FT Series Temperature Controller

Instruction Manual

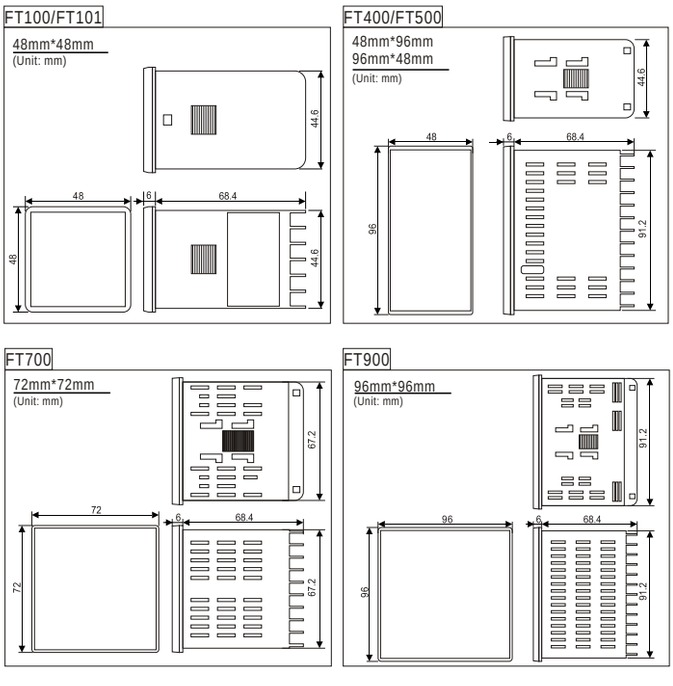
FTX-01-E1

Please read this manual carefully before operating and keep it in a safe place for future reference

