TEMPERATURE CONTROL APPLICATIONS

SHINKO TECHNOS CO., LTD.

Product line

Input sensors

Thermocouple, RTD

Infrared thermocouples

Humidity detectors

Humidity/Temp. detectors

I/O connection

Controllers

Panel mounting type

JC series NEW!

FC series

HCD-100

DIN rail mounting type

NCL-13A NEW!

DCL-33A

C series

Programmable controllers

PCD-33A

PC-900

PC-800

Output devices

SSR

SA-300-Z

Power controllers

PA-200

PA-3000

Indicators

JIR-301-M

FIR-201-M

DFT-700-M

Data loggers, Recorders

LCD-13A NEW!

HR-700

GR-100

RS-232C
RS-422A
RS-485

CC-Link

PLC

OMRON Corp.

Fuji Electric Co., Ltd.

Mitsubishi Electric Corp.

Other PLCs

PLC Interface unit

SIF-400 NEW!

Connection with other companys' PLC without programming

Programmable interfaces

Hakko Electronics Co., Ltd.
Digital Electronics Corp.

Connection with controllers, indicators, programmable controllers, etc. without progamming

PC (Monitoring software)

SWM series

Communication converter

IF-300-C5

Communication converter for PROFIBUS

IFP-100

PROFIBUS DP

Ethernet

Remote monitoring

Remote monitoring system

Web monitoring

Web monitoring system

SCADA software

Router

Router

PROFIBUS・master unit

Siemens PLC, PROFIBUS master unit

SELECTION GUIDE

Digital indicating controllers	JCL-300	JCS-300	JCR-300	JCM-300	JCD-300
					
Dimensions (W x H x Dmm)	48 x 24 x 98.5mm	48 x 48 x 96.5mm	48 x 96 x 98.5mm	72 x 72 x 100mm	96 x 96 x 98.5mm
Input	Thermocouple, RTD, DC current, DC voltage				
Control action	PID, PI, PD, P, ON/OFF				
Control output	Relay contact, Non-contact voltage, DC current				
Input sampling period	0.25sec.				
Accuracy	Within ±0.2%FS±1digit				

Digital indicating controllers	FCS-100, 200	FCR-100	FCR-200	FCD-100
				
Dimensions (W x H x Dmm)	48 x 48 x 100mm	48 x 96 x 100mm	96 x 48 x 100mm	96 x 96 x 100mm
Input	Thermocouple, RTD	Thermocouple, RTD, DC current, DC voltage		
Control action	Fuzzy self-tuning PID, PI, PD, P, ON/OFF			
Control output	Relay contact, Non-contact voltage, DC current, ON/OFF servo (only for the FCR-100, FCD-100)			
Input sampling period	0.125sec.			
Accuracy		Within ±0.2%FS±1digit		

Console unit for the DCL-33A, DIN rail mounting type indicating controllers, Communication type temperature control units, 2ch digital indicating controllers/data loggers	OMR-100	DCL-33A	NCL-13A	LCD-100
				
Dimensions (W x H x Dmm)	48 x 96 x 100mm	22.5 x 75 x 100mm	17.5 x 75 x 85mm	96 x 96 x 100mm
Input		Thermocouple, RTD, DC current, DC voltage		
Control action		PID, PI, PD, P, ON/OFF		
Control output		Relay contact, Non-contact voltage, DC current		
Input sampling period		0.25sec.		
Accuracy		Within ±0.2%FS±1digit		Within ±0.3%FS±1digit

Digital temperature indicating controllers	ECS-200	FCL-100	GCS-100	GCS-200	GCR-200
					
Dimensions (W x H x Dmm)	48 x 48 x 85mm	48 x 24 x 98.5mm	48 x 48 x 100mm	48 x 48 x 100mm	48 x 96 x 100mm
Input	Thermocouple, RTD				
Control action	PD, ON/OFF	PID, PD, ON/OFF			
Control output	Relay contact, Non-contact voltage	Relay contact, Non-contact voltage, DC voltage			
Input sampling period	0.5sec.	0.25sec.			
Accuracy	Within ±0.5%FS±1digit	Within ±0.5%FS±1digit			

SELECTION GUIDE

 GCM-200	 GCD-200	 GCS-300	 GCR-500	Digital temperature indicating controllers
72 x 72 x 100mm	96 x 96 x 100mm	48 x 48 x 96.5mm	96 x 48 x 100mm	Dimensions (W x H x Dmm)
Thermocouple, RTD				Input
PID, PD, ON/OFF				Control action
Relay contact, Non-contact voltage, DC voltage				Control output
0.25sec.				Input sampling period
Within ±0.3%FS±1digit				Accuracy

 MCS-100	 MCR-100	 MCD-100	 VCR-100	 HCD-100	Digital temperature indicating controllers, Process controllers
48 x 48 x 85mm	48 x 96 x 85mm	96 x 96 x 85mm	48 x 96 x 85mm	96 x 96 x 165mm	Dimensions (W x H x Dmm)
Thermocouple, RTD		Thermocouple, RTD, DC current, DC voltage	Thermocouple, RTD	Thermocouple, RTD, DC current, DC voltage	Input
PID, PD, ON/OFF					Control action
Relay contact, Non-contact voltage	Relay contact, Non-contact voltage, DC voltage				Control output
0.5sec.				0.1sec.	Input sampling period
Within ±0.3%FS±1digit				Within ±0.1%FS±1digit	Accuracy

 PCD-300	 PC-700	 PC-800	 PC-900	Programmable controllers
96 x 96 x 98.5mm	144 x 144 x 275mm	96 x 96 x 165mm	96 x 96 x 100mm	Dimensions (W x H x Dmm)
Thermocouple, RTD, DC current, DC voltage				Input
PID, PD, ON/OFF			Fuzzy overshoot protection PID	Control action
Relay contact, Non-contact voltage, DC voltage, etc.				Control output
0.25sec.	0.5sec.	0.1sec.	0.125sec.	Input sampling period
Within ±0.2%FS±1digit	Within ±0.3%FS±1digit	Within ±0.1%FS±1digit	Within ±0.2%FS±1digit	Accuracy

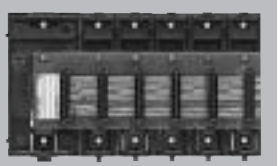
 BC series	 BOC-200	 TCU-BSN-2	Portable temperature control unit, Oven temperature control unit, 2-point temperature controller
Refer to External dimensions.	140 x 310 x 87.5mm	220 x 164 x 121mm	Dimensions (W x H x Dmm)
Thermocouple, RTD	Thermocouple		Input
Depends on the built-in instrument.	PD, ON/OFF	Depends on the built-in instrument.	Control action
	Relay contact, Non-contact voltage		Control output
	1sec.		Input sampling period
	Within ±0.5%FS±1digit		Accuracy

SELECTION GUIDE

Digital temperature indicating controllers, Digital deviation indicating temperature controllers	 ACN-100	 DCN-100	 DCN-117	 RC-400
Dimensions (W x H x Dmm)	96 x 96 x 120mm			48 x 96 x 102mm
Input	Thermocouple, RTD			Thermocouple
Control action	PD, ON/OFF		ON/OFF	PD, ON/OFF
Control output	Relay contact, Non-contact voltage	Relay contact		Relay contact, Non-contact voltage
Indication accuracy	Within ±1%FS±1digit	Within ±0.5%FS±1digit		Within ±2℃
Setting accuracy	Within ±1%FS	Within ±0.5%FS		Within ±1%FS

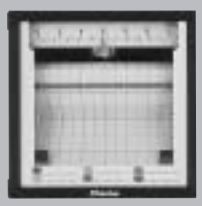
Analog temperature indicating controllers, Analog deviation indicating temperature controllers	 AF-100	 DIC
Dimensions (W x H x Dmm)	96 x 96 x 120mm	96 x 96 x 123mm
Input	Thermocouple, RTD	Thermocouple
Control action	PD, ON/OFF	
Control output	Relay contact	
Indication accuracy	Within ±1.5%FS	Within ±10%
Setting accuracy	Within ±1%FS	

Multi-point temperature control system	 CCT-235	 CPT-20A	 CIT-200	 CLT-200
Dimensions (W x H x Dmm)	24 x 96 x 94mm	48 x 96 x 94mm	48 x 96 x 94mm	24 x 96 x 94mm

Multi-point temperature control system	 CLT-20S	 CMT-200	 COT-200	 CBT-200
Dimensions (W x H x Dmm)	24 x 96 x 94mm	195 x 150 x 47mm	96 x 96 x 100mm	Refer to Dimensions.

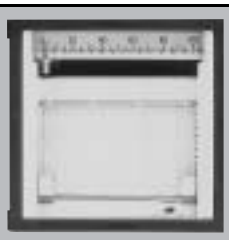
SELECTION GUIDE

FIR-101-M	FIR-201-M	JIR-301-M	EIS-201	DFT-700-M	Digital indicators, Digital temperature indicators, Hand-held digital thermo-hygrometer
					
96 x 48 x 100mm			48 x 48 x 85mm	56 x 144 x 30mm	Dimensions (W x H x Dmm)
Thermocouple, RTD, DC current, DC voltage			Thermocouple, RTD		Input
No alarm action	Alarm available	Alarm available	No alarm action		Alarm action
No control output					Control output
0.125sec.		0.25sec.	0.5sec.	0.4sec.	Input sampling period
Within ±0.2%FS±1digit			Within ±0.5%FS±1digit	Within ±0.2%FS±1digit	Accuracy

SR-200	TR-400	HR-700	GR-100	Self-balancing recorder, Hybrid recorder, Paperless recorder	
					
144 x 144 x 225mm	288 x 288 x 300mm	144 x 144 x 150mm	144 x 144 x 257mm	Dimensions (W x H x Dmm)	
Thermocouple, RTD, DC current, DC voltage				Input	
O	O	O	O	Input points	1 point
O	O	O	O		2 points
—	—	—	O		3 points
—	—	—	O		4 points
O	O	O	O		6 points
—	O	—	—		12 points

HD-500	THD-500	THD-500-F□	THD-500-W	Humidity detectors Humidity/Temp. detectors Hygrothermo transmitters	
					
Refer to External dimensions.				Dimensions (W x H x Dmm)	
—	0 to 50℃	-20 to 60℃	0 to 50℃	Measuring range	Temperature
20 to 90%RH					Humidity
—	Platinum thin film RTD			Sensor type	Temperature
High polymer thin film RTD					Humidity
—	±[0.3+0.005(T)]℃	0℃±0.3℃, 60℃±0.6℃	±[0.3+0.005(T)]℃	Accuracy	Temperature
Within ±5%RH (at 10 to 50℃)					Humidity

SELECTION GUIDE

Humidity indicating controllers, Self-balancing humidity recorders, Digital humidity indicators	 MCD-1☐0H-R/H	 SR-201H-H	 SR-206H-V	 FIR-201H-H
Dimensions (W x H x Dmm)	96 x 96 x 85mm	144 x 144 x 225mm	144 x 144 x 257mm	96 x 48 x 100mm
Rated scale	0 to 100.0%RH	0 to 100%RH		0 to 100.0%RH
Input	0 to 1V DC	HD-500 (0 to 1V DC)	0 to 1V DC	0 to 1V DC
Power for sensors	—	5V DC (Built-in)	—	5V±0.25V DC
Dead band	—	±0.1%FS		—
Balancing time	—	Within 1.6sec.		—
Recording type	—	Pen type	Multi-point	—
Input points	1 point	1 point	6 points	1 point

Infrared thermocouple	 RD-301	RD-302	RD-305	RD-310	RD-401
Dimensions (W x H x Dmm)	ø12.7 x 44.5mm	ø12.7 x 62.2mm	ø34.9 x 86.1mm	ø34.9 x 95.5mm	ø18.4 x 32.5mm
Thermocouple type	K				
Temperature range type	-18 to 25℃, 5 to 45℃, 25 to 80℃, 70 to 105℃, 90 to 120℃, 115 to 155℃, 145 to 190℃, 180 to 250℃				
Field of view	Approx. 53°	Approx. 28°	Approx. 11°	Approx. 6°	Approx. 53°
Minimum measuring diameter	ø8mm	ø4mm	ø20mm		ø8mm
Measuring distance:Visual field diameter	1:1	2:1	5:1	10:1	1:1
Air purge	Not available	Available			Not available
Material of light receiving opening	Silicone lens				

Instrument for use with infrared thermocouple	 FCS-200-☐/I	 FCR-100-☐/I	 FCD-100-☐/I
Dimensions (W x H x Dmm)	48 x 48 x 100mm	48 x 96 x 100mm	96 x 96 x 100mm
Input	Infrared thermocouple (RD-301, RD-302, RD-305, RD-310, RD-401)		
Control action	Fuzzy self-tuning PID, PID, PD, ON/OFF		
Control output	Relay contact, Non-contact voltage, DC current, ON/OFF servo		
Input sampling period	0.125sec.		
Accuracy	Within ±0.3%FS±1digit	Within ±0.2%FS±1digit	


IRT-100


IRT-200


IRT-300


IRT-500

Portable digital infrared thermometers,
Water-proof hand-held infrared thermometers

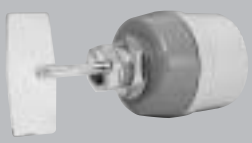

IF-300-C5


IFP-100


SIF-400


THT-400

Communication converter,
Profibus converter,
PLC interface unit,
Temperature/Humidity transmitter


LV-200S


PA-200


PA-3000

Level switch,
Power controllers


SA-300


MS-108


MS-307

SSR,
Memory number call switch


FS-106-E

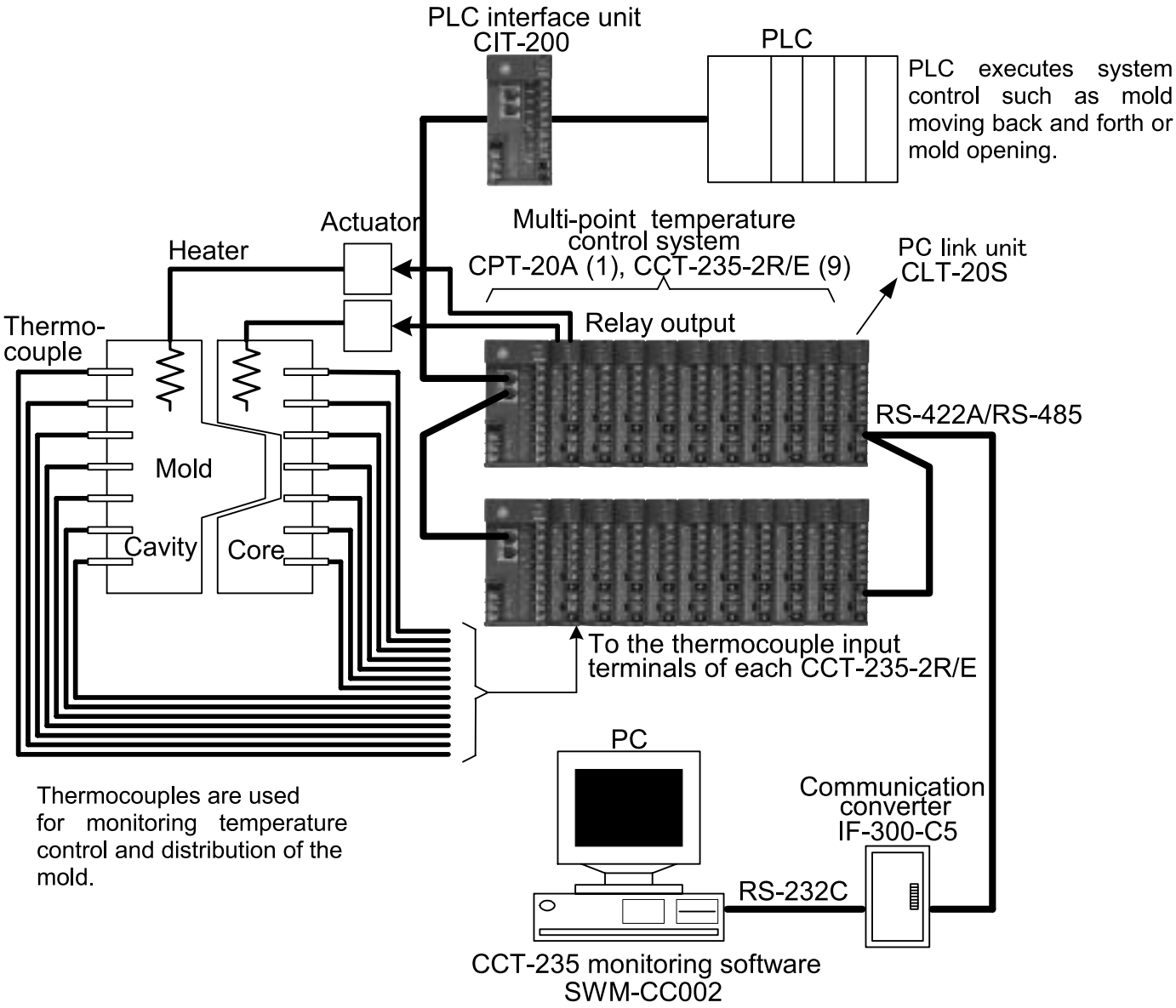

THF-500

6-point changing-over switch,
Water-proof filter

Application 1

Temperature control and monitoring of the mold

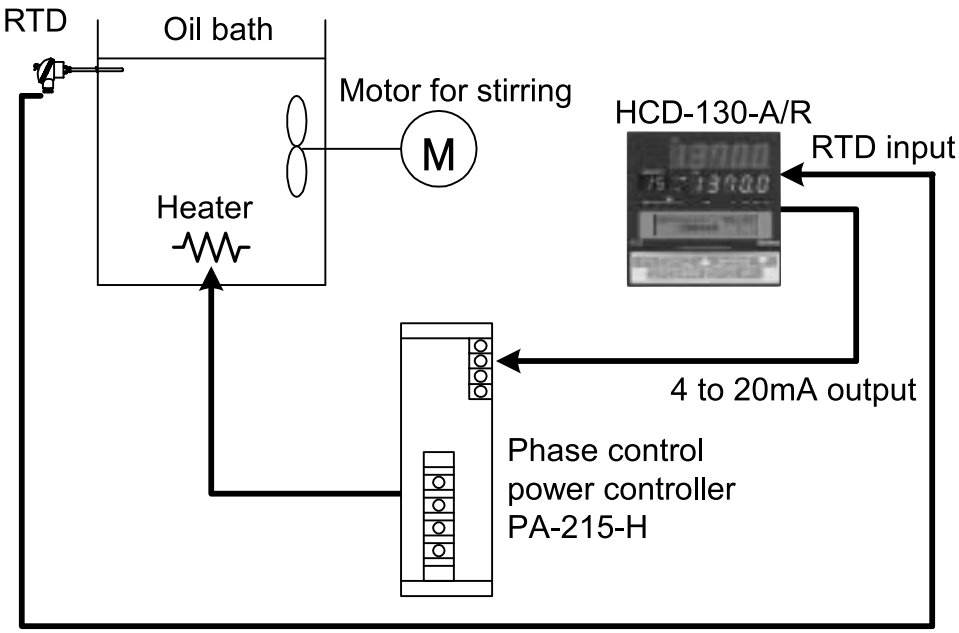
This application shows that one CCT-235 unit controls 2 points (cavity and core) of the mold temperature of an extruder, and other CCT-235 units monitor multiple places (multi-point) of the mold.



