

LCD PID Temperature Controllers



TX Series PRODUCT MANUAL

For your safety, read and follow the considerations written in the instruction manual, other manuals and Autonics website.

The specifications, dimensions, etc are subject to change without notice for product improvement. Some models may be discontinued without notice.

Features

- 50ms high-speed sampling rate and $\pm 0.3\%$ display accuracy
- Large LCD display with easy-to-read white PV characters
- Switch between current output and SSR drive output
- SSR drive output (SSRP function) control options: ON/OFF control, cycle control, phase control
- Communication output model available: RS485 (Modbus RTU)
- Parameter configuration via PC (RS485 communication): DAQMaster software included (comprehensive device management software)
- Compact, space-saving design with 45 mm depth: 30% rear-length size reduction compared to similar-sized (48×48 mm) models from Autonics
- Terminal protection cover sold separately: RSA-COVER

Safety Considerations

- Observe all 'Safety Considerations' for safe and proper operation to avoid hazards.
- ⚠ symbol indicates caution due to special circumstances in which hazards may occur.

⚠ Warning Failure to follow instructions may result in serious injury or death

- 01. Fail-safe device must be installed when using the unit with machinery that may cause serious injury or substantial economic loss.** (e.g. nuclear power control, medical equipment, ships, vehicles, railways, aircraft, combustion apparatus, safety equipment, crime/disaster prevention devices, etc.)
Failure to follow this instruction may result in personal injury, economic loss or fire.
- 02. Do not use or store the unit in the place where flammable/explosive/corrosive gas, high humidity, direct sunlight, radiant heat, vibration, impact or salinity may be present.**
Failure to follow this instruction may result in explosion or fire.
- 03. Install on a device panel to use.**
Failure to follow this instruction may result in fire or electric shock.
- 04. Do not connect, repair, or inspect the unit while connected to a power source.**
Failure to follow this instruction may result in fire or electric shock.
- 05. Check 'Connections' before wiring.**
Failure to follow this instruction may result in fire.
- 06. Do not disassemble or modify the unit.**
Failure to follow this instruction may result in fire or electric shock.

⚠ Caution Failure to follow instructions may result in injury or product damage

- 01. When connecting the power input and relay output, use AWG 20 (0.50 mm²) cable or over, and tighten the terminal screw with a tightening torque of 0.74 to 0.90 N m.**
When connecting the sensor input and communication cable without dedicated cable, use AWG 28 to 16 cable and tighten the terminal screw with a tightening torque of 0.74 to 0.90 N m.
Failure to follow this instruction may result in fire or malfunction due to contact failure.
- 02. Use the unit within the rated specifications.**
Failure to follow this instruction may result in fire or product damage
- 03. Use a dry cloth to clean the unit, and do not use water or organic solvent.**
Failure to follow this instruction may result in fire or electric shock.
- 04. Keep the product away from metal chip, dust, and wire residue which flow into the unit.**
Failure to follow this instruction may result in fire or product damage.

Cautions during Use

- Follow instructions in 'Cautions during Use'. Otherwise, it may cause unexpected accidents.
- Check the polarity of the terminals before wiring the temperature sensor. For RTD temperature sensor, wire it as 3-wire type, using cables in same thickness and length. For thermocouple (TC) temperature sensor, use the designated compensation wire for extending wire.
- Keep away from high voltage lines or power lines to prevent inductive noise. In case installing power line and input signal line closely, use line filter or varistor at power line and shielded wire at input signal line. Do not use near the equipment which generates strong magnetic force or high frequency noise.