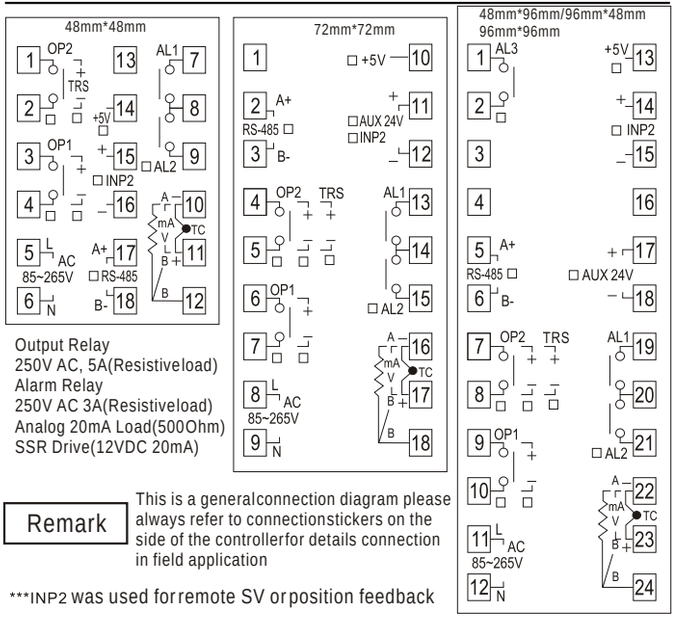
Quick Guide

- This controller is 4 digits dual display, 0.2% measuring accuracy with bar graphic display, 0.1 maximum resolution for TC, RTD inputs, 0.001 maximum resolution for analog inputs such as 4-20mA, Auto/manual bumpless transfer, position feedback and RS-485, Remote SV, Heating+cooling dual output optional.
- Please make sure the correct output has been selected for your application and power cords has been connected to correct terminals before operating the units always check the diagram stickers on the side of the controller before wiring the controller
- This device supports universal inputs and be able to switch between different thermocouple and RTD sensor via front panel key, Make sure the input sensor code matches the sensors used in the field, Analog input signal has to be specified before order. check (5.3 Parameter level 3 INP1).
- Auto/Manual bumpless transfer features available, check (6 Auto/manual bumpless transfer).
- Op1 was configured as reverse control mode for heating, OP2 configured as direct action for cooling. OP1 can be set as direct for cooling as well. Check (5.3 Parameter level 3 OUd).
- Two group of separate PID for heating and cooling available on request, Check (9 Dual output heating and cooling control).
- INP2 is the input terminals for Analog remote SV or position feedback check (8 Various control mode).
- ON/OFF Control: When P=0, control mode switch to ON/OFF control, HYS is the hysteresis. OP1 stop when PV>SV in heating process, OP1 activated when PV<SV+HYS, output terminated when PV<SV, Output activated when PV>SV+HYS, this applies to both OP1 and OP2 for cooling
  Check (5.2 Parameter level 2 "P" and 8 Control mode) for more details
- Time proportional control: Set I=0, d=0, P at any value except 0 to time proportional control, Reset Windup as rSt and control cycle time as Cyt, Output gets smaller when rSt gets smaller in heating process, Output gets bigger when rSt gets smaller in cooling application. and this applies to both Op1 and Op2 refer to (8 various control mode and 9 dual output heating and cooling)
- Please always perform auto-tuning to get better control results in PID mode, Check (7 Auto-tuning).
- Please active the soft-start function to have a better control result for analog output in some specific application , Check (5.2 parameter bUFF)

1.Dimensions



2.Wiring Diagram

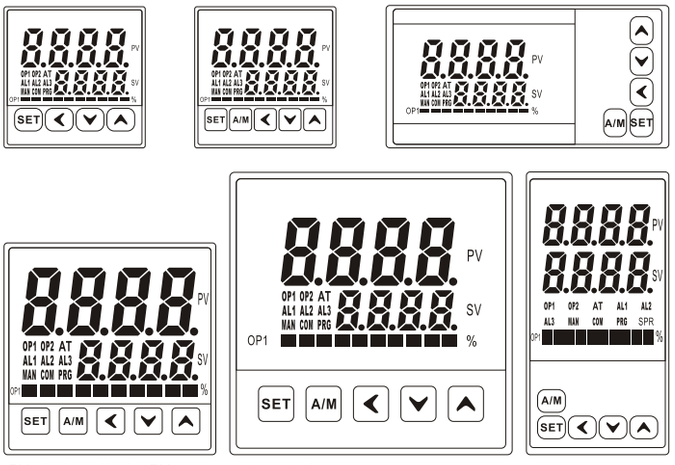


Output Relay
250V AC, 5A(Resistive load)
Alarm Relay
250V AC 3A(Resistive load)
Analog 20mA Load(500Ohm)
SSR Drive(12VDC 20mA)

Remark This is a general connection diagram please always refer to connection stickers on the side of the controller for details connection in field application

***INP2 was used for remote SV or position feedback

3.Panel Description



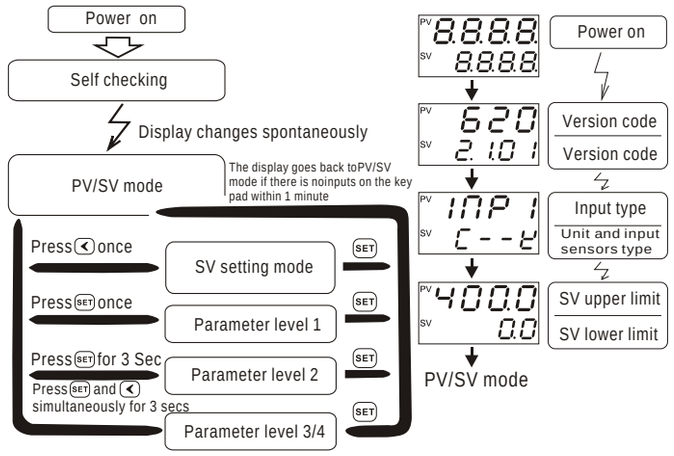
PV window, display PV or parameter notation
SV window, display SV or parameter value
Bar graphic, shows the output % or position feedback value 0-100%

SET: Function key
A/M: Auto/Manual transfer key and enter key
<: Shift key
v: Decrement key
^: Increment key