Application 2

Temperature control of oil bath

This application shows that HCD-130-A/R controls an oil bath temperature for calibration.



[Applicable models]

Economy model: General-purpose digital indicating controller JC series

JCD-33A

JCR-33A

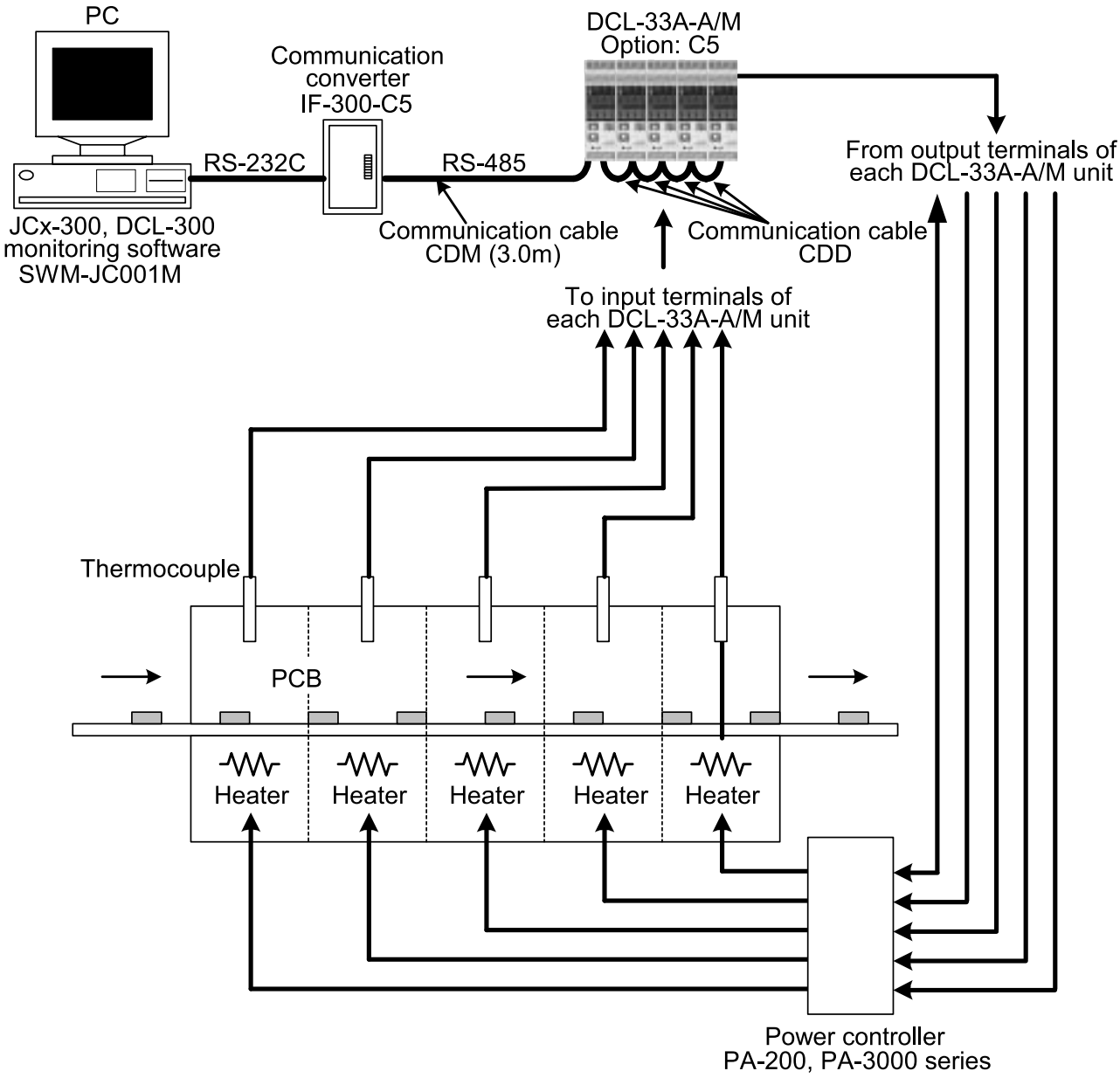
JCS-33A

JCL-33A

Application 3

Temperature control of reflow furnace

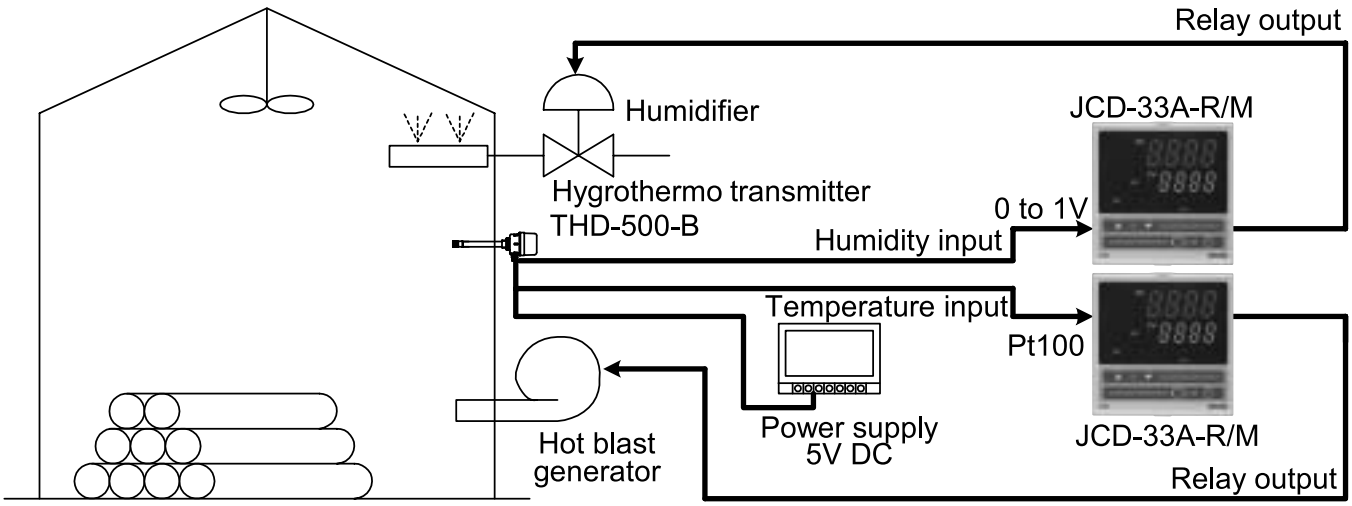
The DCL-33A monitors temperature of reflow furnace in which soldering is performed on the PCB, and PC monitors the control status.



Application 4

Humidity and temperature control of storage

This is an application example for controlling humidity and temperature of storage facilities for drying wood and preservation of vegetables and grains.



[Applicable models]

High function model: High-function digital indicating controller FC series
Temperature side: FCx-13A-R/M [Pt100]
Humidity side : FCx-13A-R/M [0 to 1V DC]

FCD-13A FCR-13A FCS-13A FCR-23A FCL-13A

Economy model: General purpose digital indicating controller JC series
Temperature side: JCx-33A-R/M [Pt100]
Humidity side : JCx-33A-R/M [0 to 1V DC]

JCD-33A JCR-33A JCS-33A JCM-33A JCL-33A

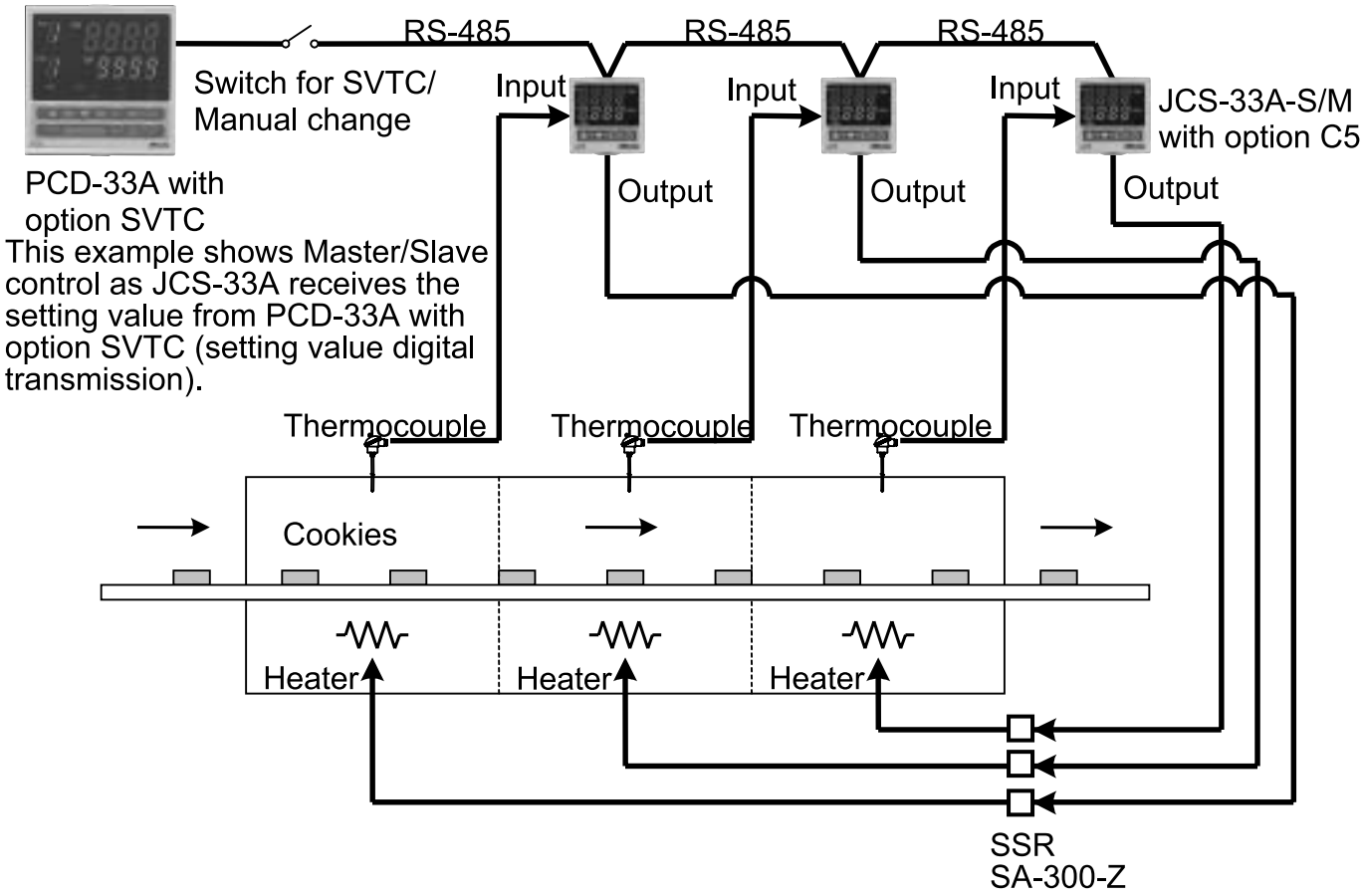
Compact model: DIN rail mounting type indicating controller DCL-300
Temperature side: DCL-33A-R/M [Pt100]
Humidity side : DCL-33A-R/M [0 to 1V DC]

DCL-33A

Application 5

Temperature control of tunnel furnace

PCD-33A and JCS-33A control temperature of tunnel furnace for baking confectioneries.



[Applicable models]

High function model: Programmable controller PC-900 with option SVTC

PC-935

Economy model: General purpose digital indicating controller JC series with option C5

JCD-33A

JCR-33A

JCM-33A

JCL-33A

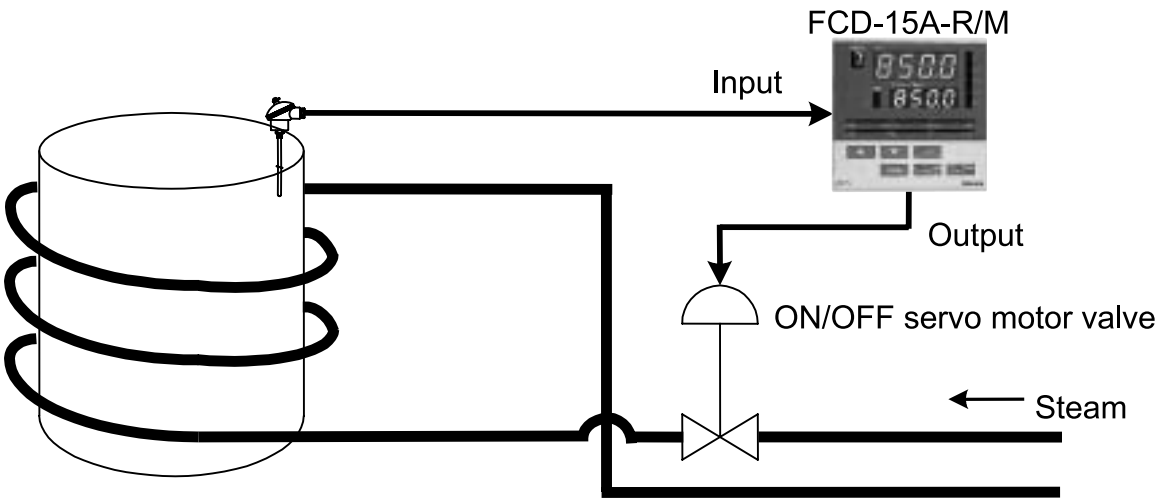
Compact model: DIN rail mounting type indicating controller DCL-300 with option C5

DCL-33A

Application 6

Temperature control of stainless steel oven

This application shows that FCD-15A-R/M controls the temperature of stainless steel oven to preserve pharmaceutical products, to keep their temperature constant or to blend dye, etc.



