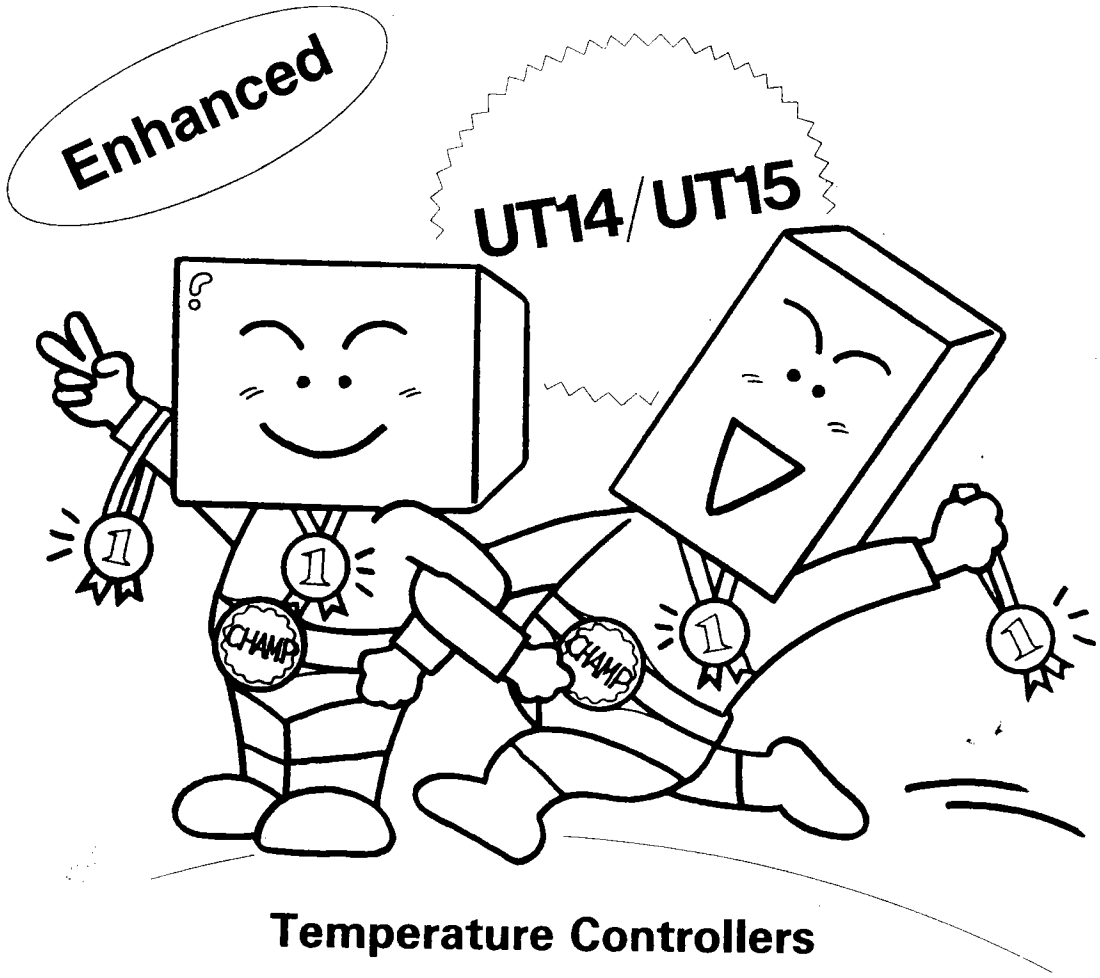
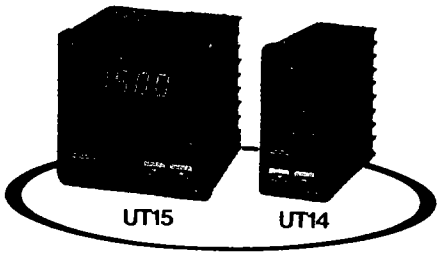
Technical Information

UT14/UT15
Digital Indicating Controllers



Temperature Controllers

This technical information describes the enhanced functions of the UT14 /UT15 digital indicating controllers. This provides information that supplements the description in the instruction manual so that user can make full use of these controllers.



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TI 5B4A7-02E
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Revision Record

Feb. 1995 TI 5B4A7-02E New Publication

UT15 and UT14 have a better input accuracy and additional functions from the manufacturing of the begining of March 1995. The manufacturer add the letter "E" to the model name on the front panel, to distinguish from the former products.

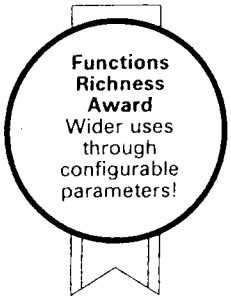
Table of Contents

Operation Simplicity Award
Only 3 operating buttons

Input Versatility Award
10 kinds of thermocouples, DC voltage, and RTD — all standard

Output Flexibility Award
Relays, voltage pulse, DC current — all standard

Control Dependability Award
A "Super" function to suppress overshoot through simple operations



1. SIMPLE OPERATIONS

1.1 Component Functions

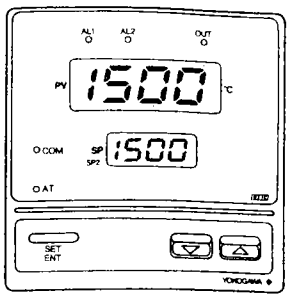
Alarm indicator lamps: 2 (red)

AL1 ..... On when alarm 1 generated
AL2 ..... On when alarm 2 generated

Note: No indicator lamp is provided for alarm 3 which can be selected only when the 4-20 mA DC or voltage pulse output is specified as the control output.

Status indicator lamps: 3 (green)

SP2 ..... On when the auxiliary setpoint has been selected
The indicator lamp blinks in the manual operation mode irrespective of whether the selected setpoint is SP or SP2.
COM..... On when in communication status, flashes when a communication error has occurred. (UT15 only)
AT..... Flashes when auto tuning is in progress



Output indicator lamp: 1 (red)

OUT..... For relay output, or voltage pulse output — On when output is ON.
For 4 to 20mA output — "on" flashes — duty ratio increases as the output increases.

Measured-value (PV) display	4-digit (red)/7-segment LED (Parameter signal and error displays)
Setpoint (SP) display	4-digit (red)/7-segment LED Carries out parameter numerical value display

SET ENT	Set/entry key:	Used when selecting parameters, and when changing numerical settings
▲	Up key:	Increases the numerical setting value. Automatic shift to higher digits
▼	Down key:	Decreases the numerical setting value. Automatic shift to lower digits. Negative values can be set.

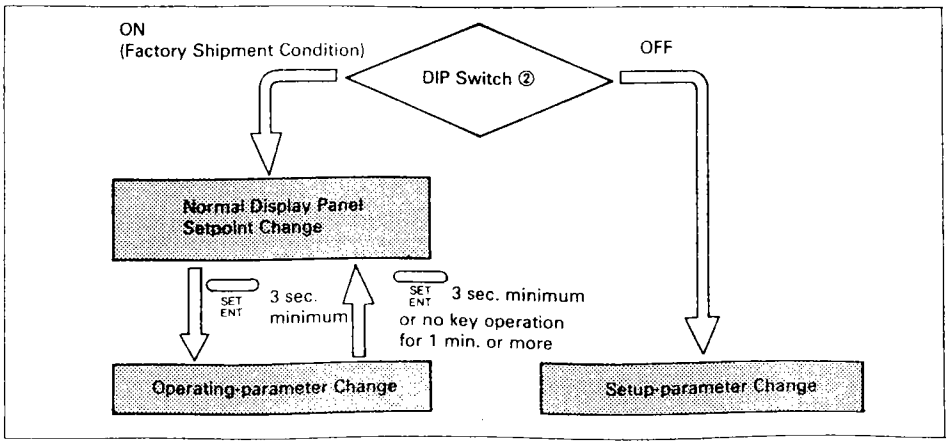
- Pressing the up or down key continuously causes a progressive increase in the rate of change in the numerical value.

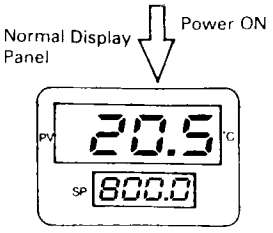
The above also applies to the UT14.

1.2 Principles of Key Operations

The key operations fall into the following three classes:

- Setpoint changes.
- Operating-parameter changes (parameters required during normal operations).
- Setup-parameter changes (parameters that set up the instrument functions)



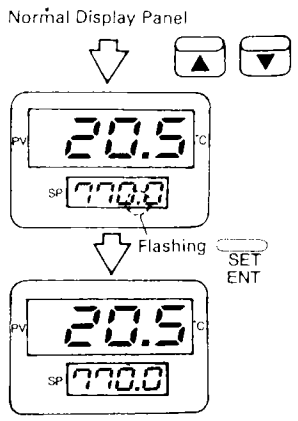


☐ **Normal display panel**

- When power is turned ON, the instrument display goes automatically to the normal display panel. The setpoint can be changed from the normal display panel at any time using the ▲ and ▼ keys.

1.2.1 Setpoint Setting (Numerical Value Setup)

- Changing the setpoint using the ▲ or ▼ key causes the decimal point to begin flashing.
- After making certain that the value is correct, press the SET ENT key. The decimal point will stop flashing, and the controller will operate with the new value.
- In the instructions that follow, set the numerical value for each individual parameter in the same way.

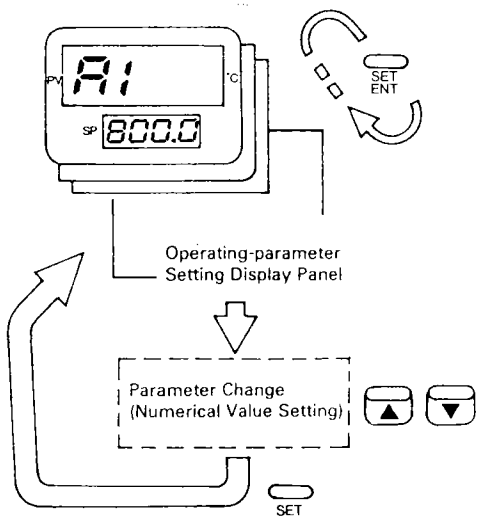


SET ENT 3 sec. minimum

SET ENT 3 sec. minimum or no key operations for 1 min. or more

1.2.2 Operating-Parameter Setting (Parameters Required for Normal Operations)

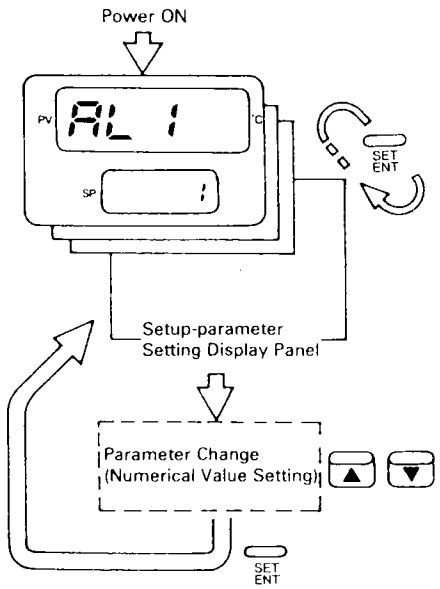
- Pressing the SET ENT key on the normal display panel for 3 seconds or more changes the display to the alarm set-value setting display panel.
- Each subsequent depression of the SET ENT key changes the setting display panel to a different operating parameter. After going through all the display panels, you will be returned again to the alarm set-value 1 (A1) setting display panel.
- Set the numerical value (see above) from the setting display panel for the operating parameter that you wish to change.
- Pressing the SET ENT key for three seconds or more from the operating-parameter setting display panel returns you to the normal display panel.



Set DIP switch ② OFF

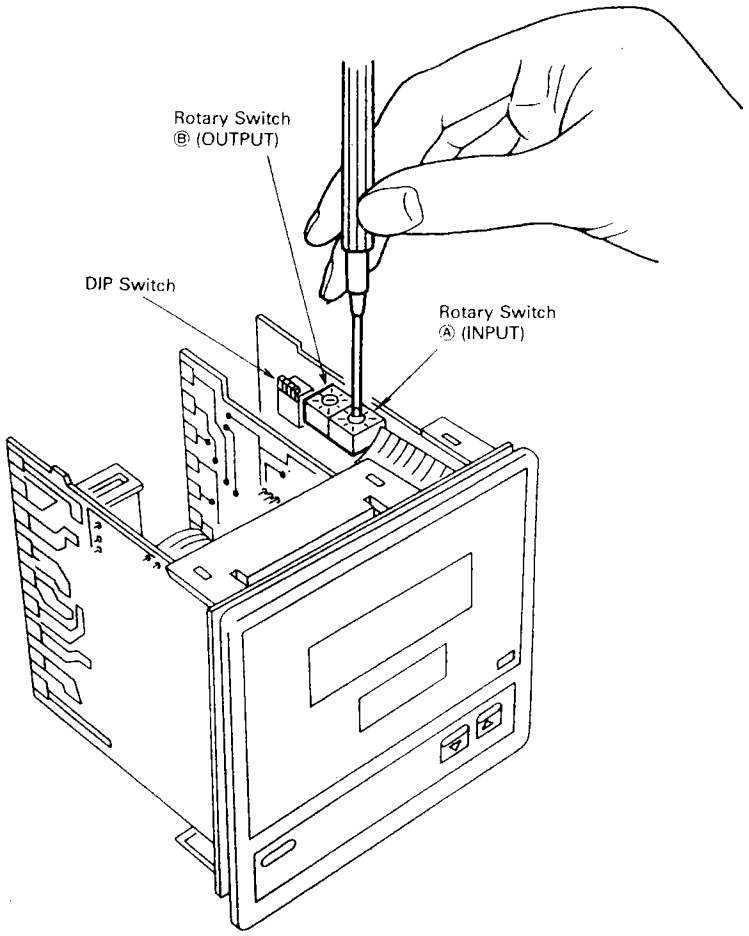
1.2.3 Setup-Parameter Setting (Parameters that Set the Instrument Functions)

- Pull out the internal unit, set DIP switch ② to OFF, and push the unit back into the housing (Described in detail later.)
- When the power is turned ON, the instrument goes to the alarm-1 type (AL1) setting display panel
- Each subsequent depression of the SET ENT key changes the setting display panel to a different operating parameter. After going through all the display panels, you will be returned again to the alarm-1 type (AL1) setting display panel.
- Set the numerical value (see above) from the setting display panel for the operating parameter that you wish to change.
- Pull out the instrument internal unit, set DIP switch ② to ON, and push the unit back into the housing.

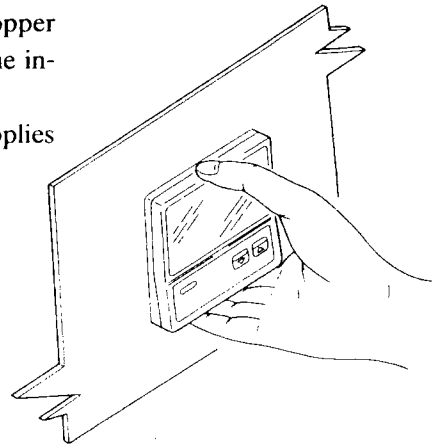


2. UNIVERSAL INPUT/OUTPUT

Input and output are freely selectable.



- While pressing up with your fingers on the bezel stopper (latch), pull the bezel out toward you, and pull out the instrument's internal unit.
- The figure uses UT15 as an example, but the same applies to the UT14.



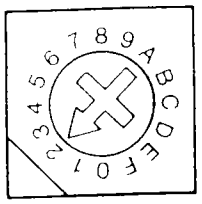
INPUT

Table 1. Input Range Code Table

	Input type/instrument range				Input range code (Note 2)
Thermo-couple	JIS	K	−200 to 1200°C	−300 to 2300°F	0
		K	−199.9 to 200.0°C	−300 to 400°F	1 (Note 3)
		S	0 ~ 1700°C	0 ~ 3100°F	
		J	−199.9 to 800.0°C	−300 to 1500°F	2
		T	−199.9 to 400.0°C	−300 to 750°F	3
		E	−199.9 to 800.0°C	−300 to 1500°F	4
		R	0 to 1700°C	0 to 3100°F	5
		B	0 to 1800°C	0 to 3300°F	6
		N	0 to 1300°C	32 to 2400°F	7
	DIN	L	−199.9 to 800.0°C	−300 to 1500°F	8
		U	−199.9 to 400.0°C	−300 to 750°F	9
RTD (Note 1)	JPt100		−199.9 to 500.0°C	−300 to 1000°F	A
	Pt100		−199.9 to 500.0°C	−300 to 1000°F	B
DC voltage	0 to 10mV		Can be scaled within the following ranges: −1999 to 9999 −199.9 to 999.9 −19.99 to 99.99 −1.999 to 9.999		C
	0 to 100mV				D
	0 to 5V				E
	1 to 5V				F

(Note 1) JIS'89 JPt100, JIS'89 Pt100/DIN
(Note 2) The number is the same as the rotary switch Ⓐ position.
(Note 3) Type of thermocouple (K or S) can be selected, using a Setup parameter when input range code is 1.

