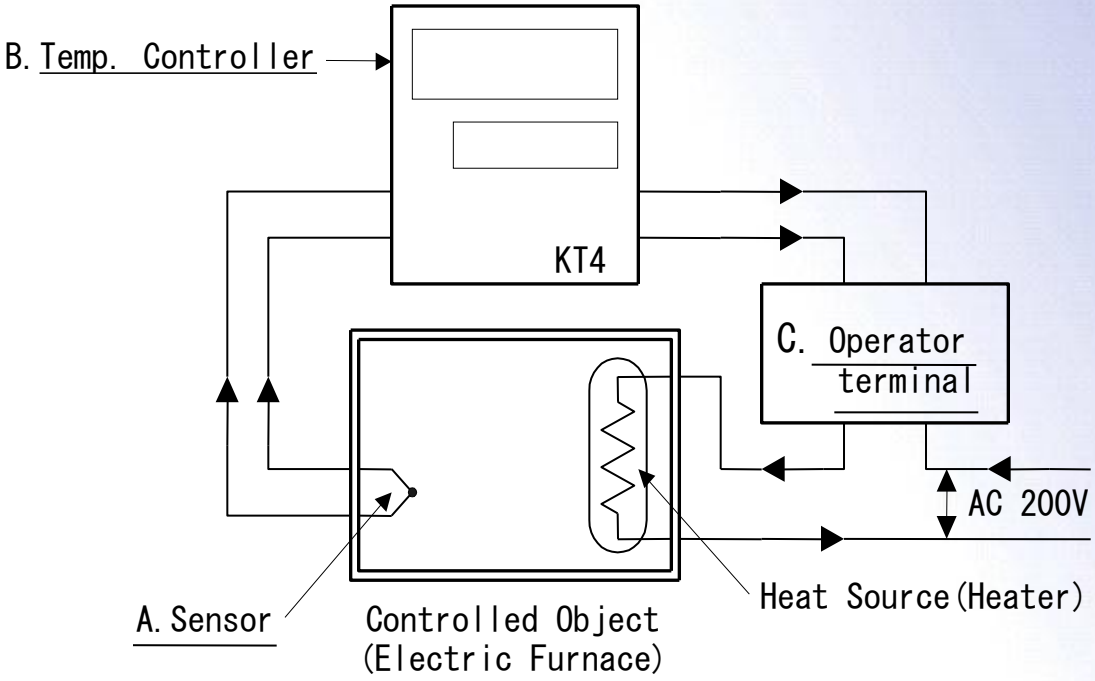
KT Series Temperature Controller Training

Configuration of Temperature Control Systems

The basic temperature controller system configuration is shown below



1. Sensor measures temperature and outputs a signal to the temp. controller.

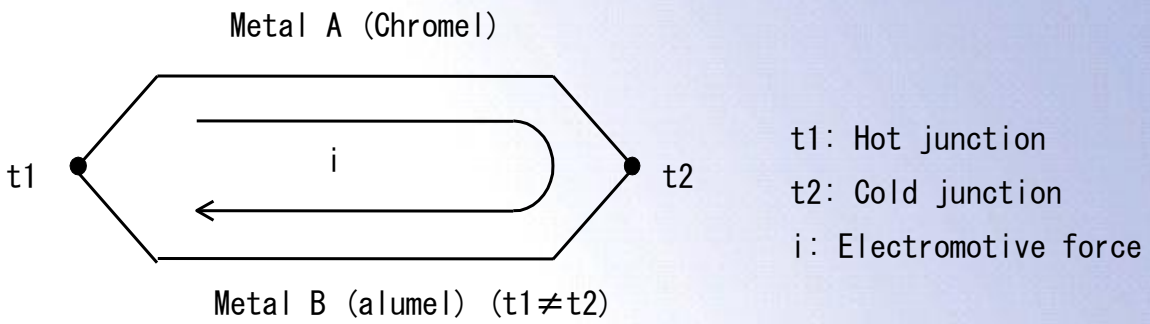
2. Signal from sensor is input into temp. controller. Set value is compared with sensor input and control signal is output.

3. Heat source is controlled by control signal from temp. controller.

About Sensors

The typical sensors used in a temperature controller are the thermocouple and RTD.

Typical thermocouples are the K, J, T, E, and N



Most commonly, the RTD uses a platinum resistance thermometer element.

Characteristics of Each type of thermocouple and RTD

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Type		Operating temperature range (degree Celsius)	Characteristics
Thermocouple	K	-200 --- 1,370	Can be used at high temperatures. Common
	J	-200 --- 1,000	Thermo-electromotive force is high. Easily corrodes.
	R	-200 --- 1,760	Can be used at high temperatures.
	E	-200 --- 800	Superior anti-corrosiveness.
RTD (Pt 100)		-200 --- 850	Good measurement accuracy. Used at low temperature.

Temperature Control

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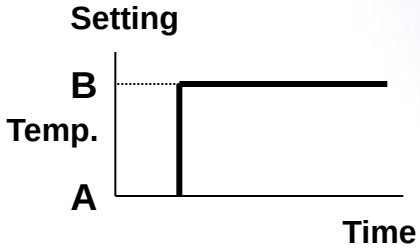
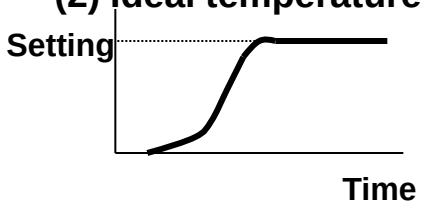
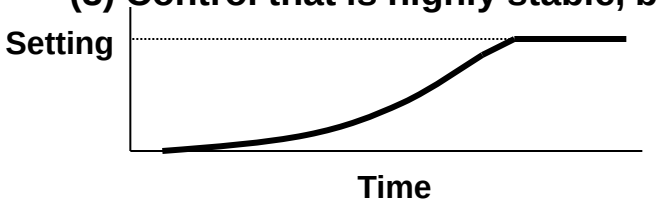
(1) Settings changed from (A) to (B)