OP1: Output 1 indicator
OP2: Output 2 indicator
AT: Auto-tuning indicator
AL1: Alarm 1 indicator
AL2: Alarm 2 indicator
AL3: Alarm 3 indicator
MAN: Manual control indicator
COM: Communication indicator
PRG: Reserved indicator
SPR: Reserved indicator

4.Setting

4.1 Basic setting flow charts



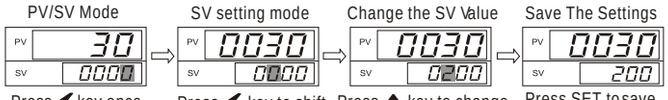
** Goes to parameter level 3 or 4 depends on different LCK value

Notation	E1	E2	E1	E2	J1	J2	n	u
Input type	K	K	E	E	J	J	N	Wu3_Re25
Range	400.0 ℃	1300 ℃	300.0 ℃	600 ℃	400.0 ℃	800 ℃	1300 ℃	2000 ℃

Notation	S	t	r	b	An4	An3	An2	An1	Pt1	Pt2
Input type	S	T	R	B	2-10VDC 1-5VDC 4-20mA	0-10VDC 0-5VDC 0-20mA	0-50mV	0-20mV	Pt100	Pt100
Range	1600 ℃	400.0 ℃	1700 ℃	1800 ℃					-199.9~200.0 ℃	-200~800 ℃

4.2 Change Setting Value

For example, Change SV from 0 to 200 Celcius



Press ◀ key once, the unit digits at SV display flashing.

Press ◀ key to shift to hundreds digits and hundreds digits flashing

Press ▲ key to change the hundreds digits from 0 to 2 and value changes to 200

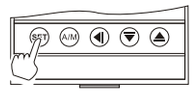
Press SET to save the configuration and display goes back to PV/SV

Remarks
The digits will increase by 1 or decrease by 1 if you press up or down key once
Digits will increase or decrease by several numbers at once if you press up or down key and do not release it, You can press A/M key once to save the configuration

5. Parameter Level

5.1 Parameter Level 1

5.1.1 Access to Parameter Level 1



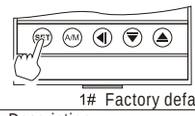
Press SET key once (Refer to image at right) to access parameter level 1
Below parameter notation will display one by one by pressing SET key, Press SET key for 3 seconds to save the changes and exit to PV/SV mode after all settings complete

1# Factory default

Notation	Name	Range	1#	Description
At	Auto-tuning AT	NO or YES	NO	AT=YES, AT ON, AT=NO, AT OFF
AL1	Alarm 1 value	-1999 to 9999	10	Alarm Value for AL1, HYS of AL1=AH1
AL2	Alarm 2 value	-1999 to 9999	10	Alarm Value for AL2, HYS of AL2=AH2
AL3	Alarm 3 value	-1999 to 9999	10	Alarm Value for AL3, HYS of AL3=AH3
Add	Device address		1	Check the controller's address in the communication cases

5.2 Parameter Level 2

Press SET key for at least 3 seconds to access to parameter level 2 below parameter notations will display one by one by pressing SET key