- Do not apply excessive power when connecting or disconnecting the connectors of the product.
- Install a power switch or circuit breaker in the easily accessible place for supplying or disconnecting the power.
- Do not use the unit for other purpose (e.g. voltmeter, ammeter), but temperature controller.
- When changing the input sensor, turn off the power first before changing. After changing the input sensor, modify the value of the corresponding parameter.
- Do not overlapping communication line and power line. Use twisted pair wire for communication line and connect ferrite bead at each end of line to reduce the effect of external noise.
- Make a required space around the unit for radiation of heat. For accurate temperature measurement, warm up the unit over 20 min after turning on the power.
- Make sure that power supply voltage reaches to the rated voltage within 2 sec after supplying power.
- Do not wire to terminals which are not used.
- This unit may be used in the following environments.
 - Indoors (in the environment condition rated in 'Specifications')
 - Altitude Max. 2,000 m
 - Pollution degree 2
 - Installation category II

Ordering Information

This is only for reference, the actual product does not support all combinations.
For selecting the specified model, follow the Autonics website .

T	X	1	2	-	3	4	5
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- 1 Display digits**
4: 4 digit

2 Size
S: DIN W 48 × H 48 mm
M: DIN W 72 × H 72 mm
H: DIN W 48 × H 96 mm
L: DIN W 96 × H 96 mm
- 3 Option in/output**
1: Alarm 1
2: Alarm 1 + Alarm 2
A: Alarm 1 + Alarm 2 + PV transmission
B: Alarm output 1 + Alarm output 2 + RS485

4 Power supply
4: 100 - 240 VAC

5 Control output
R: Relay
S: SSR drive
C: Selectable current or SSR drive output

Product Components

- Product (+ bracket)
- Instruction manual

Manual

For proper use of the product, refer to the manuals and be sure to follow the safety considerations in the manuals.
Download the manuals from the Autonics website.







Software

Download the installation file and the manuals from the Autonics website.

■ DAQMaster
DAQMaster is comprehensive device management program. It is available for parameter setting, monitoring.

Sold Separately

- Terminal protection cover: RSA / RMA / RHA / RLA-COVER
- Communication Converter: SCM-USP / SCM-38I / SCM-US48I / SCM-WF48

Specifications		
Series		TX Series
Power supply		100 - 240 VAC ~ 50/60 Hz
Permissible voltage range		90 to 110 % of rated voltage
Power consumption		≤ 8 VA
Sampling period		50 ms
Input specification		
Control output	Relay	250 VAC ~ 3 A, 30 VDC = 3 A, 1a
	SSR	TX4S: 12 VDC = ± 2 V, ≤ 20 mA TX4M/H/L: 13 VDC = ± 3 V, ≤ 20 mA
	Current	DC 4-20 mA or DC 0-20 mA (parameter), Load resistance: ≤ 500 Ω
Alarm output	Relay	AL1/2: 250 VAC ~ 3 A 1a
Option output	PV transmission	DC 4 - 20 mA (Load resistance: ≤ 500 Ω, Output Accuracy: ± 0.3% F.S.)
	RS485 Comm.	Modbus RTU
Display type		11 Segment (White, Green, Yellow), LCD type
Control type	Heating, Cooling	ON/OFF, P, PI, PD, PID Control
Hysteresis		1 to 100 (0.1 to 50.0) °C/°F
Proportional band (P)		0.1 to 999.9 °C/°F
Integral time (I)		0 to 9,999 sec
Derivative time (D)		0 to 9,999 sec
Control cycle (T)		0.5 to 120.0 sec
Manual reset		0.0 to 100.0%
Relay life cycle	Mechanical	≥ 5,000,000 operations
	Electrical	≥ 200,000 operations (resistance load: 250 VAC ~ 3 A)
Dielectric strength		Between the charging part and the case: 3,000 VAC ~ 50/60 Hz for 1 min
Vibration		0.75 mm amplitude at frequency 5 to 55Hz in each X, Y, Z direction for 2 hours
Insulation resistance		≥ 100 MΩ (500 VDC = megger)
Noise immunity		± 2 kV square shaped noise (pulse width 1 μs) by noise simulator R-phase, S-phase
Memory retention		≈ 10 years (non-volatile semiconductor memory type)
Ambient temperature		-10 to 50 °C, storage: -20 to 60 °C (no freezing or condensation)
Ambient humidity		35 to 85%RH, storage: 35 to 85%RH (no freezing or condensation)
Protection structure		IP50 (Front panel, IEC standards)
Insulation type		Double or reinforced insulation (mark:  , dielectric strength between primary circuit and secondary circuit: 3 kV)
Certification		    
Unit weight (packaged)		• TX4S: ≈ 87 g (≈ 146 g)
		• TX4M: ≈ 143 g (≈ 233 g)
		• TX4H: ≈ 133 g (≈ 214 g)
		• TX4L: ≈ 206 g (≈ 290 g)

01) When using the unit at low temperature (below 0°C), display cycle is slow.

