

# Z SERIES FUZZY CONTROLLER X (48 X 96, 96 X 96mm)

DATA SHEET

PYX5,9

The PYX is a state-the-art temperature controller offering enhanced control through the use of fuzzy logic. By employing fuzzy logic the PYX virtually eliminates system overshoot and effectively suppresses fluctuation of the process variable due to external disturbances. Fuzzy logic control is the technology of tomorrow offered today.

This controller features universal input/output circuitry and can accept signals from all thermocouple types, RTD's, and current/voltage sources. As well, the PYX-5, 9 gives you the flexibility of choosing such available features as RS-485 communications, analog retransmission, dual output, heater break alarm, and loop break alarm, to name a few.



<PYX5>



<PYX9>

## FEATURES

### 1. Incorporation of fuzzy control

An improved response characteristic of controller is ensured thanks to the fuzzy control exercised while detecting an overshoot or a difference from the set temperature value due to a large disturbance.

(Time taken for returning to the set value can be shortened and temperature variation width can be narrowed.)

### 2. Universal input

11 kinds of thermocouples, resistance bulbs and voltage/current inputs is available.

### 3. Universal output (option)

Relay contact, voltage pulse output for SSR drive and current output is available on one controller.

The communication protocol conforms either the Fuji Electric CC data line or Modbus® RTU.

### 4. Auto/Manual

Change auto-mode to manual-mode and manual operation can be done using front panel keys.

### 5. Communication function comprised (option)

Because the general-purpose interface (RS-485) is mountable, a centralized monitoring/setting system aided by a personal computer can readily be configured.

### 6. A wide variety of optional functions

- (1) A0 re-transmission (1 point)  
A0 is recordable in connection with Fuji's microjet recorder PHA/PHC.
- (2) Programmable alarm (2 points max.)  
2 points of alarm action can be registered selected from 16 kinds.
- (3) Dual output  
Dual control of heating and cooling operations are allowed.
- (4) Heater break alarm  
Use ALM1 or ALM2 output for heater break alarm. (with function of heater current display, in parameter "□□")
- (5) Ramp/soak function  
4 ramp/soak-pair patterns are registrable.
- (6) External DI function (1 point)  
SV (setting value) can be changed a predetermined value according to external command input (DI).
- (7) Remote SV  
SV (setting value) can be controlled by external 1 to 5V DC analog input.

### 7. UL, C-UL approval

Modbus® is a registered trademark of Gould Modicon.

## GENERAL SPECIFICATIONS

- Kinds of input:
  - Full multi-input type
  - Thermocouple (TC):  
J, K, R, B, T, E, S, N, U, WRe5-26, PL-II
  - Platinum resistance bulb (RTD):  
Pt 100Ω
  - Voltage/Current: 1 to 5V/0 to 5V/4 to 20mA DC
- Input accuracy: ±0.5% of full scale, ±1 digit (±1°C at thermocouple)
  - B (TC) 0 to 500°C: ±5% of } full scale
  - R (TC) 0 to 400°C: ±1% of }
- Input sampling cycle:  
0.5sec
- Control action: Fuzzy control or PID with auto-tuning
- Control output:
  - Relay contact
  - Voltage pulse output (for SSR drive)
  - Current output
  - Universal output  
(Relay contact/SSR drive/current output)
- Alarm output: 2 points max. (ALM1, ALM2)
- Operation mode:
  - Fixed value operation
  - Manual operation
- Option
  - Re-transmission analog output: 1 point
  - Communication function: RS-485  
Modbus® or CC-data line protocol.
  - Programmable alarms: 2 points max.
  - Dual output
  - Heater break alarm: 1 point
  - Ramp/soak function: 4 ramp/soak-pair patterns
  - Auxiliary digital input: 1 point
  - Remote SV input: 1 point

# FUNCTION AND PERFORMANCE

## 1. Input

### (1) Process variable input signal

Kind of input	Description
Thermocouple J K R B T E S N (Nichrosil-Nisil) U WRe5-26(Tangsten rhenium) PL-II (Platinel)	<ul style="list-style-type: none"> <li>• Cold junction compensation comprised</li> <li>• Burn-out circuit built in</li> </ul>
Resistance bulb Pt 100	<ul style="list-style-type: none"> <li>• Burn-out circuit built in</li> <li>• Allowable wiring resistance 10Ω max. (per wire)</li> </ul>
Voltage input 1 to 5V DC 0 to 5V DC	Input resistance 1MΩ min.
Current input 4 to 20mA DC	Input resistance 250Ω

Remarks: (1) For 4 to 20mA DC input specification, a 250Ω resistor is furnished with the controller delivered.

(2) The 250Ω resistor should be removed for changeover from 4 to 20mA DC to 1 to 5V DC input.

