ATEC302

TE Temperature Controller

Reference Manual

Rev 1.5

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Accuthermo Technology Corp.

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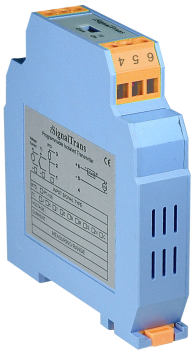
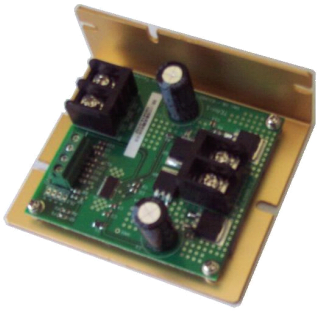
1. Introduction

This manual contains information for the installation, operation and tuning of your Accuthermo ATEC302 TE Panel Temperature Controller, ATEC402 Din-Rail TE Temperature Controller and FTX700 High Power TE Amplifier/Driver. ATEC302 can also be connectted to FTX300 or FTX100 H-bridge amplifiers.

ATEC302 TE Panel Controller	ATEC402 TE Din-rail Controller	FTX700D TE Amplifier/Driver
Pic 	Pic 	Pic 

The Accuthermo microprocessor controllers are FUZZY ENHANCED “proportional + integral + derivative” (PID) controllers that come in with industry standard DIN72x72mm and Din-Rail size. The input is configurable and allows selection of input between thermocouples, RTD and Thermistor*.

The TE Amplifier is capable of running up to 700Watt of power. It is a very efficient TE power amplifier. The amplifier can run without force air (fan) under 350Watt in ambient condition. Over 350Watt, it is recommended to add in fan for proper ventilation.

The controller can talk to PC through a dedicated USB cable or a RS232 communication daughter card (option) that Accuthermo provides. And it comes with very sophisticated PC software for FREE.

The controllers can also be serial linked together and talk to one PC by using RS-485 communication method (option).

Caution: When USB cable is connected to the controller, the RS232 or RS485 communication daughter card should not be plugged inside the controller. Otherwise, it will have conflict.

1.1 Using Manuals

There are three manuals for this system:

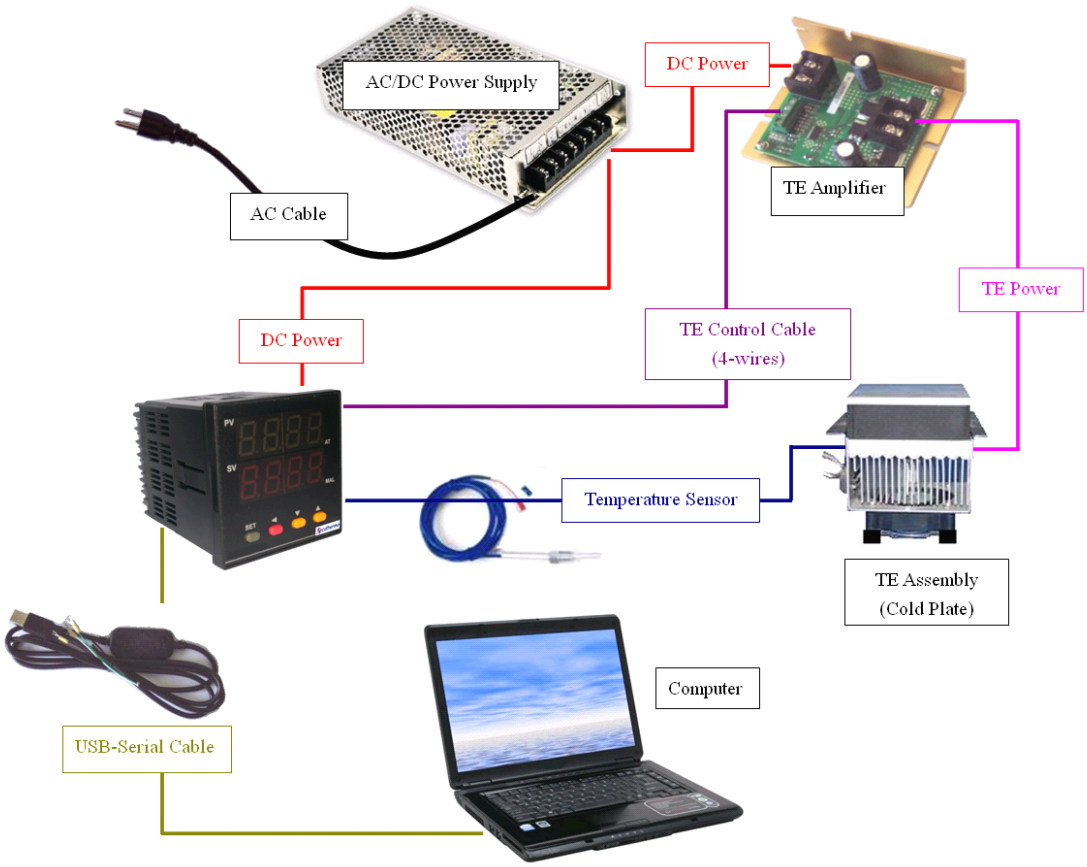
Reference Manual (this one): The manual is designed for user who wants to use the front panel buttons to controller the system. The users who want to write their own program to control the system. It provides the instructions of how to use the front panel buttons, the parameter table. Users are encouraged to read the following two manuals first.

TE Temperature Controller System Installation Guild: This is the must read document for user to putting the system together. It is a step-by-step guide, with lots of pictures for easy reading.

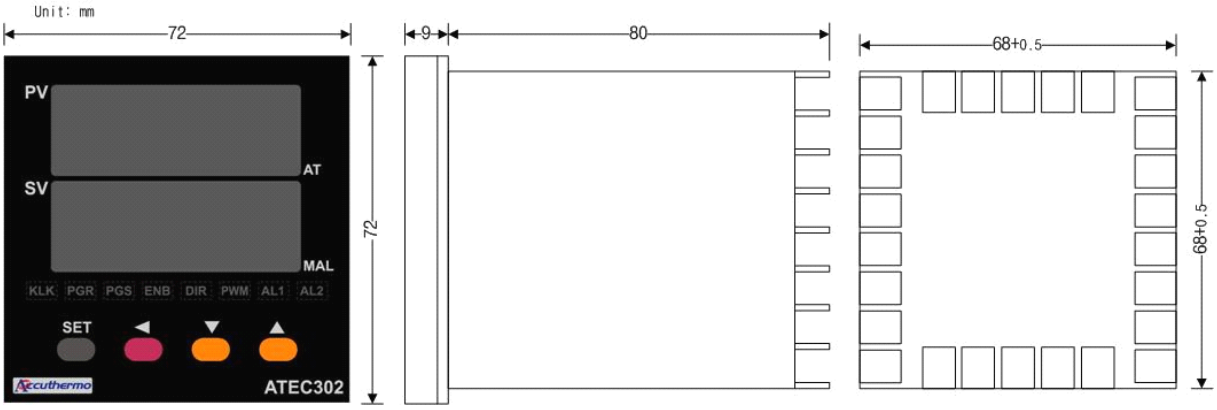
Software Installation Guild & User Manual: The software contains a very completed function sets for user to change parameters; control and run the system; monitor and logging data. It took us more than a year to design and develop the software. More than 95% of the users find the software can satisfied their task without re-writing their own software.

