ALTEC®

Temperature Differential Controller

DC220

Operating Instructions

Table of Contents

1 Introduction

The DC220 temperature difference controller has dual temperature signal inputs. The controller is idea for temperature differential, pressure differential, solution ratio applications. Especially for central air conditioner control application.

2 Features

- 16-bits high speed A/D converter, high measurement precision.
- Advanced PID control algorithm provide high control precision.
- Standard thermocouple, Pt100, Cu50, RTD, linear signal inputs.
- Various optional outputs for different applications.
- RS485/RS232 serial communications.
- Wild range switching power supply(85~264V).
- Friendly user interface, easy to use.
- More cost efficient.

3 Type designation

DC220 / □ / □ / □ / □ / □

(Fields in order: Output 2 / Output 1 / Alarm 1 / COMMS / Options)

Options

0	None

COMMS

0	None
232	RS232(3-wire), optical isolated, distance: 12m
485	RS485(2-wire), optical isolated, distance: 1.2km

Alarm 1

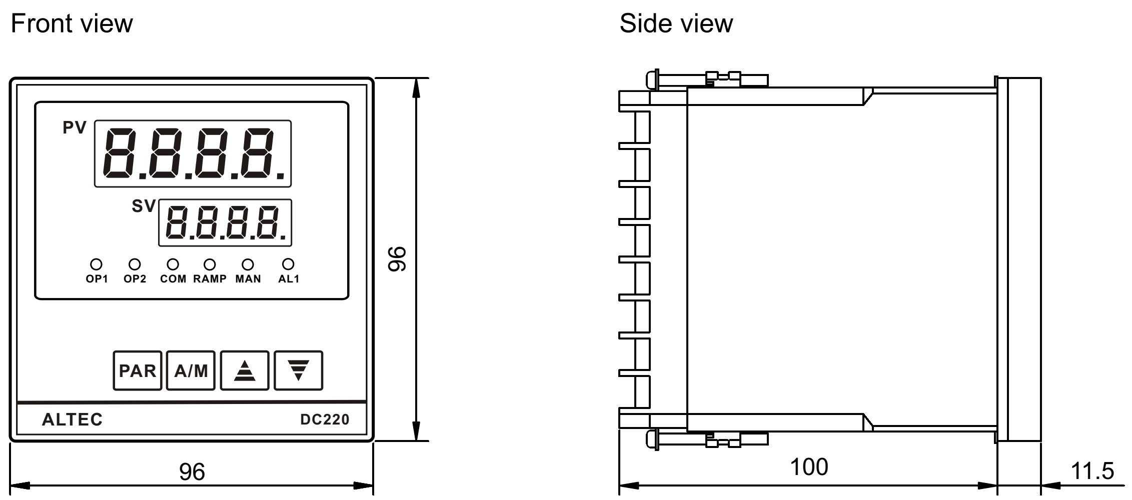
0	None
R	Relay, (NO, 3A/250VAC)

Output 1
Output 2

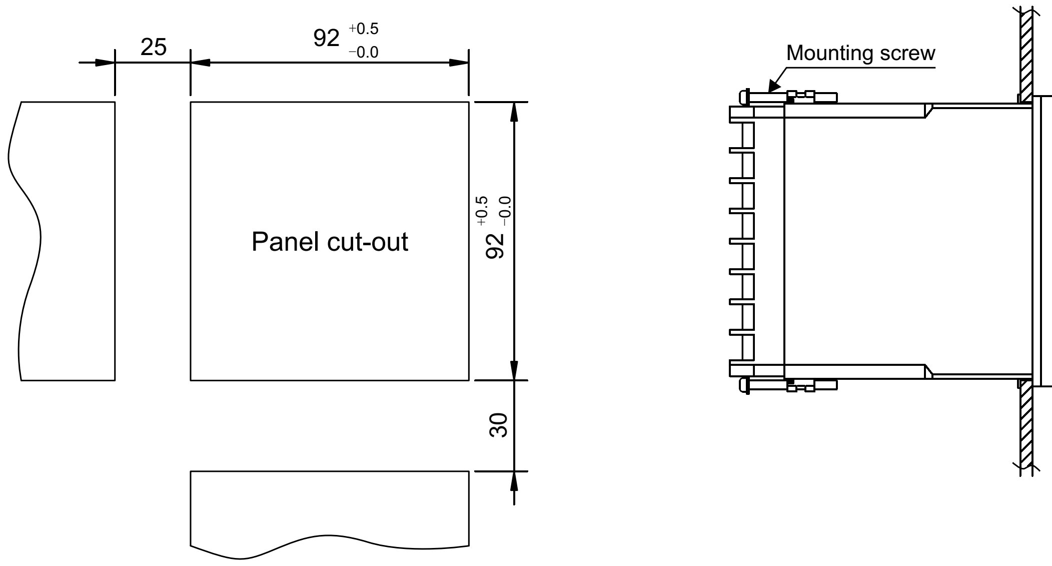
0	None
R	Relay, (NO, 3A/250VAC)
L	Logic, 20V/10mA, drive SSR
T	Triac, drive SCR
D	Analog: 0~10mA, 4~20mA, 0~20mA, 0~5V, 1~5V, 0~10V

