Simplified Operations for
TM-3100 Series Digital Tachometer

The TM-3100 series Digital Tachometers has the most fundamental function in rotational measurement of four standard models (rotation speed display, BCD output, analog output, or comparator output) and can be customized by adding optional cards in order to match your application.

TM-3110	Display only
TM-3120	With BCD open collector output
TM-3130	With analog output
TM-3140	With comparator output

This section describes the operation procedures for the above four standard models. For the measurement and calculation functions of the optional card TM-0350 (RS-232C/GATE), please refer to the complete instruction manual.

■ Basic Concept

The TM-3100 series has the following three basic concepts:

- Measures the “frequency” of the input signal and displays the results in various measurement items after calculation.
- By simply setting the unit of “measurement item”, the results are converted and automatically displayed.
- Two “measurement modes”, such as NORMAL (normal continuous measurement) and SS (measurement between start and stop timings), are available.

If the system is to be used as a replacement of the TM-2100, TM-800, or TM-8000 series or as a general tachometer or speedometer, select the NORMAL (normal continuous measurement) mode. The SS measurement mode and optional TM-0350 (RS-232C/GATE card) are newly equipped functions.

■ Measurement Mode (MEAS MODE)

Two measurement modes of “NORMAL” and “SS” are available.

1. NORMAL mode

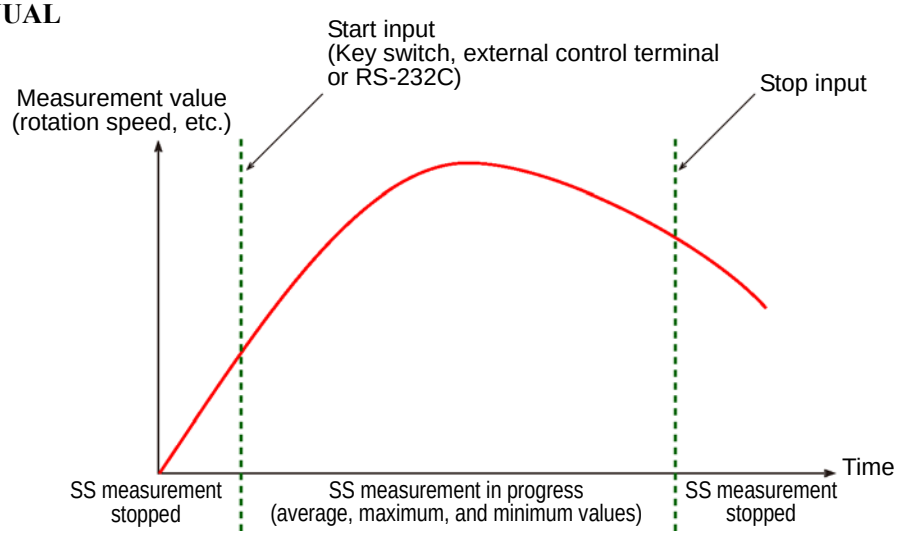
In the NORMAL mode, measurement is continued with a specified update time interval (e.g.: 1 second) and displayed.

The NORMAL mode is used for general rotation speed or line speed measurements. This mode is compatible with old models (TM-800/8000 and TM-2100 series) because the measurement method is the same.

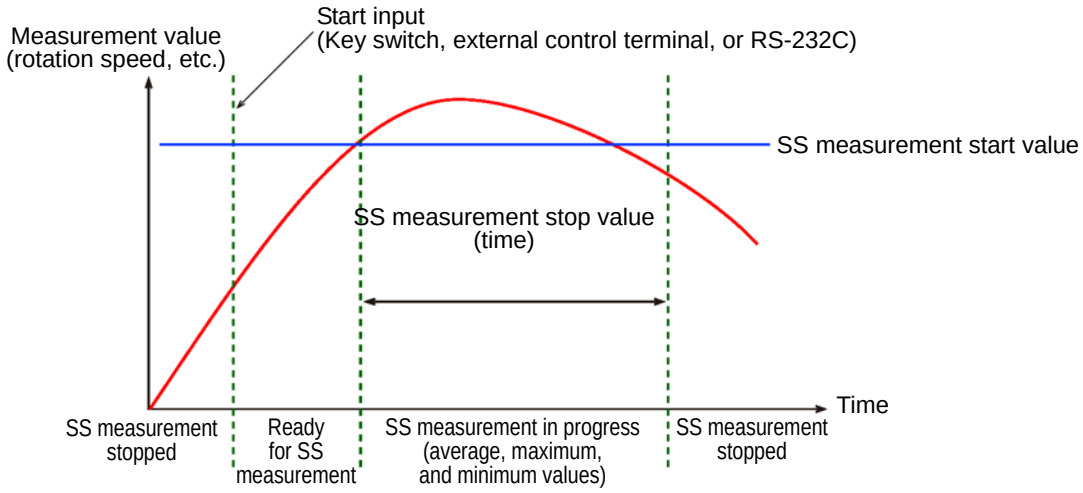
2. SS mode (Measurement between start and stop timing)

The SS mode is used to measure the AVERAGE, MAX (maximum), and MIN (minimum) values in a measurement section. Depending on what condition of the start and stop measurement section is specified, either MANUAL or AUTO measurement is used.
In the MANUAL mode, the measurement section is determined by the START and STOP switches (or by the external input of the TM-0350). In the AUTO mode, the measurement section is determined by the setup of the start condition and measurement time. The details are provided in later sections.

● **MANUAL**



● **AUTO**



Caution:
Be careful when you use the SS mode as the measurement mode, “Normal” or “SS” will affect the operation of the comparator and BCD output functions.

■ Measurement Item and Calculation Formula

The TM-3100 series tachometer measures the period (frequency) of the input signal. Process the calculation by using the measurement frequency with the value which sets at the measurement item as the coefficient value, and display with the specified unit. For example, when sets the number of pulses per rotation or the diameter of the roller, the rotation speed (r/min) or the circumferential speed (m/min) can be displayed.

The measurement items and the calculation formula (parameters) are listed in the following table. Note that the unit conversion coefficient (K) is automatically processed according to the setup of the measurement unit.

* K: Unit conversion coefficient (fixed coefficient for converting the display unit, e.g., seconds to minutes)

Measurement Item	Display Unit	Calculation Formula
ROTATION (Rotation Speed)	r/s, r/min, r/h	ROTATION = Measurement Frequency ÷ PULSE × FACTOR × K
L.SPEED (Circumferential Speed)	mm/s, m/s, mm/min, m/min	L.SPEED = Measurement Frequency ÷ PULSE × DIAMETER × π × FACTOR × K
VELOCITY (Moving Speed)	mm/s, m/s, mm/min, m/min, km/min, mm/h, m/h, km/h	VELOCITY = Measurement Frequency × PULSE DISTANCE × FACTOR × K
PERIOD (Period)	s, min	PERIOD = 1 ÷ Measurement Frequency × K
TIMES (Number of Times)	1/s, 1/min, 1/h	TIMES = Measurement Frequency × FACTOR × K
FREQ (Frequency)	Hz, kHz	FREQ = Measurement Frequency × FACTOR × K
FLOW (Flow Rate)	ml/s, ml/min, ml/h, l/s, l/min, l/h	FLOW = Measurement Frequency × FACTOR × K
P.TIME (Passing Time)	s, min	P.TIME = PROCESS LENGTH ÷ L.SPEED × FACTOR × K L.SPEED = Measurement Frequency ÷ PULSE × DIAMETER × π
OTHER (Engineering Unit)	EU/s, EU/min, EU/h	OTHER = Measurement Frequency × FACTOR × K