Communication Interface

■ RS485	
Comm. protocol	Modbus RTU
Application standard	EIA RS485 compliance with
Maximum connection	31 units (address: 01 to 127)
Synchronous method	Asynchronous
Comm. method	Two-wire half duplex
Comm. effective range	≤ 800 m
Comm. speed	2,400 / 4,800 / 9,600 (default) / 19,200 / 38,400 bps (parameter)
Response time	5 to 99 ms (default: 20 ms)
Start bit	1 bit (fixed)
Data bit	8 bit (fixed)
Parity bit	None (default), Odd, Even
Stop bit	1 bit, 2 bit (default)

Input Type and Using Range

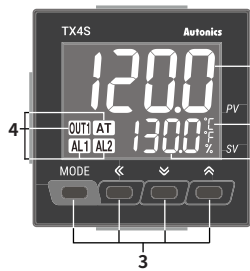
The setting range of some parameters is limited when using the decimal point display.

Input type	Decimal point	Display	Using range (°C)	Using range (°F)
Thermo-couple	K (CA)	1 0.1	$\overline{K} \overline{E} R.H$ $\overline{K} \overline{E} R.L$	-50 to 1,200 -58.0 to 2,192
	J (IC)	1 0.1	$\overline{J} \overline{I} \overline{E}.H$ $\overline{J} \overline{I} \overline{E}.L$	-30 to 800 -22 to 1,472
	L (IC)	1 0.1	$\overline{L} \overline{I} \overline{E}.H$ $\overline{L} \overline{I} \overline{E}.L$	-30.0 to 800.0 -22.0 to 999.9
	T (CC)	1 0.1	$\overline{E} \overline{E} \overline{E}.H$ $\overline{E} \overline{E} \overline{E}.L$	-50 to 400 -58.0 to 752.0
	R (PR)	1	$\overline{R} \overline{P} \overline{R}$	0 to 1,700 32 to 3,092
	S (PR)	1	$\overline{S} \overline{P} \overline{R}$	0 to 1,700 32 to 3,092
RTD	Cu50 Ω	1 0.1	$\overline{C} \overline{U} 5.H$ $\overline{C} \overline{U} 5.L$	-50 to 200 -58.0 to 392.0
	DPT100 Ω	1 0.1	$\overline{d} \overline{P} t.H$ $\overline{d} \overline{P} t.L$	-100 to 400 -148.0 to 752.0

Display accuracy

Input type	Using temperature	Display accuracy
Thermocouple RTD	At room temperature (23°C ±5°C)	(PV ±0.3% or ±1°C higher one) ±1-digit • Thermocouple R, S below 200 °C: (PV ±0.5% or ±3°C higher one) ±1-digit Over 200 °C: (PV ±0.5% or ±2°C higher one) ±1digit • Thermocouple L, RTD Cu50 Ω: (PV ±0.5% or ±2°C higher one) ±1-digit
	Out of room temperature range	(PV ±0.5% or ±2°C higher one) ±1-digit • Thermocouple R, S: (PV ±1.0% or ±5°C higher one) ±1digit • Thermocouple L, RTD Cu50 Ω: (PV ±0.5% or ±3°C higher one) ±1digit

Unit Descriptions



1. PV display part (White)

- Run mode: displays PV (Present value)
- Setting mode: displays parameter name

2. SV display part (Green)

- Run mode: displays SV (Setting value)
- Setting mode: displays parameter setting value