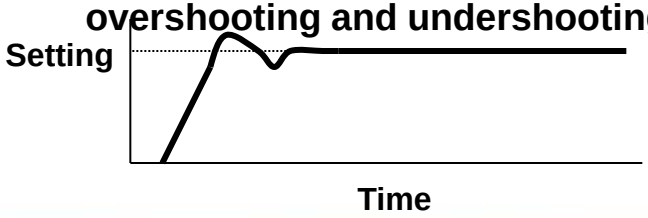
(2) Ideal temperature control



(3) Control that is highly stable, but rise time is slow



(4) Rise time is fast, but control is stabilized by overshooting and undershooting



KT Series Temperature Controller

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Common Features

- Multi-input: versatile thermocouple, RTD, DC Current, DC Voltage
- control modes: PID, on/off control, Anti-Reset-Windup (ARW)
- control output: relay, non-contact voltage output (for SSR drive), DC current output
- Accuracy : ± 0.2% of span
- Simple operation
- Heater-burn out alarm available
- alarm output with 9 different operation modes
- RS485 ASCII/Modbus communication available
- supply voltage: 24 V AC/DC or 100 to 240 V AC
- compliant with UL, CSA standards and CE marking

KT4H

First KT with Panasonic brand

Panasonic brand will come within 2006

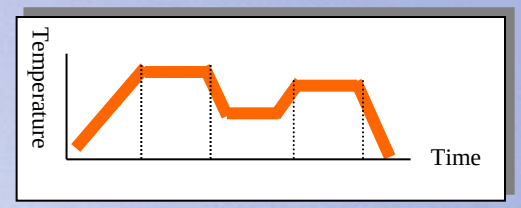
KT Series Product Line-up

Panasonic
ideas for life

Temperature Controller KT2

tiny size –pattern control

- 1/32 DIN size temperature controller
- 48 × 24 × 98.5mm (WxHxD)
- 9-step pattern control (ramp function)
- panel-mounted type
- IP66
- 2 set values possible (external selectable)
- 2nd optional alarm output
- heating and cooling control with 2nd optional control output (relay)



KT Series Product Line-up

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Temperature Controller KT7

DIN rail mounting type – ultra slim

- **Size 22.5 x 75 x 100mm (WxHxD)**
- **front screw terminals**

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ideas for life

Temperature Controller KT4

small sized standard type

- **1/16 DIN size temperature controller**
- **48 x 48 x 95 mm (WxHxD)**
- **panel-mounted type**
- **IP66**
- **2nd optional alarm output**
- **heating and cooling control with 2nd optional control output (non contact voltage output)**

KT Series Product Line-up

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ideas for life

Temperature Controller KT4H

space saving, high performance

- **1/16 DIN size temperature controller**
- **48 x 48 x 56 mm (WxHxD)**
- **panel-mounted type**
- **IP66**
- **2nd optional alarm output**
- **heating and cooling control with 2nd optional control output (non contact voltage output)**
- **11-segment display with 3 colours for PV**
- **4 set values for external selection**
- **Tool Port as standard**
- **MEWTOCOL Communication**
- **Heater burn-out alarm supports 3-phase heaters**

- USB-Tool cable AKT4H820

- KT-Monitor Software

(provided for free together with USB cable) -> see next pages

KT Series Product Line-up

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ideas for life

Temperature Controller KT8

wide variety of options, good readable display

- **1/8 DIN size temperature controller**
- **48 x 96 x 98.5 mm (WxHxD)**
- **panel-mounted type**
- **IP66**
- **2 set values possible (external selectable)**
- **2nd optional alarm output**
- **heating and cooling control with 2nd optional control output (relay, non contact voltage, or current)**

KT Series Product Line-up

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Temperature Controller KT9

big display

- **1/4 DIN size temperature controller**
- **96 x 96 x 98.5 mm (WxHxD)**
- **panel-mounted type**
- **2 set values possible** (external selectable)
- **2nd optional alarm output**
- **heating and cooling control with 2nd optional control output (relay, non contact voltage, or current)**

Elements of KT controllers

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PV display: Indicates the input value in red colour

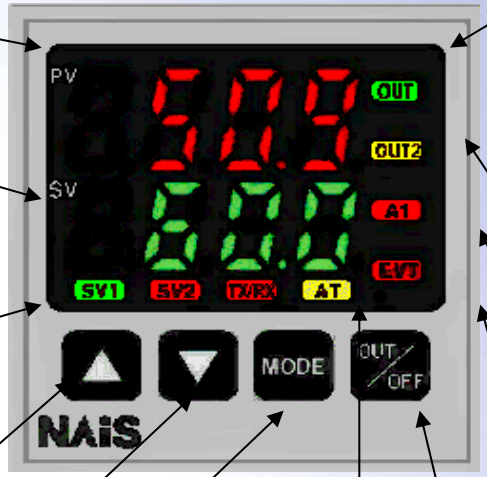
SV display: Indicates the setting value in green colour

SV1 indicator: green LED lights up when SV is indicated on the SV display.

Increase key :
Increases the numeric value.

Decrease key :
Decreases the numeric value.

Mode key: Selects the setting mode or registers the setting value. (By pressing the Mode key, the setting value can be registered)



AT indicator:
When auto-tuning or auto-reset is being performed, a yellow LED blinks.

OUT1 indicator: When OUT1 or heating output is ON, a green LED lights up. (For DC current output type, it blinks corresponding to the manipulated variable in a 0.25 second cycle.

OUT2 indicator: When OUT2 is ON, a yellow LED lights up.

A1 indicator: When A1 output is ON, a red LED lights up.

EVT indicator: When Event output (A2 output, Heater burnout alarm output) is ON, a red LED lights up.

OUT/OFF key: The control output is turned on or off. If this key is pressed for approx. 1 second, control output off function works. (To cancel the function, press the OUT/OFF key again for approx. 1 second.)