2. System Overview

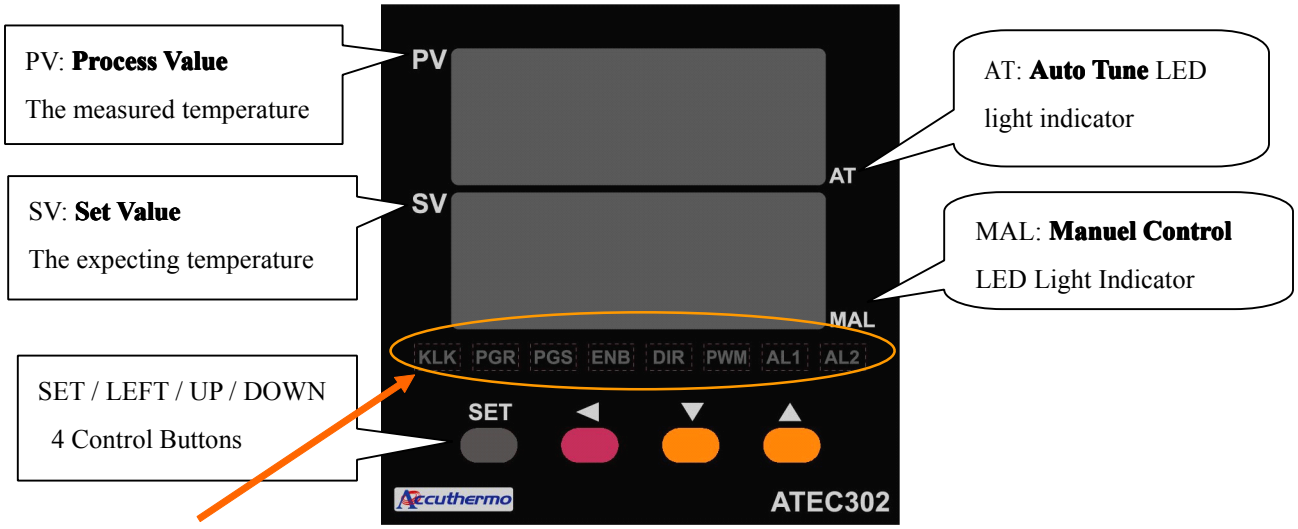
2.1 System Configuration Overview



2.2 Panel Dimension & Cutout



2.3 Front Panel Description



LED Indication:

KLK *keypad Lock:* when keyboard is locked, the push bottom is not accessible, only working through the software communication. LED lights on when keypad is enable.

PGR *Program Ramp:* LED lights on when temperature is ramping up/down.

PGS *Program Soak:* LED lights on when temperature is at soaking stage.

ENB *Controller Enable*: LED lights on when controller sent the Enable signal to the amplifier.

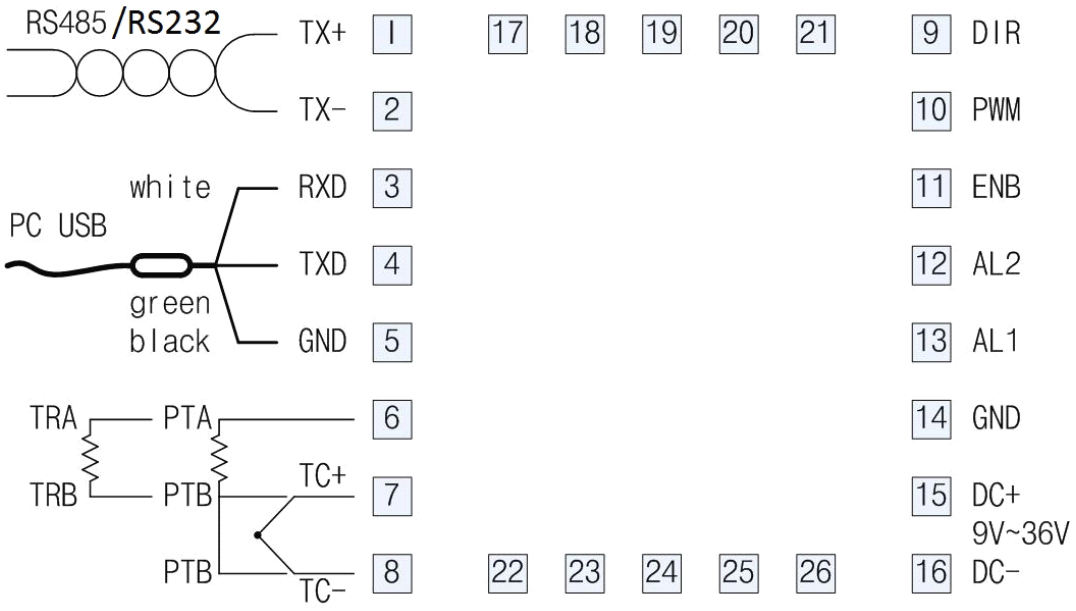
DIR *Controller Hot/Cold Direction:* LED indicator for the hot/cold direction command signal.

PWM *Pulse Width Modulation Signal:* LED signal lighted when PWM signal is send from controller to amplifier. During the low duty cycle, the LED might not be bright enough for visual.

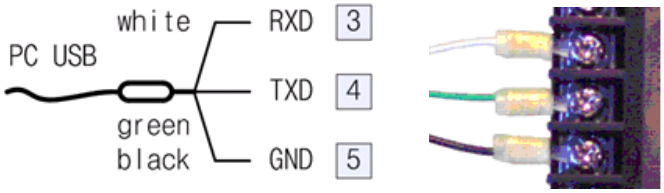
AL1 *Alarm #1 indicator:* LED on when Alarm #1 is triggered.

AL2 *Alarm #2 indicator:* LED on when Alarm #2 is triggered.

2.4 Back Panel Wiring Diagram



2.5 USB Wiring & Color Code



2.6.1 Sensor Type & Measurement Range

There are three types of sensors supported by the TE Panel controllers

Thermocouple (TC): Thermocouple is a 2-wire temperature sensor and has polarity for each wire. Please follow the installation guild for proper connections. Accuracy: ±1°C

TYPE	Range
J	-70.0°C ~ 200.0°C
K	-70.0°C ~ 200.0°C
T	-70.0°C ~ 200.0°C

Thermistor (TR): Thermistor is a resistance based temperature sensor and does not have polarity.

TYPE	Range
TR1 (2.252K ohm)	-30.0°C ~ 150.0°C
TR2 (10K ohm)	-10.0°C ~ 150.0°C

RTD PT-100 (PT): These can be 2-wire or 3-wire RTD sensors. If 2-wire is used, just short the pin7 & pin8 (PTB) together. Accuracy: ±0.2°C

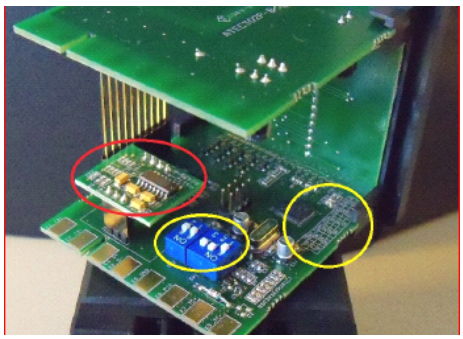
TYPE	Range
DPT(PT100)	-70.0°C ~ 200.0°C

2.6.2 Sensor Type & Dip-Switch Setting

	SW1.1	SW1.2	SW1.3	SW2.1	SW2.2
TC	**ON**	**OFF**	**OFF**	**ON**	**ON**
PT	**ON**	**OFF**	**OFF**	**OFF**	**ON**
TR	**OFF**	**ON**	**ON**	**OFF**	**OFF**

There is a Dip-Switch at the inside of the controller. The user needs to pull out the controller from back case. There are two blue-color Dip-Switch. Adjust the on/off setting according to the sensor type you want to use.
Example: TR: Thermistor 2252 or 10k ohm – SW1:OFF-ON-ON, SW2:OFF-OFF

