BULLETIN NO. T32-X
DRAWING NO. LP0477
EFFECTIVE 4/99

RED LION CONTROLS

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MODEL T32 - 1/32 DIN PID CONTROLLER

- COMPACT IN SIZE
- ACCEPTS THERMOCOUPLE, RTD, 0-20 mA, 0-50 mV INPUTS
- PID CONTROL WITH OVERSHOOT SUPPRESSION
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- STATUS INDICATORS FOR OUTPUTS
- REMOVABLE FRONT PANEL ASSEMBLY
- PARAMETER SECURITY

DESCRIPTION

The T32 1/32 DIN PID Controller accepts signals from a variety of temperature sensors (thermocouple or RTD elements), 0-20 mA or 0-50 mV process inputs. The controller will precisely display the process value and provide an accurate control output to maintain the process at the desired setpoint. The controller's comprehensive programming allows it to meet a wide variety of application requirements.

The controller operates in the PID Control mode for heating or cooling, with on-demand auto-tune that automatically establishes the PID constants. These PID constants may be fine tuned by the operator at any time. The controller employs an overshoot suppression feature that allows for quick response with minimal overshoot. The controller can also be programmed to operate in the On/Off Control mode with adjustable hysteresis.

The 4-digit display allows viewing of the process variable. Front panel indicators show the status of the outputs and auto-tune. The four front panel keys are used to program the parameters, change the setpoint, or view the configurations. A security pass code is used to lock-out configuration changes.

The alarm output can be configured to activate according to a variety of actions. These actions include: Sensor Break, Absolute HI or LO, Deviation HI or LO, or Band Inside or Outside. The main control output can be configured as an alarm output for Absolute HI or LO actions.

The controller is constructed of a lightweight, high impact plastic case with a tinted front panel. The small size allows for installation in tight areas. The rugged design of the T32 makes it extremely reliable in industrial environments.

CAUTION: Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

SAFETY SUMMARY

All safety related regulations, local codes and instructions that appear in the manual or on equipment must be observed to ensure personal safety and to prevent damage to either the instrument or equipment connected to it. If equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Do not use the unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit. An independent and redundant temperature limit indicator with alarms is strongly recommended. The indicators should have input sensors and AC power feeds independent from other equipment.

ORDERING INFORMATION

MODEL	DESCRIPTION	PART NUMBER
T32	1/32 Din PID Controller	T3200000

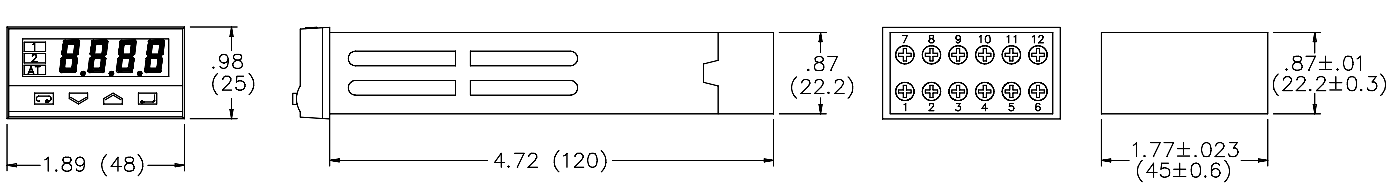
SPECIFICATIONS

1. **DISPLAY**:
   Main: Single 4-digit 0.38" (9.65 mm) green LED
   Display Messages:
   "----" - Appears when input is higher than range.
   "____" - Appears when input is lower than range.
   "ConF" - Appears with incorrect configuration code, with this message the outputs will not work.
   Status Annunciators:
   1 - OP1 or AL1 is active
   2 - AL2 is active
   AT - Auto Tune is active
2. **POWER**: 85 VAC min. to 250 VAC max., 48 to 63 Hz 2 VA max.
   Isolation: 2500 Vrms, 1 minute.
3. **CONTROLS**:
   Four front panel push buttons for modification and configuration of controller functions.
4. **MEMORY**: Nonvolatile memory stores all parameter values.

DIMENSIONS "In inches (mm)"

Note: Recommended minimum clearance (behind the panel) for mounting clip installation is 2.1" (53.4) H x 5.5" (140) W.

PANEL CUT-OUT



5. **MAIN SENSOR INPUT**:
Sample Period: 500 msec.
Failed Sensor Response:
Display: "- - - -"
Control Output: programmable 0% or 100%
Alarm 2: High acting turn on, low acting turn off
Sensor Break Alarm: AL2 programmable to turn on

6. **THERMOCOUPLE INPUT**:
Types: L, J, T, K, S, and Linear mV, software programmable
Lead resistance effect:< 5 µV / 10 Ω Wire Res.
Cold junction compensation: < 2 µV / °C Env. Temp.
Resolution: 1° for all types, except linear mV.

TC TYPE	DISPLAY RANGE	WIRE COLOR		
		ANSI	BS 1843	DIN47310
L	0 to +600 °C 32 to +1112 °F	NA	NA	red (+) blue (-)
J	0 to +600 °C 32 to +1112 °F	white (+) red (-)	yellow(+) blue (-)	NA
T	-200 to +400 °C -328 to +752 °F	blue (+) red (-)	white (+) blue (-)	NA
K	0 to +1200 °C 32 to +2192 °F	yellow(+) red (-)	brown (+) blue (-)	NA
S	0 to +1600 °C 32 to + 2912 °F	black (+) red (-)	white (+) blue (-)	NA
mV	scaleable	NA	NA	NA

7. **RTD INPUT**: 2 or 3 wire, 100 ohm platinum, alpha =.00385
Resolution: 1° or 0.1°.
Lead resistance: 20 Ω max. per lead
Lead resistance effect: < 0.5 °C / 10 Ω Wire Res.
Temperature effect: 0.1 °C / 10 °C Env. Temp.

RTD TYPE	RANGE
alpha =.00385	-99.9 to +100.0 °C -147.8 to +212.0 °F
alpha =.00385	-200 to +400 °C -328 to +752 °F

8. **PROCESS INPUT**:

INPUT RANGE	RESOLUTION
4 - 20 mA 0 - 20 mA	4 µA
0 - 50 mV 10 - 50 mV	10 µV

Input Drift: <0.1% / 20°C
Scaleable: -999....9999 (min. range of 100 digits)
Current input: utilizes external 2.5Ω resistor (included)

9. **INDICATION ACCURACY**: 0.25% ± 1 digit for temperature input
0.1 % ± 1 digit for process input

10. **OUTPUTS**:
The controller has one Relay output and one Logic / SSR output. Either output type can be programmed to perform the Ouput Control 1 (Alarm 1) function. The remaining output type then assumes the Alarm 2 function. This is done through the Configuration Code.
Relay Output:
Type: Form A Normally Open (NO)
Contact Rating: 2 A @ 250 VAC (resistive load)
Logic / SSR Output:
Rating: 5 VDC ± 10% @ 30 mA (not isolated)

11. **MAIN CONTROL**:
Control: PID (Time Proportioning) or ON/OFF
Action: Reverse (heat) or Direct (cool)
Cycle time: 1 to 200 sec.
Auto-tune: When selected, sets proportional band, integral time and derivative time values

12. **ALARMS MODES**:
The Main Control Output (OP1) can be configured as Alarm 1 (AL1). The main alarm is always Alarm 2 (AL2).
Reset Action: Automatic only
Hysteresis: Programmable
Alarm #1 Modes:
Active High with sensor break on or off
Active Low with sensor break on or off
Alarm #2 Modes:
Disabled
Sensor Break (on at break)
Active High or Low
Deviation High or Low *
Band Inside or Outside *
* Only available with single alarm configurations.

