AutomationDirect

1/16 DIN Series

Operator's Manual

TC33

PID Microprocessor-Based Temperature Controller

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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

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.)
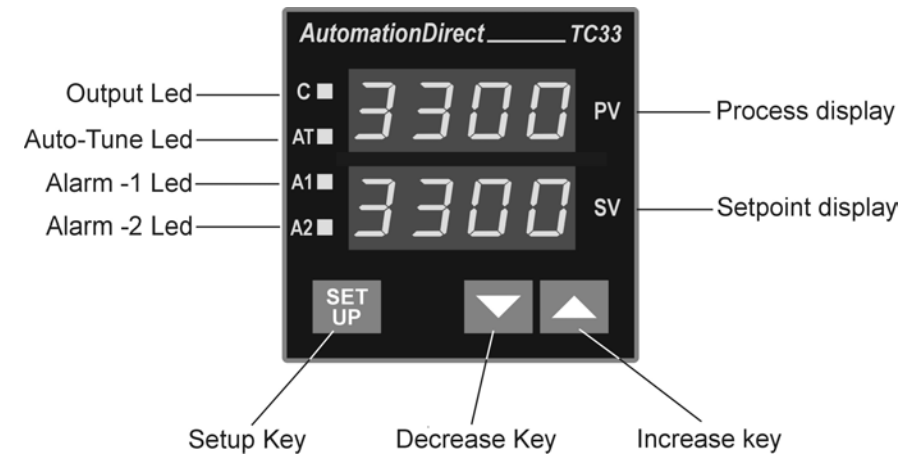
2.1 MAIN DIMENSIONS, AND PANEL CUTOUT:
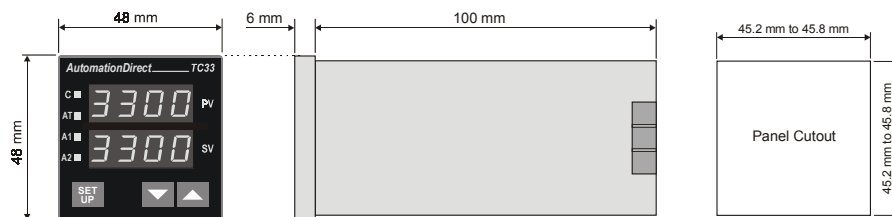
(Not to scale)

(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.
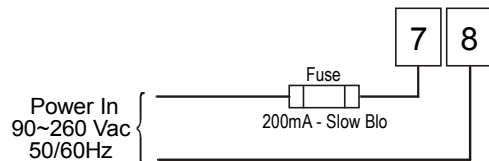
3.1 GENERAL ELECTRICAL CONNECTIONS:

Model TC33-2010-AC   **Model TC33-1100-AC**
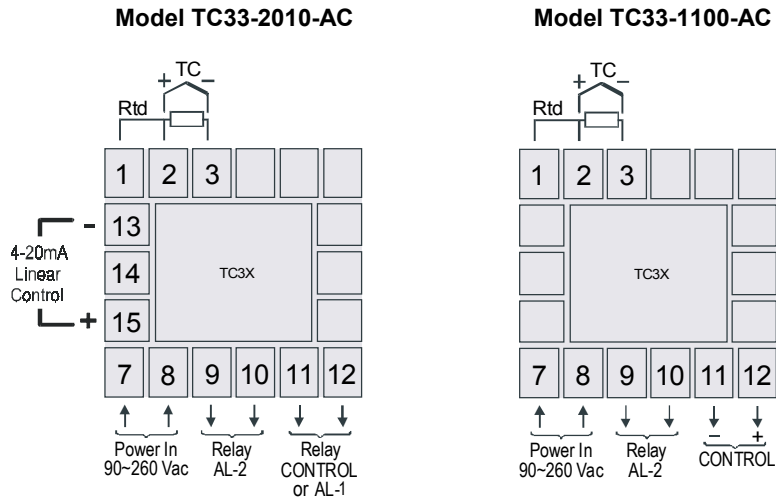
(Figure 3)

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   **One Pulsed & One Relay**
(TC33-2010-AC)   **(TC33-1100-AC)**
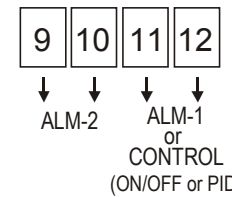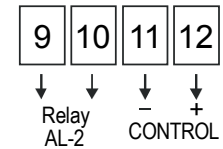
(Figure 6)

3.5 SOURCING 4-20MA OUTPUT WIRING:

Linear 4-20mA Sourcing Output
(TC33-2010-AC)
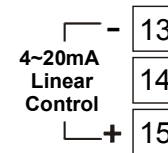
(Figure 7)

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.
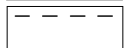
3.6 ERROR MESSAGES:

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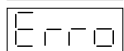
Error messages are displayed to help the user to identify possible problems.

| _ _ _ _ |: Process temperature is below the selected sensor range.