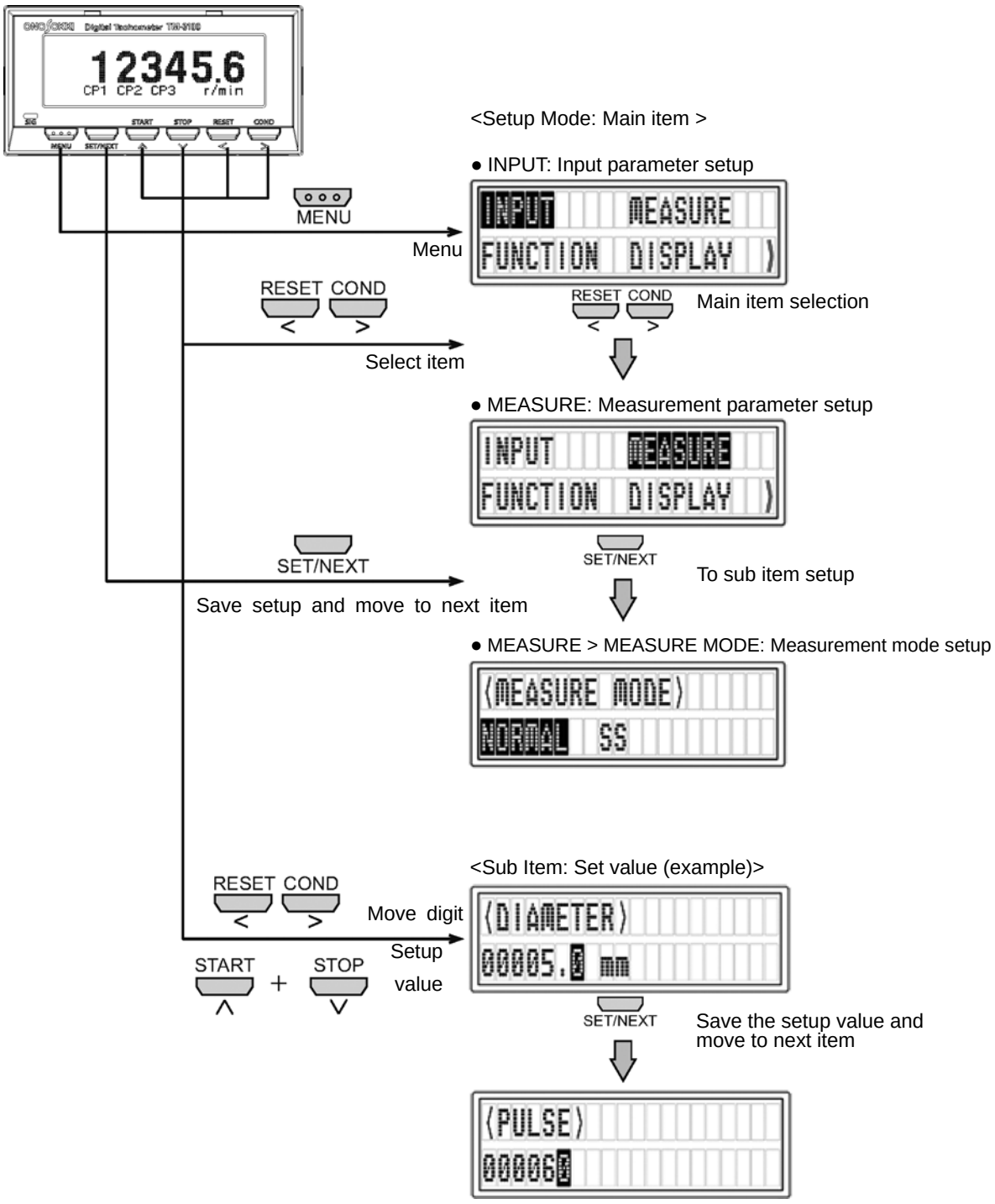
Example use of FACTOR

Assume that a decelerator is used and the rotation detector is fixed to the input axis. If it is desired to display the rotation speed of the output axis, setup the gear deceleration ratio as FACTOR. Generally, FACTOR is setup as “1”.

■Setup Menu

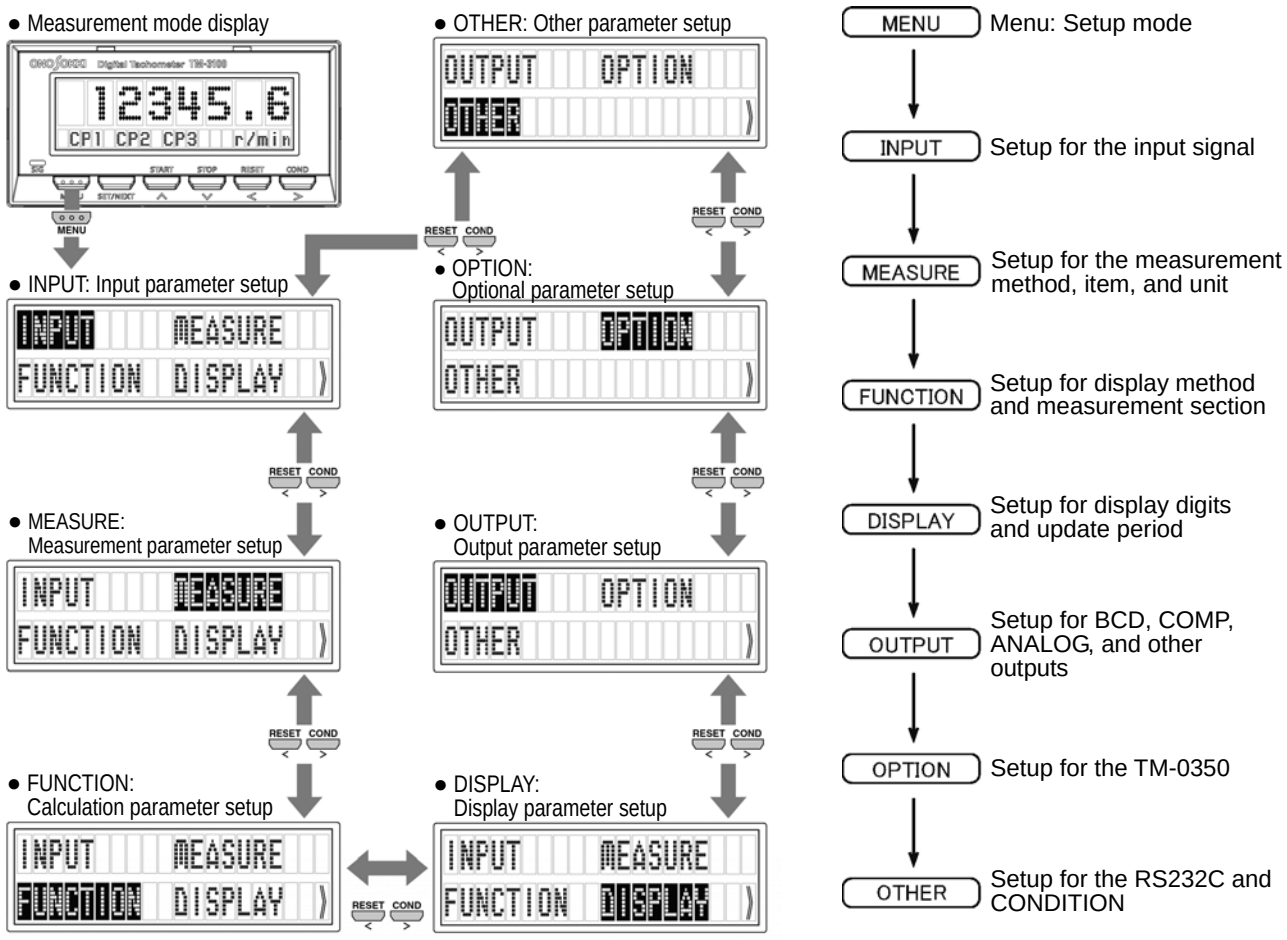
If the system is used for the first time, it is necessary to setup each menu item one by one. The following flow chart shows the sequence of basic control switch operations for each parameter setup. Note that the actual display item varies with the situation.

- **Panel switches and the basic operations**



- **Menu items**

  There are eight menu items as follows, from INPUT to OTHER. Note that the OPTION menu will not be displayed when the TM-0350 (RS232C/GATE) option is not used.

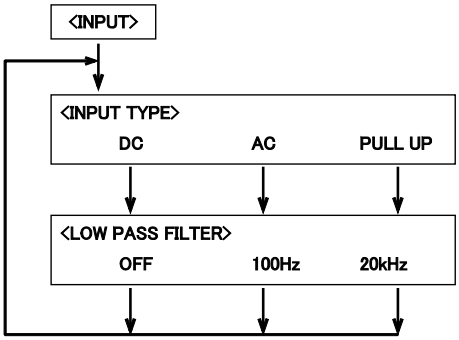


■ Setup Flowcharts

The following shows the flowcharts of each menu item setup.

1. INPUT (Setup for input conditions)

The INPUT menu is used to setup the installation of the input signal.