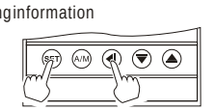


1# Factory default

Notation	Name	Range	1#	Description
P1	P1 for output 1	0.0~200.0	20.0	Proportional band for output1, Control mode switch to ON/OFF mode when P1=0.0 .Set P=2.0 for analog signals
i1	I1 for output 1	0-3600 sec	210	Integral time for OUTPUT1, Integral action off when i1=0, the smaller the i1 value is, the stronger integral action will be for the system, but system will be less stable
d1	d1 for output 1	0-3600 Sec	30	Derivative time for OUTPUT1, derivative action off when d1=0 the greater the d1 value is, the stronger derivative action will be for the system, but system will be less stable
OLAP	Heating/cooling overlapping area	0.0-10.0	1.0	Overlapping area for heating and cooling action Overlapping area are: (SV-OLPA)~(SV+OLAP)
AtdL	Autotune offset	0-199 C	0	The auto-tune offset will shift the SV value down by the AtDL value during the autotune process. that will prevent the system from damage due to overshooting during the autotune process
Cyt1	Cycle time for OUTPUT 1	0 to 999 Sec	20	Cycle time for OUTPUT1, Set as 20 seconds for relay output Set as 2 seconds for SSR Drive output
HYS1	HYS1 for OUT1 ON/OFF mode	0.0 to 100.0	1.0	Control mode switch to ON/OFF mode for Output 1 when P1=0, the Hysteresis is HYS1 value, For heating application: OP1 off when PV>SV, OP1 on when PV<SV-HYS1. For cooling application: OP1 on when PV>SV+HYS1, OP1 off when PV<SV
P2	P2 for output 1 (cooling output)	0.0~200	20	Proportional band for output2, Control mode switch to ON/OFF mode when P2=0.0, Set P2=2.0 for analog signals
i2	I2 for output 1 (cooling output)	0~3600 Sec	210	Integral time for OUTPUT2, Integral action off when i2=0, the smaller the i1 value is, the stronger integral action will be for the system, but system will be less stable
d2	d2 for output 1 (cooling output)	0~3600 Sec	30	Derivative time for OUTPUT2, derivative action off when d2=0 the greater the d1 value is, the stronger derivative action will be for the system, but system will be less stable
Cyt2	Cycle time for OUTPUT 2	0 to 999	20	Cycle time for OUTPUT2(cooling), Set as 20 seconds for relay output Set as 2 seconds for SSR Drive output
HYS2	HYS2 for OUT2 (cooling) ON /OFF mode	0.0 to 100.0	1.0	Control mode switch to ON/OFF mode for Output 2 when P2=0, the Hysteresis is HYS2 value. OP2 on when PV>SV+GAP2+HYS2 OP2 off when PV<SV+GAP2
GAP2	Offset for SV of cooling side	0.0-200.0	0.0	This parameter defines the setting value for cooling action of Output 2 SV for cooling=SV+GAP2 e.g. SV=100, GAP2=10, then the SV for cooling will be 100+10=110℃ or ℉
rE	Reserved parameter	0.0 to 100.0	10.0	Parameter reserved for customized function
rSt1	Overshoot suppression for Output1	-30 to 30	-5.0	This parameter used to suppress the overshoot at the first round of heating up process. Best way to determine the value of this parameter is by auto-tuning (the smaller the value is, the faster the heat up will be)
rSt2	Overshoot suppression for Output 2	-30 to 30	-5.0	Op2 was used as overshoot suppression for output 2 when I2=0 and d2=0, this only applies to Output 2 for cooling action the smaller the value is, the faster the cooling will be
OPL	Lower limit of Output 1	0.0 to 100.0%	0.0	This parameter defines the lower limit output for Output 1
OPH	higher limit of Output 1	0.0 to 100.0%	100.0	This parameter defines the higher limit output for Output 1
OPL2	Lower limit of Output 2	0.0 to 100.0%	0.0	This parameter defines the lower limit output for Output 2
OPH2	Higher limit of Output 2	0.0 to 100.0%	100.0	This parameter defines the higher limit output for Output 2
PVo	Initial output ratio for output 1	0.0 to 100.0%	0.0	This parameter defines the initial output ratio for Output 1 when controller has the manual output feature right after power on
bUFF	Soft-start function for output 1	0.0 to 100%	100.0	This function only applies to analog output, it restrain the output variance at a preset ratio 100% means no soft-start function, e.g. buF=5% , means the variance ratio of the output will be at 5% maximum
SSV	Preheating Setting Value	-1999~9999	0	1: In heating application, when PV<SSV value , the preheating will be activated right after power on, In cooling application, when PV> SSV value, the preheating will be activated right after power on 2:The MAN indicator flashes and the output power defined by "SouT" value 3:In heating process, Preheating terminated when PV≥SV or preheating operated time reaches to StME value (for heating) In cooling process, Preheating terminated when PV≤SV or preheating operated time reaches to StMe value (for cooling) 4:When StME=0, preheating function off 5: MAN indicator stop flashes when preheating off
StME	Preheating running period			
Sout	Output power during preheating process			
LCK	Configuration previlidge	0000-0255	0	LCK=0000, all parameters can be modified LCK=0001, only SV can be modified LCK=0010, only SV and parameters under level 1 can be modified LCK=0011, all parameters are locked LCK=0101, all parameters can be modified, access to parameter level 3