[Applicable model]

High accuracy model: ON/OFF servo type process controller HCD-150

HCD-150

Application 7

Performance test of radiator

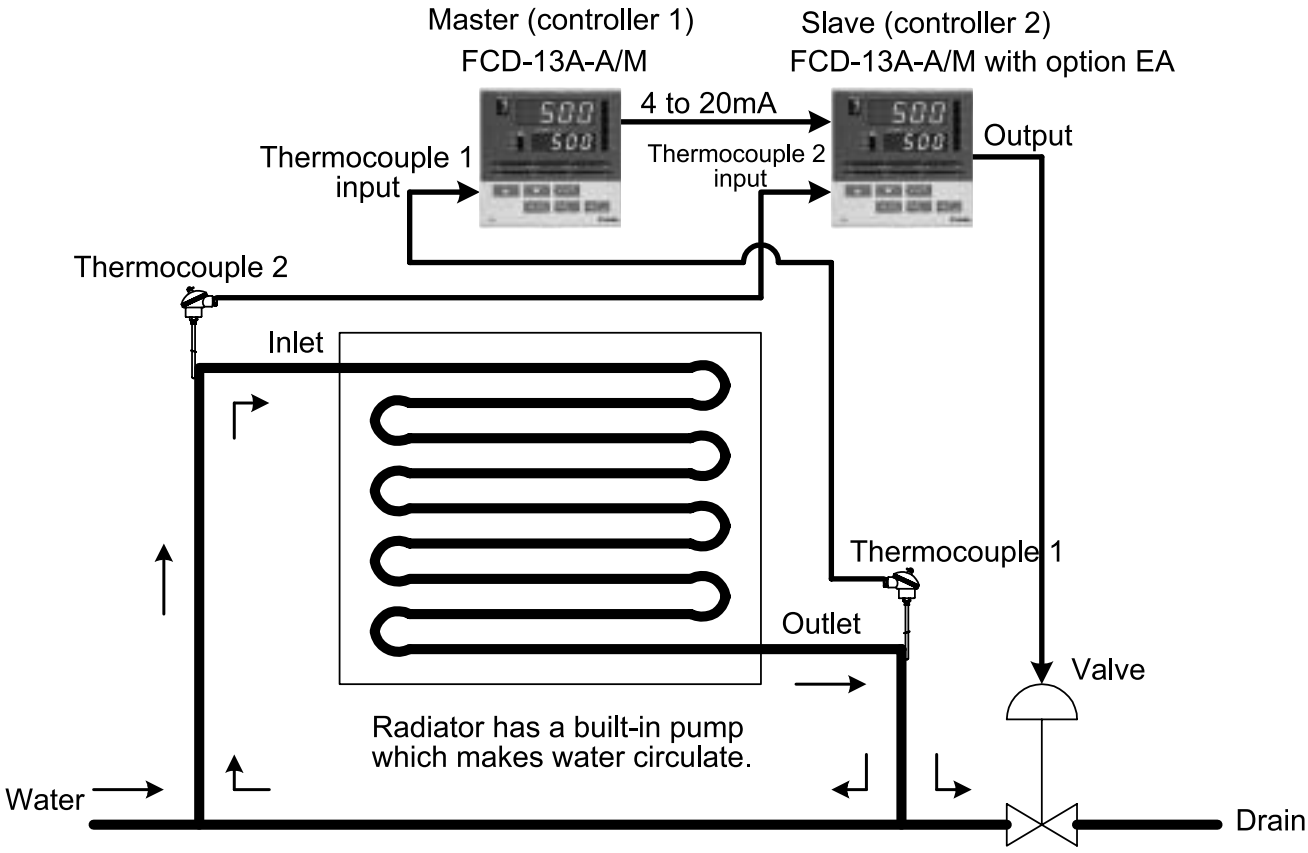
This is an application for testing the performance of a radiator by controlling the outlet temperature of the radiator while driving the engine.

A pump is installed in the radiator to make water circulate.

Outlet temperature of the radiator becomes the input for Master (controller 1), and inlet temperature becomes the input for Slave (controller 2).

The output of the Master (controller 1) becomes the setting value for Slave (controller 2), by which the valve is controlled.

Thus the outlet temperature of the radiator is controlled (cascade control) by the FCD-13A.



[Applicable model]

High accuracy model: Process controller HCD-130 with option CC (cascade control)

HCD-130

A single HCD-130 with option CC (cascade control) is enough to configure the application described above.

Application 8

Temperature control of drying furnace

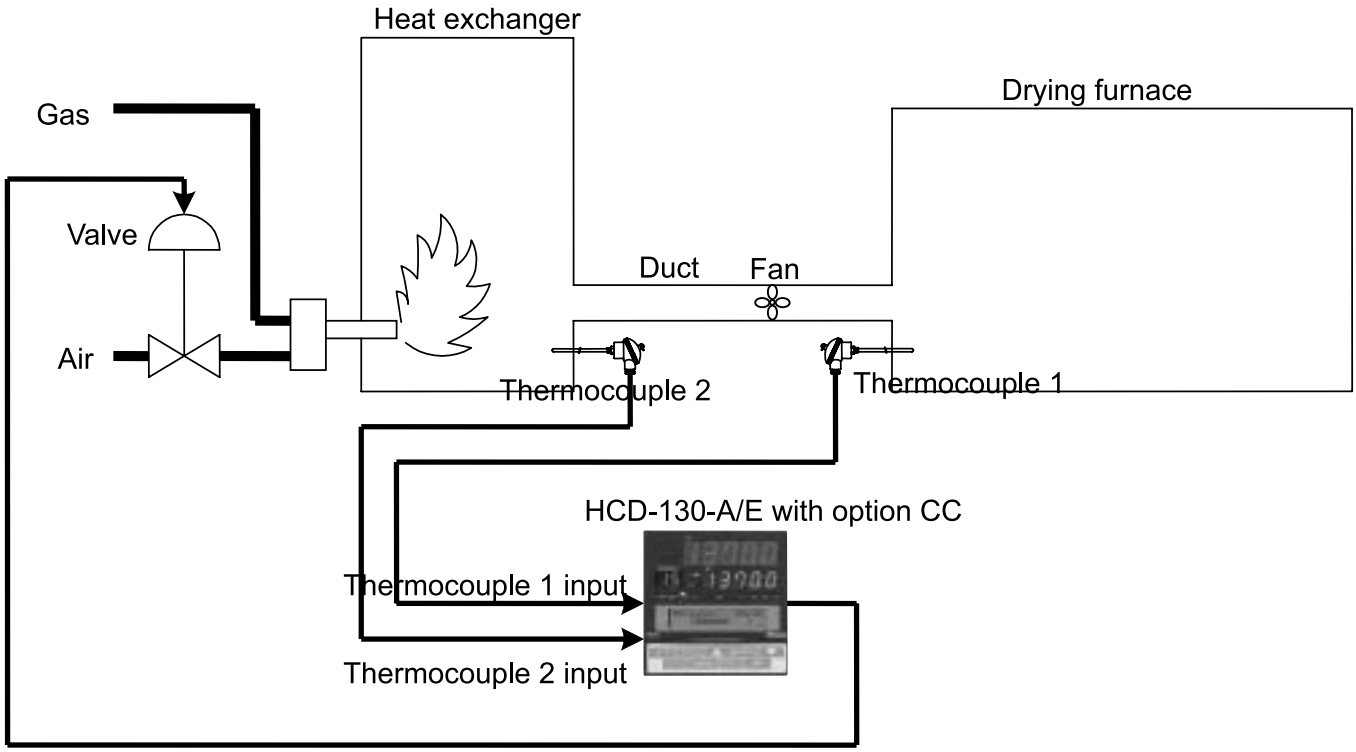
This application shows that HCD-130-A/E with option CC (cascade control) controls and stabilizes interior temperature of drying furnace with phase-lag compensation cascade control. The drying furnace is used for drying textile products.

The temperature inside the drying furnace becomes thermocouple 1 (PV1) input, and the temperature inside the heat exchanger becomes thermocouple 2 (PV2) input.

HCD-130-A/E compares drying furnace setting value (SV1) with thermocouple 1 input (PV1), of which output (MV1) becomes heat exchanger setting value (SV2).

HCD-130-A/E then compares heat exchanger setting value (SV2) with thermocouple 2 input (PV2), of which output (MV2) is used for controlling the valve of heat exchanger.

Thus cascade control function of HCD is utilized in controlling the interior temperature of the drying furnace.



[Applicable models]

Economy model: High function digital indicating controller FC series

Master (controller 1): FCx-13A-A/M

Slave (controller 2): FCx-13A-A/M with option EA

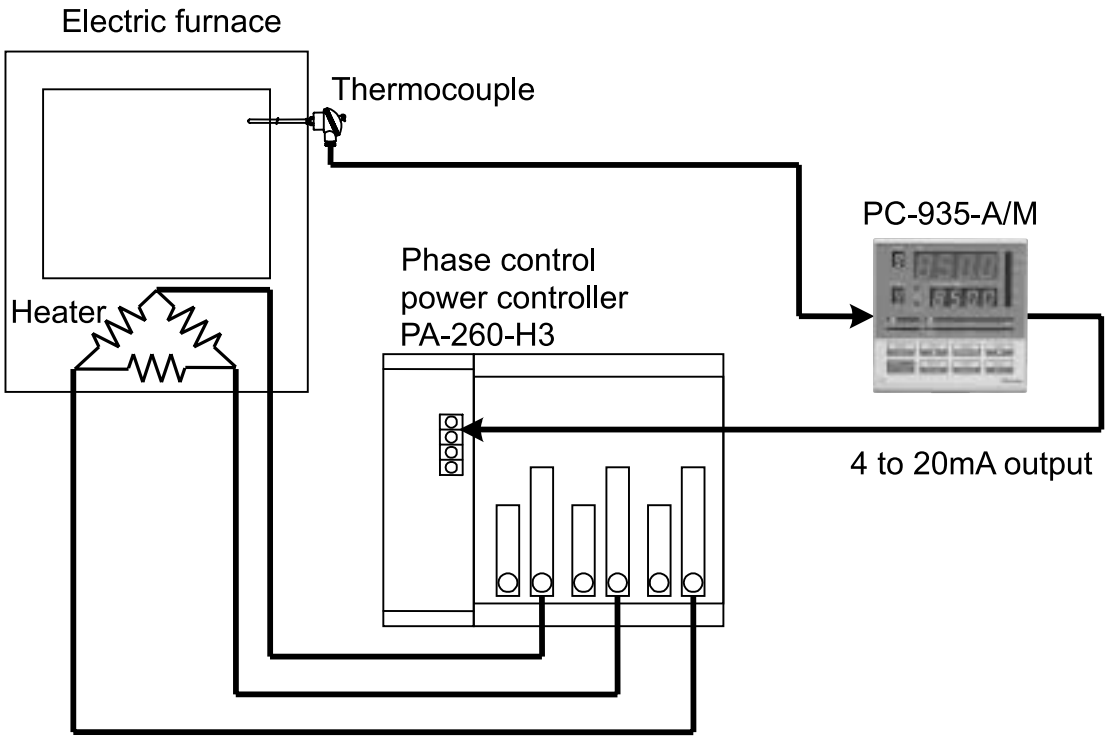
FCD-13A FCR-13A FCR-23A



Application 9

Temperature control of an electric furnace

Our programmable controller PC-935-A/M controls temperatures of ceramic kilns, testing furnaces, incubators, etc.



[Applicable models]

Economy model:

Programmable controller PCD-33A

PCD-33A

High function digital indicating controller FC series

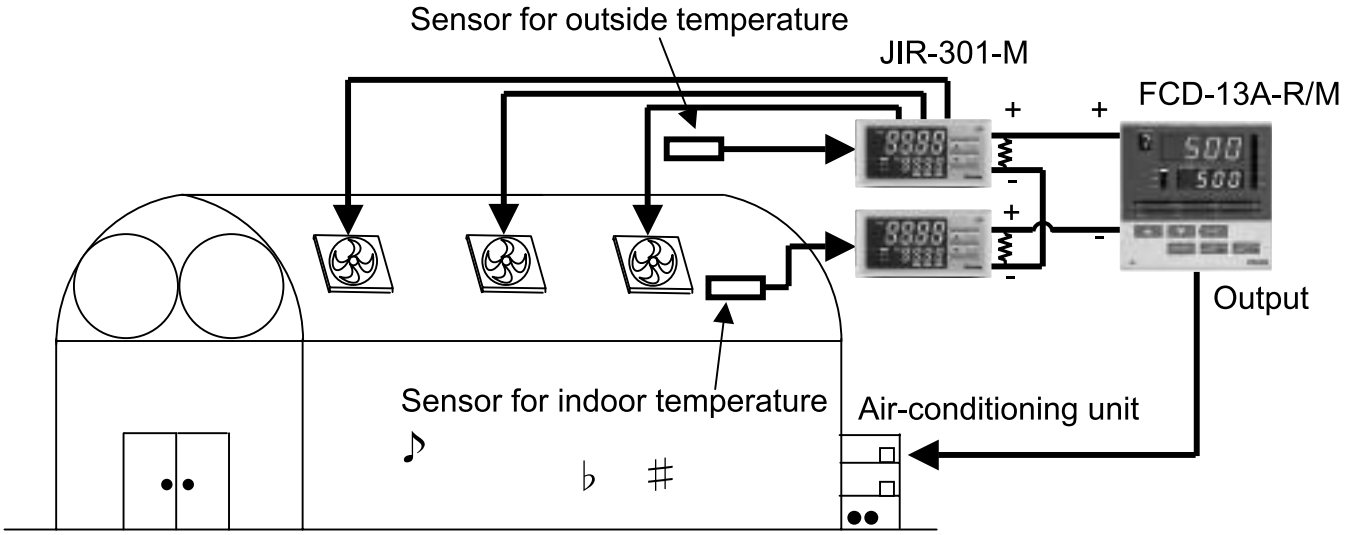
FCD-13A FCR-13A FCS-23A FCR-23A

The application described above can be configured with the FC series simplified program control function or by adding option SM (setting value memory function) to them.

Application 10

Air-conditioning control of an assembly hall

This application shows that two JIR-301-M units controls temperature of a hall by turning the ventilation fans ON or OFF.
One JIR-301-M unit indicates outside air temperature, and the other JIR-301-M unit indicates room temperature.
The ventilation fans are turned ON or OFF depending on the difference between outside and indoor temperatures, using Alarm 1, Alarm 2 and Alarm 3 functions of the JIR-301-M.
Using Transmission output of the JIR-301-M, temperature of a hall is controlled by the FCD-13A-R/M.



[Applicable models]

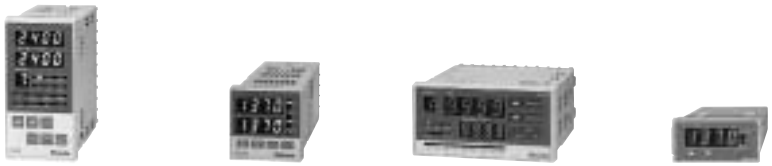
• Alternative model of the JIR-301-M: FIR-201-M with options A2, A3 and TV

FIR-201-M with options A2, A3 and TV

• Alternative models of the FCD-13A-R/M

High function model: High-function digital indicating controller FC series

FCR-13A FCS-13A FCR-23A FCL-13A



Economy model: General purpose digital indicating controller JC series

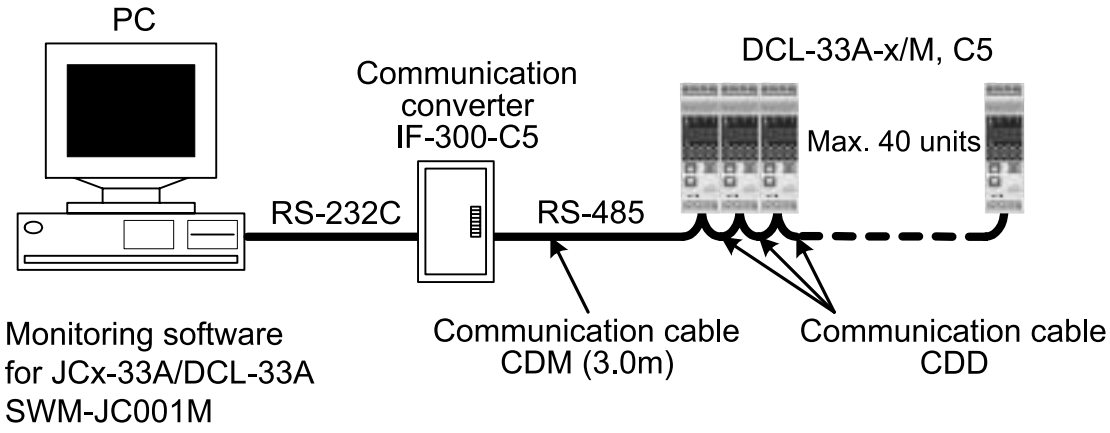
JCD-33A JCR-33A JCS-33A JCM-33A JCL-33A

Compact model: DIN rail mounting type indicating controller DCL-300

DCL-33A

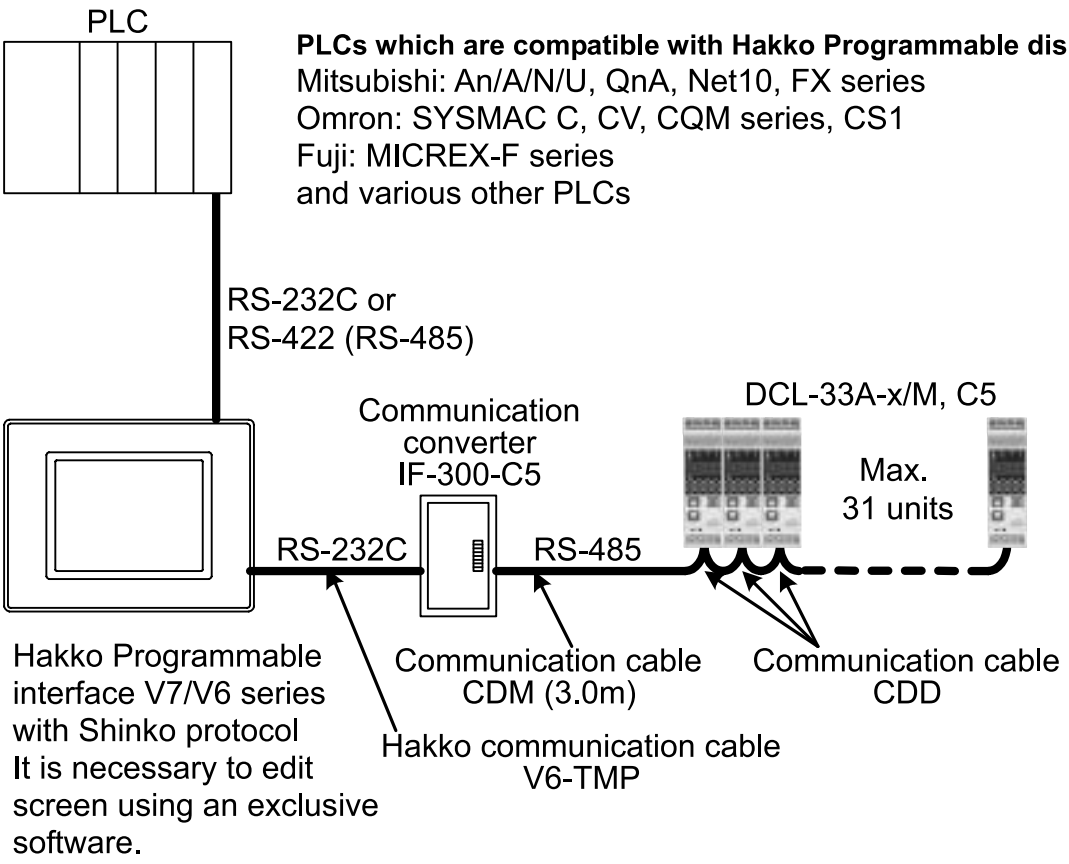
Wiring example 1

Connection between DCL-33A and PC (monitoring software SWM-JC001M)