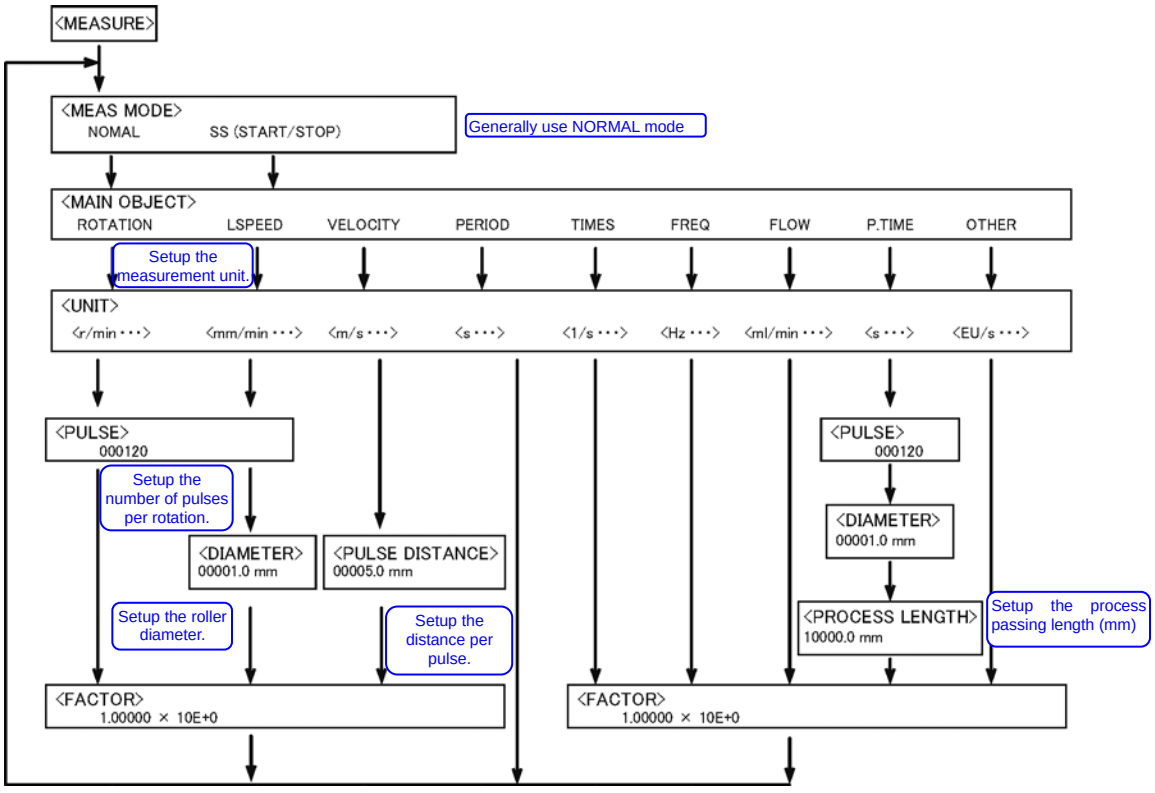
- AC: Sine wave signal
  For MP-900/9000 series Electromagnetic detectors and other detectors
- DC: Pulse signal (rectangular wave)
  For MP-981, RP-721, RP rotary encoder, and other detectors
- PULL UP: Open-collector interface

Switch	Detector	Signal waveform
AC amplifier	Electromagnetic detector	
DC amplifier	Electromagnetic detector (MP-981) Rotary encoder Photoelectric detector (LG-916/930)	
PULL UP	Proximity switch (open collector interface)	

Low pass filter
- OFF: No filter is used
- 100 Hz: LPF of fc = 100 Hz is enabled (when DC and PULL UP are enabled)
- 20 kHz: LPF of fc = 20 kHz is enabled (when AC is enabled)

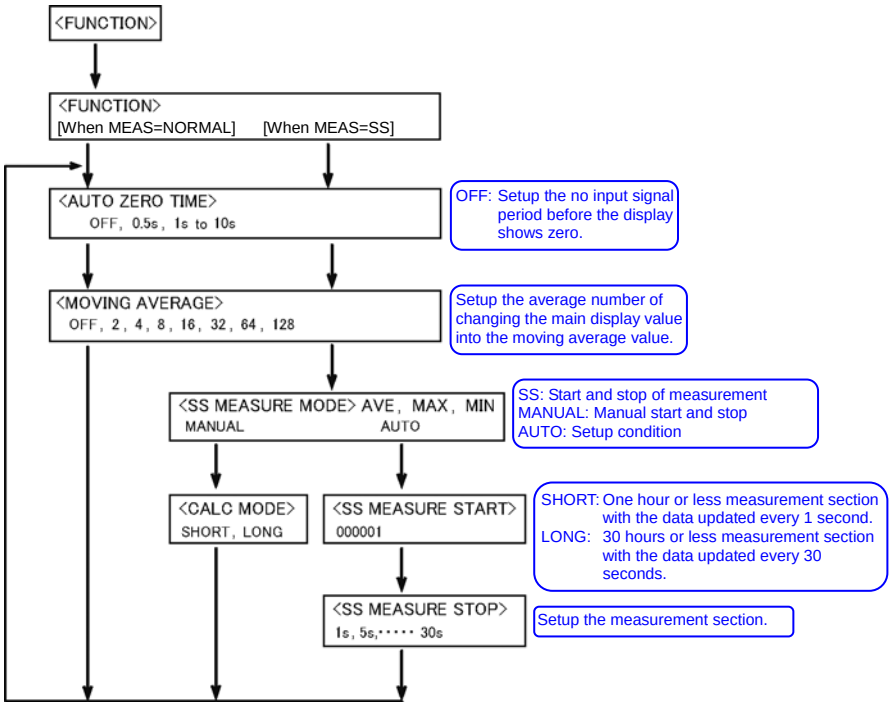
2. MEASURE (Setup for measurement functions)

In the MEASURE menu, setup the measurement method, measurement item, and associated measurement conditions.



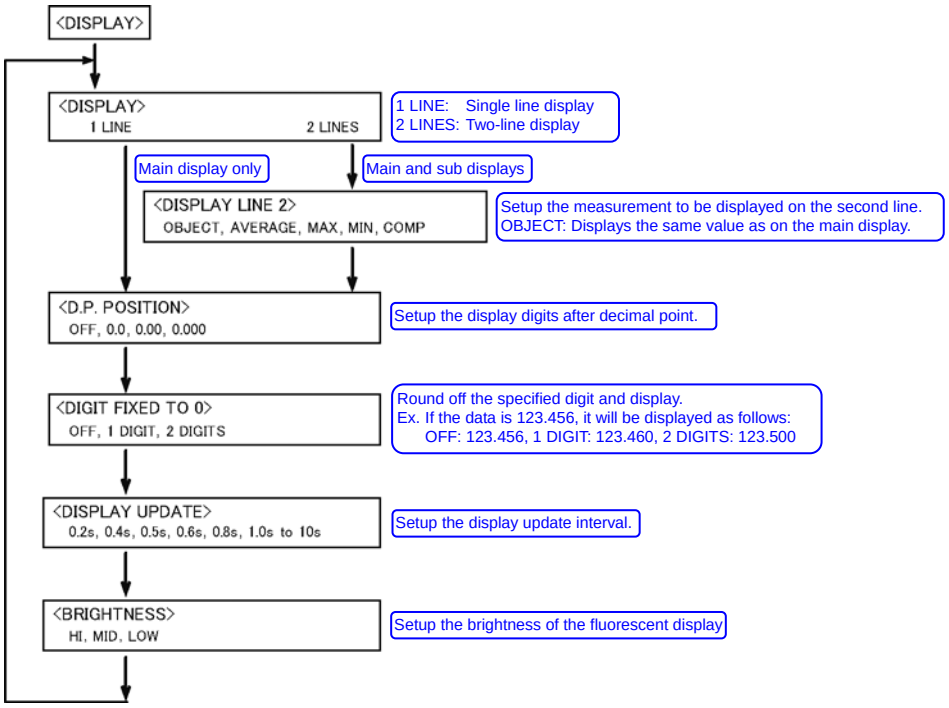
3. FUNCTION (Setup for the display method and measurement start/stop conditions)

In the FUNCTION menu, setup the display method and measurement start/stop conditions.