Remark: Not all parameters will be available for configuration, some of parameters won't be available depends on different function Refer to "8" "9" and "10" for detailed information on specific parameters, Same of parameters such as Op2 for cooling and analog output has to be specifie before order with special software and hardware included. Please check our catalogs for detailed ordering information

5.3 Parameter Level 3



5.3.1 How to access to parameter level 3

1). Follow the instruction in 5.2 and goes to parameter level 2, put 0101 as the value for parameter LCK, Pree SET key for 3 seconds to go back to PV/SV mode
2). Press SEK and key simutaneously for 3 seconds to access to parameter level 3 below parameters will be displayed one by one by pressing SET key.

1# Factory default

Notation	Name	Range	1#	Description
INP 1				

sensor notation	K1	K2	E1	E2	J1	J2	N	U
sensor type	K	K	E	E	J	J	N	Wu3_Re25
Range	400.0 ℃	1300 ℃	300.0 ℃	600 ℃	400.0 ℃	800 ℃	1300 ℃	2000 ℃

sensor notation	S	t	r	b	AN4	AN3	AN2	AN1	Pt1	Pt2
sensor type	S	T	R	B	2-10VDC 1-5VDC 4-20mA	0-10VDC 0-5VDC 0-20mA	0-50mV	0-20mV	Pt100	Pt100
Range	1600 ℃	400.0 ℃	1700 ℃	1800 ℃					-199.9~200.0 ℃	-200~800 ℃

Remark: Input sensor isfield selectable via frontpanel between all RTD and TC sensors,analog signal hasto be specified beforeorder except 0-20mA and 0-50mA

dP	Decimal points for analog inputs	0,1,2,3	0	0: W/O decimal points 1: 1 decimal points 2: 2 decimal points 3:3 decimal points (this is for analoginputs only)
LSPL	Lower limit for SV	-1999~9999	0	define the lower limitof SV or Zeropoint for re-transmission
USPL	Higher limit for SV	-1999~9999	400	define the higher limitof SV or fullscale for re-transmission
UNIt	Display units	0,1,2	0	0: Celcius 1: Fahrenheit 2: No units
PVOS	Input offset	-199~199	0	Calibration offset, PVOSis used to setan input offset tocompensate the error produced by sensors.For example,If the controller display 5 Cwhen probe was in water/ice mixture, Set PVOS=-5will make the controller display 0C
PVFt	Digital filter strength	0 to 66	55	1-30 Normal filter strength 31-60 enhanced filter strength The greater the valueis , the strongerthe filter strength will be.stronger filtering strength increase the stabilityof the readout but cause more delayin the response to changes in the temperature
ANL 1	lower limit display for analog input	-199~9999	0	E.g. for 4-20mAinput, the display willbe ANL1 when inputis 4 mA
ANH 1	Higher limit display for analog input	-199~9999	2000	E.g. for 4-20mAinput, the display willbe ANL2 when inputis 20 mA
ALd1	Alarm mode for alarm 1	00 to 16	11	To definethe alarm mode for1st alarm, refer to alarm descriptiontable for details
AH 1	Hysteresis for alarm 1	0.0 to 100.0	0.4	To definethe hysteresis for 1stalarm, (high alarm: negative hysteresis, low alarm: positive hysteresis)
ALd2	Alarm mode for alarm 2	00 to 16	10	To definethe alarm mode for2nd alarm, refer to alarm descriptiontable for details
AH2	Hysteresis for alarm 2	0.0 to 100.0	0.4	To definethe hysteresis for 2ndalarm, (high alarm: negative hysteresis, low alarm: positive hysteresis)
ALd3	Alarm mode for alarm 3	00 to 16	10	To definethe alarm mode for3rd alarm, refer to alarm descriptiontable for details
AH3	Hysteresis for alarm 3	0.0 to 100.0	0.4	To definethe hysteresis for 3rdalarm, (high alarm: negative hysteresis, low alarm: positive hysteresis)
OUd	Control action configuration	0 or 1	0	0: Reverse action (Heating) 1: Direct action(cooling)
SSrn	SSRM SCR trigger mode	PHAS or CYCL	PHAS	PHAS=Phase angled trigger mode CYCL=Full wave trigger mode
bEr	Soft-start configuration	0,1,2	0	0: Soft-start function off 1: Soft-start function on 2: Soft-start function onwhen output increase, soft-start offwhen output decrease The output variance percentagewas defined under parameter buFFfrom parameter level 1
Hz	HZ Power frequency for SCR trigger type	50HZ or 60HZ		50HZ: 50HZ frequency 60HZ: 60HZ frequency
Idn0	Device address	0-127	1	A unique addresswill be assigned toeach controller with RS-485 communication
bAUd	Communication baud rate	0,1,2,3	2	Baud rate=0 2.4K, BaudRate=1 4.8K Baud rate=2 9.6K BaudRate=3 19.2 K

