AutomationDirect

PC35

Configuration Sheet

Part#:			**Name:**
Project:			**Date:**
Main Setpoint (SV):			
Cycle 5 **INPUT**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
tYPE	J		
dPPo	oFF		
Un It	C		
oFFS	0		
SPLL	-150		
SPHL	1370		
rSLL	-150		
rSHL	1370		
Cycle 6 **I/O Config.**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
Io 1	0		
Io 2	0		
Io 3	inactive[1]		
Io 5	12		
Cycle 4 **ALARMS**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
FuA1	oFF		
FuA2	oFF		
FuA3	oFF		
FuA4	oFF		Not Available
bLA1	no		
bLA2	no		
bLA3	no		
bLA4	no		Not Available
HyA1	0		
HyA2	0		
HyA3	0		
HyA4	0		Not Available
A1t1	0		
A1t2	0		
A2t1	0		
A2t2	0		

[1] I/O-3 comes standard in the PC35-2110-AC only and is shipped from the factory with this I/O inactive. To enable I/O-3 see **I/O Defaults** in section 5.6, page 25 of the PC35 Operator's Manual.

Cycle 3 **RAMP & SOAK**	**DEFAULT**	CODE / VALUE Select Ramp & Soak Program to be executed (Pr n) in Cycle 1, page 14 of PC35 Operator's Manual. **Default: 0**						
Pr n	1							
PtoL	0							
PSP0	- 150							
PSP1	- 150							
PSP2	- 150							
PSP3	- 150							
PSP4	- 150							
PSP5	- 150							
PSP6	- 150							
PSP7	- 150							
Pt 1	0							
Pt2	0							
Pt3	0							
Pt4	0							
Pt5	0							
Pt6	0							
Pt7	0							
PE 1	0							
PE2	0							
PE3	0							
PE4	0							
PE5	0							
PE6	0							
PE7	0							
LP	0							

Cycle 2 **TUNING**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
Atun	no		
Pb	0.0		
HYSt	0		
Ir	0.00		
dt	0		
ct	8.0		
Act	rE		
b IAS	0.0		
ouLL	0.0		
ouHL	100.0		
StSt	0		
SPA 1	- 150		
SPA2	- 150		
SPA3	- 150		
SPA4	- 150		Not Available

AutomationDirect

1/16 DIN Series

Operator's Manual

PC35

PID Microprocessor-Based Process Controller

PC35 Operator's Manual
Manual Rev. 2.4
Firmware Version 1.5x
January 2008

Made In USA

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General Safety Information

Electrical Hazards and Warnings

Prior to connecting the controller, read the user's manual for proper connection and operating information.

Follow National Electrical Code (NEC) safety requirements when wiring and connecting a power source and sensors or other devices to the controller. Failure to do so could result in injury, death or damage to equipment and property.

Make sure the proper input voltage is applied to the controller. Improper voltage will result in damage to the unit.

Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician.

All terminal screws must be tightened securely. Terminal screws not properly secured can cause an electrical short that may damage property, equipment or cause injury or death. Terminal screws improperly secured may fall into equipment causing possible damage to property or equipment.

This instrument is not intended for use in life safety applications.

Important: For applications where physical injury or equipment damage might occur in the event our product fails, we recommend the installation of independent safety equipment with its own independent sensor that will shut down the process.

Important: Firmware version of controller must match the version indicated on the bottom front cover of this manual.

PC35 Process Controller

Table of Contents

PC 35
1/16 DIN Microprocessor-Based PID Process Controller

1. MAIN FEATURES

- Universal multi-sensor input without hardware change.
- Accept thermocouples J, K, T, S; RTD-Pt100; 4-20mA; 0-50mV, and 0-5Volts.
- Selectable ºF/ºC temperature.
- RTD-Pt100 with 1º temperature resolution: -328 to 986ºF (-200 to 530ºC), and 0.1º temperature resolution: -199.9 to 986.0ºF (-199.9 to 530.0ºC).
- Programmable Scaling: -1999 to 9999 with selectable decimal point for: mA, mV and Volts sensor input.
- Programmable Ramp & Soak up to 49 segments with alarm output events.
- Square Root Function (selectable input type 19).
- Sensor break protection in any condition.
- Modular Output options: Relay, SSR, Isolated Linear 4-20mA, 0-20mA or Isolated DC Pulsed Output.
- Up to 4 different Set Point alarms can be used on the same I/O output.
- Up to 2 programmable timer alarms.
- Process Variable or Setpoint 0-20mA, 4-20mA isolated analog retransmission, optional. See section 5.6, page 25 (code 11 and 12).
- Auto/Manual "bumpless" transfer.
- One isolated digital input (I/O-5) with programmable functions, optional.
- Linear Remote Setpoint input 0.4V to 2.0V (or 4-20mA using a shunt resistor of 100Ω, 0.1% tolerance), optional. See Section 5.5, page 23.
- Programmable Soft Start: 0 to 9999 seconds.
- Dual Display: PV (red) and SV (green).
- Firmware version displayed during power up.
- Digital serial number.
- Seven levels password protection, via keyboard.

2. SPECIFICATIONS

- Dimensions: 48 x 48 x 106mm (1/16 DIN). Approximate weight: 200g max.
- Panel cut-out: 45.5 x 45.5mm (± 0.3mm)
- Terminal connection: screws, accepting 6.3mm fork lugs.
- Power: 90 to 260Vac, 50/60Hz, Consumption: 7VA max.
- Operating environment: 0 to 50°C (32 to 122°F), humidity: 10 to 85% RH, n.c.
- 1/16 DIN Flame-Retardant ABS Plastic Case.
- Warm-up time: 15 minutes max.

INPUT:

- Keypad selection of input type.
- Display resolution: 0.1ºF/ºC or 1ºF/ºC (RTD-Pt100),
  -1999 to 9999 fully scalable for mA, mV and Volts input.
- Input sample rate: 5 per second (200 ms).
- Accuracy: Thermocouples J, K, T: 0.2% of span, ±1ºC, ±1 digit.
  Thermocouple S: 0.25% of span, ±3ºC, ±1 digit.
  Pt100: 0.2% of span, ±0.5ºC, ±1 digit.
  Current (4-20mA) and voltage (50mV or 5Vdc max.): 0.2% of span.
- Input impedance: 0-50mV and thermocouples: >10MΩ
  0-5V: >1MΩ
  4-20mA: 100Ω dynamic.
- Pt100 measurement: DIN 43760 standard (α=0.00385).
  3-wire circuit, cable resistance compensation.
  Excitation current: 170μA.
- Optional Remote Set Point (RSP) analog input: 0.4 to 2.0 Vdc (second linear input). "For 4 to 20mA Input, an external resistor shunt of 100 ohms, 0.1% toll. Is required between terminals 3 and 4".

OUTPUT CONTROL OPTIONS:

- Mechanical Relays: Dual-SPST (without contact suppression).
  Resistive: 3A @ 250VAC / 3A @ 125VAC / 3A @ 30VDC.
  Inductive: 2A @ 250VAC / 2A @ 30VDC.
  Dielectric Strenght: 750Vrms between open contacts (at sea level for 1 min.)
- Dual-Solid State Relay (SSR-Triac): 1Amp @ 20V to 240VAC, zero crossing (without contact suppression).
- Isolated Single - Logic Pulse for SSR drive: 0/12Vdc @ 15mA max.
- Isolated 0-20mA or 4-20mA for control output, PV or SP retransmission, 1500 levels resolution, 500Ω max. load.
  (For 0/1-5V linear output with external 250Ω - 0.1% (shunt) resistor, to be connected to terminals 5 and 6, optional).

OUTPUT CONFIGURATION:

- **Model PC35-2000-AC:** Two SPST Relays output.
- **Model PC35-0210-AC:** Two Solid State Relay, and One Linear 4-20mA output.
- **Model PC35-2010-AC:** Two SPST Relays, and One Linear 4-20mA output.
- **Model PC35-2110-AC:** Two SPST Relays, One 12Vdc Pulsed, and One Linear 4-20mA output.

Any of the above options can be selected as the main control output and the remaining outputs can be set as alarms.

ALARMS:

Up to 3 output alarms (optional) can be set with 9 different functions for each one. Other alarm features are:

- 2 Timing alarms, programmable from 0 to 6500 sec., with advanced functions.
- Independent power-up inhibition of the 4 alarms
- Programmable hysteresis (deadband) for the 4 alarms

PID CONTROL:

- User-selectable as: ON-OFF w/ hysteresis, or P, PI, PID and PID-Autotune.
- Proportional Band (P): 0 = on-off control; or 0.1% to 500.0% of maximum input span.
- Integral (I): 0 = off; or 0.01 to 25.00 rep/minutes.
- Derivative (D): 0 = off; or 1 to 250 seconds.
- Cycle-Time: 0.5 to 100.0 seconds (for PWM output control mode).
- PID-Autotune: start from the front panel.

INPUT/OUTPUT FEATURES:

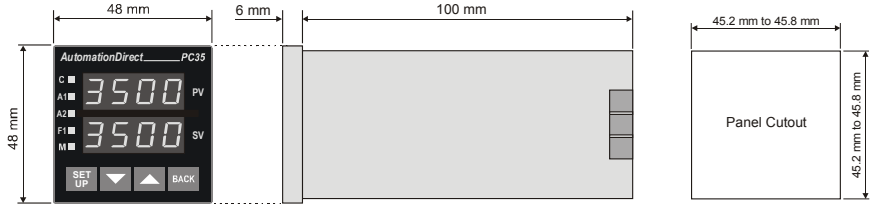
The PC35 has several models each with their own standard I/O features.

Check the label on the controller for the actual configuration of the unit.

The features are listed below:

- Linear Remote Set-Point input (RSP). **Check unit label for option.**
- Isolated Digital Input: I/O-5. **Check unit label for option.**
- Two SPST Relay output (Out-1 and Out-2). **Check unit label for option.**
- Two SSR output (Out-1 and Out-2). **Check unit label for option.**
- One isolated Switched-DC Output (I/O-3). **Check unit label for option.**
- Isolated Linear 0/4-20mA Output (I/O-5). **Check unit label for option.**

2.1 MAIN DIMENSIONS AND CUTOUT:

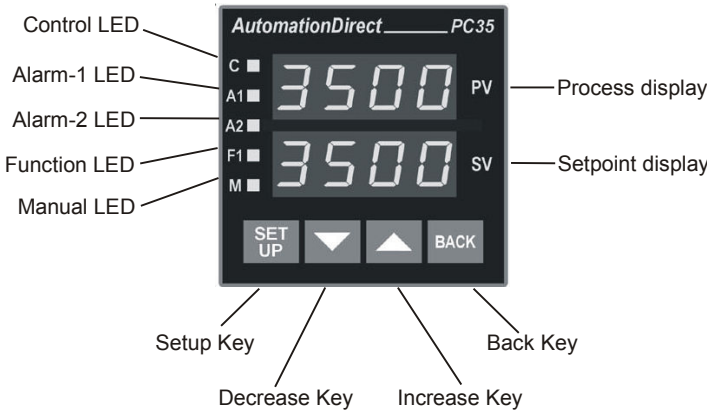


(Not to scale)

(Figure 1)

3. OPERATION

Operator Interface



(Figure 2)

Process display – PV: shows the PV (**P**rocess **V**ariable) value, and used when configuring the parameters of the controller.

Setpoint display – SV: shows the SV (**S**etpoint **V**ariable) value, and used when configuring the parameters of the controller.

Control LED – C: indicates that the Controller is active, with control and alarm outputs enabled. If there is a control output programmed as PWM, the output LED will reflect the actual state of the output (ON or OFF).

Alarm 1 – AL1 LED: status of the alarm 1 (LED On = alarm active).

Alarm 2 – AL2 LED: status of the alarm 2 (LED On = alarm active).

Function LED – F1: indicates that digital input I/O-5 is active (LED On), terminals 9 and 10 are closed (not active on PC35-2000-AC).

Manual LED – M: indicates that the controller is in manual mode (LED On). Flashes during auto-tuning execution.

SETUP key: used to set up the menu cycles.

BACK key: go back to the previous displayed parameter.

DECREASE and **INCREASE keys**: used to change parameter values.

When the controller is turned on, the firmware version is displayed for approximately 4 seconds, after which the controller starts normal operation. The values of PV and SV are displayed and the outputs are enabled after 6 seconds.

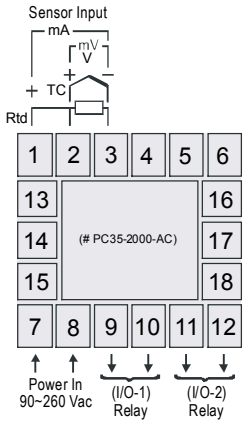
Before the controller is ready to be used in a given process, it requires some basic configuration, such as:

- **Input type** (TC, Pt100, 4-20mA, ...) at the " tYPE" prompt, according to table 4 (page 24).
- **Output type** (relay, SSR, 0-20mA, 4-20mA or pulse) at "I/O-1", "I/O-2",... "I/O-5" prompts (Table 5, page 25).
- **Setpoint variable SV**. Set the remaining parameters.
- **PID parameters** (or ON/OFF control with hysteresis adjust).
- Other functions, including alarms, ramp and soak, timer, digital input, etc., may be useful for a better system performance.

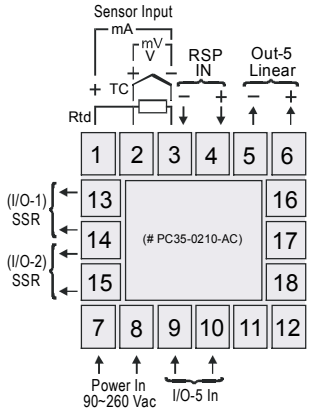
3.1 GENERAL ELECTRICAL CONNECTIONS:

CHECK UNIT LABEL FOR CONFIGURATION

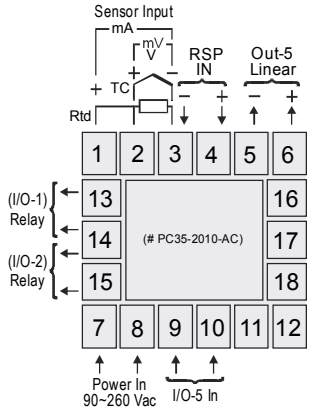
PC35-2000-AC



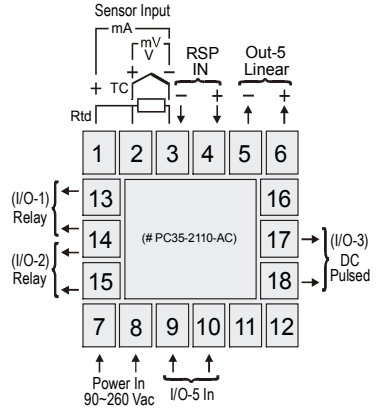
PC35-0210-AC



PC35-2010-AC



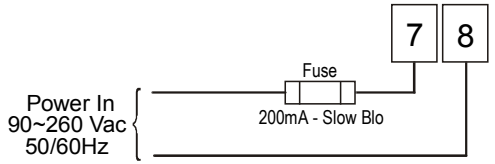
PC35-2110-AC



(Figure 3)

3.2 POWER WIRING:

High Voltage

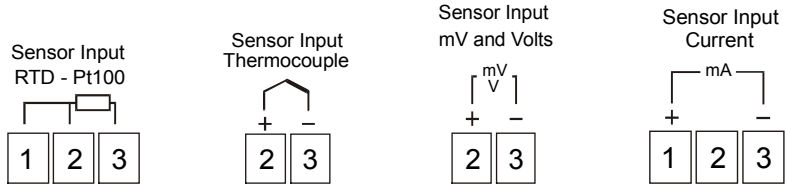


Note: The installation of fuse is optional, depending on level of protection required.

(Figure 4)

Note: Use copper conductors rated for at least 75 ºC, maximum ambient temperature 50 ºC.

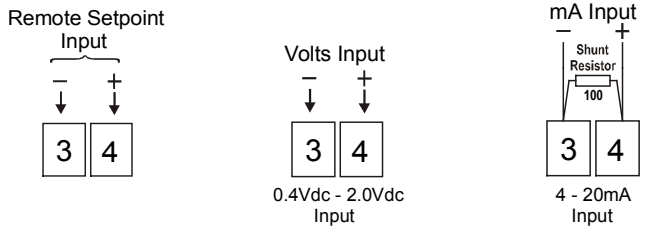
3.3 SENSOR INPUT WIRING:



(Figure 5)

Note: For Thermocouple Sensors use appropriate compensated thermocouple wires.
For RTD-Pt100 Sensor

3.4 LINEAR REMOTE SETPOINT INPUT:

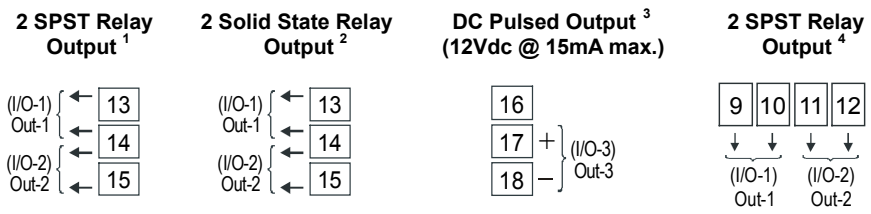


(Figure 6)

Linear Remote Set Point (RSP) analog input: 0.4 to 2.0 Vdc (second linear input).
"For 4 to 20mA Input, an external resistor shunt of 100 ohms, 0.1% toll. Is required between terminals 3 and 4". (NOTE: This option is not available on model PC35-2000-AC).

3.5 OUTPUT WIRING: OUT-1, OUT-2, AND OUT-3 OPTIONS:

CHECK UNIT LABEL FOR CONFIGURATION



(Figure 6)

[1] This output configuration is standard in the **PC35-2010-AC** and the **PC35-2110-AC**.