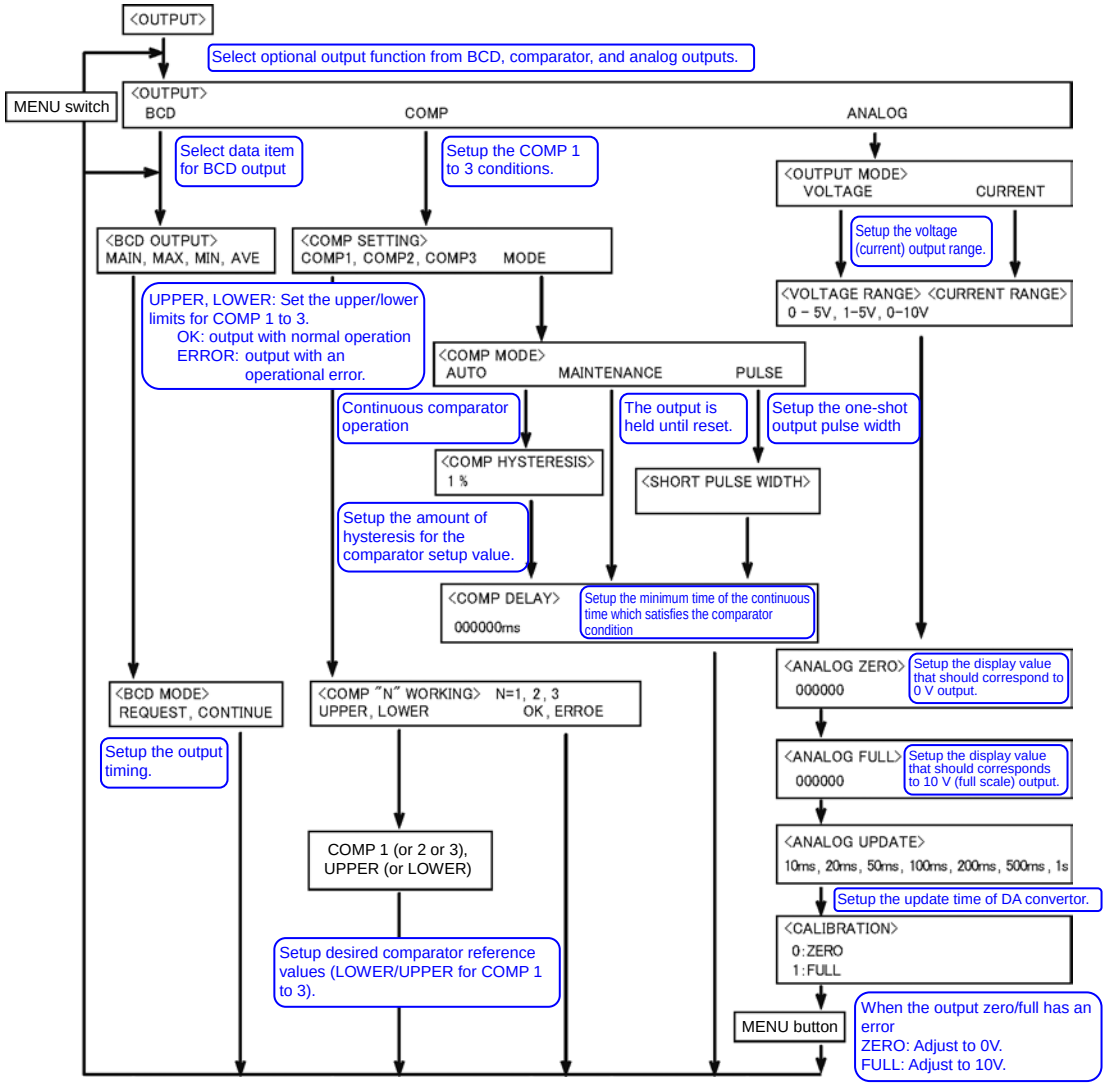
4. DISPLAY (Setup for the display)

In the DISPLAY menu, setup the number of display digits and display update.



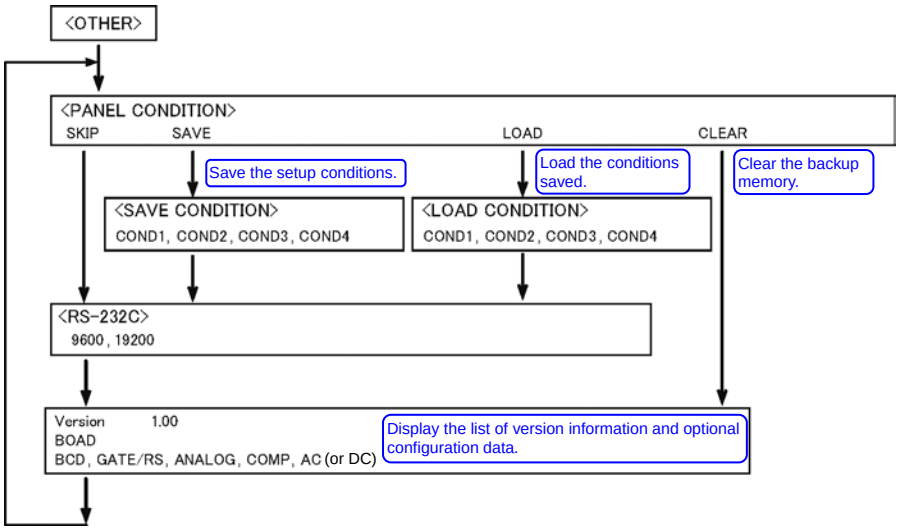
5. OUTPUT (Setup for BCD, COMP, and ANALOG outputs)

In the OUTPUT menu, setup the BCD, comparator, and analog output parameters.



6. OTHER (Setup for saving panel conditions)

In the OTHER menu, setup the saving/loading of setup conditions, the RS-232C, and option list.
The setup values are saved in a backup memory. In addition, the setup values can be saved in COND 1 to COND 4.



Saving the setup value

1. Backup memory
   The setup conditions of the main menu are saved in a backup memory. When the system is powered on, the setup conditions of the backup memory will be automatically loaded.
2. CLEAR
   Resets the setup conditions of the backup memory to the factory default values.
3. CONDITION
   The setup conditions of the backup memory can be saved as COND 1 to COND 4.
   The contents of COND 1 to COND 4 can be loaded to the backup memory by the LOAD operation.

■ Key Protect

● **Setup the Key Protection**

Press the “COND/>” switch on the front panel for more than 2 seconds. The message “K.P.” (Key Protect) will appear on the bottom center of the display, and the system will not accept any key operation.

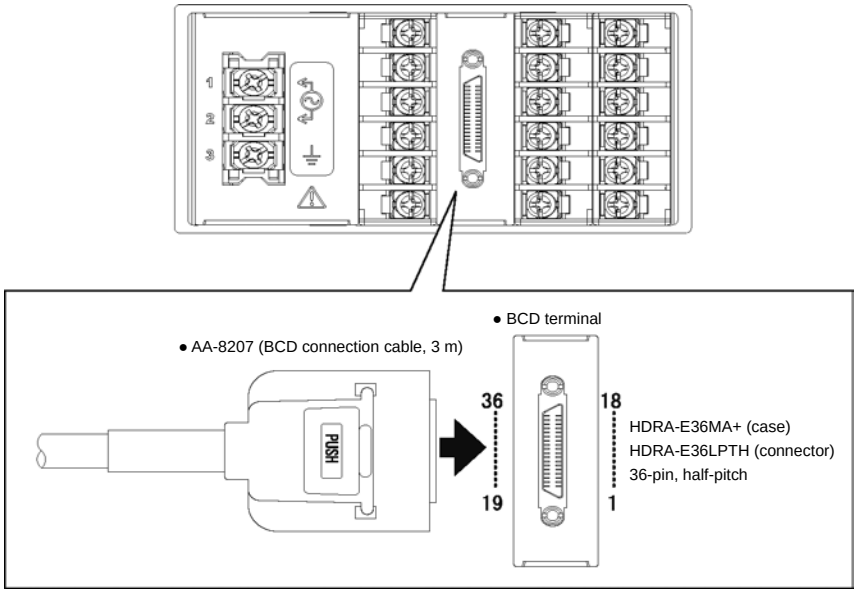
● **Cancel the Key Protection**

Press the “COND/>” switch on the front panel for more than 2 seconds. The message “K.P.” (Key Protect) will disappear from the bottom center of the display, and the key protection function will be cancelled.

■ BCD Output

To enable this function, an optional BCD output card (TM-0322 [open collector interface] or TM-0321 [TTL level interface]) is required. Note that the TM-0322 card is incorporated to the TM-3120. The measurement value (to be selected from instantaneous, average, maximum, and minimum values) will be delivered to the BCD parallel output in the 6-digit positive logic. The normal mode and request mode are available.

● BCD output terminal



● BCD pin assignment

Pin	Signal
1	BCD output, 1×10^0
2	BCD output, 2×10^0
3	BCD output, 4×10^0
4	BCD output, 8×10^0
5	BCD output, 1×10^1
6	BCD output, 2×10^1
7	BCD output, 4×10^1
8	BCD output, 8×10^1
9	BCD output, 1×10^2
10	BCD output, 2×10^2
11	BCD output, 4×10^2
12	BCD output, 8×10^2
13	BCD output, 1×10^3
14	BCD output, 2×10^3
15	BCD output, 4×10^3
16	BCD output, 8×10^3
17	BCD output, 1×10^4
18	BCD output, 2×10^4

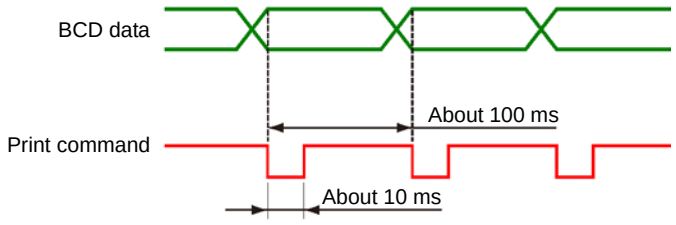
Pin	Signal
19	BCD output, 4×10^4
20	BCD output, 8×10^4
21	BCD output, 1×10^5
22	BCD output, 2×10^5
23	BCD output, 4×10^5
24	BCD output, 8×10^5
25	Start input
26	Stop input
27	Reset input
28	NC
29	NC
30	NC
31	NC
32	NC
33	Data request
34	NC
35	Print command
36	GND