Rotary swith Ⓐ (INPUT)



- By setting rotary switch Ⓐ inside the instrument and changing the terminal connections, you can switch the instrument to whichever of the input types and ranges in Table 1 that you desire.
- **Caution**
  The parameters shown below are automatically initialized when input range code is changed.
  Operating Parameter: A1, A2, A3, HYS, SP, SP2, BS
  Setup Parameter: HY1, HY2, HY3, PD, RH, RL, SP. UP, SP. DN

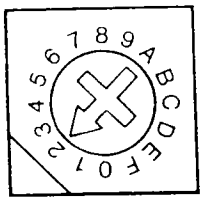
OUTPUT

Table 2. Output Type Codes

Control output type	Specification	Output type code (note 3)
Relay output time-proportioning PID	Contact capacity: 250V AC, 3A (resistive load) Cycle time: 1 to 120sec. (note 4)	0
Voltage pulse output time-proportioning PID	ON voltage: Approx. 15V DC (Load resistance 1kΩ minimum) OFF voltage: 0.1V DC maximum Cycle time: 1 to 120 sec.	1
Continuous output PID	Output current 4 to 20mA (Load resistance 600Ω maximum): 500ms Accuracy: ±0.3% (of output span) Output update interval: 500ms	2

Note 3: Number is the same as for the rotary switch Ⓑ setting position.
Note 4: The relay used is Matsushita Electronics Corp. model DSP1-DC12V.

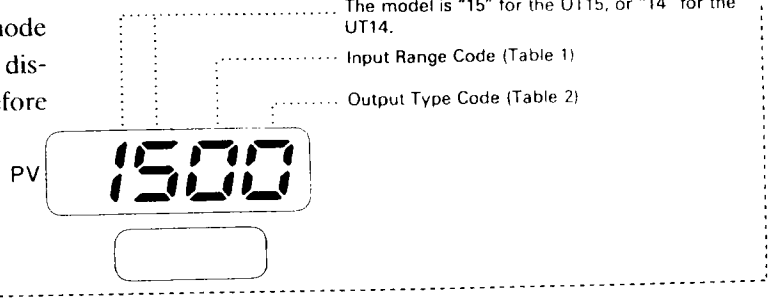
Rotary switch Ⓑ (OUTPUT)



- By setting rotary switch Ⓑ inside the instrument and changing the terminal connections, you can switch the instrument to whichever of the output types in Table 2 that you desire.

If rotary switch Ⓑ is accidentally set to a position other than 0, 1, or 2, the instrument does not go to the operating display panel when the power is turned ON, but rather displays the E003 error.

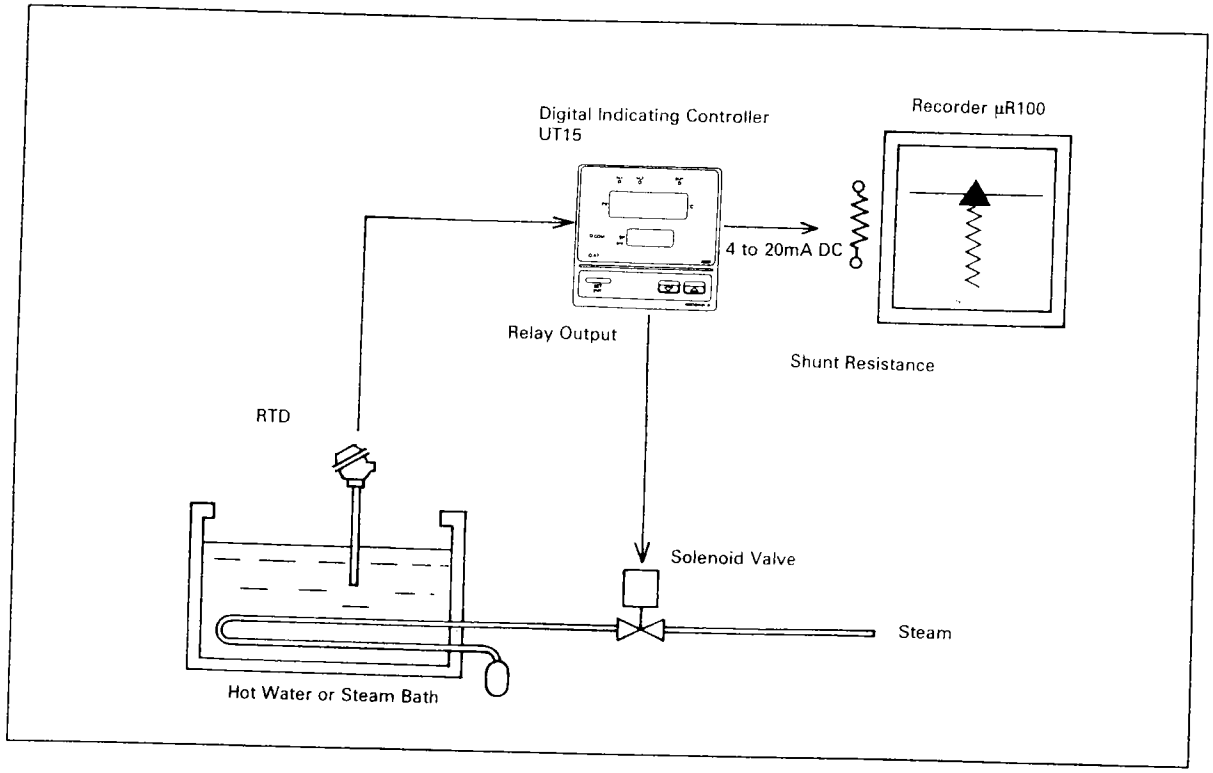
After the power is turned ON, the mode and the input and output codes are displayed for approximately 2 seconds before changing to the normal display panel.



EXAMPLES OF APPLICATIONS

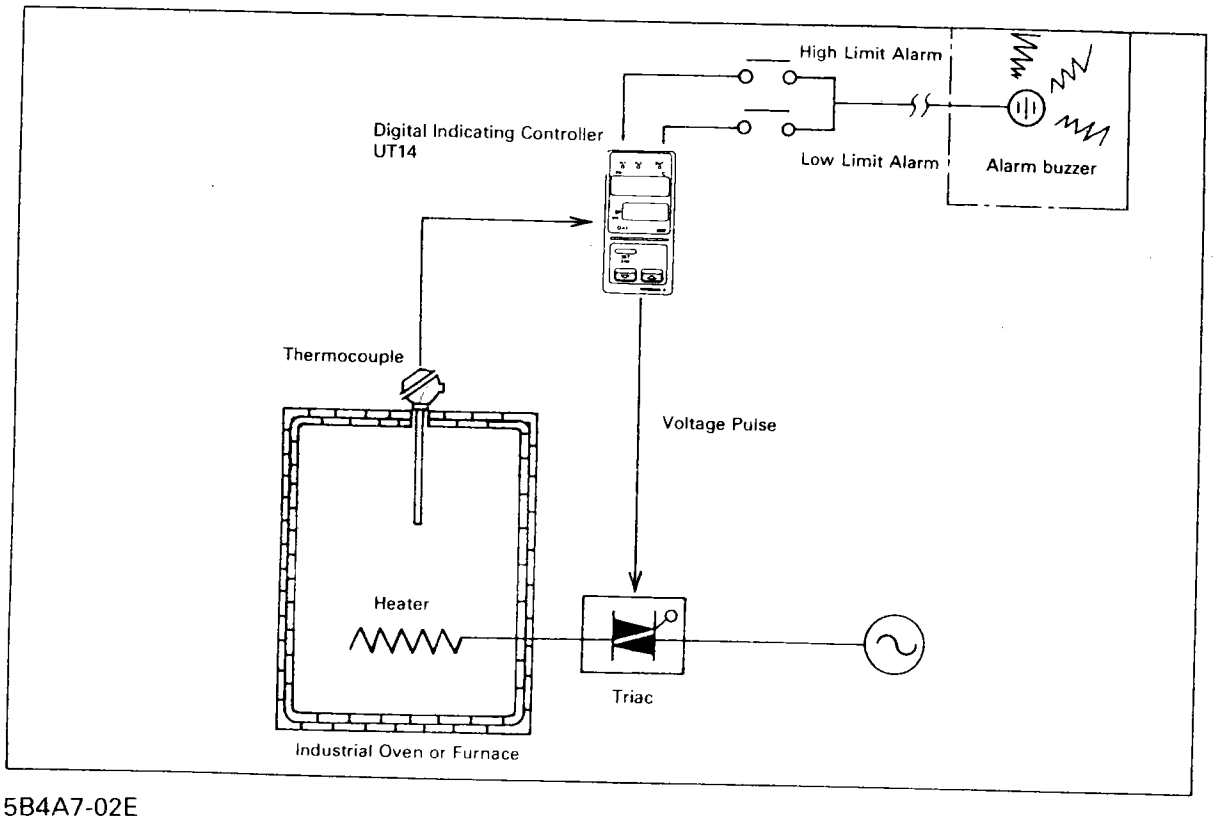
○ **RTD Input**

Relay output time-proportioning PID



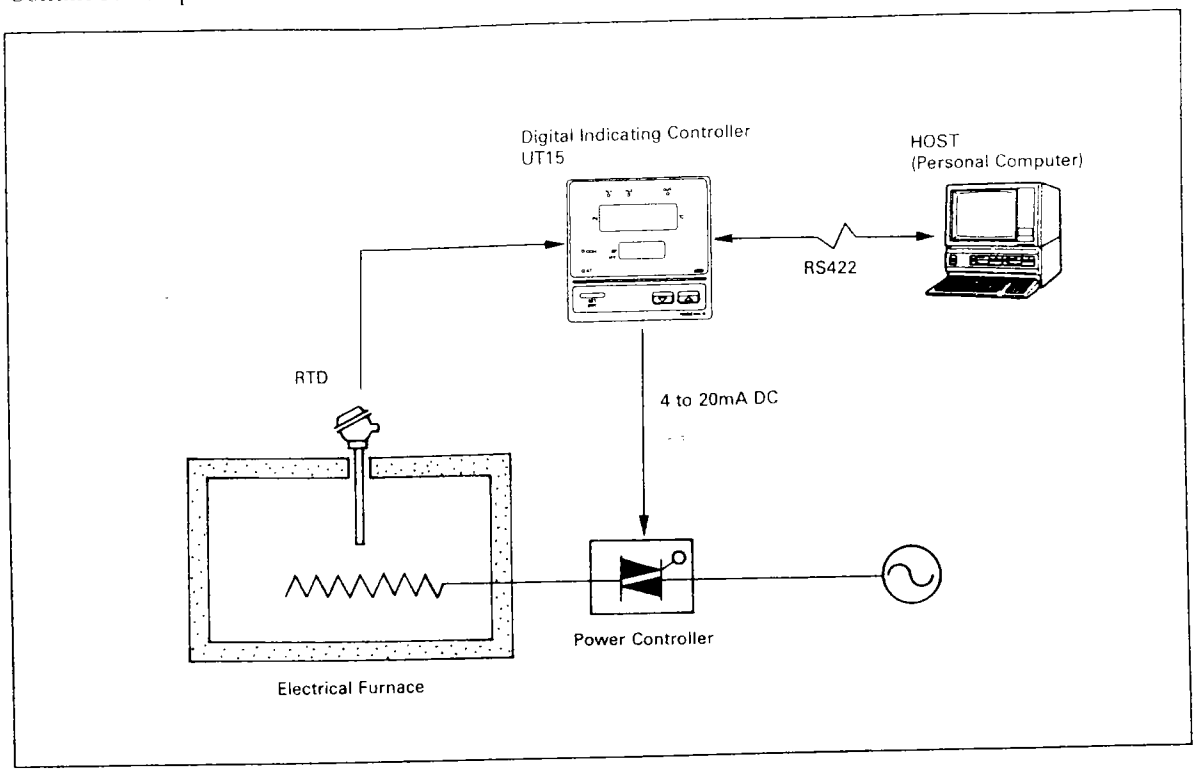
○ **Thermocouple Input**

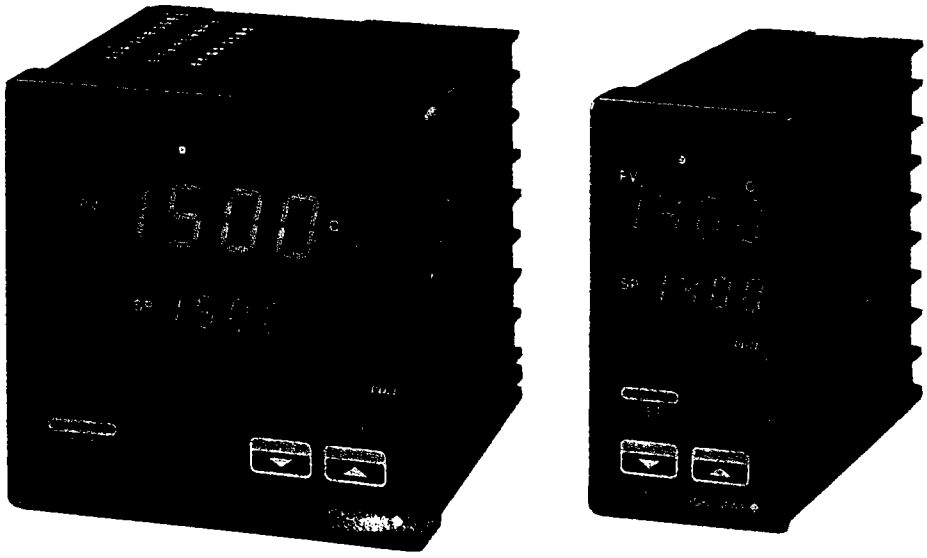
Voltage pulse output time-proportioning PID



○ **RTD Input**

Continuous output PID





3. "SUPER" – FUNCTION FOR SUPPRESSING OVERSHOOT

Provided as a standard function in the UT15 and UT14.

■ "Super" is most effective in temperature control

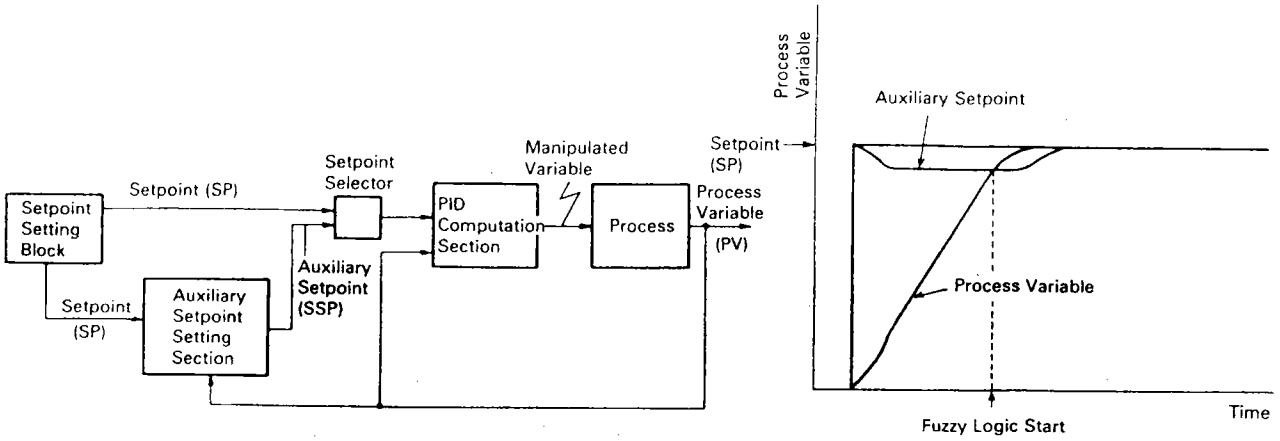
- To suppress overshoot
- To speed up starting
- For frequent load changes
- For frequent setpoint changes

■ "Super" works like a veteran operator

- When running the controller with an object that is susceptible to overshoot, the trained operator sets a low setpoint, and gradually adjusts it toward the correct setpoint while watching the control performance. "Super" applies "fuzzy logic" to carry out operations in the same way as the veteran operator does.

■ "Super" uses software that melds traditional PID control with the new "fuzzy logic."

- First auto-tuning (→ p. 16) is executed to obtain the PID constants and process characteristics (dead time and time constant). "Super" then takes control while monitoring the deviation, and upon sensing some problem from overshoot, automatically changes the setpoint (internal setpoint = SSP) to a slightly lower temporary value.
- Then while continuing to monitor the process deviation, it returns the setpoint little by little to the proper setpoint while keeping it within a range where there is no risk to over-shoot.
- "Fuzzy logic" as used here refers to "inference from vague information," based on qualitative and thus quite human representations as indicated by the underlined terms above, "little by little" and "slightly low."