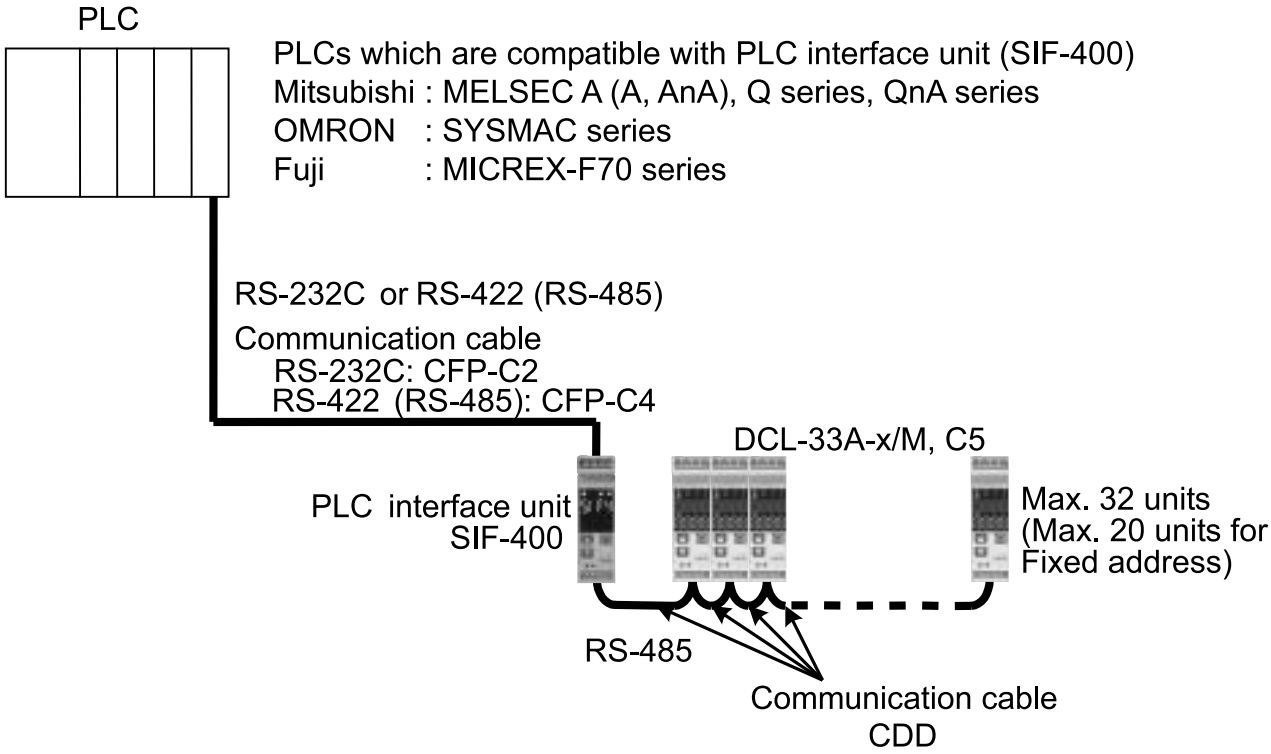
Wiring example 2

Connection between DCL-33A and PLC via Programmable interface (Hakko Electronics Co., Ltd.)



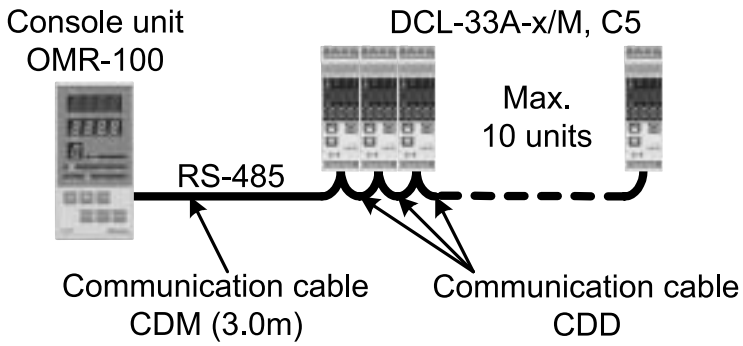
Wiring example 3

Connection between DCL-33A and PLC via PLC interface unit (SIF-400)



Wiring example 4

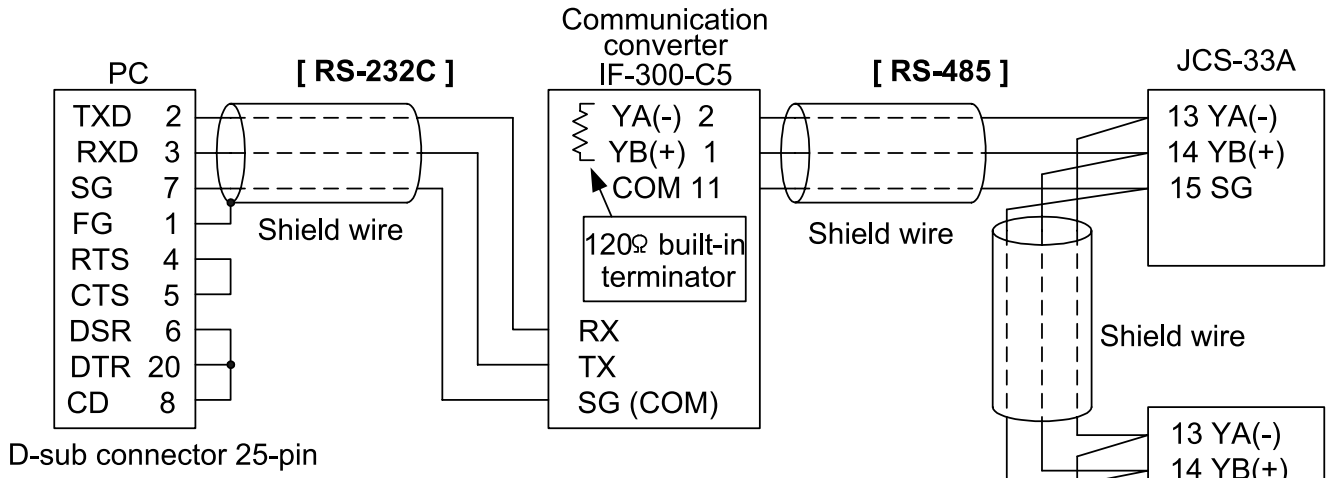
Connection between DCL-33A and Console unit OMR-100



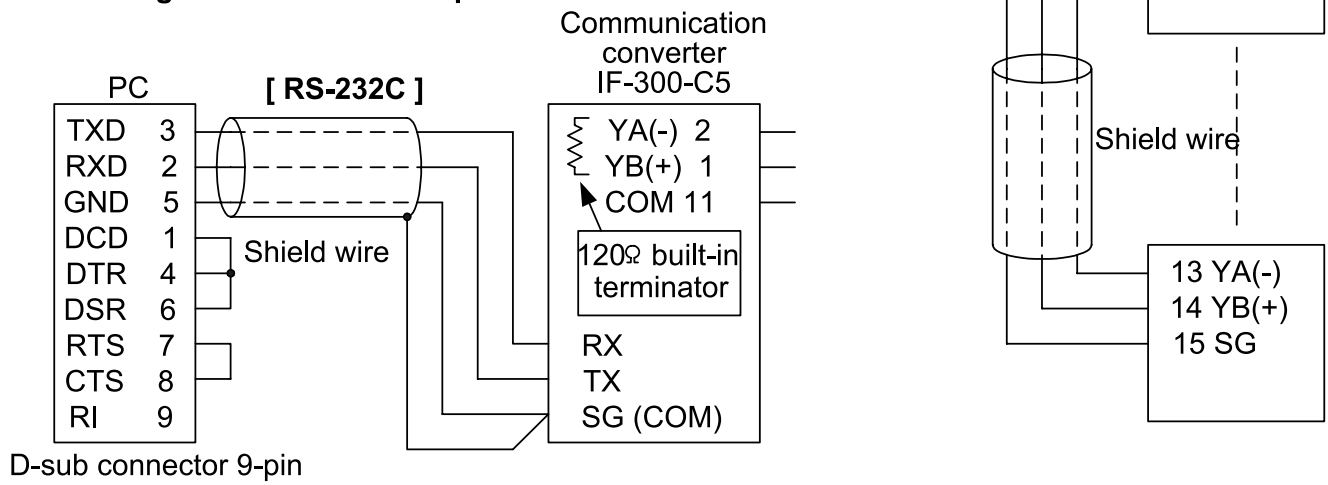
Wiring example 5

Connection between JCS-33A and PC via communication converter IF-300-C5

When using D-sub connector 25-pin



When using D-sub connector 9-pin



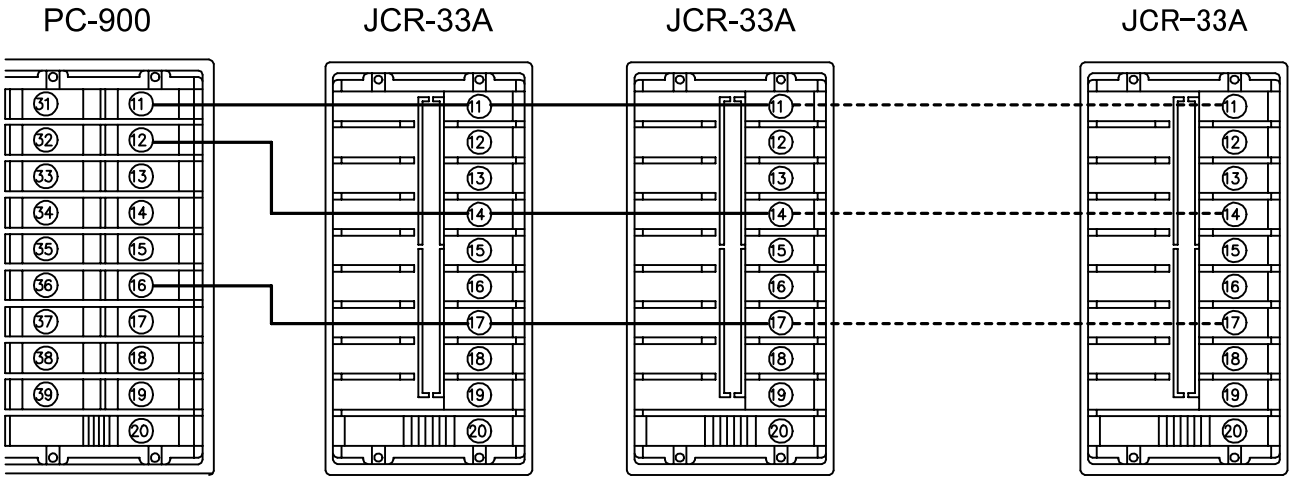
IF-300-C5 has a built-in terminator.

As to the terminator (terminal resistor):
The terminator is connected to the end of wire when connecting multiple peripheral devices to personal computer.
This makes the signal stable at the end of the wire.

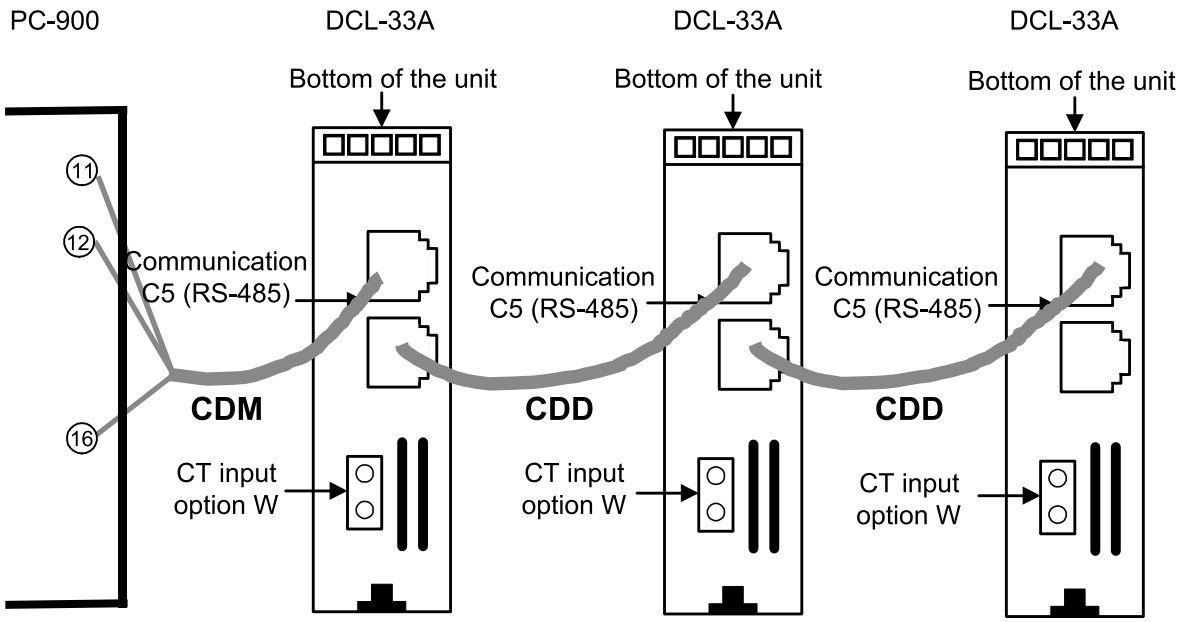
Wiring example 6

Connecting method for Setting value digital transmission (SVTC) and setup of each unit

• Connection between PC-900 with SVTC and JCR-33A with C5



• Connection between PC-900 with SVTC and DCL-33A with C5



Setup

• Setup of PC-900

If the option SVTC is applied, there are no other setting items to be set.

Be sure to select Setting value digital transmission [SVTC] during the Communication mode selection [C5] of the Communication parameter setting.

• Setup of JCR-33A or DCL-33A

Check that the communication speed (in Auxiliary function setting mode 1) of JCR-33A or DCL-33A is equal to that of the PC-900.