3. Input key

Display	Name
[MODE]	Mode key
[◀], [▼], [▲]	Setting value control key

4. Indicator

Display	Name	Description
°C, %, °F	Unit	Displays selected unit (parameter)
AT	Auto tuning	Flashes during auto tuning every 1 sec
OUT1	Control output	Turns ON when control output 1 is ON
AL1/2	Alarm output	Turns ON when each alarm output is ON

5. PC loader port: For connecting communication converter (sold separately).

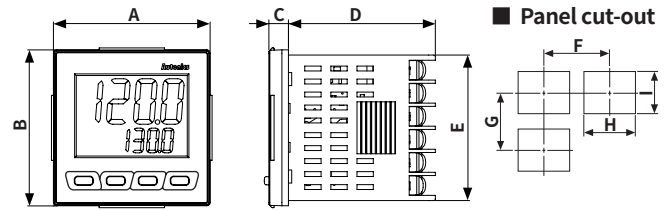
Errors

Display	Description	Troubleshooting
o P E n	Flashes when input sensor is disconnected or sensor is not connected.	Check input sensor status.
H H H H	Flashes when PV is higher than input range. ⁽⁰¹⁾	When input is within the rated input range, this display disappears.
L L L L	Flashes when PV is lower than input range. ⁽⁰¹⁾	

⁽⁰¹⁾ Be careful that when H H H H / L L L L error occurs, the control output may occur by recognizing the maximum or minimum input depending on the control type.

Dimensions

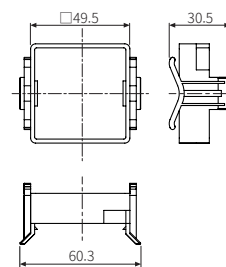
- Unit: mm, For the detailed drawings, follow the Autonics website.
- Below is based on TX4S Series.



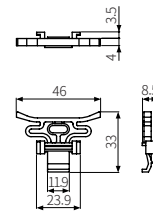
	Body					Panel cut-out			
	A	B	C	D	E	F	G	H	I
TX4S	48	48	6	45	44.8	≥ 65	≥ 65	$45^{+0.6}_0$	$45^{+0.6}_0$
TX4M	72	72	6	45	67.5	≥ 90	≥ 90	$68^{+0.7}_0$	$68^{+0.7}_0$
TX4H	48	96	6	45	91.5	≥ 65	≥ 115	$45^{+0.6}_0$	$92^{+0.8}_0$
TX4L	96	96	6	45	91.5	≥ 115	≥ 115	$92^{+0.8}_0$	$92^{+0.8}_0$

Bracket

TX4S

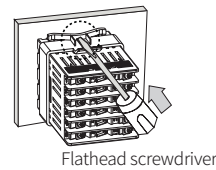


Other series



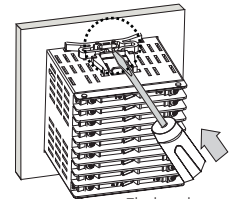
Installation Method

TX4S



Flathead screwdriver

Other series



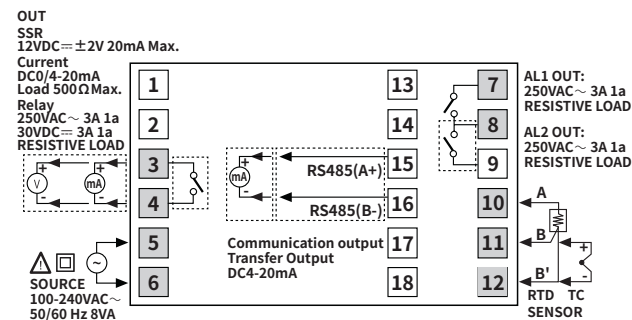
Flathead screwdriver

Insert the unit into a panel, fasten the bracket by pushing with tools with a flathead screwdriver.