● Setup items related to the BCD output

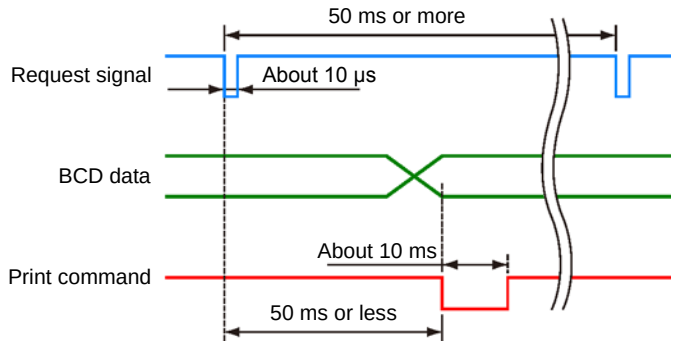
Setup item	Setup value	Remarks
BCD MODE (BCD output mode)	REQUEST	Request mode
	CONTINUE	Normal mode
BCD OUTPUT (Output data content)	MAIN	Normal output
	MAX	Maximum value output
	MIN	Minimum value output
	AVG	Average value output

● BCD output mode

● Normal (CONTINUE) mode



● Request mode



● BCD output specification

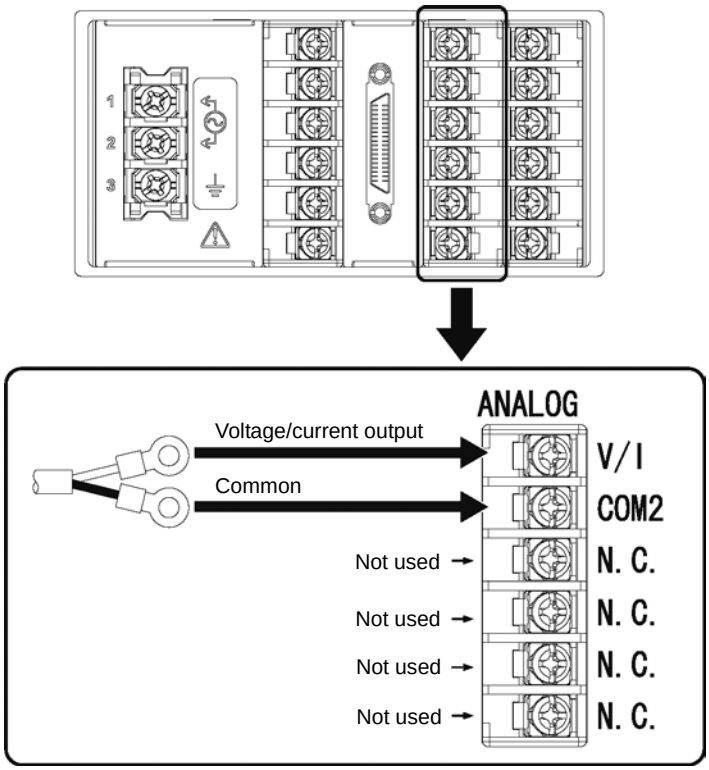
BCD output	Positive logic, 6-digit parallel output - TM-3120: Open collector output - TM-0321: TTL output
Print command output	Negative pulse TTL output (pulse width: about 10 ms)
Request signal	Negative pulse TTL input (trailing edge), 10 µs or more

Caution:
The print command outputs TTL level even for the TM-0322.

■ Analog Output

For analog output, the TM-0330 (analog output card) is required. Note that TM-0330 card is incorporated to the TM-3130. Either voltage output or current output is selected for the analog output. The display value that corresponds to the full scale voltage (or current) can be setup freely.

● Analog output terminal



●Setup items related to the analog output

Setup item	Setup value	Remarks
OUTPUT MODE (Analog output mode)	VOLTAGE	Voltage output
	CURRENT	Current output
VOLTAGE RANGE (Output voltage range)	0 - 5V	0 to 5 V
	1 - 5V	1 to 5 V
	0 - 10V	0 to 10 V
CURRENT RANGE (Output current range)	4 - 20mA	4 to 20 mA
	0 - 16mA	0 to 16 mA
ANALOG ZERO (Analog zero value)	0.000 to 999999	
ANALOG FULL (Analog full value)	0.000 to 999999	
ANALOG UPDATE (Analog output update time)	10 ms, 20 ms, 50 ms 100 ms, 200 ms, 500 ms, 1 s	
CALIBRATION (Analog output calibration)	± 0 to 20%	Adjustable for more than ± 20%, up to 100%

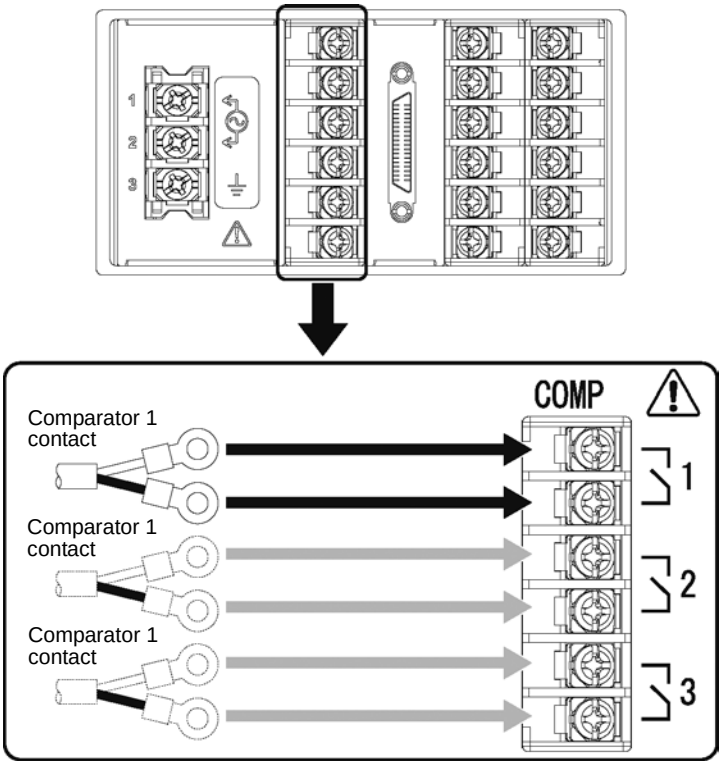
● **Analog output specification**

Output signal (Voltage/Current selectable)	Output method	12 bit D/A conversion (The resolution depends on the setup value.)
	Output voltage range	0 to 10 V, 0 to 5 V, 1 to 5 V
	Output current range	4 to 20 mA, 0 to 16 mA
Load resistance	Voltage output	100 kΩ or more
	Current output	500 Ω or less
Linearity		± 0.3% of F.S.
Analog output calibration	Voltage output	± 5 % of F.S. or more
	Current output	± 3 % of F.S. or more
Zero drift		± 0.05 % of F.S. /°C
Span drift		±0 .05 % of F.S. /°C
Output update time		10, 20, 50, 100, 200, 500 ms, 1 s

■ Comparator Output

For comparator output, the TM-0340 (comparator output card) is required. Note that the TM-0340 card is incorporated to the TM-3140. Three comparator outputs, COM 1, 2, and 3, are available. The mode is to be selected from AUTO (automatic recovery mode), MAINTENANCE (output hold mode), and PULSE (single-shot output mode). Either UPPER or LOWER judgment is made with the measurement value, compared with the setup value. It is also possible to setup the system to output the status of ERROR (operation error) or OK (normal operation). Note that the comparator output in the case of SS measurement will be synchronized with the measurement start/stop timing.

● **Comparator output terminal**



●Setup items related to the Comparator output

Setup item	Setup value	Remarks
COMP SETTING (Setup item)	COMP1	Comparator 1
	COMP2	Comparator 2
	COMP3	Comparator 3
	MODE	To comparator mode setup
COMP WORKING (Judgment mode), for each comparator	UPPER	Upper limit setup
	LOWER	Lower limit setup
	OK	Short-circuit the relay when it is determined normal.
	ERROR	Short-circuit the relay when it is determined error.
COMP UPPER (Upper judgment threshold), for each comparator	0 to 999999	
COMP LOWER (Lower judgment threshold), for each comparator	0 to 999999	
COMP MODE (Comparator mode)	AUTO	Automatic recovery mode
	MAINTENANCE	Output hold mode
	PULSE	One-shot output mode
COMP HYSTERESIS (Hysteresis setup)	± 20% (in 1% increment)	Available only for the automatic mode.
SHOT PULSE WIDTH (Output pulse width)	10 to 2000 ms (in 10 ms increment)	Available only for the one-shot output mode.
COMP DELAY (Delay time)	0 to 1000 ms (in 50 ms increment)	