4 Mounting

4.1 Dimensions



4.2 Fitting



For close mounting Minimum spacing of panel cut-outs	
horizontal	25 mm
vertical	30 mm

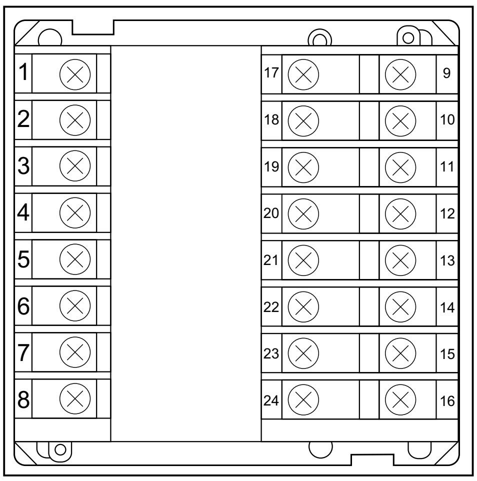
- Prepare a rectangular cut-out in the panel to the size shown above.
- Insert the controller from the front into the panel cut-out.
- From behind the panel, slide the mounting brackets into the guides on the top and bottom sides of the housing. The flat faces of the mounting brackets must lie against the housing.
- Push the mounting brackets up to the back of the panel, and tighten them evenly with a screwdriver.

5 Electrical connection

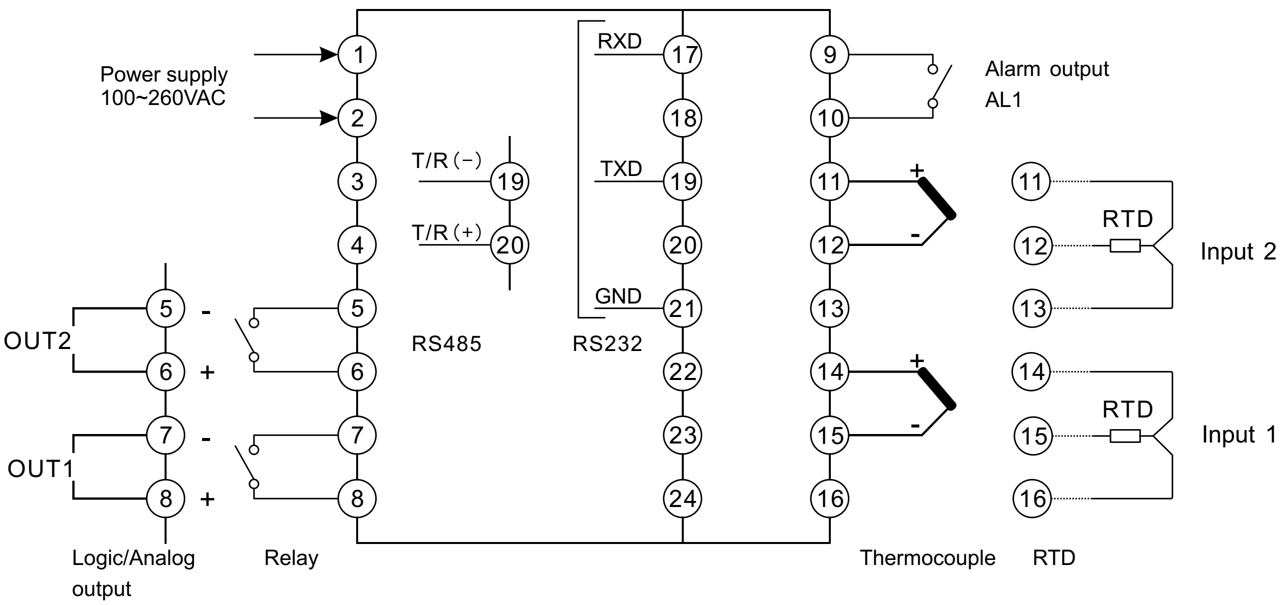
5.1 Notes on wiring

- ❑ For thermocouples inputs, please connect appropriate compensating cable.
- ❑ For RTD input, the length and gauge of all three wires must be equal.
- ❑ Input wire shall be separated from the power line and load line to avoid electrical noise.
- ❑ The inputs to the controller must be between -10mV to 50mV, voltage signal which exceed this range must be attenuated with an appropriately sized input adapter. Current signals are converted to the -10 to 50mV range with a shunt input adapter.