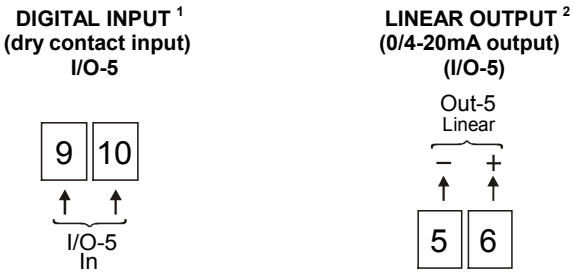
[2] This output configuration is standard in the **PC35-0210-AC**.

[3] This output configuration is standard in the **PC35-2110-AC**.

[4] This output configuration is standard in the **PC35-2000-AC**.

3.6 WIRING: INPUT I/O-5, AND OUTPUT-5 (I/O-5):

CHECK UNIT LABEL FOR CONFIGURATION



(Figure 8)

[1] Digital input I/O-5 (dry contact input) configuration is standard in the **PC35-0210-AC**, **PC35-2010-AC** and **PC35-2110-AC** (see table 5, codes 6 to 10). When this function is used then the 0/4-20mA output (terminals 5-6) cannot be used.

[2] Linear output I/O-5 (0/4-20mA output) configuration is standard in the **PC35-0210-AC**, **PC35-2010-AC** and **PC35-2110-AC** (see table 5, codes 11 to 16). When this function is used then the digital input (terminals 9-10) cannot be used.

[1, 2] Those configurations (I/O-5) are not available in the **PC35-2000-AC**.

NOTE: All terminal screws must be tightened securely. Terminal screws not properly secured can cause an electrical short that may damage property, equipment or cause injury or death. Terminal screws improperly secured may fall into equipment causing possible damage to property or equipment.

3.7 PANEL ASSEMBLY:

First remove the mounting clamp and insert the controller into the panel cut out. Place the unit into the panel cut out and slide the mounting clamp from the rear to a firm grip at the panel.

The internal circuitry can be fully removed from the housing without disconnecting any wiring. By using the thumb, just press the tab in the lower part of the front panel, grab the front panel firmly and pull the front face and circuitry from the housing.

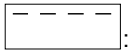
Warning: Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician. It is recommended that power to the controller be disconnected prior to removing the controller from the case.

3.8 ERROR MESSAGES:

The connection and configuration errors for most of the problems encountered in using the controller are shown below. A final revision of parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

 : Process is below the selected sensor range.

 : Process is above the selected sensor range

 : Controller or sensor error. Example:

- Broken thermocouple or Pt100.
- Pt100 badly connected, short-circuited or high cable resistance.

3.9 SERIAL NUMBER ACCESS:

To read the controller's serial number (8 digits), hold down the BACK key for a few seconds. The first four digits will appear in red on the top display and the second four will appear in green on the bottom display.

The serial number is recorded in the factory and cannot be changed.

4. MENU SYSTEM

The Parameter Menu System is organized into seven basic cycles. This is shown in the chart below.

Cycle	Access
1- Operation	Free access parameters
2- Tuning	Reserved access parameters
3- Ramp & Soak Program	
4- Alarms	
5- Input Configuration	
6- I/Os	
7- Calibration	

4.1 INITIAL STARTUP

When the controller is initially energized the Firmware version is displayed for approximately 4 seconds in the PV display after which the controller reverts to the normal operation mode or **Operation** cycle. This is **SETUP Cycle-1.** The upper display, **PV**, shows the **Process Variable** and the lower display, **SV**, shows the **Set Point Variable** in this cycle.

Important: Firmware version of controller must match the version indicated on the bottom front cover of this manual.

4.2 MENU CYCLE PARAMETER ACCESS

The Operation Cycle is the default Cycle and all parameters in this menu can be accessed using the **SETUP key** (move forward through the menu) and the **BACK key** (move backward through the menu).

The other Cycles can be accessed by pressing and holding the **BACK key** then pressing the **SETUP key** to move through each Cycle. The first item in the menu of each cycle is shown in the **PV** display, i.e., the **Tuning** Cycle displays **AtUn** in the **PV** display and the **Alarms** Cycle displays **FuA1** in the **PV** display, etc. The **SETUP** and **BACK keys** can be used independently to move back and forth through the menu after the Cycle is chosen. After moving through the end of the Cycle menu the controller reverts to the **Operation** Cycle. The chart on the following page shows the parameter menu for each Cycle. To move rapidly through a Cycle menu **press** and **hold** the **SETUP key**.

Important: Disable all outputs prior to programming by pressing the SET UP key until "run" is displayed in the PV display. Then, using the ▲ or ▼ keys select "no" in the SV display. This will keep any information from effecting the process prematurely.

Cycle Parameter Menu

Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6	Cycle-7
OPERATION	TUNING	R&S Prog.	ALARMS	INPUT Conf.	I/O Conf.	CALIBRATION
PV Indication (Red Display)	AtUn	Pr n	FuA1	tYPE	Io 1	InLC
	Pb	PtoL	FuA2	dPPo	Io 2	InHC
SV Indication (Green Display)	HYSt	PSP0 to PSP7	FuA3	Un It	Io 3	ouLC
	Ir		FuA4	oFFS	Io 4	ouHC
	dt		bLA1 bLA2 bLA3 bLA4	SPLL	Io 5	CJL
AUto	Ct	Pt1 to Pt7		SPHL		HtYP
PV Indication (Red Display)	Act			rSLL		rSLC
	b IAS			rSHL		rSHC
MV Indication (Green Display)	ouLL	PE1 to PE7	HYA1	bAud		
	ouHL		HYA2	Addr		
	StSt		HYA3			
Pr n	SPA1	LP	HYA4			
run	SPA2		A It1			
	SPA3		A It2			
	SPA4		A2t1			
			A2t2			

4.3 CYCLE PROGRAM SECURITY:

Each menu Cycle can be locked (protected) by pressing **BACK** and ▲ **keys** simultaneously for 3 seconds, a short blink of the display confirms the lock cycle. Press **BACK** and ▼ **keys** for 3 seconds to unlock, a short blink of the display confirms the unlock cycle. This will alternately lock or unlock the ▲ and ▼ **keys** to avoid tampering.

5. CONFIGURATION (PROGRAMMING)

The configuration section gives information on parameter settings in each Cycle which help to configure the controller for the desired operation. However, the **first parameter that needs to be set is the Input type (tYPE)** in the **INPUT** Cycle-5 (see 5.5 page 23, and Table 4 page 24). This allows access to those parameters that operate with the designated input. **Output Configuration is the second parameter that needs to be set (see Cycle-6 section 5.6 page 25, and Table 5).**

In each Cycle the PV display shows the menu parameter and the SV display shows the value of that parameter, i.e., **Auto** will be shown in the PV display and **YES** or **no** will be shown in the SV display. Again, the ⏶ and ⏷ will change the parameter value.

5.1 CYCLE 1 - OPERATION:

PV Indication (Red) SV Indication (Green)	PV AND SV INDICATION: The status display shows the present value of PV (Process Variable). The parameter display shows SV (Set Point Variable). SV **cannot** be adjusted if **Pr n** Ramp & Soak Program is a value other than **0** (zero). The status display shows **- - - -** whenever PV exceeds the maximum range or there is no signal at the input. In case of hardware error the status display will show **Erro**, where n is the error code number in the SV display. If an erro code number is displayed, the controller's hardware is damaged. Consult factory for repair or replacement.
Auto	CONTROL MODE: **YES** indicates automatic control mode (closed loop, PID or ON/OFF). **no** indicates manual control mode (open loop). Bumpless transfer from auto ↔ to manual mode is available. If in doubt program **YES**.
PV Indication (Red) MV Indication (Green)	MANIPULATED VARIABLE VALUE (MV): The upper display shows PV value and the lower display shows the percentage of MV applied to the control output. When in manual control (open loop) the MV value can be manually changed. When in auto mode the MV value can only be viewed. To distinguish the MV display from the SV display, the MV is shown flashing intermittently. MV is the percentage of control output, i.e.; if 4-20mA is the control output and 50 (50%) is the value in the SV display then the output will be 12mA. If a relay (any PWM) is used as the control output and the Cycle Time (**Ct**) is set for 10 seconds and 50 (50%) is the value in the SV display then the relay will be ON (closed) for 5 seconds and OFF (open) for 5 seconds.
Pr n	RAMP AND SOAK PROGRAM SELECTION: Selects the ramp and soak program to be executed (7 programs possible). To disable function set to **0**. Refer to Cycle 3, page 16 section 5.3, for R&S programming. Default value: **0**
run	CONTROL ENABLE: **YES** indicates that the control output and alarms are enabled and **no** indicates they are disabled.

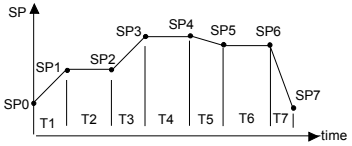
5.2 CYCLE 2 - GENERAL TUNING:

Atun	AUTO-TUNE: **YES** enables the auto tuning of the PID parameters, and **no** disables it (manual tune). **Default: no**
Pb	PROPORTIONAL BAND: 0 to 500% of maximum input span. Select **0** (zero) for ON/OFF control w/ hysteresis. **Default: 0.0**
HYSt	CONTROL HYSTERESIS (engineering units): This parameter is only shown for ON/OFF control (Pb=0). **Default: 0**
Ir	INTEGRAL RATE: 0.00 to 25.00 = Integral time constant in repetitions per minute (Reset). **Default: 0.00**
dt	DERIVATIVE TIME: 0 to 250 = Derivative time constant, in seconds. **Default: 0**
Ct	CYCLE TIME: PWM period in seconds. Can only be changed if proportional band is other than zero. **Default: 8.0**
Act	CONTROL ACTION: For Auto Mode only. • Reverse Action set: **rE**, usually used for heating. • Direct Action set: **d Ir**, usually used for cooling. **Default: rE**
bIAS	Offset (manual reset) for MV (Manipulated Variable, or % of Output Control). Range: -100% to +100%. Default: **0.0**.
ouLL	OUTPUT LOW LIMIT: minimum percentage value for MV (% of Output Control) when in automatic control and PID. Default: **0.0**%
ouHL	OUTPUT HIGH LIMIT: Maximum percentage value for MV (% of Output Control) when in automatic control and PID. Default: **100.0**%
StSt	SOFT START: Time in seconds during which the controller limits the MV (% of Output Control) value progressively from 0 to 100%. It is enabled at power up or when the control output is activated. "To disable function set to **0**. " Default: **0**
SP.A1	ALARM 1 PRESET: Tripping point for alarm 1. **Default: - 150**
SP.A2	ALARM 2 PRESET: Tripping point for alarm 2. **Default: - 150**
SP.A3	ALARM 3 PRESET: Tripping point for alarm 3. **Default: - 150**
SP.A4	ALARM 4 PRESET: Tripping point for alarm 4. **Default: - 150**

5.3 CYCLE 3 - RAMP AND SOAK PROFILE PROGRAMMING:

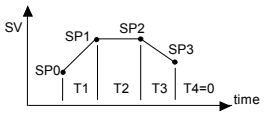
Pr n	PROGRAM TO BE VIEWED: Selects the ramp and soak profile program to be edited/viewed in the following cycle prompts (7 programs available). **Default:** 1
PtoL	RAMP AND SOAK TOLERANCE: maximum deviation between PV and SV. Whenever this deviation is exceeded the time counter is halted until deviation lowers to within the tolerance. Set zero to disable this function. **Default:** 0
PSP0 to PSP7	RAMP AND SOAK SET POINTS (0 to 7): Set of 8 SV values which define the ramp and soak profile segments. See also Pt 1 to Pt 7 and PE 1 to PE 7 below. **Default:** - 150
Pt 1 to Pt 7	RAMP AND SOAK SEGMENTS TIME (1 to 7): Set of 7 time intervals in minutes (9999 max.) for the 7 segments of the ramp and soak program. **Default:** 0
PE 1 to PE 7	RAMP AND SOAK EVENT (1 to 7): Set of 7 Event programs with 15 possible codes that define which alarms must be activated during a ramp and soak program segment. Alarm function depends on rS setting (see: Table 1 – R&S Event Alarm Function). **Default:** 0
LP	LINK TO PROGRAM: Number of the next profile program to be linked to follow the current profile. Profiles can be linked to make larger programs of up to 49 segments. **Default:** 0

Seven ramp and soak profiles with up to 7 segments each can be programmed. Longer profiles of up to 49 segments can be created by linking 2 or more profiles.



Example of a complete ramp and soak profile

(Figure 9)

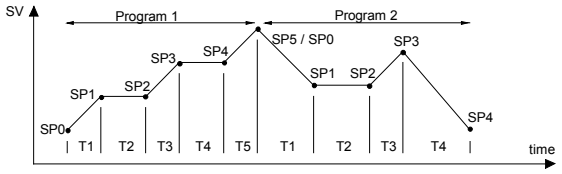


Example of a profile with fewer segments. (T4 is set 0).

(Figure 10)

To execute a profile with fewer segments just program 0 (zero) for the time intervals that follow the last segment to be executed.

The program tolerance " PtoL " defines the maximum deviation between PV and SV for the execution of the profile. If this deviation is exceeded, the program will be interrupted until the deviation falls to within the tolerance band. Programming 0 (zero) at this prompt disables the tolerance and the profile execution will not to be halted even if PV does not follow SV (time priority as opposed to SV priority).



(Figure 11)

Example of two linked programs

Ramp & Soak Program, and Event Alarm:

Table 1 – Ramp & Soak Event alarm function

Code	Alarm 1	Alarm 2	Alarm 3	Alarm 4
0				
1	X			
2		X		
3	X	X		
4			X	
5	X		X	
6		X	X	
7	X	X	X	
8				X
9	X			X
10		X		X
11	X	X		X
12			X	X
13	X		X	X
14		X	X	X
15	X	X	X	X

To configure and execute a Ramp and Soak program:

- Set Control Mode to manual in the Operation Cycle (Cycle-1).
- Set the Control Enable **run** to **no** in the Operation Cycle (Cycle-1).
- Program the Tolerance value **PtoL**, Set Point **PSP**, Segment Time **Pt**, and Event **PE** (if required) in the Ramp & Soak Program Cycle (Cycle-3).
- Set the Control Mode to automatic in the Operation Cycle.
- Select Ramp and Soak program **Pr n** to be executed (1 to 7) in the Operation Cycle.
- Set the Control Enable **run** to **YES** in the Operation Cycle to start the process.

Before executing the program the controller waits for PV to reach the first set point **PSP0** if **PtoL** is different than zero.

If any power failure occurs then the controller will resume at the beginning of the previous segment.

Ramp and Soak event alarms:
The ramp and soak event function is used to activate alarms at any segment of program 1. This applies only to program 1.

To enable this event function the alarms to be activated must be selected for **rS** function and are programmed at the **PE 1** to **PE7** prompts. The number to be programmed at the prompt defines the alarms to be activated.

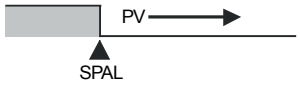
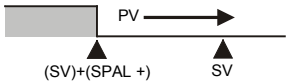
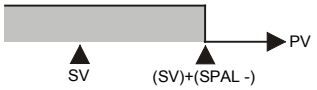
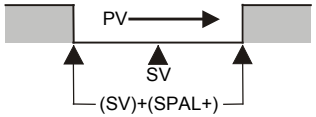
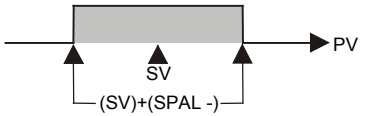
5.4 CYCLE 4 – ALARMS CONFIGURATION:

FuA 1	ALARM 1 FUNCTION: Select options from Table 2 (page 20). **Default: oFF.**
FuA2	ALARM 2 FUNCTION: Select options from Table 2. **Default: oFF**
FuA3	ALARM 3 FUNCTION: Select options from Table 2. **Default: oFF**
FuA4	ALARM 4 FUNCTION: Select options from Table 2. **Default: oFF**
bLA 1 **bLA2** **bLA3** **bLA4**	ALARM BLOCK 1 TO 4: This function blocks the alarm at power-up when the unit is first energized. **YES** enables and **no** inhibits this blocking function. When enabled the alarm will not be active at power-up waiting for PV (Process Variable) to reach a non-alarm situation. From this point on the alarm will be free to actuate should a new alarm situation occur.
HyA 1	ALARM 1 HYSTERESIS: Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off (in engineering units). **Default: 0**
HyA2	ALARM 2 HYSTERESIS: Same as above.
HyA3	ALARM 3 HYSTERESIS: Same as above.
HyA4	ALARM 4 HYSTERESIS: Same as above.
A 1t 1	ALARM 1 TIME 1[1]: Defines the time (6500 sec. max.) during which the alarm 1 output will be **on** when alarm 1 is active. Program zero to disable this function. **Default: 0**
A 1t2	ALARM 1 TIME 2[1]: Defines the **oFF** state time for the alarm 1 output, after being **on** during the time selected on ALARM 1 TIME 1. Program zero to disable this function. **Default: 0**
A2t 1	ALARM 2 TIME 1[1]: Defines the time (6500 sec. max.) during which the alarm 1 output will be **on** when alarm 1 is active. Program zero to disable this function. **Default: 0**
A2t2	ALARM 2 TIME 2[1]: Defines the time during which the alarm 2 output will be, after being **on** during the time selected on ALARM 2 TIME 1. Program zero to disable this function. **Default: 0**

[1]Table 3, page 22, shows the advanced features that can be achieved with this time function.

The controller has optional up 3 alarms (check unit label for option). Only alarms 1 and 2 have front panel LED's associated to them. The alarms can be configured to operate in any of the nine functions listed on Table 2.