■ "Super" can be turned ON or OFF

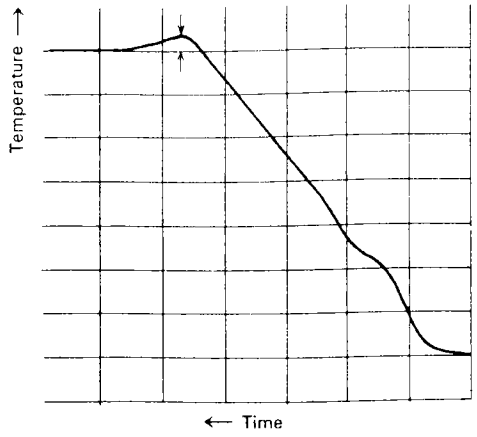
- When "super" is off, it does not function, and PID control is managed as usual according to the operator-entered setpoint. Upon shipment from the factory, "super" is set to off.
- If "super" is on, and auto-tuning has been run, the UT14/UT15 executes "fuzzy logic" based on the PID values calculated by it.

  If the constants have been set up manually, "fuzzy logic" is executed based on the PID values that the operator has set. Although this may not give the optimum setpoint, optimization adjustments will be made within the parameters given.

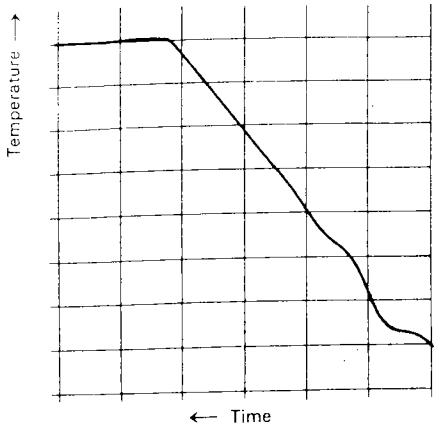
Examples of "Super" On and Off Comparisons

Response at time of change from rising → constant

With "super" OFF

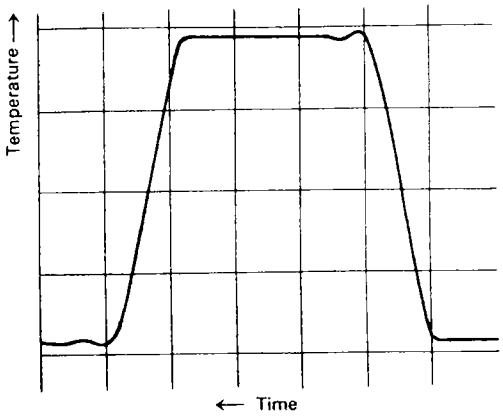


With "super" ON

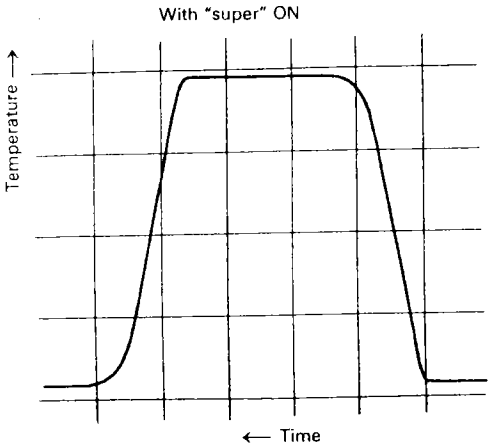


Response to an abrupt change in the setpoint

With "super" OFF

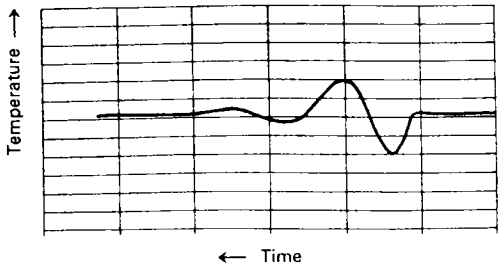


With "super" ON

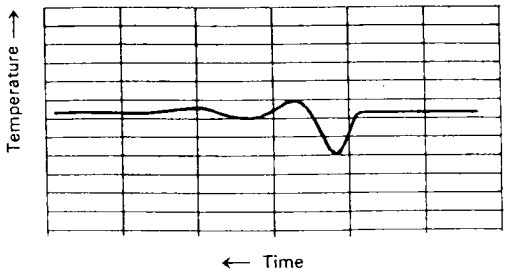


Response to a disturbance

With "super" OFF



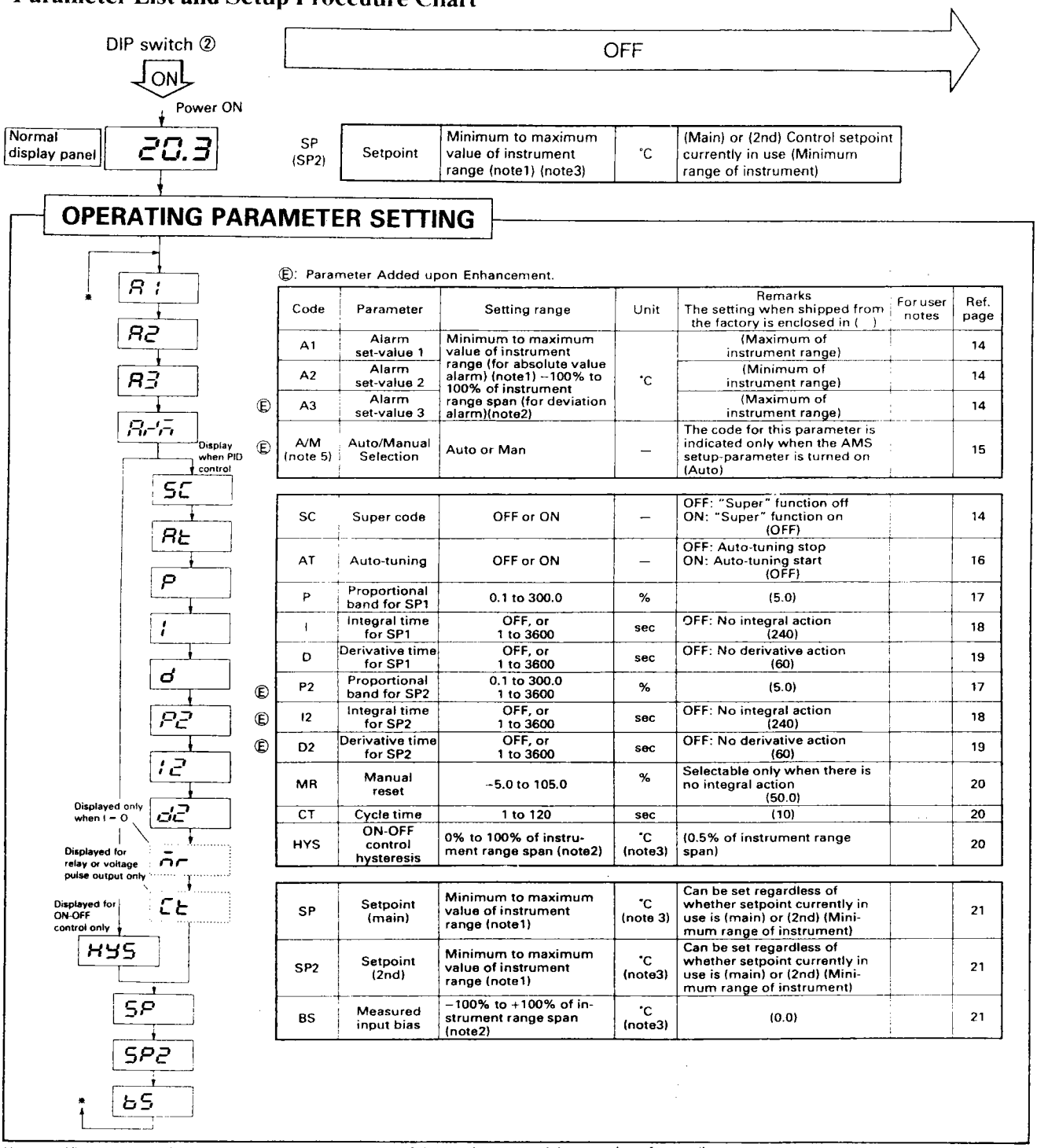
With "super" ON



4. BROAD RANGE OF FUNCTION VARIATIONS

Changing the settings for various parameters, especially the setup parameters, enables the selection of a broad range of instrument functions and greatly expands the usefulness of the instrument. (For details on individual functions, see the sections that describe them.)

Parameter List and Setup Procedure Chart



Ⓔ: Parameter Added upon Enhancement.

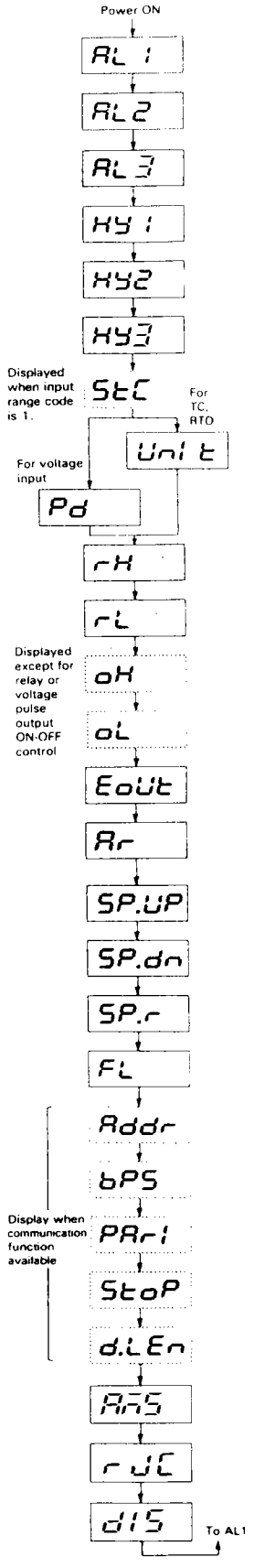
	Code	Parameter	Setting range	Unit	Remarks The setting when shipped from the factory is enclosed in ( )	For user notes	Ref. page
	A1	Alarm set-value 1	Minimum to maximum value of instrument range (for absolute value alarm) (note1) –100% to 100% of instrument range span (for deviation alarm)(note2)	°C	(Maximum of instrument range)		14
	A2	Alarm set-value 2			(Minimum of instrument range)		14
Ⓔ	A3	Alarm set-value 3			(Maximum of instrument range)		14
Ⓔ	A/M (note 5)	Auto/Manual Selection	Auto or Man	—	The code for this parameter is indicated only when the AMS setup-parameter is turned on (Auto)		15

	SC	Super code	OFF or ON	—	OFF: "Super" function off ON: "Super" function on (OFF)		14
	AT	Auto-tuning	OFF or ON	—	OFF: Auto-tuning stop ON: Auto-tuning start (OFF)		16
	P	Proportional band for SP1	0.1 to 300.0	%	(5.0)		17
	I	Integral time for SP1	OFF, or 1 to 3600	sec	OFF: No integral action (240)		18
	D	Derivative time for SP1	OFF, or 1 to 3600	sec	OFF: No derivative action (60)		19
Ⓔ	P2	Proportional band for SP2	0.1 to 300.0 1 to 3600	%	(5.0)		17
Ⓔ	I2	Integral time for SP2	OFF, or 1 to 3600	sec	OFF: No integral action (240)		18
Ⓔ	D2	Derivative time for SP2	OFF, or 1 to 3600	sec	OFF: No derivative action (60)		19
	MR	Manual reset	–5.0 to 105.0	%	Selectable only when there is no integral action (50.0)		20
	CT	Cycle time	1 to 120	sec	(10)		20
	HYS	ON-OFF control hysteresis	0% to 100% of instrument range span (note2)	°C (note3)	(0.5% of instrument range span)		20

	SP	Setpoint (main)	Minimum to maximum value of instrument range (note1)	°C (note 3)	Can be set regardless of whether setpoint currently in use is (main) or (2nd) (Minimum range of instrument)		21
	SP2	Setpoint (2nd)	Minimum to maximum value of instrument range (note1)	°C (note3)	Can be set regardless of whether setpoint currently in use is (main) or (2nd) (Minimum range of instrument)		21
	BS	Measured input bias	–100% to +100% of instrument range span (note2)	°C (note3)	(0.0)		21

Note 1: When scaling is in use, range (mesurement range) of the maximum or minimum value after scaling
Note 2: When scaling is in use, range (measurement range) after scaling
Note 3: °C or °F in the case of a thermocouple or RTD, no units in the case of voltage input
Note 4: A3 (Alarm 3) is indicated only when the 4-20 mA DC or voltage pulse output is specified as the control output.
Note 5: A/M is displayed only when the AMS setup-parameter is turned on.

SETUP-PARAMETER SETTING



Ⓔ: Parameter Added upon Enhancement.

	Code	Parameter	Setting range	Unit	Remarks The setting when shipped from the factory is enclosed in ( )	For user notes	Ref. page
	AL1	Alarm 1 Type	Off, or 1 to 20	—	OFF: No alarm For codes, see Table 3 (p.24) (1)		24
	AL2	Alarm 2 Type	OFF, or 1 to 20	—	OFF: No alarm For codes, see Table 3 (p.24) (2)		24
Ⓔ	AL3	Alarm 3 Type	OFF, or 1 to 21	—	OFF: No alarm For codes, see Table 3 (p.24)		24
	HY1	Alarm 1 hysteresis	0% to 100% of instrument range span	°C (note 3)	(0.5% of instrument range span in Engineering unit)		24
	HY2	Alarm 2 hysteresis	0% to 100% of instrument range span	°C (note 3)	(0.5% of instrument range span in Engineering unit)		24
Ⓔ	HY3	Alarm 3 hysteresis	0% to 100% of instrument rnage span	°C (note 3)	(0.5% of instrument range span in Engineering unit)		24
	STC	TC type selection (K or S)	(type K) (type S) 0 or 1	—	Can be set when input range code is 1. (0)		24
	UNIT	Temperature display units	°C or °F	—	Can be set only for a thermocouple or RTD (°C)		25
	PD	Decimal point position	0, 1, 2, 3	—	Can be set only for voltage input (1) 0:□□□□ 1:□□□.□ 2:□□.□□ 3:□.□□□		25
	RH	Maximum measurement range value	Maximum to minimum value of instrument range. But RL<RH	°C (note 3)	(Minimum range of instrument or 100.0)		25
	RL	Minimum measurement range value	Maximum to minimum value of instrument range. But RL<RH	°C (note 3)	(Minimum range of instrument or 0.0)		25
	OH	Output high limit	−5.0% to 105.0% of output. But OL<OH≤105.0%	%	Can be set except for time-proportioning PID ON-OFF control (100.0%)		26
	OL	Output low limit	−5.0% to 105.0% of output. But −5.0%≤OL<OH	%	Can be set except for time-proportioning PID ON-OFF control (0.0%)		26
	EOUT	Error output code	0: OFF or 0% 1: ON or 100%	—	Control output at time of burnout or A/D converter error is set to either 0% or 100%		26
	AR	Anti reset wind-up	0 or 0.1~999.9	%	Set the deviation of the PV from the SP at the point where the suspended PID computation is resumed. (0)		26
	SP.UP	Setpoint up-ramp slope	OFF or minimum to maximum span of instrument range per hr. or min. (note 2)	°C/hr. °C/min. (note 3)	Control setpoint is sloped at the specified angle on a change to the set point, on switching main ⇆ sub. and at power ON The slope time units are specified by SP.R. (OFF)		27
	SP.DN	Setpoint down-slope angle	OFF or minimum to maximum span of instrument range per hr, or min. (note 2)	°C/hr. °C/min. (note 3)			27
	SP.R	Slope setting units	0.1	—	0: °C/hr. 1: °C/min (0)		27
	FL	Filter	OFF, 1 to 120	sec	Set when the input fluctuates (1st-order laq time constant) OFF: NO filter (OFF)		27
	ADDR	Address	1 to 16	—	Specifies the number of the UT as seen from the host. (1)		34
	BPS	Communication rate	0, 1, 2, 3, 4, 5, 6	—	For codes, see p.34 (6)		34
	PARI	Parity	0, 1, 2	—	0: No parity 1: Even 2: Odd (0)		34
	STOP	Stop bits	1, 2	—	1:1 bit 1: 2 bits (1)		34
	D.LEN	Data length	7, 8	—	7: 7 bits 8: 8 bits (8)		34
Ⓔ	AMS	Auto/Manual Select function Setting	OFF, ON	—	OFF: Not display parameter ON: Display parameter (OFF)		28
Ⓔ	RJC	Reference Junction Temperature Compensation	OFF, or ON	—	OFF: Suspended ON: Activated (ON)		28
Ⓔ	DIS	DI selection	0, or 1	—	0: Setpoint 2 Selection 1: Key lock/unlock (0)		28

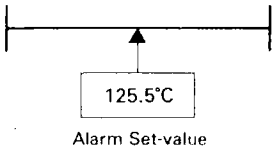
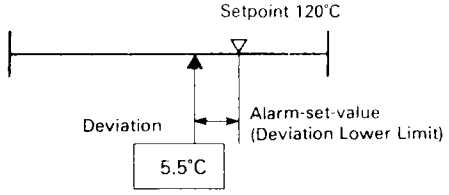
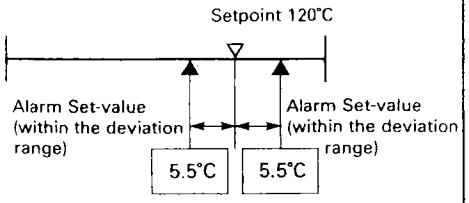
5. OPERATING-PARAMETER DESCRIPTIONS

5.1 Alarm Set-Value 1 (A1), Alarm Set-Value 2 (A2), Alarm Set-Value 3 (A3)

- There are three alarms, 1, 2 and 3. When shipped from the factory, alarm 1 is set as a high limit alarm, alarm 2 is set as a low limit alarm, and alarm 3 is set as a measurement upper limit alarm.
  The code for this parameter is indicated only when the AMS setup-parameter is turned on (Auto).
- Alarm setting corresponds to the alarm lamp and output of the same number

Alarm	Alarm set-value	Alarm lamp	Alarm output	Output terminal
1	A1	AL1	Dry relay contacts Contact rating 250V AC, 1A (resistive load)	⑬ ⑭
2	A2	AL2		⑫ ⑭
3	A3	AL3	Dry relay contacts Contact rating 250V AC, 3A (resistive load)	⑨ ⑩ ⑪

- Alarms 1, 2, and 3 can be selected individulally with AL1, AL2, and AL3 in the setup parameters. (→p.24)
- The types that can be selected fall into three classes: measured-value, deviation and deviation range alarms.