**Alarm mode description (ALd_=00~16)

10: No alarmoutput
11: Deviationhigh alarm
12: Deviation low alarm
13: Deviation high/low alarm
14: Deviation bandalarm
15: Process highalarm
16: Process lowalarm

00: No alarmoutput
01: Deviation high alarm with holdaction
02: Deviation low alarm with holdaction
03: Deviation high/low alarm with holdaction
04: Deviation bandalarm with holdaction
05: Process high alarm with holdaction
06: Process low alarm with holdaction

NOTE: The alarm action will be suppressed right after power on even the condition is satisfied, and the alarm standby only works 1 time right after power on. the alarm will go off if the condition satisfied again after suppression at the first time

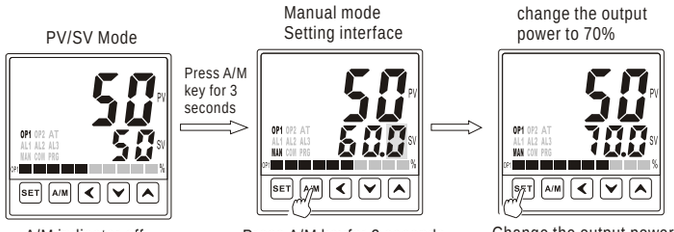
5.3.2 Alarmmode description Table

Code	ALD	Specification(Example for alarm 1)
N	10 or 00	No alarm
A	11	AL1≥0: Deviation high alarm — AH1, Alarm ON, LOW, SV, SV+AL1, HIGH
		AL1<0: Deviation high alarm — AH1, Alarm ON, LOW, SV+AL1, SV, HIGH
B	12	AL1≥0: Deviation low alarm — Alarm ON, AH1, LOW, SV, SV+AL1, HIGH
		AL1<0: Deviation low alarm — Alarm ON, AH1, LOW, SV+AL1, SV, HIGH
C	13	Deviation high/low alarm — Alarm ON, AH1, LOW, SV-AL1, SV, AH1, Alarm ON, SV+AL1, HIGH
D	14	Deviation band alarm — Alarm ON, LOW, SV-AL1, SV, SV+AL1, HIGH
H	15	Process high alarm — AH1, Alarm ON, LOW, AL1, HIGH
J	16	Process low alarm — Alarm ON, AH1, LOW, AL1, HIGH
E	01	AL1≥0: Deviation high alarm withhold action — AH1, Alarm ON, LOW, SV, SV+AL1, HIGH
		AL1<0: Deviation high alarm withhold action — AH1, Alarm ON, LOW, SV+AL1, SV, HIGH
F	02	AL1≥0: Deviation low alarm with hold action — Alarm ON, AH1, LOW, SV, SV+AL1, HIGH
		AL1<0: Deviation low alarm with hold action — Alarm ON, AH1, LOW, SV+AL1, SV, HIGH
G	03	Deviation high/low alarm withhold action — Alarm ON, AH1, LOW, SV-AL1, SV, AH1, Alarm ON, SV+AL1, HIGH
M	04	Deviation band alarm withhold action — Alarm ON, LOW, SV-AL1, SV, SV+AL1, HIGH
K	05	Process high alarm withhold action — AH1, Alarm ON, LOW, AL1, HIGH
L	06	Process low alarm withhold action — Alarm ON, AH1, LOW, AL1, HIGH