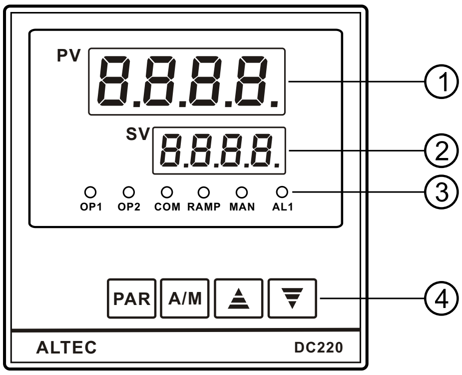
5.2 Rear terminals view



5.3 Connection diagram



6 Front panel layout



SN	Item	Description
①	PV Display	Indicates the Process Value and parameters
②	SV Display	Indicates the setpoint, manual manipulation output, parameter values, alarms code
③	OP1	Output 1 indicator(green)
	OP2	Output 2 indicator(green)
	COM	Communication indicator(red)
	MAN	Manual operating mode indicator(red)
	AL1	Alarm 1 indicator(red)
④	PAR	Parameter setting key
	A/M	Automatic/Manual key
	▲	Raise key
	▼	Lower key

7 Operation

7.1 Display & Basic Operation

There are two LED displays indicate the operating parameters.

The **upper display**(green) indicates the channel-1(input 1) measured temperature(T1) and temperature difference(dt). On selecting a parameter, the appropriate parameter abbreviation appears.

The **lower display**(red) indicates the channel-2(input 2) measured temperature(T2) and the setpoint(SV). On selecting a parameter, the appropriate parameter value appears here.

When the controller is powered on, the upper display indicates the basic models of the controller, and the lower display indicates the software version.

The type of contents displayed in the upper and lower display depend on the parameters di S1 and di S2.

di S1 = t 1, upper display indicates T1

di S1 = dt, upper display indicates dt

di S1 = r1, upper display indicates T2/T1

di S2 = t2, lower display indicates T2
di S2 = SP, lower display indicates SV
di S2 = C1, lower display indicates C1

3 seconds later, the upper display will indicate measured values (PV), and the lower display will indicate set values (SV), or,

When the controller runs in manual control mode(indicator '**MAN**' is ON), the lower display will indicate the output power.

Both the LED indicators '**OP1**' and '**OP2**' indicate the state of the relevant output. The LED is illuminated when the output is 'ON'.

The LED indicator '**COM**' flashes when the controller is in active communication with a host computer.

The LED indicator '**RAMP**' is illuminated when the setpoint is ramping towards the target setpoint (only if ramp-to-setpint has been configured).

The LED indicator '**MAN**' indicates manual operating mode, the indicator flashes if sensor break is detected.

7.2 Setpoint adjusting

In automatic control mode, the upper display indicates channel-1 measured temperature(T1) or temperature difference between T1 and T2(dt = T1-T2), the lower display indicates channel-2 measured temperature(T2) or setting value or setting ratio.

Press keys ▲ or ▼ to increase or decrease setpoint, keeping it pressed results in a progressively faster variation. Adjustable range: SP L ~ SP H.

7.3 Automatic/Manual mode

With the Auto/Manual key('A/M'), the controller can be switched between automatic mode and manual mode.

When in manual mode, the indicator 'MAN' will be lit. The output power will appear on the lower display, the value can be modified by pressing ▲ and ▼ key. Adjustable range: output power low limit(code: L PL) ~ output power high limit(code: H PL).

The automatic/manual exchange function can be disabled by

If set the parameter 'Automatic/Manual enable'(code: A H) to Auto, the automatic/manual exchange function will be disabled.

If set the parameter A H to HAnd, the automatic/manual exchange function will be enabled.

When the controller runs in the automatic control mode and the automatic/manual exchange function has been disabled, press A/M key, the output power will appear in the lower display.

7.4 Modifying the Operation Parameter

When the controller is in the PV/SV displaying status, press PAR key and hold for 3 seconds reveals the first parameter. The parameter value can either be modified with the ▲ or ▼ key, or left unmodified. Press PAR key again, the next parameter and its current value appears, the modified data has been saved.
If the last parameter is displayed or there's no key operation within 16 seconds, the menu times out automatically.