Elements of KT4H controllers

(1) Action Indicators
T/R
AT
OUT1
OUT2
EVT1 Alarm 1
EVT2 Alarm 2 or Heater burnout Alarm
LOCK

(2) Memo Display
Set Value Memory Number
(3) PV Display

(4) SV Display

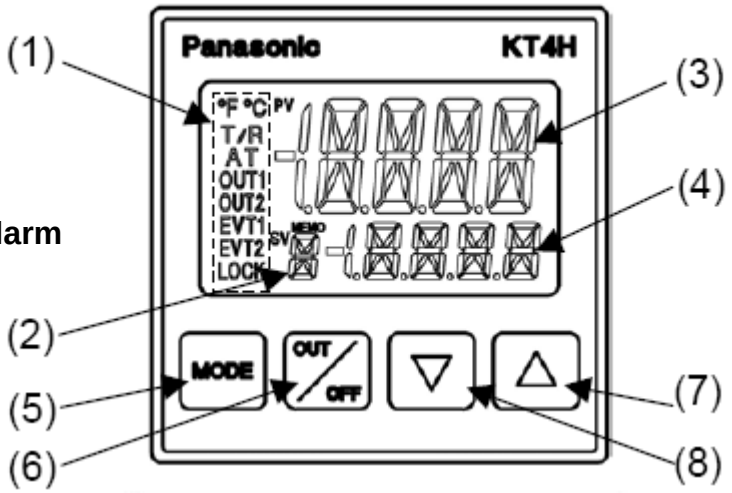
(5) Mode key

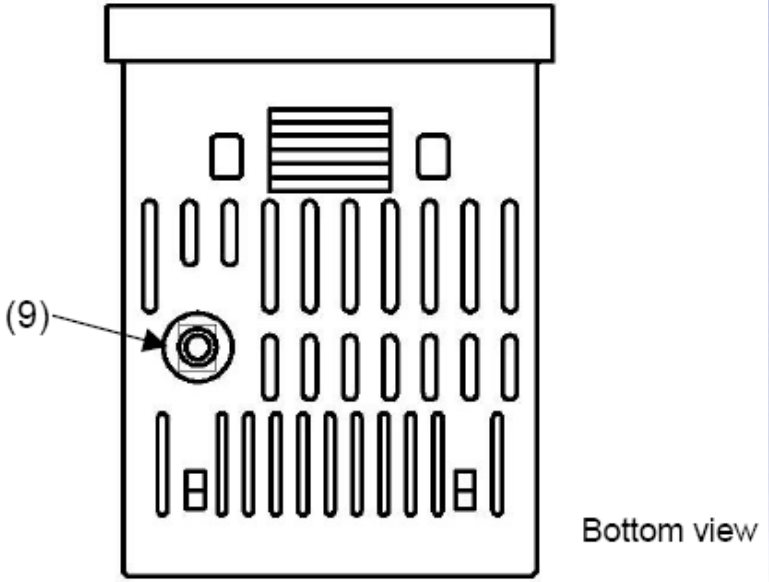
(6) Out/Off key

(7) Up key

(8) Down key

(9) Tool-Port





Operation of KT series

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4 setting modes:

Main setting mode	MODE	**to change set value SV**
Sub setting mode	▲ + MODE	**to enter AT, or change PID-settings, ARW, out1/2, A1/2, burnout AI.**
Auxilliary function setting mode	▼ + MODE	**approx. 3 s., to enter lock level, sensor limits, sensor correction, RS485 Communication settings**
Auxilliary function setting mode 2	▲ + ▼ + MODE	**approx. 3 s.,**

Temperature Sensors

Panasonic
ideas for life

A wide range of different both thermocouple and RTD can be connected to all KT s !

Input type		Input range
Thermocouple	K	–200 to 1370°C
		–199.9 to 400.0°C
	J	–200 to 1000°C
	R	0 to 1760°C
	S	0 to 1760°C
	B	0 to 1820°C
	E	–200 to 800°C
	T	–199.9 to 400.0°C
	N	–200 to 1300°C
	PL-II	0 to 1390°C
	C (W/Re5-26)	0 to 2315°C
RTD	Pt100	–200 to 850°C
		–199.9 to 850.0°C
	JPt100	–200 to 500°C
		–199.9 to 500.0°C
DC Current	4 to 20mA DC	–1999 to 9999, –199.9 to 999.9 –19.99 to 99.99, –1.999 to 9.999
	0 to 20mA DC	
DC Voltage	0 to 1V DC	
	0 to 10V DC	
	1 to 5V DC	
	0 to 5V DC	

The sensor type can be set, when there is no sensor connected at power on (self-test) or In „Auxilliary function setting mode 2“ by Pressing  +  + 

for 3 sec.

Operation of KT series

Panasonic
ideas for life

4 setting modes:

Main setting mode — **to change set value SV**

Sub setting mode — MODE + ▲ — **to enter AT, or change PID-settings, ARW, out1/2, A1/2, burnout AI.**

Auxilliary function setting mode — MODE + ▼ — **approx. 3 s., to enter lock level, sensor limits, sensor correction, RS485 Communication settings**

Auxilliary function setting mode 2 — MODE + ▲ + ▼ — **approx. 3 s.,**

SCLH	**Scaling high limit setting** • Sets scaling high limit value. • Available only for DC input type • Setting range: Scaling low limit value to input range high limit value	9999
SCLL	**Scaling low limit setting** • Sets scaling low limit value. • Available only for DC input type • Setting range: Input range low limit value to scaling high limit value	–1999
dP	**Decimal point place selection** • Selects decimal point place. • Available only for DC input • No decimal point: 0 0 1 digit after decimal point: 0 .0 2 digits after decimal point: 0 .00 3 digits after decimal point: 0 .000	No decimal point
PV FILT	**PV filter time constant setting** • Sets PV filter time constant. (If the value is set too large, it affects control result due to the delay of response) • Setting range: 0.0 to 10.0 seconds	0.0 seconds