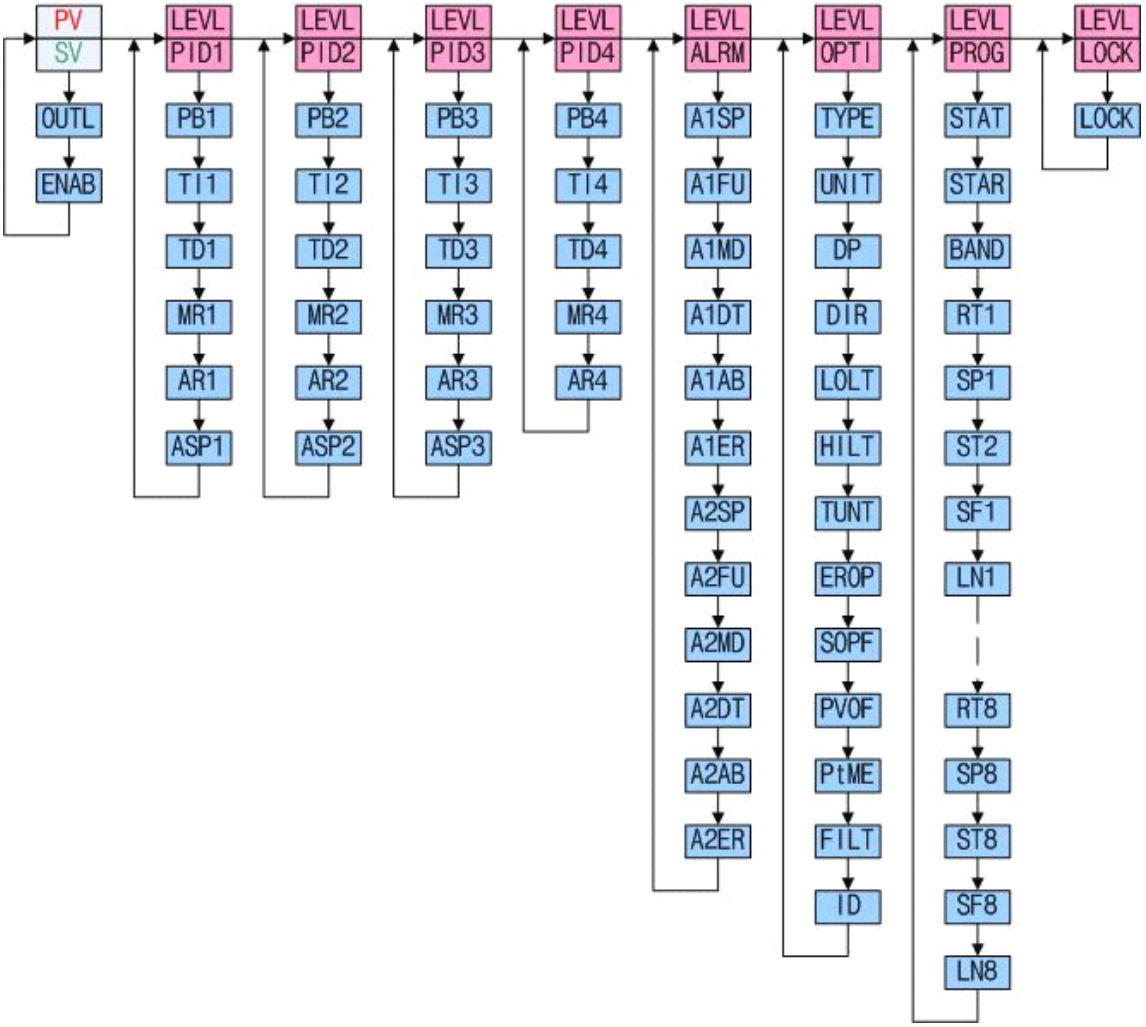
1. Pull out the Panel Cover



2. Sensor Setting Switch

Note: The yellow circles are the Dip-Switches and Switch setting table, the red circle showing the communication daughter card (either for RS232 or RS485) position.

2.7 Menu (Parameters) Overview



2.8 Error Message & Troubleshooting

Symptom	Probable	Solution
PV value flashing	-Input signal below the low limit -Incorrect input sensor selection	-Set a higher value to high limit. -Check connect input sensor selection.
PV value flashing	-Input signal below the low limit -Incorrect input sensor selection	-Set al lower value to low limit. -Check correct input sensor selection
oPEn	-Sensor break error -Sensor not connected	-Replace sensor -Check the sensor is connected correctly
AdEr	-A/D converter damage	-Unit must be repaired or replaced. -Check for outside source of damage such as transient voltage spikes.
Keypad no function	-Keypads are locked,	-Set"LoCU"to a proper value

	-When key locked, LED is off.	-If you lock the keypads, you can only use our PC software to unlock it (page. 16)
Process value unstable	-Improper setting of Pb, Ti, Td and CT	-Start AT process to set Pb, Ti, Td automatically -Set Pb, Ti, Td manually
No heat/cold or output	-No heater/cold power -Output device defective or incorrect output used	-Check output wiring and fuse -Replace output device
All LED's and display not light	-No power to controller	-Check power lines connection
Process Value changed abnormally	-Electromagnetic Interference (EMI) or Radio Frequency Interference (RFI)	-Suppress arcing contacts in system to eliminate high voltage spike sources. Separate sensor and controller wiring from "dirty" power lines. Ground heaters
Entered data lost	-Fail to enter data to EEPROM	-Update EEPROM again

2.9 Power Input

The default setting is 9V-36V DC. There is a jumper inside the controller that you can set it for a fixed 5VDC. When use 5VDC as supply, the USB cable CANNOT work. If the jumper has converted for 5VDC, connecting to supply power other than 5V will damage the system; and the warranty is void.

3. Front Panel Operation

User should learn some front panel operation during hardware installation. This section will describe more in detail.

3.1 Push Buttons 

Referring to 2.4 Menu Overview, users can select different level of menu and change the parameters using these four push buttons.

i. Return to Top Level Display

If you make mistake, just press 

&  two buttons, it will return to top level display 

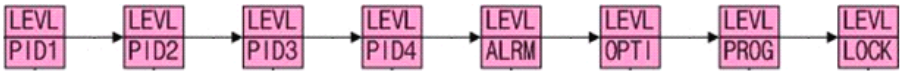
for normal operation.

ii. Go to Menu Mode

Press and hold 

two buttons for 5 seconds, the screen will jump to menu mode. The RED LED line should show 

. It is the first level menu. By pressing  button, user can select various top menus in sequence, using  button to select the previous menu.



Note: If keypads are locked, you can only run our PC software to unlock it (page. 16)

iii. Select Parameters in Menu

The parameters selection in each menu is in a loop format. At each top menu, press 

button to select its parameters. If you miss it, just press 

continuously until it reaches the parameter you are looking for.

iv. Changing Parameter value

The parameter is Number (ex. temperature): To change a parameter value, press  to select the digit you want to change, the specific digit LED should be highlighted. Then press  to add number or  to reduce the number. Press  to confirm the value.

The parameter is Type (ex. sensor type): Use  or  buttons to choose the desire one.

3.2 Power UP Display Sequence

When power up the controller, the display will show from Top/Bottom display in sequence:
LED all on test → Sensor type/Temperature unit → High Limit/Low Limit
→ PV(process value)/SV(set value)

3.3 Change the SV (Set Value) Number

i. Use  to highlight the digit you want to change.

ii. Use  or  buttons to change to the value desired.

iii. Press  to confirm the value.