(a) Input accuracy: ±0.5% of full scale, ±1 digit

Cold junction compensation error: ±1°C

### (b) Input range

Kinds of input	Code	Temperature range [°C]	Temperature range [°F]	0.1°C display	0.1°F display	
Resistance bulb JIS IEC	Pt100	00	0 to 150	32 to 302	○	○
		01	0 to 300	32 to 572	○	○
		02	0 to 500	32 to 932	○	○
		03	0 to 600	32 to 1112	○	×
		04	-50 to 100	-58 to 212	○	○
		05	-100 to 200	-148 to 392	○	○
		06	-150 to 600	-238 to 1112	○	×
		07	-150 to 850	-238 to 1562	○	×
Thermocouple	J	20	0 to 400	32 to 752	○	○
	J	21	0 to 800	32 to 1472	○	×
	K	22	0 to 400	32 to 752	○	○
	K	23	0 to 800	32 to 1472	○	×
	K	24	0 to 1200	32 to 2192	×	×
	R	25	0 to 1600	32 to 2912	×	×
	B	26	0 to 1800	32 to 3272	×	×
	T	27	-199.9 to 200	-328 to 392	○	×
	T	28	-150 to 400	-238 to 752	○	×
	E	29	0 to 800	32 to 1472	○	×
	E	2A	-199.9 to 800	-328 to 1472	○	×
	S	2B	0 to 1600	32 to 2912	×	×
	N	2C	0 to 1300	32 to 2372	×	×
	U	2D	-199.9 to 400	-328 to 752	○	×
	WRe5-26	2E	0 to 2300	32 to 4172	×	×
	PL-II	2F	0 to 1300	32 to 2372	×	×
Voltage	1 to 5V DC	Scale settable within				
	0 to 5V DC	-1999 to 9999				
Current	4 to 20mA DC	40* (*Connect 250Ω between terminal No. 16 and 18 in case of current input)				

(c) Input sampling cycle: 500ms

### (d) Burn-out

- Control output direction (upper side or lower side) is programmable at occurrence of burn-out.
- For resistance bulb input, detection is allowed even if any of the three wires is discontinued.

### (2) Digital input (option)

Number of input points: 1 point

Spec. : 16V DC, 15mA

### (3) Remote SV input (option)

Input signal: 1 to 5V DC, 1 point

Accuracy: ±0.5% ±1 digit

Input sampling cycle: 0.5sec

Input scaling: Allowed

Input filter: First delay (time constant 1sec fixed)

Display of remote mode: LED on front panel

Detection of input signal wire discontinued: None

Changeover Remote/Auto: Bumpless

## 2. Control functions

(1) Fuzzy control: The basic actions in PID control have been realized according to fuzzy control rules.

### (2) PID control with auto-tuning:

Proportional band (P): 0 to 999.9%  
(2-position action when P = 0)

Reset time (I): 0 to 3200sec  
(Integral action cut when I = 0)

Rate time (D): 0 to 999.9sec  
(Derivation action cut when D = 0)

(Fuzzy control action or PID action with auto-tuning is selectable by using the front panel key.)

### (3) Proportional cycle: 1 to 120sec

### (4) Control cycle: 500ms

## 3. Output

### (1) Control output

#### – Standard type – (option)

Of the following output types, any one should be specified.

Relay contact output	Normally open SPDT contact	Electrical expected life : More than 10 <sup>5</sup> operations at 220V AC, 3A (resistive load)  Mechanical expected life : More than 2 x 10 <sup>7</sup> operations
SSR drive output	Transistor output	ON: 9 to 24V DC, 20mA max. OFF: 0.5V or less Load resistance: 600Ω or more
Current output	4 to 20mA DC	Allowable load resistance : 600Ω or less

#### – Dual output type – (option)

Of the following output types, any one should be specified for each of the heating and cooling sides.

Relay contact output	Normally open SPDT contact	Electrical expected life : More than 10 <sup>5</sup> operations at 220V AC, 3A (resistive load)  Mechanical expected life : More than 2 x 10 <sup>7</sup> operations
SSR drive output	Transistor output	ON: 9 to 24V DC, 20mA max. OFF: 0.5V or less Load resistance: 600Ω or more
Current output	4 to 20mA DC	Allowable load resistance : 600Ω or less

### (2) AO re-transmission (option)

- Number of output points: 1 point
- Output data: Any of process variable, set value or manipulated variable
- Output accuracy: ±0.5% of full scale
- Kind of output: 1 to 5V DC
- Add-on function: Scaling function
- Load resistance: 500kΩ or more

## 4. Setting and indication

(1) Accuracy: ±0.5% of full scale, ±1 digit (±1°C at 23°C)  
B (TC) 0 to 500°C: ±5% of full scale  
R (TC) 0 to 400°C: ±1% of full scale

### (2) Setting method:

Key operation

### (3) Indication method:

Numerical display; Each of PV and SV independently displayed (PV: Red, SV: Green)