13. **ENVIRONMENTAL CONDITIONS**:
Operating Range: 0 to 50°C
Operating Humidity: 5 to 95% max. relative humidity (non-condensing)
Altitude: up to 2000 meters

14. **CERTIFICATIONS AND COMPLIANCES**:
EMC Emissions:
Meets EN 50081-2: Industrial Environment
EMC Immunity:
Meets EN 50082-2: Industrial Environment
Electrical Safety:
Meets EN 61010-1: Installation Category II, Pollution Degree 2

15. **CONNECTION**: Wire clamping screw terminals

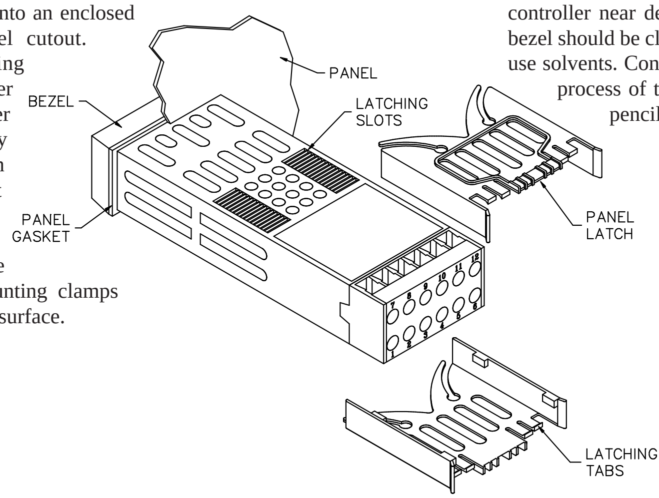
16. **CONSTRUCTION**:
IP20 terminal block
IP65 front panel

17. **WEIGHT**: 0.25 lb (110 g.)

1.0 INSTALLING THE CONTROLLER

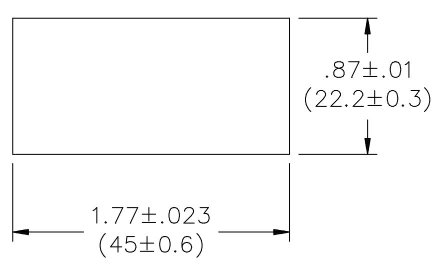
Installation

The T32 controller meets IP65 requirements for indoor use when properly installed. The controller is intended to be mounted into an enclosed panel. Prepare the panel cutout. Remove the mounting clamps from the controller by inserting a screwdriver behind the clamps. Verify that a panel gasket is in back of the bezel. Insert the controller into the panel cutout. Position the mounting clamps onto the controller. Push the mounting clamps tightly towards the panel surface.



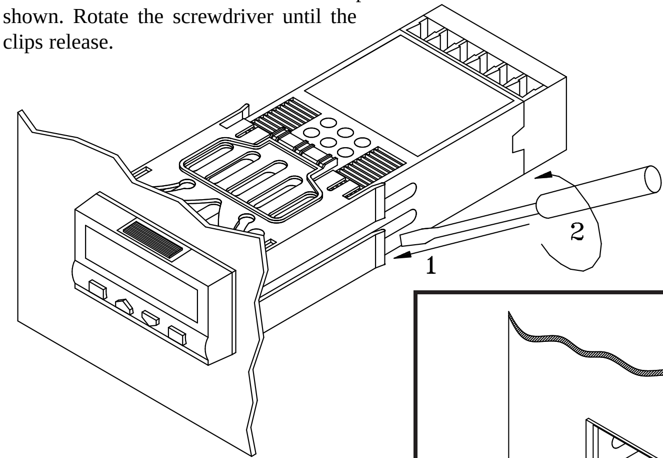
Installation Environment

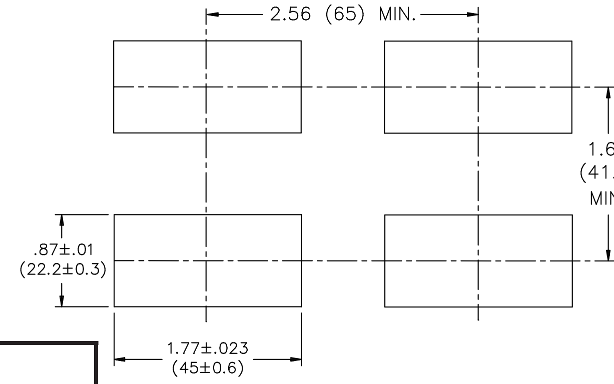
The controller should be installed in a location that does not exceed the maximum operating temperature and provides good air circulation. Placing the controller near devices that generate excessive heat should be avoided. The bezel should be cleaned only with a soft cloth and neutral soap product. Do not use solvents. Continuous exposure to direct sunlight may accelerate the aging process of the bezel. Do not use tools of any kind (screwdrivers, pens, pencils, etc.) to operate the keypad of the controller.



Removing the Mounting Clips

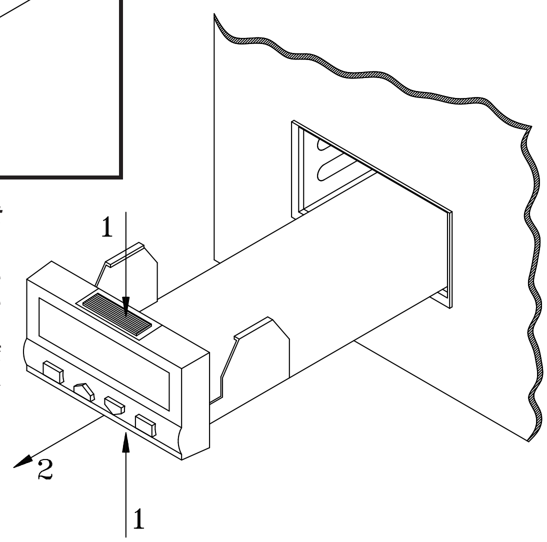
Insert a screwdriver behind the clips as shown. Rotate the screwdriver until the clips release.





Removing The Front Panel Assembly

The main assembly of the controller is removable from the case even after panel installation. Push firmly on the center top of the bezel and pull the bezel straight out.



Controller Spacing

The design of the controller allows for close spacing of multiple units. Units can be spaced either horizontally or vertically. The minimum spacing from center line to center line of units for horizontal installation is 2.56” (65 mm). The spacing for vertical installationed is 1.65” (42 mm) from center line to center line.

Note: When closely spacing multiple units, provide adequate ventilation in the panel to ensure that the maximum operating temperature of the controller is not exceeded.

2.0 WIRING THE CONTROLLER

WIRING OVERVIEW

Electrical connections are made via screw-clamp terminals located on the back of the meter. All conductors should conform to the meter’s voltage and current ratings. All cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power supplied to the meter (DC or AC) be protected by a fuse or circuit breaker.

When wiring the meter, compare the numbers embossed on the back of the meter case against those shown in wiring drawings for proper wire position. Strip the wire, leaving approximately 0.3” (7.5 mm) bare lead exposed (stranded wires should be tinned with solder). Insert the lead under the correct screw-clamp terminal and tighten until the wire is secure. (Pull wire to verify tightness.) Each terminal can accept wire sizes from #22 AWG to #16 AWG (0.5 mm to 1.5 mm).