• Setting value digital transmission (SVTC) start

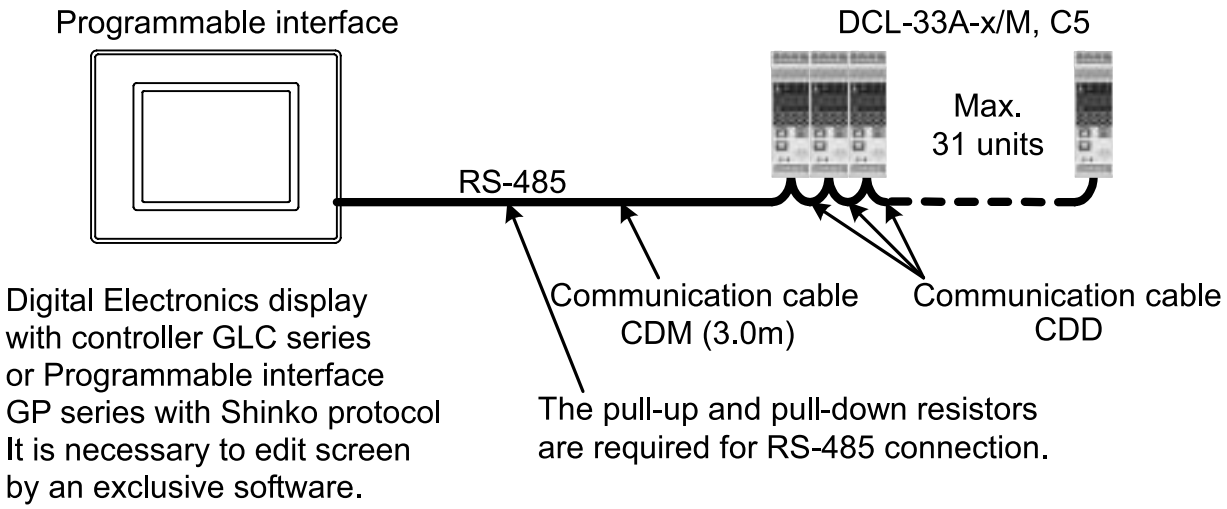
Input the program setting value to PC-900.

When the program is executed by pressing the RUN/RUN key, the setting value of PC-900 is sent to JCR-33A or DCL-33A.

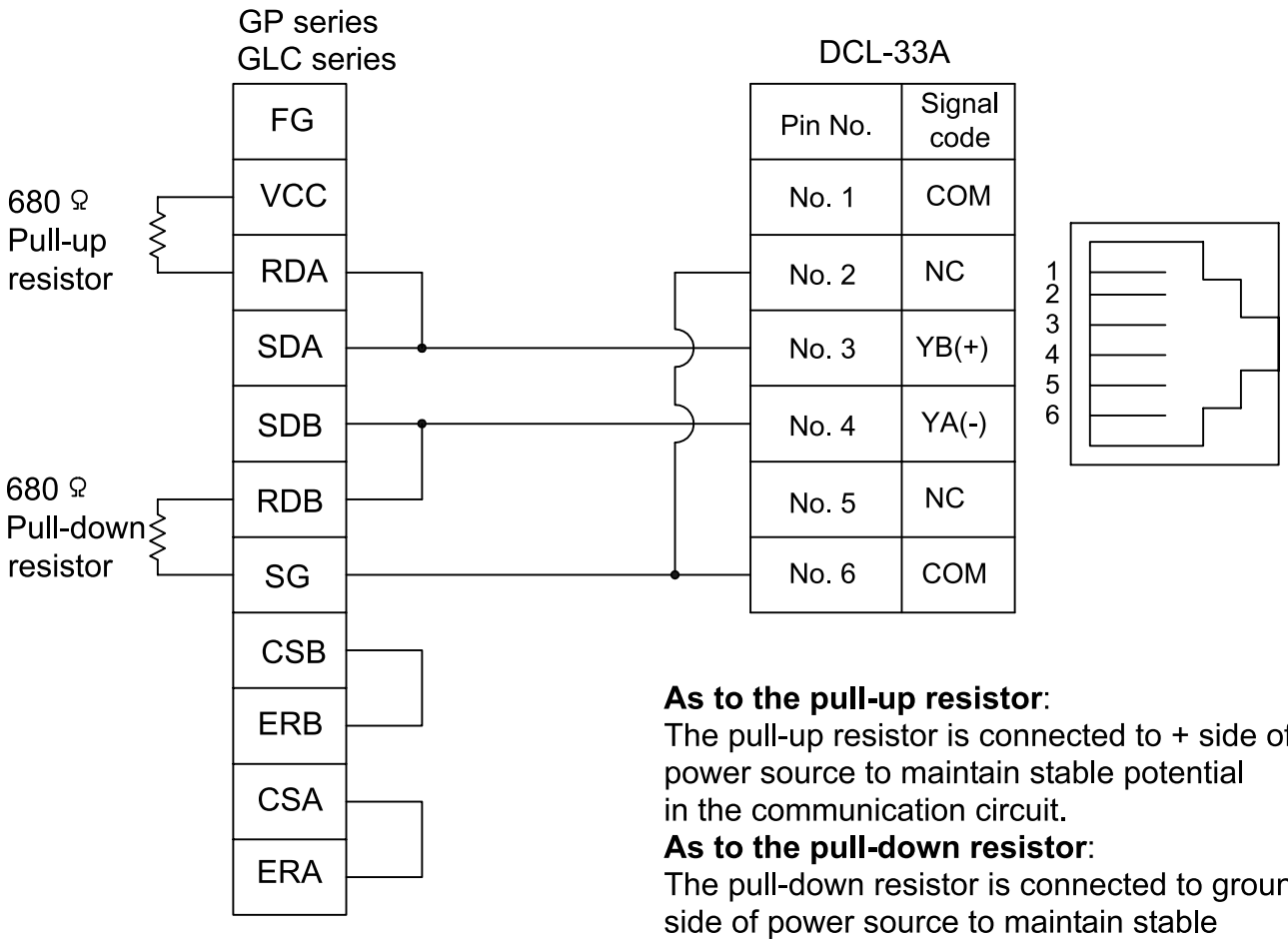
During the standby mode, “0” is sent to the JCR-33A or DCL-33A.

Wiring example 7

Connection between DCL-33A and Programmable interface (Digital Electronics Corp.)



Connection method

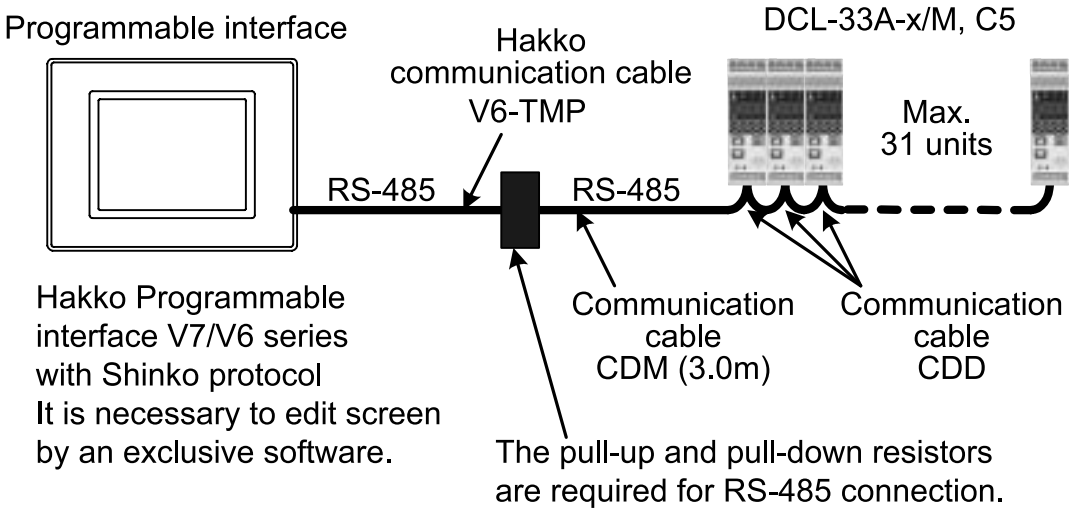


As to the pull-up resistor:
The pull-up resistor is connected to + side of power source to maintain stable potential in the communication circuit.

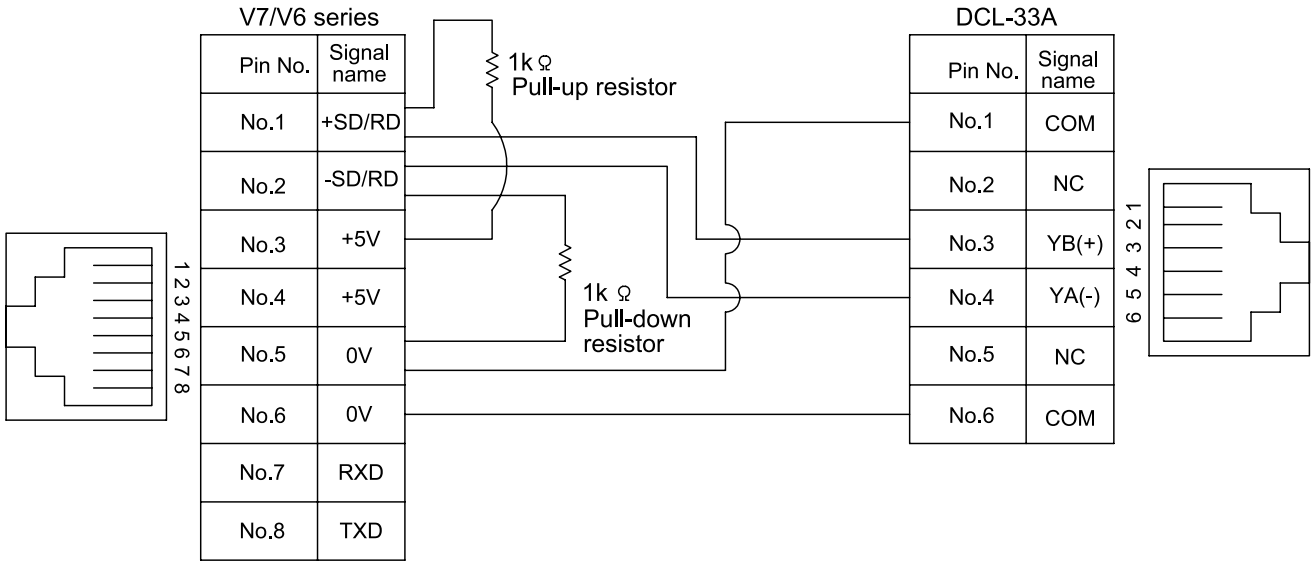
As to the pull-down resistor:
The pull-down resistor is connected to ground side of power source to maintain stable potential in the communication circuit.

Wiring example 8

Connection between DCL-33A and Programmable interface (Hakko Electronics Co., Ltd)



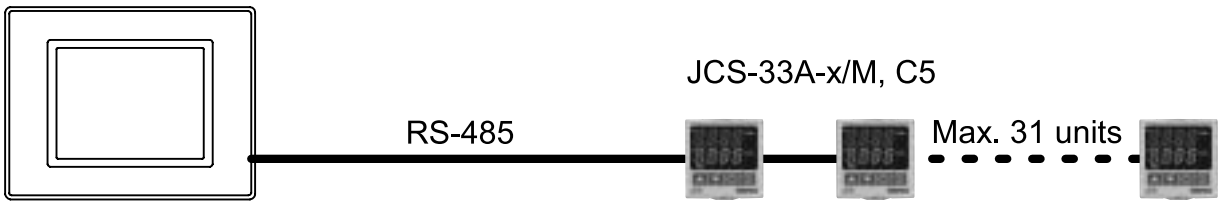
Connection method



Wiring example 9

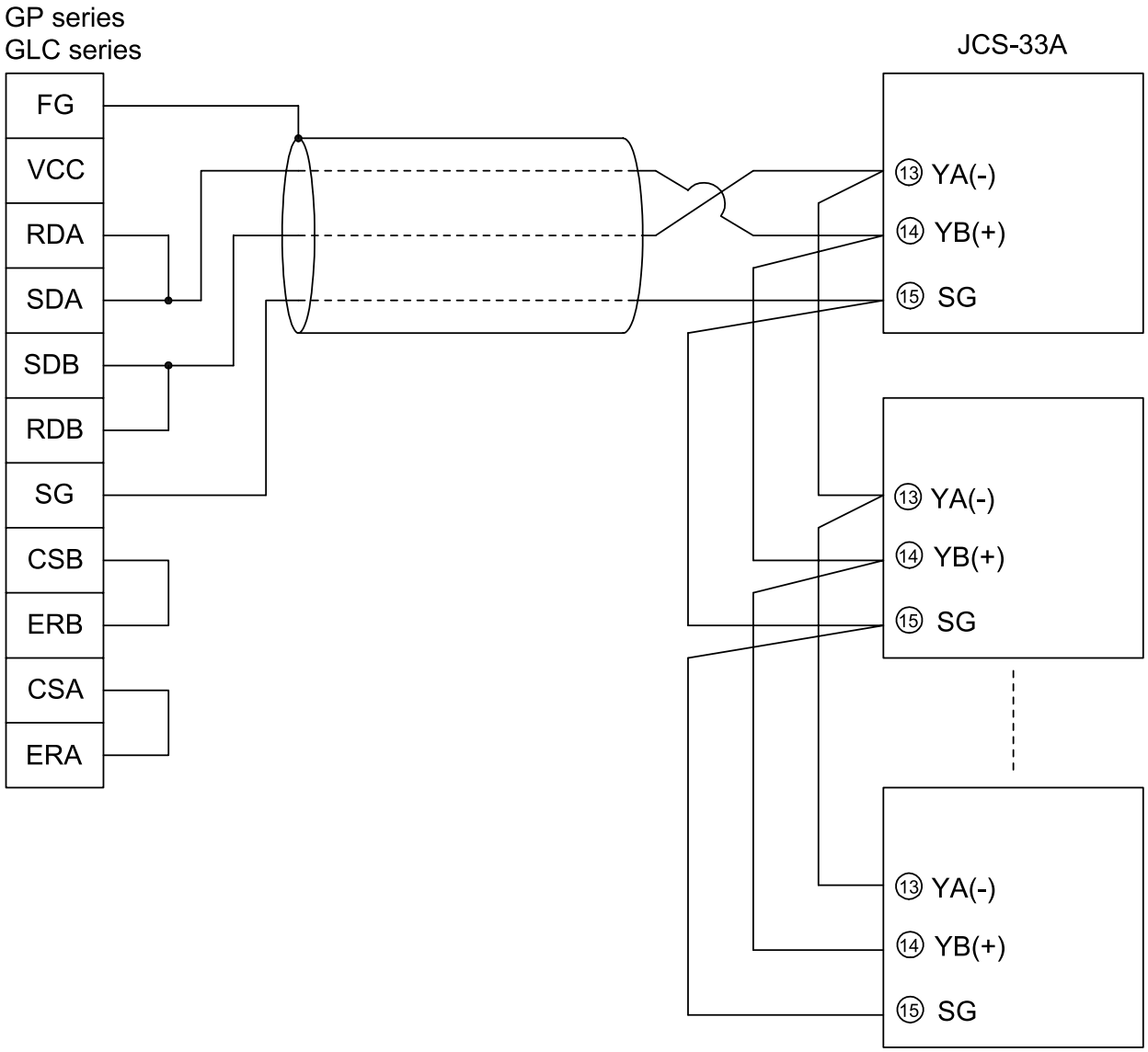
Connection between JCS-33A and Programmable interface (Digital Electronics Corp.)

Programmable interface



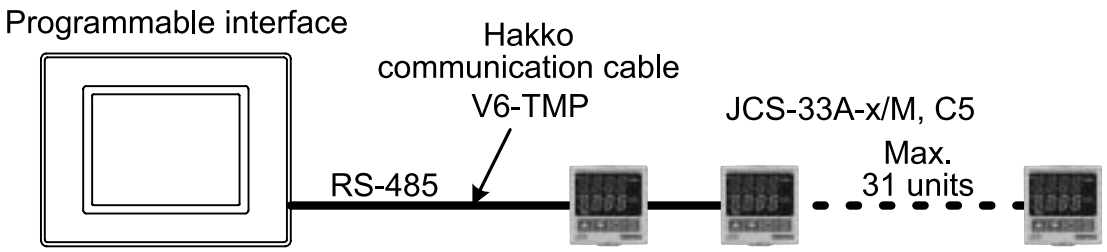
Digital Electronics display
with controller GLC series
or Programmable interface
GP series with Shinko protocol
It is necessary to edit screen by
an exclusive software.