● Comparator output specification

<table>
<tr><td>UPPER setup</td><td>6-digit setup (Relay is ON when; UPPER ≦ display value)</td></tr>
<tr><td>LOWER setup</td><td>6-digit setup (Relay is ON when; LOWER ＞ display value)</td></tr>
<tr><td>OK setup</td><td>The relay is ON when both UPPER and LOWER output contacts are open.</td></tr>
<tr><td>ERROR setup</td><td>The relay is ON when any error occur other than the RS communication error.</td></tr>
<tr><td>Output type</td><td>Single make contact output
• Three outputs of COMP 1, COMP 2, and COMP 3 (with one UPPER, LOWER, OK, or ERROR output)</td></tr>
<tr><td>Measurement mode</td><td>Selection of the comparator operation mode
<table><tr><td>Automatic recover mode</td><td>The comparator automatically recovers when the rotation speed is within the specified range.
• Comparator hysteresis
Adds a hysteresis to the comparator reference value for recovery.</td></tr><tr><td>Output hold mode</td><td>The output status is held even after the rotation speed is returned to the specified range.</td></tr><tr><td>Shot output mode</td><td>OFF (factory default output), 10 to 2000 ms in 10 ms increments
• The comparator output is held for a period of time when the rotation speed is within the specified range.</td></tr></table></td></tr>
<tr><td>COMP delay function</td><td>0 to 1000 ms in 50 ms increments
• The comparator produces the output only when the reference value is exceeded continuously for a specified period.</td></tr>
<tr><td>Reset function</td><td>Returns to the comparator hold mode.</td></tr>
</table>

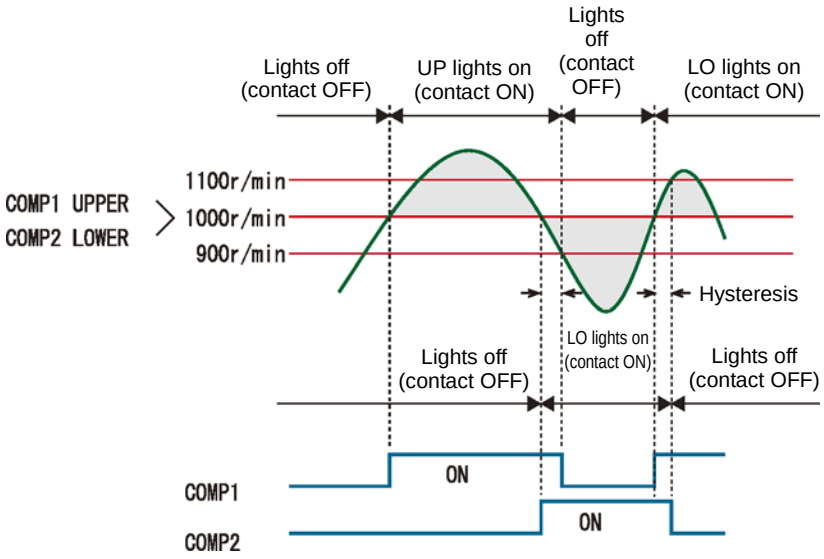
Maximum rating	DC: 30 V/1 A
	AC: 250 V/1 A
Output interface	Terminal block
Output update time	About 10 ms

● **Comparator output specification**

1. Comparator automatic recover mode: AUTO

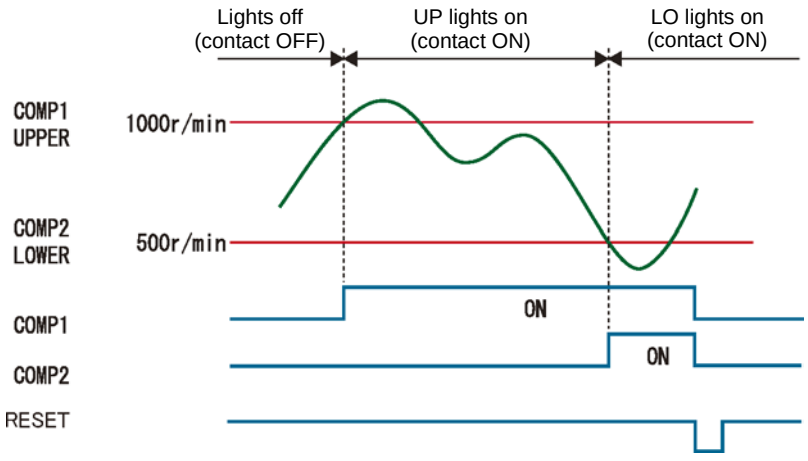
The comparator will continuously output the comparison result for the measurement value. For the judgment, a hysteresis can be setup to provide the difference between the rising edge (when the comparator turns ON) and trailing edge (when the comparator turns OFF).

The following example shows the case when COMP 1 is setup to UPPER and COMP 2 is setup to LOWER comparators, with the rotation speed of 1000 r/min, and the hysteresis of 10%.



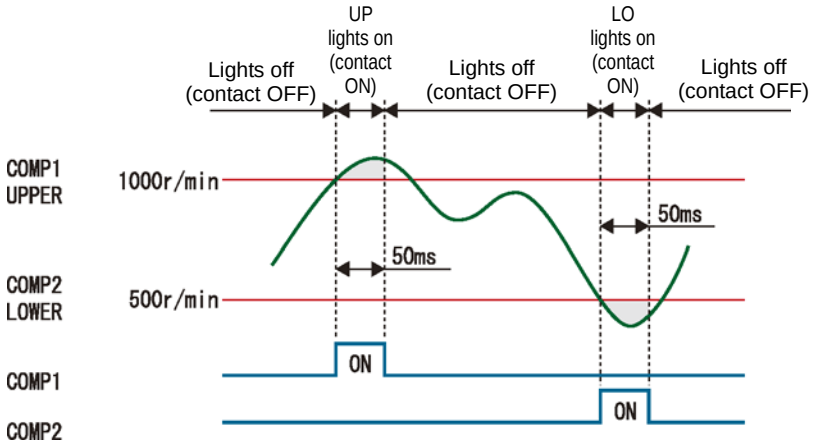
2. Comparator hold mode: MAINTENANCE

Once the comparison condition is satisfied, the result of comparator output will be held. When the RESET switch is pressed or an external reset signal is applied with optional TM-0350, the comparator output will be reset. Note that in the case of SS measurement, the reset function can be used only after the measurement is stopped.



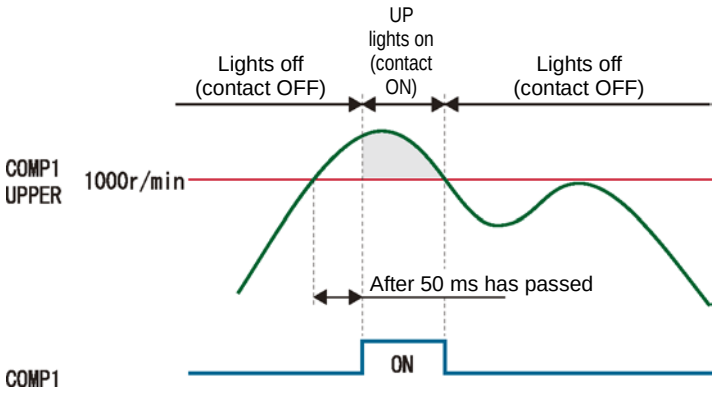
3. Comparator pulse output mode: PULSE

When the comparison condition is satisfied, a single-shot output is operated within the setup period of time. For example, when the output pulse time (SHOT PULSE WIDTH) is setup to 50 ms, the system operates as shown in the following figure.



4. Comparator output delay: COMP DELAY

The comparator output turns on when the comparison condition is continuously satisfied for a period of time. This delay can be specified in any comparator mode. By using the comparator output delay function, a stable operation can be expected. For example, when the comparator output delay (COMP DELAY) is set to 50 ms, the comparator output will be turned on after the input level exceeds the UPPER reference level, while the output is held for the 50 ms period.



5. **Comparator normal: OK**
Comparator error: ERROR

Besides the UPPER and LOWER comparator setups, OK and ERROR setup is available. When OK is selected, it outputs when the system is operating normally. Conversely, when ERROR is selected, it outputs when the system is operating abnormally due to improper input signal or setup conditions.

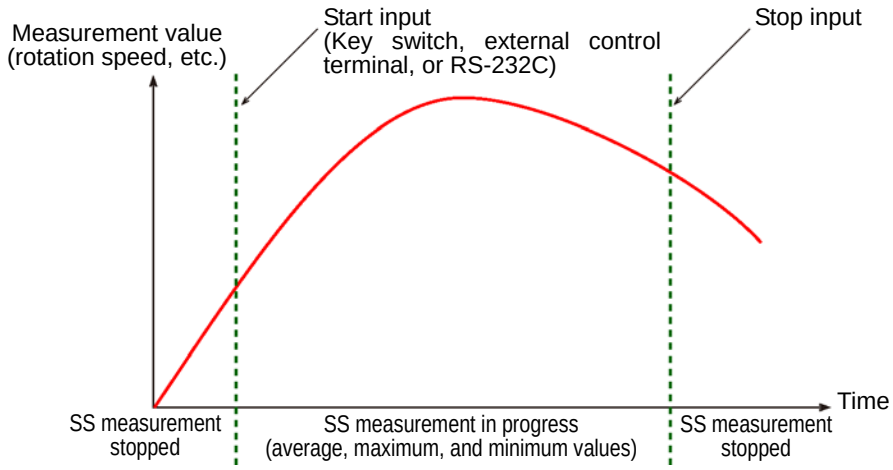
- Comparator normal: OK
  When the system is normally operating, the contact is turned ON. When either one of other two comparators is operated, the contact is turned OFF (excluding the case ERROR is set).
- Comparator error: ERROR
  The contact will be turned ON when an error occurs (excluding the RS communication errors).