NOTE: The alarm action will be suppressed right after power on even the condition is satisfied, and the alarm standby only works 1 time right after power on. the alarm will go off if the condition satisfied again after suppression at the first time

6. Auto/Manual bumpless transfer

All models has a A/M key where you can switch the control mode whenever you want, the transfer is bumpless transfer, e.g. if the controller at 75% of power at PID mode, it will stay at 75% of power when it is switched to manual mode until it is manually adjusted. below is an example of changing the PID mode to manual mode and set the output at 70% of power



Remark:

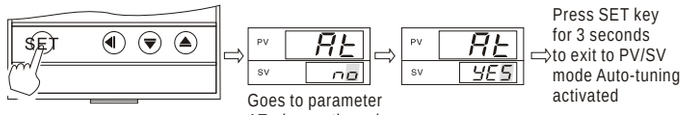
Press A/M key at manual mode for 3 seconds can switch back to PID mode

The control mode can be set as manual mode automatically right after power on, and the output power can be defined under parameter Pk0 from parameter level 2

A/M key can be used to save a modification which you made on the parameter during the configuration

7. Auto-tuning

Always recommended to performance auto-tuning in a new application. The best time to start the auto-tuning is right after power on when process value is far away from the Setting value this will help the auto-tuning to get most optimized auto-tune result



Remark:

1: AT indicator flashing after auto-tuning initiated, goes to parameter AT and change the AT value to NO if you want to turn off the auto-tuning

2: Auto-tuning is an ON/OFF control mode, significant temperature oscillation is expected and the time duration for the auto-tuning could be extra long then expected depends on different system

3: AT indicator stop flashing after autotune finished, P1, I1, d1, rE and rSt1 value was calculated automatically during the autotune process. controller goes back to PV/SV mode and with all the mentioned parameter saved with a new value. Controller starts to control the system with new parameter

4: For some of specific system where the control effect has not been improved after autotune, we recommend to manual fine tune the P.I.D and other parameters to have a better control effect

5: P1 is the proportional band of the Output 1, it's value should fall into the range of SV -/+ P1/2, The P1 should be set as 10% to 15% of SV when manually set the P1

6: I1 is the integral time for the Output 1, the factory default is 200, the integral action gets stronger when I1 gets smaller, controller has a better responding to temperature changes with a small I1 value, but it will cause temperature oscillation around the Set point

below points are things you should know about on adjusting the I1 value

(1) If the heat up is slow and the output has not increased significantly, try to decrease the I1 see if it improves

(2) If the heat up is very rapid and output still there, try to decrease the I1 value to counterbalance it

(3) If the temperature oscillate around the SV, try to increase the I1 value to counterbalance it

7: d1 is the derivative time for output 1, normally the value should be at 20%~30% of the I1 value, derivative action was to balance the overact that integral had on the system, the derivative action gets stronger when d1 gets greater

(1) Mannually increase the d1 value If the heat up is too fast after proportional action kick in, and overshoot was caused. take the same steps and increase the d1 value if the cooling down is too fast and undershoot was created.

(2) In some of application where the controlled object is too sensitive on even a small variance of output. should decrease the d1 value even consider to set d1=0 to have a stable control, this applies to some typical application such as constant water supply system

8: Parameter rE is used to suppress the overshoot of the first round heat up. or overshoot caused by changing the setting value, this parameter kick in at the first round heat up and dismissed after SV reached. Increase the rE value will make the chance of overshoot gets smaller, but the output power will be small and heat up gets slower

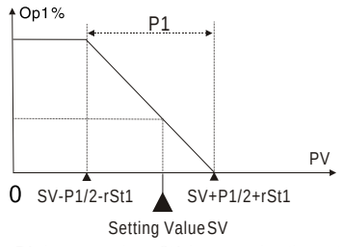
9: rSt1 is the offset value for proportional band of Op1, it will make the system more stable in a time proportional control system, adjust the rSt1 value will make the system stable as soon as possible in a PID control case.