Table 2 - Alarm functions

TYPE	PROMPT	ACTION
Disabled	oFF	No active alarm. This output can be used as a digital output to be set by the serial communication.
Sensor Break (Input **Err**or)	iErr	Alarm will be ON if PV sensor breaks, input signal is out of range or Pt100 is shorted.
Event Alarm (**R**amp and **S**oak)	rS	Can be activated at a specific segment of ramp and soak program.
Factory Reserved	rFAIL	Don't use (Factory Reserved)
Low Alarm (Low Process Alarm)	Lo	**Low SPAL** 
High Alarm (High Process Alarm)	HI	**High SPAL** 
Differential **L**OW (Deviation Low)	dIFL	**Dif-Low SPAL+**  **Dif-Low SPAL-** 
Differential **H**IGH (Deviation High)	dIFH	**Dif-High SPAL+**  **Dif-High SPAL-** 
Differential (Band Alarm)	dIF	**Dif-SPAL+**  **Dif-SPAL-** 

(where SPAL means: SPA1 , SPA2 , SPA3)

Alarm Functions:

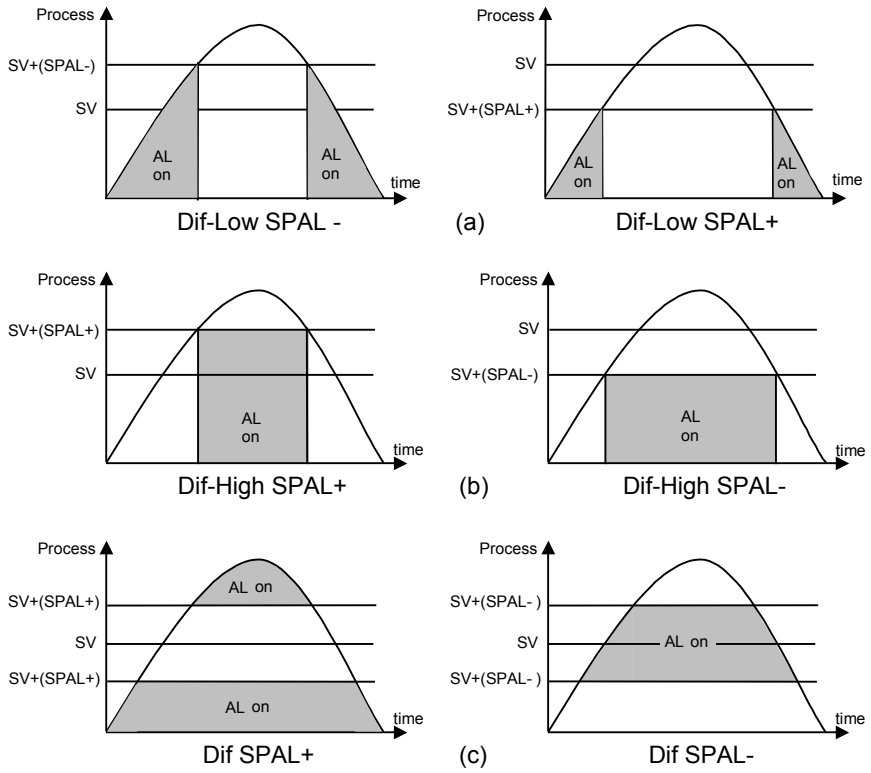
Low Alarm: Activates at present value, independent of main setpoint (SV). Low process-alarm activates at and below alarm setting.

High Alarm: Activates at present value, independent of main setpoint (SV). High process-alarm activates at and above alarm setting.

Differential Low: Activates at present deviation (negative or positive) value from main setpoint (SV). Low deviation-alarm activates below alarm setting. Figure 12(a) below gives a graphical description of this.

Differential High: Activates at present deviation (negative or positive) value from main setpoint (SV). High deviation-alarm activates above alarm setting. This is represented in Figure 12(b).

Differential: Activates when the process exceeds a specified band-alarm centered around the main setpoint (SV). See Figure 12(c).

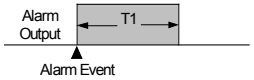
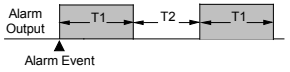


(Figure 12)

Alarms 1 and 2 can be programmed to have timer functions. The 4 modes of operation are: Normal, Pulsed, Delayed, or Oscillator.

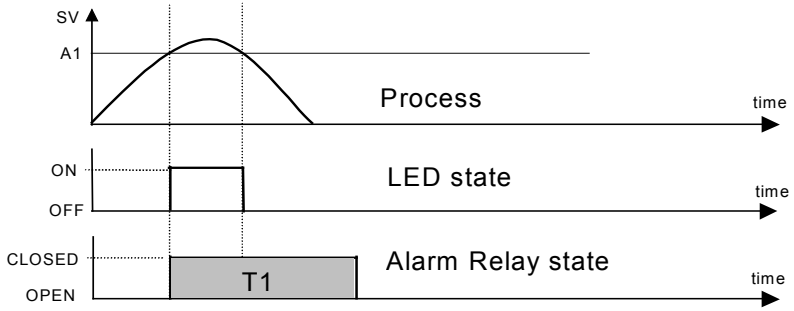
The desired function can be achieved programming the parameters "A1t1", "A1t2", "A2t1" and "A2t2" (see Table 3).

Table 3 - Advanced Timer Alarm (for alarm 1 and alarm 2)

Alarm Function	T1	T2	ACTION
Normal	0	0	
Delayed	0	1s to 6500s	
Pulse	1s to 6500s	0	
Oscillator	1s to 6500s	1s to 6500s	

The initial blocking option inhibits the alarm from being recognized if an alarm condition is present when the controller is first energized. The alarm will activate only after the occurrence of a non-alarm condition followed by a new occurrence for the alarm.

Under Pulsed, Delayed, or Oscillator alarm operation the LED's associated to the alarms will only light during the actual process state, i.e., when the process is in alarm situation. The alarm relay, however, will remain closed throughout the time delay set by the operator. Under Normal operation both the LED's and alarm relays will coincide. Figure 13 shows a process with a Pulsed alarm relay where A1 is the alarm setpoint and T1 is the alarm pulse (0 – 6500s). In this figure the alarm relay T1 is ON (closed) over a time span that exceeds the actual process alarm A1 and its associated LED.



(Figure 13)

5.5 CYCLE 5 - INPUT CONFIGURATION:

"Input Type is the first parameter that needs to be set"

tYPE	INPUT TYPE: Selects the input signal type to be connected to the process variable input. Refer to Table 4, page 24. ***This is the first parameter to be set. The second parameter that needs to be set is the Output Control in the I/O Configuration Cycle (Cycle-6). See page 25 section 5.6 and Table 5.***
dPPo	DECIMAL POINT POSITION: For linear input types 16, 17, 18 and 19 only. Selects the decimal point position to be viewed in both PV and SV. **Default:** oFF
Un it	TEMPERATURE INDICATION IN ºC OR ºF: Selects the display indication to be in ºC or ºF. Only available if input type is other than 16, 17, 18 or 19. **Default:** C
oFFS	SENSOR OFFSET: Offset value to be added to the PV to compensate sensor error. **Default**: 0
SPLL	SET POINT LOW LIMIT: - Linear inputs: Sets the lower range for SV and PV indication. - T/C and Pt100 inputs: sets the lower range for SV. **Default:** -150
SPHL	SET POINT HIGH LIMIT: - Linear inputs: Sets the upper range for SV and PV indication. - T/C and Pt100 inputs: sets the upper range for SV. **Default:** 1370
rSLL	REMOTE SET POINT (RSP) LOW LIMIT: Selects the lower range for indication of the Remote Setpoint. **Default:** -150
rSHL	REMOTE SET POINT (RSP) HIGH LIMIT: Selects the upper range for indication of the Remote Setpoint. **Default:** 1370
bAud	DIGITAL COMMUNICATON BAUD RATE SELECTION: **NOT AVAILABLE**
Addr	SLAVE ADDRESS SELECTION: **NOT AVAILABLE**

Linear Remote Set Point (RSP) Input:

The Remote Setpoint (RSP) is enabled by an external digital signal in (dry contact input, terminals 9-10) I/O-5, when programmed with the code 8 (*Select Remote SP input*).

NOTE: Linear Remote Setpoint (RSP) analog input is 0.4 to 2.0 Vdc. To obtain 4 to 20mA RSP Input, an external resistor shunt of 100Ω, 0.1% tolerance is required between terminals 3 and 4.

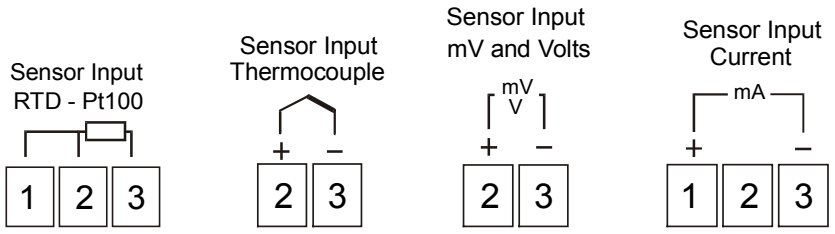
Sensor Types Input:

Table 4 - Input Types

Select the input type (in parameter **tYPE**) from Table :

TYPE INPUT	CODE	CHARACTERISTICS
Tc. J	0	range: -110 to 760 °C (-166 to 1400ºF)
Tc. K	1	range: -150 to 1370 °C (-238 to 2498ºF)
Tc. T	2	range: -160 to 400 °C (-256 to 752ºF)
Tc. S	5	range: 0 to 1760 °C (32 to 3200ºF)
Pt100	6	range: -199.9 to 530.0 °C (-199.9 to 986.0ºF)
Pt100	7	range: -200 to 530 °C (-328 to 986ºF)
4 to 20 mA	8	Tc. J linearization. Programmable range: -110 to 760°C
4 to 20 mA	9	Tc. K linearization. Programmable range: -150 to 1370°C
4 to 20 mA	10	Tc. T linearization. Programmable range: -160 to 400°C
4 to 20 mA	13	Tc. S linearization. Programmable Range: 0 to 1760°C
4 to 20 mA	14	Pt100 linearization. Prog. Range: -199.9 to 530.0°C
4 to 20 mA	15	Pt100 linearization Prog. Range: -200 to 530°C
0 to 50mV	16	Linear. Programmable indication -1999 to 9999
4 to 20 mA	17	Linear. Programmable indication -1999 to 9999
0 to 5 Volts	18	Linear. Programmable indication -1999 to 9999
4 to 20mA	19	Square Root Extraction

Wires Sensor Input



(Figure 14)

Notes:

1) For Thermocouple Sensors use appropriate compensated thermocouple wires.

2) Use copper conductors only rated at least 75 ºC (except on T/C).

5.6 CYCLE 6 - I/O CONFIGURATION FOR OUTPUTS AND DIGITAL INPUTS:

The controller input/output channels can assume multiple functions, depending on configuration: control output, alarm output, digital input, and PV or SV analog retransmission. These channels are identified as I/O-1, I/O-2, I/O-3, and I/O-5.

The function code of each I/O can be selected among the options in Table 5. Only valid function codes are displayed for each I/O (for example, I/O1, which is a relay, can be configured with functions 0 to 5 only; and I/05 can perform all 16 functions). See page 26 for a description of codes.

To configure a relay output (any PWM output) for main control select code **5** for "**Io 1**" or "**Io 2**". To configure Pulsed DC output for main control select code **5** for "**Io 3**" (I/O-3 is only available in the **PC-2110-AC** and must be enabled in Cycle-7, see I/O Defaults below) . To configure linear output (analog) for main control select codes **11** or **12** for "**Io 5**".

"This is the second parameter to be set"

Table 5 - Code functions for I/O-1 to I/O-5

CODE	I/O Type	I/O Function
0	Off	No Function
1	Alarm Output	Alarm 1 Output
2	Alarm Output	Alarm 2 Output
3	Alarm Output	Alarm 3 Output
4	Alarm Output	Not Available
5	Control Output	PWM CONTROL Output (Relays, SSR, or Pulsed DC)
6	Function Input	Automatic/Manual mode change
7	Function Input	Run/Stop mode change
8	Function Input	Select Remote Set Point Input
9	Function Input	Executes/Holds selected Ramp & Soak profile
10	Function Input	Enable/Disable R&S profile 1 selection
11	Analog Control Output	0 to 20mA Analog control output
12	Analog Control Output	4 to 20mA Analog control output
13	PV Analog Output	0 to 20mA PV retransmission
14	PV Analog Output	4 to 20mA PV retransmission
15	SP Analog Output	0 to 20mA SP retransmission
16	SP Analog Output	4 to 20mA SP retransmission

The description for the functions follows:

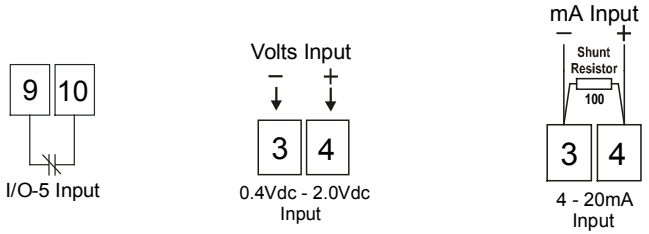
- **CODE 0 - no function** - The I/O channel programmed with code 0 will not be used by the controller.
- **CODES 1 to 3 - Alarm output** - Available for all I/O channels. The selected channel can be used as output for alarms 1 to 3.
- **CODE 5 - PWM (Pulse Width Modulation: Relay, SSR, Pulsed DC) control output** - Available for all I/O channels.
- **CODE 6 - Digital input - I/O5:**
  Contact Closed: Manual control (open loop control)
  Contact Open: Automatic control
- **CODE 7 - Digital input - I/O5:**
  Run/Stop input ("run": YES / no).
  Contact Closed: outputs enabled
  Contact Open: outputs disabled
- **CODE 8 - Digital input - I/O5:**
  Contact Closed: linear Remote Setpoint input active (external linear setpoint input).
  Contact Open: main SP active (internal programmed SP)
- **CODE 9 - Digital input - I/O5:**
  Contact Open: enables "Ramp & Soak" program
  Contact Closed: holds "Ramp & Soak" program
- **CODE 10 - Digital input -I/O5:**
  Selects Ramp & Soak program 1. Used to alternate between the main Setpoint and a second Setpoint defined by the **"**Ramp & Soak" program 1.
  Contact Closed: selects program 1
  Contact Open: uses main Setpoint
- **CODE 11 - Analog control output** - I/O5 only, 0-20mA control output.
- **CODE 12 - Analog control output** - I/O5 only, 4-20mA control output.
- **CODES 13 to 16 - Analog retransmission** - I/O5 only. Configures I/O5 to output a 0-20mA or 4-20mA analog signal proportional to PV or SP.

NOTE: Codes 6 to 16 are not available in the model PC35-2000-AC.

Linear Remote Set Point (RSP) Input:

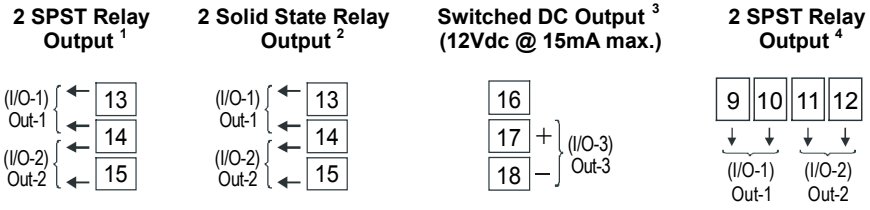
The Linear Remote Set Point is a function that enables the operator to change the set point remotely via a linear signal (0.4Vdc – 2Vdc or 4–20mA). To enable the use of the RSP, select code 8 (Select Remote Set Point Input) for Io S in Cycle-6. Then connect a discrete input (dry contact) across terminals 9-10 as shown in figure 15(a) on the following page. A linear input signal must then be connected to terminals 3-4 as shown in Figures 15(b) or 15(c). The Remote Set Point function (RSP) is enabled when terminals 9-10 are closed. When this function is used then the 4-20mA Analog Output (terminals 5-6) cannot be used.

REMOTE SET POINT WIRING



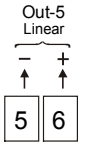
(Figure 16)

OUTPUT WIRING



(Figure 16)

0/4-20mA Linear Output [5]
I/O-5



(Figure 17)

[1] This output configuration is standard only in the **PC35-2010-AC** and **PC35-2110-AC**.

[2] This output configuration is standard only in the **PC35-0210-AC**.

[3] This output configuration is standard only in the **PC35-2110-AC**.

[4] This output configuration is standard only in the **PC35-2000-AC**.

[5] This output configuration is standard only in the **PC35-0210-AC, PC35-2010-AC** and **PC35-2110-AC**.

5.7 CYCLE 7 - CALIBRATION:

NOTE: All input and output types are factory calibrated. Experienced personnel only should access this cycle. If in doubt do not press the ▼ or ▲ keys in this cycle. To access this cycle press and hold the* SETUP *and* BACK *keys for approximately 6 seconds while (in Cycle-6, I/O Configuration), until " InLC" is shown in the PV display.

InLC	INPUT LOW CALIBRATION: Sets the Process Variable low calibration (offset). Several keystrokes at ▼ **or** ▲ might be necessary to increment one digit.
InHC	INPUT HIGH CALIBRATION: Sets the Process Variable span calibration (gain).
ouLC	OUTPUT LOW CALIBRATION: Sets the analog current output low calibration (offset).
ouHC	OUTPUT HIGH CALIBRATION: Sets the analog current output span calibration (gain).
CJ L	COLD JUNCTION OFFSET CALIBRATION: Sets the cold junction in °F or °C offset calibration. A good thermometer or a temperature simulator should be used to properly adjust this parameter.
HtyP	HARDWARE TYPE: Configures the controller to recognize the actual installed optional hardware (I/O-3 and I/O-4 module). The parameters menu will show the parameters relative to the optional hardware: 0 - I/O-3 and I/O-4 disabled. 1 - I/O-3 active. 2 - I/O-3 and I/O-4 active. 3 - Factory reserved (don't use).
rSLC	REMOTE SET POINT LOW CALIBRATION: Sets the Remote Set Point low calibration (offset). Several keystrokes at ▼ or ▲ might be necessary to increment one digit.
rSHC	REMOTE SET POINT HIGH CALIBRATION: Sets the Remote Set Point span calibration (gain). Several keystrokes at ▼ or ▲ might be necessary to increment one digit.