Operation of KT series (2)

oLH	**OUT1 high limit setting** • Sets the high limit value of OUT1. Not available for ON/OFF action • Setting range: OUT1 low limit value to 105% (Setting greater than 100% is effective to the current output type)	100%
oLL	**OUT1 low limit setting** • Sets the low limit value of OUT1. Not available for ON/OFF action. • Setting range: –5% to OUT1 high limit value (Setting less than 0% is effective to the current output type)	0%
HYS	**OUT1 ON/OFF action hysteresis setting** • Sets ON/OFF action hysteresis for OUT1. Available only when the control action is ON/OFF action • Setting range: 0.1 to 100.0℃ (℉), or 1 to 1000	1.0℃
cRcF	**OUT2 action mode selection** • Selects OUT2 action from air cooling, oil cooling and water cooling. • Air cooling: AIr oil cooling: oIL water cooling: H2O	Air cooling
oLHb	**OUT2 high limit setting** • Sets the high limit value of OUT2. • Setting range: OUT2 low limit value to 105% (Setting greater than 100% is effective to DC current output type)	100%
oLLb	**OUT2 low limit setting** • Sets the low limit value of OUT2. • Setting range: -5% to OUT2 high limit value (Setting less than 0% is effective to DC current output type)	0%
db	**Overlap band/Dead band setting** • Sets the overlap band or dead band for OUT1 and OUT2. + setting value: Dead band – setting value: Overlap band • Setting range: –100.0 to 100.0℃ (℉), or 1 to 1000	0℃

Operation of KT series (3)

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HYS6	**OUT2 ON/OFF action hysteresis setting** • Sets ON/OFF action hysteresis for OUT2. • Setting range: 0.1 to 100.0℃ (℉), or 1 to 1000	1.0℃
AL 1F	**A1 action selection** • Selects an action for A1. No alarm action : ---- High limit alarm action : H Low limit alarm action : L High/Low limits alarm action : HL High/Low limit range alarm action : o Process high alarm action : PH Process low alarm action : PL High limit alarm action with standby : H Low limit alarm action with standby : L High/Low limits alarm action with standby: HL	No alarm action
AL2F	**A2 action selection** • Selects an action for A2. • Action selection and default value are the same as those of A1 action selection.	No alarm action
A1LA	**A1 action Energized/Deenergized selection** • Selects Energized/Deenergized for A1. • Not available if No alarm is selected in A1 action selection • Energized: nonL Deenergized: rEVS	Energized
A2LA	**A2 action Energized/Deenergized selection** • Selects Energized/deenergized for A2. • Not available if No alarm is selected in A2 action selection • Action selection and default value are the same as those of A1 action Energized/Deenergized selection.	Energized
A1HY	**A1 hysteresis setting** • Sets hysteresis for A1. • Not available if No alarm is selected in A1 action selection • Setting range: 0.1 to 100.0℃(℉), or 1 to 1000	1.0℃

Output Method

Panasonic
ideas for life

3 different output types

Output method	Characteristics
Relay contact output	Since the contact capacity of the temperature controller is small, an electromagnetic switch is connected. Since mechanical contact is used, this type is used in applications in which the on-off frequency is low.
Voltage output for SSR drive	This voltage output is used for driving the SSR . Since the SSR is a semiconductor relay, contact life is long. This type is used in applications in which the on-off frequency is high.
DC current output	This current output is used to control a power regulator. Smooth and accurate control is possible because phase control corresponds to the current output.

Differences between controllers, feedback control types

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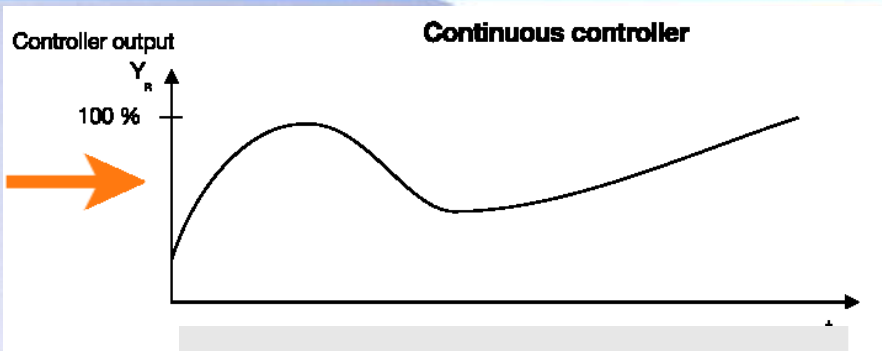
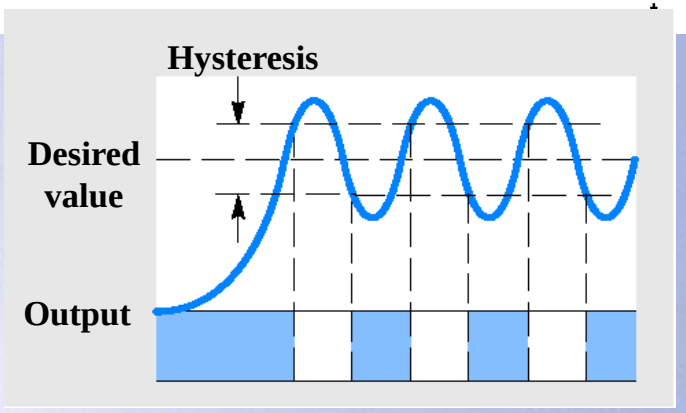
Continuous controllers: (not with KT series)

These are controllers which receive a continuous (analog) signal and produce an output signal that is also continuous. The manipulating signal can take on any value within the manipulating range.



