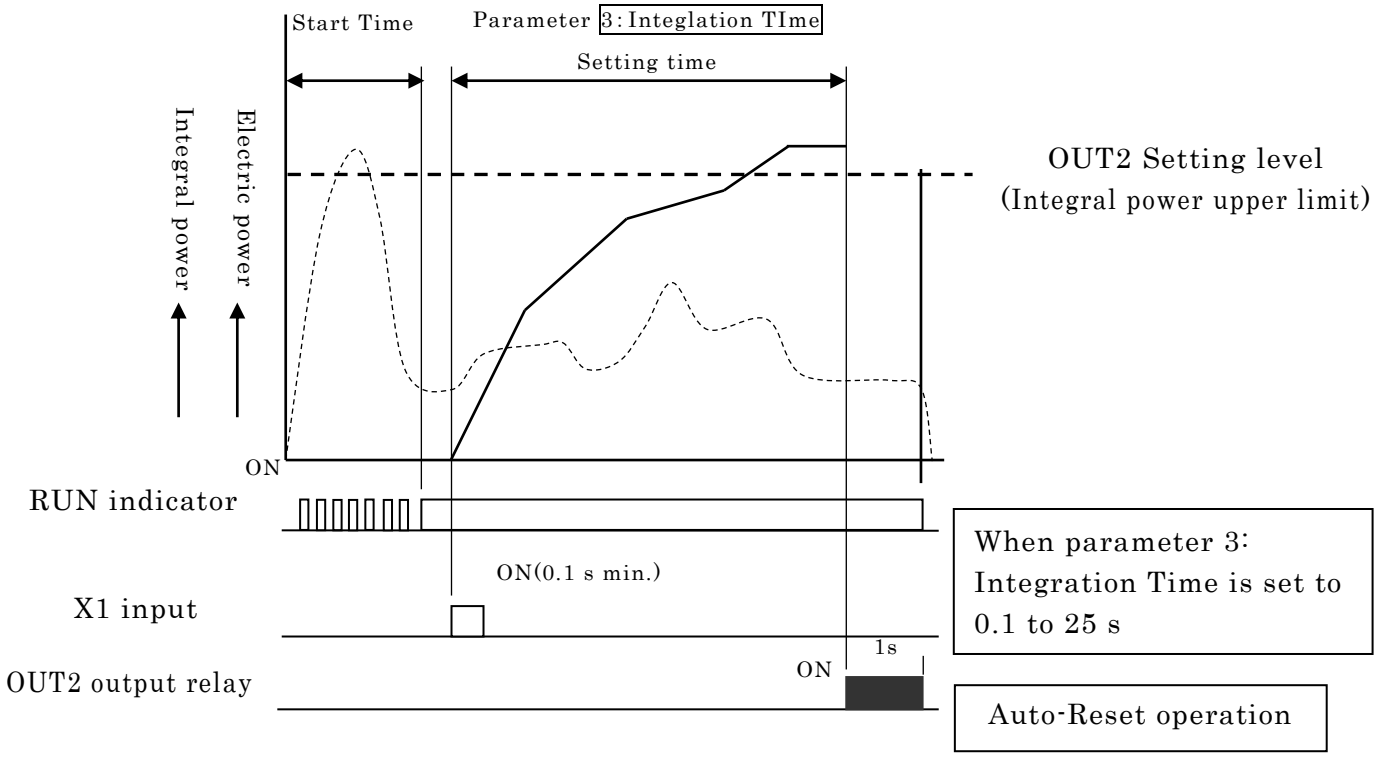
	(2)Auto-Reset (Automatic reset)	The status is reset one second after the relay output condition is cleared.