6. PID AUTO TUNE

During auto tune the process is controlled in ON/OFF mode at the programmed Set Point (SV). Depending on the process characteristics large oscillations above and below SV may occur and auto-tuning may take several minutes to be concluded. The following page gives the standard procedure for auto-tune.

The standard auto-tune procedure is as follows:

- Disable the control output at the **run** prompt in the Operation Cycle (Cycle-1) by selecting **no**.
- Select auto mode operation at the **Auto** prompt in Cycle-1 by selecting **YES**.
- Disable the ramp and soak function by setting **Pr n** to **0** in Cycle-1, then program the setpoint (SV) variable close to the desired process variable (PV).
- Enable auto tuning at the **Atun** prompt in the Tuning Cycle (Cycle-2) by selecting **YES.**
- Enable the control output at the **run** prompt in Cycle-1 by selecting **YES**.

During auto-tune the "M" LED flashes. Once auto-tune is complete the "M" LED turns off.

Note: During the auto tune procedure the soft-start function will not operate and large oscillations will be induced around the setpoint depending on the process characteristics. Make sure the process can accept these oscillations and fast control output changes without being damaged.

The **recommended** auto-tune procedure is as follows:

- Follow the procedure above **except**, program a setpoint 10 – 20% below the final desired value.
- After auto-tune is complete (the "M" LED is off) change the setpoint to the final desired value.

If auto-tuning results are not satisfactory refer to section 7 and Table 6 for manual fine tuning procedure.

NOTE: Certain processes behave in very irregular manners. In these cases, control type "On/Off with hysteresis adjust" is recommended.

7. PID MANUAL TUNE

The operator may choose to tune the controller manually for optimum process perfomance once all parameters are set. This can be achieved by using Table 6 below or by determining the values for the propotional band **Pb**, integral rate **Ir** and derivative time **dt** by following the steps on page 30. **The procedure on page 29 should only be done on processes that will not be damaged by large fluctuations in the process variable (PV).**

Table 6 - Suggestions for manual tuning of PID parameters

PARAMETER	RESPONSE	SOLUTION
Proportional Band	Slow Response	Decrease
Proportional Band	Large Oscillation	Increase
Integral Rate	Slow Response	Increase
Integral Rate	Large Oscillation	Decrease
Derivative Time	Slow Response or Instability	Off (**dt = 0**)
Derivative Time	Large Oscillation	Increase

Step 1. Disable all outputs in Cycle-1 by changing **run** to **no**. Change the setpoint to the desired process variable (PV) in the Operation Cycle. This value should be below (PV) if overshoot will cause damage to the process.

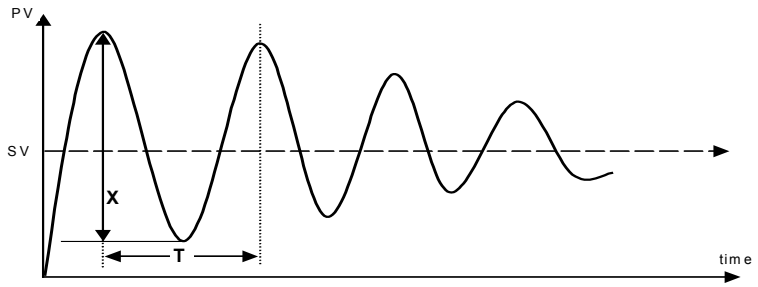
Step 2. Make sure **Pb** is set to **0** in Cycle-2, page 15. This places the controller in ON/OFF control.

Step 3. Enable all outputs by changing **run** to **YES** in Cycle-1. Once the outputs are enabled the process variable (PV) will approach and eventually overshoot the setpoint (SV). At this point the operator should note the following values (see Figure 18):

- The value from the highest point of overshoot to the lowest point of undershoot, **X**.
- The cycle time of the oscillation, **T** = cycle repetitions per minute.

Using the following information and the values above the operator can determine the PID setting for the process:

- **Pb** = **X** ÷ scale range x 100
- **Ir** = **T** = cycle repetitions per minute
- **dt** = **T** ÷ 6

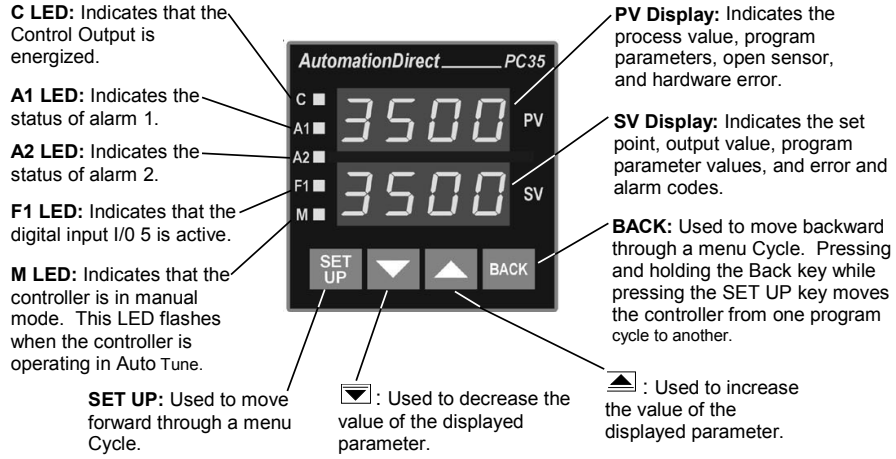


(Figure 18)

The operator may then lock access to Cycle-2 to keep the PID parameters from being changed, see Program Security section 4.3 page 13.

PC35 Quick PID Setup Reference

Key and Display Functions



Set Up Cycle Parameter Access

Cycle-1	Cycle-2	Cycle-3	Cycle-4	Cycle-5	Cycle-6	Cycle-7
OPERATION	TUNING	R&S Prog.	ALARMS	INPUT Conf.	I/O Conf.	CALIBRATION
PV Indication (Red Display)	Atun	Pr n	FuA1	tYPE	Io 1	InLC
SV Indication (Green Display)	Pb	PtoL	FuA2	dPPo	Io 2	InHC
AUto	HYSt	PSP0 to PSP7	FuA3	Unit	Io 3	ouLC
PV Indication (Red Display)	Ir	Pt1 to Pt7	FuA4	oFFS	Io 4	ouHC
MV Indication (Green Display)	dt	PE1 to PE7	bLA1 bLA2 bLA3 bLA4	SPLL	Io 5	CJL
Pr n	Ct	LP	HYA1	SPHL		HtYP
run	Act		HYA2	rSLL		rSLC
	bIAS		HYA3	rSHL		rSHC
	ouLL		HYA4	bAud		
	ouHL		A1t1	Addr		
	StSt		A1t2			
	SPA1		A2t1			
	SPA2		A2t2			
	SPA3					
	SPA4					

Quick Set Up

This quick reference setup is intended to be used by experienced users that are familiar with the PC35 set up menu or those that need only basic PID operation. This guide will show how to configure the input, output control and basic alarm function. For detailed programming information refer to the Table of Contents to find the required instructions for a particular function. Follow these steps:

1. **Operation:** Connect power input to proper terminal connections. After power-up the controller is in the Operation Cycle (Cycle-1). See Above Cycle Menu. Disable all outputs by pressing the **SET UP key** until **run** is displayed in the PV display. Press the ▲ or ▼ keys until **no** is shown in the SV display. The controller outputs are now disabled. Press the **SET UP** key again and values will be shown in the PV and SV displays. To move from one Cycle to the next press and hold the **BACK key** then press the **SET UP key**.

2. **Input Type:** Press and hold the **BACK key** then press the **SET UP key** 4 times (Input Cycle-5) or until **tYPE** is displayed in the PV display. Select the Input Type code from Table 4 on page 24 using the ▲ or ▼ keys, i.e., T/C J = 0, T/C K = 1, etc.

3. **Output Control Configuration:** From Input Cycle-5 press and hold the **BACK key** then press the **SET UP key** once to move to the Output Configuration menu (Cycle-6) or until **Io 1** is displayed in the PV display. Use the **SET UP key** to move forward through the I/O's and BACK to move backward. There are five optional outputs with the PC35, they include relays, SSR, pulsed DC, and one 0/4-20mA. Outputs 1, 2, 3, 4, and are designated for these outputs. Therefore, **Io 1** to **Io 4** are the designated outputs for the relays, SSR, pulsed DC, and **Io 5** is the designated output for the 0/4-20mA analog output. If **Io 1** or **Io 2** is to be used for main output control then select code **5** from Table 5 on page 25 for one of the two outputs using the ▲ or ▼ keys otherwise select **0**. If **Io 5** (4-20mA) is to be used for main output control then select code **12** using the ▲ or ▼ keys otherwise select **0**.

4. **Output Alarm Configuration:** Once the output control is configured in Cycle-6, then up to 2 alarms can be configured as well. Use Table 5 on page 25 to configure which outputs will be used for alarms. For example, if **Io 1** is used as the main output control then **Io 2** can be selected for either Alarm 1 through 4 (codes 1 through 4) by pressing ▲ or ▼ keys. The same applies to **Io 5**.
   Note: Two I/O's cannot be configured for the same alarm output.

5. **Alarm Functions:** After the Alarms are configured for the designated I/O's the alarm functions can be programmed. Press and hold the **SET UP key** to move rapidly back to the Operation Cycle. Press and hold the **BACK key** then press the **SET UP key** 3 times or until **FuA1** is displayed in the PV display. This is Alarm 1 Function. Select the parameter for this function by using the ▲ or ▼ keys. See Table 2 on page 20 for alarm functions. After the 1st alarm function is selected press the **SET UP** key to move to the next, **FuA2** and select the 2nd alarm function from Table 2. A full description of alarm configurations is shown on page 19.

6. **Alarm Set Points:** To set the alarm set points press and hold the **SET UP** key to move back to Cycle 1. Then press and hold the **BACK key** and press the **SET UP key** once or until **AtUn** is displayed in the PV display. This is the General Tuning Cycle (Cycle-2). Use the **SET UP key** to move through the cycle until **SPA1** is displayed in the PV display. Use the ▲ or ▼ keys to select the set point for Alarm 1. Press the **SET UP key** again to move to the set point for Alarm 2 and do the same. The Alarm(s) are now configured.

7. **Auto Tune & Cycle Time:** In the General Tuning Cycle use the **BACK key** to move to the top of the menu to **AtUn**. This is the Auto Tuning parameter. Use the ▲ or ▼ keys to select **YES** in the SV display. This enables the PID Auto Tuning function. The default for the Cycle Time in the menu cycle is 16 seconds. If a different Cycle Time is required then press the **SET UP key** until **Ct** is displayed in the PV display. Change the Cycle Time by pressing the ▲ or ▼ keys to the desired setting. The controller is now ready for basic process operation.

8. **Set Point:** Press and hold the **SET UP key** to move rapidly back to Cycle 1. Program the set point in by pressing the ▲ or ▼ keys in the Operation Cycle to increase or decrease the set point to the desired value.

9. **Enable Process Outputs:** Press the **SET UP key** to display **Auto** and press the ▲ or ▼ to select **YES**. This allows automatic operation. Press **SET UP key** again until **run** is displayed in the PV then press the ▲ or ▼ keys to select **YES**. All outputs are now enabled and the controller is fully operational.

NOTES:

Error Codes Table for Temperature/Process Controllers

Document # C0504

The connection and configuration errors for most of the problems encountered in using the controller are shown below. A final revision of the connections and parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

Error Codes Table

Display Shows	Cause
____	Process or temperature is below the selected sensor range.
----	Process or temperature is above the selected sensor range.
Erro	Sensor error. Example: 1. No connections on the sensor input terminals. 2. Broken thermocouple (open wire) or broken RTD-Pt100. 3. RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 1	RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 6	This kind of error is caused when, for instance, a 4-20mA signal goes through the mV or Thermocouples input and can introduce signals of up to 30VDC at the input point and force the Auto/Zero and Auto/Span to work outside the limits that guarantee the precision of the controller. This error goes away when the signal is removed from the input and the connection is fixed (normally, input signals of up to 30VDC do not damage the controller's hardware).
Err 2	Auto/Zero Problem: This error is caused by a wong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Zero circuit was damaged. It is necessary to revise the controller.
Err 4	Auto/Span Problem: This error is caused by a wrong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Span circuit was damaged. It is necessary to revise the controller.

NOTE: The controllers do not accept AC-Voltage or AC-Current in the sensor input. This type of signal can damage the controller.

AutomationDirect

PM24

Configuration Sheet

Part#:			**Name:**
Project:			**Date:**
Process Setpoint:			
Cycle 3 **CONFIGURATION**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
tYPE	1		
dPPo	0		
Un It	0		
InLL	-150		
InHL	1370		
A1FU	0		
A2FU	0		
A1HY	1		
A2HY	1		
Prot	1		
Cycle 2 **ALARMS**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
A1SP	610		
A2SP	610		
ALrE	-150		

AutomationDirect

1/16 DIN Series

Operator's Manual

PM24

Microprocessor-Based Process/Temperature Limit Controller

PM24 Operator's Manual
Manual Rev. 2.2
Firmware Version 1.50
March 2003

Made In USA

Technical Support

We strive to make our manuals the best in the industry. We rely on your feedback to let us know if we are reaching our goal. If you cannot find the solution to your particular application, or, if for any reason you need additional technical assistance, please call us at 770-844-4200.

Our technical support group is glad to work with you in answering your questions. They are available weekdays from 9:00am to 6:00pm Eastern Standard Time. We also encourage you to visit our website where you can find technical and non-technical information about our products and our company. Visit us at www.automationdirect.com for additional information and FAQ's on our process controllers.

General Safety Information

Electrical Hazards and Warnings

Prior to connecting the controller, read the user's manual for proper connection and operating information.

Follow National Electrical Code (NEC) safety requirements when wiring and connecting a power source and sensors or other devices to the controller. Failure to do so could result in injury, death or damage to equipment and property.

Make sure the proper input voltage is applied to the controller. Improper voltage will result in damage to the unit.

Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician.

All terminal screws must be tightened securely. Terminal screws not properly secured can cause an electrical short that may damage property, equipment or cause injury or death. Terminal screws improperly secured may fall into equipment causing possible damage to property or equipment.

This instrument is not intended for use in life safety applications.

Important: For applications where physical injury or equipment damage might occur in the event our product fails, we recommend the installation of independent safety equipment with its own independent sensor that will shut down the process.

Important: Firmware version of controller must match the version indicated on the bottom front cover of this manual.

PM 24 Limit Controller

Table of Contents

1/16 DIN Series
PM24 Operator's Manual
Manual Rev. 2.2
Firmware Version 1.50

PM24
1/16 DIN Microprocessor-Based Temperature/Process Limit Controller

1. MAIN FEATURES

- Process/Temperature multi-sensor input, without hardware change.
- Accepts 7 thermocouples, RTD-Pt100, DC mA, mV and Volts. All inputs are factory calibrated.
- Programmable Scaling: -1999 to 9999 with selectable decimal point for: mA, mV and Volts input.
- Selectable ºF/ºC temperature.
- RTD-Pt100 with 1º temperature resolution: -326 to 986ºF (-199 to 530ºC), and 0.1º temperature resolution: -199.9 to 986.0ºF (-199.9 to 530.0ºC).
- Input sample rate: 10 reading per second (100 ms).
- Output Alarms: Dual stationary SPST Alarm Relays, with individual hysteresis adjustment.
- Sensor break protection in any condition.
- Easy-to-set programming menu.
- Firmware version displayed during power up.
- High impact ABS enclosure.
- Dimensions: 48x48x106mm.
- Power: 90 to 260Vac.

2. SPECIFICATIONS

- Dimensions: 48 x 48 x 106mm (1/16 DIN) Approximate weight: 200g max.
- Panel cut-out: 45.5 x 45.5mm (± 0.3mm)
- Terminal connection: screws, accepting 16 – 24 AWG or 6.3 mm fork lugs.
- Power: 90 to 260Vac, 50/60Hz, Consumption: 7VA max.
- Operating environment: 0 to 50°C (32 to 122°F, humidity: 10 to 90% RH, non-condensing.
- Flame-Retardant ABS Plastic Case.
- Warm-up time: 15 minutes max.

INPUT

- Keypad selection of input type (refer to table 1)
- Display resolution : 0.1ºF/C or 1ºF/C (RTD-Pt100),
  -1999 to 9999 fully scalable for mA, mV and Volts input
- Input sample rate: 10 per second (100 ms)
- Accuracy : Thermocouples J, K, T, E, N: 0.2% of span, ±1ºC, ±1 digit
  Thermocouples R, S: 0.25% of span, ±3ºC, ±1 digit
  Pt100, mA, mV and Volts: 0.2% of span, ±1 digit
- Input impedance: 0-50mV and thermocouples: >10MΩ
  0-10 Volts DC: >1MΩ
  4-20 mADC: 100 Ω
- Pt100 measurement: DIN 43760 standard (α=0.00385).
  3-wire circuit, cable resistance compensation.
  Excitation current: 170μA.