EMC INSTALLATION GUIDELINES

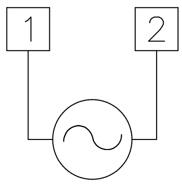
Although this unit is designed with a high degree of immunity to Electro Magnetic Interference (EMI), proper installation and wiring methods must be followed to ensure compatibility in each application. The type of the electrical noise, source or coupling method into the unit may be different for various installations. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation.

Listed below are some EMC guidelines for successful installation in an industrial environment.

1. The controller should be mounted in a metal enclosure, that is properly connected to protective earth.
2. Use shielded (screened) cables for all Signal and Control inputs. The shield (screen) pigtail connection should be made as short as possible. The connection point for the shield depends somewhat upon the application. Listed below are the recommended methods of connecting the shield, in order of their effectiveness.
   a. Connect the shield only at the panel where the unit is mounted to earth ground (protective earth).
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is above 1 MHz.
   c. Connect the shield to common of the unit and leave the other end of the shield unconnected and insulated from earth ground.
3. Never run Signal or Control cables in the same conduit or raceway with AC power lines, conductors feeding motors, solenoids, SCR controls, and heaters, etc. The cables should be run in metal conduit that is properly grounded. This is especially useful in applications where cable runs are long and portable two-way radios are used in close proximity or if the installation is near a commercial radio transmitter.
4. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.
5. In extremely high EMI environments, the use of external EMI suppression devices, such as ferrite suppression cores, is effective. Install them on Signal and Control cables as close to the unit as possible. Loop the cable through the core several times or use multiple cores on each cable for additional protection. Install line filters on the power input cable to the unit to suppress power line interference. Install them near the power entry point of the enclosure. The following EMI suppression devices (or equivalent) are recommended:
   Ferrite Suppression Cores for signal and control cables:
      Fair-Rite # 0443167251 (RLC # FCOR0000)
      TDK # ZCAT3035-1330A
      Steward # 28B209-0A0
   Line Filters for input power cables:
      Schaffner # FN610-1/07 (RLC # LFIL0000)
      Schaffner # FN670-1.8/07
      Corcom # 1 VR3
   Note: Reference manufacturer’s instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
   Snubbers:
      RLC #SNUB0000

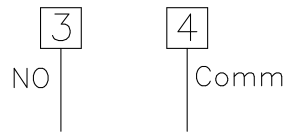
2.1 POWER WIRING

AC Power

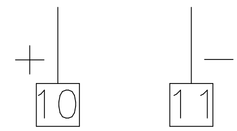


2.2 OUTPUT WIRING

Relay Output

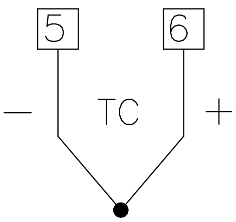


Logic/SSR Output

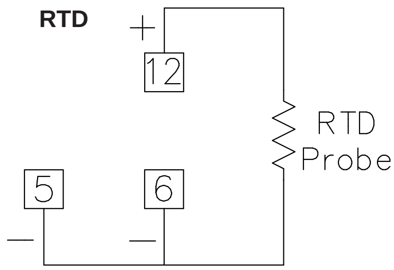


2.3 INPUT SIGNAL WIRING

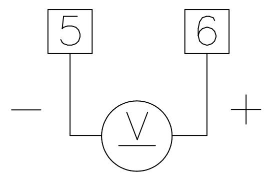
Thermocouple



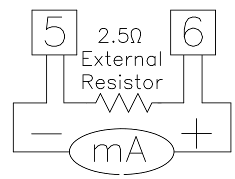
RTD



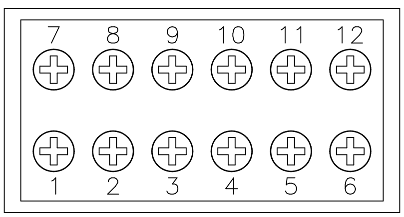
mV DC



mA DC

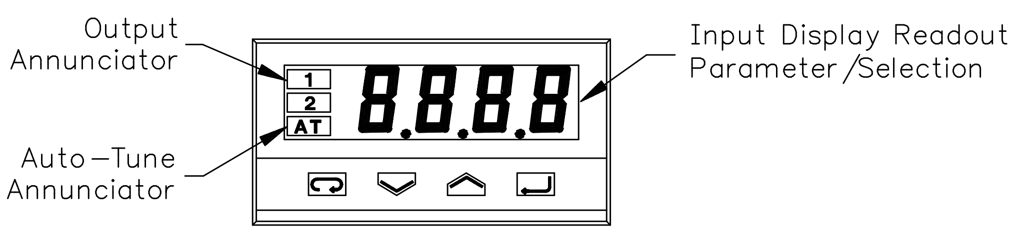


2.4 REAR TERMINALS



TERMINAL	LABELED	CONNECTION
1	AC	Controller Power
2	AC	Controller Power
3	NO	Normally Open, Relay Output
4	COMM	Common, Relay Output
5	TC-	(-) TC or (-) RTD or (-) mV or (-) mA*
6	TC+	(+) TC or (-) RTD or (+) mV or (+) mA*
7	N/C	No Connection
8	N/C	No Connection
9		No Connection
10	LOGIC+	(+) Logic (SSR) Output
11	LOGIC-	(-) Logic (SSR) Output
12	RTD	(+) RTD
		*Using an external 2.5Ω resistor between 5&6

3.0 REVIEWING THE FRONT KEYS AND DISPLAY

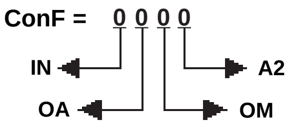


KEY	KEY TERM	OPERATION MODE	SETPOINT MODE	VIEW MODE	PROGRAMMING MODE
	"Module"	Enters Programming Mode	-----	After "Return", steps through Controller View	Advances to next Module, Returns to Operation Mode
	"Down"	Enters Setpoint Mode	Decreases Setpoint	-----	Decreases Parameter Values
	"Up"	Enters Setpoint Mode	Increases Setpoint	-----	Increases Parameter Values
	"Return"	Enters View Mode	-----	Steps through Process View	Steps through Parameter Menus, Enters Parameter Values

4.0 FIRST TIME POWER-UP

During first time power-up from the factory, ConF will immediately appear. At this prompt, enter a four digit Configuration Code that meets the requirements of the application. After this initial power-up, the controller's configuration code can only be changed in Module 3 of the Programming Mode.