4. Parameters Description

4.1 Communication Protocol

4.1.1 Communication Method

One controller to one PC: There is a special USB data cable supplied by Accuthermo. It is a serial-to-USB data converter. While connecting a PC and the controller with this cable, the software Accuthermo supplied will work on this setup.

Multiple controllers to one PC: By serialized multiple controllers together through the RS485 lines (TX+/ TX-). A PC act as a master and talk to those controllers as slave units. Each controller should have a unique ID address number. We recommend a RS485-to-USB converter act as a communication agent between PC and controllers. The software supplied by Accuthermo cannot talk to multiple controllers; only one at a time with proper ID address selected.

4.1.2 Communication Protocol Format

RS232/ RS485-Modbus RTU	
Party	None
Data bit	8 Bit
Stop bit	1 Bit
Baud rate	19200 bps
CRC16	YES

4.1.3 Communication Read/Write Format

Read Command Code: hex x03	Write Command Code: hex x06

Each time a command is sent from the master (ex. Computer) to the controller, the controller receives should immediately response a similar message back to its master. For example:
SEND: The PC send a command set (total of 8 bytes) asking for the temperature that was just measured: x01-03-1000-0001-CCCC
RETURN: The slave unit (controller) returned an 8-bytes data to its master: x01-03-0002-01F7-CCCC. Where "x01F7" is the temperature measured in Hex format (=50.3℃); where "x" means hex format, "C" means CRC data.

	1	2	3	4	5	6	7	8
Represent	ID	R/W Function	Parameter Address or Byte count		Data Cnt Or Rtn		CRC	
Byte Count	1	1 bytes	2 bytes		2 bytes		2 bytes	

Byte 1 – ID: It is the ID number of the controller, the default is 1.
Byte 2 – R/W Function: Read function is hex number x03, Write function is hex number x06
Byte 3,4 – Parameter Address or Return Byte Count: See the following example and description for detail.
Byte 5,6 – Data/Data Count/Data Return Count. The 2 bytes have different meanings during the read-send/return. For write process, the send return should have the same value.
Byte 7,8 – Modbus CRC: 16bits Cyclic Redundancy Check is done to prevent corrupted data

during communication transmission. It takes the first known command bytes through a CRC calculation and generates the 2-CRC bytes at the end.

Write Process Example:

During the write process the response bytes should match the command set.

Master ask the controller to set the SV temperature at 55.0℃

	1	2	3	4	5	6	7	8
Represent	ID	R/W Function	Parameter Address		Data		CRC	
Byte Count	1	1 bytes	2 bytes		2 bytes		2 bytes	
	x01	x06	x0000		x0226		xCCCC	

Response from the controller

	1	2	3	4	5	6	7	8
Represent	ID	R/W Function	Parameter Address		Data		CRC	
Byte Count	1	1 bytes	2 bytes		2 bytes		2 bytes	
	x01	x06	x0000		x0226		xCCCC	

Read Process Example:

During the read process, you can ask for one data back, or you can ask a set of data back in sequence. The byte 3-4 is the initial parameter address. The byte 5-6 is to tell slave how many consecutive data you want. The following example only asks for one data.

The master ask the controller to read current temperature (PV value)

	1	2	3	4	5	6	7	8
Represent	ID	R/W Function	Parameter Address		Data Cnt		CRC	
Byte Count	1	1 bytes	2 bytes		2 bytes		2 bytes	
	x01	x03	x1000		x0001		xCCCC	

In the response data set, the byte 3-4 is the byte count of the data return. The following example is the response data from above command. The byte 3-4 tell the master it has 2 bytes of data. The content of the return data is at byte 5-6.

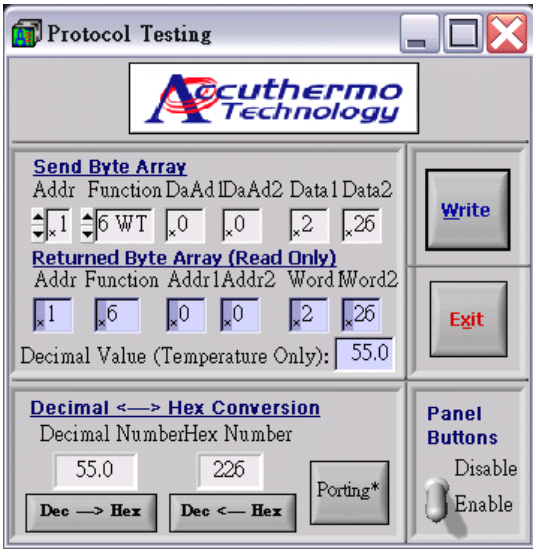
Response from the controller (measured 28.7℃)

	1	2	3	4	5	6	7	8
Represent	ID	R/W Function	Byte Count		Data Rtn		CRC	
Byte Count	1	1 bytes	2 bytes		2 bytes		2 bytes	
	x01	x03	x0002		x011F		xCCCC	

Note: Byte Count value =2 x Data Count value

4.1.4 Prior to Writing Your Own Software

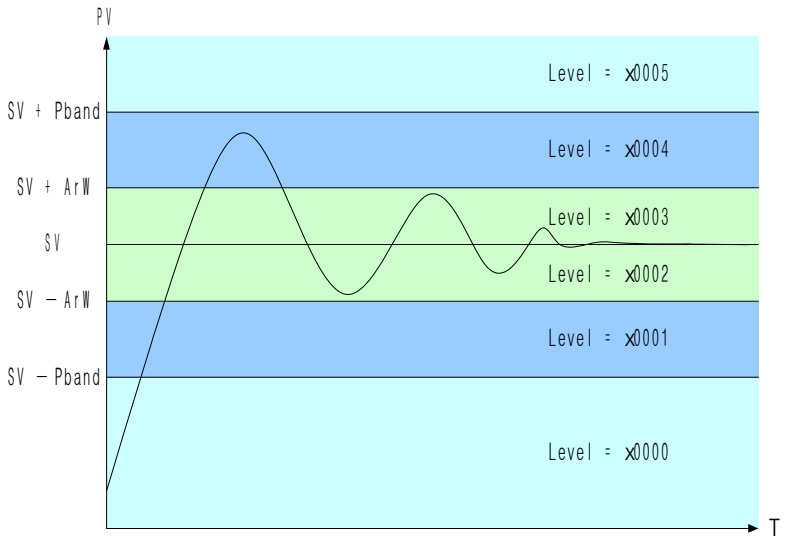
Most use will find the software come with the system should work just fine. There are about 5% engineers need to write their own software to integrate with other hardware. To better understand how the parameters work, Please use the Protocol Section of the software that Accuthermo supplied. You can then try out all the parameters in tables of 4.2 and see how they interacting each others.