### (4) Status indication:

Control outputs 1 and 2

Alarms 1 and 2

Remote SV

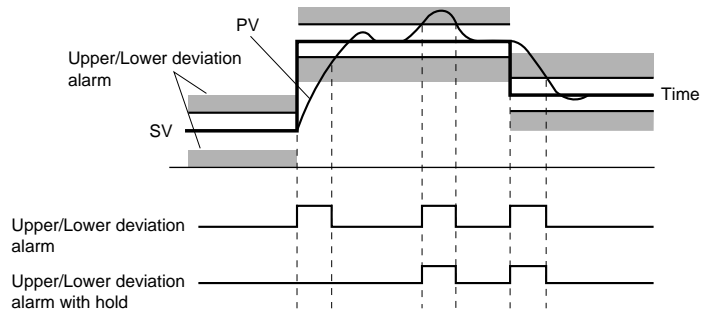


Kinds of alarm

Fig. 1

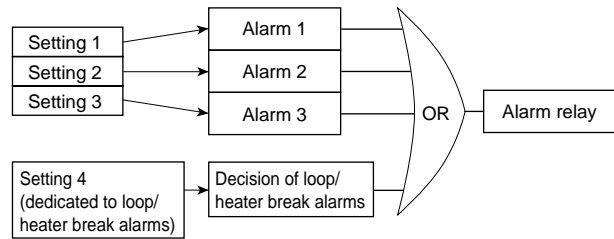
Function	Action	Alarm code	Alarm group	
Nothing	No Alarm	0	A	
High absolute alarm		1		
Low absolute alarm		2		
High deviation alarm		3		
Low deviation alarm		4		
High deviation alarm (invert)		5		
Low deviation alarm (invert)		6		
High/Low deviation alarm		7		
High/Low deviation alarm (invert)		8		
Low absolute alarm with hold		9		
Low deviation alarm with hold		A		
Low deviation alarm with hold (invert)		B		
High/Low deviation alarm with hold		C		
High/Low deviation alarm with hold (invert)		D		
SV High absolute alarm		E		
SV Low absolute alarm		F		
Nothing		0		B
Heater break		1		
Loop break		2		
Loop break + Heater break		3		

- Remarks : (1) ASV : Alarm Setting Value  
 (2) alarm band  
 (3) What is "alarm with hold"?  
 Alarm does not live immediately even when PV enters into alarm band.  
 After PV exits from alarm band and re-enters into alarm band, alarm fires.  
 (4) SV High absolute alarm/Low absolute alarm are effect only with Remote SV function.

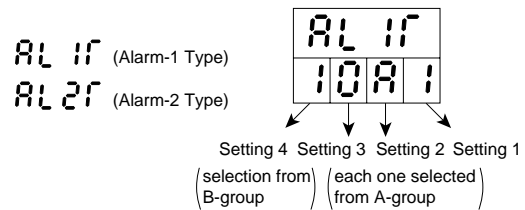


Multi-alarms

It allows a maximum of 4 types of alarm settings (among which, one is dedicated to loop/heater disconnection), detects those types of alarm individually, and makes logical OR before outputting it to the alarm relay.  
 (Multi-alarm)



Operation procedure

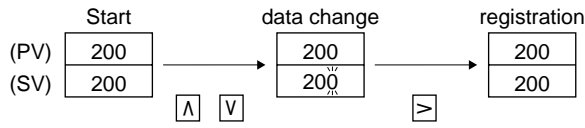


Note:  
 For the setting in the above figure the result of ORing of the heater break alarm, "holding"-featured low-limit deviation alarm, and high-limit absolute alarm is output

## SETTING METHOD

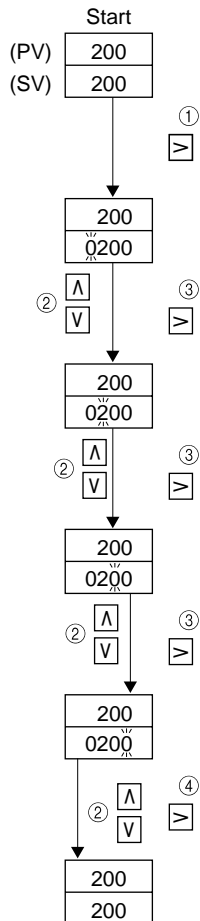
### 1. SV setting

#### (1) Method 1



or  $\left[ \begin{array}{|c|} \hline \Delta \\ \hline \end{array} \right]$  : The first digit flashes to allow inc or dec of data.

#### (2) Method 2



① SV change mode

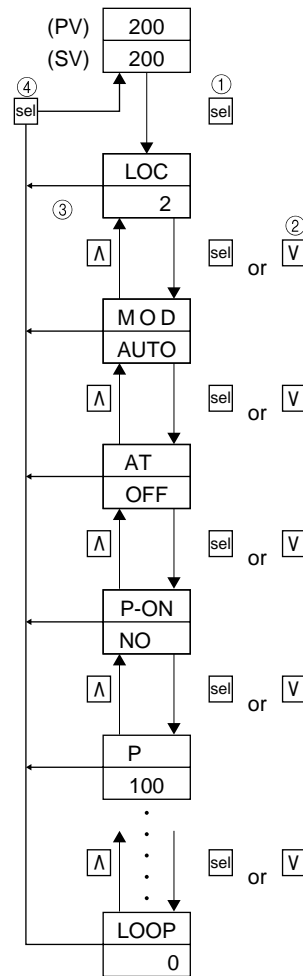
② Inc or dec data in the flashing digit by  $\left[ \begin{array}{|c|} \hline \Delta \\ \hline \end{array} \right]$  or  $\left[ \begin{array}{|c|} \hline \nabla \\ \hline \end{array} \right]$  key.