CONFIGURATION CODE TABLE



INPUT TYPE	INPUT DEVICE TYPE	IN
RTD Pt100	-99.9 to 100.0 °C -147.8 to 212.0 °F	0
RTD Pt100	-200 to 400 °C -328 to 752 °F	1
TC L	0 to 600 °C 32 to 1112 °F	2
TC J	0 to 600 °C 32 to 1112 °F	3
TC T	-200 to 400 °C -328 to 752 °F	4
TC K	0 to 1200 °C 32 to 2192 °F	5
TC S	0 to 1600 °C 32 to 2912 °F	6
Linear scale	0 to 50 mV or 0 to 20 mA scaleable	7
Linear scale	10 to 50 mV or 4 to 20 mA scaleable	8

OUTPUT ASSIGN	OUTPUT FUNCTION AND TYPE ASSIGNMENT	OA
PID	OP1 Relay with AL2 Logic / SSR	0
PID	OP1 Logic / SSR with AL2 Relay	1
On - Off	OP1 Relay with AL2 Logic / SSR	2
On - Off	OP1 Logic / SSR with AL2 Relay	3
Indicator	AL1 Relay with AL2 Logic / SSR	4
Indicator	AL1 Logic / SSR with AL2 Relay	5
Relay = (terminals 3 & 4), Logic / SSR = (terminals 10 & 11)		

OUTPUT MODE	OP1 SENSOR BREAK/ AL1 FUNCTION	OM
Reverse (heat)	Sensor Break = 0% (off), Active Low	0
Direct (cool)	Sensor Break = 0% (off), Active High	1
Reverse (heat)	Sensor Break = 100% (on), Active Low	2
Direct (cool)	Sensor Break = 100% (on), Active High	3

AL2 ACTION	ALARM 2 FUNCTION (see Alarm Figures)	A2
Disable	No action	0
Sensor Break	Output is on only at Sensor Break	1
Absolute	Active High, on during Sensor Break	2
Absolute	Active Low, off during Sensor Break	3
Deviation	Active High (Available if OA = 0-3)	4
Deviation	Active Low (Available if OA = 0-3)	5
Band	Active Out (Available if OA = 0-3)	6
Band	Active In (Available if OA = 0-3)	7

Example: Configuration Code of **3002** is:
3 = (IN) Type J thermocouple input
0 = (OA) Output function is PID with OP1 as relay and AL2 as logic
0 = (OM) Reverse Acting Output
2 = (A2) Alarm 2 set as Absolute Alarm, Active High

TEMPERATURE INPUT PROGRAMMING (CONF: 0000 to 6537)

1. Hold"Down" until appropriate Configuration Code (ConF) is reached, then press "Return".
2. Press "Down" or "Up"to select °C or °F for Unit, then press "Return",
3. Press "Down" or "Up" to set Pass CodE (factory setting is 33*, then press"Return".

mA or mV INPUT PROGRAMMING (CONF: 7000 to 8537)

1. Hold"Down" until appropriate Configuration Code (ConF) is reached, then press "Return".
2. Press "Down" or "Up" until appropriate Engineering Unit * is reached, then press "Return".
3. Press "Down" or "Up" to select appropriate scaling decimal point (Sc.d.d) *, then press "Return".
4. Press "Down" or "Up" to select appropriate scaling value for low limit of range (Sc.Lo) *, then press "Return".
5. Press "Down" or "Up" to select appropriate scaling value for high limit of range (Sc.Hi), then press"Return".
6. Press "Down" or "Up" to set Pass CodE (factory setting is 33*), then press"Return".

*Note: * For further information see Module 3 explanation.*

5.0 IDENTIFYING THE MODES

OPERATION MODE

In the Operation Mode, the controller displays the temperature or scaled process value that corresponds to the input signal. In this mode, the outputs control the process based on the their configuration. The controller automatically returns to the Operation Mode from the other controller modes if no keys are pressed for at least 30 seconds.

Some programming changes only take affect after returning to the Operation Mode. If power is lost during programming, the controller powers up in the Operation Mode. If this happens, review the programming to verify that the changes were saved.

SETPOINT MODE

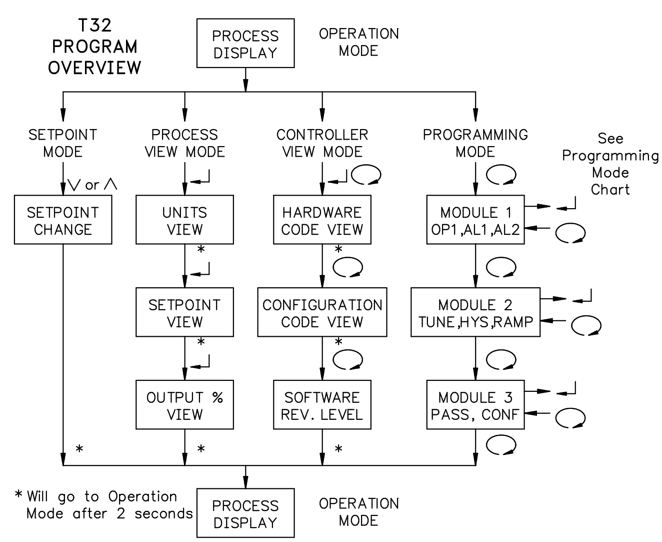
The Setpoint Mode is accessed by pressing the "Up" or "Down" keys from the Operation Mode. While in this mode, the operator can make changes to the setpoint value using the "Up" and "Down" keys. Two seconds after the last key is pressed, the display flashes once to acknowledge the change in setpoint value and the controller returns to the Operation Mode.

When configuring the control output (OP1) as Alarm 1, the setpoint does not affect OP1 or AL1 trigger points, but does still affect Alarm 2 deviation or band trigger points.

VIEW MODES

The Process View Mode is accessed from the Operation Mode by pressing the "Return" key. In this mode, the operator can view the Engineering Units (Unit), Setpoint Value (S.P.) and the Output % Power (Out) by pressing the "Return" key. These values can only be modified in the Programming Mode. The Output % Power can not be changed by the user.

The Controller View Mode is accessed from the Operation Mode by pressing the "Return" key and then the "Module" key. In this mode, the operator can view the Hardware Code (Hard), Configuration Code (ConF), and the Software Revision Level (rEL.) by pressing the "Module" key. The Hardware Code and Software Revision Level are for reference only, and can not be changed. The Configuration Code is modified in Module 3 of the Programming Mode.



6.0 PROGRAMMING THE CONTROLLER

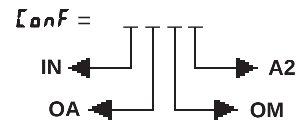
PROGRAMMING MODE

The Programming Mode is accessed from the Operation Mode by pressing the “Module” key. In this mode, the controller parameters are configured. The parameters are organized into three modules that are selected by pressing the “Module” key. The parameters within the modules are selected by pressing the “Return” key. The values of the parameters are viewed and/or changed by pressing the “Up” or “Down” keys.

Based on the Configuration Code, some modules may start with a different parameter than those listed in the programming, and some parameters may not be displayed. Each of the parameters listed in the programming show the portion of the Configuration Code that is necessary for that parameter to appear during programming. To aid in programming this controller, use the Configuration Code Chart provided here to write down your configuration code.

KEY	KEY TERM	PROGRAMMING MODE
	“Module”	Advances to next Module, Returns to Operation Mode
	“Down”	Decreases Parameter Values
	“Up”	Increases Parameter Values
	“Return”	Steps through Parameter Menus, Enters Parameter Values

CONFIGURATION CODE CHART



6.1 MODULE 1

A1SP — ALARM 1 THRESHOLD

PRESS ▽ 0

Range determined by Process Display Scaling Limits

ConF =

IN	OA	OM	A2
*	4-5	*	*

The threshold value is combined with the Alarm 1 hysteresis value, based on the Alarm 1 Action, to determine the on and off points (trigger points) of Alarm 1. This value is determined by the Process Display scaling limits.

A2SP — ALARM 2 THRESHOLD

PRESS ▽ 0

Range determined by Process Display Scaling Limits

ConF =

IN	OA	OM	A2
*	*	*	2-7

The threshold value is combined with the Alarm 2 hysteresis value, based on the Alarm 2 Action, to determine the on and off points (trigger points) of Alarm 2. This value is determined by the Process Display scaling limits.