Measured-value alarm	Deviation alarm	Deviation range alarm
Measured-value upper limit, measured-value lower limit	Deviation upper limit, deviation lower limit	Deviation upper/lower limit, deviation within upper/lower limit
Directly specified as the numerical value at the alarm point	Specified as a unidicrectional deviation band from the setpoint	Specified as a bidirectional deviation band around the set-point
		

- If not using an alarm function, specify "OFF" for (AL1), (AL2), or (AL3) in the setup parameters.

5.2 Super Code (SC)

- If the super code (SC) is ON, the "super" function operates, and if it is OFF, the "super" function does not operate.
  However, "super" functions only for PID control action. If I, D, or ID is set to OFF, "super" does not function, even if SC = ON has been specified. (For descriptions concerning P, I, D, see → p.17 through 19.)
- Since it is a condition of the "super" operation for P, I, and D to all be set, an effective approach is to start autotuning after setting the super code to ON.

5.3 Auto/Manual (A/M)

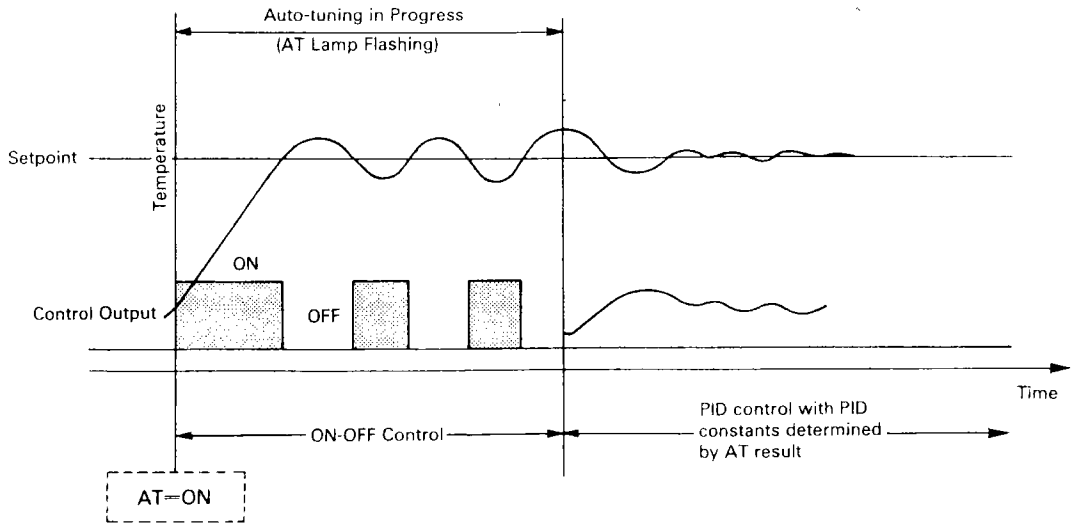
- Select Auto or Manual mode according to the procedure below.
  ① Turn off DIP switch 2.
  ② Turn on the AMS setup parameter. (See page 28)
  (The parameter has been preset to off before shipment from the factory.)
  ③ Select AUT or MAN for the A/M operating parameter.
- Notes on the Auto/Manual function
  ① In the MAN mode, the SP2 lamp blinks irrespective of whether the selected point is SP or SP2.
  ② If a power failure occurs in the AUTO or MAN mode, operation can be resumed from the state before the power failure.
  ③ The output upon re-powering after a power failure in the MAN mode is as follows:

a. OL: when EOUT = 0 and OL > 0.0
b. 0.0% when EOUT = 0 and OL≦0.0
c. OH: when EOUT = 1 and OH > 100.0
d. 100%: when EOUT = 1 and OL≧100.0

where,
EOUT is the output code upon abnormality
OH is the high limit in the measurement range
OL is the low limit in the measurement range
Upon re-powering after a power failure in the AUTO mode, the output is generated under the same conditions as those upon the power failure.

5.4 Auto-Tuning (AT)

- "Auto-tuning" refers to the process by which the UT15/UT14 itself computes and automatically sets its own PID constants (operating parameters, described later). Auto-tuning will not operate for ON-OFF control.
- In the UT14/UT15, the method used for auto-tuning is the "limit cycle method." Setting the operating parameter (AT) to "ON" starts auto-tuning. The UT15/UT14 then temporarily acts as an ON-OFF controller, computes the appropriate proportional band (P), integral time (I), and derivative time (D) from the resulting response, and sets those values as its own parameter values.
- After starting, the display panel automatically goes to the operating display panel, and the "AT lamp" on the front instrument panel continues flashing while auto-tuning is in progress.



- If the output upper and lower limits (setup parameters) have been set, the ON-OFF action during auto-tuning operates between the output high limit and low limit.
- Even if the setpoint is changed during auto-tuning, auto-tuning will continue with the setpoint that was in effect when it started. Note also that setpoint up- and down-slope angles are ignored during auto-tuning.
- Notice

  Auto-tuning should not be used in the following kinds of control systems:

  (1) Fast-response control systems, such as flow or pressure control

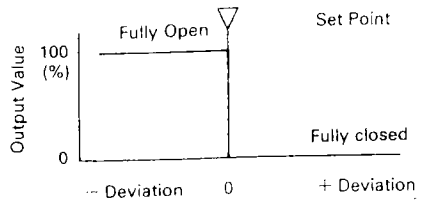
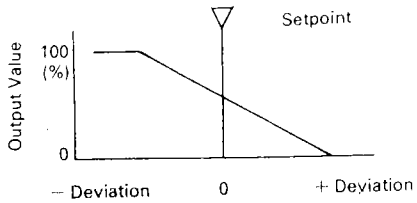
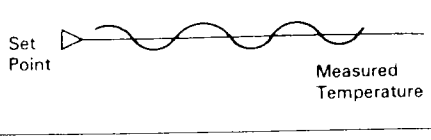
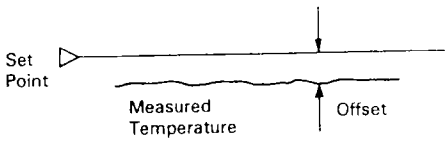
  (2) Processes where even short-term use of ON-OFF control may have undesirable effects.

  (Processes where there will be undesirable effects such as significant stress on final control elements, and processes where there is a risk that the measured value will exceed its permissible range with detrimental effects on product quality.
- Aborting auto-tuning before completion

  If auto-tuning must be aborted while in progress, set the operating parameter (AT) to "OFF." Auto-tuning is halted, and the AT lamp turns off. The PID constants go to the numerical values in effect before auto-tuning started.

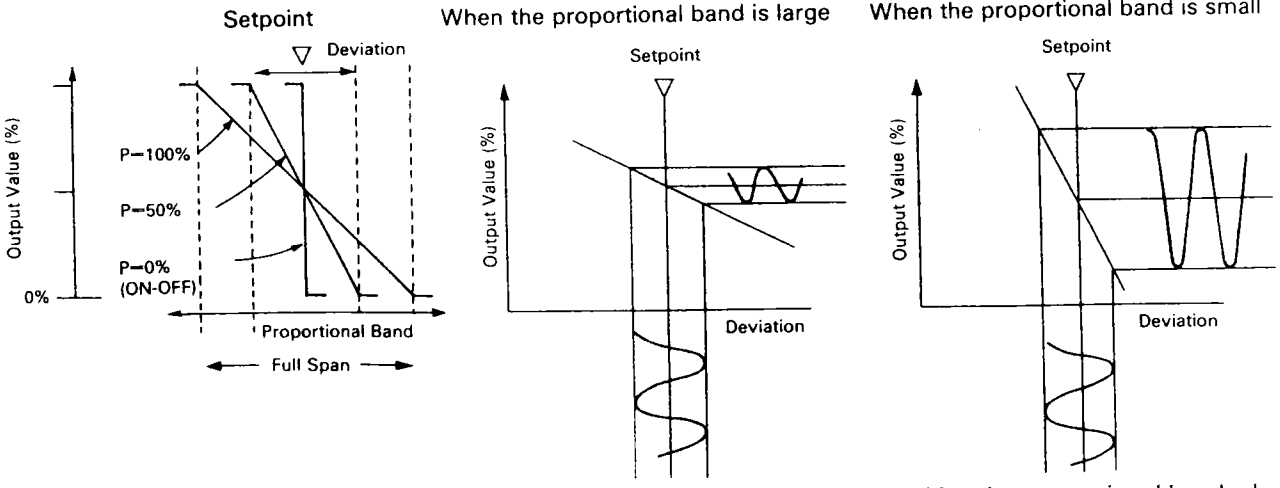
5.5 Proportional Band (P, P2)

- The proportional band is the parameter that regulates the effect of the proportional action (described below). The diagrams below illustrate proportional action by comparison to the simplest and purest sort of ON-OFF action.

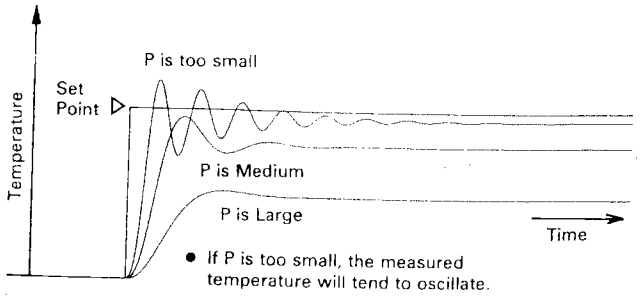
	ON-OFF action	Proportional action
Control output (Example of reverse action)	No intermediate state 	The output size changes continuously in proportion to the deviation magnitude 
Control performance	Easily leads to fluctuations 	Control performance is smooth 
Offset (normal deviation)	None	A difference (offset) between the setpoint and the measured temperature arises inherently from the basic operating principle.

- The proportional band (P) is defined as the quotient of the input change (in percent) [or deviation band (%)] that corresponds to a change from 0 to 100% in the control output. The smaller the proportional band is set, the greater the output change for a small deviation, and the more susceptible the system will be to oscillation in the control performance; on the other hand, the offset will be smaller. If the proportional band is set to the smallest value possible (proportional band = 0%), ON-OFF control results.

(Example of reverse action)

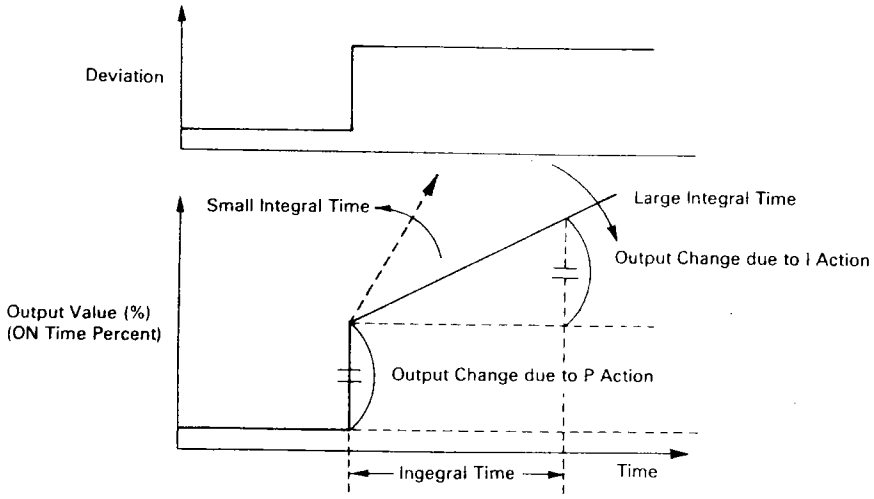


- If making fine adjustment to a proportional band obtained from auto-tuning, or making the proportional band adjustment manually, it is best to keep the following in mind:
  - Adjust from larger numerical values to smaller ones.
  - If cycling appears, the value is too small
  - You cannot make offset disappear by a proportional-band adjustment



5.6 Integral Time (I, I2)

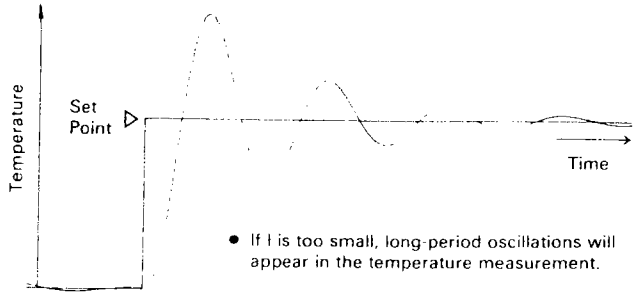
- "Integral action" (I action) is a function that will automatically diminish the offset (normal deviation) that cannot be inherently prevented with proportional action. The parameter that specifies how the integral action will operate is the integral time (I).
- The integral action continuously increases or decreases the output in proportion to the time integral of the deviation (the product of the deviation and the time that deviation continues).
- Integral action is normally used together with proportional action as proportional-plus-integral action (PI action).



The integral time (I) is defined as the time required, when a stepwise change in deviation is imposed, to develop an output change due to integral action that is exactly equal to the change due to proportional action.

The longer the integral time set, the slower the change in output; the smaller the time, the faster the output changes. If integral action is not to be used, the integral parameter is set to OFF.

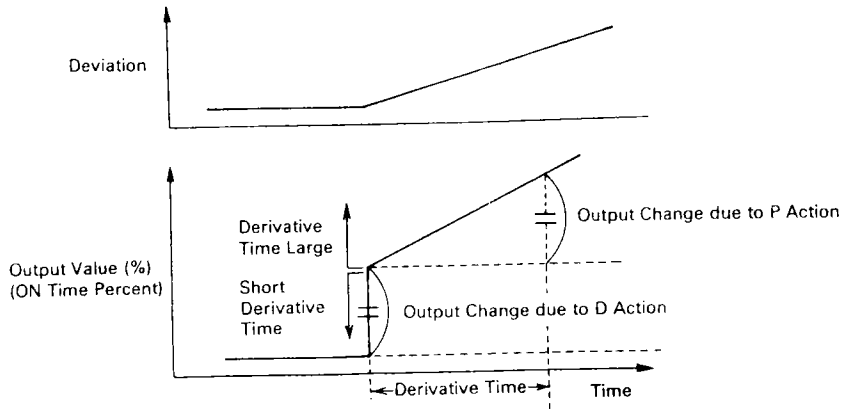
- Shortening the integral time, like narrowing the proportional band, will cause the measured temperature to become oscillatory. However, a peculiarity of oscillation due to integral action is the period which is longer than that of the oscillation occurring when the proportional band is reduced.
- If the integral time is to be adjusted manually, the following should be kept in mind:



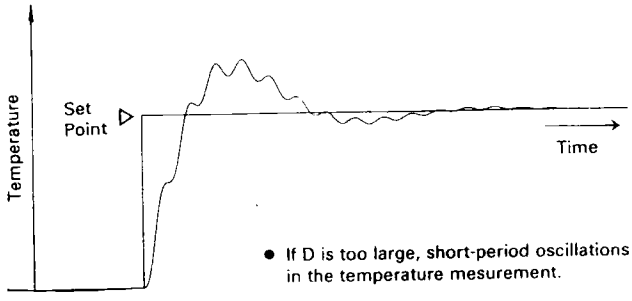
- Place the main emphasis on making the offset smaller.
  - Adjust from a longer time to a shorter one.
  - If oscillation appears with a longer period than that occurring when the proportional band is made smaller, you have made the integral time too short.