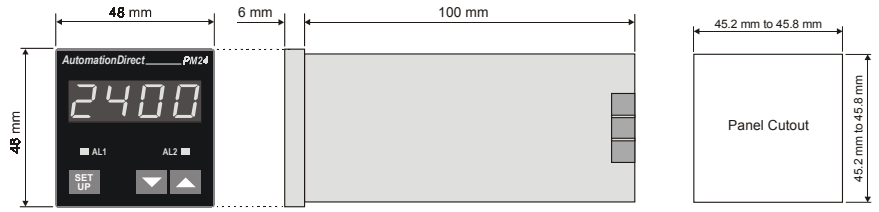
SENSOR WIRE INPUT:

- **Thermocouples** are connected to terminals 2(+) and 3(-), with positive on terminal 2.
- **Voltage signals up to 50 mV** should be connected to terminals 2(+) and 3(-).
- **Pt100 sensors** are connected to terminals 1, 2 and 3, as indicated in this manual. For full compensation of cable resistance only cables with equal wire electrical resistance should be used.
- **Voltage signals up to 10 Vdc** should be connected to terminals 5(+) and 3(-)
- **Current 4 to 20mA** signals should be connected to terminals 4 (+) and 3 (-).

OUTPUT:

- Two SPST Relays (without contact suppression):
  Resistive: 3A @ 250VAC / 3A @ 125VAC / 3A @ 30VDC
  Inductive: 2A @ 250VAC / 2A @ 30VDC
  Dielectric Strenght: 750Vrms between open contacts (at sea level for 1 min.)

2.1 MAIN DIMENSIONS AND CUTOUT:

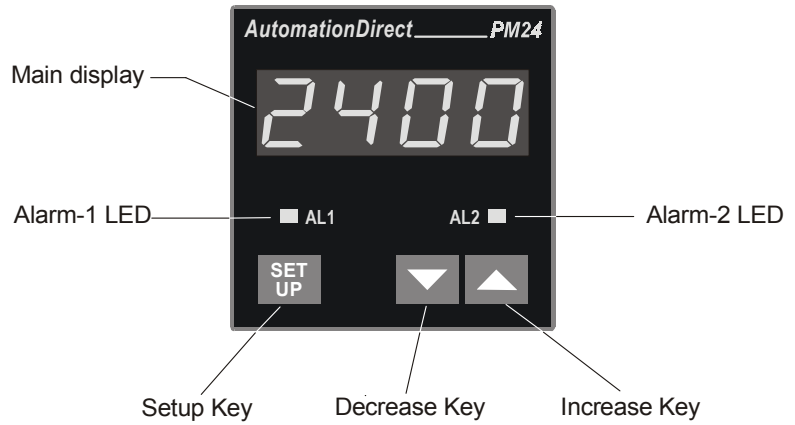


(not to scale)

(Figure 1)

3. OPERATION

Operator Interface



(Figure 2)

Main display - PV: Displays the PV (**P**rocess **V**ariable) value, and used when configuring the parameters of the controller.

Alarm 1 - AL1 LED: status of the alarms, (LED On = alarm active).

Alarm 2 - AL2 LED: status of the alarms, (LED On = alarm active).

SETUP key: used to set up the menu cycles.

DECREASE key: used to change parameter values.

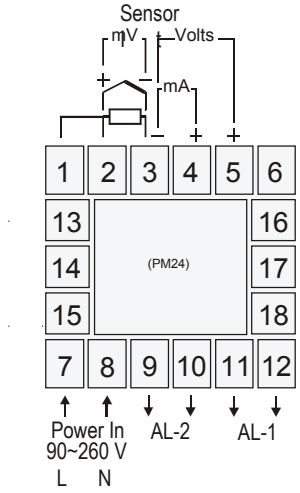
INCREASE key: used to change parameter values.

IMPORTANT:

When the controller is turned on, the firmware version is displayed for approximately 4 seconds, after which the controller starts normal operation. The value of PV is displayed and the outputs are enabled after 6 seconds.

Prior to first operation, the controller should be fully configured. The user must set basic parameters such as input type ("tYPE"), alarm set points ("A1SP" and "A2SP"), etc.

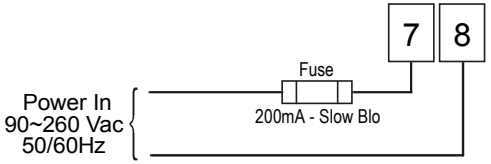
3.1 ELECTRICAL CONNECTIONS:



(Figure 3)

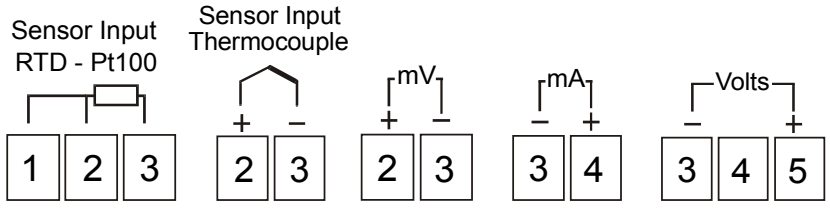
3.2 POWER WIRING:

AC Voltage Power Wiring



Note: The installation of fuse is optional, depending on level of protection required.

3.3 INPUT SIGNAL WIRING:

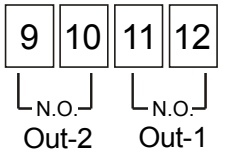


(Figure 4)

NOTE: Use copper conductors rated for at least 75 ºC. For Thermocouple sensors use appropriate compensated thermocouple wires.

3.4 OUTPUT ALARM WIRING:

Dual SPST Relay
Output Alarms



(Figure 5)

3.5 PANEL ASSEMBLY:

First remove the mounting clamp and insert the controller into the panel cut out. Place the unit into the panel cutout and slide the mounting clamp from the rear to a firm grip at the panel.

The internal circuitry can be fully removed from the housing without disconnecting any wiring. By using the thumb, just press the tab in the lower part of the front panel, grab the front panel firmly and pull the front face and circuitry from the housing.

Warning: Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician. It is recommended that power to the controller be disconnected prior to removing the controller from the case.

3.6 ERROR MESSAGES:

The connection and configuration errors for most of the problems encountered when using the controller are shown below.

Error messages are displayed to help the user to identify possible problems.

: Process temperature is below the selected sensor range.

: Process temperature is above the selected sensor range

: Controller or sensor error.

Example: - Broken (open) thermocouple, mA, mV or Volts open loop.
- Pt100 badly connected, short-circuited, open, or high cable resistance.

4. MENU SYSTEM:

The Parameter Menu System is organized into four basic cycles. This is shown in the chart below.

Cycle
1 – Indication
2 – Alarms
3 – Configuration
4 – Calibration

4.1 INITIAL STARTUP

When the controller is initially energized the Firmware version is displayed for approximately 4 seconds after which the controller reverts to the normal operation mode in the **Indication** cycle. The value of the process variable (**PV**) is displayed and the outputs are enabled after 6 seconds.

Important: The Firmware version of the controller must match the version indicated on the bottom front cover of this manual.

4.2 SETUP CYCLE PARAMETER ACCESS:

The Indication cycle is the default cycle for the controller and only shows the PV. All other cycles have parameters that can be accessed and changed to configure the controller as needed.

The cycles need only to be accessed when a change of parameters is necessary. To reach the other parameters the user must keep the **SETUP key** pressed for approximately 4 seconds. After this time the controller will display the first parameter of the next cycle. By keeping the **SETUP key** pressed for another 3 seconds the next cycle will be accessed.

Release the **SETUP key** when the desired cycle is reached. Press the **SETUP key** once to access the next parameter in the same cycle or quickly press the **SETUP** key to move through the parameters in the cycle. After the last parameter in a cycle is reached, pressing the SETUP key one last time will bring the controller back to the **Indication** cycle (**Cycle-1**). The display will also revert to the **Indication** cycle after 20 seconds if the parameters in a cycle are not changed.

Once in a desired parameter the display will alternate the name and value. The value can then be changed by pressing the ▼ or ▲ key.

The following page shows the Cycle Parameter Menu.

Cycle Parameter Menu

Cycle-1	Cycle-2	Cycle-3	Cycle-4
INDICATION	ALARMS	CONFIGURATION	CALIBRATION
PV Indication	A1SP Alarm 1	tYPE Input Type	InLC Input Low Calibration
	A2SP Alarm 2	dPPo Decimal Point Position	InHC Input High Calibration
	ALrE Differential	un It Unit	CJL Cold Junction Low Calibration
		InLL Input Low Limit	
		InHL Input High Limit	
		OFFS Offset Signal Input	
		A1Fu Alarm 1 Funtion	
		A2Fu Alarm 2 Funtion	
		A1HY Alarm 1 Hysteresis	
		A2HY Alarm 2 Hysteresis	
		Prot Security Protection	

NOTE: Any changed parameter is saved into non-volatile memory when scrolling to the next parameter or 20 seconds after the new parameter is changed.

4.3 DIGITAL SERIAL NUMBER ACCESS:

To read the controller's serial number (8 digits), hold down the ▲ key for a few seconds and the first four digits will appear on the display. To read the second four digits, hold down the ▼ key for a few seconds and the second four digits will appear on the display, completing the 8 digits serial number.

The serial number is recorded in the factory and cannot be changed.

5. CONTROLLER CONFIGURATION

The Configuration section gives information on parameter settings in each Cycle which will help to configure the controller for the desired operation. **However, the first parameter that needs to be programmed is the Input Type (tYPE) in the Configuration cycle, Cycle-3 (see section 5.3 page 11, and Table 1 page 12).** This will determine the scale for all other parameter values, i.e.: a J thermocouple has different temperature range than a K thermocouple and will have a different setpoint range.

5.1 CYCLE 1 – OPERATION:

PV INDICATION	After power up the display indicates the measured value proportional to the input signal.

5.2 CYCLE 2 – ALARM SETPOINTS:

Low and high alarms are used to signal minimum and maximum temperature values as programmed in the "A1SP" and "A2SP" prompts

A1SP Alarm 1	**SETPOINT for Alarm 1**: Tripping point for alarm 1 (see Table 2, page 13).
A2SP Alarm 2	**SETPOINT for Alarm 2**: Tripping point for alarm 2 (see Table 2, page 13).
ALrE **Al**arm **Re**ference (Diferential)	**REFERENCE VALUE FOR DIFFERENTIAL ALARM**: a value in respect to which the differential, differential low, and differential high alarms will be set. **Valid for alarms type 2, 3, 4, 8, 9, and 10 (see Table 2, page 13).**

5.3 CYCLE 3 – INPUT TYPE, AND ALARMS CONFIGURATION:

tYPE **Type**	**INPUT TYPE:** Selects the input sensor type to be connected to the indicator. **Default: 1 (T/C Type K)** ***"This is the first parameter to be set"*** (Refer to Table 1, page 12).
dPPo **D**ecimal **P**oint	**DECIMAL POINT POSITION:** Available only for input types 18, 19 or 20. Defines the number of digits to be shown after the decimal point. Programmable from 0 to 3. **Default: 0**
un It **unit**	**TEMPERATURE UNIT:** Selects display indication for degrees Celsius or Fahrenheit. **Default: 0** 0 - degrees Celsius (°C) 1 - degrees Fahrenheit (°F)
InLL **In**put **L**ow **L**imit	**INPUT LOW LIMIT:** Available for input types from 9 to 20. Defines the lowest value to be displayed when the input signal is at its lower value. For input types from 0 to 8 it defines the lowest alarm set point value. **Default: -150**
InHL **In**put **H**igh **L**imit	**INPUT HIGH LIMIT:** Available for input types from 9 to 20. Defines the highest value to be displayed when the input signal is at its upper value. For input types from 0 to 8 it defines the highest alarm set point value. **Default: 1370**
OFFS **Offs**et Input	**OFFSET SIGNAL INPUT:** Offset value to be added to the PV to compensate sensor error. **Default: 0**
A1Fu **A**larm **1** **Fu**nction	**FUNCTION OF ALARM 1:** Refer to Table 2, page 13, for function description and respective codes to set at this prompt. **Default: 0**
A2Fu **A**larm **2** **Fu**nction	**FUNCTION OF ALARM 2:** Refer to Table 2, page 13, for function description and respective codes to set at this prompt. **Default: 0**
A1HY **A**larm **1** **Hy**steresys	**ALARM 1 HYSTERESIS:** Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off (in engineering units). **Default: 1**
A2HY **A**larm **2** **Hy**steresys	**ALARM 2 HYSTERESIS:** Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off (in engineering units). **Default: 1.**
Prot **Prot**ection	**FUNCTION PROTECTION:** See description and Figure 8 on page 15, and Figure 9 on page 16. **Default: 1** 0 = No protection, all cycles can be accessed. 1 = No access to cycle 4 2 = No access to cycle 3, and cycle 4. 3 = No access to cycle 2, cycle 3, and cycle 4.

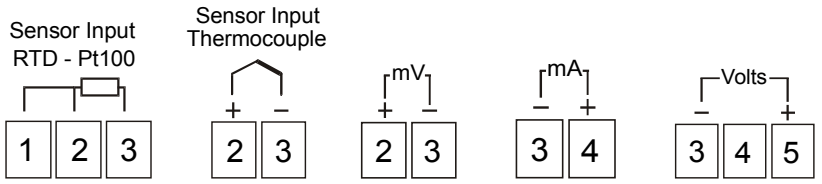
Input Type:

Table 1 – Input Type:

INPUT TYPE	CODE	RANGE
Thermocouple **J**	0	-166 to 1400°F (-110 to 760°C)
Thermocouple **K**	1	-238 to 2498°F (-150 to 1370°C)
Thermocouple **T**	2	-256 to 752°F (-160 to 400 °C)
Thermocouple **E**	3	-130 to 1328°F (-90 to 720°C)
Thermocouple **N**	4	-238 to 2372°F (-150 to 1300°C)
Thermocouple **R**	5	32 to 3200°F (0 to 1760°C)
Thermocouple **S**	6	32 to 3200°F (0 to 1760°C)
Pt100 (Resolution 0.1°)	7	-199.9 to 986.0°F (-199.9 to 530.0°C)
Pt100 (Resolution 1°)	8	-326 to 986°F (-199 to 530°C)
4 to 20mA	9	Linearized J: -166 to 1400°F (-110 to 760°C)
4 to 20mA	10	Linearized K: -238 to 2498°F (-150 to 1370°C)
4 to 20mA	11	Linearized T: -256 to 752°F (-160 to 400 °C)
4 to 20mA	12	Linearized E: -130 to 1328°F (-90 to 720°C)
4 to 20mA	13	Linearized N: -238 to 2372°F (-150 to 1300°C)
4 to 20mA	14	Linearized R: 32 to 3200°F (0 to 1760°C)
4 to 20mA	15	Linearized S: 32 to 3200°F (0 to 1760°C)
4 to 20mA	16	Linearized Pt100: -199.9 to 986.0°F (-199.9 to 530.0°C)
4 to 20mA	17	Linearized Pt100: -326 to 986°F (-199 to 530°C)
0 to 50mV	18	Linear. Programmable range from -1999 to 9999
4 to 20mA	19	Linear. Programmable range from -1999 to 9999
0 to 10V	20	Linear. Programmable range from -1999 to 9999

NOTE: In case of sensor break or failure an error "**Erro**" message is displayed.

Wires Sensor Input



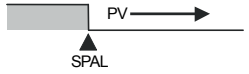
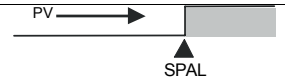
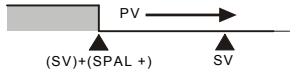
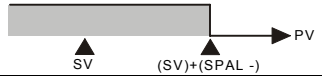
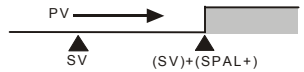
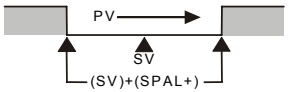
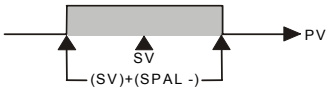
(Figure 6)

Notes: 1) For Thermocouple Sensors use appropriate compensated thermocouple wires.

2) Use copper conductors rated for at least 75 ºC (except on T/C).

Alarm Type:

Table 2 – Alarm Type

TYPE	CODE	ACTION
Low Alarm (Low Process Alarm)	0	**Low SPAL** 
High Alarm (High Process Alarm)	1	**High SPAL** 
Differential Low (Deviation Low)	2	**Dif-Low SPAL+**  **Dif-Low SPAL-** 
Differential High (Deviation High)	3	**Dif-High SPAL+**  **Dif-High SPAL-** 
Differential (Band Alarm)	4	**Dif-SPAL+**  **Dif-SPAL-** 
Input Sensor Error	5	**Alarm is ON whenever:** • Process is below selected range. • Process is above selected range. • Thermocouple or Pt100 is broken (open). • Pt100 is shorted, badly connected or wire impedance is too high.
(Alarm Functions) Alarm with inhibition at power-up	6	**Low alarm** disabled at power-up
	7	**High alarm** disabled at power-up
	8	**Differential low** limit alarm disabled at power-up
	9	**Differential high** limit alarm disabled at power-up
	10	**Differential** alarm disabled at power-up

(where SPAn means: **A 1SP** and **A2SP**)

Alarm Functions:

Low Alarm: Activates at present value, independent of main setpoint. Low process-alarm activates at and below alarm setting.