Number of moving average sampling times
`13:Response`
`(2)NORMAL`
▲…Increment the setting value.
▼…Decrement the setting value.
SET…Make the set data effective.
	(1)QUICK
	(2)NORMAL
	(3)SLOW
		Set the response time for electric power detection.
		The moving average of the sampling values obtained at every 20 ms (*) is calculated and treated as effective data. There are three options to set the number of sampling values used for the average calculation.
		・QUICK: Set this option when quick response is required. The data of one sampling value is regarded as effective data (20 ms).
		・NORMAL: Use this setting for normal operation. The average of five sampling values is regarded as effective data (100 ms).
		・SLOW: Set this option when you want to reduce display fluctuation. The average of 20 sampling values is regarded as effective data (400 ms).
		*…The sampling cycle is fixed to 20 ms at 50 Hz or higher frequencies, and to one cycle at less than 50 Hz.
		Motor power supply frequency: 50 Hz or more
		Detection time = 20 ms x (Setting value of Parameter 13)
		Motor power supply frequency: Less than 50 Hz
		Detection time = 1 cycle x (Setting value of Parameter 13)

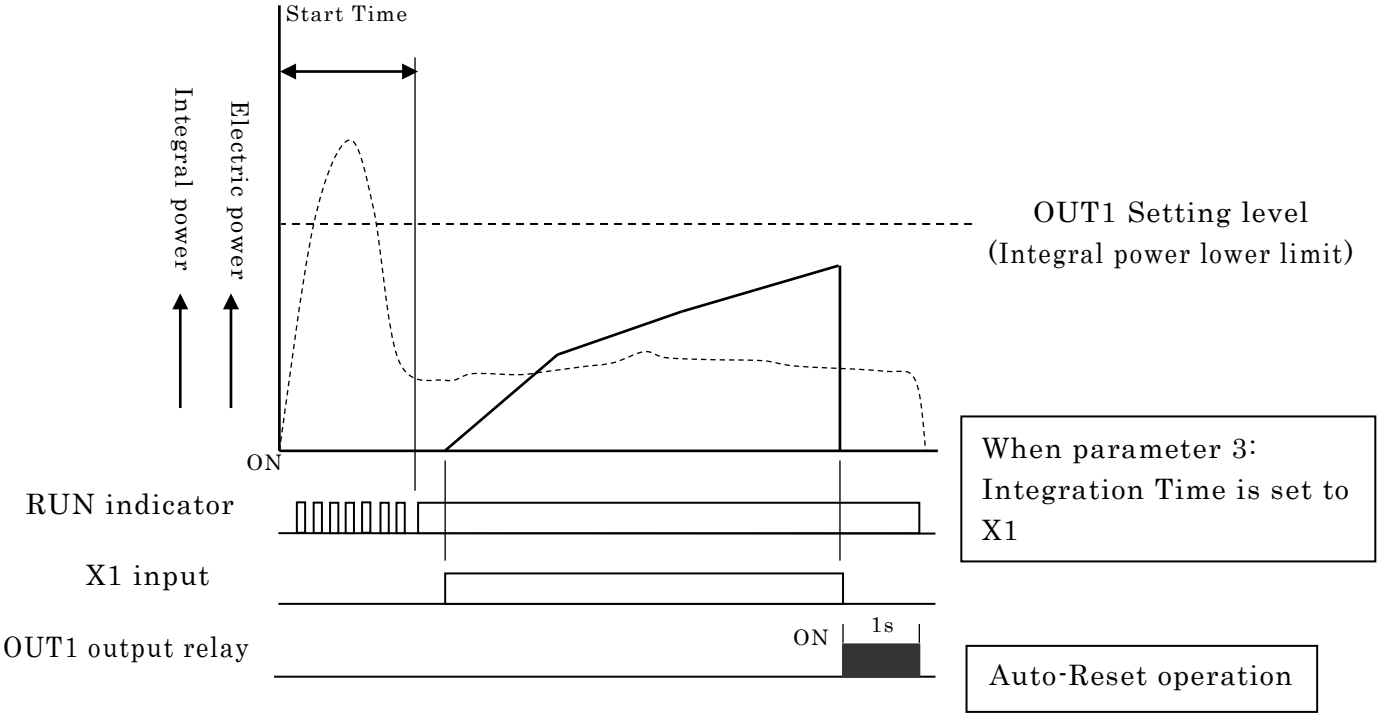
Parameter (Default data is shown.)	Data	Description
14:Inhibit Time IH ▲ ...Select data. ▼ SET…Make the set data effective.	IH	・Load monitoring is disabled while the input signal IH is ON. The load ratio display shows flashing 0%. ・When the input signal IH turns OFF and the load ratio has reached or exceeded the setting level for the Shock Time period or longer, the relay output is activated immediately.
	0.1 to 10.0 s	・When the input signal IH turns from OFF to ON, load monitoring is disabled within this specified time. ・After the process switching signals X1, X2, and X3 are changed, load monitoring is disabled within this specified time. ・When this specified time elapses and the load ratio has reached or exceeded the setting level for the Shock Time period or longer, the relay output is activated immediately.
15:Auto Inhibit (2)Off ▲ ...Select data. ▼ SET…Make the set data effective.	(1)On	・When the Shock Monitor detects the change in the motor power supply frequency and the frequency continues changing at the rate of 4 Hz or higher per second, inhibit function is activated regardless of the inhibit time setting.
	(2)Off	The Auto Inhibit is disabled.
LCD backlight setting 16:LCD Backlight (1)Always ▲ ...Select data. ▼ SET…Make the set data effective.	(1)Always	The backlight illuminates all the time.
	(2)2min	The backlight will turn off two minutes after the last key operation on the panel. After the backlight turns off, it illuminates again when any key is pressed.