P.b. — OP1 PROPORTIONAL BAND

PRESS ▽ 5.0

0.5 to 999.9% of span

ConF =

IN	OA	OM	A2
*	0-1	*	*

This band is a percent of process range that causes the output power to change from 0% to 100%. Low proportional band settings result in quick controller response at the expense of stability and increased overshoot. Settings that are excessively low, result in continuous oscillations at setpoint. High proportional band settings result in a sluggish response with long periods of process “droop”. This parameter can be calculated by Auto-tune.

t. i. — OP1 INTEGRAL TIME

PRESS ▽ 5.0

OFF or 0.0 to 100.0 minutes

ConF =

IN	OA	OM	A2
*	0-1	*	*

Integral action shifts the center point position of the proportional band to eliminate error in the steady state. Integral action changes the output power to bring the process to setpoint. Integral times that are too fast do not allow the process to respond to the new output value. This causes over-compensation and leads to an unstable process with excessive overshoot. Times that are too slow cause a slow response to steady state errors. This parameter can be calculated by Auto-tune.

t.d. — OP1 DERIVATIVE TIME

PRESS ▽ 1.00

OFF or 0.00 to 10.00 minutes

ConF =

IN	OA	OM	A2
*	0-1	*	*

Derivative action shortens the process response time and helps to stabilize the process by providing an output based on the rate of change of the process. Increasing the derivative time helps to stabilize the response, but too much derivative time coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. None or too little derivative action usually results in decreased stability with higher overshoots. This parameter can be calculated by Auto-tune.

t.c. — OP1 CYCLE TIME

PRESS ▽ 20

1 to 200 seconds

ConF =

IN	OA	OM	A2
*	0-1	*	*

This value is used by the Power % to determine how long OP1 is on. It is recommended to use a cycle time of 1/10 or less of the process time constant. Higher cycle times could degrade control and shorter times provide little benefit at the expense of shortened relay life.

O.C. — OP1 OVERSHOOT CONTROL

PRESS ▽ 1.00

0.01 to 1.00

ConF =

IN	OA	OM	A2
*	0-1	*	*

After auto-tune is executed, this value can be used to reduce overshoot generated by a setpoint change. A setting of 1.00 disables overshoot control. A value below 0.50 is not recommended.

OP. H — OP1 % POWER HIGH LIMIT

PRESS ▽ 100.0

10.0 to 100.0%

ConF =

IN	OA	OM	A2
*	0-1	*	*

This value can be used to limit the % power that PID can calculate. A lower value can reduce overshoots by limiting the process approach level.

hY. — OP1 ON / OFF HYSTERESIS

PRESS ▽ 0.5

0.1 to 10.0% of span

ConF =

IN	OA	OM	A2
*	2-3	*	*

This value determines the hysteresis value by using the entered percentage of the full scale. This hysteresis value is balanced around OP1 Setpoint to determine the OP1 output on and off points (trigger points) per the OP1 On / Off Action as illustrated in the Action Figures.

6.2 MODULE 2

tunE

PRESS ▽ **StoP**

AUTO-TUNING START / STOP

StoP   Strt

ConF =

IN	OA	OM	A2
✷	0-1	✷	✷

Before starting Auto-tune, see the Auto-tune explanation. There are two types of tuning algorithm, the Step Response and the Natural Frequency. These types are explained in the OP1 Control Mode Explanations. The AT indicator will be on during the Auto-Tune operation.

SL. u

PRESS ▽ **OFF**

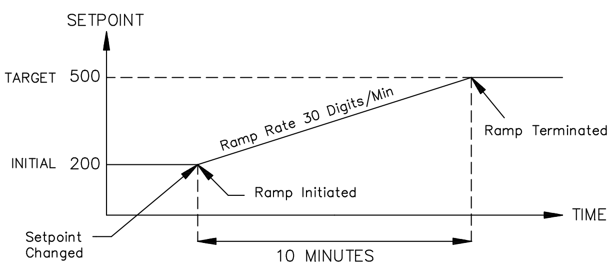
SETPOINT RAMP-UP

OFF or 0.1 to 999.9 digits/minute

ConF =

IN	OA	OM	A2
✷	0-3	✷	✷

This parameter specifies the maximum rate of change of the setpoint value, when going from a low value to a higher value. This is specified in digits per minute. When the parameter is OFF, this function is disabled, allowing the controller to stabilize as fast as possible to the new setpoint value.



SL. d

PRESS ▽ **OFF**

SETPOINT RAMP-DOWN

OFF or 0.1 to 999.9 digits/minute

ConF =

IN	OA	OM	A2
✷	0-3	✷	✷

This parameter specifies the maximum rate of change to the setpoint value, when going from a high value to a lower value. This is specified in digits per minute. When the parameter is OFF, this function is disabled, allowing the controller to stabilize as fast as possible to the new setpoint value.

S.P. L

PRESS ▽ **OFF**

SETPOINT LOW LIMIT

-999 to 9999

ConF =

IN	OA	OM	A2
✷	0-3	✷	✷

This parameter specifies the lower limit for the setpoint value. Set the limit values so that the temperature setpoint value cannot be set outside the safe operating area of the process.

S.P. H

PRESS ▽ **OFF**

SETPOINT HIGH LIMIT

-999 to 9999

ConF =

IN	OA	OM	A2
✷	0-3	✷	✷

This parameter specifies the high limit for the setpoint value. Set the limit values so that the temperature setpoint value cannot be set outside the safe operating area of the process.

A1hY

PRESS ▽ **0.5**

ALARM 1 HYSTERESIS

0.1 to 10.0 % of the input range

ConF =

IN	OA	OM	A2
✷	4-5	✷	✷

This value determines the hysteresis value by using the entered percentage of the full scale. This hysteresis value is balanced around Alarm 1 threshold value to determine the Alarm 1 output on and off points (trigger points) based on the Alarm 1 Action, as illustrated in the Action Figures.

A2hY

PRESS ▽ **0.5**

ALARM 2 HYSTERESIS

0.1 to 10.0 % of the input range

ConF =

IN	OA	OM	A2
✷	✷	✷	2-7

This value determines the hysteresis value by using the entered percentage of the full scale. This hysteresis value is balanced around Alarm 2 threshold value to determine the Alarm 2 output on and off points (trigger points) based on the Alarm 2 Action, as illustrated in the Action Figures.

t.FiL

PRESS ▽ **OFF**

INPUT FILTER TIME CONSTANT

OFF or 1 to 30 seconds

ConF =

IN	OA	OM	A2
✷	✷	✷	✷

This value controls the input filter applied to the process input. If the displayed process signal is difficult to read due to small process variations or noise, increased levels of filtering will help to stabilize the display.