Operation parameter list

SN	Mnemonic	Parameter	Adjustable Range	Comments
1	C1	Ratio Coefficient	0.01~99.99	Appears when Func = Pro
2	SP	Setpoint	SP H ~ SP L	
3	t1	Temperature 1		Input 1 measured temperature(Read only)
4	t2	Temperature 2		Input 2 measured temperature(Read only)
5	dt	Difference of Temperature		dt = t1 - t2 (Read only)
6	tunE	PID Auto-tune	OFF on	Turn off PID auto-tune Turn on PID auto-tune
7	AL1	Alarm value 1	Measurement range	
8	HYS1	Alarm 1 hysteresis	0.01~99.99	Disappears when HYS = OFF
9	AL2	Alarm value 2	Measurement range	
10	HYS2	Alarm 2 hysteresis	0.01~99.99	Disappears when HYS = OFF
11	ProP	Proportional band	1~9999 °C	
12	Int.t	Integral time	OFF, 1~8000 sec.	
13	dEr.t	Derivative time	OFF, 1~999 seconds	Disappears when Ctrl = On.OF
14	H c.t	Output cycle	0.1~240.0 seconds	
15	Loc	Configuration password	0~9999	

Operation parameters description

1). Regulation parameters - ProP, Int.t, dEr.t

These three parameters directly affect the precision of control. The PID auto-tuning function could automatically measure, compute, and set these three constants. If the controller is configured as an ON/OFF controller(Ctrl = On.OF), the proportional band(ProP) becomes the output hysteresis.

proportional band(ProP) is the band of error within which the power output is proportional to the error. Error values outside this band give 100% or 0% power output. If the proportional band is too narrow it will give control resembling on/off control with continuous oscillation. Wide proportional bands give stable but sluggish control with an offset in the steady-state condition.

Parameter Int.t provides automatic compensation for long term control offsets. It is the time taken for the output to change by one proportional band width for a constant error equal to the proportional band. Typically this must be set to a value longer than the response time of the process being controlled.

The parameter dEr.t provides anticipation and fast recovery from disturbances. It can be taken as the 'look ahead' period of the controller. It is typically set to a time approximately one sixth of the integral time.

2). Output cycle time - H c.t

If output 1 was set as time-proportioned output(OP1 = tP), the output cycle time(code: H c.t) should be set to high values(e.g. 10 seconds) if contactors are used, and to low values(e.g. 2 second) if thyristors or SSR are used.

8 Controller configuration

In order to get the best control performance, DC220 must be set properly.

1) Press PAR key and hold for 3 seconds to enter the 1st level menu(i.e. operation parameter list);

2) Press PAR key to scroll the parameter to Loc and set its value to 808(the initial password);

3) Press PAR key and ▲ key and hold for about 3 seconds, the first parameter appears on the upper display, at the same time the parameter value appears on the lower display. The values can be modified by pressing keys ▲ and ▼. After modification, press the PAR key, the next parameter appears, the modified data has been saved in the memory.

If the last parameter is displayed or there is no key operation within 16 seconds, the controller will time out automatically.

After configuration, set the configuration password(code Loc) to data other than 808 in order to protect the parameter values from being inadvertent modification.

Configuration parameter list

SN	Mnemonic	Parameter	Adjustable range	Comments
1	SP H	Setpoint high limit	Measurement range	always > SP L
2	SP L	Setpoint low limit	Measurement range	always < SP H
3	H PL	Output power high limit	0.0~100.0	
4	L PL	Output power low limit	0.0~100.0	
5	OFS1	Input 1/calibration offset	0.00~10.00	
6	OFS2	Input 2/calibration offset	-9.99~99.99	
7	C F	°C/°F unit selection	C Centigrade F Fahrenheit	Disappears when Sn = linear signal inputs
8	Sn	Input signal	Jtc CAtc Etc rtc Stc btc ttc rtd .rtd cu .cu Lin .Lin PrE .PrE	J thermocouple K thermocouple E thermocouple R thermocouple S thermocouple B thermocouple T thermocouple Pt100 Pt100(0.1 prec) Cu50 Cu50(0.1 prec) Linear input Linear input (0.1 prec) Pressure resistance signal Pressure resistance signal (0.1 prec)
9	Addr	Instrument address	00~99	
10	bAud	Baud rate	600, 1200, 2400 4800, 9600, 19.2	
11	Func	Controller Function	dt Pro	Temperature differential controller Ratio controller(optional)
12	Ctrl	Control algorithm	On.OF Pid	ON/OFF control Proportional integral derivative(PID) control
13	OP1	Output 1 (main output)	tP 0-20 4-20	Time-proportioned output 0~20mA output 4~20mA output

Configuration parameter list(continued)

14	1AL	Object of Alarm 1	t1 t2 dt	Temperature 1 Temperature 2 Difference of Temperature
15	2AL	Object of Alarm 2		
16	ALo1	Alarm 1	HiAL LoAL HdA LdA dAo ndAo Pout	Full-scale high alarm Full-scale low alarm High-deviation alarm low-deviation alarm outside deviation band alarm Inside deviation band alarm Alarm when program halt
17	ALo2	Alarm 2 Appears only if OP2 is configured as ALO2		
18	di S1	Contents of upper display indicates	t1 dt r1	Display temperature 1 Display difference of temperature Display R1=T2/T1
19	di S2	Contents of lower display indicates	t2 SP C1	Display temperature 2 Display setpoint Display ratio setpoint C1
20	A H	Auto/Manual enable	Auto HAnd	Changeover locked out Changerover possible
21	HYS	Alarms hysteresis	OFF on	Turn alarms hysteresis off Turn alarms hysteresis on
22	Act	Control action	rEu dir	Reverse control Direct control
23	HiL	Measurement range upper limit(sensor break)	-999~9999	Appers only when input are linear input(Sn is set as Li n or .Li n, PrE or .PrE)
24	LoL	Measurement range lower limit(sensor break)	-999~9999	
25	FiL	Input filter	0.01~99.99	
26	Proc	Process scaling (straight line equation)	P1 P2 C1 C2	

