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

CE

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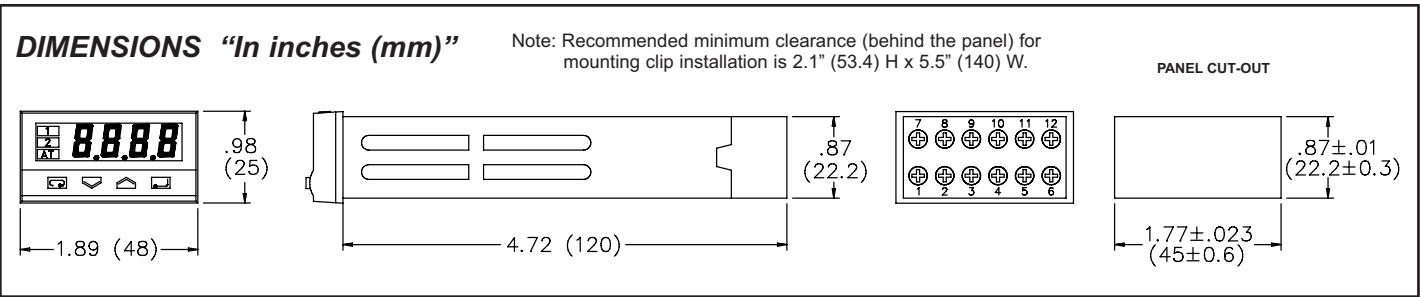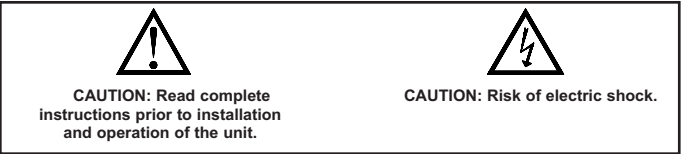
Do not use the unit to directly command motors, valves, or other actuators not equipped with safeguards. To do so can be potentially harmful to persons or equipment in the event of a fault to the unit. An independent and redundant temperature limit indicator with alarms is strongly recommended. The indicators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

.98 (25)

.87 (22.2)

1.89 (48)

4.72 (120)

.87±.01 (22.2±0.3)

1.77±.023 (45±0.6)

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
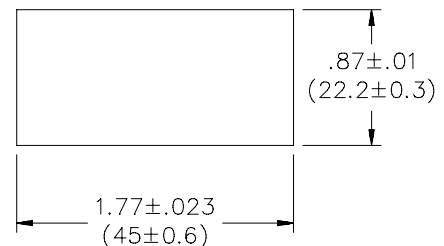
Installation

  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.
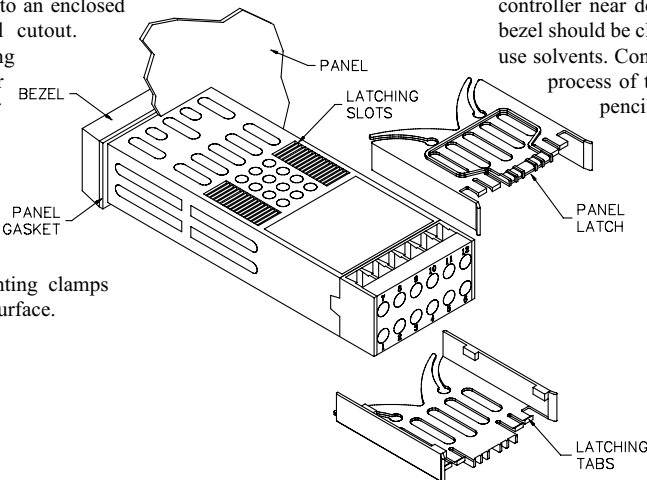
Installation Environment

  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.