In.Sh

PRESS ▽ **OFF**

INPUT DISPLAY SHIFT

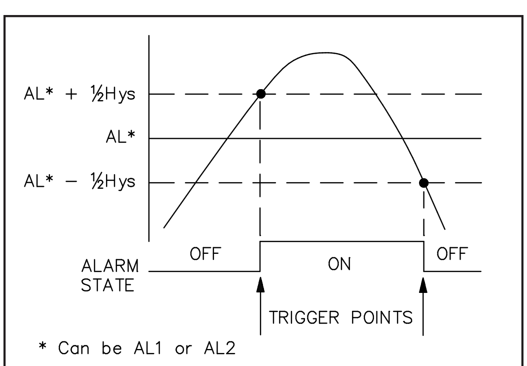
OFF or -60 to 60 digits

ConF =

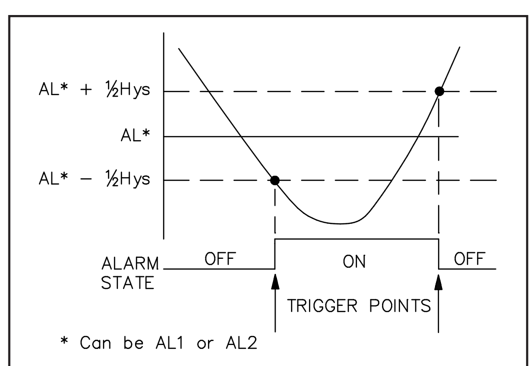
IN	OA	OM	A2
✷	✷	✷	✷

This value is added to the measured process value. It can be used to correct a known error, or to provide a user desired display at a specific input.

AL2 and AL1 ALARM ACTION FIGURES



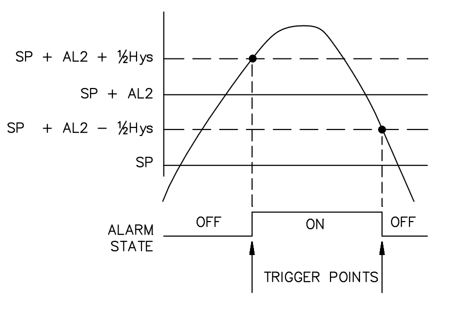
Absolute High; Direct; Active High



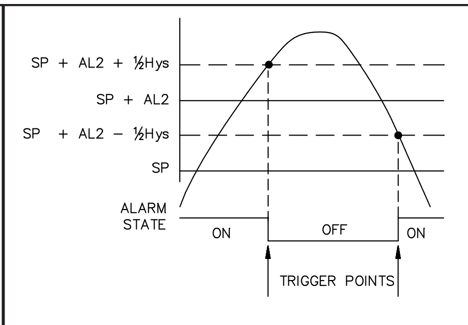
Absolute Low; Reverse; Active Low

AL2 ALARM ACTION FIGURES

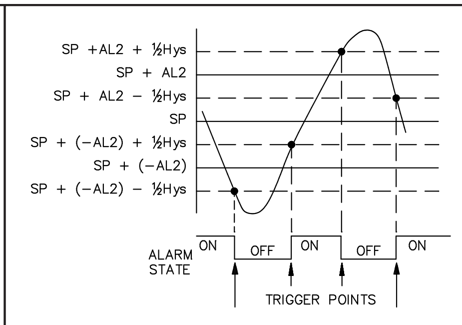
The Hys value shown for the below figures, refers to Alarm 2 hysteresis.



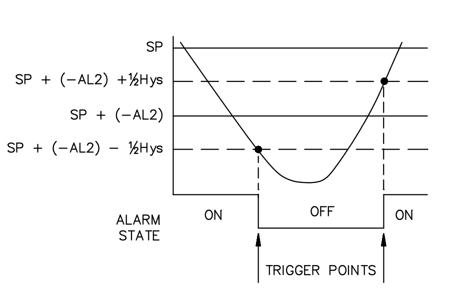
Deviation High with Positive Alarm Values



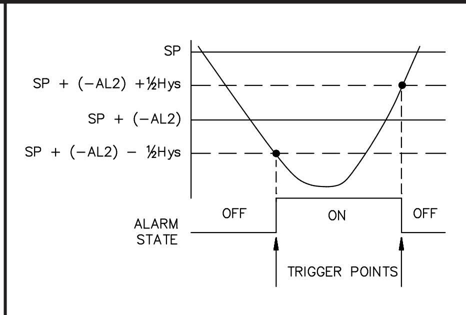
Deviation Low with Positive Alarm Values



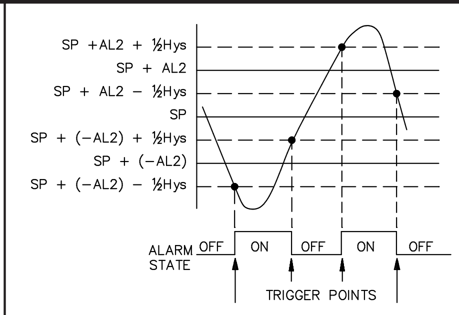
Band Inside Acting Alarm Values



Deviation High with Negative Alarm Values



Deviation Low with Negative Alarm Values



Band Outside Acting Alarm Values

6.3 MODULE 3

PASS

PRESS ▽

33

PASS CODE VERIFY

0 to 9999

ConF =

IN	OA	OM	A2
✷	✷	✷	✷

After the first start-up, a PASS CodE will be required to make changes in Module 3. From the factory, 33 is the PASS value stored in CodE and must be entered to make any additional changes.

ConF

PRESS ▽

2002

CONFIGURATION CODE

0000 to 8537

ConF =

IN	OA	OM	A2
✷	✷	✷	✷

Enter a four digit Configuration Code that meets the requirements of the application (see Configuration Code Table). The controller will not allow an invalid Configuration Code.

Unit

PRESS ▽

oF

ENGINEERING UNITS

Selection	Description	ConF: IN
oC	Centigrade	0-8
oF	Fahrenheit	0-8
nonE	None (blank)	7-8
nU	Millivolts	7-8
U	Voltage	7-8
nA	Milliamps	7-8
A	Ampere	7-8
bAr	Bar	7-8
PSI	PSI	7-8
rh	Rh	7-8
Ph	pH	7-8

✷ The remaining ConF values have no effect on this selection.

Only Centigrade and Fahrenheit affect the scaling of the Process Display. The other selections are for Units View purposes only.

Sc.d.d

PRESS ▽

0

DECIMAL POINT

- 0 — **0**
- 1 — **0.0**
- 2 — **0.00**
- 3 — **0.000**

ConF =

IN	OA	OM	A2
7-8	✷	✷	✷

Determines decimal point location for Process Display.

Sc.Lo

PRESS ▽

0

SCALING VALUE FOR LOW LIMIT

-999 to 9999

ConF =

IN	OA	OM	A2
7-8	✷	✷	✷

Determines Process Display scaling value for low end of selected Linear Scale Range.

Sc.Hi

PRESS ▽

0

SCALING VALUE FOR HIGH LIMIT

-999 to 9999

ConF =

IN	OA	OM	A2
7-8	✷	✷	✷

Determines Process Display scaling value for high end of selected Linear Scale Range.

CodE

PRESS ▽

33

PASS CODE SETUP

0 to 9999

ConF =

IN	OA	OM	A2
✷	✷	✷	✷

Determines the value to be entered at PASS, to allow access to programming. A value between 0 and 9998 restricts access to Module 3 only. A value of 9999 restricts access to all of the Programming Modes. If parameter security is not needed, it is strongly recommended that a value of 0 be entered here. There is no universal PASS value that will override the CodE value. If the CodE value is forgotten, then every number combination must be tried until the match is found. It is highly recommended to write down the CodE value.