③ Shift flashing digit to right by  $\left[ \begin{array}{|c|} \hline \triangleright \\ \hline \end{array} \right]$  key.

④ Registration of the setting value by  $\left[ \begin{array}{|c|} \hline \triangleright \\ \hline \end{array} \right]$  key.

### 2. How to assign parameters

#### (1) Calling parameters



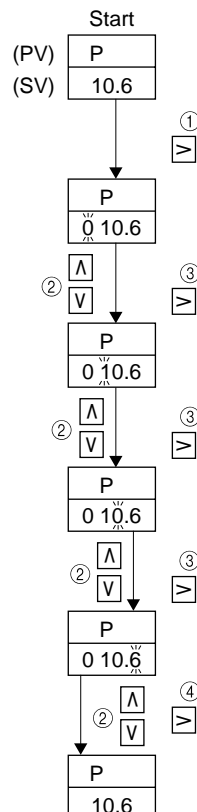
① Keep  $\left[ \begin{array}{|c|} \hline \text{sel} \\ \hline \end{array} \right]$  key pressed for about 3 sec. in PV/SV display condition.

② Press  $\left[ \begin{array}{|c|} \hline \text{sel} \\ \hline \end{array} \right]$  or  $\left[ \begin{array}{|c|} \hline \nabla \\ \hline \end{array} \right]$  key for parameter change.

③ Press  $\left[ \begin{array}{|c|} \hline \Delta \\ \hline \end{array} \right]$  key for reverse direction.

④ Keep  $\left[ \begin{array}{|c|} \hline \text{sel} \\ \hline \end{array} \right]$  key pressed for about 3 sec in parameter display mode, back to PV/SV mode.

#### (2) Data changing



① P change mode

② Inc or dec data in the flashing digit by  $\left[ \begin{array}{|c|} \hline \Delta \\ \hline \end{array} \right]$  or  $\left[ \begin{array}{|c|} \hline \nabla \\ \hline \end{array} \right]$  key

③ Shift flashing digit to right by  $\left[ \begin{array}{|c|} \hline \triangleright \\ \hline \end{array} \right]$  key.

④ Registration of the setting value by  $\left[ \begin{array}{|c|} \hline \triangleright \\ \hline \end{array} \right]$  key.

Parameter sheet for PYX

Lock level						
All locked	Only SV	End User	Set Maker			
0	1	2	3			
Dis-play				Mean of parameters	Range	Unit
####				Measured value (PV)	0~100%	Engineering unit
####				Setting value (SV)	0~100%	Engineering unit
####				Manual manipulated variable (MV)	-3~103%	%
LOCK				Lock for other parameters	0~3	
			CAS	Remote SV input value	0~100%	Engineering unit
			OUT 1	MV for output 1	-3~103%	%
			OUT 2	MV for output 2	-3~103%	%
		MOD		Mode of control	AUTO MAN REM	
	AT			Auto tuning command	OFF ON LOW	
		D-SV		Second SV	0~100%	Engineering unit
	STAT			Ramp / Soak location	OFF 1-RP 1-SK 2-RP 2-SK 3-RP 3-SK 4-RP 4-SK END	
	TIME			Ramp / Soak rest time	0.0~99.59/100h	HH. mm
	PROG			Ramp / Soak command	OFF RUN HOLD (END)	
	SV1			1st. target point (SV)	0~100%	Engineering unit
	TM1R			Time of 1st. Ramp segment	0.0~99.59	HH. mm
	TM1S			Time of 1st. Soak segment	0.0~99.59	HH. mm
	SV2			2nd. target point (SV)	0~100%	Engineering unit
	TM2R			Time of 2nd. Ramp segment	0.0~99.59	HH. mm
	TM2S			Time of 2nd. Soak segment	0.0~99.59	HH. mm
	SV3			3rd. target point (SV)	0~100%	Engineering unit
	TM3R			Time of 3rd. Ramp segment	0.0~99.59	HH. mm
	TM3S			Time of 3rd. Soak segment	0.0~99.59	HH. mm
	SV4			4th. target point (SV)	0~100%	Engineering unit
	TM4R			Time of 4th. Ramp segment	0.0~99.59	HH. mm
	TM4S			Time of 4th. Soak segment	0.0~99.59	HH. mm
		P-ON		Auto start demand when turn on for Ramp/Soak	NO YES	
		P		Proportional Band	0.0~999.9	%
		HYS		Hysteresis for two step control	0~100%	Engineering unit
		I		Reset time	0~3200	Second
		D		Rate time	0~999.9	Second
		COOL		Rate of Proportional Band for cooling	0.0~10.0	
		DB		Dead Band/ Overlap	-50~50%	%
		AR		Anti-Reset Wind-up	0~100%	Engineering unit
		MAN		Manual Reset value	-100.0~100.0	%
		AL1T		Alarm actions for Alarm 1	0000~(*1) 3FFFh	
		AL11		Set value for Alarm 11	0~100%	Engineering unit