5.7 Derivative Time (D, D2)

- If the controlled object has a large time constant or dead time, the corrective action will be too slow with proportional action or proportional-plus-integral action alone, causing over-shoot. However, even just sensing whether the deviation is on an increasing or decreasing trend and adding some early corrective action can improve the controllability. Thus, the derivative action (D action) is action that changes the output in proportion to the deviation derivative (rate-of-change). The parameter that sets how the derivative action is to operate is the derivative time (D).
- The derivative time (D) is defined as the time required with PD action, when a constant-slope change in deviation is imposed, to develop an output change due to derivative action that is exactly equal to the change due to proportional action.



- The longer the derivative time set, the stronger the corrective action, and the more likely the output will become oscillatory. Oscillations due to derivative action are characterized by a short period.
- The derivative time = 0 seconds when D = OFF is specified; the derivative action does not function when this is set. For control of fast-responding input such as pressure and flow, or of input characterized by rapid fluctuation, such as optical sensors, a specification of D = OFF should always be used.
- If the D parameter is to be adjusted manually, the following should be kept in mind:
  - Adjust from a shorter time to a longer one.
  - If short-period oscillations appear, you have made the time too long.



- If D is too large, short-period oscillations will appear in the temperature mesurement.

5.8 Manual Reset (MR)

(Can be selected only when integral time (I) = OFF is set)

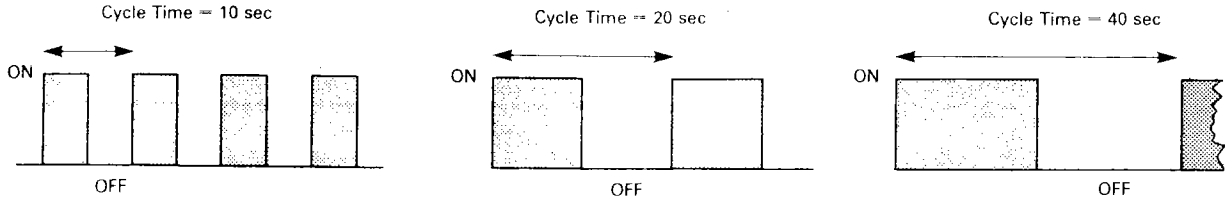
- If the integral action is OFF (if proportional action only or proportional-plus-derivative action is specified), a deviation will remain at all times between the setpoint and measured value, for every change in the process state (offset = normal deviation). The parameter that is used to manually reduce this normal deviation is the manual reset.

5.9 Cycle Time (CT)

(Can be set in the case of relay output time-proportioning PID or voltage pulse output time-proportioning PID)

- In the case of time-proportioning PID control, the cycle time is the time required for the relay output or voltage pulse output to go through one full ON-OFF cycle. The proportion of ON time in the cycle is proportional to the control output value. Setting a shorter cycle time results in a faster period, and allows for more finely-grained control. At the same time, shortening the ON-OFF interval reduces the life of relays. With relay output the cycle time is generally set at 10 to 30 seconds.

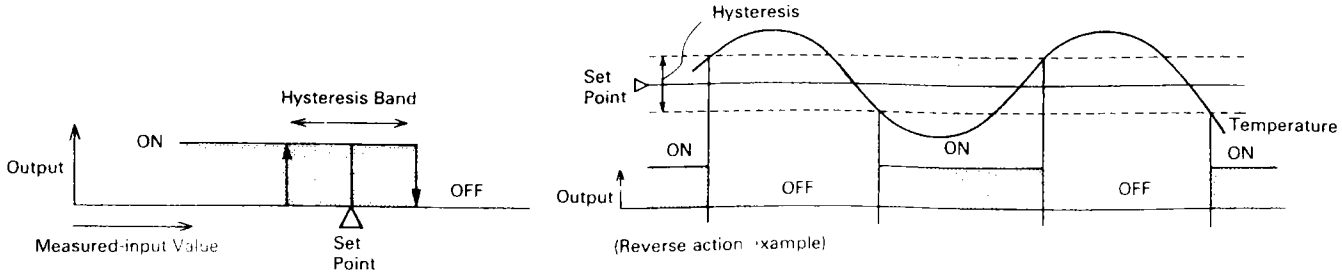
Comparison of operation for identical control output (50%)



5.10 ON-OFF Control Hysteresis (HYS)

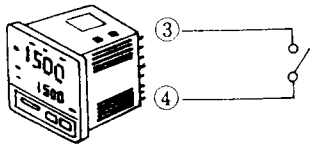
(Can be selected only when DIP switch ③ is OFF, and ON-OFF control has been selected)

- Because there are only two output states, ON and OFF, in ON-OFF control, the result of control will cycle as shown in the figure below. Because rapid, repetitive ON-OFF action may occur if the hysteresis is set too narrow, chattering will result in the case of relay contact output and will significantly reduce the relay life, which is not desirable. If this occurs, increase the hysteresis so that there is no relay chattering.

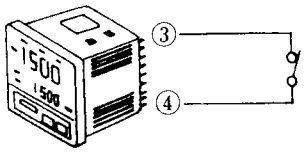


5.11 Setpoint (SP), 2nd Setpoint (SP2)

- If you wish to change or display the "main" setpoint when running with the "2nd" setpoint, you can use the (SP) operating parameter.
- If you wish to change or display the "2nd" setpoint when running with the "main" setpoint, you can use the (SP2) operating parameter.
- Switching between "main" and "2nd" is done from outside the instrument using dry contacts. To use this function, set the setup paramenter DIS to 0 (See "DI selection", page 28). As shown in the figure below, when the contact between terminal ③ and ④ is open, the (main) setpoint is selected, and when it is closed, the (2nd) setpoint is selected. This switching cannot be done using the front panel keys.



Setpoint (main)



Setpoint (2nd)

Contact Rating
(12V Minimum,
10mA Minimum)

- When setpoint (2nd) has been selected, the "SP2" lamp on the display turns on.
- When the "SP2" lamp is off, the setpoint that is displayed and set through the operating display panel is the "main" setpoint; when the "SP2" lamp is on, it is the "2nd" setpoint that is displayed and set.

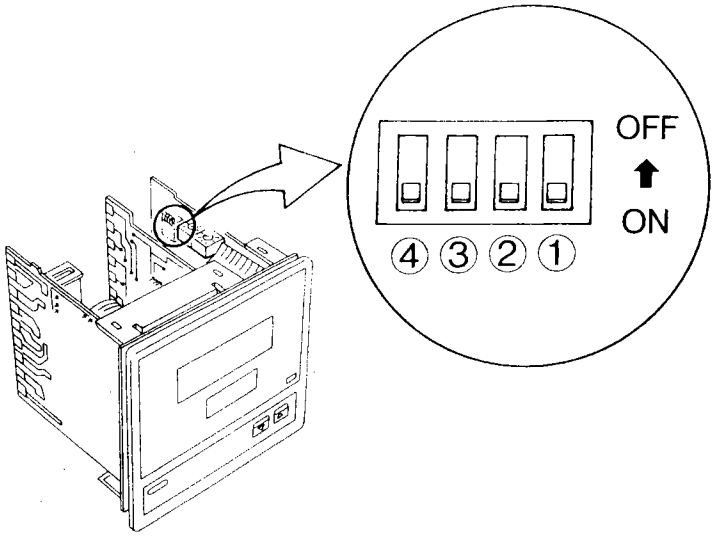
5.12 Measured-Input Bias (BS)

- This function adds a constant bias to the input, and causes the resulting value to be used within the instrument for display and control.

Measured Input Value	+	Bias Value	=	Instrument internal measured value

- There are some situations where, due to the physical characteristics of the sensor, the measured value is lower than the true value by a constant amount. One example of this is where a furnace's internal temperature is measured and used as a substitute for the temperature of the material. This function is used in situations such as these.
- If the measured value is within the accuracy rating but there is a difference from the numerical value at another instrument, and this is found annoying, this function can be used for fine adjustments.

6. FUNCTION SELECTION USING DIP SWITCHES



6.1 Key Lock/Unlock Selection (DIP switch ①)

- Key lock is selected when you want to keep parameters from being changed. Setting internal DIP switch ① of the instrument to OFF turns the lock on, and none of the keys will function when pressed. When the DIP switch is turned back ON, the keys are unlocked and function normally.

DIP switch ①	ON	OFF
Key lock	Unlock	Lock

is status when shipped

Note: The key lock mode can also be switched by turning on/off the external contact. See Section 7.14, "DI Selection (DIS)." P. 28

6.2 Operating/Setup Parameter Selection (DIP Switch ②)

- For everyday operations, operate with DIP switch ② ON. Turn this DIP switch OFF only to change the setup parameters.

DIP switch ②	ON	OFF
Parameter	Operating parameters	Setup parameters

is status when shipped

6.3 PID/ON-OFF Control Selection (DIP Switch ③)

- DIP switch ③ is used to select whether the UT15 or UT14 will be used as a PID controller, or as an ON-OFF controller.

DIP switch ③	ON	OFF
Control mode	PID control	ON-OFF control

is status when shipped

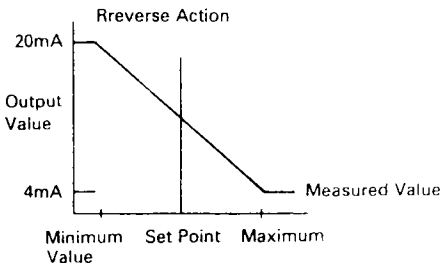
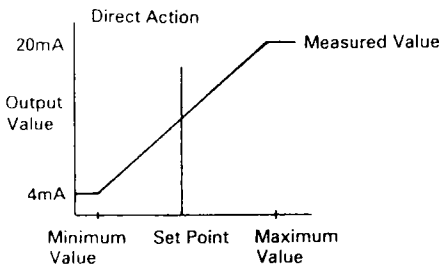
6.4 Direct/Reverse Action Selection (DIP Switch ④)

- Use DIP switch ④ to switch between direct and reverse action.

DIP switch ④	ON	OFF
Control acton	Reverse	Direct

□ is status when shipped

- Direct and reverse action refer to the direction of output change for a positive or negative deviation. The relationships are shown in the following table. Reverse action is used for temperature control in a heating system, and direct action for a cooling system.

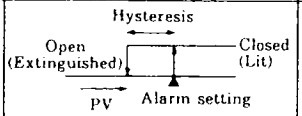
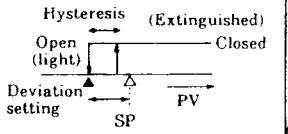
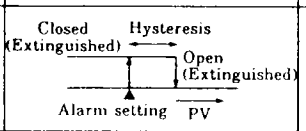
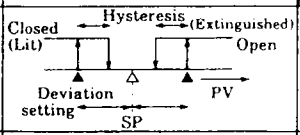
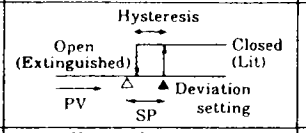
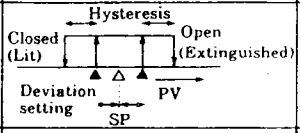
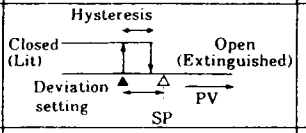
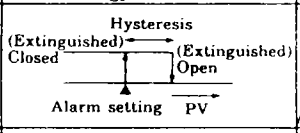
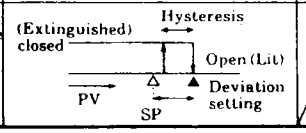
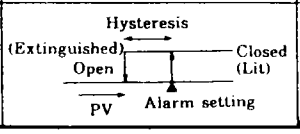
	Measured value > Setpoint		Measured value < Setpoint	
Action	Reverse action	Direct action	Reverse action	Direct action
ON-OFF	OFF	ON	ON	OFF
mA output	Current decreases	Current increases	Current increases	Current decreases
ON-OFF time proportion	On time decreases	ON time increases	ON time increases	ON time decreases
Output change direction				

7. DESCRIPTION OF SETUP PARAMETERS

7.1 Alarm 1 Type (AL1), Alarm 2 Type (AL2), Alarm 3 Type (AL3)

- The alarm type is specified individually for Alarm 1, Alarm 2, and Alarm 3 using the alarm codes from the table. An alarm whose number is specified as OFF does not function.
  A3 (Alarm 3) can be set only when the 4-20 mA DC or voltage pulse output is specified as the control output.

Table 3. Alarm Codes

Alarm Type	Alarm Action Open/Closed represents relay contact status. (Lit)/(Extinguished) represents lamp status.	Alarm Type Code: Contact Closed On Alarm Generation	Alarm Type Code: Contact Open On Alarm Generation	Alarm Type	Alarm Action Open/Closed represents relay contact status. (Lit)/(Extinguished) represents lamp status.	Alarm Type Code: Contact Closed On Alarm Generation	Alarm Type Code: Contact Open On Alarm Generation
Without alarm		OFF					
PV high limit		1 11		De-energize on deviation low limit alarm			6 16
PV low limit		2 12		Deviation high/low limit		7 17	
Deviation high limit		3 13		Within deviation high/low limit		8 18	
Deviation low limit		4 14		De-energize on PV high limit			9 19
De-energize on deviation high limit			5 15	De-energize on PV low limit			10 20

- Other than above alarm types, Fail output can be selected for AL3.
  Alarm Type Code: 21
  Alarm contact will be opened when an instruments fails.

7.2 Alarm 1 Hysteresis (HY1), Alarm 2 Hysteresis (HY2)

- If an alarm turns on and off repeatedly at a high frequency, the hysteresis band can be set wider.

7.3 TC Type (K or S) Selection (STC)

(Can be set only when input range code is 1.)

- This parameter is to select TC type of input between K and S when input range code is 1.
- The initial value from the factory is 0 (K type). When S thermocouple input is required, set Rotary switch Ⓐ to 1 in advance, and then set this parameter to 1.

● — **Notice** —

The parameters shown below are automatically initialized when this parameter (STC) or/and Temperature Display Units parameter (UNIT) is changed.

Operating Parameters: A1, A2, A3, HYS, SP, SP2, BS

Setup Parameters: HY1, HY2, HY3, PD, RH, RL, SP.UP, SP.DN

7.4 Temperature Display Units (UNIT)

(Can be set only for thermocouple or RTD input)

- This parameter is used when °F must be selected.

● — **Notice** —

Some parameters are automatically initialized when this parameter is changed. (See 7.3 for the details.)

7.5 Decimal Point Position (PD)

(Can be set for voltage input only)

- In the case of voltage input such as 1 to 5V DC, the initial range for the converted input is 0.0 to 100.0 (no units). If the input is to be scaled to read in the engineering units associated with the physical quantity measured (for example, 0 to 600 (t/h) or 4 to 12 (pH)), the decimal point position is set by this code.

Range after scaling	Code
−1999 to 9999	0
−199.9 to 999.9	1
−19.99 to 99.99	2
−1.999 to 9.999	3

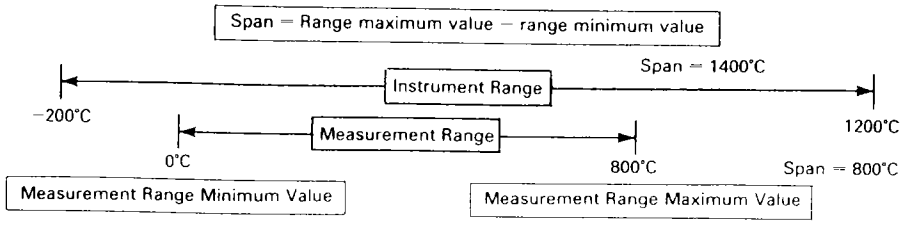
K	°C	°F	%	kg/cm²
kgf/cm²	m³/min	m³/h	Nm³/min	Nm³/h
Nm³/s	m³/s	l/s	l/min	l/h
kl/h	g/s	g/min	g/h	kg/s
kg/min	kg/h	t/s	t/min	t/h
mm/s	m/s	mmH₂O	mmAq	mmHg
cmHg	Wt%	Vol%	m	cm
mm	cm²	m²	cm³	m³
%RH	mol	min	h	l
kl	Torr	rpm	pH	abs
kg/cm²G	kgf/cm²G	×10²	×10³	×10⁶

Unit Seals (Labels)

- "Unit seals" (labels) are provided for use when the engineering units are other than °C or °F, and should be affixed adjacent to the display. If there is no appropriate unit seal, write the desired units on one of the blank seals and affix it adjacent to the display.