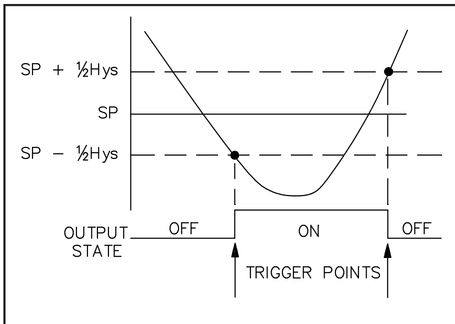
7.0 ON/OFF CONTROL EXPLANATION

Single Output

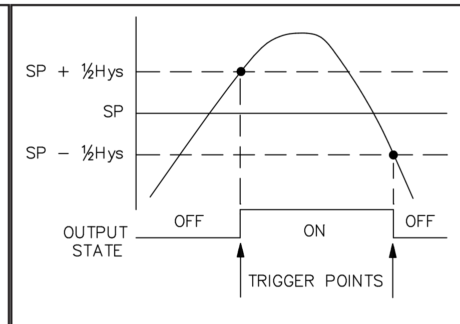
The controller operates in On/Off Control when Configuration Code OA is set for 2 or 3. In this control action OP1 operates without PID control. The setpoint and OP1 hysteresis values determine the on and off trigger points of the OP1 output.

In this control, the process will oscillate around the setpoint value. The OP1 On/Off Hysteresis value, together with the process characteristics, determine the period and amplitude of the oscillations. Larger values of hysteresis increase both the amplitude and period of oscillations but also reduce the number of output switching cycles.

The output mode OM (third digit of the Configuration Code) can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications.



ON/OFF, Reverse Acting (Heat)



ON/OFF, Direct Acting (Cool)

8.0 PID CONTROL EXPLANATIONS

Proportional Band

Proportional band is defined as the "band" (range) the process changes to cause the percent output power to change from 0% to 100%. The band may or may not be centered about the setpoint value depending upon the steady state requirements of the process. The band is shifted by manual offset or integral action (automatic reset) to maintain zero error. Proportional band is expressed as percent of input sensor range.

Example: Thermocouple type T with a temperature range of 600°C is used and is indicated in degrees Celsius with a proportional band of 5%. This yields a band of 600°C X 5% = 30°C.

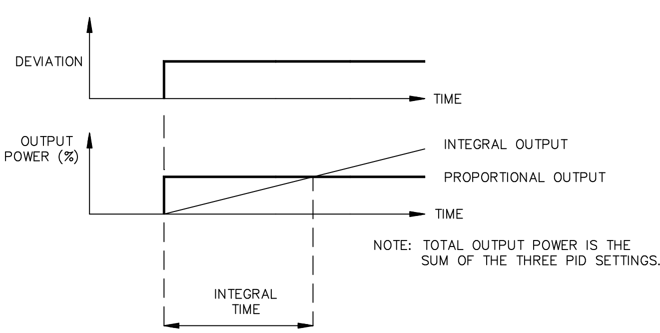
The proportional band should be set to obtain the best response to a disturbance while minimizing overshoot. Low proportional band settings (high gain) result in quick controller response at expense of stability and increased overshoot. Settings that are excessively low produce continuous oscillations at setpoint. High proportional band settings (low gain) result in a sluggish response with long periods of process "droop".

Integral Time

Integral time is defined as the time, in seconds, in which the output due to integral action alone equals the output due to proportional action with a constant process error. As long as a constant error exists, integral action repeats the proportional action each integral time. Integral action shifts the center point position of the proportional band to eliminate error in the steady state. The units of integral time are seconds per repeat.

Integral action (also known as "automatic reset") changes the output power to bring the process to setpoint. Integral times that are too fast (small times) do not allow the process to respond to the new output value. This causes over-compensation and leads to an unstable process with excessive overshoot. Integral times that are too slow (large times) cause a slow response to steady state errors. Integral action may be disabled by setting the time to zero. If time is set to zero, the previous integral output power value is maintained.

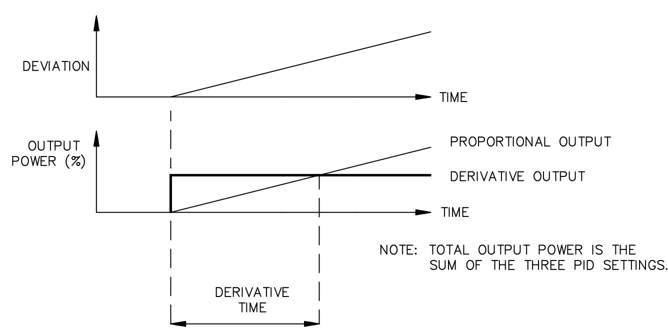
If integral action is disabled, manual reset is available by modifying the output power offset (initially set to zero) to eliminate steady state errors.



Derivative Time

Derivative time is defined as the time, in seconds, in which the output due to proportional action alone equals the output due to derivative action with a ramping process error. As long as a ramping error exists, the derivative action is "repeated" by proportional action every derivative time. The units of derivative time are seconds per repeat.

Derivative action is used to shorten the process response time and helps to stabilize the process by providing an output based on the rate of change of the process. In effect, derivative action anticipates where the process is headed and changes the output before it actually "arrives". Increasing the derivative time helps to stabilize the response, but too much derivative time coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. None or too little derivative action usually results in decreased stability with higher overshoots. No derivative action usually requires a wider proportional and slower integral times to maintain the same degree of stability as with derivative action. Derivative action is disabled by setting the time to zero.



9.0 AUTO-TUNE EXPLANATION

Auto-Tune is a user initiated function during which the controller automatically determines the PID settings based upon the process characteristics. During Auto-Tune, the controller oscillates the output and monitors the input response. The AT indicator will be on during the Auto-Tune operation. At the end of this operation, the calculated PID values are stored in memory and the controller returns to the Operation Mode.

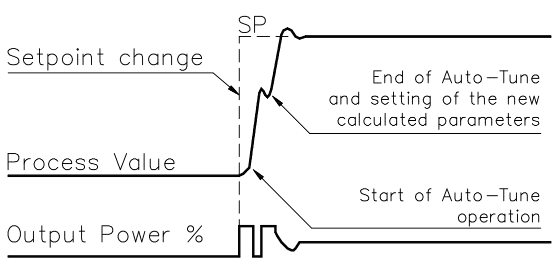
Prior to initiating Auto-Tune, it is essential that the controller Cycle Time parameter and the Setpoint value be configured for the application. Auto-Tune is started or stopped using the tunE parameter in Module 2. The Overshoot Control parameter in Module 1 should be set to 1.00 before initiating Auto-tune.

The controller automatically selects (based on the process conditions) one of two types of tuning algorithm. The length and number of cycles required to calculate Proportional, Integral, and Derivative (PID) values are application dependent. (When Integral and Derivative parameters are configured for OFF, they are not included in the control algorithm.)

Step Response

This type of tuning algorithm is automatically selected when the process value is more than 5% span from the Setpoint at the start of Auto-Tune. This method has the advantage of faster calculation, with a reasonable accuracy in the results.

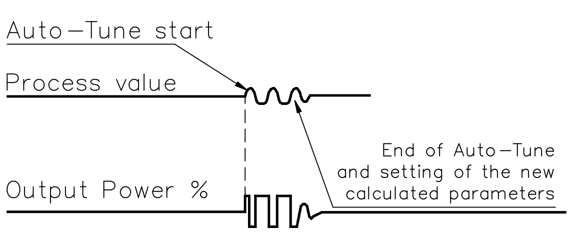
STEP RESPONSE



Natural Frequency

This type of tuning algorithm is automatically selected when the process value is close to the Setpoint. This method has the advantage of higher accuracy in the results, with a reasonable speed calculation.