Example timing chart for the tool abrasion detection using the integral power monitoring

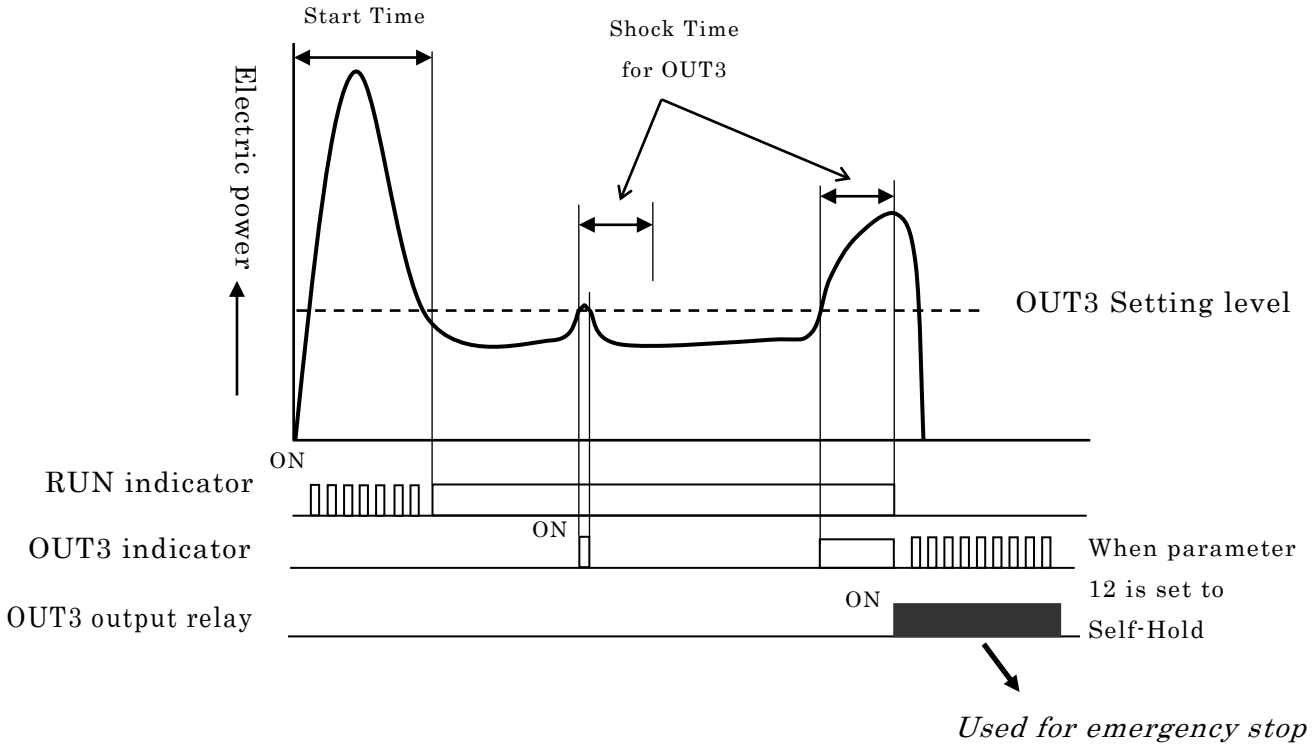
Integral power upper limit output



Integral power lower limit output



Emergency stop against tool overload using the instantaneous power monitoring



11. Troubleshooting

Problem	Inspection item	Inspection result	Countermeasure
The LCD display shows nothing.	Wiring of the operational power supply (Between terminals 11 and 12)	No wiring installed.	Install the wiring properly.
	Operational power supply voltage (Between terminals 11 and 12)	Less than 90 VAC	Provide voltage of 90 to 250 VAC.
		90 to 250 VAC	Replace or repair Shock Monitor.
The LCD display is illegible.	Adjust the contrast (Refer to page 9.).	The display becomes dark.	Re-adjust the contrast.
		The display does not improve.	Replace or repair Shock Monitor.
Output is activated immediately after Shock Monitor starts.	In the Program mode, check the setting value of 6:Start Time.	Short	Set a little longer value.
		Long (It is clear that the output is activated within the setting value.)	Replace or repair Shock Monitor.
Even when a long value is set to 6:Start Time (20 seconds max.), the relay is activated as soon as the time is up.	Startup time of the motor Acceleration time of the inverter	Longer than 20 seconds	Review the motor capacity.
			Set a shorter acceleration time.
	In the Monitor mode, check the load ratio and setting level at startup.	The setting value is small.	Set a larger value in the Program mode.
		Wrong detection level is selected.	Check the process switching input.
The load ratio is shown as 0%.	Is the current sensor and main unit connected?	The sensor cable is disconnected.	Connect the cable properly.
	Does the V-phase motor wire pass through the current sensor?	・No wire passes through the sensor. ・Other phase	Install the wiring properly.
	Check the wiring of the voltage input U, V, W (Terminals 1, 2, 3).	・No wiring installed or wiring is disconnected. ・Incorrect wiring	Install the wiring properly.