2-step controllers: ***On-Off Control***

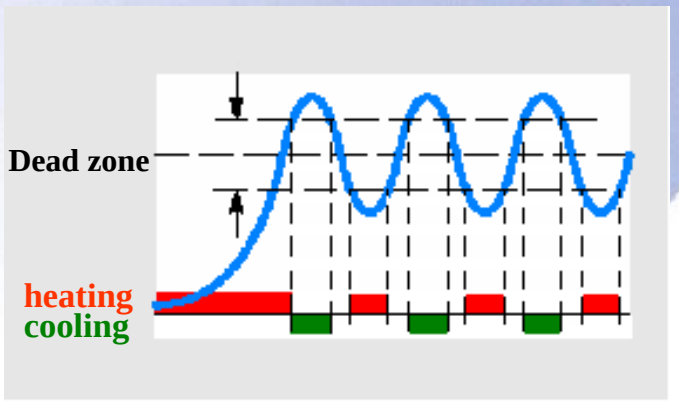
Also called single setpoint, two-positions, on-off, or black-white controllers, these are controllers with one switching control output that produces a discontinuous output signal for a continuous input one. It is mainly used for heating or cooling systems where you only need to switch the temperature on and off.



3-step controllers:

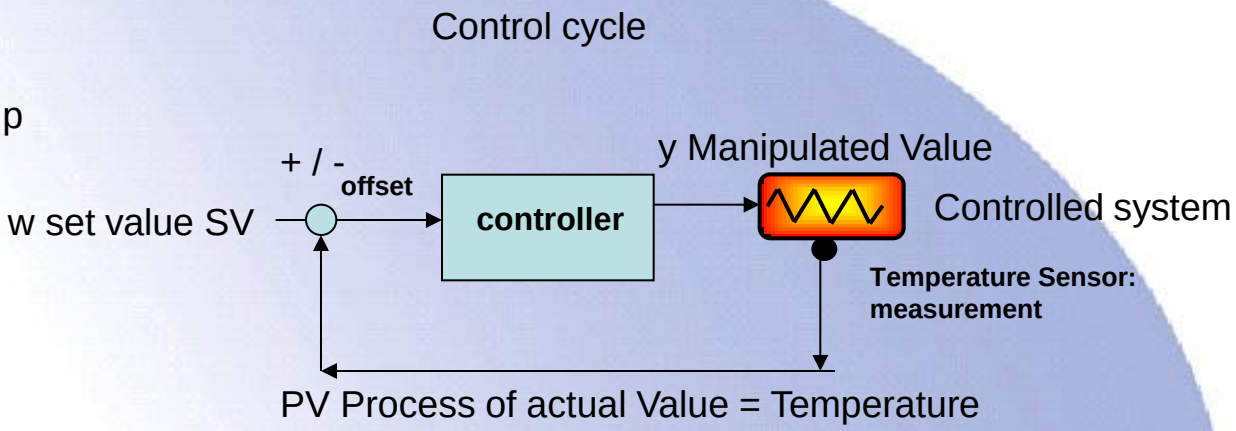
With optional second control output for cooling

Also called double setpoint controllers or three-position controllers, these are controllers with two switching control outputs. Using the same system as above, the only difference is that there are two outputs for manipulating variables, which are used for a heating/cooling system, for example.



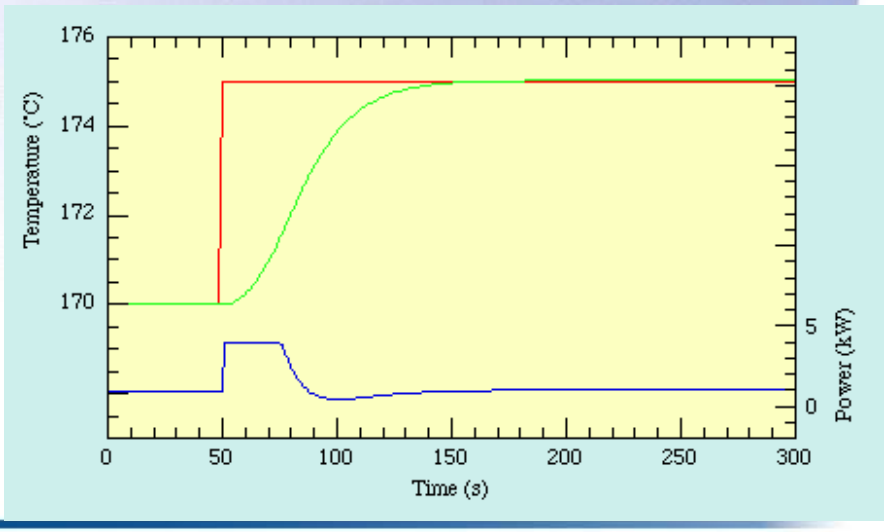
PID Control

Parameters: Kp Proportional band
Ti Integral time
Td Derivative time
ARW Auto Rewind Setup



Anti-Reset-Windup

Phaenomenon: Caused by limited output range the offset decreases slower as desired and the integrator is loaded too much. Result is overshoot and system is not stable.



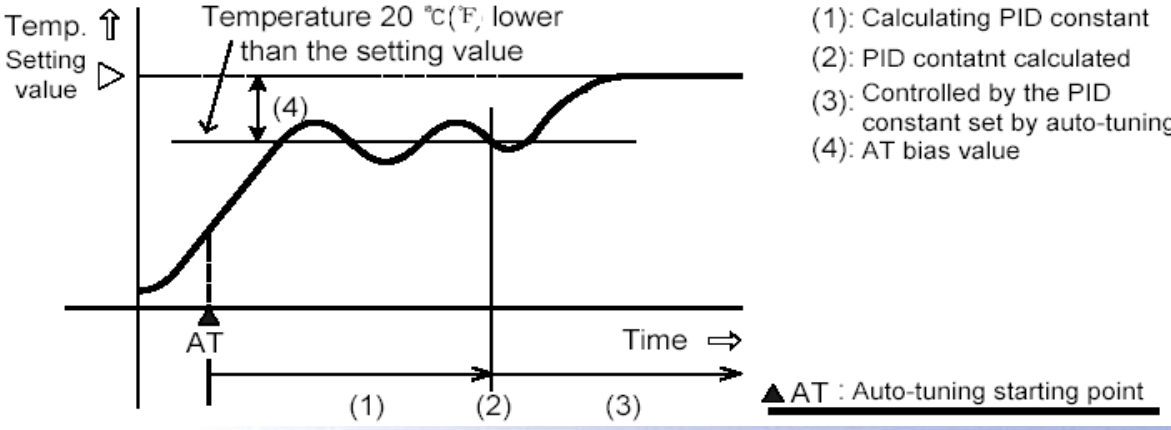
counteractive measures:

1. the integrator gets only loaded when there is no limit.
2. correction of u(k ¡ 1) so that manipulated value is within limit
3. limitation of manipulated value and setup of controller as for shock free switching

Autotuning (1)

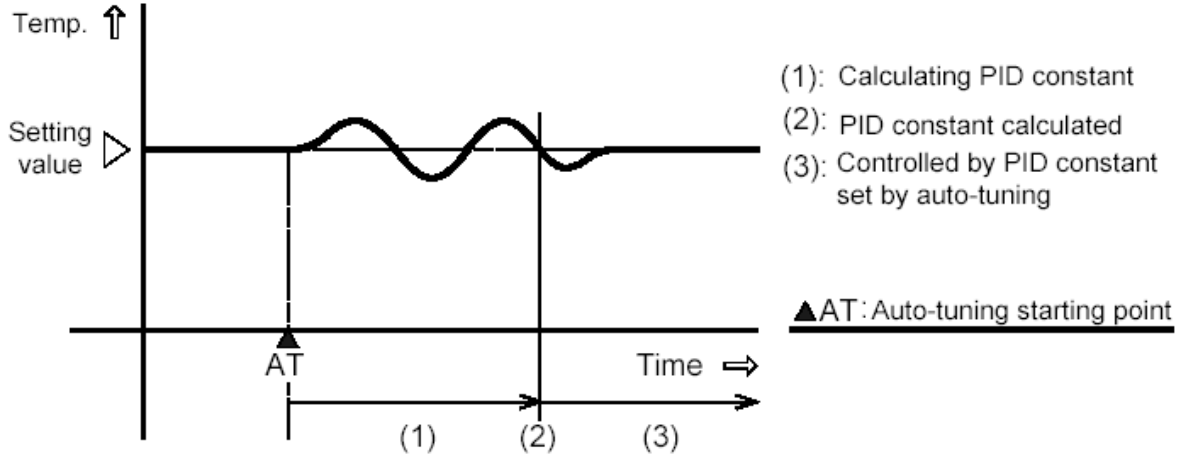
Autotuning: Kp, Ti and Td are set automtically

(1) When the difference between the setting value and processing temperature is large as the temperature rises.



(2) When the control is stable

Fluctuation is applied at the setting value.

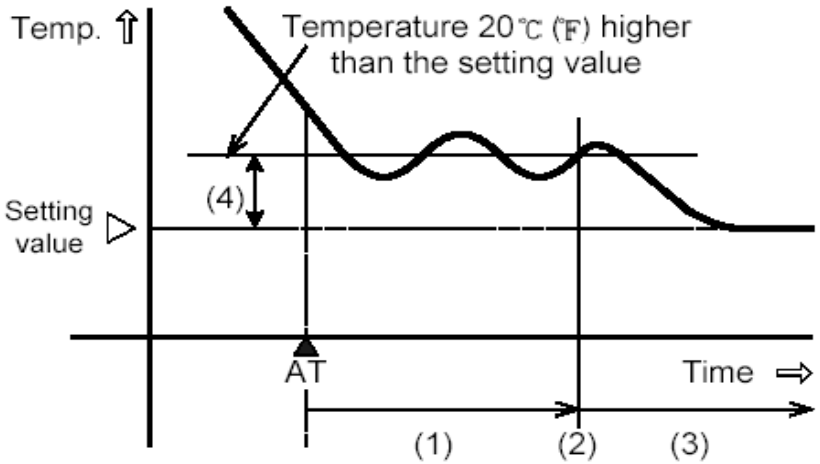


Autotuning (2)

Autotuning: Kp, Ti and Td are set automtically

(3) When the difference between the setting value and processing temperature is large as the temperature falls.

When AT bias is set to 20℃(℉), fluctuation is applied at the temperature 20℃ (℉) higher than the setting value.