(1) rSt1 set as 0 in a heating application with stronger heating inertia effects, set rSt1>-P/2 when manually adjust the rSt1, e.g. P1-30.0, rSt1>-15, normally rSt1>-30%P1, heating gets slower when decrease the rSt1 value

(2) On the contrary, rSt1 set as positive value in cooling application, cooling gets slower when rSt1 value increase

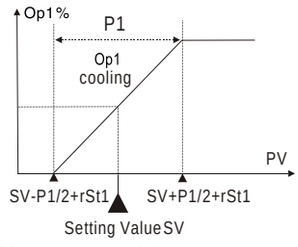
8. Various Control Mode

(1) OP1, PID reverse control (heating)
PV increase and OP1 decrease



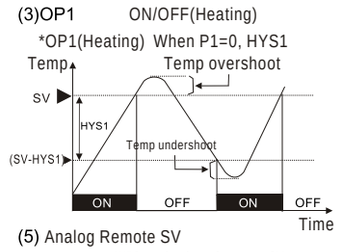
P1 decrease when rSt1 decrease, heating gets slower

(2) OP1, PID direct control (cooling)
PV increase and OP1 increase

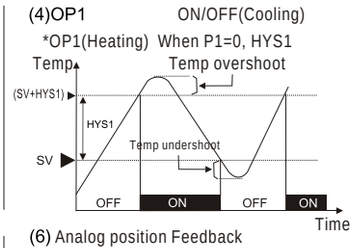


P1 increase when rSt1 increase, cooling gets slower

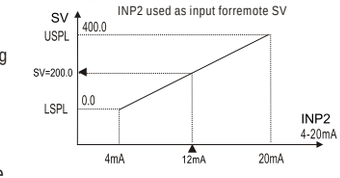
(3) OP1 ON/OFF (Heating)



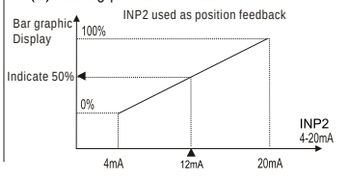
(4) OP1 ON/OFF (Cooling)



(5) Analog Remote SV

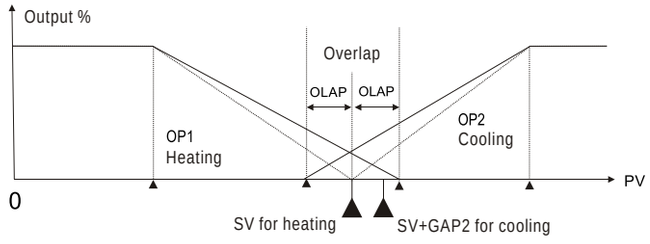


(6) Analog position Feedback



9. Dual output heating and cooling control

If the controlled object has a temperature overshoot tendency during the heating process, and natural cooling is not sufficient, a heating+cooling control mode will help in this case, Parameter OLAP is used to define the overlap area between cooling and heating no overlap area if OLAP=0



Parameters P2, I2, d2 is used to define the control mode of Op2 such as P.I.D control, time proportional control or ON/OFF control

10. RS-485 Communication

(1) Support Modbus-RTU protocol, support 03 read command, 06 and 10 write command

(2) Communication mode: single-master Rs485 asynchronous serial communication baud rate: 2400, 4800, 9600, 19200 (9600 baud rate is factory default value)
Format: 1 start bit+ 8 digital bit+N+1 stop bit
1 start bit+8 digital bit+N+2 stop bit

(3) The maximum write command for the controller is 36 at once, maximum read command is 37 at once for the read command

(4) For more details, refer to communication details of MF06