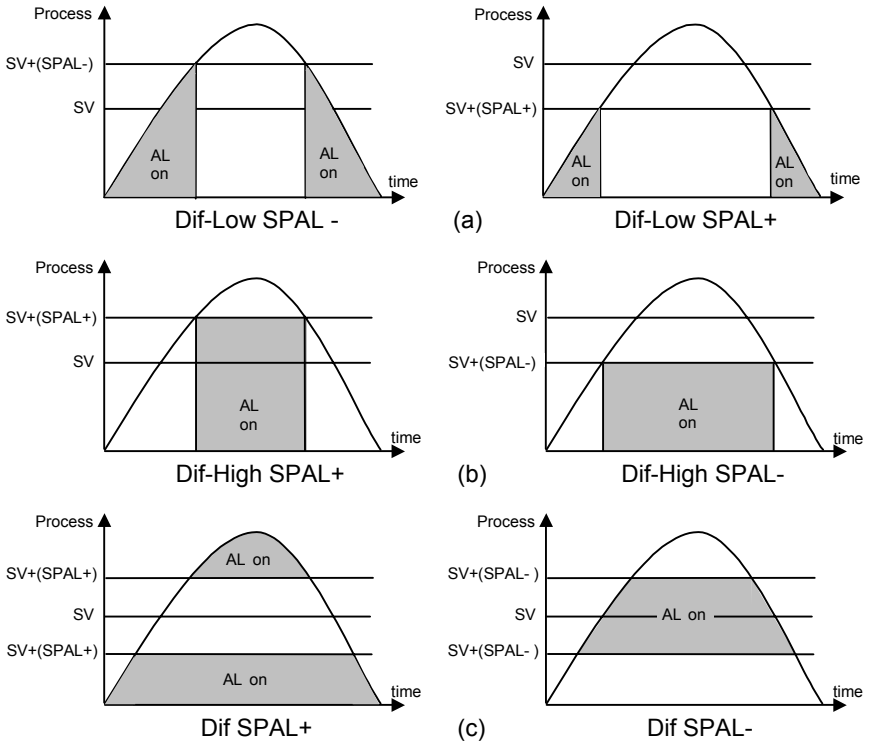
High Alarm: Activates at present value, independent of main setpoint. High process-alarm activates at and above alarm setting.

Differential Low: Activates at present deviation (negative or positive) value from Alarm Reference (**ALrE**). Low deviation-alarm activates below alarm setting. Figure 7(a) gives a graphical description of this.

Differential High: Activates at present deviation (negative or positive) value from Alarm Reference (**ALrE**). High deviation-alarm activates above alarm setting. This is represented in figure 7(b).

Differential: Activates when the process exceeds a specified band-alarm centered around the Alarm Reference (**ALrE**). See Figure 7(c).

Inhibition at power-up: Alarm blocking at power-up inhibits the relay alarm from activating when the unit is first energized. The alarm will only trip after the process variable reaches a new alarm situation.



(Figure 7)

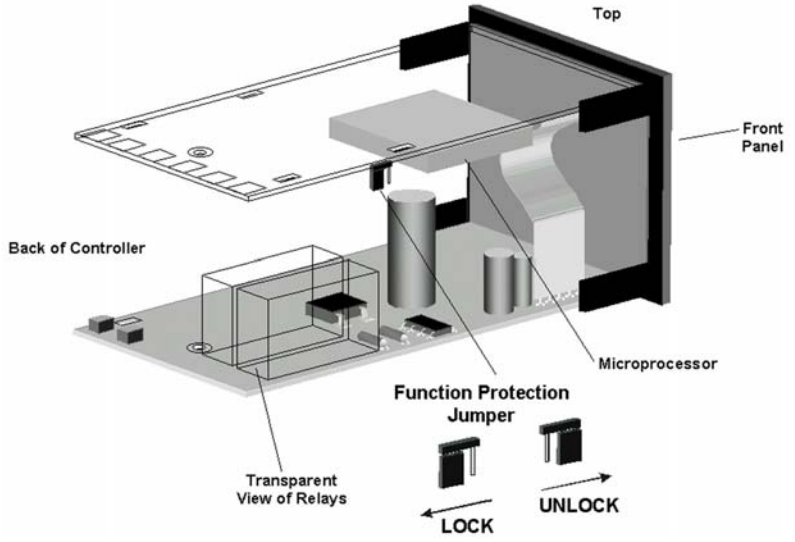
*Function Protection (**Prot**):*

The controller is shipped with full accessibility. If you want to use the "Function Protection" to disable access to cycles 2, 3 and 4, follow the steps below:

- After programming the controller for the desired operation select the level of cycle access desired in Cycle-3 at the **prot** parameter using the ▼ or ▲ keys.
- Remove the controller circuitry from the housing by using the thumb to press the tab in the lower front face of the controller, then, while firmly grabbing the front face at the top and bottom pull it and the circuitry from the case.

Warning: Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician. It is recommended that power to the controller be disconnected prior to removing the controller from the case.

- View the controller in the position shown in Figure 8 and note the Protection Jumper on the top main board.
- **Enable Function Protection** (locks the **Prot** parameter) by placing the jumper over both jumper prongs as shown in figure below.
  Needle nose pliers are recommended for changing jumper position.
- **Disable Function Protection** (unlocks the **Prot** parameter) by placing the jumper over both jumper prongs as shown in figure below.
- Once the desired protection is obtained slide the controller back in the case making sure that the main board and power supply board stay in the circuit board channels at the top and bottom side walls of the case. Use the palm of the hand to press the front panel flush into the controller housing.



(Figure 8)

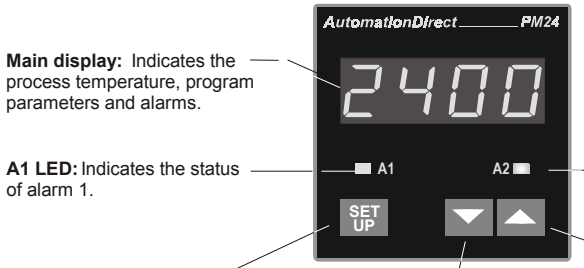
CYCLE 4 - CALIBRATION LEVEL:

NOTE: *All input and output types are factory calibrated. This cycle should only be accessed by experienced personnel. If in doubt do not press the ▼ or ▲ keys in this cycle.*

InLC **In**put **L**ow **C**alibration	**SENSOR OFFSET CALIBRATION**. Sets the temperature sensor low calibration (offset). The display shows only the corrected temperature and not the offset added. A signal simulator should be used to inject a low value signal to properly adjust the offset.
InHC **In**put **H**igh **C**alibration	**INPUT HIGH CALIBRATION**. Sets the sensor input circuit gain or high calibration. A signal simulator should be used to inject a high value signal to properly adjust the offset.
CJ L **C**old **J**unction **L**ow **C**alibration	**COLD JUNCTION OFFSET CALIBRATION**: Sets the cold junction °C offset calibration. A good thermometer or a temperature simulator should be used to properly adjust this parameter.

PM24 Quick Setup Reference

Key and Display Functions



Main display: Indicates the process temperature, program parameters and alarms.

A1 LED: Indicates the status of alarm 1.

A2 LED: Indicates the status of alarm 2.

SET UP: Used to move forward throught a menu Cycle. Used to advance to the next Cycle when pressed and held for 4 seconds.

▲: Used to increase the value of the displayed parameter.

▼: Used to decrease the value of the displayed parameter.

Set Up Cycle Parameters

Cycle-1	Cycle-2	Cycle-3	Cycle-4
INDICATION	ALARMS	CONFIGURATION	CALIBRATION
PV Indication	A 1SP Alarm 1	tYPE Input Type	InLC Input Low Calibration
	A2SP Alarm 2	dPPo Decimal Point Position	InHC Input High Calibration
	ALrE Differential	un It Unit	CJL Cold Junction Low Calibration
		InLL Input Low Limit	
		InHL Input High Limit	
		OFFS Offset Signal Input	
		A 1Fu Alarm 1 Funtion	
		A2Fu Alarm 2 Funtion	
		A 1HY Alarm 1 Hysteresis	
		A2HY Alarm 2 Hysteresis	
		Prot Security Protection	

Quick Set Up

This quick reference setup is intended to be used by experienced users that are familiar with the PM24 set up menu or those that need only basic limit alarm operation. This guide will show how to configure the input and basic alarm functions. For detailed programming information refer to the Table of Contents to find the required instructions for a particular function. Follow these steps:

1. **Indication**: Connect Power and Input wiring to the proper terminal connections (page 6). After power-up the controller is in the **Indication** Cycle and shows the PV in the display.

2. **Input Type**: Press and hold the **SETUP** key until tYPE is shown in the display, approximately 7 seconds. Select the Input Type from **Table 1** on page 12 by using the ▼ or ▲ keys. If Input Type is linear (codes 18,19 or 20) proceed to 3. If Input Type is temperature (codes 0 – 17) proceed to 4.

3. **Decimal Point Position: Used only if input is linear, Input Types 18,19 or 20.** After selecting the Input type in Cycle-3 press the **SETUP** key once until dPPo is shown in the display. Select the desired decimal point position using the ▼ or ▲ keys.

4. **Unit: Used only if Input Type is temperature, Input Types 0 – 17.** After selecting the Input Type in Cycle-3 press the **SETUP** key twice until Un It is shown in the display. Using the ▼ or ▲ keys select the unit, 0 = °C and 1 = °F.

5. **Alarm Functions:** While still in Cycle-3 press the **SETUP** key a few times until A1Fu is shown in the display. Select the Alarm Type from Table 2 on page 13 using the ▼ or ▲ keys. If another limit alarm is desired then press the **SETUP** key once until A2Fu is shown in the display then select the Alarm Type for alarm 2.

6. **Alarm Set Points:** After setting up the Alarm Functions press the SETUP key several times until the Indication Cycle is reached (PV display). From the Indication Cycle press and hold the **SETUP** key for approximately 4 seconds until A1SP is shown in the display, Cycle-2. Select the value of the set point for Alarm 1 using the ▼ or ▲ keys. If a second alarm limit was programmed, then press the SETUP key once until A2SP is shown in the display. Select the value of the set point for this alarm using the ▼ or ▲ keys as well. This will set up the controller for limit alarm operation.

All parameter settings are stored in non-volatile memory when scrolling to the next parameter or if the value has not been changed within a 20 second period.

NOTES:

PM24

Configuration Sheet

Name:_____ Date:_____

Part#: _____

Project:_____

Process Setpoint:			
Cycle 3 CONFIGURATION	Default	CODE/VALUE	CHARACTERISTICS / FUNCTION
tYPE	1		
dPPo	0		
Un It	0		
I n.LL	- 150		
I n.HL	1370		
A 1FU	0		
A2FU	0		
A 1HY	1		
A2HY	1		
Prot	1		
Cycle 2 ALARMS	Default	CODE/VALUE	CHARACTERISTICS / FUNCTION
A 1SP	6 10		
A2SP	6 10		
ALrE	- 150		

Error Codes Table for Temperature/Process Controllers

Document # C0504

The connection and configuration errors for most of the problems encountered in using the controller are shown below. A final revision of the connections and parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

Error Codes Table

Display Shows	Cause
_ _ _ _	Process or temperature is below the selected sensor range.
- - - -	Process or temperature is above the selected sensor range.
Erro	Sensor error. Example: 1. No connections on the sensor input terminals. 2. Broken thermocouple (open wire) or broken RTD-Pt100. 3. RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 1	RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 6	This kind of error is caused when, for instance, a 4-20mA signal goes through the mV or Thermocouples input and can introduce signals of up to 30VDC at the input point and force the Auto/Zero and Auto/Span to work outside the limits that guarantee the precision of the controller. This error goes away when the signal is removed from the input and the connection is fixed (normally, input signals of up to 30VDC do not damage the controller's hardware).
Err 2	Auto/Zero Problem: This error is caused by a wong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Zero circuit was damaged. It is necessary to revise the controller.
Err 4	Auto/Span Problem: This error is caused by a wrong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Span circuit was damaged. It is necessary to revise the controller.

NOTE: The controllers do not accept AC-Voltage or AC-Current in the sensor input. This type of signal can damage the controller.

AutomationDirect

TC33

Configuration Sheet

Part#:			**Name:**
Project:			**Date:**
Main Setpoint (SV):			
Cycle 3 **CONFIGURATION**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
tYPE	1		
Un It	0		
Act	0		
Cntr	2		
SPHL	1370		
A1FU	0		
A2FU	0		
Cycle 2 **ALARMS**	**DEFAULT**	CODE/VALUE	CHARACTERISTICS / FUNCTION
Atun	0		
Pb	10.0		
Ir	0.00		
dt	0		
ct	0.5		
HYSt	0		
A1SP	610		
A2SP	610		
Cycle 1 **OPERATION**	**DEFAULT**		
rAtE	0.0		
t SP	0		
run	1		

AutomationDirect

1/16 DIN Series

Operator's Manual

TC33

PID Microprocessor-Based Temperature Controller

TC33 Operator's Manual
Manual Rev. 2.2
Firmware Version 1.40
July 2003

Made In USA

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General Safety Information

Electrical Hazards and Warnings

Prior to connecting the controller, read the user's manual for proper connection and operating information.

Follow National Electrical Code (NEC) safety requirements when wiring and connecting a power source and sensors or other devices to the controller. Failure to do so could result in injury, death or damage to equipment and property.

Make sure the proper input voltage is applied to the controller. Improper voltage will result in damage to the unit.

Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician.

All terminal screws must be tightened securely. Terminal screws not properly secured can cause an electrical short that may damage property, equipment or cause injury or death. Terminal screws improperly secured may fall into equipment causing possible damage to property or equipment.

This instrument is not intended for use in life safety applications.

Important: For applications where physical injury or equipment damage might occur in the event our product fails, we recommend the installation of independent safety equipment with its own independent sensor that will shut down the process.

Important: Firmware version of controller must match the version indicated on the bottom front cover of this manual.

TC33 Temperature Controller

Table of Contents

1/16 DIN Series
TC33 Operator's Manual
Manual Rev. 2.2
Firmware Version 1.4x

TC33
1/16 DIN - PID Autotune Temperature Controller

1. MAIN FEATURES

- Temperature multi-sensor input without hardware change.
- Accepts thermocouples J, K, S, T, N, E, R, and RTD-Pt100.
- Dual Display: PV (red) and SV (green).
- Selectable ºF/ºC temperature.
- RTD-Pt100 with 1º temperature resolution: -328 to 986ºF (-200 to 530ºC), and 0.1º temperature resolution: -199.9 to 986.0ºF (-199.9 to 530.0ºC).
- Input sample rate: 10 reading per second (100 ms).
- Isolated 4 to 20mA linear control output, optional.
- Ramp and Soak: one controlled ramp and one timed soak are standard.
- Auto-tuning PID control, or manual PID control, or ON/OFF control with hysteresis adjust.
- Sensor break protection in any condition.
- Independent alarm hysteresis adjust.
- Easy-to-set programming menu.
- Firmware version displayed during power up.
- Digital serial number.
- High impact ABS enclosure.
- Dimensions: 48x48x106mm.
- Power: 90 to 260Vac, 50/60Hz.

2. SPECIFICATIONS

- Dimensions: 48 x 48 x 106mm (1/16 DIN) Approximate weight: 200g max.
- Panel cut-out: 45.5 x 45.5mm (± 0.3mm)
- Terminal connection: screws, accepting 16 to 24 AWG wires or 6.3 mm fork lugs.
- Power: 90 to 260Vac, 50/60Hz, Consumption: 7VA max.
- Operating environment: 0 to 50°C (32 to 122°F), humidity: 10 to 85% RH, non-condensing.
- Flame-Retardant ABS Plastic Case.
- Warm-up time: 15 minutes max.

INPUT

- Keypad selection of input type (refer to Cycle 3).
- Display resolution: 0.1ºF/C or 1ºF/C (RTD-Pt100).
- Input sample rate: 10 per second (10Hz).
- Accuracy: Thermocouples J, K, T, N, E: 0.2% of span, ±1ºC, ±1 digit.
  Thermocouples S, R: 0.25% of span, ±3ºC, ±1 digit.
  Pt100: 0.2% of span, ±0.5ºC, ±1 digit.
- Input impedance: Thermocouple: >10MΩ
- Pt100 measurement: DIN 43760 standard (α=0.00385).
  3-wire circuit, cable resistance compensation.
  Excitation current: 170μA.

PID CONTROL:

- User-selectable as: ON-OFF w/ adjustable hysteresis, or manual P, PI, PID and PID-Autotune.
- Proportional Band (Pb): 0 = ON/OFF control; or 1% to 500% of maximum input span.
- Integral (Ir): 0 = off; or 0.01 to 25.00 rep/minutes
- Derivative (Dt): 0 = off; or 1 to 250 seconds.
- Cycle-Time: 0.5 to 99.9 seconds (for PWM-PID output control).
- PID-Autotune: start from the front panel.

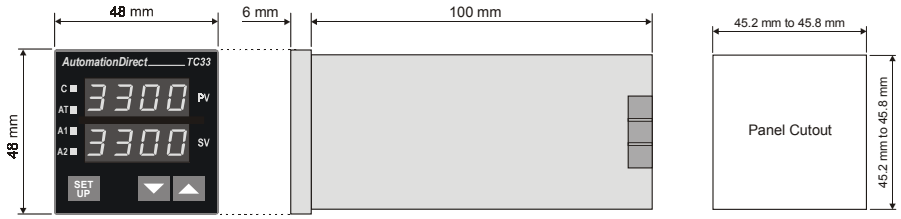
OUTPUT: model TC33-1100-AC:

- One isolated Pulsed DC Output Control (12Vdc pulsed @ 15mA max.).
- One SPST Relay Alarm (without contact suppression):
  Resistive: 3A @ 250VAC / 3A @ 125VAC / 3A @ 30VDC
  Inductive: 2A @ 250VAC / 2A @ 30VDC
  Dielectric Strenght: 750Vrms between open contacts (at sea level for 1 min.)

OUTPUT: model TC33-2010-AC:

- One isolated Linear Control sourcing 4-20mA output @ 500 ohms max. load.
- Two SPST Relay Alarms (without contact suppression):
  Resistive: 3A @ 250VAC / 3A @ 125VAC / 3A @ 30VDC
  Inductive: 2A @ 250VAC / 2A @ 30VDC
  Dielectric Strenght: 750Vrms between open contacts (at sea level for 1 min.)