Configuration parameter description

1). Controller Function - Func

When Func = dt, the controller performs as temperature differential controller, difference of temperature is dt(dt = t1 - t2).

When Func = Pro, the controller performs as ratio controller, the temperature 2(measured by input 2) times the ratio coefficient will be the setpoint of temperature 1.(In formula: SP1 = t2 * C1)

2). Input Signal - Sn

The parameter Sn should be set to the correct sensor type the controller connected, otherwise the measured value will be incorrect.

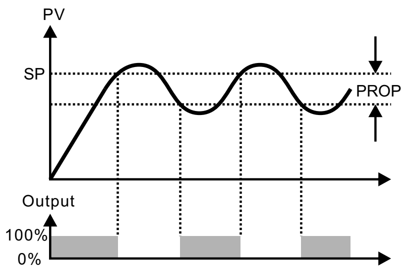
E.g. for Pt100 RTD input, set Sn to rtd or .rtd. And for 4~20mA linear signal input, set Sn to Li n or .Li n.

3). Control Algorithm - CtrL

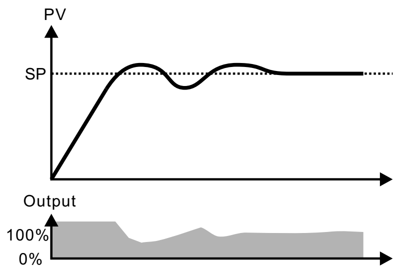
There are 2 types of control algorithm can be selected for the controller: ON/OFF and PID.

If CtrL=On.OF, the controller is configured as an ON/OFF controller, the output hysteresis is set using the proportional band(ProP). The ON/OFF control is intended for applications which needs no high control precision. In PID control mode, the output can be set to mV, mA or time-proportioned.

If CtrL=Pid, the controller is configured as a PID controller, PID is intended for high precision control applications. See the figure below.



ON/OFF Control



PID Control

4). Display Contents Configuration - diS1 & diS2

The upper and lower displays' displayed contents can be configured very flexibly. For detailed settings, see the parameter list.

5). Output Parameter - OP1 & H c.t

The setting value for OP1 depends on which type of output drive device the controller installed.(check the controller's part number) There are generally two types of outputs.

- **Time proportioned output**

This applies to relay, logic or triac outputs(i.e. ON/OFF devices) and PID control. The percentage 'ON' time of the device over a period is proportional to the power demand of the PID. Appropriate cycle times can be selected to suit the type of output device and the process response time.

- **Analogue output**

Where continuously variable control is required. DC volts or current are available. 4 to 20 mA is a standard output.

If the output module is relay, logic or SCR, OP1 would be set to tP output.

If the output module is analog output, oP1 would be set to 0~20 mA or 4~20 mA.

Especially, if output 1 was set to time-proportioned output(OP1 = tP), the output cycle time(code: H c.t) should be set to high values(e.g. 10 seconds) if contactors are used, and to low values(e.g. 2 second) if thyristors or SSR are used.

6). Control Action - Act

A reverse acting controller(Act = rEu) will reduce its output as the process variable increases. rEu should be selected for temperature control loops with the heat output.

A direct acting controller(Act = dir) will increase its output as its process variable increases. dir should be selected for temperature control loops with the cool output.

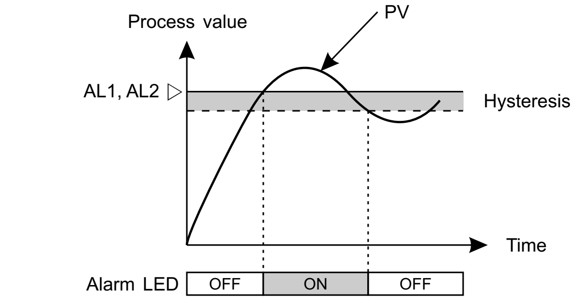
7). Alarms - ALo1, ALo2, 1AL, 2AL

Six different types of alarm can be configured with ALo1 and ALo2.