Although the motor starts, the displayed load ratio is wrong with respect to the actual load.	Model number of the current sensor	Wrong	Replace with a correct sensor.
	Does the V-phase motor wire pass through the current sensor?	Other phase (U-phase or W-phase)	Install the wiring properly.
	Is the No. of times to pass the wire through the sensor correct?	Wrong	
	Check the wiring of the voltage input U, V, W (Terminals 1, 2, 3).	・No wiring installed or wiring is disconnected. ・Incorrect wiring	Install the wiring properly.
	In the Monitor mode, check that the correct motor has been selected.	The selection does not correspond with the actual motor.	Set the parameters (4 and 5) properly.
	Start the motor, change the display screen, and check the voltage and current values.	The load ratio far deviate from the displayed current value.	Repair Shock Monitor. Replace Shock Monitor.
The displayed load ratio is negative.	Is the motor operation status negative torque?	Rapid deceleration is caused by inverter operation.	If the actual torque is negative, the display is not abnormal.
		The operation is affected by load.	If the actual torque is negative, the display is not abnormal.
	Check the wiring of the voltage input U, V, W (Terminals 1, 2, 3).	・No wiring installed or wiring is disconnected. ・Incorrect wiring	Install the wiring properly.
	Does the motor wire pass through the current sensor in the right direction? (Does the direction match with the arrow on the top of the current sensor?)	Opposite direction	Install the wiring properly.
		The load torque is positive and the motor wire correctly passes through the current sensor.	・Replace Shock Monitor. ・Repair Shock Monitor.
Although the load ratio display is correct, the relay output is not activated.	In the Monitor mode, check the multi-step selection and level setting values.	The process switching selection is incorrect. (X1, X2, X3)	Set the detection level selection input properly.
		The level setting values are not set properly.	Set appropriate values.
	In the Program mode, check the Shock Time.	Too long.	Set a shorter value.