2.1 MAIN DIMENSIONS, AND PANEL CUTOUT:

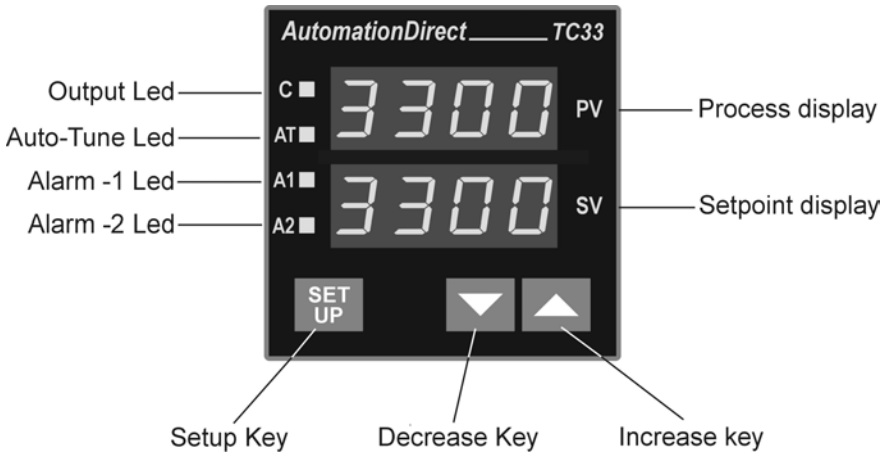


(Not to scale)

(Figure 1)

3. OPERATION

Operator Interface



(Figure 2)

Process Display - PV: shows the PV (**P**rocess **V**ariable) value, and used when configuring the parameters of the controller.

Setpoint Display – SV: shows the SV (**S**etpoint **V**ariable) value, and used when configuring the parameters of the controller.

Control – C LED: indicates that the controller is active, with control. If there is a control output programmed as PWM or ON/OFF, the output LED will reflect the actual state of the output (ON or OFF). If there is a Linear 4-20mA control output, the LED will be continuos ON.

Auto-Tune – AT LED: indicates that the controller is in Auto-Tune mode, (LED On = Auto-Tune active).

Alarm 1 – AL1 LED: indicates the status of the alarm, (LED On = alarm active).

Alarm 2 – AL2 LED: indicates the status of the alarm, (LED On = alarm active).

SET UP key: used to set up menu cycles.

Decrease key: used to change parameter values.

Increase key: used to change parameter values.

When the controller is initially energized, the firmware version is displayed for approximately 4 seconds, after which the controller starts normal operation. The values of PV (temperature), and SV (setpoint) are displayed and the outputs are enabled after 6 seconds.

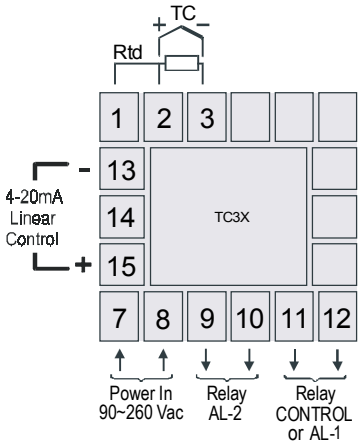
Before the controller is ready to be used in a given process, it requires some basic configuration, such as:

- **Input Type** (T/C, or Pt100) at the **tYPE** prompt, section 5.3 (page13).
- **Output Configuration** (control, alarms) at **Cntr** prompt, section 5.3 (page13).
- **Setpoint Variable SV**.
- **PID parameters** (or hysteresis for ON/OFF control), see Cycle-2 (page12).

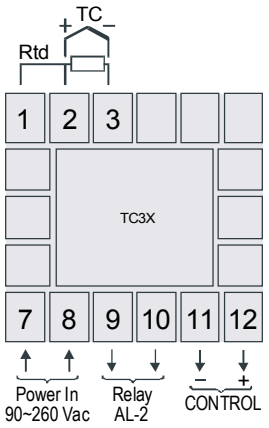
Other functions, including alarms, ramp to soak, etc., may be useful for a better system performance.

3.1 GENERAL ELECTRICAL CONNECTIONS:

Model TC33-2010-AC



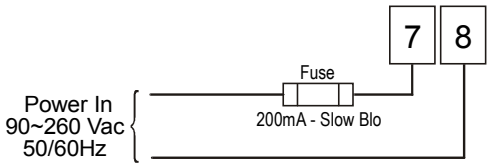
Model TC33-1100-AC



(Figure 3)

3.2 POWER WIRING:

AC Voltage Power Wiring



Note: The installation of fuse is optional, depending on level of protection required.

(Figure 4)

3.3 INPUT WIRING: RTD-PT100 AND THERMOCOUPLE:

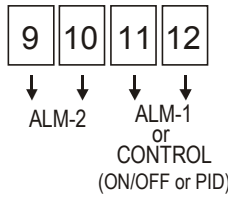
(Figure 5)

Notes: 1) For Thermocouple Sensors use appropriate compensated thermocouple wires.

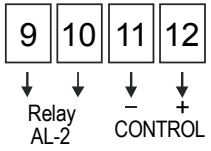
2) Use copper conductors rated for at least 75 ºC (except on T/C).

3.4 OUTPUTS:

Two SPST Relay Output (TC33-2010-AC)



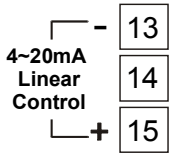
One Pulsed & One Relay (TC33-1100-AC)



(Figure 6)

3.5 SOURCING 4-20MA OUTPUT WIRING:

Linear 4-20mA Sourcing Output (TC33-2010-AC)



(Figure 7)

NOTE: All terminal screws must be tightened securely. Terminal screws not properly secured can cause an electrical short that may damage property, equipment or cause injury or death. Terminal screws improperly secured may fall into equipment causing possible damage to property or equipment.

PANEL ASSEMBLY:

First remove the mounting clamp and insert the controller into the panel cut out. Place the unit into the panel cut out and slide the mounting clamp from the rear to a firm grip at the panel.

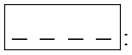
The internal circuitry can be fully removed from the housing without disconnecting any wiring. By using the thumb, just press the tab in the lower part of the front panel, grab the front panel firmly and pull the front face and circuitry from the housing.

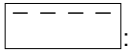
Warning: Use caution when removing the controller from its case, there may be live voltage present at the terminals. This should only be done by a qualified technician. It is recommended that power to the controller be disconnected prior to removing the controller from the case.

3.6 ERROR MESSAGES:

The connection and configuration errors for most of the problems encountered in using the controller are shown below. A final revision of parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

 : Process temperature is below the selected sensor range.

 : Process temperature is above the selected sensor range

 : Controller or sensor error. Example:

- Broken thermocouple or Pt100.
- Pt100 badly connected, short-circuited or high cable resistance.

4. MENU SYSTEM

The Parameter Menu System is organized into four basic cycles. This is shown in the chart below:

After the last parameter in one level is reached the controller returns to the Operation Cycle and the display will indicate the measured temperature.

CYCLE	ACCESS
1- Operation	Free access parameters
2- Tuning and Alarms	Reserved access
3- Input Type and Configuration	
4- Calibration	

NOTE: The display will also go back to the measured temperature whenever the display is inactive for 20 seconds or more.

4.1 INITIAL STARTUP:

When the controller is initially energized the Firmware version is displayed for approximately 4 seconds in the PV display after which the controller reverts to normal operation mode or **Operation Cycle**. This is **SET UP Cycle-1**. The upper display, **PV**, shows the **Process Variable** (temperature) and the lower display, **SV**, shows the **Set Point Variable** in this cycle. The controller remains in this cycle while under normal operation.

Important: Firmware version of controller must match the version indicated on the bottom front cover of this manual.

4.2 GENERAL SETUP CYCLE PARAMETERS:

The cycles need only to be accessed when a change of parameters is necessary (except for Set Point change). To reach the other parameters the user must keep the **SETUP key** pressed for about 4 seconds. After this time the controller will show the first parameter of the next cycle, i.e., **AtUn** for Cycle-2. By keeping the **SETUP key** pressed for another 3 seconds the next cycle will be accessed.

Release the **SETUP key** when the desired cycle is reached. Press the **SETUP key** once to go to the next menu parameter in the cycle. The PV display will show the parameter and the SV display will show the value in the parameter.

To change the value of the parameter press the ▼ or ▲ keys until the desired value is reached.

Cycle Menu System

Cycle-1	Cycle-2	Cycle-3	Cycle-4
OPERATION	TUNING	INPUT Conf.	CALIBRATION
PV Indication (RED display) and **SV Indication** (GREEN display)	AtUn	tYPE	InLC
rAtE	Pb	unit	InHC
t SP	Ir	ACt	CJ L
run	dt	Cntr	
	Ct	SPLL	
	HYSt	SPHL	
	A1SP	A1Fu	
	A2SP	A2Fu	
		A1HY	
		A2HY	

4.3 DIGITAL SERIAL NUMBER ACCESS:

To read the controller's serial number (8 digits), hold down the ▲ key during the power up. The first four digits will appear in red on the top display, and the second four digits will appear in green on the bottom display.

The serial number is recorded in the factory and cannot be changed.

5. CONFIGURATION

Prior to first operation, the controller should be fully configured. After the controller is energized and is in normal operation mode press the **SET UP key** several times until the **run** parameter is displayed. Using the ▼ or ▲ keys change the value to **0**, this disables all outputs. After disabling all of the outputs **t**he user can now set the basic parameters such as **Input Type** ("**tYPE**") in Cycle-3, the desired control **Set Point** (" **SP** ") in Cycle-1, the **Alarm Set Points** ("**A 1SP**" and "**A2SP**") in Cycle-2, etc. **The first parameter that needs to be programmed is the Input Type (tYPE) in the Input Cycle, Cycle-3 (see section 5.3 page 13).**

After all parameters are set, enable the controller operation by changing the **run** parameter back to **1**. This enables all outputs. The following menu Cycles give information on programming each parameter.

All parameter settings are stored in non-volatile memory after moving to the next parameter or if the value has not been changed within a 20 second period.

5.1 CYCLE 1 – OPERATION:

CYCLE 1

PV Indication (RED display) **SV Indication** (GREEN display)	**PV AND SV INDICATION:** **PV:** The status display shows the present value of PV (Temperature). **SV:** Adjust the desired temperature value (Setpoint) for the controlled system by pressing ▼ or ▲ within the limit defined in the parameter "**SPHL**" in Cycle-3.
rAtE (ramp)	**TEMPERATURE RATE OF RISE**: The user defines the rate of temperature rise from the starting temperature to the value set in **SV**. Rate is defined in **°F or °C per minute** (programmable range: 0 to 100.0°/minute). **Default: 0.0** See page 11 for a description of this. "To disable the ramp function set: **rAtE** = **0.0** ".
t SP (soak)	**TIME FOR SOAK**: Time in minutes in which the temperature will remain at the selected **t SP** (soak setpoint in SV display). (Set: 0 to 9999 minutes). **Default: 0** See page 11 for a description of this. **Note:** Setting value **0** at "**t SP**", if "rate function" (ramp) is disabled. "To disable the soak function set: **t SP** = **0**".
run	**RUN**: At this prompt the user sets the control output and alarms to active or to inactive. **Default: 1** **0** - inactive outputs **1** - active outputs

RAMP & SOAK

"rAtE" (ramp) function:

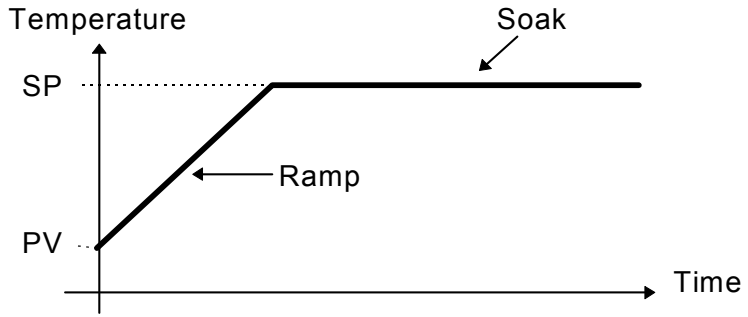
This function makes the process temperature rise gradually (ramp) from the starting point (present PV) to a final specified value in setpoint (SV), creating a heating ramp. The user defines the rate of rise in degrees per minute (from 0.1 to 100.0°F or °C / minute) at the "**rAtE**" prompt.
To disable the ramp function set **0.0** at the "**rAtE**" prompt (default = **0.0**).

" t SP" (soak) function:

When SP is reached the temperature is leveled at this point for 1 to 9999 minutes as programmed at the "**t SP** " prompt. After the programmed period (**t SP**) the output control is turned Off. To restart control set **1** at the "**run**" prompt.
Setting value **0** at "**t SP**" (disable the soak function) defines an infinite length soak profile (default = **0**).

Note 1: Setting value **0** at "**t SP**", if "rate function" (ramp) is disabled.

Note 2: After a power failure the controller will resume ramp to soak execution at the equivalent previous ramp point. If the process temperature is the same as the setpoint, SV, (no temperature drop) the controller will repeat the soak segment.



(Figure 8)

Single Ramp - The controller allows the temperature to gradually rise from an initial value to a final specified value in setpoint, creating a heating ramp. The user may determine the rising time of the ramp on the controller, which defines the velocity of the temperature in degrees per minute.

5.2 CYCLE 2 – TUNING AND ALARMS:

CYCLE 2

AtUn	**AUTO-TUNE**: Activates the auto-tuning of PID parameters. 0 - Auto-tune is off (led "AT" = off) When set to 0 the controller is in Manual PID control or ON/OFF control (Pb = 0). 1 - Auto-tune is on (led "AT" = on) When set to 1 the controller is in PID Auto-tune control. **Default: 0**
Pb	**PROPORTIONAL BAND**: 0 to 500% of maximum input span. When this parameter is set to zero (Pb= 0) and AtUn is set to 0 the control action is **ON/OFF** output mode, with control hysteresis adjust. **Default: 10.0**
Ir	**INTEGRAL RATE**: 0.00 to 25.00 rep/min = Integral time constant in repetitions per minute (Reset). **Default: 0.00** This constant is not used when controller is set to ON/OFF action (Pb= 0).
dt	**DERIVATIVE TIME**: 0 to 250 = Derivative time constant in seconds. This constant is not used when controller is set to ON/OFF action (Pb= 0). **Default: 0**
Ct	**CYCLE TIME**: Pulses in period per second. This term is only used when the controller is set to PID action. **Default: 0.5** (in seconds)
HySt	**CONTROL HYSTERESIS**: Is the hysteresis for ON/OFF control (set in temperature units). **Default: 0** This parameter is only used when the controller is in ON/OFF mode (Pb= 0).
A1SP	**SETPOINT value for ALARM 1**: Set-point for alarm 1 **Default: 610**
A2SP	**SETPOINT value for ALARM 2**: Set-point for alarm 2 **Default: 610**

5.3 CYCLE 3 – INPUT TYPE, AND OUTPUT CONFIGURATION:

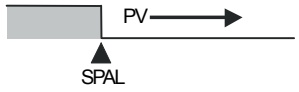
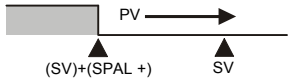
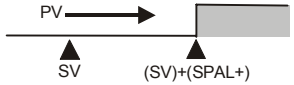
CYCLE 3

tYPE	**INPUT TYPE**: Selects the input sensor type to be connected to the controller. **Default: 1 (T/C Type K)** ***"This is the first parameter to be set."*** **0 - T/C type J: -58 to 1400°F (-50 to 760°C)** **1 - T/C type K: -130 to 2498°F (-90 to 1370°C)** **2 - T/C type S: 32 to 3200°F (0 to 1760°C)** **3 - RTD-Pt100 with 0.1° resolution: -199.9 to 986.0°F (- 199.9 to 530.0°C)** **4 - RTD-Pt100 with 1° resolution: -328 to 986°F (-200 to 530°C)** **5 - T/C type T: -148 to 752°F (-100 to 400°C)** **6 - T/C type E: -22 to 1328°F (-30 to 720°C)** **7 - T/C type N: -130 to 2372°F (-90 to 1300°C)** **8 - T/C type R: 32 to 3200°F (0 to 1760°C)** **NOTE:** In case of sensor break or failure an error " Erro" message is displayed, and the control output is turned off.
unIt	**TEMPERATURE UNIT:** Selects display indication for degrees Celsius or Fahrenheit. **Default: 0** 0 - degrees Celsius (°C); 1 - degrees Fahrenheit (°F);
ACt	**ACTION CONTROL: Default: 0** 0 - **Reverse action**. Generally used for heating. 1 - **Direct action**. Generally used for cooling.
Cntr	**CONTROL OUTPUT CONFIGURATION:** 0 - Sets **Control output** (ON/OFF or PWM-PID) on terminals 13-15 (4-20mA pulsed), with **Alarm-1** on terminals 11-12, and **Alarm-2** on terminals 9-10. See AtUn and Pb for ON/OFF and PID control description in Cycle-2, page 12. **Note:** 4-20mA will operate as PWM in the 4mA or 20mA state, (This is not a linear 4-20mA output control in this configuration). 1 - Sets **Control output** (ON/OFF or PWM-PID) on terminals 11-12, and **Alarm-2** on terminals 9-10**.** 2 - Sets **Linear 4-20mA PID Control output** on terminals 13-15, with **Alarm-1** on terminals 11-12, and **Alarm-2** on terminals 9-10. **NOTE:** • Controller model TC33-1100-AC: **Default = 1** • Controller model TC33-2010-AC: **Default = 2**
SPLL	**SETPOINT LOW LIMIT:** Sets the lower range for SV and PV indication. **Default: -150**
SPHL	**SETPOINT HIGH LIMIT:** Sets the upper range for SV and PV indication. **Default: 1370**

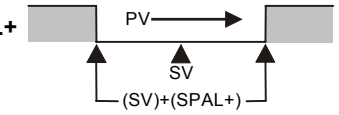
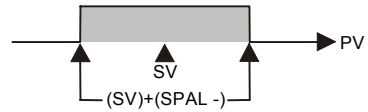
A 1Fu	**ALARM 1 Function:** (code 0 to 11): Refer to Table 1 page 14 for function description and respective codes to set at this prompt. **Default:** 0
A2Fu	**ALARM 2 Function:** (code 0 to 11): Refer to Table 1 page 14 for function description and respective codes to set at this prompt. **Default:** 0
A 1HY	**ALARM 1 HYSTERESIS:** Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off. **Default:** 0
A2HY	**ALARM 2 HYSTERESIS:** Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned. **Default:** 0

Table 1 – Alarm Functions

Table 1 shows each alarm function operation with their respective code.