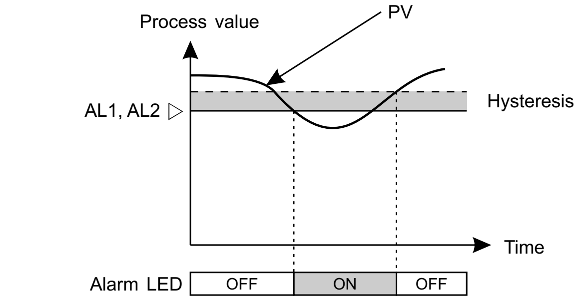
1). Full-scale High Alarm(HIAL) Alarm operates above an absolute level.
2). Full-scale Low Alarm(LoAL) Alarm operates below an absolute level.
3). High-Deviation Alarm(HdA) Alarm operates above a defined band above the control level.
4). Low-Deviation Alarm(LdA) Alarm operates below a defined band below the control level.
5). Outside deviation band alarm(dAo) Alarm operates outside a defined band around the control level.
6). Inside deviation band alarm(ndAo) Alarm operates inside a defined band around the control level.

Hysteresis is used to provide a definite indication of the alarm condition and to prevent alarm relay chatter. The hysteresis is HYS1 and HYS2. See the figures below.

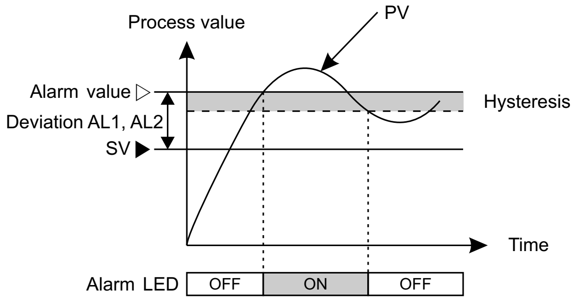
Full-scale High Alarm(HIAL)



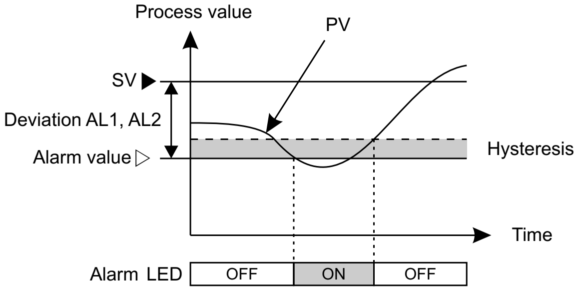
Full-scale Low Alarm(LoAL)



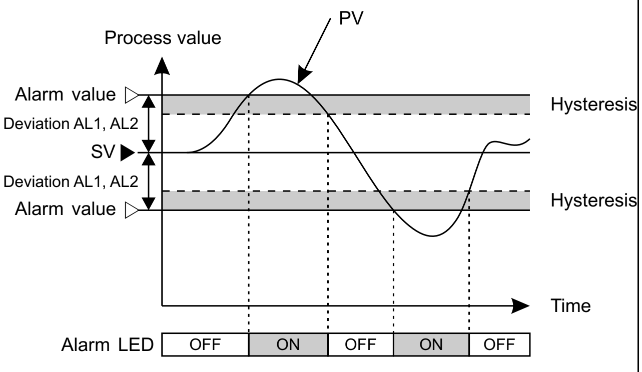
High-Deviation Alarm (HdA)



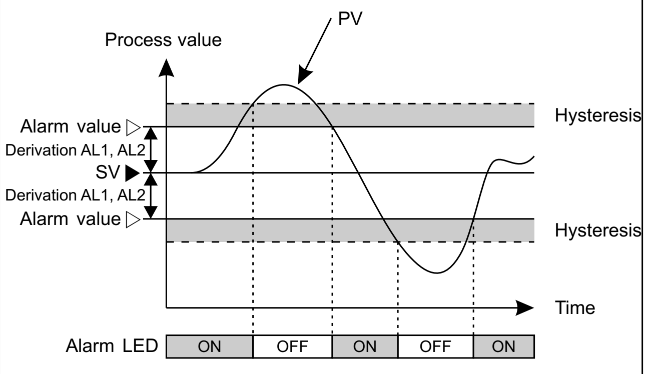
Low-Deviation Alarm(LdA)



Outside Deviation Band Alarm(dAo)



Inside Deviation Band Alarm(ndAo)

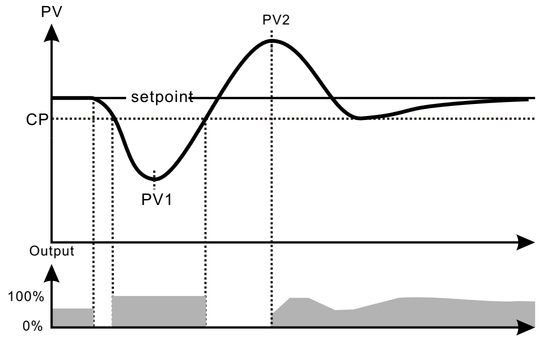


9 PID Auto-tuning

In order to achieve a good control performance, the PID control parameters(ProP, Int.t, dEr.t) must be optimized first. The PID auto-tuning function could automatically measure, compute, and set PID constants.