■ SS (start and stop) Measurement

Either MANUAL or AUTO measurement mode can be used. In either mode, a single measurement is completed from the start to stop. When repeating the measurement, it is to be started again.

1. SS-MANUAL mode

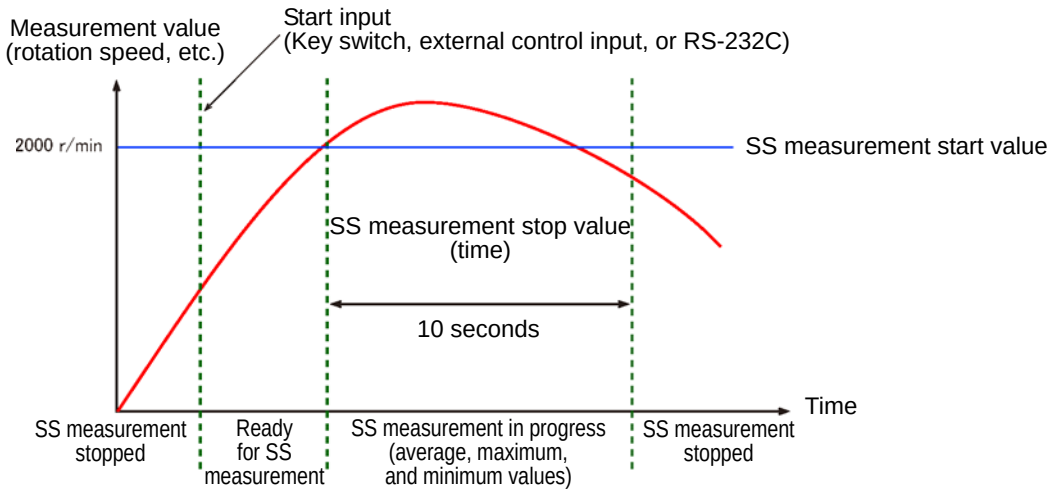
In the SS-Manual mode measurement, the average and other values are measured in the interval from the point when the START switch is pressed until the STOP switch is pressed.



2. SS-AUTO mode

In the SS-Auto mode, pressing the START switch sets the system ready for measurement. The measurement starts when the setup start condition is satisfied and stops when the setup stop condition is satisfied. Then, measures in the interval between the start and stop times.

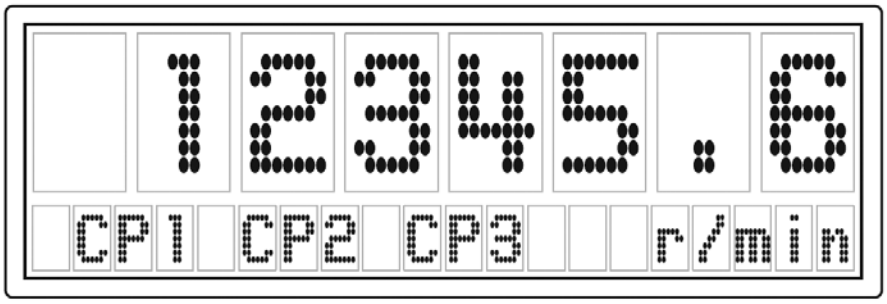
Example: When the condition is; START at 2000 r/min and STOP after 10 seconds
If the START switch is pressed at the rotation speed of 1000 r/min, the measurement will start when it reaches 2000 r/min after gradual acceleration. Then, the average, maximum, and minimum values are measured in the passing intervals of 10 seconds. As another example, if the START switch is pressed at the rotation speed of 2500 r/min and the rotation speed is decreased to 2000 r/min, the measurement will be started at this point. Please be careful about the rotation speed when you press the START switch. The measurement value will be displayed on the sub display.



● **Main display and sub display**

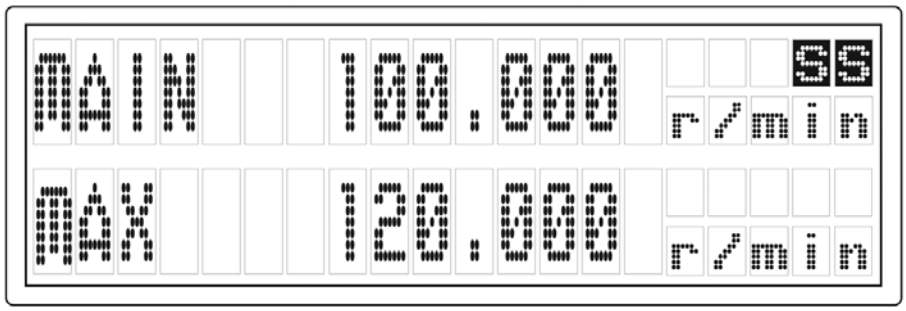
When DISPLAY - 2 LINE is selected in the setup mode, the main display shows the NORMAL measurement value and the sub display shows either the average, maximum, or minimum value of the SS measurement according to the selected value. Examples of the main display in a single line mode and the main/sub display in the two line mode are shown as follows.

■ **Main Display of TM-3140 (with the comparator function) (1 LINE display mode)**



The display of instantaneous rotation speed is updated every 1 second.

■ **Main and Sub Displays of TM-3110 (display only) (2 LINE display mode)**



SS: Indicates while measuring the maximum value.

MAX: Display of maximum value in the measurement section which updates every 1 second.

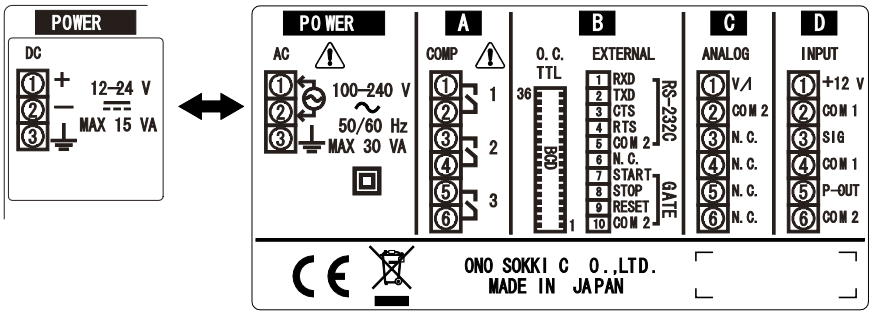
■ Function Board

The rear card slots A to D are assigned to specific boards: slot A for the comparator, slot B for BCD or RS-232C/GATE, slot C for analog output, and slot D for the input board.

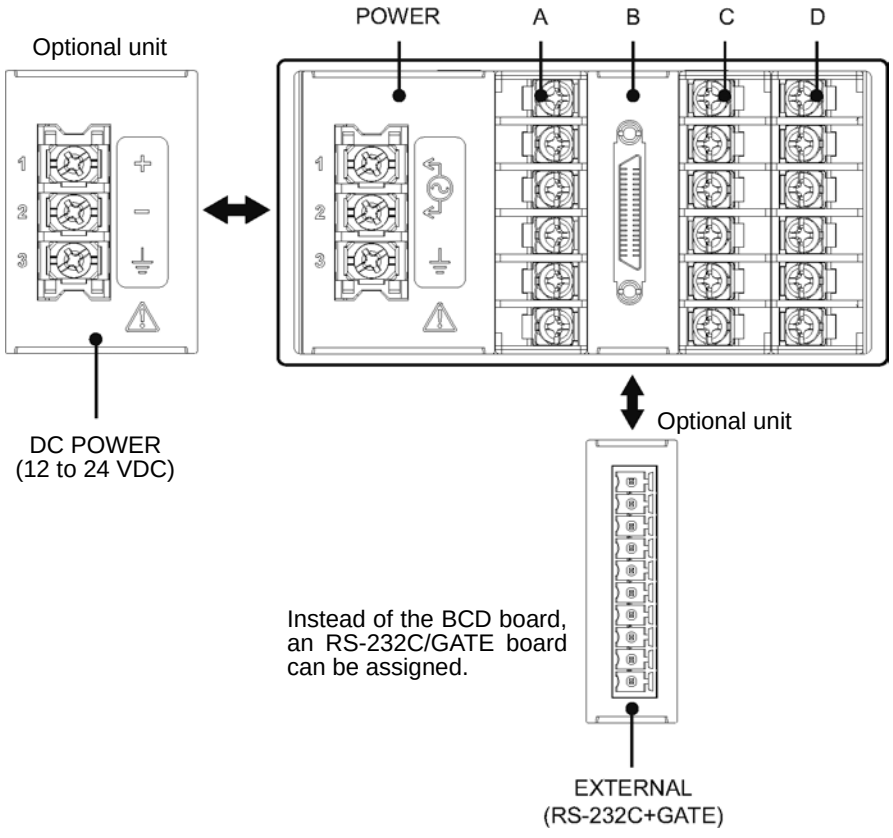
For the TM-3110 (display only), TM-3120 (open collector BCD output), TM-3130 (analog output), and TM-3140 (comparator output), the specific function cards are already mounted in the corresponding rear slots.