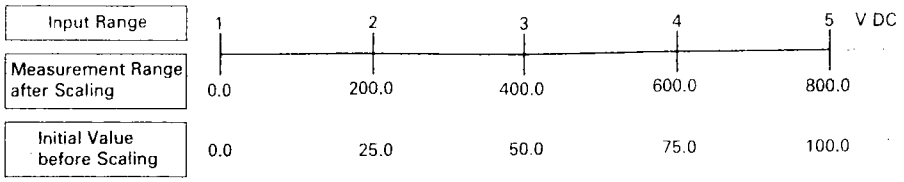
7.6 Maximum Mesurement Range Value (RH), Minimum Measurement Range Value (RL) [For range changes and scaling]

- The ranges listed in the "Input Range Code Table" for the UT14/UT15 are referred to by the name instrument range. To change to a desired range within an "instrument range," that range can be specified using these parameters.
- Any range other than an "instrument range" is referred to in a UT14/UT15 as a measurement range. Note that span refers to the width of the range, with which it has the following relationship:



TI 5B4A7-02E

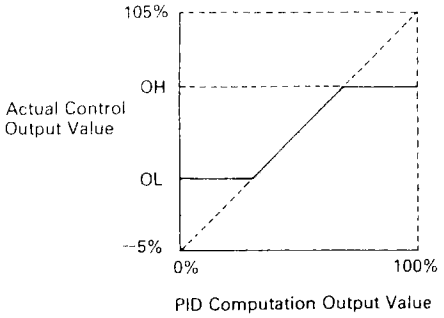
- Even though a new measurement range has been specified, the accuracy of the instrument does not change. An exception is with RTD ranges. A change in range from a 100°C span (±0.5% of span ±1 digit) to a 200°C span (±0.4% of span ±1 digit) yields an improvement.
- In the case of DC voltage input, the user can specify conversion to an engineering unit scale and select the decimal point position.
  Example of scaling to 0.0 to 800.0 for 1 to 5V DC input



7.7 Output High Limit (OH), Output Low Limit (OL)

(Cannot be set for relay or voltage pulse output ON-OFF control)

- Specified when restrictions are to be placed on the output value.
- The operating range of the restricted output is limited to the range between the output low limit (OL) and the high limit (OH)
- This feature can be used if you need to maintain a certain base heating level even if output goes to its minimum, and/or if you do not wish to allow the heating level to go all the way to 0% or 100%, in order to protect equipment.



7.8 Error Output Code (EOUT)

- The error output code (EOUT) determines whether the control output will be set to 0% (or OFF), or to 100% (or ON) if one of the errors shown in right table is detected by the self-diagnostic function of the UT14/UT15.
- Whenever power is returned to the instrument after a power outage of 20ms or more, the control output restarts from the value specified by (EOUT).

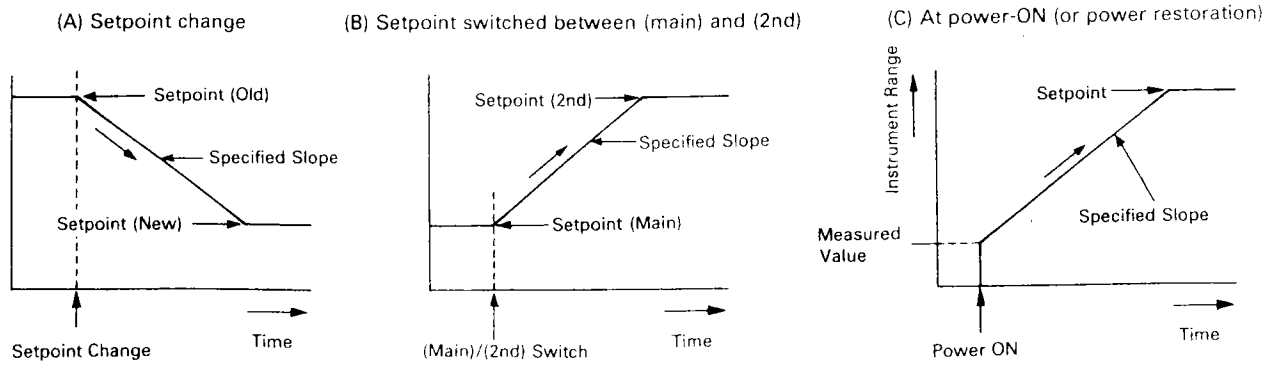
Error	Display
Thermocouple RTD burnout	b.oUt
A/D converter error	E300
Setting data error	E400

7.9 Anti-reset Wind-up (AR)

- If a large deviation is present for a very long time, at the begining of operation, for example, a phenomenon known as reset wind-up can occur. In such cases, UT14/UT15 suspend PID computation to eliminate this and automatically set the point where it resume the PID calculation.
  In those few cases where this automatic calculation cannot eliminate the reset wind-up, AR function can be used to fix the point where UT14/UT15 resume PID calculation. (Note: AR is set in % of Proportional Band.)
  AR: 0 (default)
  This should be used in most cases.
  UT14/UT15 automatically determinded the point at which PID communication resumes.
  : 0.1 to 999.9 (% of Proportional Band)
  Fixes the point at which PID computation resumes.

7.10 Setpoint Up-Ramp Slope (SP.UP), Setpoint Down-Ramp Slope (SP.DN), Slope Setting Units (SP.R)

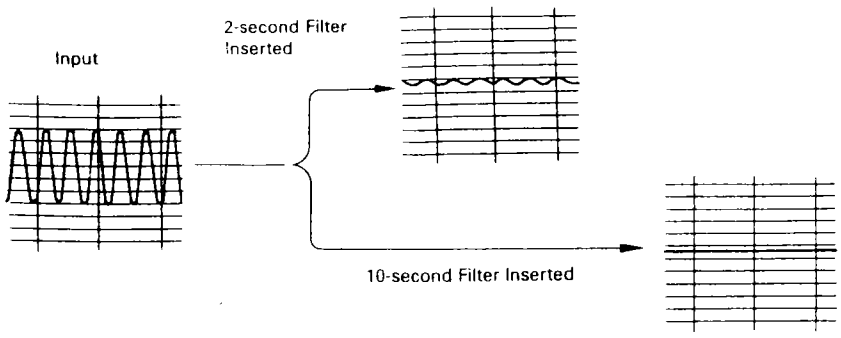
- When you do not want the setpoint to change suddenly, or when you want it to change with a constant slope, these set the slope values to increase or decrease.
- This feature functions in the following three situations:
  - When the setpoint is changed.
  - When the setpoint is switched between (main) and (2nd).
  - When power is turned ON (or when it is restored after a power outage).
    When power is turned ON, or is restored, the value goes from the current measured-value to the setpoint, and the effective setpoint changes according to the slope that has been specified.



- The slope setting units for both up-ramp (SP.UP) and down-ramp (SP.DN) can be specified as either "/hr." or as "/min." When shipped from the factory, "/hr." is selected.
- The amount of increase or decrease in the setpoint for each output update period is truncated to a certain resolution. Therefore, if the range is broad and a very gradual slope has been specified, a slight disparity may arise in the setpoint after a long time has elapsed. If strict adherence to a preset slope is required under such extreme conditions, a program controller (UP25, UP30, or UP40) should be selected.

7.11 Filter (FL)

- When there are severe fluctuations in the displayed value, such that the lower-order digits are difficult to read, a digital filter can be inserted in the signal path. The parameter specifies a first-order lag time constant. When OFF is specified, the filter does not function.



7.12 A/M Parameter Setting (AMS)

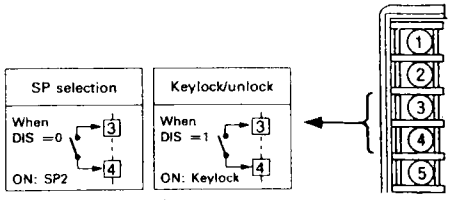
- To view and manipulate the control output in the manual mode, first the A/M parameter must be set by turning on the AMS parameter which has been preset to off (A/M not set) before delivery from the factory. Then the user is allowed to alternate the mode between Auto and Man as necessary.

7.13 Reference Junction Compensation (RJC)

- Usually input values are compensated with the RJC function provided for the controller. However, if it is necessary to rigorously compensate the values with a device other than the function of the controller, for example with a zero-compensator, the RJC function of the controller can be suspended by turning off the RJC parameter.

7.14 DI Selection (DIS)

- When the DI selection (DIS) parameter is set to 0, the setpoint can be alternated between SP and SP2 by switching on/off external contacts 3 and 4 below. (When they are switched on, SP2 is selected.)
- When the DI selection (DIS) parameter is set to 1, the key lock mode can be alternated between Key lock/Unlock by switching on/off terminals 3 and 4 below. (When they are switched on, Key lock is selected.)



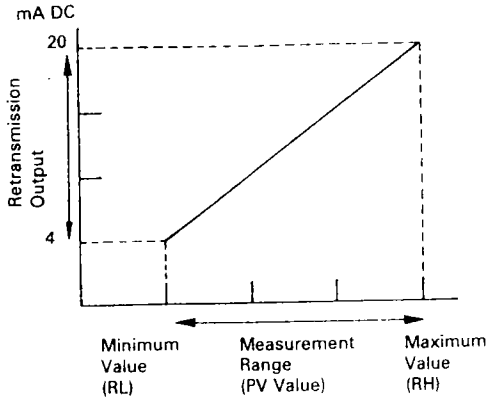
8. MEASURED-VALUE RETRANSMISSION AND RS422 COMMUNICATIONS (OPTIONS)

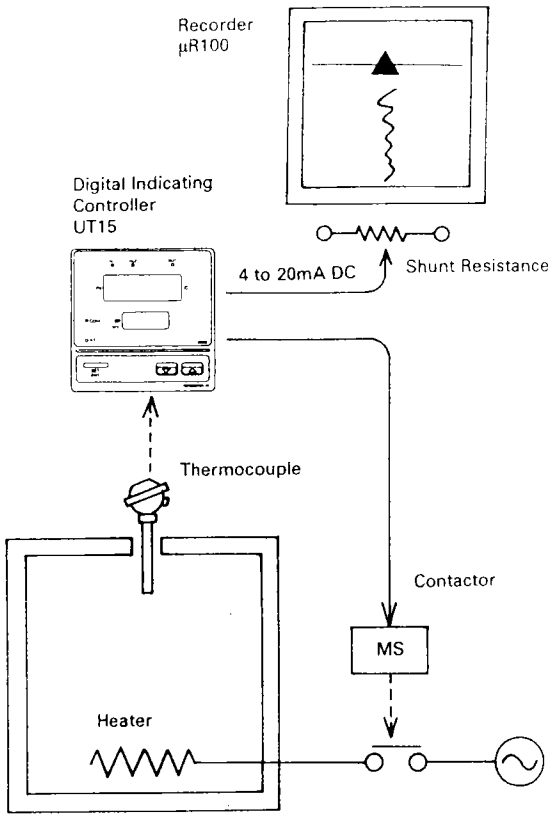
8.1 Retransmission Output

(Available when /RET optional code is specified. This option can be added to the UT15 only.)

If this function is added, the temperature measurement can be retransmitted as an analog current signal to a remote instrument such as a recorder. This function outputs a 4 to 20mA DC signal corresponding to the range between the measurement range minimum value (RL) and the measurement range maximum value (RH).

Permissible load resistance	600Ω
Accuracy	±0.3% (relative to output)



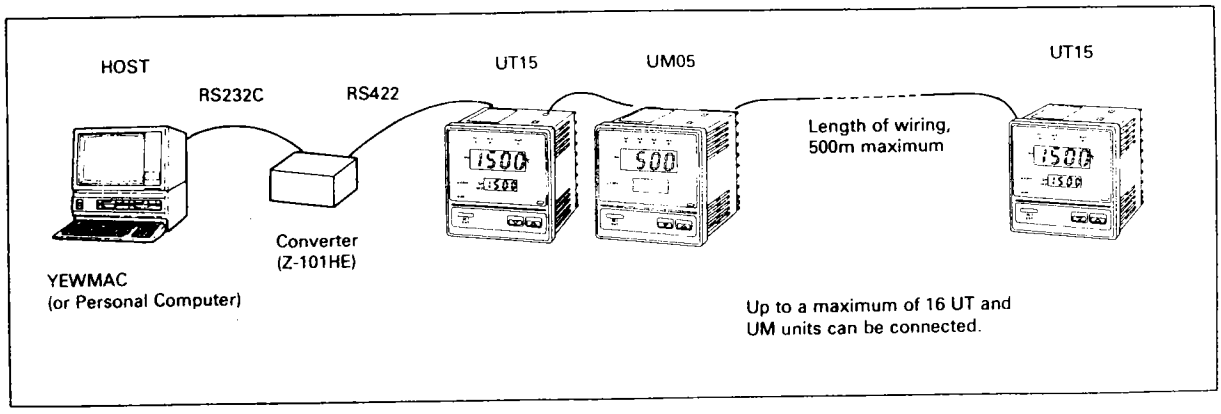


8.2 RS422 Communications

(Available when option code /RS422 is specified. This option can be added to the UT15 only.)

8.2.1 Communication Overview

The UT15 enables a host computer acting via communications to set data from the host to the UT15, and to read out measurement data and internal setting data from the UT15. For an RS232C port, the connection can be accomplished via a converter (for example, Sharp Model Z-101HE).

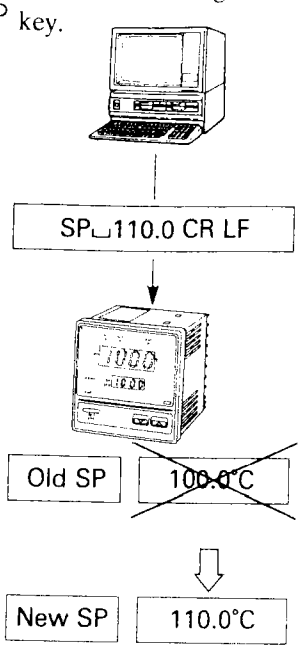


8.2.2 Procedures for Changing UT15 Operating Parameters from the Host (PC)Side

SET command = Command ␣ Data CR LF

␣ : Space code
CR LF: Terminator

Concept is the same as for entering a setting with the SET ENT key.



Command	Parameter changed
A1	Alarm 1 (AL1) set-value (A1)
A2	Alarm2(AL2) set value (A2)
A3	Alarm 3 (AL3) set value (A3)
HY	ON-OFF control hysteresis
SC	Super code (SC)
AT	Auto-tuning (AT)
PB	Proportional band for SP1 (P)
TI	Integral time for SP1 (I)
TD	Derivative time for SP1 (D)
P2	Proportional band for SP2 (P2)
I2	Integral time for SP2 (I2)
D2	Derivative time for SP2 (D2)
MR	Manual reset (MR)
CT	Cycle time (CT)
SP	Setpoint (main) (SP)
S2	Setpoint (2nd) (SP2)
BS	Bias (BS)
OP	Manipulated output value during manual operation
AM	Auto/Manual selection (AM)

A UT15 that has accepted a command from a host will return a response (within 125 ms). The host computer should always compare the data in the response to that in the SET command.

Response ␣ Command ␣ Data CR LF

␣ : Space code
CR LF: Terminator

- Outside setting range
- Key-lock on

In these cases..

Data are not changed, and the current setting is returned.

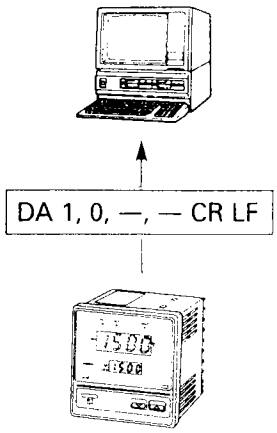
8.2.3 Procedure for Reading Internal UT15 Data from the Host (PC) Side

DISP command or READ command = Command ␣ CR LF

␣ : Space code
CR LF: Terminator

DISP=Abbreviation for "display"

Command	Parameters that can be read
DP	Control output value (OP) Input measured-value (PV) Setpoint (CSP) (Control target value currently in use) Control deviation value (DEV) ··· (PV−CSP) SP identifier (SNO) 1 = (main) 2 = (2nd) (Identify control setpoint currently in use)
DA	Alarm 1 (AL1) status 0 = OFF Alarm 2 (AL2) status 1 = ON Alarm 3 (AL3)



Command	Parameter(s) that can be read
RH	Maximum measurement range value (RH)
RL	Minimum measurement range value (RL)
DV	Device code For UT15, code "UT15"
A1	Alarm 1 (AL1) set-value (A1)
A2	Alarm 2 (AL2) set-value (A2)
A3	Alarm 3 (AL3) set-value (A3)
HY	ON-OFF control hysteresis
SC	Super code (SC)
AT	Auto-tuning (AT)
PB	Proportional band for SP1 (P)
TI	Integral time for SP1 (I)
TD	Derivative time for SP1 (D)
P2	Proportional band for SP2 (P2)
I2	Integral time for SP2 (I2)
D2	Derivative time for SP2 (D2)
MR	Manual reset (MR)
CT	Cycle time (CT)
SP	Setpoint (main) (SP)
S2	Setpoint (2nd) (SP2)
BS	Bias (BS)
OP	Manipulated output value during manual operation
AM	Auto/Manual selection (AM)

The UT15 that received the DISP or READ command from the host returns a response including the data. (Less than 20msec.)