Problem	Inspection item	Inspection result	Countermeasure
The LED indicator illuminates, but the relay output is not activated.	Is the load fluctuation too great?	The load fluctuates greatly and it instantaneously exceeds the setting level repeatedly.	Set the parameters (8, 9, 10, and 13) properly.
		The load does not fluctuate and there is a great difference from the setting level.	Repair Shock Monitor.
The relay output is activated as soon as Shock Monitor is turned ON.	Is the motor starts when Shock Monitor is turned ON?	The displayed load is larger than the setting value.	Set the parameters (8 and 9) properly.
		The output is activated even when the motor is stopped and the displayed load is 0. (Shock Monitor is used in a highly humid environment with corrosive gas.)	Repair Shock Monitor.

12. Trip Reset Procedure

(1) Inspect the equipment for any abnormalities.
(2) If an abnormality is found, eliminate the cause and reset the equipment to normal status.
(3) If the relay output is in self-holding status, press the RESET key to reset it. The reset is also possible by turning off the operational power supply for the Shock Monitor for a short time.
(4) After confirming steps (1), (2), and (3), restart the equipment.

13. Precautions on Maintenance/Inspection

Be sure to observe the following during the maintenance/inspection work.

(1) To prevent secondary damage, clean up the surrounding area and ensure safety during the work.
(2) Before inspecting the installation or connection of the Shock Monitor, be sure to turn off the power to make the machine completely stop and the LCD display of the Shock Monitor completely turn off. Ensure that the Shock Monitor will not be turned on accidentally.
(3) Observe the guidelines listed in the Labor Safety and Health Regulation.
(4) When conducting a megger test or dielectric withstanding voltage test, remove the Shock Monitor main unit from the socket to avoid test voltage.

14. Periodic Inspection

(1) Inspect that the "MOTOR RUN" LED indicator of the Shock Monitor illuminates while the motor is running, and the load ratio value on the LCD display is normal. (Daily inspection)
(2) In the Test mode, inspect the operation of the relay outputs OUT1, OUT2, and OUT3 on a regular basis.
(3) Inspect for looseness in the installation of the Shock Monitor main unit and current sensor on a regular basis.
(4) Inspect for looseness in the terminal connection of the Shock Monitor main unit and sensor cable connection on a regular basis.
(5) Although the life of the Shock Monitor varies depending on the installation environment and operating time, the life of the electrolytic capacitor is normally about 10 years under continuous energization at annual average ambient temperature of 30°C. It is recommended to overhaul the Shock Monitor or replace it with a new one before any problem occurs.
(6) The brightness of the LCD display varies depending on the ambient temperature and operating time. If the display becomes illegible, adjust the contrast.

Perform the periodic inspection during trial operation, and when the equipment was moved, and when the wiring was changed.

15. For Your Safety

(1) If any danger is expected as a result of the operation of Shock Monitor, be sure to take measures to avoid such danger.
(2) Also, give due consideration on the equipment side so that, even if Shock Monitor does not operate normally, no dangerous situation would develop.