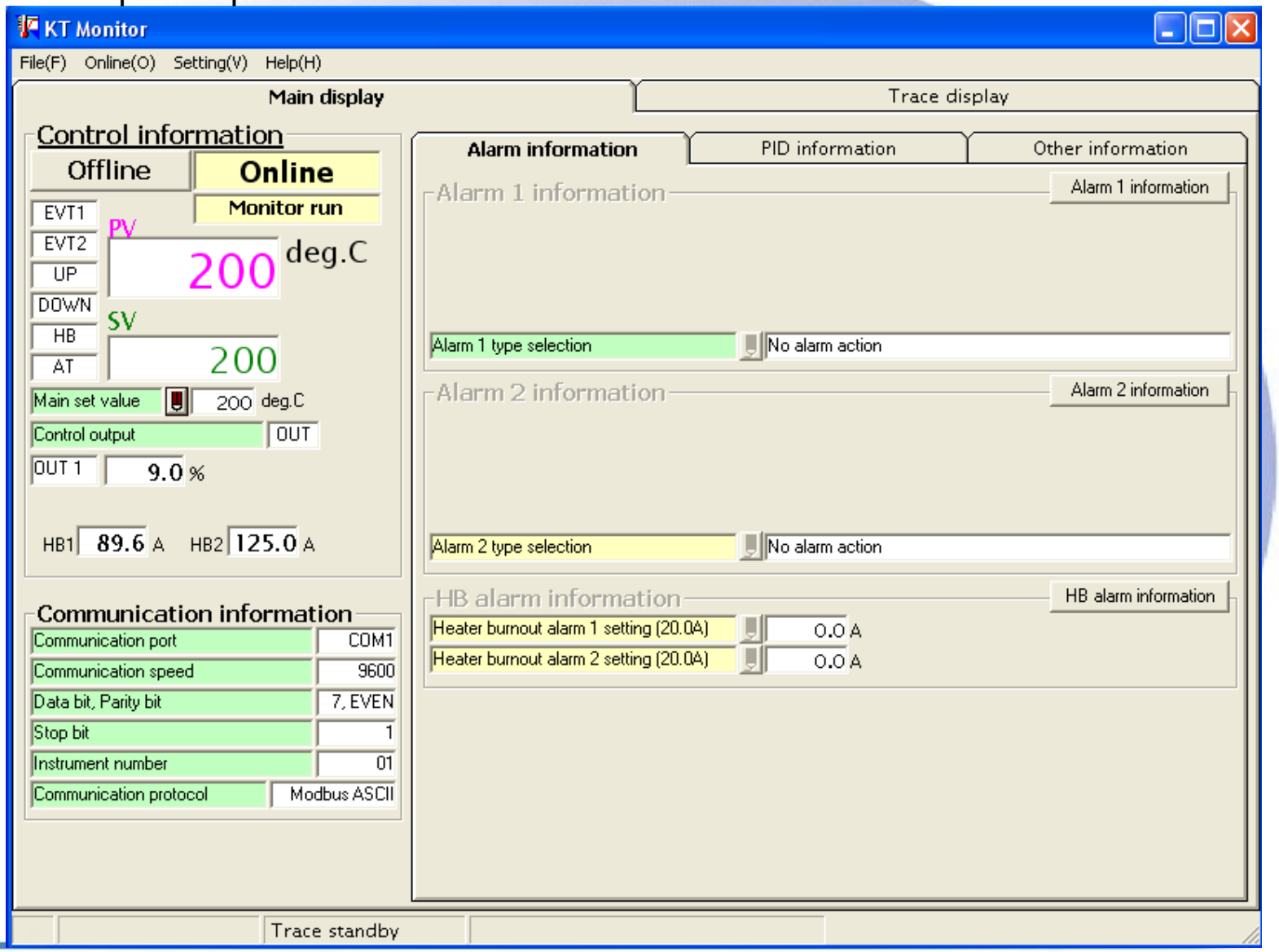


(1): Calculating PID constacnt
(2): PID constant calculated
(3): Controlled by PID constant set by auto-tuning
(4): AT bias value