Lock level						
All locked	Only SV	End User	Set Maker			
0	1	2	3			
Dis-play				Mean of parameters	Range	Unit
			A11H	Hysteresis for Alarm 11	0~100%	Engineering unit
		AL12		Set value for Alarm 12	0~100%	Engineering unit
		A12H		Hysteresis for Alarm 12	0~100%	Engineering unit
		AL13		Set value for Alarm 13	0~100%	Engineering unit
		A13H		Hysteresis for Alarm 13	0~100%	Engineering unit
		AL2T		Alarm actions for Alarm 2	0000~(*1) 3FFFh	
		AL21		Set value for Alarm 21	0~100%	Engineering unit
		A21H		Hysteresis for Alarm 21	0~100%	Engineering unit
		AL22		Set value for Alarm 22	0~100%	Engineering unit
		A22H		Hysteresis for Alarm 22	0~100%	Engineering unit
		AL23		Set value for Alarm 23	0~100%	Engineering unit
		A23H		Hysteresis for Alarm 23	0~100%	Engineering unit
		LOOP		Time for Loop break detection	0.0~99.59	MM. ss
		HB-A		Curent setting for Heater break detection	1~50	Amp.
		CT		Heater Curent indicated value	0~50	Amp.
		PVT		Input type/Decimal point/Temp. Unit	0000~4111h (*2)	Code No.
		PVF		Upper scale for PV	-1999~9999	1 word DEC
		PVB		Lower scale for PV	-1999~9999	1 word DEC
		PVD		Decimal point position	0~2	1 byte DEC
		TF		Rate of Digital Filter	0.0~900.0	Second
		SFT		PV offset	-50~50%	Engineering unit
		SV-H		High limit setting of SV	0~100%	Engineering unit
		SV-L		Low limit setting of SV	0~100%	Engineering unit
		REMF		Upper scale of Remote SV	0~100%	Engineering unit
		REMB		Lower scale of Remote SV	0~100%	Engineering unit
		CTRL		Kind of control	FUZY PID	
		DT		Cycle of computing	0.5	Second
		REV-1		Control action for output 1 (Direct of reverse)	NORM REV	
		REV-2		Control action for output 2 (Direct of reverse)	NORM REV	
		TC-1		Proportional Cycle for output 1	1~120	Second
		TC-2		Proportional Cycle for output 2	1~120	Second
		MV-H		High limit of MV	-3~103%	%
		MV-L		Low limit of MV	-3~103%	%
		BURN		Action when input is abnormal	0~4	
		AOT		Kind of Analog output source	PV SV MV	
		AO-H		Upper scale of AO	0~100%	%
		AO-L		Lower scale of AO	0~100%	%
		STNO		Station No. for communication	1~15	

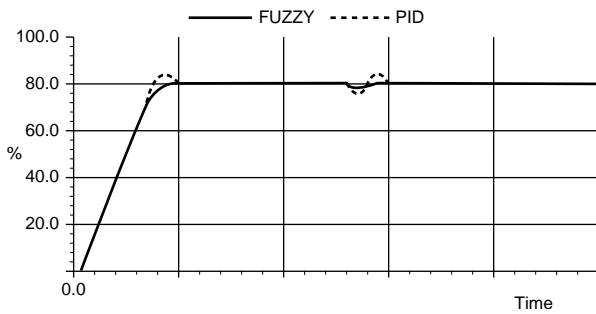
Not es : (\*1) : Hexa decimal code : refer to "Kinds of alarm" (page 4).  
 (\*2) : Hexa decimal code : refer to "Input range" (page 2).

## FUNCTIONS

### (1) Fuzzy feedback control

Fuzzy feedback control expresses the basic actions of PID control in fuzzy rules and has a nonlinear characteristic in order to straighten out the problem inherent to PID control (i.e., overshoot occurs when improving response or instability arises due to a change in system even when optimum PID parameters are assigned).

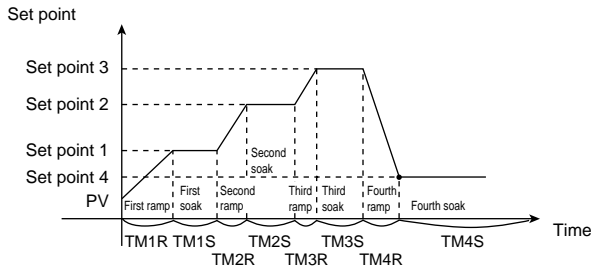
- Comparison of controllability  
Each result of fuzzy control and PID control is shown below.  
It is understandable that the overshoot due to a change of set value has been suppressed in fuzzy control.