| ‾ ‾ ‾ ‾ |: Process temperature is above the selected sensor range

| Erro |: 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 OPERATION	Cycle-2 TUNING	Cycle-3 INPUT Conf.	Cycle-4 CALIBRATION
PV Indication (RED display) and SV Indication (GREEN display)	Atun	tYPE	InLC
	Pb	un It	InHC
	ir	ACt	CJL
	dt	Cntr	
rAtE	Ct	SPLL	
t SP	HYSt	SPHL	
run	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 the 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** ("**A1SP**" 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.
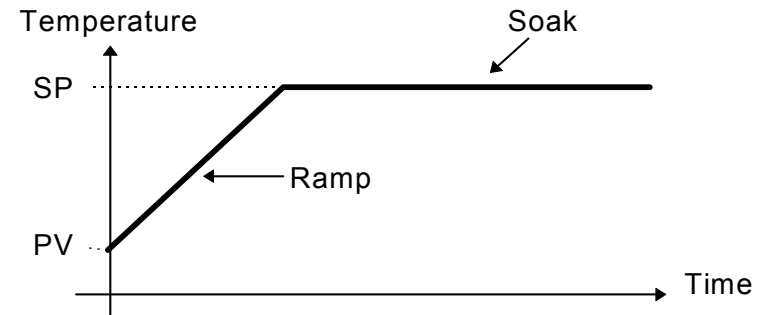
(Figure 8)

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. <u>NOTE:</u> • 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):

Dif-Low SPAL -   (a)   Dif-Low SPAL+

Dif-High SPAL+   (b)   Dif-High SPAL-

Dif SPAL+   (c)   Dif SPAL-
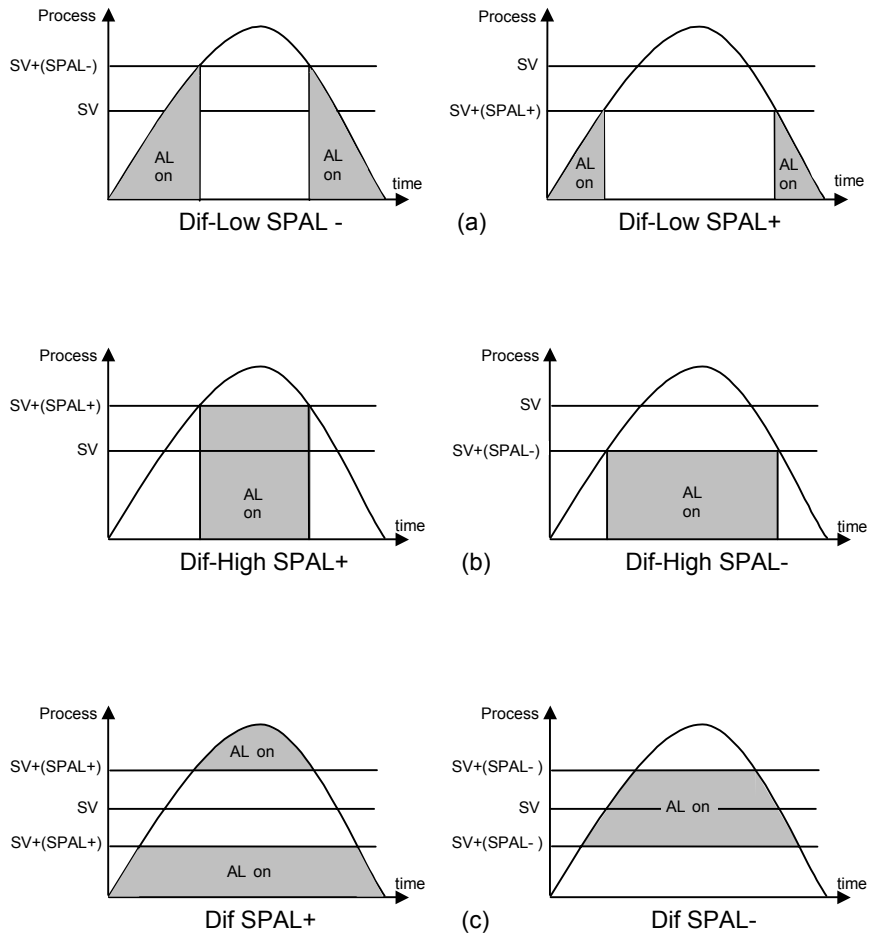
(Figure 9)

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.
CJL **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.

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
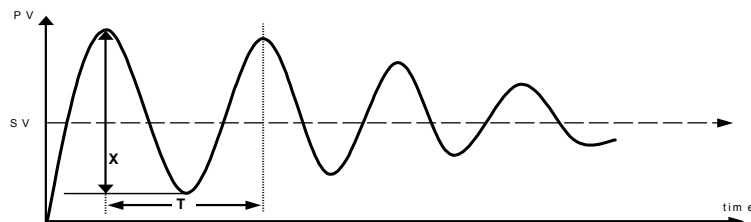
(Figure 10)

TC33 Quick PID Setup Reference

Key and Display Functions

C Led: Indicates that the Control Output is energized.

AT Led: Indicates that the controller is in AutoTune mode.

A1 Led: Indicates the status of alarm 1.

A2 Led: Indicates the status of alarm 2.

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

PV display: Indicates the process temperature, program parameters, sensor errors.

SV display: Indicates the setpoint, program parameter values, and alarm codes.

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

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

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
	Pb	unit	InHC
	Ir	ACt	CJL
	dt	Cntr	
rAtE	Ct	SPLL	
t SP	HYSt	SPHL	
run	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 $un\,lt$ 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 $A1Fu$ is displayed in the PV display. $A1Fu$ 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 $A1SP$ 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. $A1SP$ 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.