16. Specifications

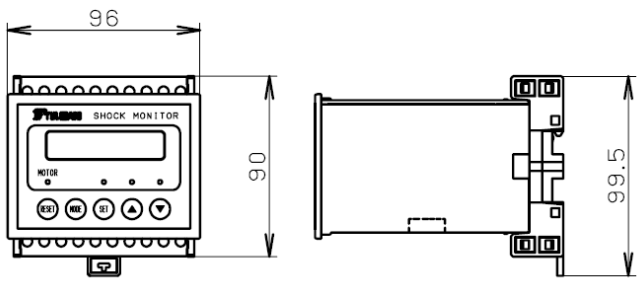
Model number			TSM4000M2	TSM4000M2P
Applicable motor		Capacity	0.1 to 110 kW	
		Voltage	3-phase, 200/220 VAC or 400/440 VAC	
		Power supply frequency	5 to 120 Hz	
Operational power supply voltage			Commercial power supply 90 to 250 VAC 50/60 Hz, 90 to 250 VDC No polarity	
Input	Terminals 1, 2, 3		250 VAC max. *1	
	Current sensor		±15 V	
Setting	Power setting range	Integral power lower limit (OUT1)	0 to 99%	
		Integral power upper limit (OUT2)	5 to 200%	
		Absolute value upper limit (OUT3)	5 to 200%	
	Start Time setting range		0.1 to 20.0 s	
	Shock Time setting range		MIN or 0.1 to 10.0 s When the motor power supply frequency is 50 Hz or more, the Shock Time for "MIN" is approximately 30 ms. *2	
	No. of processes		1 to 8	
	Response		QUICK, NORMAL, SLOW	
Display	Power percentage display range		0 to +200%	
	Voltage display range		0 to 500 V (Resolution: 1% of motor rated voltage)	
	Current display range		0.01 to 999 A (Resolution: 1% of motor rated current)	
	Frequency display range		5 to 120 Hz	
Output	Relay contact output (OUT1 - OUT3)		250 VAC, 0.5A (Inductive load cosφ = 0.4) 30 VDC, 0.4 A (Inductive load) 110 VDC, 0.2A (Inductive load)	
			24 VDC, 4 mA	
			100,000 times of operation	
	Analog output signal		0 to 10 VDC	
Other	Inhibit function		When the frequency changes by 4 Hz/s or more, the electric power detection is stopped. When the section between X5 and CM is short-circuited, electric power detection is stopped for a period between 0.1 and 10.0 s or while the section is short-circuited.	
	Test function		Operation check of relays in Test mode	
	Peak-hold function		When OUT3 is illuminating and flashing, the absolute value of the determined maximum load ratio is displayed.	
Power consumption			10 VA (Inrush current 5A within 5 ms)	
Approximate weight			1.0 kg	
Operating environment		Ambient temperature	0 to +50℃	
		Relative humidity	45 to 85% RH, no condensation	
		Altitude	1,000 m max.	
		Atmosphere	No oil mist, corrosive gases, and dust	
Mounting			DIN rail, screw mounting	Panel mounting

Note) *1. To use a 400/440 VAC motor, the optional 400 V class resistor "TSM-PR1" is required.

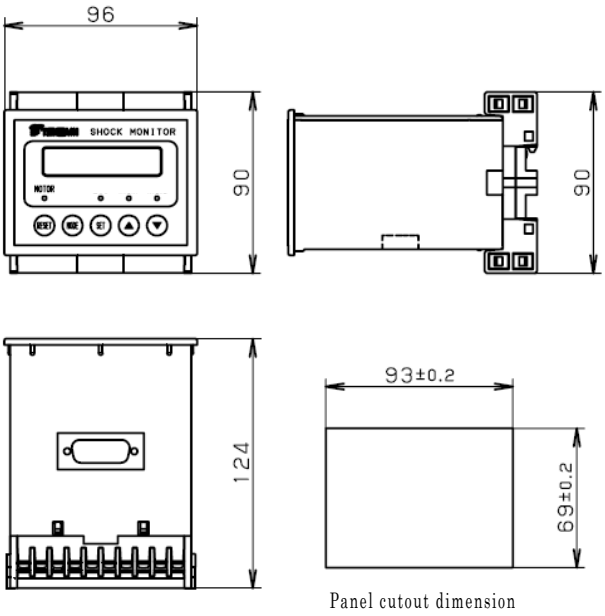
*2. When the motor power supply frequency is less than 50 Hz, the Shock Time for "MIN" is 2 cycles of the power supply frequency + Approx. 10 ms. (Example for the case of 50 Hz: 40 + 10 = 50 ms)