### (2) Ramp soak function (option)

Function to automatically change the set point value with elapsing of time, in accordance with the preset pattern, as shown below. This device allows maximum of 4 ramp soak programs.

This first ramp starts at the value measured immediately before the program is executed (PV).



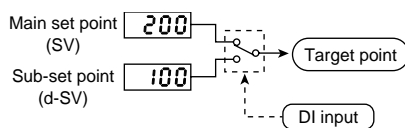
Ramp : Region in which the SP changes toward the target value.

Soak : Region in which the SP keeps unchanged at the target value.

Powering on can automatically trigger the program run (power-on start function), or an external contact signal can also do that.

### (3) Two set points (option)

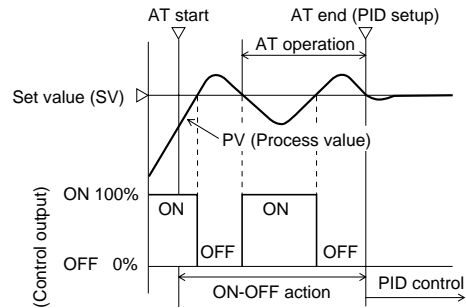
Change set points digital input.



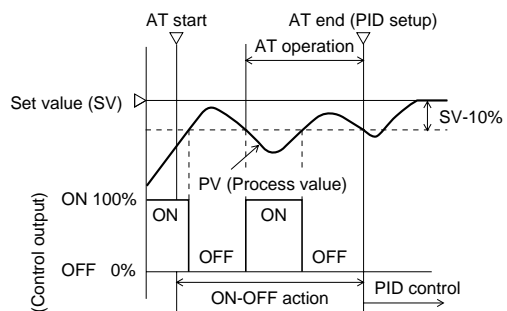
### (4) Auto-tuning

PID parameters are automatically set by controller's measurement and operation.

#### (a) Standard type



#### (b) Low PV type



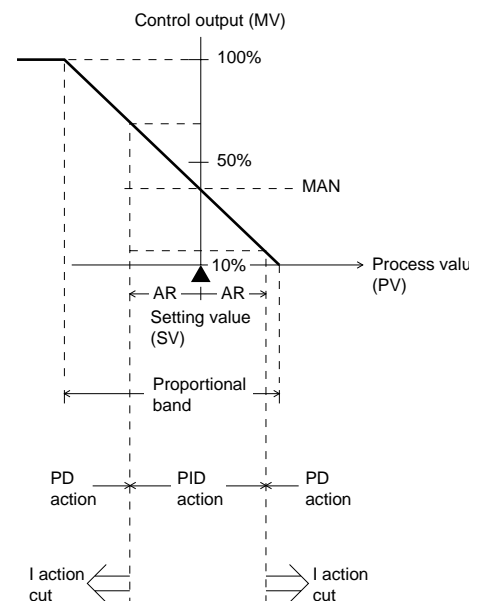
Remarks: (1) Once auto-tuning has been made, PID parameter values are retained despite power-off operation. Therefore, auto-tuning need not be repeated for the subsequent operations.

(2) During auto-tuning, control output corresponds to ON/OFF action. This may cause PV to change widely depending on process. If such a change is unallowable, auto-tuning should not be used.

(3) Do not use the auto-tuning function for a process having a quick response, such as pressure control, flow control, etc.

### (6) Dual output (option)

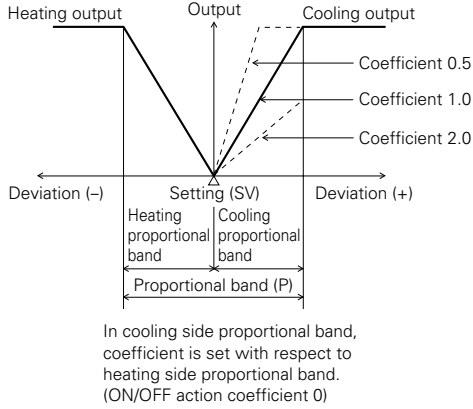
### (5) Anti-reset Windup (ARW)(\*)



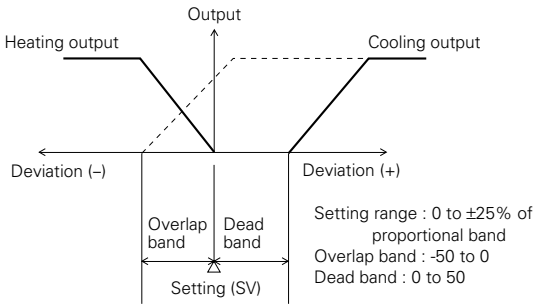
Note : \*ARW: INTEGRAL action is cut when PV is out range of AR value.