(Example)

Response = { DP ␣ OP, PV, CSP, DEV, SNO CR LF
RH ␣ 105.0 CR LF }

8.2.4 Communucation Protocol

① Send the OPEN command.

HOST ——— ESC O␣address CR LF ———→ Destination UT15 (ESC) ASCII Escape code $(27)_{10}$, $(1B)_{16}$

② If the destination UT15 recognizes the address and OPEN command, it returns a response.

HOST ←——— ESC O␣address CR LF ——— UT15 opened by command

③ The destination UT15 goes from the CLOSE status (in which it will accept only the OPEN command) to the OPEN status (in which it will accept any command). The COM lamp of a UT15 in the OPEN status turns on.

④ Transmit any desired command (SET, DISP, READ command).

⑤ Transmit the CLOSE command.

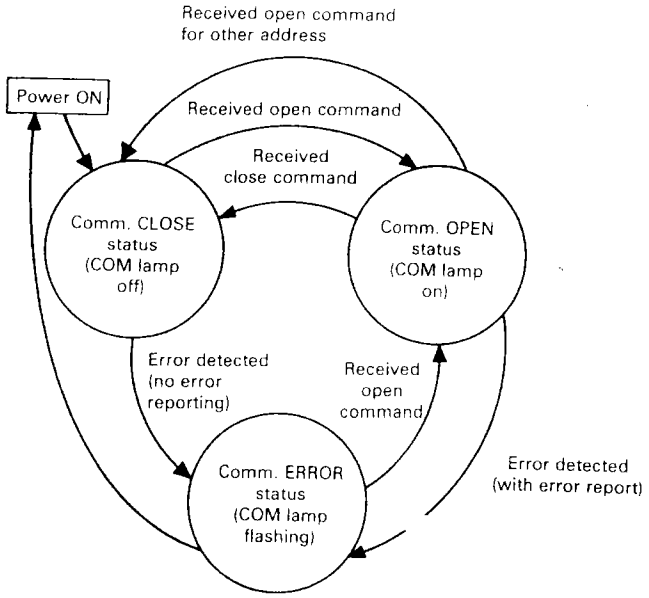
HOST ——— ESC C␣address CR LF ———→ OPEN UT15

⑥ The OPEN UT15 goes to CLOSE status, and returns a response. The COM lamp turns off.

HOST ←——— ESC C␣address CR LF ——— CLOSE UT15

8.2.5 State Transitions During Communications

The following figure shows the conditions governing the transitions of a single UT15 through the three statuses of CLOSE, OPEN, and ERROR:



8.2.6 Responses to Instrument Errors

When an error occurs in the instrument, it returns the data associated with that error as a response to a DISP command.

Error	Data returned
Measurement value (PV) above 105% of measurement range	+OVER
Measurement value (PV) below −5% of measurement range	−OVER
Burnout (thermocouple or RTD input open-circuit)	B_OUT _ is an underscore $(5F)_{16}$
Reference junction compensation (RJC) error	"R" is added immediately after the PV value Example: DP_82.3, 30.5R, 250.0, 215.5, 1 CR LF
A/D converter error	E300
Setting data error	E400
System data error	E002

8.2.7 Responses to Communication Errors

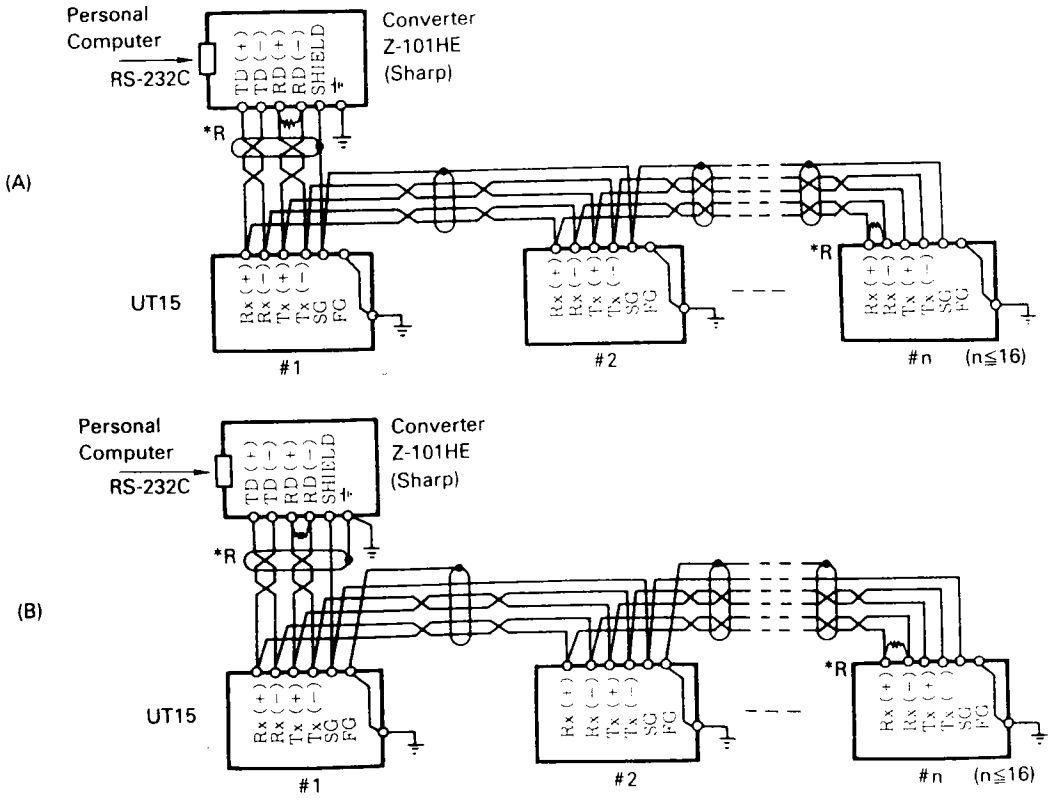
If a UT15 in the OPEN status cannot understand a command that has been sent it will return the code corresponding to that error. The COM lamp will begin flashing.

Error	Return code
Received text format was incorret (Format error)	ERR␣101
Undefined command (2 bytes) was received (Illegal command error)	ERR␣102
Data format was incorrect (Data error)	ERR␣103
Communication error (Framing error, parity error, etc., including effects of noise)	ERR␣200

For a communication error, the ERR␣200 response is returned only by the currently OPEN UT15, but those UT15s in the CLOSE status will also start their COM lamps flashing.

8.2.8 Communication Wiring

If the host (personal computer) has an RS-422 communication port, the connection can be made directly; if the host has only an RS-232C port, the connection must be made through a converter (for example, Sharp Model Z-101HE). The connection examples in Figures (A) and (B) differ only in the handling of the frame shield. If the connections are to extend between different panels, you should connect the wiring as shown in (B).



*R Terminating resistors: 100Ω, 1/2W minimum

8.2.9 Communication-Parameter Setting

Before attemting communications, you must set the communication parameters as shown in the following table. The procedure for setting these parameters is the same as for setting the other setup parameters (→ p.5).

Display	Items	Setting range	Initial value	Remarks
Addr	Address	1 to 16	1	
bPS	Communication rate	0 to 6	6	0: 150, 1: 300, 2: 600, 3: 1200, 4: 2400, 5: 4800, 6: 9600 BPS
PAr1	Parity	0, 1, 2	0	0: None 1: Even 2: odd
StoP	Stop bits	1, 2	1	1: 1 bit, 2: 2 bits
d.LEn	Data length	7, 8	8	7: 7 bits 8: 8 bits

8.2.10 Communication Specifications

Connection system	Multi-drop	
Communication system	4-wire half duples, EIA RS-422A conformant	*1
Synchronization system	Start-stop synchronization	
Communication protocol	Protocol-free	
Communication distance	Maximum 500m	
Communiction rate (BPS)	150, 300, 600, 1200, 2400, 4800, 9600	*2
Start-bit length	1 bit (fixed)	*3
Data length	7 bits or 8 bits	*2
Parity	Even, odd, no parity	*2
Stop-bit length	1 bit or 2 bits	*2
Communication code	ASCII code	

*1: A maximum of 16 UT15 and UM05 units can communicate with a single host. Assign each UT15 and UM05 a unique communication address (1 to 16).
*2: Refer to the above communication-parameter setting.
*3: Because the system uses start-stop synchronization, the start bit is set automatically to 1 bit. No special setup is required.

NOTICE

When the UT15 receives a set command, data are stored in the EEP ROM. The EEP ROM's life expectancy (memory cell life) is about 10,000 writes. So, use the set command only when stored data must be changed; do not write data unnecessarily.

8.2.11 Examples of Programming

(1) Using YEWMAC300 (built-in RS-232C)

```
100   DIM A$512,D$512                          A$, D$ 512 exharacters
110   A$=CHR$(27)+"O 01"                       ESC O□01 Store address 1 open command to A$
120   OUTPUT 99, 1 ; A$                        Same as above. Transmit
130   ENTER 99, 1 ; D$                         Reas response to D$
140   PRINT D$                                 Display response data
150   LEFT$ (A$,4)<>LEFT$(D$,4) THEN
      PRINT "ADDRESS ERROR"; GOTO 270          Compare A$ and D$, and if not in agreement, output error message.
160   PRINT "CMD=";
170   LINPUT A$                                Input command
180   IF A$="END" THEN GOTO230                 End if command is "end"
190   OUTPUT 99,1 ; A$                         Transmit command
200   ENTER 99,1 ; D$                          Read response to D$
210   PRINT D$                                 Display response data
220   GOTO 160                                 Go to command input
230   A$=CHR$(27)+"C 01"                       ESC C□01 Store address 1 close command to A$
240   OTPUT 99,1 ; A$                          Same as above. Transmit
250   IF LEFT$(A$,4)<>LEFT$(D$,4) THEN PRINT   Compare A$ and D$, and if not in agreement, output error message
      "ADDRESS ERROR" ELSE PRINT "TEST END"    Display test end
270   END                                      END
```

(2) Using PC9801 (NEC)

```
1'    ==================
2'
3'    RS 422 (RS232C) TEST PROGRAM
4'
5'
6'    ==================
10    'SAVE " 1: UTRSTST
20    OPEN "COM:N81NN" AS #2                   Open file #2 for communications
                                               No parity, 8 data bits, 1 stop bit
30    A$=CHR$(&H1B)+"O 01"                     ESC O□01 Store address 1 open command to A$
40    PRINT #2, A$                             Same as above. Transmit
50    LINE INPUT #2,D$                         Read response to D$
60    IF A$<>D$ THEN PRINT
      "ADDRESS ERROR": GOTO 180                Compare A$ and D$, and if not in agreement, output error message.
70    LINE INPUT"CMD="C$                       Input command
80    IF C$="END" THEN GOTO 130                End if command is "end"
90    PRINT #2, C$                             Transmit command
100   LINE INPUT #2, D$                        Read response to D$
110   PRINT D$                                 Display response data
120   GOTO 70                                  Go to command input
130   A$=CHR$(&H1B)+"C 01"                     Store address 1 close command to A$
140   PRINT #2, A$                             Same as above. Transmit
150   LINE INPUT #2, D$                        Read response to D$
160   IF A$<>D$ THEN PRINT "ADDRESS ERROR"
      : GOTO 180                               Compare A$ and D$, and if not in agreement, output error message
170   PRINT "TEST END"                         Display test end
180   CLOSE                                    Close file
190   END                                      END
```

9. TROUBLE/POWER FAILURE RESPONSES

9.1 Self-Diagnostics

- The UT15 and UT14 carry out self-diagnostics in the following table at power-ON or during operation.
- The table summarizes for each error how the display, output, and communication functions will be affected.

Action upon Self-Diagnostic Error

	Display	Diagnosis			Process variable	Control output	Alarm output	Retransmission output	RS422 communication
At power-ON	E000	RAM error			—	0% max., or OFF	OFF	0% max.	Not possible
	E001	ROM error			—	0% max., or OFF	OFF	0% max.	Not possible
	E002	System data error			—	0% max., or OFF	OFF	4mA	Possible
	E003	Output code selection error			—	0% max., or OFF	OFF	0% max.	Possible
	E400	Setting data error			Normal operation	Per setting of parameter EOUT (output code on error) (note 1)	Normal operation	Normal operation	Possible
	Decimal point of process variable display flashing	Calibration data error			Operation (accuracy not guaranteed)	Normal opertion	Normal operation	Normal operation	Possible
During operation	E300	A/D converter error			Maximum measurement range value	Per setting of parameter EOUT (output code on error) (note 1)	Normal operation	20.8mA	Possible
	Alternate display of r JC and measured value	Reference junction compensation error			Process variable without reference junction compensation	Normal operation	Normal operation	Normal operation	Possible
	Process variable flashing on measured value display	Non-volatile memory error				Normal operation	Normal operation	Normal operation	Possible
	b.oUt	Input open-circuit	For thermocouple For RTD		Maximum measurement range value	Per setting of parameter EOUT (output code on error) (note 1)	Normal operation (upper limit alarm)	20.8mA	Possible
	Undefined		Voltage input	For mV input	Undefined	—	Undefined	Undefined	Possible
	0%			For 0 to 5V input	0%	Normal operation	Normal operation (lower limit alarm)	4mA	Possible
	-oUr			For 1 to 5V input	Minimum measurement range value or below	Normal operation	Normal operation (lower limit alarm)	3.2mA max.	Possible
		"Over" input lower limit			−5% of measurement range	Normal operation	Normal operation	3.2 mA max.	Possible
	oUr	"Over" input upper limit			105% of measurement range	Normal operation	Normal operation	20.8mA min.	Possible
	Undefined	CPU ran away, etc.			Undefined	0% max., or OFF	OFF	0% max.	Not possible
	Display Off	Power circuit failure			—	0% max., or OFF	OFF	0% max.	Not possible

Note 1: 0: 0% or OFF
1: 100% or ON

Note 2: "Normal operation" means that the individual function continues to operate normally using the current measured value in the error state. For example, if a thermocouple burns out and an upper limit alarm is set, the alarm is set off. See p. 32 concerning problems related to communications.

9.2 Actions Upon a Power Outage

- As shown in the following table, power outages and the actions taken are classified according to whether the power outage lasts for more or for less than 20ms.

Actions taken upon a power outage

For power outage of 20ms or less	Normal operation continues, as if there were no power cutoff.	
For power outage of 20ms or more	Display	Power OFF state
	Output	
	Setting Parameters	Parameters whose entry has been completed are maintained. If the power outage occurs while entry is in progress, an error code (E400) is displayed.
	Auto-tuning	Auto-tuning is halted. The operating parameter (AT) automatically switches from ON → OFF.
Power restoration after power outage	Control action	Action in progress before power outage is continued. Control output is restarted from the value specified by the set-up parameter (EOUT)
	Alarm action	If "standby" is selected, restarts including standby action.

9.3 What to Do When a Problem Occurs

- The following table shows the actions to be taken in response to the self-diagnostic results:

Display	Diagnosis			Action to be taken
E000	RAM error			Replace with good unit
E001	ROM error			
E002	System data error			
E003	Output-code selection error			Recheck the rotary switch position, and correct the setting.
E400	Setting data error			Recheck parameters, and correct setups
Decimal point of measured value display flashing	Calibration data error.			Recalibrate.
E300	A/D converter error			Replace with good unit.
Alternate display of rJC and measured value	Reference junction compensation error			
Measured value flashing in measured value display	Non-volatile memory error			
b.oUt	Input open-circuit	For thermocouple For RTD		Check for open circuit in input system wiring and sensor, and repair. If the problem is in the instrument itself, replace it with a good unit.
Undefined		Voltage input	For mV input	
0%			For 0 to 5V input	Check input voltage. Check for open circuit in input system wiring and sensor, and repair. Recheck whether the instrument and measurement ranges are appropriate.
-oUr			For 1 to 5V input	
	"Over" input lower limit			
oUr	"Over" input higher limit			
Undefined	CPU runaway, etc.			Replace with good unit.
Display off	Power circuit failure			Check whether specified voltage is being supplied to the power terminals. If the problem is in the instrument itself, replace it with a good unit.