Connection method



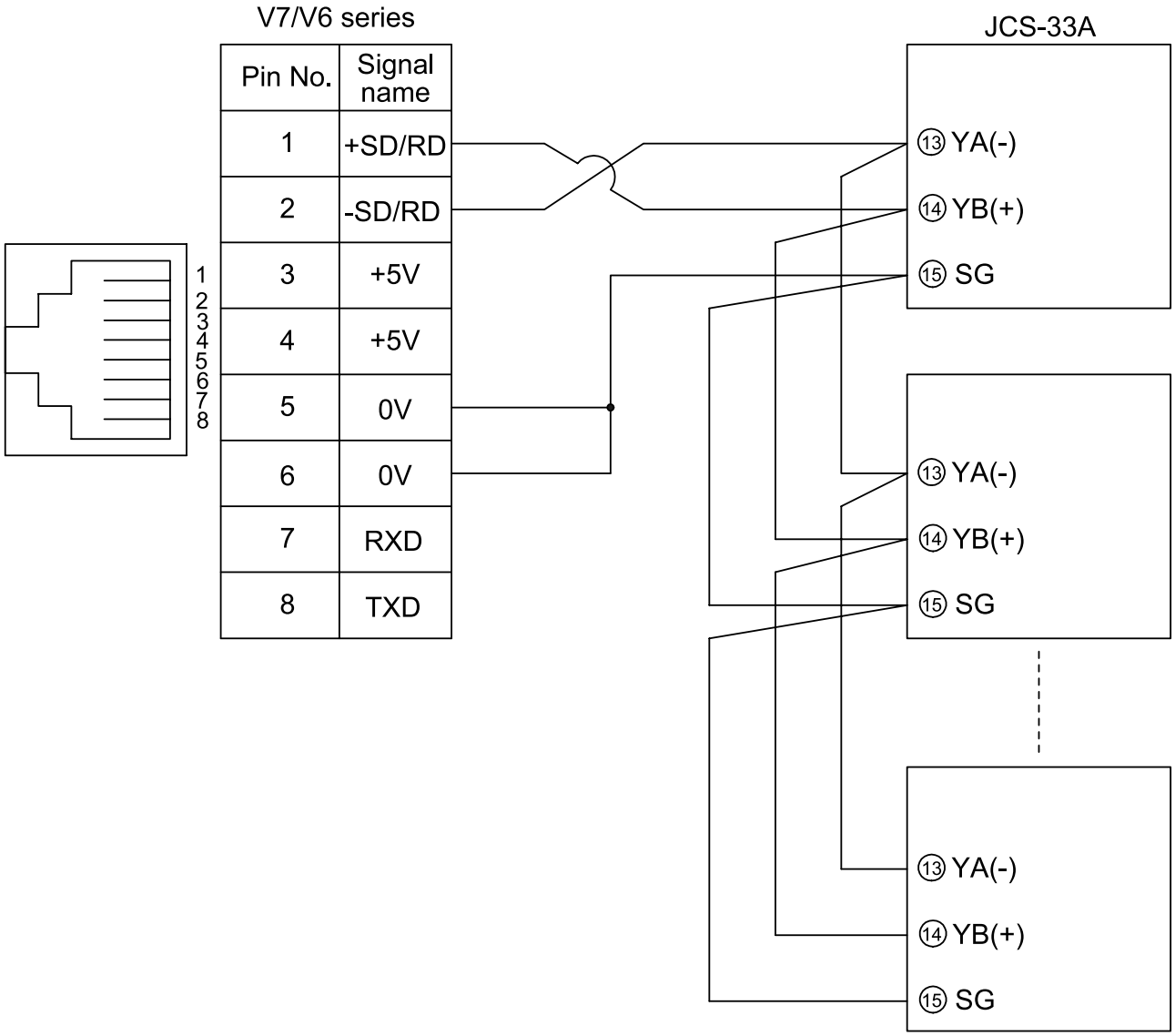
Wiring example 10

Connection between JCS-33A and Programmable interface (Hakko Electronics Co., Ltd.)



Hakko Programmable interface V7/V6 series with Shinko protocol
It is necessary to edit screen by an exclusive software.

Connection method



Industry-classified applicable products

Industry classification	Control contents	Temperature for use	Applicable products
[Plastic, rubber, equipment] 1. Injection molding machinery 2. Extruding machinery 3. Mold temperature controllers 4. Vacuum forming, Pneumatic forming, Foaming machinery 5. Blow molding (Thermofoaming) 6. Rubber press 7. Film extruder (calender roll)	Temperature control of: Injection cylinder Hot runner, Dies part, Water and oil, Parison section, Press metal molding, Calender roller section	0 to 550℃	FC□, GC□, JC□, DCL, C series
[Packing machine industry] 1. Bag-making machinery 2. Filling packing machinery 3. Sealing machinery 4. Shrinking packing machinery 5. Hot blast sealing	Temperature control of: Heating welding section Tunnel furnace Hot blast	0 to 300℃	GC□, JC□, DCL, C series
[Food related industry] 1. Bakery, confectionery equipment 2. Cooking appliances 3. Refrigerating machine (General, for fishing vessel) 4. Humidifier 5. Dryer 6. Brewing machine (Liquor, soy sauce, Miso) 7. Tobacco dryer	Temperature control of: Oven Fryer, grilling, Rice cooking Freezing, Unfreezing, Fermenting, Grain warehouse, Hot air drying Fermenter	-50 to 300℃ 0 to 100%RH	FIR, JIR BOC-200, GC□, JC□, DCL, HD-500, THD-500, DFT-700, PC-900
[Semiconductor electronic components industry] 1. Bonding machine 2. Mold equipment 3. Preheater 4. Cleaning equipment 5. Photo resist coating 6. Diffusion equipment 7. TFT liquid crystal manufacturing equipment	Temperature control of: Solder bath, Molding, Tablet, Testing, Cleaning liquid, Wafer board, Furnace	-200 to 1600℃ 0 to 300℃	HCD, PC-800, FCD, FIR, HR-700 FCS, RD-300, IRT-100
[Electric furnaces in large and small size] 1. Tunnel furnace 2. Reflow furnace 3. Vacuum furnace 4. Baking furnace 5. Kiln furnace 6. Diffusion furnace	Temperature control of: Each block (hot air), Furnace	0 to 1200℃ 0 to 1600℃ 0 to 800℃ 0 to 1200℃	C series, JC□, HR-700, PC-900, PCD, FIR, JIR, DCL, HCD
[Metal heat treating] 1. Tools, cutting jig manufacturing 2. Stretching of wire bars, compressing and expanding roll, copper alloy, casting	Temperature control of: Furnace Dies section Roll section	0 to 1200℃ 0 to 1600℃	FC□, JC□, DCL, DFT-700, FIR, JIR, HR-700, IRT-300

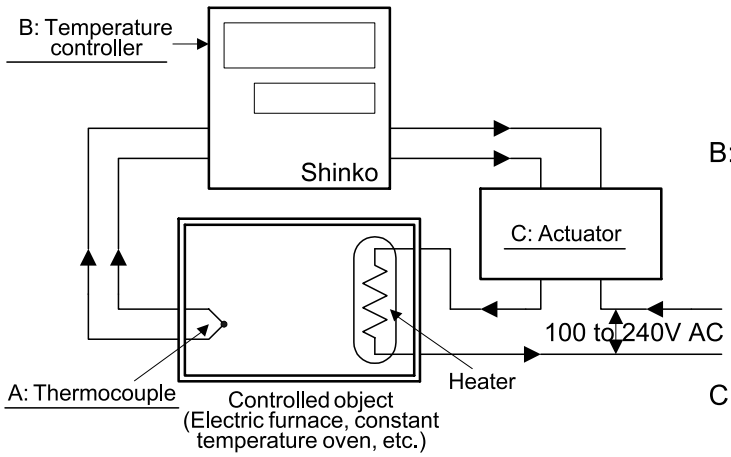
Industry-classified applicable products

Industry classification	Control contents	Temperature for use	Applicable products
[Other furnaces] 1. Heavy oil, gas furnaces 2. Aluminum, tin, lead, zinc melting furnace 3. Incinerator	Temperature control of furnace	0 to 1200℃	HR-700, PC-900, PCD, FC□, JC□
[Textile machinery] 1. Dyeing machinery 2. Dryer 3. Heater 4. Thread plying	Temperature control of: Furnace (hot air) Film pressure applying section Yarn section	0 to 300℃	PC-700, PC-900, HR-700, DCL, C series
[Pottery manufacturing industry, Ceramic and Glass industry] 1. Flame resistant bricks 2. Ceramic industry 3. Concrete, Asphalt, Cement industries 4. Glass industry 5. Porcelain enameling 6. Grind stone manufacturing	Temperature control of: Furnace, Ceramic firing kiln Concrete curing Cement kiln	0 to 2000℃	HCD, PC-800, PC-900, FCD, C series, HR-700, FIR, JIR, IRT-200, IRT-300
[Synthetic leather industry] 1. Vinyl, synthetic leather	Temperature control of sealing and roll section	0 to 400℃ 0 to 100℃	FIR, DFT-700, GC□, JC□, DCL
[Scientific instruments industry] 1. Constant temperature oven	Temperature control of chamber	-200 to 200℃	FC□, HR-700, PC-900 HD-500, THD-500
[Industrial machinery] 1. Incinerator 2. Washer 3. Printing machine (Hot stamping)	Temperature control of Furnace, Bath, Surface	0 to 800℃ 0 to 1000℃ 0 to 200℃	PC-900, PCD, FC□, JC□, DCL, HR-700, FIR, GC□
[Chemical equipment industry] 1. Fat industry 2. Chemical fertilizer 3. Camphor manufacturing 4. Plating and coating	Temperature control of tanks	0 to 200℃ 0 to 600℃	FIR, DFT-700, GC□ FC□, JC□, DCL, HR-700, PC-700, PC-800, PC-900, PCD
[Other industrial machinery] 1. Engine temperature of automobiles and ships 2. Air conditioners (for cooling and heating) 3. Bath and pool 4. Pressing iron		0 to 50℃ 0 to 150℃ 0 to 600℃	FIR, HR-700 GC□, JC□,
[Plant equipment] 1. Petroleum chemistry 2. Gas 3. Iron and steel 4. Pulp 5. Textile 6. Water treatment 7. Air conditioning 8. Electric power (thermal power, water power, nuclear power, wind power) 9. Others	Monitoring and controlling of: Temperature, Pressure, Humidity, PH, Number of revolutions, Tensile force, Flow rate, Fluid surface, Displacement, Viscosity,	-1999 to 9999 -1999.9 to 2000.0	FIR, FC□, JIR, PC-900, HR-700, HCD, PC-800

About temperatue control

[Temperature control configuration example]

The following shows the basic configuration of temperature control.



A: **Thermocouple (Sensor)**
Outputs the measured temperature with DC voltage.
As well as thermocouples, there are other sensors such as RTD and thermistors.

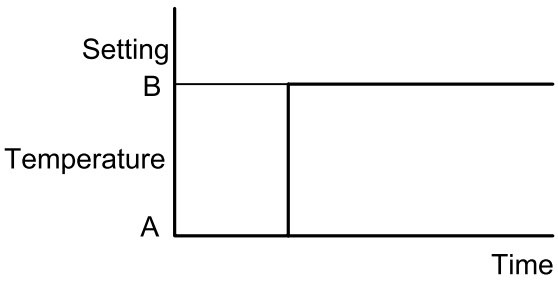
B: **Temperature controller**
Receives the output signal (DC voltage) from the thermocouple, compares the signal with the setting value and outputs the control signal to the actuator.
For control signal, there are relay contact output, non-contact voltage output and current output.

C: **Actuator**
Receives control signal from the temperature controller and turns on or off the load power supply to heater, etc. There are electromagnetic switches, SSR and power controllers for actuators.

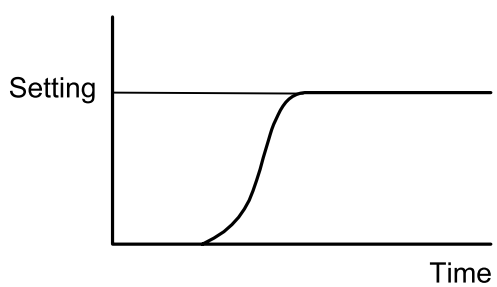
[Optimal temperature control]

An ideal temperature control, as shown below [Fig. 1], is to control the temperature to correspond with the setting value regardless of any disturbances. There should be no overshoot or response delay of time until the temperature reaches the setting value.
In reality, this kind of temperature control is almost impossible to achieve due to a number of complicated factors such as thermal capacity, static characteristics, dynamic characteristics and disturbances.
However, [Fig.2] is regarded as an optimal temperature control result.
Depending on the usage and objective, for some temperature control, suppression of overshoot is required even if the temperature rises very slowly as shown in [Fig. 3].
For some temperature control, it is necessary to stabilize the temperature as quickly as possible by raising the temperature rapidly even if overshoot is generated as shown in [Fig. 4].
In general, [Fig.2] is regarded as an optimal temperature control.

Shinko temperature controllers, as shown in [Fig. 2], are designed to raise the current temperature to the setting value as quickly as possible in order to stabilize the temperature at the setting value.
If the temperature fluctuates due to sudden disturbances, Shinko temperature controllers respond to the fluctuation with speedy response in the shortest possible time, and perform quick control to stabilize the temperature.

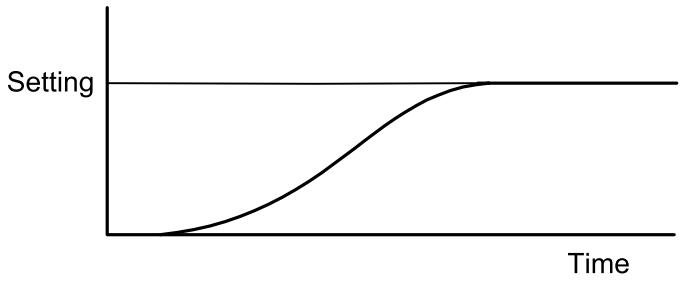


[Fig. 1]: Setting value is changed from A to B.

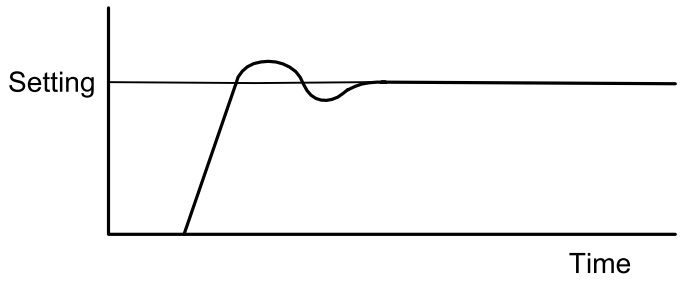


[Fig. 2] : Optimal temperature control

About temperature control



[Fig. 3] : Stable temperature control, however, the temperature rises slowly.



[Fig. 4] : Temperature rises rapidly, however, the control stabilizes after overshoot and undershoot.

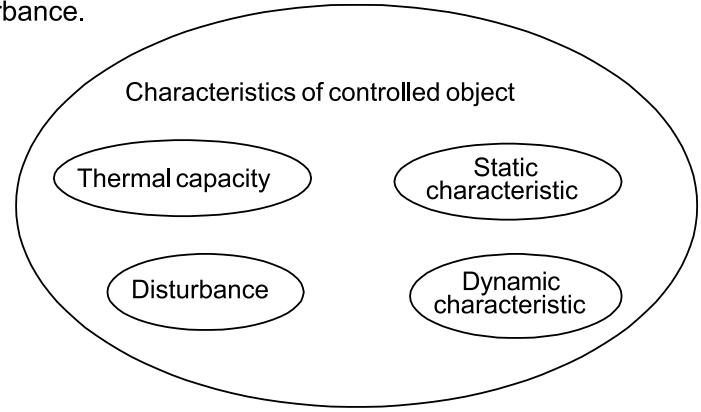
[Characteristics of the controlled object]

To perform optimal temperature control, it is necessary to have a good knowledge about the thermal characteristics of temperature controllers, sensors, actuators as well as controlled objects.

For example, for a controlled object such as a constant temperature oven whose static characteristic is that its temperature can rise up to 100℃, even if setting value of the temperature controller is set to 200℃, the temperature of the constant temperature oven rises only to 100℃.

The characteristic of controlled object is determined by the following 4 factors.

1. Thermal capacity:
   This represents how the object is easily heated, and has relation with the volume size of the controlled object.
2. Static characteristic:
   This represents the capability of heating, and is determined by the size of the heater capacity.
3. Dynamic characteristic:
   This represents the rising characteristic (transitional response) during initial heating.
   This is a complicate process involving heater capacity, furnace capacity size and sensor location.
4. Disturbance:
   Any change in control temperature causes disturbance.
   For example, the change of an ambient temperature and supply voltage, etc. are causes of disturbance.

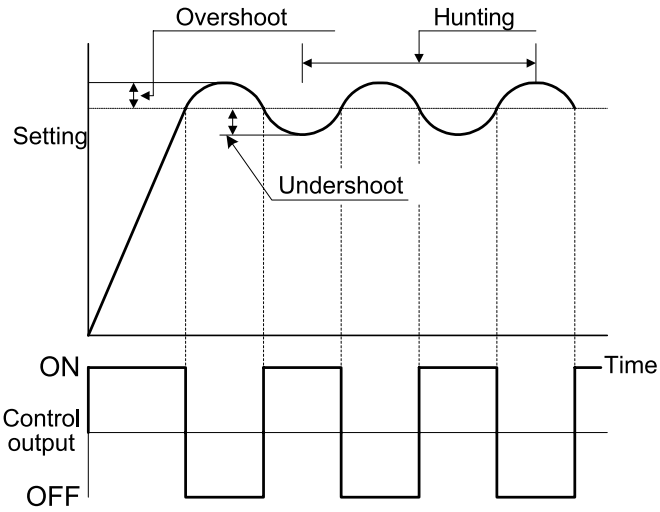


About temperatue control

[About control action]

1. ON/OFF action

When the input value is lower than the setting value, the control output is turned on, and if the input value exceeds the setting value, the control output is turned off.
Overshoot, undershoot and hunting are generated.
Therefore, this is not suitable for the temperature controls which require accuracy.