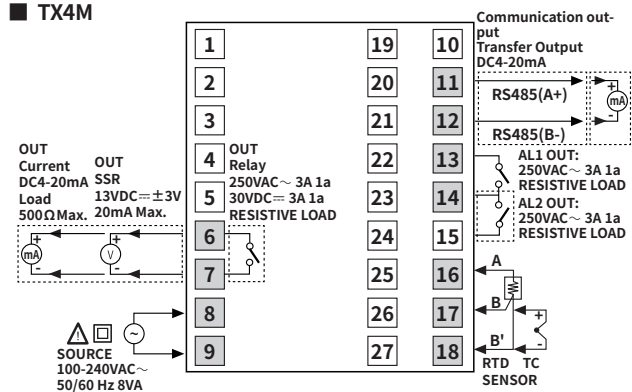
Connections

- Shaded terminals are standard model.

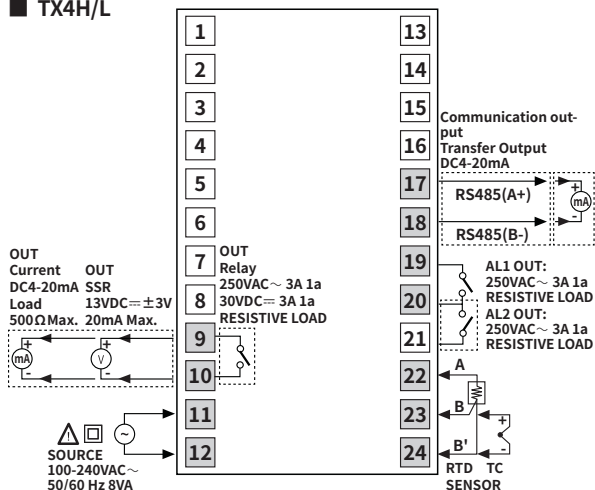
TX4S



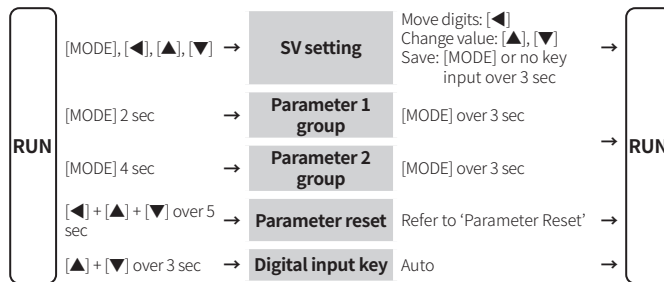
TX4M



TX4H/L



Mode Setting



Parameter Reset

- Press the [◀] + [▲] + [▼] keys for over 5 sec. in run mode, INIT turns ON.
- Change the setting value as YES by pressing the [▲], [▼] keys.
- Press the [MODE] key to reset all parameter values as default and to return to run mode.

Parameter Setting

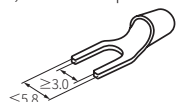
- Some parameters are activated/deactivated depending on the model or setting of other parameters. Refer to the descriptions of each item.
- [MODE] key: Move to next item after saving / Return to RUN mode after saving (\geq 3 sec) / Return to previous parameter after saving (within 1 sec returning to RUN mode)
- [◀] key: Select parameter / Move digits / Return to the upper level without saving (\geq 2 sec) / Return to RUN mode without saving (\geq 3 sec)
- [▲], [▼] key: Select parameter / Change setting value
- Return to the upper level without saving when there is no key input for more than 30 seconds.
- The range in parentheses '(')' is the setting range when the set value of the 'input specification' parameter is used with one decimal point.
- Recommended parameter setting sequence: Parameter 2 group → Parameter 1 group → SV setting mode