17. Outer Dimensions

■Main unit TSM4000M2

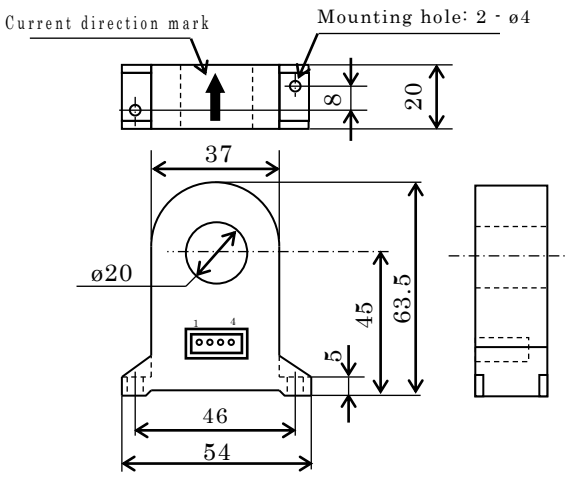


TSM4000M2P

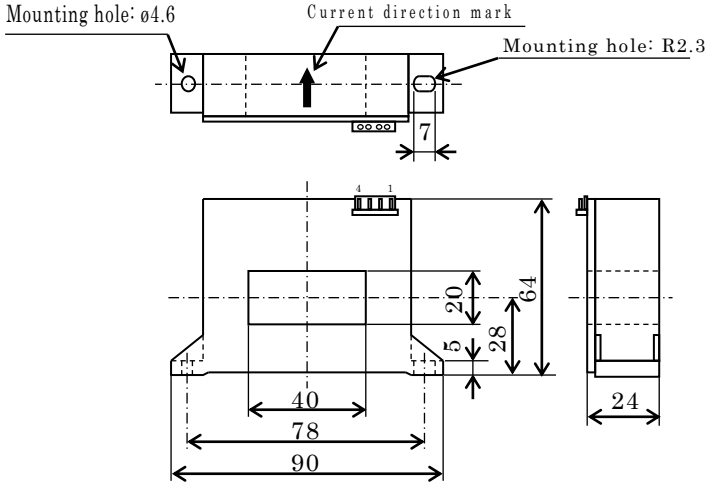


■Current sensor

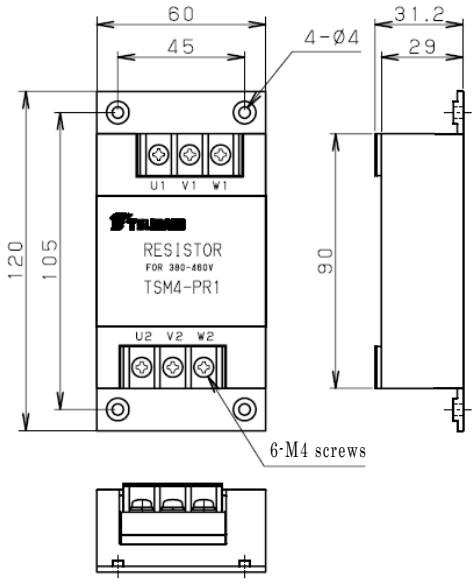
TSM-U010, TSM-U050, TSM-U100
TSM-U150, TSM-U200



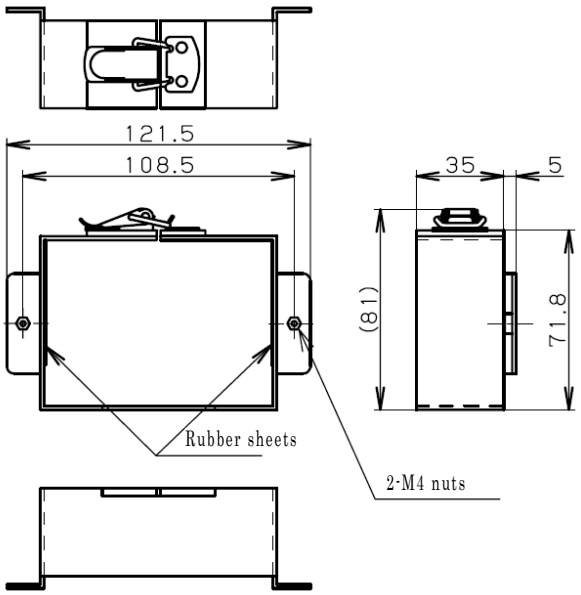
TSM-M300, TSM-M400, TSM-M600
TSM-M800



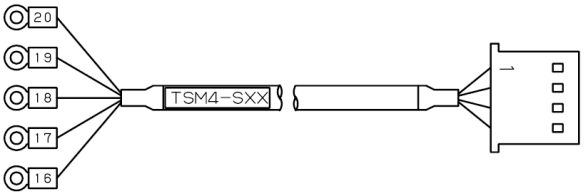
■400 V class resistor
TSM4-PR1



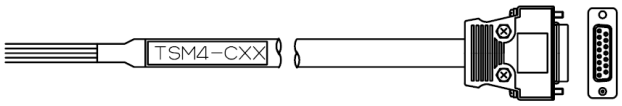
■ Panel mounting bracket (for TSM4000M2P)
TSM4-PL1



■Sensor cable
TSM4-S01, TSM4-S03, TSM4-S05
TSM4-S10, TSM4-S20, TSM4-S30



■I/O cable
TSM4-C01
TSM4-C03



18. Warranty

18.1 Free warranty period

TC shall offer free warranty period of 18 months after the shipment from the factory or 12 months after the beginning of the use (counted from the completion of the installation of the TC product into your equipment), whichever is shorter.