4.2 Read Only Parameters [x03] Table

Read Only Parameters: Read parameter and value from the controller

Address	Parameter Name	Contents	Unit
x1000	PVPVOF	PV + PVOF	°C/°F
x1001	SVSVOF	SV + SVOF	°C/°F
x1002	OUTL	Output Power in Percentage	%
x1003	WKERNO	x _ _ _ 0 Alarm2 Off , Alarm1 Off x _ _ _ 1 Alarm2 Off , Alarm1 On x _ _ _ 2 Alarm2 On , Alarm1 Off x _ _ _ 3 Alarm2 On , Alarm1 On x 0 0 0 _ ENB ,DIR ,PWM Output Off *(Autotune type 1: x010_ ~ x015_ use SV as target temperature)* x 0 1 0 _ Autotune SV initial x 0 1 1 _ Autotune SV start ramping x 0 1 2 _ Autotune SV the first positive half cycle x 0 1 3 _ Autotune SV the first negative half cycle x 0 1 4 _ Autotune SV the second positive half cycle x 0 1 5 _ Autotune SV P.I.D in analyzing and calculating *(Autotune type 2: x020_ ~ x025_ use SV × 90% as target temperature)* x 0 2 0 _ Autotune 90% SV initial x 0 2 1 _ Autotune 90% SV start ramping x 0 2 2 _ Autotune 90% SV the first positive half cycle x 0 2 3 _ Autotune 90% SV the first negative half cycle x 0 2 4 _ Autotune 90% SV the second positive half cycle x 0 2 5 _ Autotune 90% SV P.I.D in analyzing and calculating x 0 3 0 _ Manual Output x 0 4 0 _ General Control (single point temperature control) *Programmable step temperature control (multipoint temperature control)* x 0 5 0 _ Program control Ramp 1 x 0 5 1 _ Program control Hold 1 x 0 5 2 _ Program control Ramp 2 x 0 5 3 _ Program control Hold 2 x 0 5 4 _ Program control Ramp 3 x 0 5 5 _ Program control Hold 3 x 0 5 6 _ Program control Ramp 4 x 0 5 7 _ Program control Hold 4 x 0 5 8 _ Program control Ramp 5 x 0 5 9 _ Program control Hold 5 x 0 5 A _ Program control Ramp 6 x 0 5 B _ Program control Hold 6 x 0 5 C _ Program control Ramp 7 x 0 5 D _ Program control Hold 7 x 0 5 E _ Program control Ramp 8 x 0 5 F _ Program control Hold 8 x 0 6 0 _ Hold (pause) Program control x 1 0 0 _ Error Message OPER (Error sensor input is OPEN) x 2 0 0 _ Error Message ADER (Error in A/D converting) x 3 0 0 _ Error Message EPER (memory error) x 4 0 0 _ Error Message ATER (auto tune error) x 5 0 0 _ Error Message HIER (PV higher than HILT) x 6 0 0 _ Error Message LOER (PV lower than LOLT)	Code
x1004	RAMP_TL	Tim passed at script programming during ramping or soaking	Sec/Min

x1005	RAMP_TH		
x1006 x1007	ALM1_TL ALM1_TH	Time left when using delay alram	Sec/Min
x1008	SV0	SV + SVOF (fixed 1 decimal point)	°C/°F
x1009	PV0	PV value (fixed 1 decimal point)	°C/°F
x100A	PV1	PV history value1 (fixed 1 decimal point)	°C/°F
x100B	PV2	PV history value2 (fixed 1 decimal point)	°C/°F
x100C	ET0	SV – Pv value (fixed 1 decimal point)	°C/°F
x100D	ET1	SV - PV history value1 (fixed 1 decimal point)	°C/°F
x100E	ET2	SV - PV history value2 (fixed 1 decimal point)	°C/°F
x100F	Px	Proportional factor	%
x1010	Ix	Integral factor	Sec
x1011	Dx	Differential factor	Sec
x1012	MRx	MR factor	%
x1013	ARx	AR factor	%
x1014	Pout	Proportional output %	%
x1015	Iout	Integral output %	%
x1016	Dout	Differential output %	%
x1017	Pband	Proportional band	°C/°F
x1018	ARW	Integral band	°C/°F
x1019	LEVEL		Code
x101A	AD0	A/D 0 after filter Count	Count
x101B	AD1	A/D 1 after filter Count	Count
x1F00	VER	Hardware & Firmware version	Code
x1F01 x1F02	SERIAL_NH SERIAL_NL	Product Model number	Code

4.3 Read[x03]/Write[x06] Parameter Table

Read/Write-able Parameters: The following parameter's data can be changed or just be read out without change.

Address	Naming	Range	Init Value	Unit
x0000	SV	LOLT ~HILT	20.0	°C/°F
x0001	OUTL	0.0 ~ 100.0	0.0	%
x0002	ENAB	x0000 / OFF (Turn off output) x0001 / AT1 (auto-tune at SV) x0002 / AT2 (auto-tune at 90% of SV) x0003 / MPWR (Manual set duty cyl) x0004 / SPON (Single Temp point ctrl) x0005 / PROG (Run Programmable temp profile) x0006 / HOLD (Hold Temp during prog profile run)	OFF	Index Code
x0003	PB1	0.00 ~ 300.00	5.0	%
x0004	TI1	0 ~ 4000	240	100mSec
x0005	TD1	0~ 1000	60	100mSec
x0006	MR1	0.0 ~ 51.0	0.0	%
x0007	AR1	5.0 ~ 100.0	50.0	%
x0008	ASP1	LOLT ~HILT (region-1 PID range ex. <0~50.0C)	50.0	°C/°F
x0009	PB2	0.00 ~ 300.00	5.0	%
x000A	TI2	0 ~ 4000	240	100m Sec
x000B	TD2	0~ 1000	60	100m Sec
x000C	MR2	0.0 ~ 51.0	0.0	%
x000D	AR2	5.0 ~ 100.0	50.0	%
x000E	ASP2	LOLT ~HILT (region-2 PID range ex. <50.1~100.0C)	100.0	°C/°F
x000F	PB3	0.00 ~ 300.00	5.0	%
x0010	TI3	0 ~ 4000	240	100m Sec
x0011	TD3	0~ 1000	60	100m Sec
x0012	MR3	0.0 ~ 51.0	0.0	%
x0013	AR3	5.0 ~ 100.0	50.0	%
x0014	ASP3	LOLT ~HILT (region-3 PID range ex. <100.1~150.0C)	150.0	°C/°F
x0015	PB4	0.00 ~ 300.00	5.0	%
x0016	TI4	0 ~ 4000	240	100m Sec
x0017	TD4	0~ 1000	60	100m Sec
x0018	MR4	0.0 ~ 51.0	0.0	%
x0019	AR4	5.0 ~ 100.0	50.0	%
x001A	A1SP	LOLT ~HILT (Alarm 1 set point)	100.0	°C/°F
x001B	A1HY	-200.0 ~ 200.0 (value for alarm region or delta-t)	0.0	°C/°F
x001C	A1FU	x0007 / OFF (alarm not activate) x0008 / HI (alarm on when >HiLt) x0009 / LO (alarm on when <LoLt) x000A / DIFH (alarm on when >delta) x000B / DIFL (alarm on when <delta) x000C / BDHI (alarm on when out off region) (alarm on when exit region) x000D / BDLO (alarm on when PV within region)	OFF	Index Code
x001D	A1MD	x000E / NONE (Alarm run in normal condition) (Alarm on normal condition) x000F / STDY (Ignore first alarm) x0010 / LATH (turn alarm on when latch)	NONE	Index Code