Auto-tuning can be activated under the following conditions:
●Automatic operating(closed loop)
●PID control algorithm

Before activating the auto-tuning, set SV(Setting Value) to the desired value. By setting the parameter tunE to on, the auto-tunging will start. During auto-tuning execution, the code tunE and the setpoint will flash in the lower display alternately.
The tuning operation is finished when the code tunE no longer flashes. The user can abort self-tuning at any time by setting the parameter tunE to OFF.



Self-tuning from setpoint-heating process

During auto-tuning, the controller will execute ON/OFF regulation, PV will oscillate, 1.5 period later, auto-tuning finished. According to the period and amplitude of the oscillation, the controller will calculate the optimum PID parameters and stored them in the memory automatically.

During auto-tuning, do not change any of the parameters, because each modification of setpoint will restart the auto-tuning.
If the user use PI(Proportional Integral) control algorithm, please set the derivative time(code: dEr.t) to OFF before turning on the PID auto-tuning, the derivative time will not be change during the auto-tuning process. PI control is suited to systems which allow of no frequent outputs variation.

10 Sensor failure

A sensor break and likewise an input error occurs when the input is open circuit or the measured value at the input over or under ranges the linerisation span of the controller.

If the input is open circuit or the measured value is over range, error code Snb appears on the upper display. In an under range condition or the sensor is shorted, error code ur appears on the upper display. In both case, the output will be closed, the output becomes 0, at this time the output can be modified by pressing the ▲ and ▼ key, the indicator **'MAN'** will flash.

Once failure eliminated, the controller will return to automatic control mode.

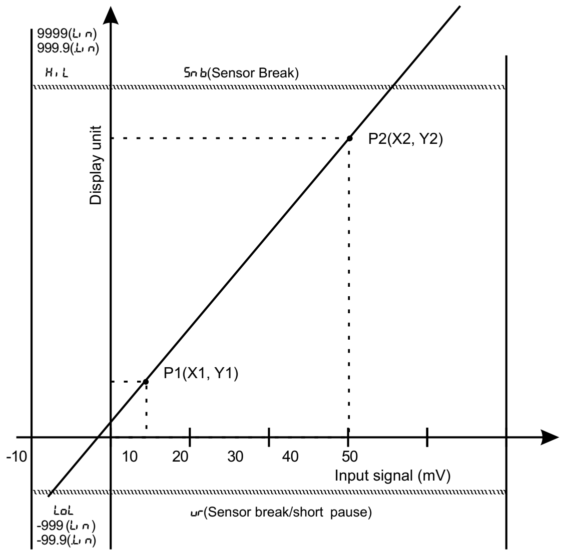
11 Linear input

11.1 Introduction

To measure physical quantities such as humidity and pressure or measure temperature by using transmitters, the physical quantities must be converted to analog signals, and set the "input signal" parameter(code: Sn) to Lin or .Lin.

The input to the controller must be between -10mV to 50mV, Voltage signal which **exceed** this range must be attenuated with an appropriately sized input adapter. Current signals are converted to the -10 to 50mV range with a shunt input adapter.

e.g.	Input	Adapter
	4 to 20 mA	Ri=2.5Ω
	0 to 10 V	Ri=1k/200kΩ



Principle

If for the given input signal X1, the corresponding display value is Y1; And for the given input signal X2, the corresponding display value is Y2. Then for linear input signals, the two points define a straight line which maps the input signal to the display unit.

The figure right illustrates the principle clearly.

11.2 Parameter settings

Set the "input signal" parameter Sn to Lin or .Lin.

Set proper "input filter"(code: FiL) value. The greater the FiL, the more stable display but slower response.

11.3 Calibration procedure

The following practical examples illustrate calibration procedures clearly.

Assume that there are two temperature transmitters: Transmitter 1 is connected to input 1 while transmitter 2 is connected to input 2.

Transmitter 1 outputs a 4~20 mA signal which corresponds to display unit 0~50°C, transmitter 2 outputs a 4~20 mA signal which corresponds to display unit 0~100°C.

Note that the transmitters can also be replaced by standard signal generators, in the examples, we use signal generator to get the mA signals.

Note:

* Both the two inputs must be connected at the same time. When calibrate e.g. input 1, make sure input 2 is 0, and vice versa.

* Input 1 and input 2 can't be supplied with the same power supply.