Overshoot, undershoot

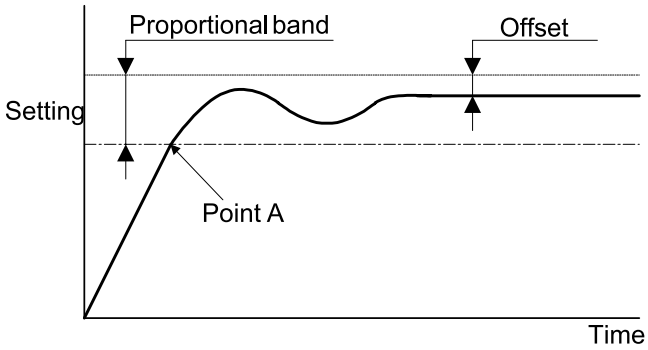
As the temperature of the controlled object rises as shown on the right, the input temperature sometimes exceeds the setting value greatly.
This is called overshoot.
If the input temperature drops below the setting value, this is called undershoot.

Hunting

The control result oscillates as shown on the right.
This is the hunting.

2. P action (Proportional action)

This outputs manipulated variable (MV) in proportion to the deviation between the input value and setting value within the proportional band.
The control output is turned on until current temperature reaches the point A.
If temperature exceeds A (enters proportional band), the control output starts to be turned off and on. If temperature exceeds the setting value, the control output is turned off.
(As the temperature rises from A to the setting value, control output ON time decreases, and control output OFF time increases.)
Compared to ON/OFF action, there is no overshoot in P action, and hunting becomes less frequent, however, offset is generated.
The offset can be decreased to zero by performing automatic or manual reset.
(This function is called reset.)

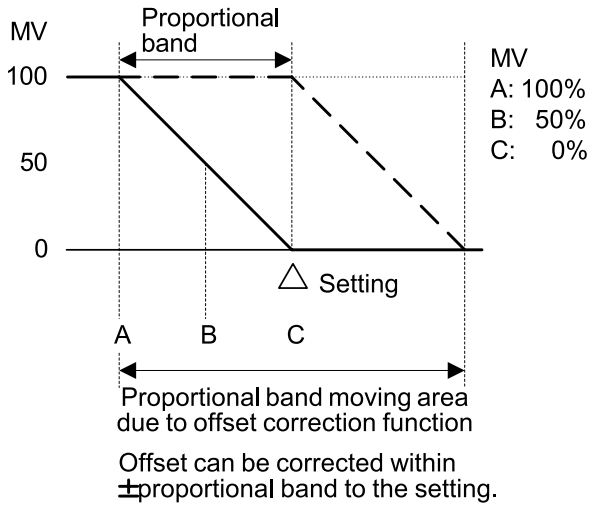


When proportional band is widened

As the control output is turned on and off from the low temperature, it takes time until input temperature rises to the setting value, and the offset is large.

When proportional band is narrowed

As the control output is turned on and off at around the setting value, the time during which the input temperature reaches the setting value is shortened, and the offset is small, however, hunting is frequent.
If the proportional band is narrowed greatly, the control action becomes the same as that of ON/OFF action.



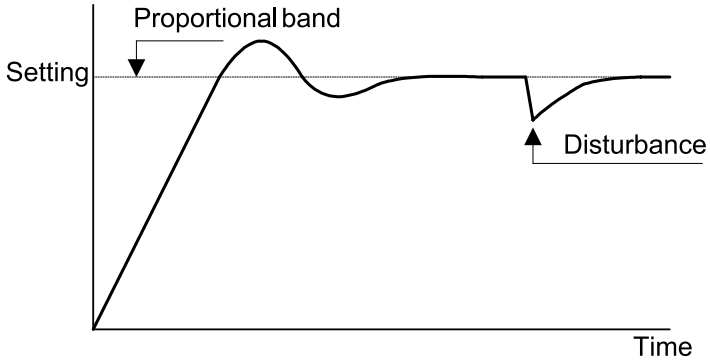
About temperature control

3. PI action (Proportional action + Integral action)

I (Integral) action automatically corrects the offset caused by P action, and the control is performed at the setting value. However, it takes some time until the temperature is stabilized if temperature is changed rapidly due to disturbance.

- If I action time is shortened, correction action becomes strong, and the offset is corrected in shorter time, however, hunting is likely to occur.
- If I action time is extended longer, correction action becomes weak, and it takes more time to offset correction.

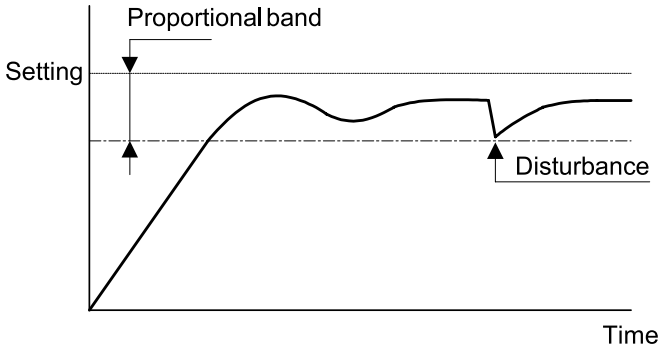
PI action is suitable for the control to which slow temperature change is required.



4. PD action (Proportional action + Derivative action)

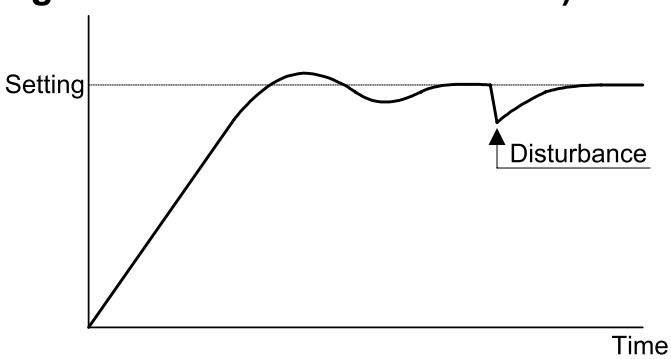
Compared with P action, the response to the rapid temperature change due to disturbance is quickened, and control can be stabilized in shorter time and transitional response characteristic can be improved in PD action.

- If D action time is shortened, correction action becomes weak. As a result, the response to the rapid temperature change is slow.
  As the action to suppress the rapid temperature change when temperature rises becomes weaker, the time until the input temperature reaches the setting value is shortened, however, overshoot is likely to occur.
- If D action time is extended further, correction action becomes strong and the response to the rapid temperature change is quickened.
  As the action to suppress the rapid temperature change when temperature rises becomes strong, time until the input temperature reaches the setting value is extended, however, hardly any overshoot occurs.



5. PID action (Proportional action + Integral action + Derivative action)

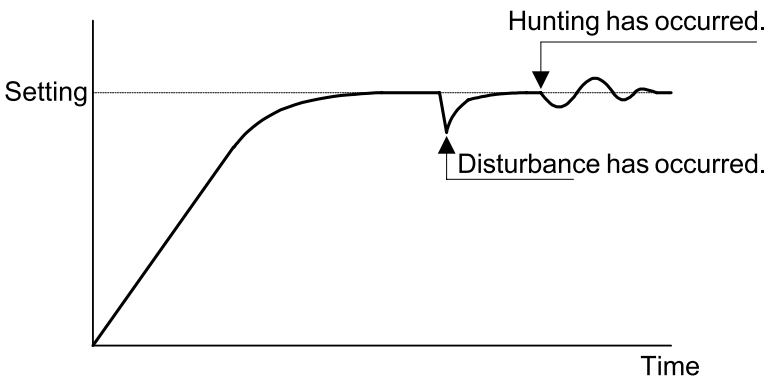
PID action has combined all control actions mentioned above (until now). In short, P action suppresses overshoot and hunting, I action corrects offset and D action converges temperature change due to disturbance in shorter time. Thus, using PID action, ideal temperature control can be carried out.



About temperature control

6. Fuzzy self-tuning PID action (Proportional action + Integral action + Derivative action)

If disturbance has generated while performing control action, this action controls the object by performing fine adjustment of PID values automatically to calculate optimal PID values in current status.
When temperature rises, control is performed with the PID values tuned beforehand. (*1)
If disturbance occurs while temperature is stabilized at the setting value, the controller checks the converging status, and carries out fine adjustment of the PID values if necessary. (*2)



- If the convergence of the temperature change due to disturbance is performed smoothly, PID values are not changed.
- If the convergence speed is slow, the controller corrects the PID values to accelerate the convergence.
- If overshoot is generated during the convergence, the controller corrects the PID values so as not to generate the overshoot.
- If hunting is generated, the controller checks its waveform and performs a fine adjustment of PID values.

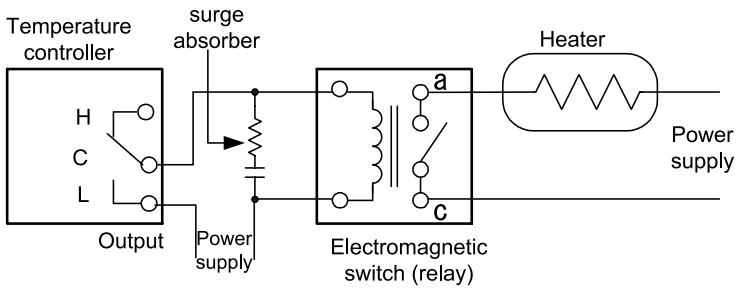
*1: When using a controller for the first time, perform PID auto-tuning or set suitable PID values using the keypad.
*2: If disturbance fluctuation is large compared to the proportional band, PID auto-tuning is automatically performed. The PID values when PID auto-tuning ends are not cancelled even if the power to the controller is turned off.

If the power to the controller is turned off, the PID values determined by a fine adjustment in fuzzy self-tuning PID action returns to the preset values when temperature rises or returns to those values when PID auto-tuning ends.

Glossary

[Relay contact output]

The load current is turned on or off depending on whether the relay contact is open or closed.
The basic function of this output is turning the electromagnetic switch on or off. When the load current is small, the load is directly turned on or off by the controller relay contact, however, in general the load current is turned on or off via the external electromagnetic switch (relay).

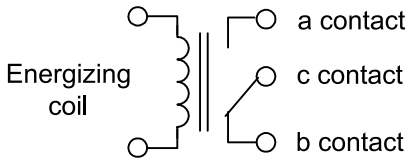


The relay life of the controller can be extended by installing the electromagnetic switch (relay) between the controller relay contact and the load as shown above.
To avoid harmful effects from noise, a CR filter (surge absorber) should be installed.
Considering the relay contact life (approx. 200,000 times for controller rated load, approx. 3,000,000 times or more for external electromagnetic switch) and proportional cycle setting, proportional cycle is required to be 30 seconds or longer.
For example, If the proportional cycle is set to 30 seconds, and if evaluation criteria of control result is within 1℃, prerequisite for process time constant is 1℃/30 seconds or less. (If the time constant is larger than this value, the control result cannot be improved with the PID auto-tuning.)
To place importance on the control result to transitional response and disturbance, process time constant must be smaller than the value mentioned previously to get a desirable result.

Merits : This is the most cost-effective output of its type. It can handle large current.
Demerits: If the proportional band is narrow, abrasion of contact point or welding may easily occur.

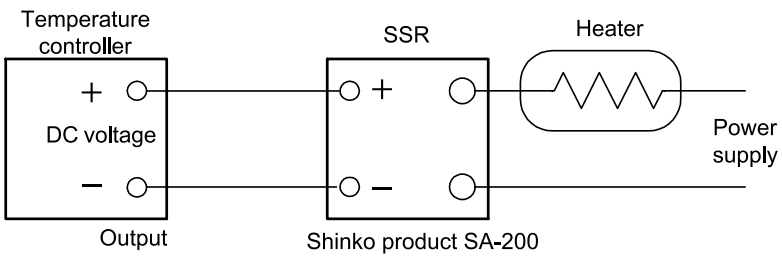
- **Relay contact**

a contact: Contacts when the current is flowing to the energizing coil.
This is also called NO (normally open) contact.
b contact: Contacts when the current is not flowing to the energizing coil. This is also called NC (normally closed) contact.
c contact: This contact is movable to “a” or “b” contact side depending on the coil energized or de-energized.
This is also called Common contact.



[Non-contact voltage output (for SSR drive)]

This outputs DC voltage to drive the non-contact relay (SSR).
This is applicable for most of thermal processes because this is not relevant to the contact life and proportional band can be narrowed.
However, to lower noise, zero cross type is used for most of the SSR, and the output resolution equals commercial frequency multiplied by proportional cycle.



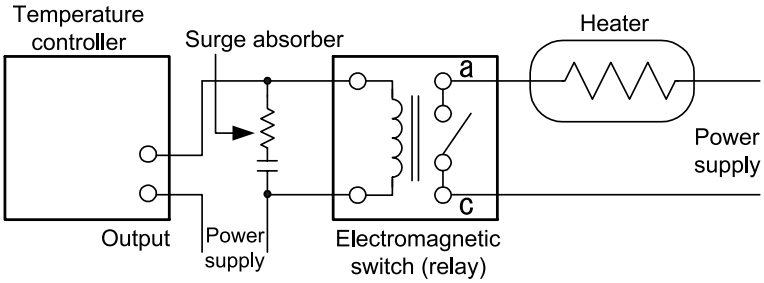
The default value for proportional cycle is 3 seconds. Therefore output resolution is 150.
The controllers’ proportional band is 10℃, and the resolution is 0.1℃, However, in high-speed thermal processes, the proportional band sometimes rises above 100℃, and as a result, the resolution becomes 1℃. Thus for SSR, if the proportional band is set to below 3 seconds, the control result may deteriorate.

Merits : Since there are no mechanical contacts, there is hardly any degradation.
Demerits: Degradation due to heat may occur to SSR.

Glossary

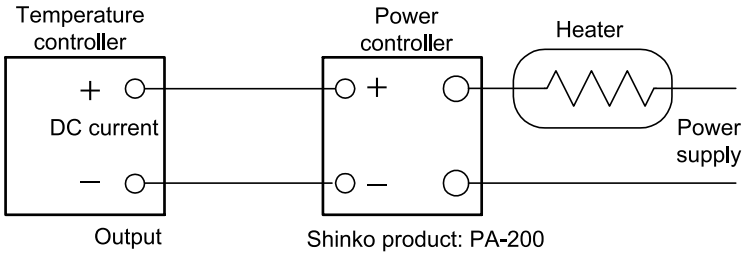
[Non-contact relay output (SSR built-in)]

The small capacity SSR is built in the output section of the temperature controller, and the load current is turned on or off through the electro-magnetic switch (relay).
Use an electro-magnetic switch (relay) with less than 1A energized current.



[DC current output]

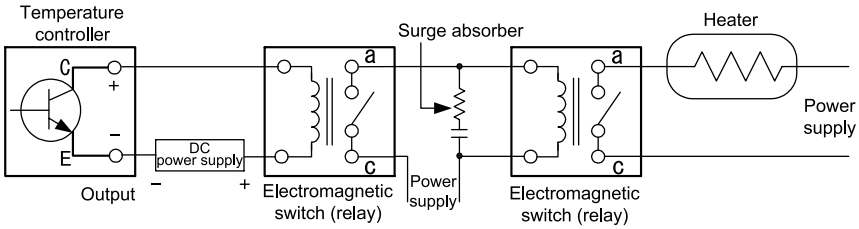
This outputs 4 to 20mA DC depending on deviation.
For actuators, there are PA-200 series with phase control and motor valves and inverters for fuel flow control with higher resolution.
Since controllers' resolution is 12000, this can apply to various processes such as high-speed thermal processes, flow rate and pressure.



Merits : More elaborate control by high resolution and continuous output.
Demerits: Costly

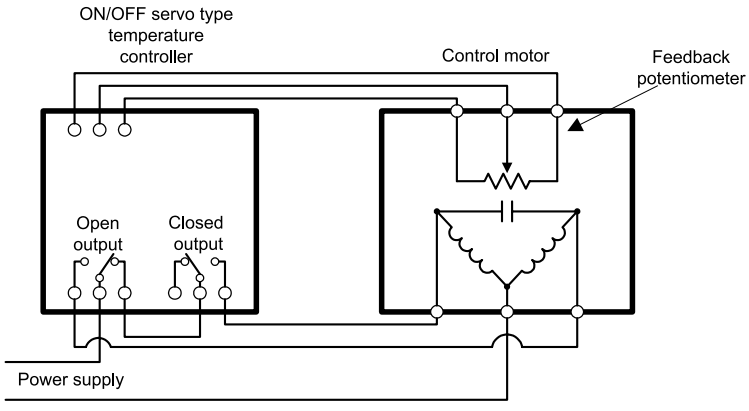
[Open collector output]

The output transistor collector is directly connected to the output terminals.
DC power source and electro-magnetic switch (relay) are required.