10. INSTALLATION AND WIRING

10.1 Installation Location

Install the instrument in a location that meets the following criteria:

(1) Little or no mechanical vibration.
(2) No corrosive gases.
(3) Minimal temperature fluctuations, and near normal room temperature (23°C).
(4) No directly subject to radiant heat.
(5) Not subject to strong electromagnetic fields.
(6) No excessive humidity

10.2 External Dimensions and Panel Cutout Dimensions

See Chapter 11 (→ p. 41)

10.3 Mounting Procedure

(1) Insert the UT15 or UT14 from the front of the panel
(2) To fasten the instrument to the panel, use the accessory installation bracket. Take care not to overtighten the screws when mounting.

10.4 Wiring

When wiring, see the rear terminal diagram, and observe the following precautions:

(1) In the case of thermocouple input, use the proper thermocouple extension wire type (compensating leads).

Thermocouple type	+ Terminal	− Terminal	Color of extension wire insulation
K	Chromel	Alumel	Blue
J	Iron	Constantan	Yellow
T	Copper	Constantan	Brown
E	Chromel	Constantan	Purple
R	Platinum rhodium (13%)	Platinum	Black
B	Platinum rhodium (30%)	Platinum rhodium (6%)	Gray

(2) For RTD input, use wiring having low conductor resistance, and no significant differences in resistance among the three conductors.
(3) For power supply wiring, use a cable or wiring with the characteristics of 600V vinyl insulated wire (JIS C3307) or the equivalent. If necessary, insert a noise filter in the power supply circuit.
(4) The ground conductor should have at least a $2mm^2$ cross-sectional area, with the resistance to the ground not exceeding 100Ω maximum.
(5) Plan the input circuit wiring so as to avoid noise pick-up.
  (a) The input circuit wiring should be kept as far away as possible from power and ground circuits.
  (b) Use of shielded wire is effective against noise due to electrostatic induction. If necessary, connect the shield to the ground terminal of the UT14/UT15. (Be careful that this does not result in a two-point ground.)

(c) Use of conductor pairs twisted with a constant spacing between twists is relatively effective against noise due to electromagnetic induction.

(6) When connecting the wiring to the terminals, we recommend the use of crimp terminal lugs (3.5mm screws) with insulated sleeves.

(7) See the chapter concerning wiring for communications. (→ p. 33).

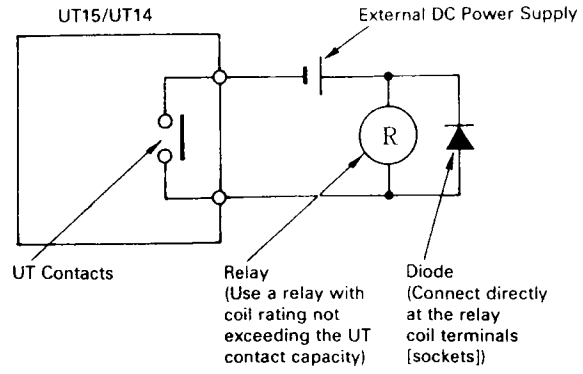
(8) If converting a 4 to 20mA DC input to 1 to 5V DC, order and install the following component (not included with the instrument):

Shunt resistor, 250Ω (±0.1%)

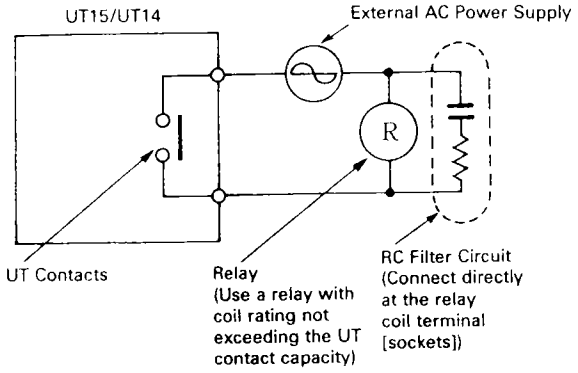
Notice

1) There are no fuses or power supply switches in the UT14/UT15. If required, these must be provided separately. For fusing, use time-lag fuses with a rated voltage of 250V, and a rated current of 1A (for example, an BUSS ATG type).
2) If a load exceeds a relay output contact rating (control output: 250V, 3A AC resistive load; alarm output: 250V AC, 1A resistive load), use an auxiliary relay to turn the load on and off.
3) If using an inductive load such as an auxiliary relay on a relay contact output, connect a diode (for DC) or an RC filter (for AC) in parallel as a surge suppressor circuit to suppress sparking.

● For DC relay

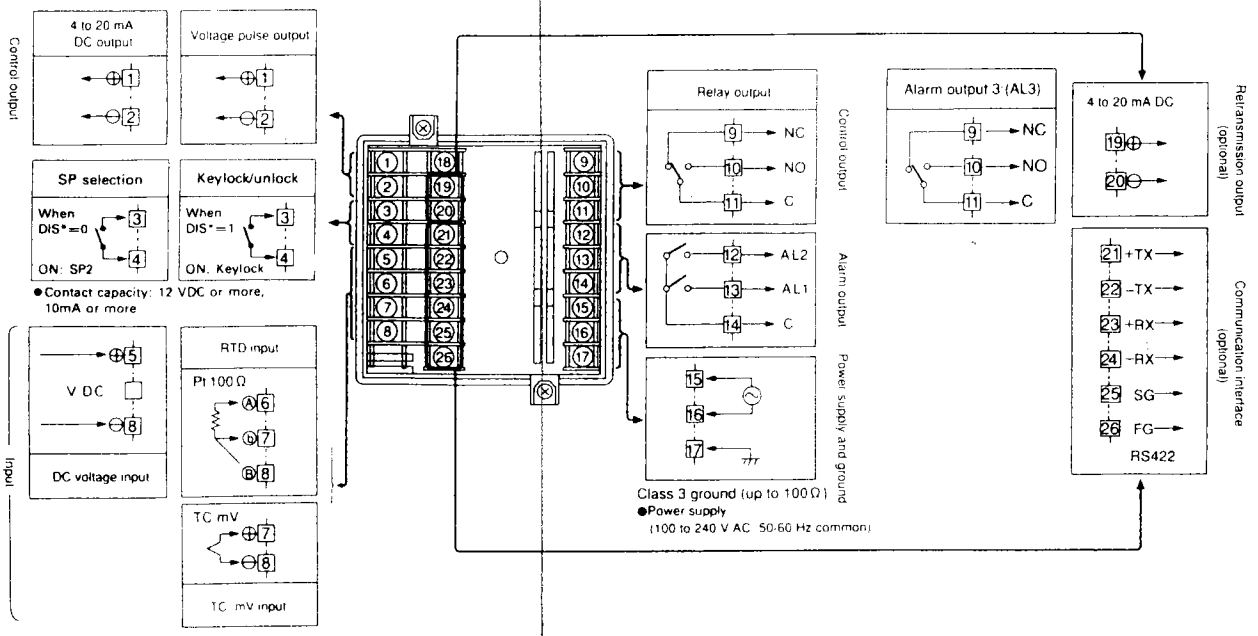


● For AC relay



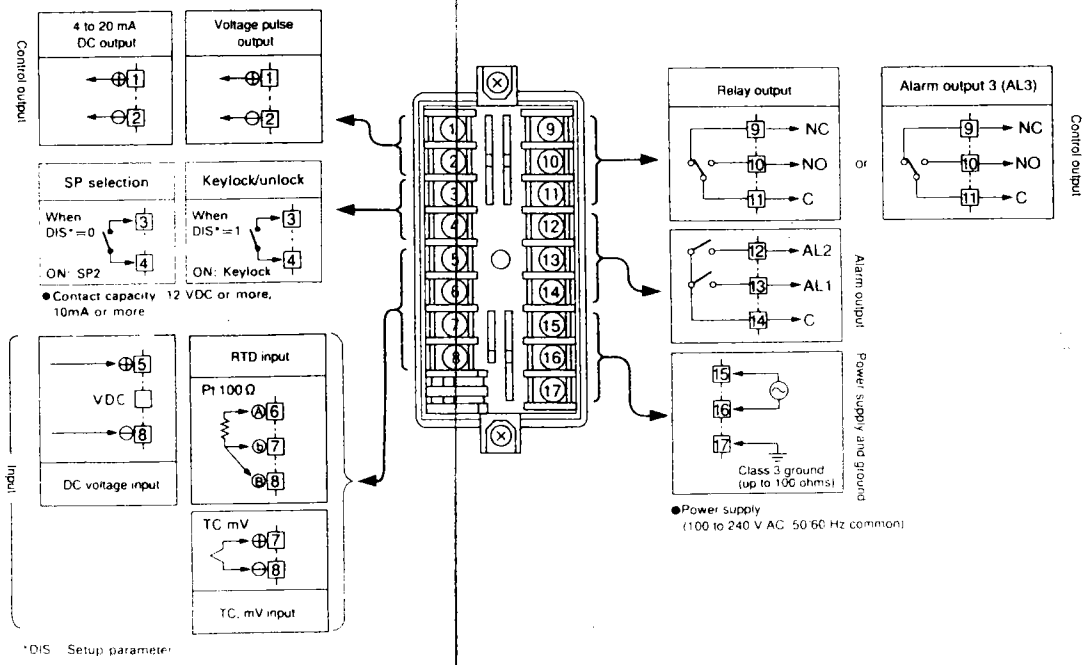
REAR TERMINAL DIAGRAM

UT15



*DIS... Setup parameter

UT14



*DIS Setup parameter

11. GENERAL SPECIFICATIONS

GENERAL SPECIFICATIONS

Measuring Accuracy

Accuracy is expressed as ±(% with respect to instrument range width) ±1% digit. (See Table below.) Here, digit is the smallest possible display increment — identical in value to the display resolution. The thermocouple reference-junction compensation error is not included.

Instrument range code	Input type	Instrument range	Accuracy
0	K	−200 to 1200℃ (0℃ or less)	±0.1% ±1 digit ±0.2% ±1 digit
1	K	−199.9 to 200.0℃ (0℃ or less)	±0.1% ±1 digit ±0.2% ±1 digit
1	S	0 to 1700℃	±0.15% ±1 digit
2	J	−199.9 to 800.0℃	±0.1% ±1 digit
3	T	−199.9 to 400.0℃ (−199.9 to 0.0℃)	±0.1% ±1 digit ±0.2% ±1 digit
4	E	−199.9 to 800.0℃ (−199.9 to 0.0℃)	±0.1% ±1 digit ±0.2% ±1 digit
5	R	0 to 1700℃	±0.15% ±1 digit
6	B	0 to 1800℃ (0 to 400℃)	±0.2% ±1 digit ±5.0% ±1 digit
7	N	0 to 1300℃ (0 to 200℃)	±0.1% ±1 digit ±0.15% ±1 digit
8	L	−199.9 to 800.0℃ (−199.9 to 0.0℃)	±0.1% ±1 digit ±0.2% ±1 digit
9	U	−199.9 to 400.0℃ (−199.9 to 0.0℃)	±0.1% ±1 digit ±0.2% ±1 digit
A	JPt100	−199.9 to 500.0℃) (When 100℃ span is set)	±0.1% ±1 digit (±0.5% ±1 digit)
B	Pt100		
C	mV DC	0 to 10mV	±0.2% ±1 digit
D		0 to 100mV	±0.1% ±1 digit
E	V DC	0 to 5V	±0.1% ±1 digit
F		1 to 5V	

Power Supply/Dielectric Strength/Insulation/Grounding

Power supply	Voltage	90 to 250V AC (universal power supply)
	Frequency	50/60Hz (common)
Power consumption		Approximately 6VA (100V) Approximately 9VA (200V) (If fuses are supplied externally, 1A time-lag fuses are recommended.)
Memory hold		Non-volatile memory
Dielectric strength		Power terminals ⟷ ground ..... 1500V AC/1 min. Input terminals ⟷ ground ..... 1000V AC/1 min. Output terminals ⟷ ground ..... 1500V AC/1 min.
Insulation resistance		Any terminal ⟷ ground ..... 500V DC/2MΩ max.
Grounding		Grounding resistance of 100Ω or less.

Environmental Conditions

Normal operating conditions (Conditions for which the instrument is designed to operate properly)	Ambient temperature	0 to 50°C
	Ambient humidity	20 to 90% R.H. (non-condensing)
	Reference junction temperature compensation error	Between 0 and 50°C, ±1.5°C or between 15 to 35°C, ±1°C.
	Magnetic field	400AT/m max.
	Warm-up time	30 minutes minimum
Operating influences	Ambient temperature influence	Input section stability (±1μV/°C or ±0.01%/°C, whichever is larger) max. Output stability 4 to 20mA DC or 1 to 5V DC, ±0.05%/°C maximum
	Power supply variation	Input section stability (±1μV/10% or ±0.01%/10%, whichever is larger) maximum Output section stability 4 to 20mA DC or 1 to 5V DC, ±0.05%/10% max.
Shipping/storage condition	Temperature	−25 to 70°C
	Humidity	5 to 95% R.H. (non-condensing)

Construction/Dimensions/Weight

Construction	Dustproof, drip-proof construction (front panel)	
Installation	Mounting (see external dimensions, p. 42)	
Case	Molded resin	
Outside dimensions	UT15	96W×96H×100Dmm
	UT14	48W×96H×100Dmm
Weight	UT15	Approximately 450g
	UT14	Approximately 300g

MODELS

Model Code Table

Model	Suffix code	Description
UT15		Digital-Indicating Controller
Style code	*A	Style A
Optional code	/RET	Retransmission output (4 to 20mA DC)
	/RS422	RS-422A communication interface

Model	Suffix code	Description
UT14		Digital Controller
Style code	*A	Style A

Items to specify when ordering:

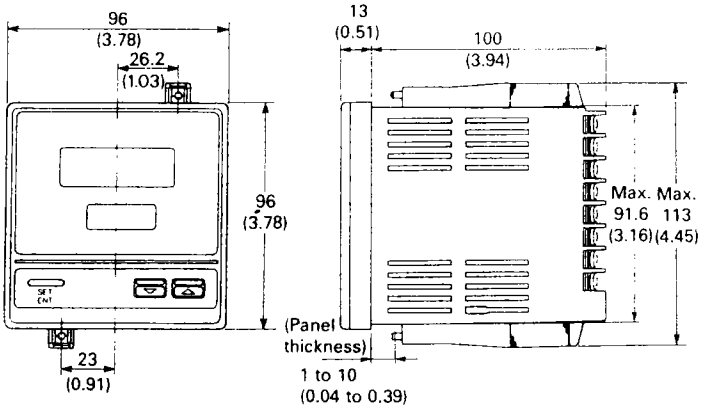
(1) Model and style code.
(2) Option code.

Note: Shipped from the factory with range code = 0 (thermocouple type K), and control output type code = 0 (relay output)

EXTERNAL DIMENSIONS

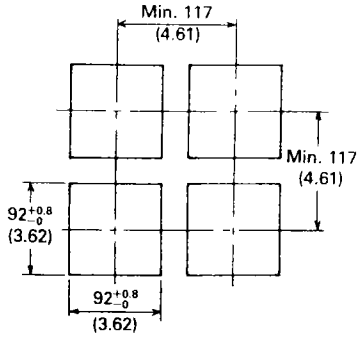
UT15

Dimensions

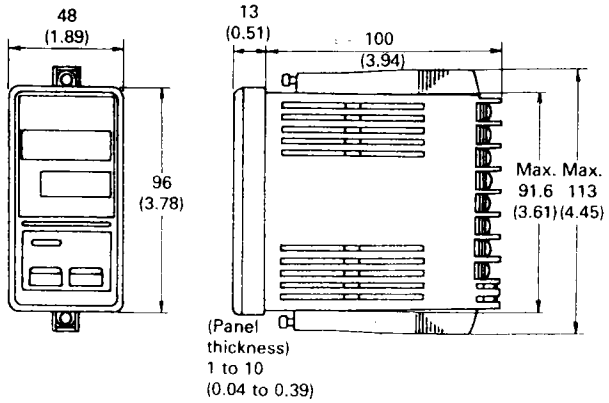


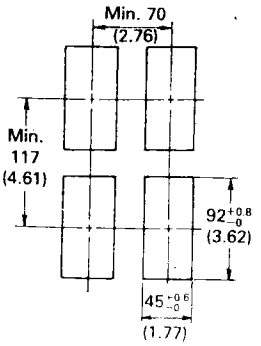
Panel Cutout and Spacing

Unit: mm
(approx. inch)



UT14





SAFETY STANDARD

SAFETY STANDARD:	CSA C22.2 No.142 UL 508
POWER SUPPLY (Note):	90 to 264 V AC, 50/60 Hz, 0.2 A Max.
CONTROL OUTPUT RELAY CONTACT:	Max. 250 V AC, 3 A
ALARM OUTPUT RELAY CONTACT:	Max. 250 V AC, 1 A
AMBIENT TEMPERATURE:	0 to 50°C
MOUNTING LOCATION:	Non-Hazardous Location, Indoor. Mounting in an indoor (controlled environment) instrument panel.

(Note) Range of POWER SUPPLY is printed "90-250 V AC" on the Name plate put on the case. (90 to 250 V AC is Operating range.)