Parameter 1 group

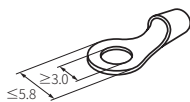
Parameter	Display	Default	Setting range	Condition
1-1 AL1 alarm temperature	AL 1	125.0	Deviation alarm: -F.S. to F.S. °C/°F Absolute value alarm: Within input range	2-16/19 AL1/2 alarm Operation:
1-2 AL2 alarm temperature	AL 2	125.0	[Alarm output2 model] Same as 1-1 AL1 alarm temperature	AM1 to AM6, HBA
1-3 Auto tuning	AL t	OFF	OFF: Stop, ON: Execution	-
1-4 Proportional band	P	10.0	0.1 to 999.9 °C/°F	2-8 Control type: PID
1-5 Integral time	I	24.0	0 (OFF) to 9,999 sec	
1-6 Derivative time	d	4.9	0 (OFF) to 9,999 sec	
1-7 Manual reset	RES t	50.0	0.0 to 100.0%	2-8 Control type: PID & 1-5 Integral time: 0
1-8 Hysteresis	HYS	2	1 to 100 (0.1 to 50.0) °C/°F	2-8 Control type: ONOF

Crimp Terminal Specifications

- Unit: mm, Use the crimp terminal of follow shape.



Fork crimp terminal



Round crimp terminal

■ Parameter 2 group

Parameter	Display	Default	Setting range	Condition
2-1 Input specification ⁽⁰¹⁾	I N - t	IKC RH	Refer to 'Input Type and Using Range'	-
2-2 Temperature unit ⁽⁰¹⁾	UNI t	°C	°C, °F	-
2-3 Input correction	I N - b	0	-999 to 999 (-199.9 to 999.9) °C/°F	-
2-4 Input digital filter	MAV.F	Q.1	0.1 to 120.0 sec	-
2-5 SV low limit ⁽⁰²⁾	L - SV	- 50	Within '2-1 Input specification: using range'	-
2-6 SV high limit ⁽⁰²⁾	H - SV	1200	L-SV ≤ H-SV - 1-digit °C/°F H-SV ≥ L-SV + 1-digit °C/°F	-
2-7 Control output mode	o - F t	HEAT	HEAT: Heating, COOL: Cooling	-
2-8 Control type ⁽⁰³⁾	C - M d	PI d	PID, ONOF: ON/OFF	-
2-9 Control output	o U t	CURR	[Selectable current or SSR drive output model] CURR: Current, SSR	-
2-10 SSR drive output type	SSRM	STND	[SSR drive output model] STND, CYCL, PHAS	-
2-11 Current output range	oMR	4 - 20	4-20: 4-20 mA, 0-20: 0-20 mA	2-9 Control output: CURR
2-12 Control cycle	t	20.0 (Relay) 2.0 (SSR)	0.5 to 120.0 sec	2-8 Control type: PID or 2-10 SSR drive output type: STND
2-13 AL1 alarm operation	AL - 1	AM 1A □□□■	<div> <div>□□□</div> <div>AM0: Off</div> <div>AM1: Deviation high limit alarm</div> <div>AM2: Deviation low limit alarm</div> <div>AM3: Deviation high, low limit alarm</div> <div>AM4: Deviation high, low reverse alarm</div> <div>AM5: Absolute value high limit alarm</div> <div>AM6: Absolute value low limit alarm</div> <div>SBA: Sensor break alarm</div> <div>LBA: Loop break alarm (LBA)</div> </div>	-
2-14 AL1 alarm option		■	<div> <div>A: Standard alarm</div> <div>B: Alarm latch</div> <div>C: Standby sequence 1</div> <div>D: Alarm latch and standby sequence 1</div> <div>E: Standby sequence 2</div> <div>F: Alarm latch and standby sequence 2</div> </div> <div> • Enter to option setting: Press [◀] key in 2-13 AL-1 alarm operation. </div>	-
2-15 AL2 alarm operation	AL - 2	AM2A	[Alarm output2 model]	-
2-16 AL2 alarm option			Same as '2-13/14 AL1 alarm operation/option'	-
2-17 Alarm output hysteresis	APHYS	1	1 to 100 (0.1 to 50.0) °C/°F	2-13/14 AL1/2 alarm operation: AM1 to 6
2-18 LBA time	L b R t	0	0 (OFF) to 9,999 sec or auto ⁽⁰⁴⁾	2-13/14 AL1/2 alarm operation: LBA
2-19 LBA band	L b R b	2	0 (OFF) to 999 (0.0 to 999.9) °C/°F or auto ⁽⁰⁵⁾	2-13/14 AL1/2 alarm operation: LBA & 2-18 LBA time: > 0
2-20 Transmission output low limit	F S - L	- 50	[PV transmission output model]	-
2-21 Transmission output high limit	F S - H	1200	Refer to 'Input Type and Using Range'	-
2-22 Comm. address	AdRS	1	[Communication output model] 1 to 127	-
2-23 Comm. speed	bPS	96	[Communication output model] 24, 48, 96, 192, 384 (×100) bps	-
2-24 Comm. parity bit	PRt y	NONE	[Communication output model] NONE, EVEN, ODD	-
2-25 Comm. stop bit	S t P	2	[Communication output model] 1, 2 bit	-
2-26 Response time	RSWt	20	[Communication output model] 5 to 99 ms	-
2-27 Comm. write	C o M W	ENR	[Communication output model] EN.A: Enable, DIS.A: Disable	-
2-28 Digital input key	dI - k	St o P	STOP: Stop control output, AL.RE: Alarm reset, AT*: Execute auto tuning, OFF	*2-8 Control type: PID
2-29 Sensor error, MV	ERMV	0.0	0.0: OFF, 100.0: ON	2-8 Control type: ONOF
2-30 Lock	L o C	o F F	0.0 to 100.0%	2-8 Control type: PID
			OFF LOC1: Lock parameter 2 group LOC2: Lock parameter 1/2 group LOC3: Lock parameter 1/2 group, SV setting	-