		x0011 / STLA (Ignore first alarm and turn next alarm on when latch)		
x001E	A1DT	9999 ~ 0 (delay time to turn alarm on)	0	Sec/Min
x001F	A1AB	x0012 / ALNO (alarm normal open_L ,when latch turn H) x0013 / ALNC(alarm normal close_H ,when latch turn L)	Default	Index Code
x0020	A1ER	x0014 / NONE (controller keep running if alarm is latch) x0015 / STOP (controller off if alarm is latch)	Default	Index Code
x0021	A2SP	LOLT ~HILT (Alarm 2 set point)	100.0	°C/°F
x0022	A2HY	-200.0 ~ 200.0 (value for alarm region or delta-t)	0.0	°C/°F
x0023	A2FU	x0007 / OFF (alarm not activate) x0008 / HI (alarm on when >HiLt) x0009 / LO (alarm on when <LoLt) x000A / DIFH (alarm on when >delta) x000B / DIFL (alarm on when <delta) x000C / BDHI (alarm on when out off region) (alarm on when exit region) x000D / BDLO (alarm on when PV within region)	OFF	Index Code
x0024	A2MD	x000E / NONE (Alarm run in normal condition) (Alarm on normal condition) x000F / STDY (Ignore first alarm) x0010 / LATH (turn alarm on when latch) x0011 / STLA (Ignore first alarm and turn next alarm on when latch)	NONE	Index Code
x0025	A2DT	9999 ~ 0 (delay time to turn alarm on)	0	Sec/Min
x0026	A2AB	x0012 / ALNO(alarm normal open_L ,when latch turn H) x0013 / ALNC(alarm normal close_H ,when latch turn L)	Default	Index Code
x0027	A2ER	x0014 / NONE (controller keep running if alarm is latch) x0015 / STOP (controller off if alarm is latch)	Default	Index Code
X0028	TYPE	x0016 / J x0017 / K x0018 / T x0019 / DPT x001A / TR1 (2.252K) x001B / TR2 (10K)	T	Index Code
x0029	UNIT	x001C / °C x001D / °F	°C	Index Code
x002A	DP	x001E / 0000. (no decimal pt) x001F / 000.0 (one decimal pt)	DP0	Index Code
x002B	DIR	x0020 / REV (TE output direction rev) x0021 / FWD (TE output direction forward)	REV	Index Code
x002C	LOLT	TYPE / Range J /K /T: -70.0°C ~ 200.0°C DPT: -70.0 °C ~ 200.0°C TR1 (2.252K): -30.0 °C ~ 150.0°C TR2 (10K): -10.0 °C ~ 150.0°C	0.0	°C/°F
x002D	HILT	Same as LOLT parameters	1000.0	°C/°F
x002E	TUNT	x0022 / Sec (controller time unit in sec) x0023 / Min (controller time unit in min)	Sec	Index Code
x002F	EROP	(Select output operation when alarm latch) x0024 / 00 (Alarm OFF ,PWM & ENB OFF)	00	Index Code

		x0025 / 01 (Alarm OFF ,PWM & ENB ON) x0026 / 10 (Alarm ON ,PWM & ENB OFF) x0027 / 11 (Alarm ON ,PWM & ENB ON)		
x0030	SPOF	-200.0 ~ 200.0 (set-point offset)	0.0	°C/°F
x0031	PVOF	-200.0 ~ 200.0 (process-value offset)	0.0	°C/°F
x0032	FILT	0.0 ~ 99.9 (noise filter, larger value filter noise better but delay process operation)	0.0	Coefficient
x0033	ID	255 ~ 1 (controller ID address)	255	address
x0034	STAT	x0028 / OFF (don't save position) x0029 / ON (save current position)		Index Code
x0035	STAR	x002A / ZERO (run program start SV-t from 0C) x002B / PV (run program start SV-t from current PV)	PV	Index Code
x0036	BAND	-200.0 ~ 200.0	20.0	°C/°F
x0037	RT1	0 ~ 9999 (Ramp Time)	60	Sec/Min
x0038	SP1	LOLT ~HILT (1st Set Point Value)	20.0	°C/°F
x0039	ST1	0 ~ 9999 (1st SP Sock Time)	60	Sec/Min
x003A	SF1	x002C / RT8 (after ST time jump to RT8) x002D / RT7 (after ST time jump to RT7) x002E / RT6 (after ST time jump to RT6) x002F / RT5 (after ST time jump to RT5) x0030 / RT4 (after ST time jump to RT4) x0031 / RT3 (after ST time jump to RT3) x0032 / RT2 (after ST time jump to RT2) x0033 / RT1 (after ST time jump to RT1) x0034 / END (After prog turn off output) x0035 / HOLD (After prog hold temperature) x0036 / NEXT (After prog goto RT2)	END	Index Code
x003B	LN1	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x003C	RT2	0 ~ 9999	60	Sec/Min
x003D	SP2	LOLT ~HILT	20.0	°C/°F
x003E	ST2	0 ~ 9999	60	Sec/Min
x003F	SF2	x002C / RT8 (after ST time jump to RT8) x002D / RT7 (after ST time jump to RT7) x002E / RT6 (after ST time jump to RT6) x002F / RT5 (after ST time jump to RT5) x0030 / RT4 (after ST time jump to RT4) x0031 / RT3 (after ST time jump to RT3) x0032 / RT2 (after ST time jump to RT2) x0033 / RT1 (after ST time jump to RT1) x0034 / END (After prog turn off output) x0035 / HOLD (After prog hold temperature) x0036 / NEXT (After prog goto RT3)	END	Index Code
x0040	LN2	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x0041	RT3	0 ~ 9999	60	Sec/Min
x0042	SP3	LOLT ~HILT	20.0	°C/°F
x0043	ST3	0 ~ 9999	60	Sec/Min
x0044	SF3	x002C / RT8 (after ST time jump to RT8) x002D / RT7 (after ST time jump to RT7) x002E / RT6 (after ST time jump to RT6) x002F / RT5 (after ST time jump to RT5)	END	Index Code

		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
		x0036 / NEXT (After prog goto RT4)		
x0045	LN3	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x0046	RT4	0 ~ 9999	60	Sec/Min
x0047	SP4	LOLT ~HILT	20.0	°C/°F
x0048	ST4	0 ~ 9999	60	Sec/Min
x0049	SF4	x002C / RT8 (after ST time jump to RT8)	END	Index Code
		x002D / RT7 (after ST time jump to RT7)		
		x002E / RT6 (after ST time jump to RT6)		
		x002F / RT5 (after ST time jump to RT5)		
		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
		x0036 / NEXT (After prog goto RT5)		
x004A	LN4	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x004B	RT5	0 ~ 9999	60	Sec/Min
x004C	SP5	LOLT ~HILT	20.0	°C/°F
x004D	ST5	0 ~ 9999	60	Sec/Min
x004E	SF5	x002C / RT8 (after ST time jump to RT8)	END	Index Code
		x002D / RT7 (after ST time jump to RT7)		
		x002E / RT6 (after ST time jump to RT6)		
		x002F / RT5 (after ST time jump to RT5)		
		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
		x0036 / NEXT (After prog goto RT6)		
x004F	LN5	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x0050	RT6	0 ~ 9999	60	Sec/Min
x0051	SP6	LOLT ~HILT	20.0	°C/°F
x0052	ST6	0 ~ 9999	60	Sec/Min
x0053	SF6	x002C / RT8 (after ST time jump to RT8)	END	Index Code
		x002D / RT7 (after ST time jump to RT7)		
		x002E / RT6 (after ST time jump to RT6)		
		x002F / RT5 (after ST time jump to RT5)		
		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
		x0036 / NEXT (After prog goto RT7)		

x0054	LN6	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x0055	RT7	0 ~ 9999	60	Sec/Min
x0056	SP7	LOLT ~HILT	20.0	°C/°F
x0057	ST7	0 ~ 9999	60	Sec/Min
x0058	SF7	x002C / RT8 (after ST time jump to RT8)	END	Index Code
		x002D / RT7 (after ST time jump to RT7)		
		x002E / RT6 (after ST time jump to RT6)		
		x002F / RT5 (after ST time jump to RT5)		
		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
		x002C / RT8 (after ST time jump to RT8)		
x0059	LN7	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x005A	RT8	0 ~ 9999	60	Sec/Min
x005B	SP8	LOLT ~HILT	20.0 °C	°C/°F
x005C	ST8	0 ~ 9999	60	Sec/Min
x005D	SF8	x002C / RT8 (after ST time jump to RT8)	END	Index Code
		x002D / RT7 (after ST time jump to RT7)		
		x002E / RT6 (after ST time jump to RT6)		
		x002F / RT5 (after ST time jump to RT5)		
		x0030 / RT4 (after ST time jump to RT4)		
		x0031 / RT3 (after ST time jump to RT3)		
		x0032 / RT2 (after ST time jump to RT2)		
		x0033 / RT1 (after ST time jump to RT1)		
		x0034 / END (After prog turn off output)		
		x0035 / HOLD (After prog hold temperature)		
x005E	LN8	1~9998 (x270E) Loop number Infinite loop = 9999 (x270F)	1	count
x005f	LOCK	x0028 / Keyboard Enable X0029 / Keyboard Disable	Enable	Index Code

4.4 Error Read Back Parameter Table

After PC talks to the controller, the controller will return bytes of info. If for some reason the controller felt there is an error, it will return Error Code.