18.2 Warranty coverage

Any failure or malfunction occurred in the TC product within the free warranty period shall be repaired or be handled by replacing the failed part with no charge through the return of the product to TC, as long as the proper installation, usage, and maintenance in accordance with the instruction manual are provided by the customer.
Note, however, that this free warranty shall cover only the TC product delivered to the customer and the following expenses shall not be covered by the warranty.

(1) The cost for the removal or installation of the TC product from or to the customer's equipment for the purpose of replacement or repair, and the cost associated with such work.
(2) The transportation cost for sending the customer's equipment to the customer's repair plant or other place.
(3) The lost earnings of the customer resulted from the failure and/or repair, as well as other increased damages.

18.3 Paid warranty

Even within the free warranty period, if a failure or malfunction occurs in the TC product due to any of the following causes, the investigation/repair shall be charged.

(1) The customer did not install the TC product properly in accordance with the instruction manual.
(2) The customer did not handle the product properly and/or did not provide sufficient maintenance.
(3) The failure or malfunction was resulted from improper connection between the TC product and other equipment.
(4) The customer changed the structure of the TC product such as modification.
(5) The TC product was not repaired at TC or TC-designated plants.
(6) The TC product was not used in the appropriate operating environment described in the instruction manual.
(7) The failure or malfunction was caused by force majeure such as disasters or by illegal behavior of a third party.
(8) The failure of the TC product was caused incidentally by the malfunction of the customer's equipment.
(9) The failure was caused by the installed customer-supplied part or by the part used in accordance with the designation of the customer.
(10) The failure was caused by failed wiring or incorrect parameter setting conducted by the customer.
(11) The product has reached its life which is normal for the operating condition.
(12) Damage occurred due to the cause for which TC was not liable.

MEMO

实　体

倍电电阻

中国 RoHS 资料

(本资料是中国 RoHS 的必备资料)

(This information is essential for China RoHS)

部件名称 (Component Name)	有害有毒物质或者元素									
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr6)	PBB	PBDE	DBP	DIBP	BBP	DEHP
基板部品 (PCB parts)	○	○	○	○	○	○	○	○	○	○
框架 (Case)	○	○	○	○	○	○	○	○	○	○

○：表示该零部件所有均质材料中有害有毒物质的含量均在 GB/T 26572 标准规定的限量要求以下。
Indicates that the concentration of the hazardous substance in all homogeneous materials of the part is below the relevant threshold of the GB/T 26572 standard.

×：表示该零部 件所有均质材料中有害有毒物质的含量超出 GB/T 26572 标准规定的限量要求。
Indicates that the concentration of the hazardous substance in at least one homogeneous material of the part is above the relevant threshold the GB/T 26572 standard

电流传感器

中国 RoHS 资料

(本资料是中国 RoHS 的必备资料)

(This information is essential for China RoHS)

部件名称 (Component Name)	有害有毒物质或者元素									
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr6)	PBB	PBDE	DBP	DIBP	BBP	DEHP
基板部品 (PCB parts)	○	○	○	○	○	○	○	○	○	○
框架 (Case)	○	○	○	○	○	○	○	○	○	○

○：表示该零部件所有均质材料中有害有毒物质的含量均在 GB/T 26572 标准规定的限量要求以下。
Indicates that the concentration of the hazardous substance in all homogeneous materials of the part is below the relevant threshold of the GB/T 26572 standard.

×：表示该零部 件所有均质材料中有害有毒物质的含量超出 GB/T 26572 标准规定的限量要求。
Indicates that the concentration of the hazardous substance in at least one homogeneous material of the part is above the relevant threshold the GB/T 26572 standard

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