(01) Below parameters are initialized when the setting value is changed.

- Parameter 1 group: AL1/2 alarm temperature,
- Parameter 2 group: Input correction, SV high/low limit, LBA band, Alarm output Hysteresis

(02) If SV is lower/higher than low/high limit when the value is changed, SV is changed to the low/high limit value.

(03) When changing the value from PID to ONOF, each value of following parameter is changed.

2-28 Digital input key: OFF, 2-29 Sensor error, MV: 0.0 (Setting value is lower than 100.0)

(04) After auto tuning, the range is set as twice of the integral time automatically. If the previous setting value is outside of the range automatically set, it is set to the nearest Max. or Min. value of the range.

(05) After auto tuning, the range is set as 10% of the proportion band automatically. If the previous setting value is outside of the range automatically set, it is set to the nearest Max. or Min value of the range.

Function: Alarm

888.8

Alarm operation Alarm option

Set both alarm operation and alarm option by combining.
Each alarm operates individually in two alarm output models.
When the current temperature is out of alarm range, alarm clears automatically.

■ Operation

• H: Alarm output hysteresis

Mode	Name	Alarm operation	Description
AM0	-	-	No alarm output
AM1	Deviation high limit	<p>High deviation: Set as 10°C</p>	If deviation between PV and SV as high-limit is higher than set value of deviation temperature, the alarm output will be ON.
AM2	Deviation low limit	<p>Low deviation: Set as 10°C</p>	If deviation between PV and SV as low limit is higher than set value of deviation temperature, the alarm output will be ON.
AM3	Deviation high, low limit	<p>High, Low deviation: Set as 10°C</p>	If deviation between PV and SV as high/low-limit is higher than set value of deviation temperature, the alarm output will be ON.
AM4	Deviation high, low limit reverse	<p>High, Low deviation: Set as 10°C</p>	If deviation between PV and SV is higher than the lower limit deviation set value and less than the upper limit deviation set value, the alarm output will be ON.
AM5	Absolute value high limit	<p>Absolute value: Set as 90°C</p>	If PV is higher than the absolute value, the output will be ON.
AM6	Absolute value low limit	<p>Absolute value: Set as 90°C</p>	If PV is lower than the absolute value, the output will be ON.
SbA	Sensor break	-	It will be ON when it detects sensor disconnection.
LbA	Loop break	-	It will be ON when it detects loop disconnection.