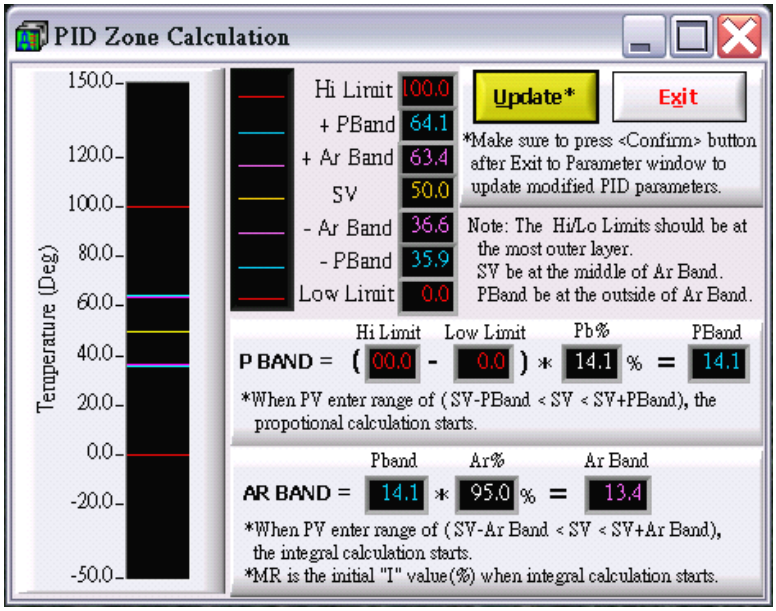
	ID	Function + x80	00	Error code	x00	x00
Function error	xx	x8x	x00	X01	x00	x00
	Function error (write or read) only with x03H or x06H					
Address error	xx	x8x	x00	X02	x00	x00
	Addr error (write or read parameter addr) parameter address of x00H ~ x57H					
Data error	xx	x8x	x00	X03	x00	x00
	Data error (only write)					

5. Control Method

5.1 PID Control:

A proportional–integral–derivative controller (PID controller) is a control loop feedback mechanism used in this temperature control. It attempts to correct the error between a measured Process Value and a desired Set-Point Value by calculating and then outputting a corrective action that can adjust the process accordingly and rapidly, to keep the error minimal.

Please use the software provided with this system to better understand the relationship of the PID and temperature control.

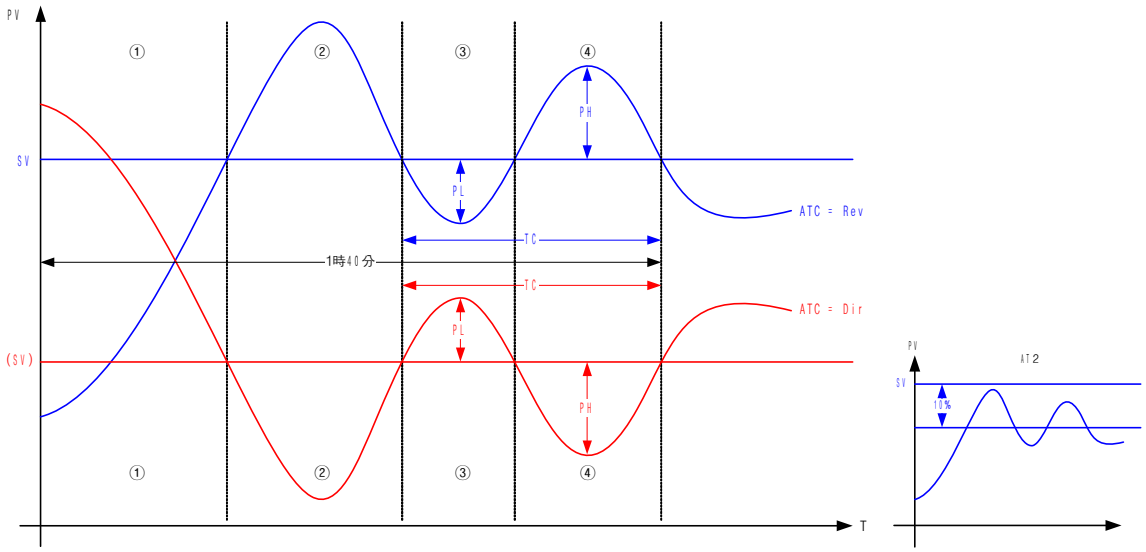


5.2 Auto-tune Function:

The controller has a build-in auto-tune function, it will calculate to a optimized set of PID values with the desired temperature.

AT1: use SV as the target temperature

AT2: use SV × 90% as the target temperature



$$Pb = \frac{(PH + PL)^2 \times 766}{\sqrt{PH \times PL} \times (HiLt - LoLt)} \quad , \quad 0.1\% \le Pb \le 300.0\%$$

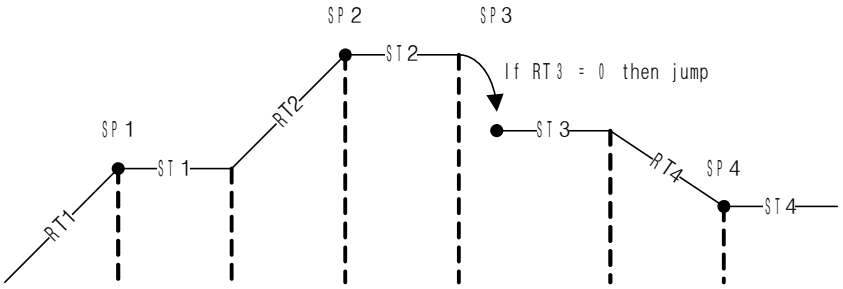
$$Mr = \frac{PL}{PH + PL} \times 100.0\% \quad , \quad 0.0\% \le Mr \le 51.0\%$$

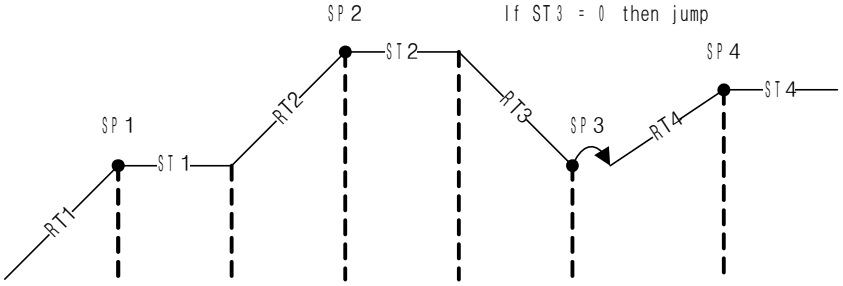
$$Ti = Tc \times \frac{3}{4} \quad , \quad 0 \le Ti \le 4000$$