TYPE	CODE	ACTION
Low Alarm (Low Temperature Alarm)	0	**Low SPAL** 
High Alarm (High Temperature Alarm)	1	**High SPAL** 
Differential Low (Deviation Low)	2	**Dif-Low SPAL+**  **Dif-Low SPAL-** 
Differential High (Deviation High)	3	**Dif-High SPAL+**  **Dif-High SPAL-** 

(where SPAL means: A 1SP and A2SP)

Differential (Band Alarm)	4	**Dif-SPAL+**  **Dif-SPAL-** 
Input Sensor Error	5	**Alarm is ON whenever:** • Temperature is below selected range. • Temperature is above selected range. • Thermocouple or Pt100 is broken. • Pt100 is shorted, badly connected or wire impedance is too high.
End of Soak Timer	6	**Alarm turn On** ("Time for Soak", see function " t SP " on Cycle 1)
Alarm Functions "With alarm inhibition at power-up"	7	**Low alarm** disabled at power-up
	8	**High alarm** disabled at power-up
	9	**Differential low** limit alarm disabled at power-up
	10	**Differential high** limit alarm disabled at power-up
	11	**Differential** alarm disabled at power-up

(where SPAL means: A 1SP and A2SP)

Alarm Functions:

Low Alarm: Activates at present value, independent of main setpoint. Low process-alarm activates at and below alarm setting.

High Alarm: Activates at present value, independent of main setpoint. High process-alarm activates at and above alarm setting.

Differential Low: Activates at present deviation (negative or positive) value from main setpoint. Low deviation-alarm activates below alarm setting. Figure 9(a) on page 16 gives a graphical description of this.

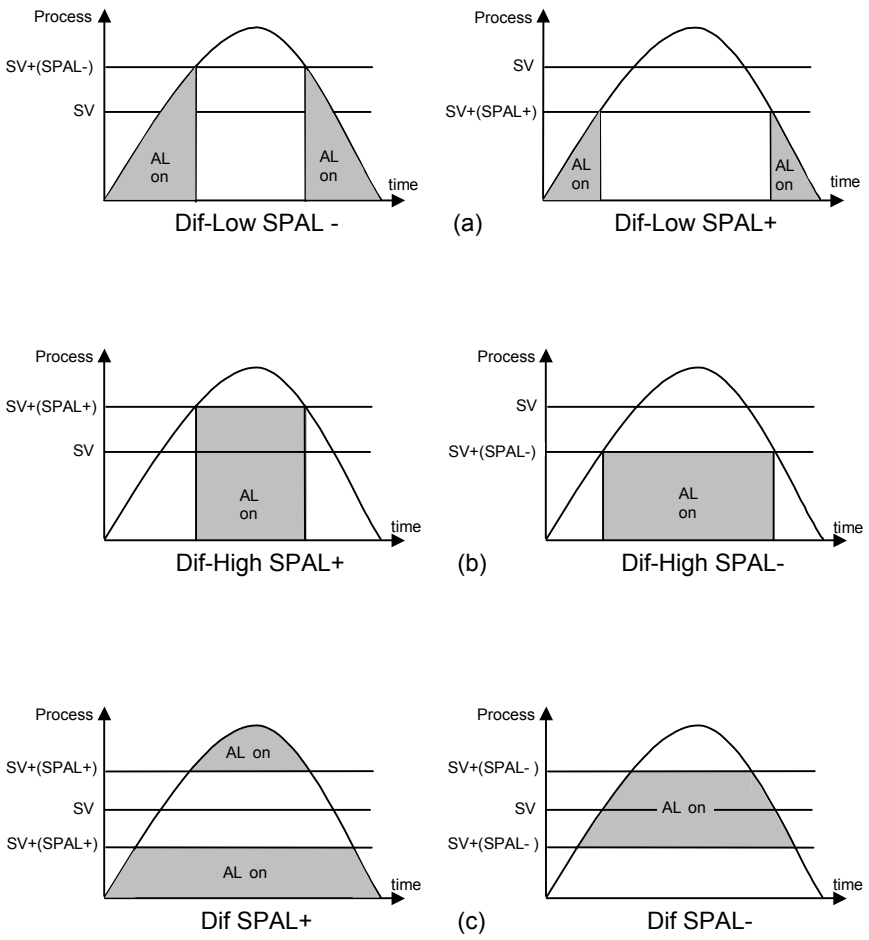
Differential High: Activates at present deviation (negative or positive) value from main setpoint. High deviation-alarm activates above alarm setting. This is represented in Figure 9(b) on page 16.

Differential: Activates when the process exceeds a specified band-alarm centered around the main setpoint. See Figure 9(c) on page 16.

Inhibition at power-up: Alarm blocking at power-up inhibits the relay alarm from activating when the unit is first energized. The alarm will only trip after the process variable reaches a new alarm situation.

Alarm Hysteresis: Defines the differential range between the PV value at which the alarm is turned on and the value at which it is turned off.

Alarm Functions (Graphic):



(Figure 9)

5.4 CYCLE 4 – CALIBRATION LEVEL:

NOTE: ***All input and output types are factory calibrated. This cycle should only be accessed by experienced personnel. If in doubt do not press the ⩛ or ⩓ keys in this cycle.***

InLC **In**put **L**ow **C**alibration	**SENSOR OFFSET CALIBRATION**. Sets the temperature sensor low calibration (offset). The display shows only the corrected temperature and not the offset added. A signal simulator should be used to inject a low value signal to properly adjust the offset.
InHC **In**put **H**igh **C**alibration	**INPUT HIGH CALIBRATION**. Sets the sensor input circuit gain or high calibration. A signal simulator should be used to inject a high value signal to properly adjust the offset.
CJ L **C**old **J**unction **L**ow **C**alibration	**COLD JUNCTION OFFSET CALIBRATION**: Sets the cold junction °C offset calibration. A good thermometer or a temperature simulator should be used to properly adjust this parameter.

PID AUTO-TUNE OPERATION:

During auto tune the temperature is controlled in ON/OFF mode until is reaches the programmed Set Point (SV). Depending on process characteristics large oscillations above and below SV may occur and auto tuning may take several minutes to be concluded.

The standard procedure is as follows:

- Disable all outputs at the **run** prompt in the Operation Cycle (Cycle-1) by selecting **0**.
- Disable the **rAtE** and **t SP** in Cycle-1 by selecting **0** for each.
- Enable auto-tuning at the **AtUn** prompt in the Tuning Cycle (Cycle-2) by selecting **1**.
- Enable all outputs at the **run** prompt in Cycle-1 by selecting **1**.

During auto-tune the AT LED is ON. Once auto-tune is complete, the AT LED turns OFF.

The **recommended** procedure is as follows:

- Follow the procedure above **except**, program a setpoint 10 – 15% below the final desired value.
- After auto-tune is complete (the “AT” LED is off), change the setpoint to the final desired value.

If auto-tuning results are not satisfactory, refer to section 6.5 and Table 2 for manual fine tuning procedure.

NOTE: Certain processes behave in very irregular manners. In these cases, control type “On/Off with hysteresis adjust” is recommended.

5.5 PID MANUAL TUNING

Table 2 - Suggestions for manual tuning of PID parameters

PARAMETER	RESPONSE	SOLUTION
Proportional Band	Slow Response	Decrease
Proportional Band	Large Oscillation	Increase
Integral Rate	Slow Response	Increase
Integral Rate	Large Oscillation	Decrease
Derivative Time	Slow Response or Instability	Off (dt = 0)
Derivative Time	Large Oscillation	Increase

The operator may choose to tune the controller manually for optimum process performance once all parameters are set. This can be achieved by using Table 2 or by determining the values for the proportional band Pb, integral rate Ir, and derivative time dt. **The procedure below should only be implemented on processes that will not be damaged by large fluctuations in the process variable.**

Step 1. Disable all outputs in Cycle-1 by changing run to 0. Change the setpoint to the desired process variable (PV) in the Operation Cycle. This value should be below (PV) if overshoot will cause damage to the process.

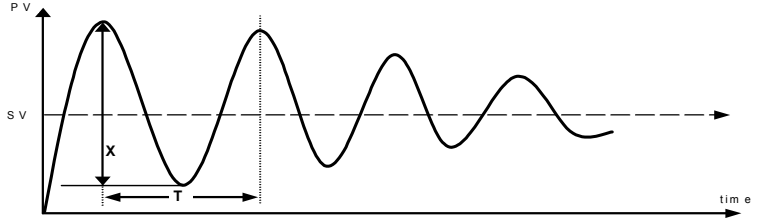
Step 2. Make sure Pb is set to 0 in Cycle-2, page 13. This places the controller in ON/OFF control.

Step 3. Enable all outputs by changing run to 1 in Cycle-1. Once the outputs are enabled the process variable (PV) will approach and eventually overshoot the setpoint (SV). At this point the operator should note the following values (see Figure 10):

- The value from the highest point of overshoot to the lowest point of undershoot, **X**.
- The cycle time of the oscillation, **T**.

Using the following information and the values above the operator can determine the PID setting for the process:

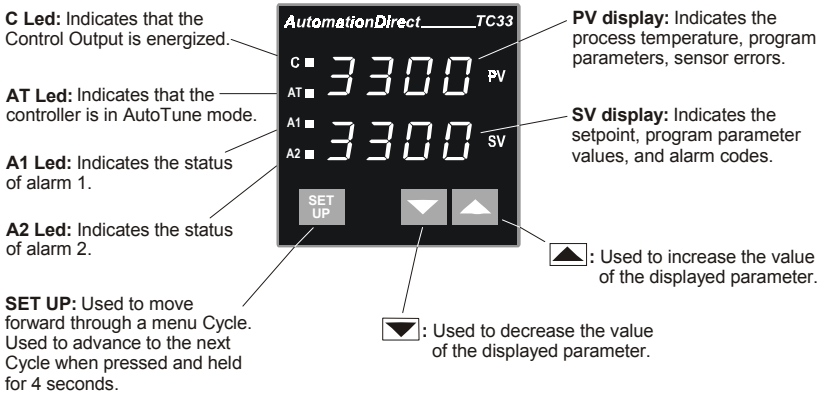
- Pb = **X** ÷ scale range x 100
- Ir = **T** = cycle repetitions per minute
- dt = **T** ÷ 6



(Figure 10)

TC33 Quick PID Setup Reference

Key and Display Functions



Set Up Cycle Parameter Access

Cycle-1 OPERATION	Cycle-2 TUNING	Cycle-3 INPUT Conf.	Cycle-4 CALIBRATION
PV Indication (RED display) and SV Indication (GREEN display)	AtUn	tYPE	InLC
rAtE	Pb	Unit	InHC
t SP	Ir	ACt	CJ L
run	dt	Cntr	
	Ct	SPLL	
	HYSt	SPHL	
	A1SP	A1Fu	
	A2SP	A2Fu	
		A1HY	
		A2HY	

TC33 Quick Set UP

This quick reference setup is intended to be used by experienced users that are familiar with the TC33 set up menu or those that only need basic PID operation. This guide will show how to configure the input, output control and basic alarm function. For Detailed programming information refer to the Table of Contents to find the required instructions for a particular function. Follow these steps below:

1. **Operation:** Connect power input to the proper terminal conections. See page 6 sections 3.1 & 3.2. After power-up the controller is in the Operation Cycle (Cycle-1). Refer to Cycle Menu on previous page. Disable all outputs by pressing the **SET UP key** until **run** is displayed in the PV display. Press the ▼ or ▲ keys until **0** is displayed in the SV display. The controller outputs are now disabled. To move from one Cycle menu to the next **press** and **hold** the **SET UP key** for 4 seconds. The first parameter in the Cycle will be displayed in the PV display.

2. **Input Type:** From the Operation Cycle press and hold the **SET UP key** for approximately 7 seconds to advance to the Input Cycle (Cycle-3), **tYPE** will be displayed in the PV display. Select the input type from section 5.3 on page 13 using the ▼ or ▲ keys. For example, **0** shown in the SV display designates a type **J** thermocouple for the input sensor.

3. **Temperature Unit:** While in Cycle-3 press the **SET UP key** until **un It** is displayed in the PV display. Press the ▼ or ▲ keys to select the temperature unit in the SV display, **0** for **°C** or **1** for **°F**.

4. **Control Action:** Press the **SET UP key** again in Cycle-3 until **Act** is displayed in the PV display. Press the ▼ or ▲ keys to select the control action in the SV display, **0** for reverse action (generally used for heating) or **1** for direct action (generally used for cooling).

5. **Output Configuration:** Press the **SET UP key** again in Cycle-3 until **Cntr** is displayed in the PV display. Select control output configuration **0, 1**, or **2** in the SV display using the ▼ or ▲ keys. See section 5.3 on page 13 for a description of these configurations.

6. **Alarm Functions:** Press the **SET UP key** 2 more times in Cycle-3 until **A 1Fu** is displayed in the PV display. **A 1Fu** should be programmed only if the Output Configuration, **Cntr** (in 5. above), is set to **0** or **2**. When set to **1** this output is used for control. Refer to Cycle 3, page 13. Select the alarm function from Table 1 on page 14. After this alarm function is chosen press the **SET UP key** again to move to **A2Fu** and follow the same steps if a second alarm is desired based on the control action set above in 5. Press the **SET UP key** again and the controller reverts to Cycle-1.

7. **Set Point:** Program the set point in Cycle-1 by pressing the ▼ or ▲ keys to increase or decrease the set point (SV Display) to the desired value.

8. **Auto Tune:** Press and hold the **SET UP key** for 4 seconds to advance to the Tuning Cycle (Cycle-2), **Atun** will be displayed in the PV display. Press the ▼ or ▲ keys until the number **1** is displayed in the SV display. The controller is now set for Auto Tune.

9. **Cycle Time** (optional): Press the **SET UP key** several times until **Ct** is displayed in the PV display. The default cycle time is factory set for 16 seconds. If a different cycle time is desired then press the ▼ or ▲ keys to increase or decrease the value shown in the SV display.

10. **Alarm Set Points:** Press the **SET UP key** two more times in Cycle-2 until **A 1SP** is displayed in the PV display. Press the ▼ or ▲ keys to increase or decrease Alarm 1 set point in the SV display to the desired value. **A 1SP** should be programmed only if the Output Configuration, **Cntr** (in 5. above), is set to **0** or **2**. When set to **1** this output is used for control. Refer to Cycle 3 page 13. Press the **SET UP key** again and **A2SP** is displayed in the PV display. Follow the same steps if Alarm 2 is configured. Press the **SET UP key** to go back to the Operation Cycle (Cycle-1).

11. **Enable Process Outputs**: In the Operation Cycle press the **SET UP key** until **run** is displayed in the PV display. Press the ▼ or ▲ keys to change the SV value to **1**. All outputs are now enabled and the controller is fully operational in PID auto tune mode.

NOTES:

TC33

Configuration Sheet

Name:_____ Date:_____

Part#: _____

Project:_____

Main Setpoint (SV):			
Cycle 3 CONFIGURATION	Default	CODE/VALUE	CHARACTERISTICS / FUNCTION
tYPE	1		
Unit	0		
Act	0		
Cntr	2		
SPHL	1370		
A1FU	0		
A2FU	0		
Cycle 2 ALARMS	Default	CODE/VALUE	CHARACTERISTICS / FUNCTION
Atun	0		
Pb	100		
Ir	000		
dt	0		
Ct	05		
HYSt	0		
A1SP	610		
A2SP	610		
Cycle 1 OPERATION	Default	CODE/VALUE	CHARACTERISTICS / FUNCTION
rAtE	00		
t SP	0		
run	1		

Error Codes Table for Temperature/Process Controllers

Document # C0504

The connection and configuration errors for most of the problems encountered in using the controller are shown below. A final revision of the connections and parameters will save time and further losses.

Error messages are displayed to help the user to identify possible problems.

Error Codes Table

Display Shows	Cause
____	Process or temperature is below the selected sensor range.
----	Process or temperature is above the selected sensor range.
Erro	Sensor error. Example: 1. No connections on the sensor input terminals. 2. Broken thermocouple (open wire) or broken RTD-Pt100. 3. RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 1	RTD-Pt100 badly connected, short-circuited or high cable resistance.
Err 6	This kind of error is caused when, for instance, a 4-20mA signal goes through the mV or Thermocouples input and can introduce signals of up to 30VDC at the input point and force the Auto/Zero and Auto/Span to work outside the limits that guarantee the precision of the controller. This error goes away when the signal is removed from the input and the connection is fixed (normally, input signals of up to 30VDC do not damage the controller's hardware).
Err 2	Auto/Zero Problem: This error is caused by a wong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Zero circuit was damaged. It is necessary to revise the controller.
Err 4	Auto/Span Problem: This error is caused by a wrong connection and indicates that a voltage greater than 30VDC was input into the sensor and the Auto/Span circuit was damaged. It is necessary to revise the controller.

NOTE: The controllers do not accept AC-Voltage or AC-Current in the sensor input. This type of signal can damage the controller.