The controller incorporates both the heating output and the cooling output for setting "cooling control cycle", "cooling proportional band" and "dead band or overlap band".

(a) Setting of cooling proportional band



(b) Setting of dead band or overlap band



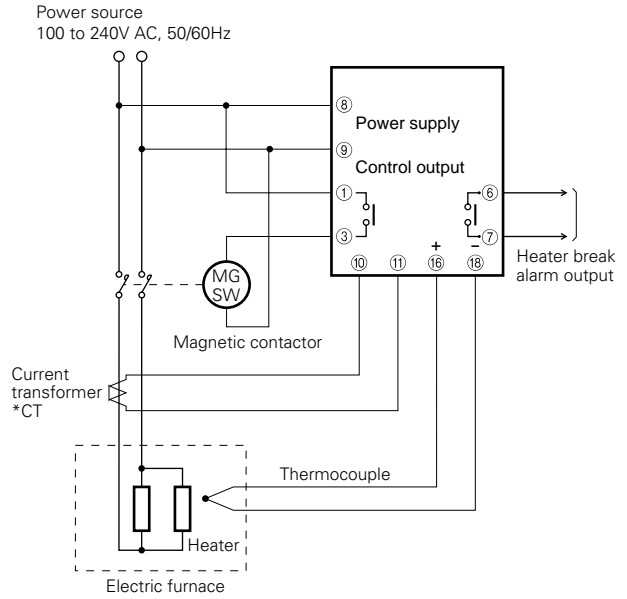
Remarks:

- (1) PID auto-tuning is carried out only on the heating side. During auto-tuning, output on the cooling side remains turned off. After auto-tuning, both heating and cooling operations are performed according to the same PID values.
- (2) ID set value is the same between heating and cooling sides. Individual setting cannot be accepted.

(7) Heater break alarm (option)

- Use the current transformer (CT) specified by Fuji.
- Heater break is detected only when single-phase heater is used.
- Heater break alarm is not available when controlling the heater by thyristor phase-angle control method.
- [alarm detection point] and [Heater current] are registered using of front key.

• Example of connection of heater break alarm



(8) Error message

Display	Cause
	(1) Thermocouple disconnection (2) RTD disconnection (3) Above 105% of input signal
	(1) Thermocouple disconnection (lower direction setting in burnout) (2) RTD disconnection (lower direction setting in burnout) (3) Short circuit between A and B of RTD (4) Below -5% of input signal

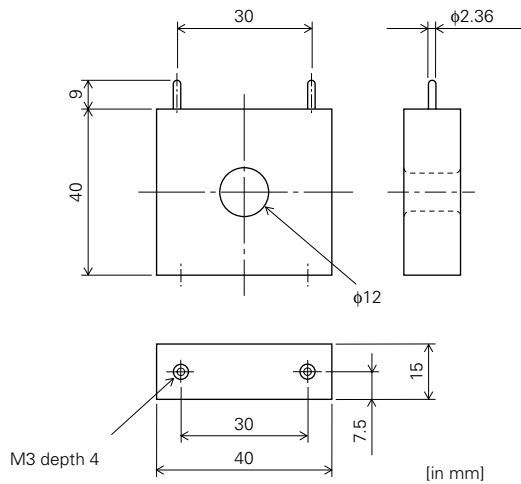
# OUTLINE DIAGRAM (Unit:mm)

Type	Outline	Panel cutout												
PYX5		<p>When mounting one unit</p> <p>When mounting several units (2≤n≤6)</p> <table border="1"> <thead> <tr> <th>No. of unit</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>93</td> <td>141</td> <td>189</td> <td>237</td> <td>285</td> </tr> </tbody> </table>	No. of unit	2	3	4	5	6	a	93	141	189	237	285
No. of unit	2	3	4	5	6									
a	93	141	189	237	285									
PYX9														