Any vacant slot can be used for an additional function. For example, you can add TM-0340 comparator to a TM-3130 system. If it is desired to implement an additional function after the unit has been delivered, the unit must be returned to the supplier

● Label on lateral side

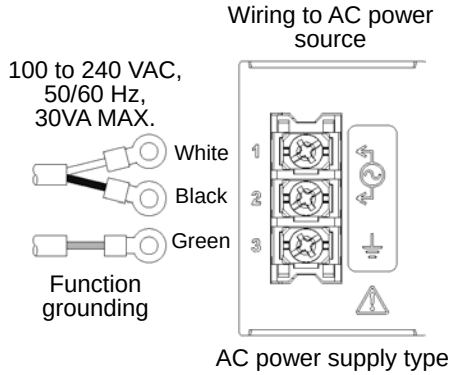


● Rear panel

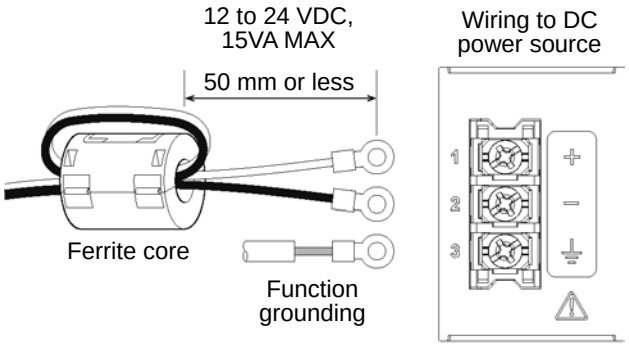


● **Power source connection**

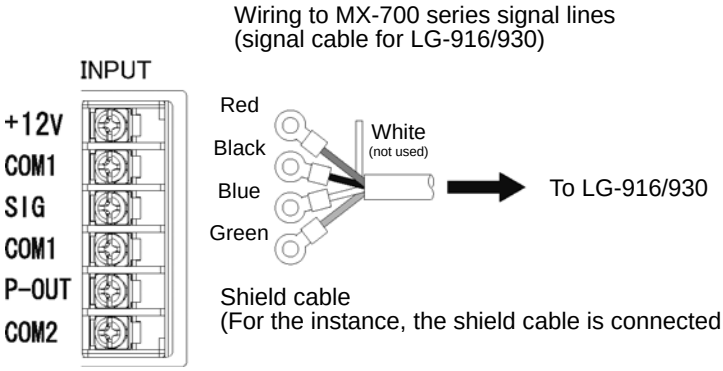
(1) Wiring to AC power source



(2) Wiring to DC power source



● **Example connection wiring of INPUT signal**



■ The shield cable is connected to the power earth terminal. However, this method is not applicable for the electromagnetic compatibility (EMC) requirements. For EMC compatibility, please refer to the instruction manual.

■ General Specifications

● Input

Amplifier input type	AC/DC selectable	
AC amplifier	Signal waveform	Sine wave: 0.2 to 45 Vrms
	Signal voltage range	Square wave: 0.6 to 63 Vp-p
	Signal frequency range	1 Hz to 100 kHz
DC amplifier	Signal waveform	Square wave of 5 µs or longer pulse width
	Signal voltage range	Hi level: +4 to +30 V Lo level: −1 to +1 V
	Signal frequency range	0.1 Hz to 100 kHz
	Time measurement	10 ms to 3600 s
Input impedance	10 kΩ min.	
Input type	Voltage/No voltage (open collector interface)	
Low pass filter	OFF, fc = 100 Hz, or fc = 20kHz, selectable	
Input connector	Terminal block	

● Function/Calculation

Calculation type	Frequency calculation type
Time reference	Crystal oscillator (20 MHz)
Rotation speed measurement accuracy	Display value × (±0.01%) ± 1 count ■ The display value is the actual count value excluding the decimal point.
Measurement time	10 ms + 1 cycle time (periodic calculation type)
Auto zero	OFF and 0.5 to 10 s (factory default: 1 s). See below.
	OFF, 0.5 s, 1.0 s, 2.0 s, 3.0 s, 4.0 s, 5.0 s, 6.0 s, 7.0 s, 8.0 s, 9.0 s, 10.0 s
	■ When the signal is not inputted for 11 seconds or longer, the display will be reset to zero, excluding the setup time. ■ For the passing time measurement, a measurement error will be declared when there is no signal for 3600 seconds or longer.
Rapid deceleration tracking function	When the input signal is reduced rapidly and the signal is not inputted for around one second or longer, the measurement is automatically decelerated with this function and the display shows zero after around 11 seconds.
Moving average	OFF (factory default), 2, 4, 8, 16, 32, 64, 128
Peak hold function	OFF (factory default), average, maximum, minimum
Section data	Holds the peak value during the section from start to stop of the measurement.

● **Setup**

Panel condition memory	The measurement condition, which keeps the current conditions, and other four conditions are memorized.
Pulse setup	1 to 999999 P/R
Roller diameter setup	0.1 to 99999.9 mm
Pulse distance setup	0.1 to 99999.9 mm
Process line length setup	0.1 to 99999.9 mm
Factor	9.99999 × 10E (-3 to 3) EU/PULS

● **Display**

Display	Fluorescent display tube	
Display update time	Average display 0.2 s (factory default), 0.4 s, 0.5 s, 0.6 s, 0.8 s, 1.0 s to 10 s (in 1.0 s steps)	
Unit display	Rotation speed (ROTATION)	r/s, r/min, r/h
	Circumferential speed (L.SPEED)	mm/s, m/s, mm/min, m/min
	Moving speed (VELOCITY)	mm/s, m/s, mm/min, m/min, km/min, mm/h, m/h, km/h
	Period (PERIOD)	s, min
	1/s (cycles) (TIMES)	1/s, 1/min, 1/h
	Frequency (FREQ)	Hz, kHz
	Flow rate (FLOW)	ml/s, ml/min, ml/h, l/s, l/min, l/h
	Passing time (P.TIME)	s, min
	Arbitrary engineering unit (OTHER)	EU/s, EU/min, EU/h
Number of decimal points	OFF (factory default) ■ Selectable from 1, 2, and 3 digits	
Selection of digits fixed to zero	OFF (factory default); minimum of 1 or 2 digits	
SIG indicator	Blinks in synchronization with input signal.	
Error display	- Backup memory error - Board error - Maximum input frequency exceeded - Maximum display digit exceeded - Memory full error - Setup value error	
Brightness selection	LOW, MID, HI	

● **Output**

Pulse output	Output voltage	Hi: +4.5 V or more Lo: +0.5 V or less
	Output logic	Negative logic
	Load resistance	100 kΩ or more

● **Power supply for detector**

Output voltage:	12 VDC ±10%
Maximum output current	100 mA

● **General specifications**

Power voltage	100 to 240 VAC, 50/60 Hz, 30 VA max.	
Power consumption	TM-3110	11 to 19 VA
	TM-3120	13 to 21 VA
	TM-3130	16 to 25 VA
	TM-3140	12 to 21 VA
	ANALOG, BCD, COMP	20 to 30 VA
Operating temperature range	0 to +50ºC	
Storage temperature range	-10 to +60ºC	
Operating humidity range	30 to 80% (without condensation)	
Storage humidity range	30 to 85% (without condensation)	
Location of use	Indoors, up to an altitude of 2000 m	
Outer dimensions	96 (W) × 48 (H) × 140 (D) mm or less	
Weight	Around 310 g	
Voltage resistance	AC 1500 V (Input to FG, 1 min.)	
Insulation resistance	10 MΩ min. (with a DC 500 V mega)	
Applicable standards	CE marking	
	Low voltage directive	EN61010-1:2001 (2nd) Over-voltage category II, Pollution degree 2
	EMC directive	EN61326-1: 2006, embedded board type
Mark	CE	This mark declares compatibility to the applicable EC directive.
	⧈	This mark indicates the double insulation structure.

● **Accessories**

Instruction manual	2 (Specification × 1, Basic operation procedure× 1)
Mounting fixture	1 set