▲ AT: Auto-tuning starting point

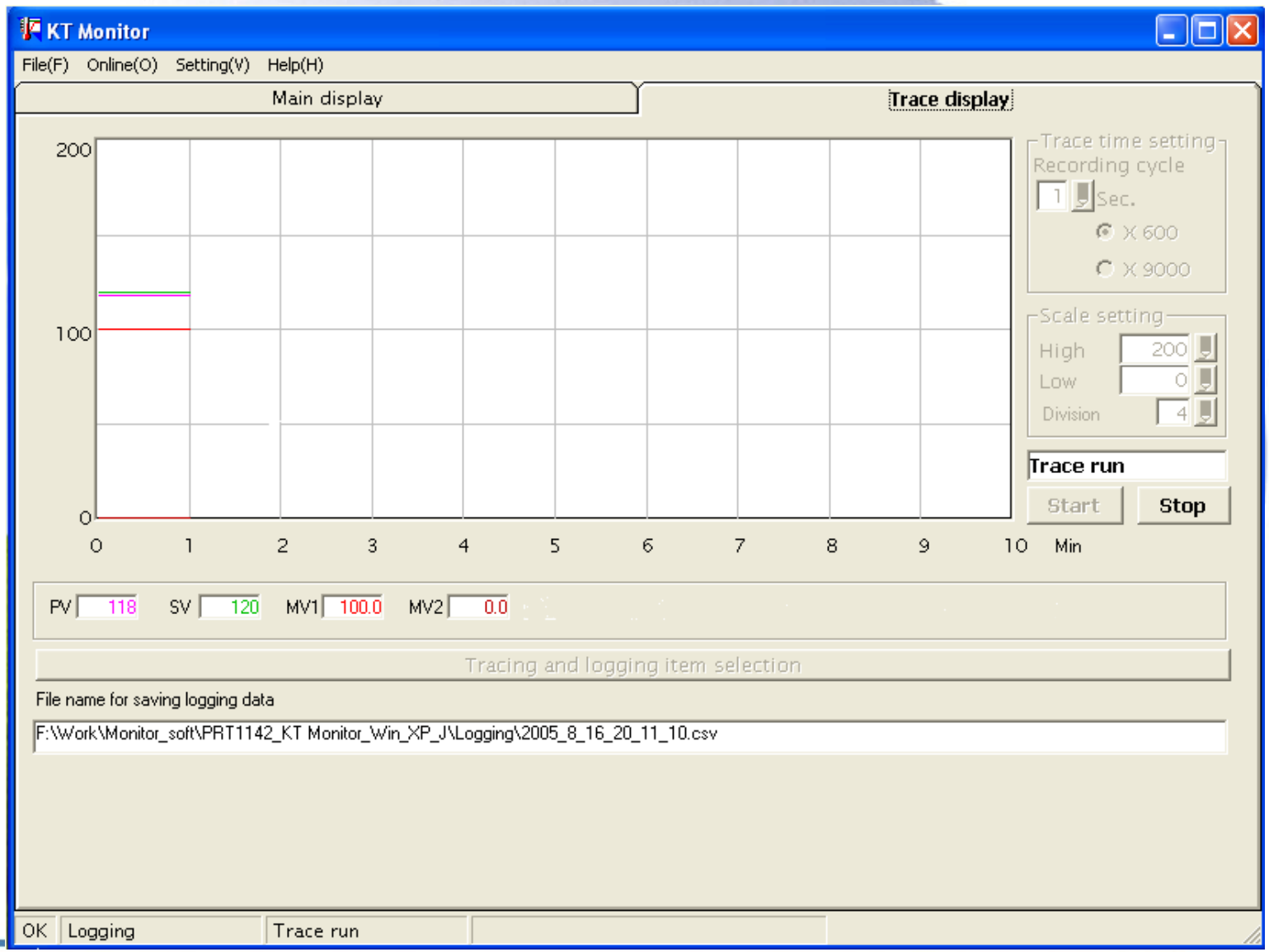
KT-Monitor for KT4H

Clear display and setup of all parameters and values



KT Monitor für KT4H

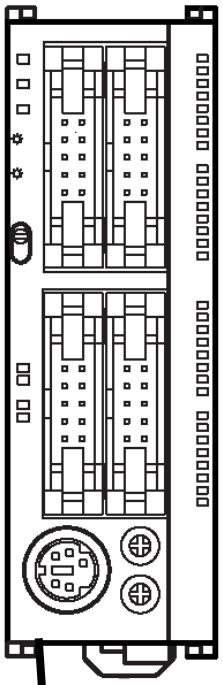
Sampling and trend monitoring of PV, SV, MV1 and MV2



Save all data in CSV-formatted files

Example 1

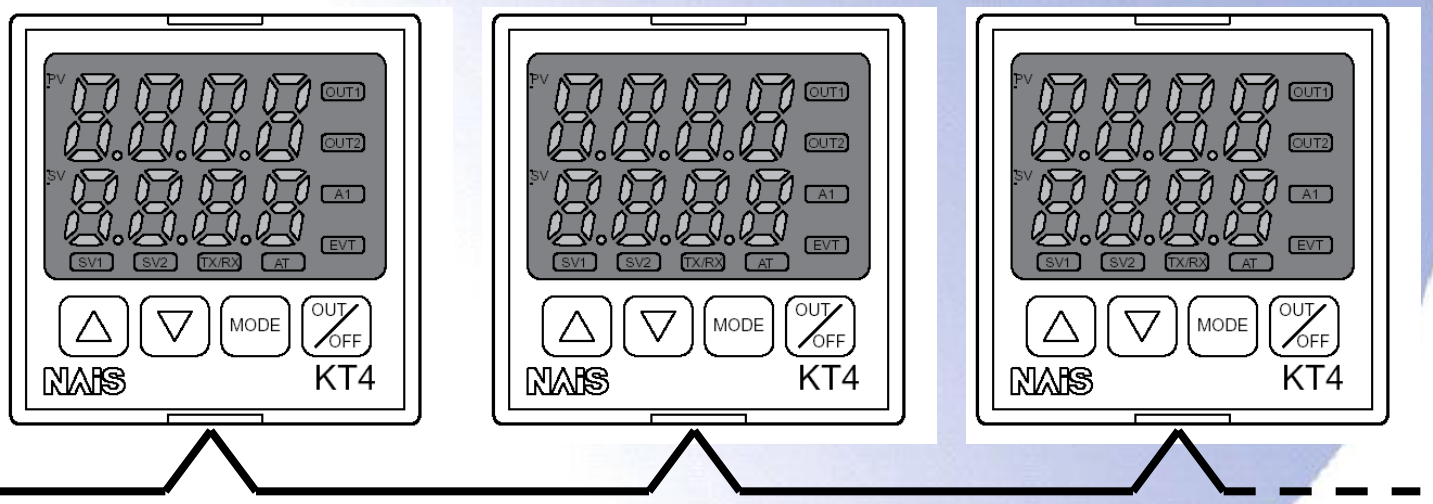
Multidrop communication with a programmable logical controller (PLC)



FPΣ PLC

with FPG-COM3 communication cassette

Standard ASCII or Modbus ASCII Protocol

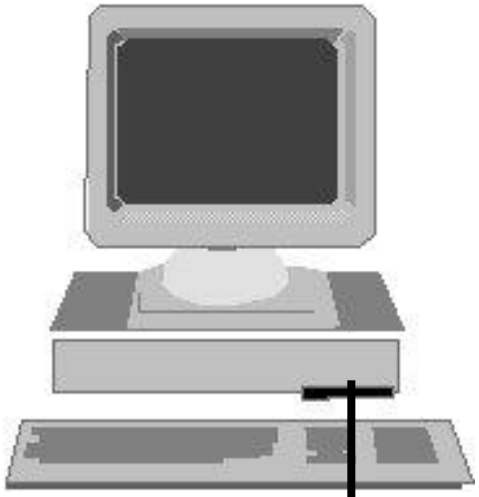


RS-485

Up to 31 units can be connected

Example 2

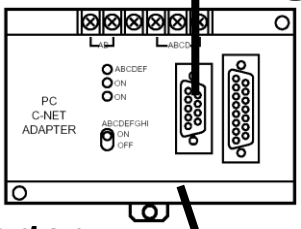
Multidrop communication with a Personal Computer



PC
with RS-232 Interface

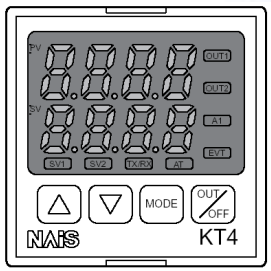
Standard ASCII, Modbus ASCII, or Modbus RTU Protocol

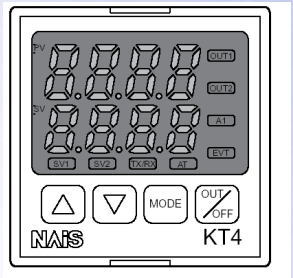
RS-232

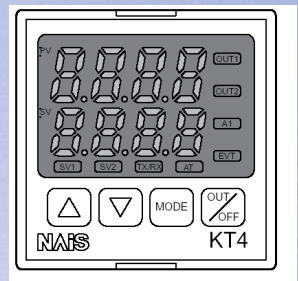


Converter
RS232 – RS485
e.g. AFP8532J

RS-485







Up to 31 units can be connected