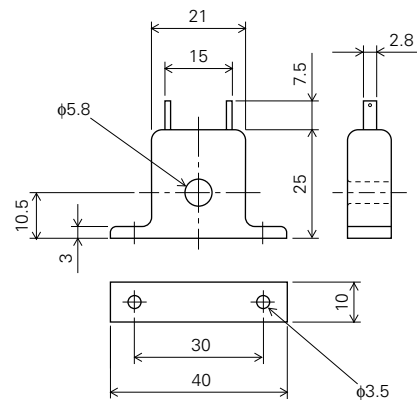
## ORDERING OF CURRENT TRANSFORMER

Current transformer for heater break

Specification : For 20 to 50A  
Ordering code : CTL-12-S36-8F

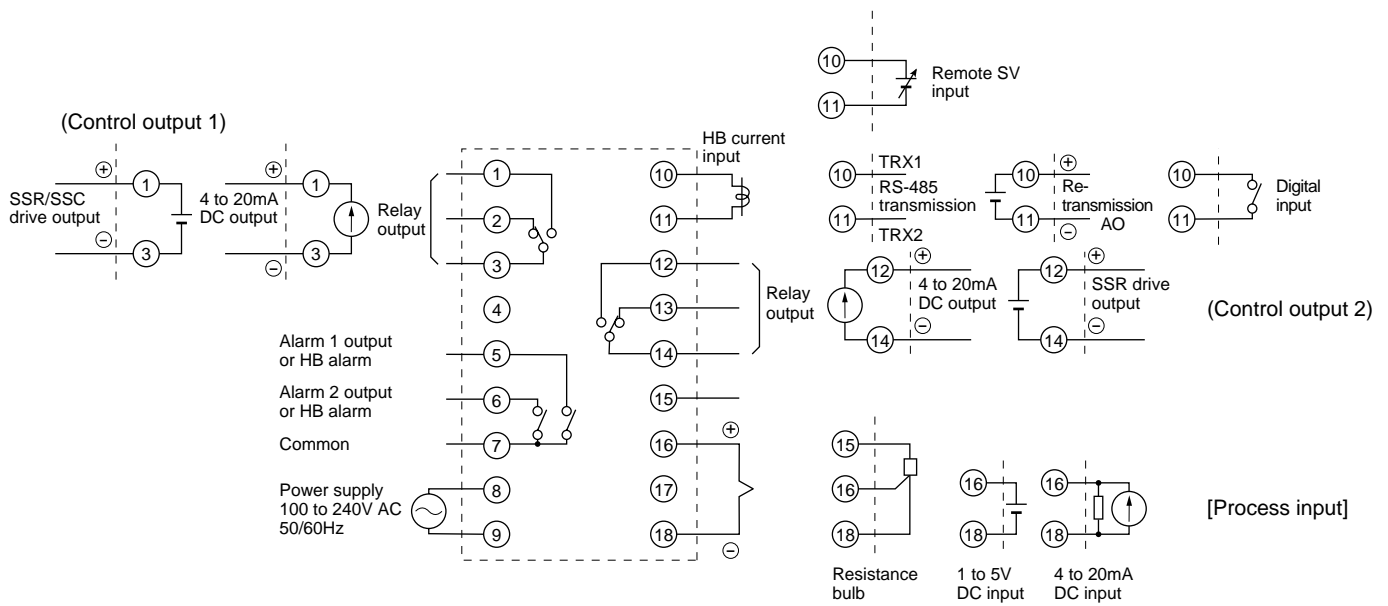


Specification : For 1 to 30A  
Ordering code : CTL-6-SF

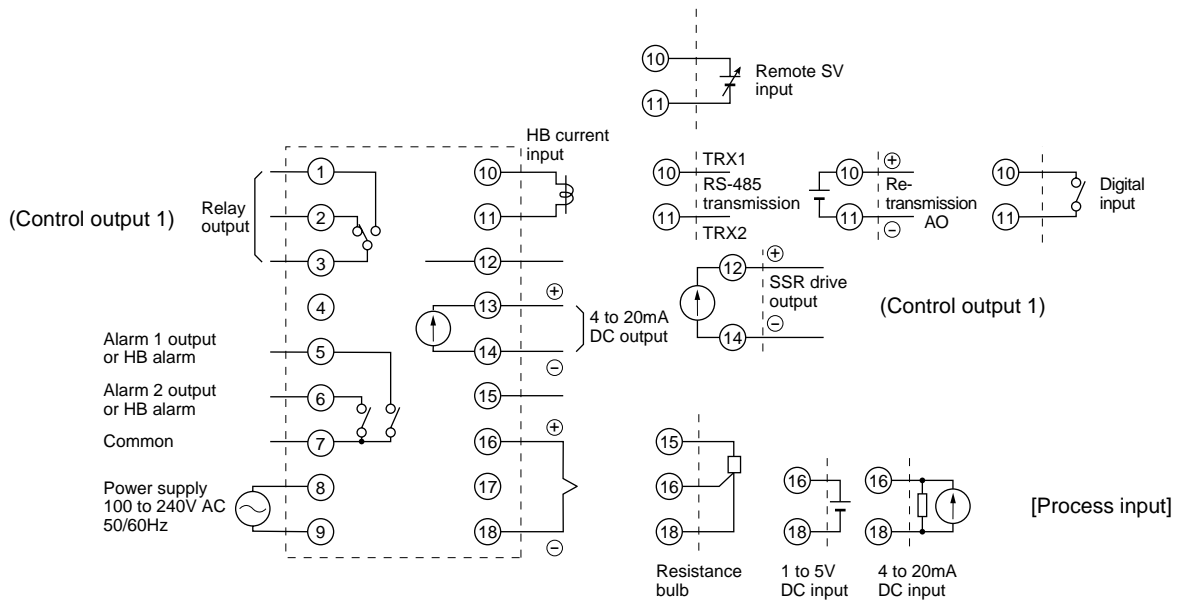


■ TERMINAL WIRING

(1) Standard type



(2) Universal output type



⚠ Caution on Safety

\*Before using this product, be sure to read its instruction manual in advance.

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