NATURAL FREQUENCY

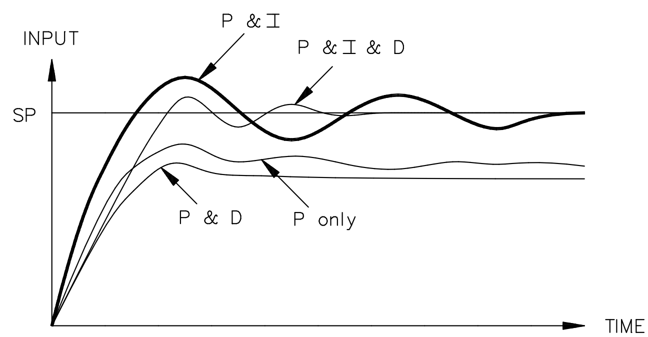


Manual Adjustments

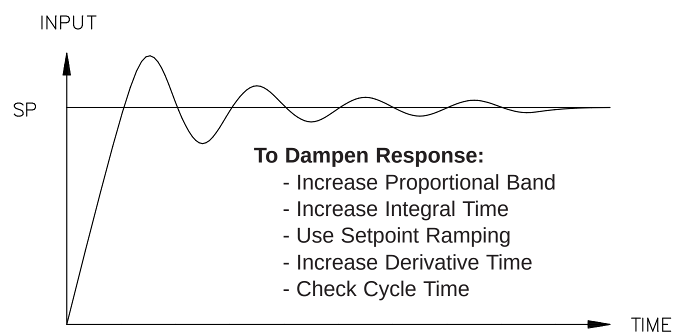
To aid in the adjustment of the PID parameters for improved process control, a chart recorder is necessary to provide a visual means of analyzing the process. Compare the actual process response to the PID response figures with a step change to the process. Make changes to the PID parameters in no more than 20% increments from the starting value and allow the process sufficient time to stabilize before evaluating the effects of the new parameter settings.

The Overshoot Control parameter can also be adjusted for tighter control after Auto-Tune.

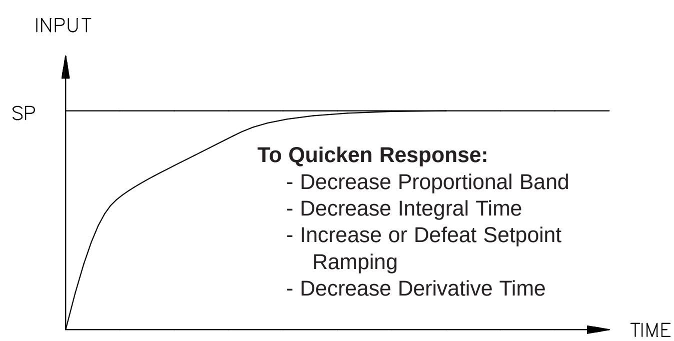
TYPICAL RESPONSE CURVE



OVERSHOOT AND OSCILLATIONS



SLOW RESPONSE



10.0 CALIBRATION

The controller has been fully calibrated at the factory. Display offset and scaling in Module 3 converts the input signal to a desired process value. If the controller appears to be indicating incorrectly or inaccurately, these parameters should be checked first.

When recalibration is required (generally every 2 years), it should only be performed by qualified technicians using appropriate, highly accurate equipment. The equipment must remain switched on for a minimum of one hour at a maintained environmental condition. Calibration may be aborted by disconnecting power to the controller before pressing the "Return" key. No controller parameter changes are necessary to perform calibration.

Input Calibration

For thermocouple, mV and mA input calibration, connect a 50.000 mV input to terminals 5 (-mV) and 6 (+mV). For RTD input calibration, place a 313.594 ohm resister between terminals 6 and 12 and connect terminals 6 and 5 together. (If both types of input are being calibrated, then connect only one input, perform the complete calibration and repeat the procedure with the other input.)

Now perform the following:

PRESS KEY(S)	DISPLAY RESULT
"Return", "Module", "Module", "Module"	rPL
"Down" & "Up" together	PASS
Enter programmed Pass Code, "Return"	CAL.1
"Down" (If calibrating for RTD, do not wait.)	Wait for stable display *
"Return"	CAL.2
"Down" (If not calibrating for RTD, do not wait.)	Wait for stable display *
"Return"	CAL.3
"Return"	CAL.4
"Return"	Process Display

* Display may not vary more than ± 1 digit. If not stable after a few seconds, then press "Down" or "Up" and wait again. Continue this action until a stable display is shown.

TROUBLESHOOTING

PROBLEM	REMEDIES
NO DISPLAY	**CHECK**: Power level, power connections
CAN NOT ENTER MODULE 3 or PROGRAMMING MODE	**PRESS**: The "Module" key until PASS appears then enter the correct pass code and press the "Return" key
CAN NOT REMEMBER PASS CODE	**ENTER**: Other pass code combinations and press the "Return" key
CAN NOT CHANGE CONF CODE	**VERIFY**: The controller is in Programming Module 3 Mode and code value is valid
INCORRECT DISPLAY VALUE	**CHECK**: Configuration Code, Input Display Shift, Scaling Low, Scaling High
"- - - -" in DISPLAY	**CHECK**: Signal wiring, Configuration Code
"_ _ _ _" in DISPLAY	**CHECK**: Signal wiring, Configuration Code
"ConF" in DISPLAY	**CHECK**: Configuration Code
OUTPUT DOES NOT WORK	**CHECK**: Output wiring, output power, Configuration Code, setpoint or alarm threshold value, hysteresis value
CONTROLLER OVERSHOOTS or DOES NOT GET TO SETPOINT	**CHECK**: Overshoot Control, PID values, Setpoint Slopes **PERFORM**: Auto-tune
SOME PARAMETERS DO NOT APPEAR	**CHECK**: Configuration Code
SETPOINT ENTRY STOPS AT A VALUE	**CHECK**: Setpoint High Limit

For further technical assistance, contact technical support.

PARAMETER VALUE CHART
T32 1/32 DIN PID Controller

Programmer ________________ **Date** ________
Meter# ______________ **Pass Code** __________

Based on the Configuration Code of the controller, some parameters may not be available.

Module 1

DISPLAY	PARAMETER	USER SETTING
A1SP	AL1 THRESHOLD	
A2SP	AL2 THRESHOLD	
hY.	OP1 HYSTERESIS	
P.b.	OP1 PROPORTIONAL BAND	
t.i.	OP1 INTEGRAL TIME	
t.d.	OP DERIVATIVE TIME	
t.c.	OP1 CYCLE TIME	
O.C.	OP1 OVERSHOOT CONTROL	
OP. H	OP1 % POWER HIGH LIMIT	

Module 2

DISPLAY	PARAMETER	USER SETTING
SL. u	SETPOINT SLOPE-UP	
SL. d	SETPOINT SLOPE-DOWN	
S.P. L	SETPOINT LOW LIMIT	
S.P. H	SETPOINT HIGH LIMIT	
A1hY	AL1 HYSTERESIS	
A2hY	AL2 HYSTERESIS	
tFiL	FILTER TIME CONSTANT	
In.Sh	INPUT DISPLAY SHIFT	

Module 3

DISPLAY	PARAMETER	USER SETTING
ConF	CONFIGURATION CODE	
Unit	ENGINEERING UNIT	
Sc.d.d	DECIMAL POINT	
Sc.Lo	SCALING LOW	
Sc.Hi	SCALING HIGH	
CodE	PASS CODE SETUP	

PROGRAMMING MODE CHART

Module starts with first appropriate parameter.