[ON/OFF relay servo]

Each relay contact is provided to the open output and closed output. If any one of contacts is actuated depending on deviation, this makes control motor rotate forward or in reverse or motor valve open or closed.
The motor and potentiometer are linked to each other and the control status (open/closed status) is fed back to the controller.

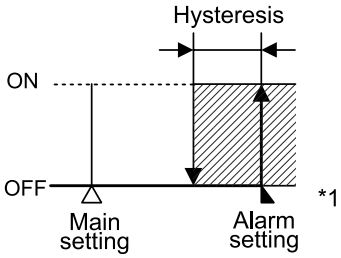


Glossary

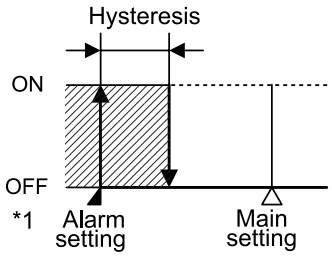
[Alarm action]

If the input reaches the value set by the deviation value from the SV or by the process value, the alarm is activated to inform of abnormal condition.
The temperature alarm action type is as follows.

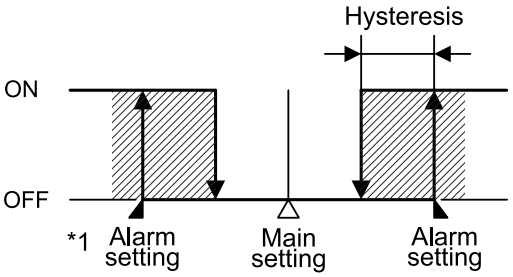
- **High limit alarm (Deviation setting)**
  The alarm action point is set by a ±deviation from the SV and when the input exceeds the alarm setting high limit value, the alarm output turns ON.



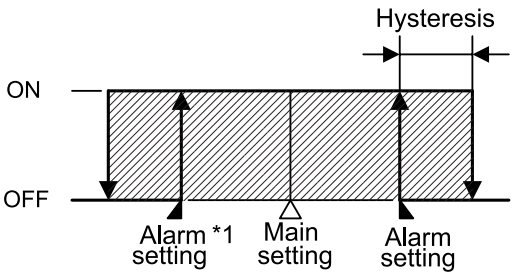
- **Low limit alarm (Deviation setting)**
  The alarm action point is set by a ±deviation from the SV and when the input drops below the alarm setting low limit value, the alarm output turns ON.



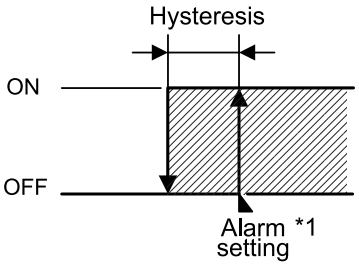
- **High/Low limits alarm (Deviation setting)**
  This alarm contains both alarm setting high limit and low limit value, and if the input goes outside either the high limit or low limit value, the alarm output turns ON.



- **High/Low limit range alarm (Deviation setting)**
  When the input is in the setting range of high and Low limit value with the alarm output ON status, the alarm output is turned OFF if the input goes outside either the high or low limit alarm set point.



- **Process value alarm**
  The alarm action point can be set randomly within the scale range regardless of the main setting value, and if the input exceeds the alarm setting value, the alarm output turns ON.



The alarm output turns on in  .

***1 Standby function**

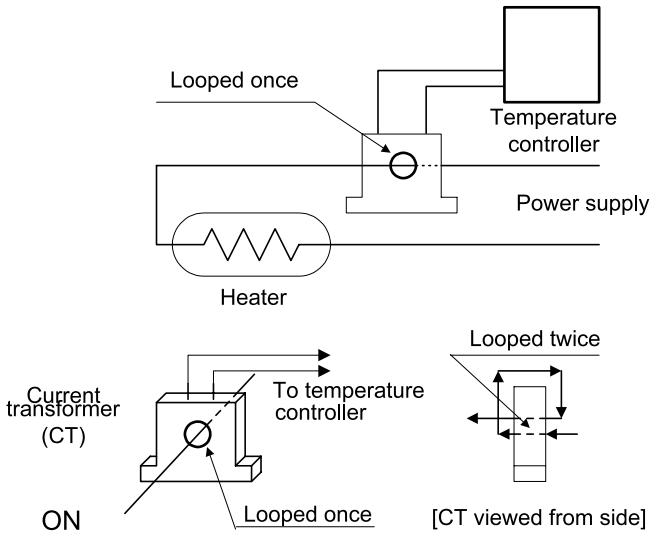
When the power supply to the instrument is turned on, even if the input enters the alarm action range, the alarm is not activated.
Even if the alarm action point enters the alarm action range due to the SV being changed while the controller is running, the alarm is not activated, either.
Once the input exceeds the alarm action point, the standby function is released, ensuring the controller continues to run.

Glossary

[Heater burnout alarm]

Pass one heater circuit lead wire into the CT hole as shown right, and connect the Output wire from the CT with CT input terminal of the controller. If AC runs through the heater circuit wire, a magnetic field is generated around the wire and AC is generated in the CT due to the magnetic field.

Measure the AC to get the current value running through the heater and compare the value with the heater burnout alarm setting value. If the AC is lower than the heater burnout alarm setting value, the heater will be read as burnout, and the heater burnout alarm will be actuated.



Notice on CT (current transformer)

- CT is used to measure not DC but AC.
  CT cannot be used for detecting the current under phase control.
- If the current which is actually running in the heater is too small compared with the rated current for the heater burnout (e.g. when current is 0.5A and the CT rated current is 5A, the current is one tenth of the rated current), by looping the lead wire twice or 3 times through CT hole, actual current value can be doubled or tripled, and the controller senses the doubled or tripled current value.
- When wiring from the CT to controller, the distance between the CT and controller has to be as short as possible.
  Keep them 10cm or more away from power source or any power lines so that they will be less affected by noise. Moreover, twisted wiring from the CT to controller will be effective against the noise.
  3-phase AC heater detects heater burnout by using 2 pieces of CT.

[Loop break alarm]

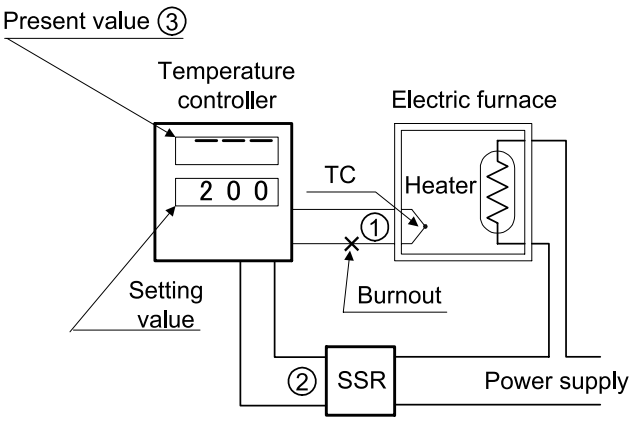
The alarm is activated when the PV (process variable) does not **rise** as much as the span or more within the time it takes to assess the loop break alarm after the MV (manipulated variable) has reached 100% or the output high limit value.

The alarm is also activated when the PV (process variable) does not **fall** as much as the span or more within the time it takes to assess loop break alarm after the MV (manipulated variable) has reached 0% or the output low limit value.

For cooling control output, read "**rise**" for "**fall**" and vice versa.

[Sensor burnout alarm]

If sensor ① (thermocouple, RTD, etc.) connected to the controller is burnt out during temperature control, control output ② is automatically turned OFF, and the present value indicates the burnout ③.



Glossary

[Sensor correction function]

This is the function of correcting the input value from the sensor.

When a sensor cannot be set at a location where control is desired, the sensor measuring temperature may deviate from the temperature in the controlled location. In such a case, the control can be set at the desired temperature by adjusting the input value of sensors.

[Scaling function]

The scaling high and low limit values can be changed within the maximum rated scale. However, if the range is decreased less than the minimum guaranteed rated scale span, the accuracy is not guaranteed.

[Multi-range function]

The input type of the controller can be selected by the front keypad, rotary switch or DIP switch.

[Setting value limit function]

The settable range of the main setting value can be limited.

(e.g.) Rated scale: 0 to 999℃

Setting value low limit: 0℃

Setting value high limit: 600℃

In this case, main setting value can only be set within the range of 0 to 600℃.

[Output limit function]

This function limits the output manipulated variable of the control output.

For instance, if the control output manipulated variable high limit value is large, it can be set to 80%, and if the manipulated variable low limit value is too small, it can be set to 20%.

[Setting value rising (falling) rate (Setting value ramp)]

This is the function of setting the rising or falling rate of change to rise or fall to a new setting value from the current value.

(The rising or falling value for 1 minute can be set)

[Manual operation function]

The output manipulated variable can be changed manually by the front keypad regardless of deviation.

In automatic control, the manipulated variable is automatically outputted in proportion to deviation like a proportional action.

[Balanceless-Bumpless function]

This restricts rapid change of MV (manipulated variable) when switching from automatic control to manual control or vice versa.

[PV filter function]

This is the function of cutting high frequency element of PV input signal.

If the filter is applied, the instrument becomes strong against input noise, however, control response speed becomes slow.

[Transmission output]

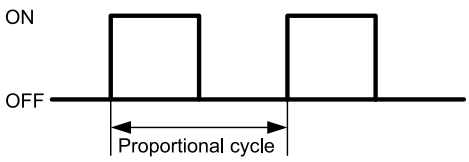
PV (process variable), SV (setting value) or MV (manipulated variable) is outputted in analog regardless of the control action.

[Proportional band]

This is the range in which the control output varies in proportion to the deviation between the SV (setting value) and the PV (process variable).

[Proportional cycle]

ON/OFF time ratio of control output in the proportional band varies according to the deviation between the SV (setting value) and PV (process variable). This one cycle of ON/OFF time is proportional cycle.



Glossary

[Offset]

In P (Proportional) action or PD (Proportional and Derivative) action, the system is often stabilized without the SV (setting value) corresponding to PV (process variable).
The difference between the SV (setting value) and PV (process variable) is called offset.

[Reset in PD action]

This is the function of correction by eliminating the offset which is created in P (Proportional) action or PD (Proportional and Derivative) action.

[Hysteresis (in ON/OFF control action)]

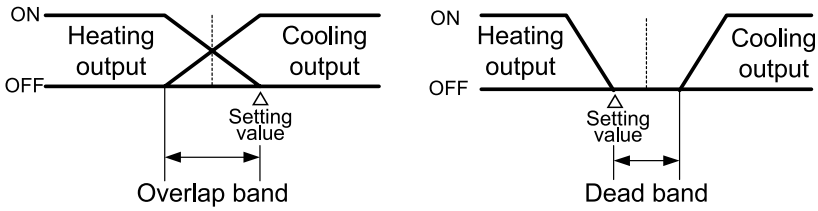
If control output is frequently turned ON or OFF, relay chatter may occur.
To prevent the relay chatter, certain span is provided between control output ON point and OFF point. This span is called hysteresis.

[ARW function (Anti-reset windup)]

When PID control action is rising, overshoot may occur due to excessive integral (I) action. ARW is the function for reducing the overshoot on start-up.

[Overlap band/Dead band]

With the controller to which both heating and cooling control action are provided, the range at which heating and cooling control action are simultaneously outputted is called overlap band, and the range at which none of the actions is outputted is called dead band.



[Heating (reverse) action]

When the process variable is lower than the setting value, the control output is turned on, and when the process variable is higher than the setting value, the control output is turned off.
For instance, electric furnace performs heating (reverse) action.

[Cooling (direct) action]

When the process variable is higher than the setting value, the control output is turned on, and when the process variable is lower than the setting value, the control output is turned off.
For instance, freezer performs cooling (direct) action.

[Alarm action delayed timer function]

The alarm is not activated even if the process variable enters the range in which the alarm is turned on or off, and the alarm action is delayed until the set time is passed.
For example, if alarm action delayed timer is set to 10 seconds, the alarm is activated in 10 seconds after the process variable enters the range in which the alarm is turned on or off.

[Automatic cold junction temperature compensation]

This detects the temperature at the connecting terminal between thermocouple and the instrument, and always keeps it on the same status as when the reference junction is located at 0℃ (32℉).

[Sensor burnout alarm]

This warns of thermocouple or RTD burnout.
If the sensor is burnt out, a safety function for turning all control outputs off is provided.

[3-wire system]

With RTD, 2 wires are connected to the end of resistance element and another wire is connected to the other end of resistance element to eliminate the effect of wire resistance when extending the wire. However, to fulfill the instrument's accuracy requirements, allowable resistance value per wire is determined.

[Input sampling period]

This is the processing time it takes to convert input analog signal to digital signal, and is peculiar to the digital controllers.

Glossary

[Remote/Local]
When the SV is changed by remote external operation, it is called Remote.
When the SV is changed by front keypad operation, it is called Local.

[Setting value memory function]
The setting value and other setting parameters can be saved and called up as one file.

[External setting]
An external analog or digital signal can be set as a SV.

[Heating/Cooling control]
In order to perform temperature control, two outputs of heating and cooling control are used for one setting value of one controller.

[Warm-up indication function]
When power to the controller is turned on, the selected sensor type is indicated for the multi-range input type.

[Multi-function]
Various setups such as sensor input, alarm action, direct/reverse action alternation can be performed as desired.

[Power failure countermeasure]
The setting data is backed up in the non-volatile memory if power failure lasts more than 30ms.

[Self-diagnosis function]
The CPU is monitored by a watchdog timer, and when any abnormal status is found on the CPU, the controller is switched to warm-up status with all outputs turning off.

[Control output off function]
This is a function to turn the control output off as the same status as when the power to the controller is turned off.

[Setting value lock function]
All setting values or other setting values except for main setting value can be locked so as not to be changed.

[Simplified program controller]
By setting a simple program with temperature and time, the same control action like a programmable controller can be performed.

[Pattern end output]
This indicates program completion after the program has ended.

[Serial communication]
In this communication system, data is transmitted one bit by one bit.
(Typical rating: RS-232C, RS-422A, RS-485)

[Communication speed]
This is the transmission speed of data. If 2400bps is taken as a communication speed, this means that 2400 bits for 1 second can be transmitted.
Since one character is calculated as 10 bits, so 240 characters for 1 second can be transmitted.

[Start bit]
This is a signal to inform the receiving side that 1 character data transmission is started.

[Stop bit]
This is a signal to inform the receiving side that 1 character data transmission is complete.

[Parity]
This is a system to check if there are any errors during transmission of each piece of data.
This consists of even and odd parity.

[Half-duplex communication start-stop synchronous]
Sending and receiving data cannot be carried out at the same time even if transmissions in both directions are possible.
This is known as a bit synchronization transmission for every piece of data and it appends start bit at the top of each data and stop bit at the end of each data.

Glossary

[Relative humidity]

This is most commonly used for describing humidity.
This is indicated with ratio of water vapor pressure (e) and saturated water vapor pressure (es) in the gas.

%RH = e/es x 100

[Absolute humidity]

The water vapor weight (g) contained in the gas of unit volume ($1m^3$) is called absolute humidity.

[Water vapor pressure]

This is pressure caused by water vapor which exists in the gas.

[Saturated water vapor pressure]

When there is no more room for water vapor to enter, it is called saturation and the water vapor pressure at this time is called saturated water vapor pressure.

[Dew point]

If the temperature of the air containing water vapor is lowered while pressure is constant, the water vapor in the air becomes saturated (saturated water vapor pressure, relative humidity 100%RH) and the water vapor condenses at this temperature.
This is dew point.
The condensation temperature is dew point temperature.

[Infrared ray]

This is an invisible electromagnetic wave that exists outside of the red color of the spectrum (wavelength of light lined in sequence). All the objects radiate infrared rays.
The higher the temperature of the object rises, the stronger the infrared ray is radiated.

[Emissivity]

Emissivity is the opposite of reflectance. If reflectance of the object surface is “0”, this means that emissivity is 100%, that is “1”.
This object is called black body.
The reflectance of the lustrous metal surface is 80 to 95%, whose emissivity is 0.05 to 0.2.
Infrared sensor cannot measure this low emissivity, however, by using black body tape, low emissivity can be determined.

[Air purge]

This is used for protecting the senor from corrosive gases, inflammable gases or dust by sending the air to the infrared sensor lens head. This also prevents the sensor from rising its temperature.

[Thermopile]

When elements absorb the infrared ray radiated from the object, they are heated up and electromotive force is generated. These elements are called thermopile.

[Angle of visibility]

This is the ratio of visual field diameter and measuring distance of infrared sensor. When measuring the same visual field diameter, the narrower the angle of visibility becomes, the longer the measuring distance becomes, and the broader the angle of visibility becomes, the shorter the measuring distance becomes.

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