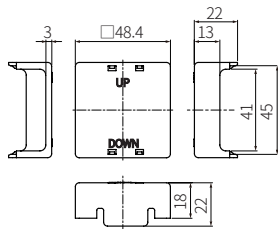
■ Option

Mode	Name	Description	Condition of reapply
A	Standard alarm	If it is an alarm condition, alarm output is ON. If it is a clear alarm condition, alarm output is OFF.	-
b	Alarm latch	If it is an alarm condition, alarm output is ON and maintains ON status.	-
C	Standby sequence 1	First alarm condition is ignored and from second alarm condition, standard alarm operates. When power is supplied and it is an alarm condition, this first alarm condition is ignored and from the second alarm condition, standard alarm operates.	Power ON
d	Alarm latch and standby sequence 1	If it is an alarm condition, it operates both alarm latch and standby sequence. When power is supplied and it is an alarm condition, this first alarm condition is ignored and from the second alarm condition, alarm latch operates.	Power ON
E	Standby sequence 2	First alarm condition is ignored and from second alarm condition, standard alarm operates. When re-applied standby sequence and if it is alarm condition, alarm output does not turn ON. After clearing alarm condition, standard alarm operates.	Power ON, change SV, change alarm
F	Alarm latch and standby sequence 2	Basic operation is same as alarm latch and standby sequence1. It operates not only by power ON/OFF, but also alarm set value, or alarm option changing. When re-applied standby sequence and if it is alarm condition, alarm output does not turn ON. After clearing alarm condition, alarm latch operates.	temperature / operation or change STOP to RUN mode

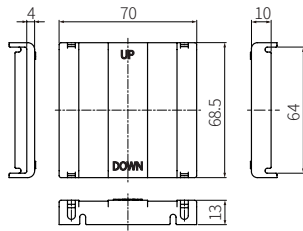
Sold Separately: Terminal Protection Cover

• Unit: mm

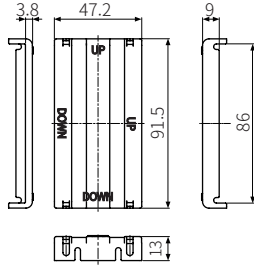
RSA-COVER: DIN W48 × H48



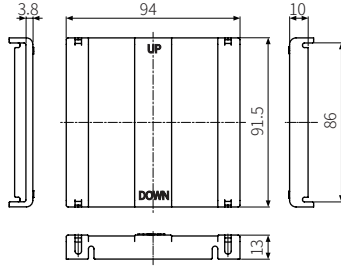
RMA-COVER: DIN W72 × H72



RHA-COVER: DIN W48 × H96



RLA-COVER: DIN W96 × H96



Segment Table

The segments displayed on the product indicate the following meanings. It may differ depending on the product.

7 Segment	11 Segment	12 Segment	16 Segment
0 0 I I	0 0 I I	0 0 I I	0 0 I I
1 1 J J	1 1 J J	1 1 J J	1 1 J J
2 2 K K	2 2 K K	2 2 K K	2 2 K K
3 3 L L	3 3 L L	3 3 L L	3 3 L L
4 4 M M	4 4 M M	4 4 M M	4 4 M M
5 5 N N	5 5 N N	5 5 N N	5 5 N N
6 6 O O	6 6 O O	6 6 O O	6 6 O O
7 7 P P	7 7 P P	7 7 P P	7 7 P P
8 8 Q Q	8 8 Q Q	8 8 Q Q	8 8 Q Q
9 9 R R	9 9 R R	9 9 R R	9 9 R R
A A S S	A A S S	A A S S	A A S S
b B t T	b B t T	b B t T	b B t T
c C u U	c C u U	c C u U	c C u U
d D v V	d D v V	d D v V	d D v V
E E w W	E E w W	E E w W	E E w W
F F x X	F F x X	F F x X	F F x X
G G y Y	G G y Y	G G y Y	G G y Y
H H z Z	H H z Z	H H z Z	H H z Z