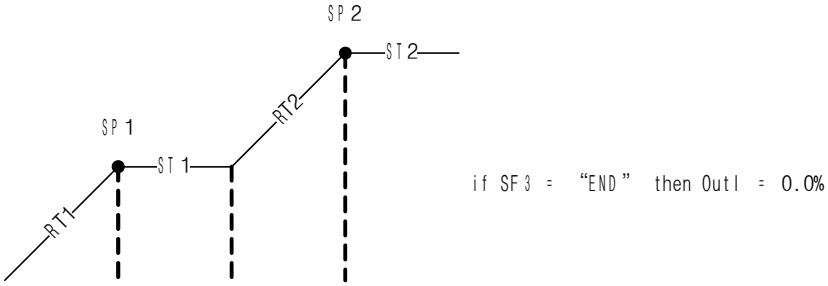
$$Ar = 51.0\% - Mr \quad , \quad 0.0\% \le Ar \le 51.0\%$$

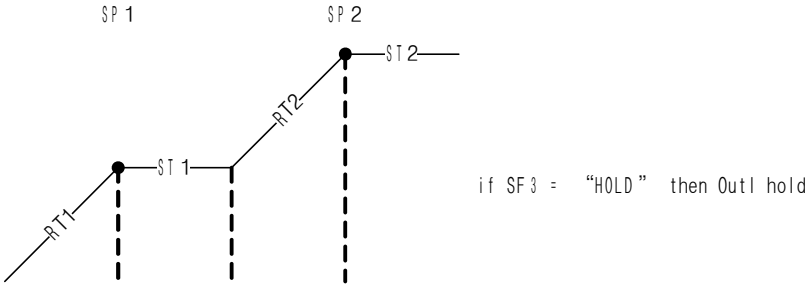
$$Td = \frac{Ti}{4} \quad , \quad 0 \le Td \le 1000$$

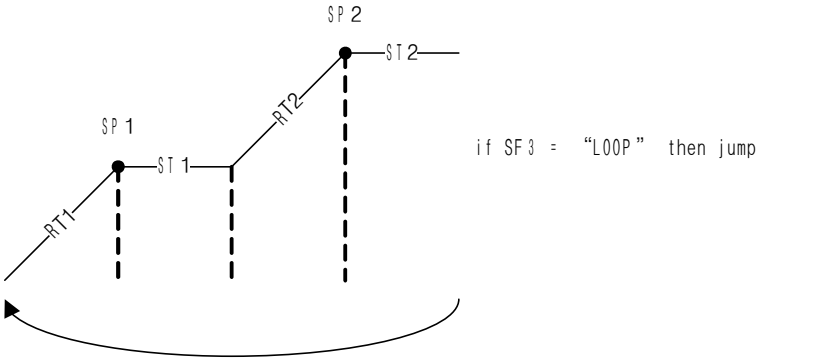
5.3 Programmable Step Control Profile:





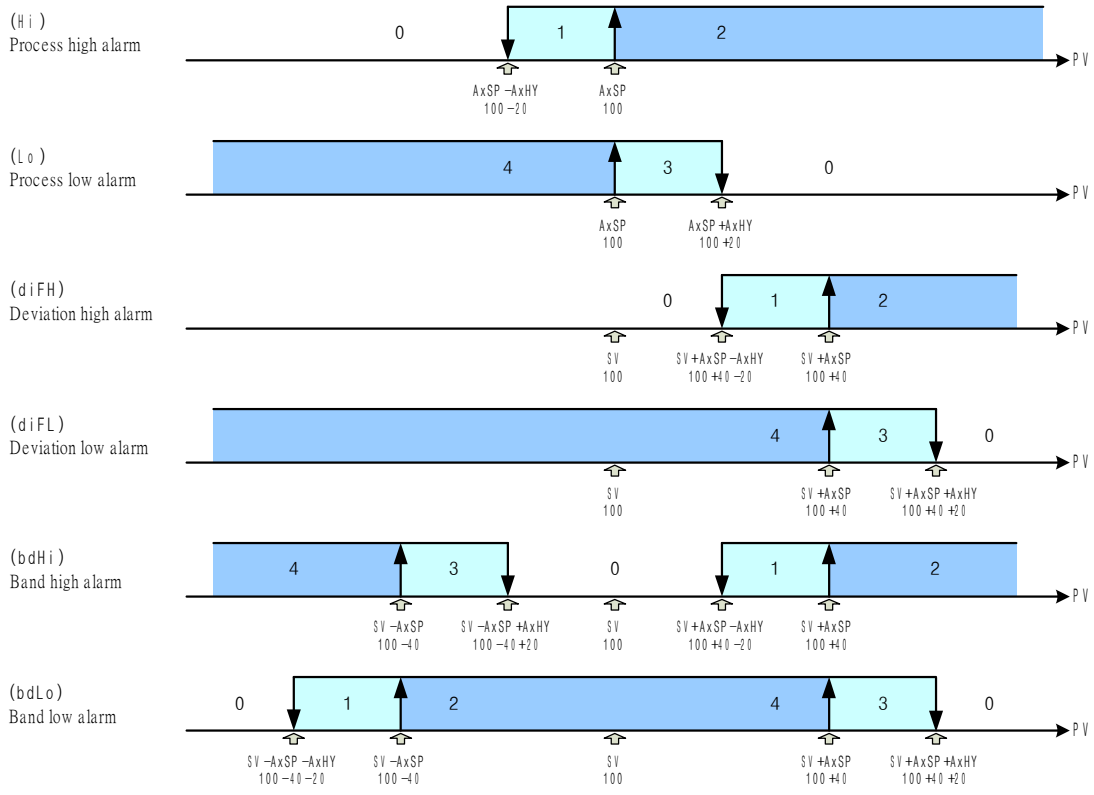






5.4 Alarm Function:

ALARM FUNCTION



6. SPECIFICATIONS

INPUT

Thermocouple	J, K, T(default)
RTD	DIN PT-100
Thermistor	2252 ohm, 10k ohm
Range	-50°C ~200°C (*sensor type dependable)
Accuracy	±0.1°C (*depends on sensor type and temperature range)
Cold Junction Compensation	0.1°C/°C ambient
Normal Mode Rejection	60 dB
Common Mode Rejection	120 dB

CONTROL FUNCTION

Proportional Band	0.0 ~ 300.0 %
Integral Time	0 ~ 4000 (100mSec)
Derivative Time	0 ~ 1000 (100mSec)
Hysteresis	0.0 ~ 200.0/ 0 ~ 2000
Sampling Rate	10Hz
Temperature Control Res.	0.1°C / 0.1°F
Programmable Profile	8 Steps, ramp/soak time, loop-in-loop, complex loop profile
Control Software	Full function Window Program, plot chart, log data, engineer debug

OUTPUT

Display Resolution	0.1°C / 0.1°F(default) or 1°C / 1°F
Alarm Relay Output	Logic 5VDC Level (on:1 /off:0)
PWM Output	Logic 5VDC Level, Freq: 1K Hz
Enable	Logic 5VDC Level
H/C Control Action	Logic 5VDC Level, Direct or Reverse (for cooling or heating direction)
Communication	USB, Serial (logic), RS485

GENERAL

Rated Voltage	9~36 VDC(default) or 5VDC jumper setting
Power Consumption	Less than 3VA (100mA@24VDC)
Memory Backup	EEPROM and non-volatile memory (Approx. 10 years)
Operation Condition	Temperature: 0 ~ 50°C, Humidity 0 ~ 90% RH (Non-condensing)