11.3.1 Input 1 Calibration

1). P1 Calibration

Step	Button Operation	Display
1	Connect source.(form signal generator or sensor to input 1 terminals) Apply a signal equal to 4mA.	
2	Press PAR key until Proc appears in the upper display	Proc ----
3	Press ▲ key, P1 appears in the lower display	Proc P1
4	Press PAR key, the number in the lower display will be the value after adjustment assigned to the injected input signal	P1 15.0
5	Press ▲ and ▼ key to adjust the number in the lower display until it corresponds to the represented by the injected signal	P1 0.0
6	Press PAR key	0.0 no
7	Press ▲ key to affirm	0.0 YES
8	Press PAR key, P1 appears in the upper and lower display at the same time	P1 P1
9	5 seconds later, the scaling of the 1st point is completed	Proc ----

2). P2 Calibration

Step	Button Operation	Display
1	Apply a signal equals to 20mA for the second setup point(P2)	
2	Press PAR key until Proc appears in the upper display	Proc ----
3	Press ▲ key, P2 appears in lower display	Proc P2
4	Press PAR key, the number in the lower display will be the value after adjustment assigned to injected input signal	P2 60.0
5	Press ▲ and ▼ key to adjust the number in the lower display until it corresponds to the value represented by the injected signal(here 50)	P2 50.0
6	Press PAR key	50.0 no
7	Press ▲ key to affirm	50.0 YES
8	Press PAR key, P2 appears in the upper and lower display at the same time	P2 P2
9	5 seconds later, the scaling of the 2nd point is completed	Proc ----

11.3.2 Input 2 Calibration

1). C1 Calibration

Step	Button Operation	Display
1	Connect source.(form signal generator or sensor to input 2 terminals) Apply a signal equal to 4mA.	
2	Press PAR key until Proc appears in the upper display	Proc ----
3	Press ▲ key, C1 appears in the lower display	Proc C1
4	Press PAR key, the number in the lower display will be the value after adjustment assigned to the injected input signal	C1 5.0
5	Press ▲ and ▼ key to adjust the number in the lower display until it corresponds to the represented by the injected signal	C1 0.0
6	Press PAR key	0.0 no
7	Press ▲ key to affirm	0.0 YES
8	Press PAR key, C1 appears in the upper and lower display at the same time	C1 C1
9	5 seconds later, the scaling of point C1 is completed	Proc ----

2). C2 Calibration

Step	Button Operation	Display
1	Apply a signal equals to 20mA for the second setup point(C2)	
2	Press PAR key until Proc appears in the upper display	Proc ----
3	Press ▲ key, C2 appears in lower display	Proc C2
4	Press PAR key, the number in the lower display will be the value after adjustment assigned to injected input signal	C2 80.0
5	Press ▲ and ▼ key to adjust the number in the lower display until it corresponds to the value represented by the injected signal(here 100)	C2 100.0
6	Press PAR key	100.0 no
7	Press ▲ key to affirm	100.0 YES
8	Press PAR key, C2 appears in the upper and lower display at the same time	C2 C2
9	5 seconds later, the scaling of point C2 is completed	Proc ----

Technical data

Accuracy	±0.2%FS+1 digital
Sample rate	125ms
Input	Thermocouple: Type J, K, E, R, S, T, B RTD: Pt100, Cu50 Analog: 0~20mA, 4~20mA, -10.0~50.0mV, 0~10V
Output	Relay, (NO, max.250VAC/3A) Logic, 20V/10mA, Drive SSR SCR Analog:0~10mA, 4~20mA, 0~20mA or 0~5V, 1~5V, 0~10V
Alarms	Relay, (NO, max.250VAC/3A) Modes: upper and lower limit alarm, and deviation alarm
Control algorithm	ON/OFF PID with PID Auto-tuning
Communication	RS232, RS422, RS485
Dimensions	W96×H96×D100mm
Power supply	85~264VAC, 45/60Hz
Environmental	Temp: 0~50°C, Rel. Humidity: ≤85%

Measurement range

Code	Input	Measurement Range(°C)	Measurement Range(°F)
Jtc	J thermocouple	-135~1000	-211~1832
cAtc	K thermocouple	-255~1395	-427~2543
Etc	E thermocouple	-99~749	-427~1380
rtc	R thermocouple	-50~1767	-58~3213
Stc	S thermocouple	-50~1767	-58~3213
btc	B thermocouple	-50~1967	-58~3313
ttc	T thermocouple	-260~400	-436~752
rtd	Pt100	-100~1000	-100~1000
.rtd	Pt100(1/10's prec)	-99.9~999.9	-99.9~999.9
cU	Cu50	-50~150	-50~150
.cU	Cu50(1/10's prec)	-49.9~149.9	-49.9~149.9
Lin	Linear	-1999~9999	-1999~9999
.Lin	Linear(1/10's prec)	-199.9~999.9	-199.9~999.9
PrE	Pressure resistance signal	-1999~9999	-1999~9999
.PrE	Pressure resistance signal (1/10's prec)	-199.9~999.9	-199.9~999.9