PANEL

BEZEL

LATCHING SLOTS

PANEL GASKET

PANEL LATCH

LATCHING TABS

.87±.01
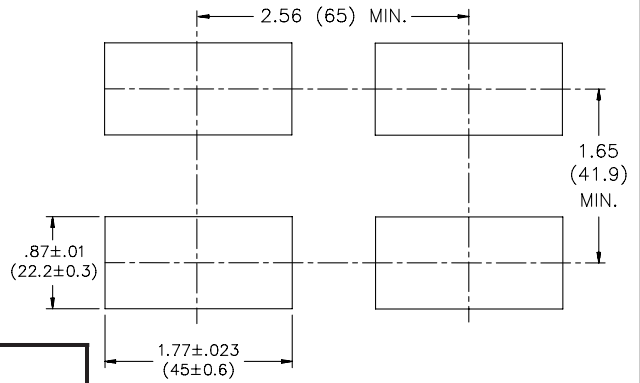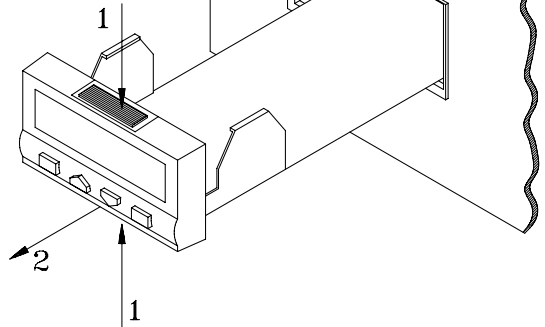(22.2±0.3)

1.77±.023
(45±0.6)

Removing the Mounting Clips

Insert a screwdriver behind the clips as shown. Rotate the screwdriver until the clips release.
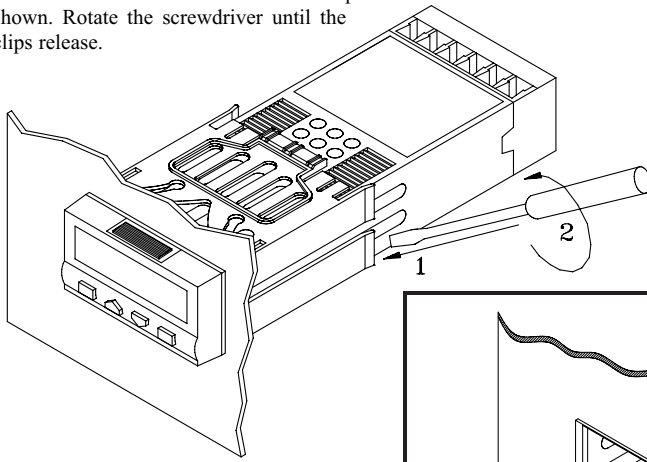
Removing The Front Panel Assembly

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)
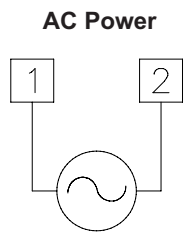   Schaffner # FN670-1.8/07
   Corcom # 1 VR3
Note: Reference manufacturer's instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
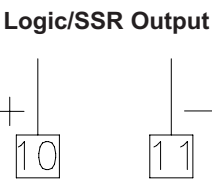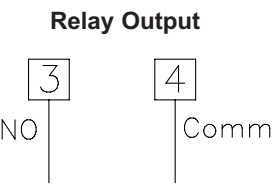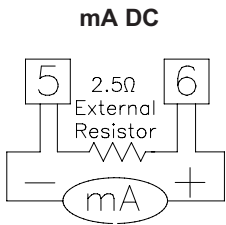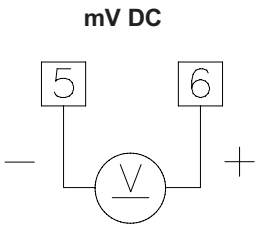Snubbers:
   RLC #SNUB0000

2.1 POWER WIRING

AC Power

2.2 OUTPUT WIRING

Relay Output

NO   Comm

Logic/SSR Output

2.3 INPUT SIGNAL WIRING

Thermocouple

RTD

mV DC

mA DC
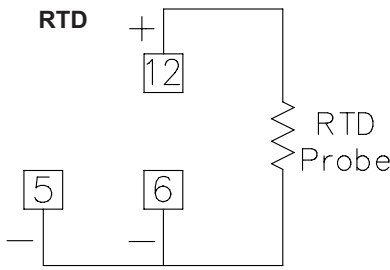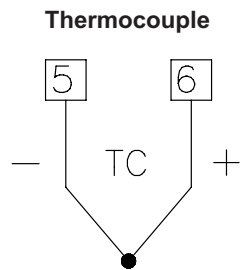
2.4 REAR TERMINALS
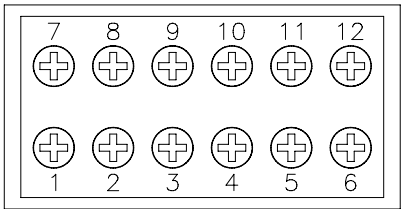
TERMINAL	LABELED	CONNECTION
1	AC	Controller Power
2	AC	Controller Power
3	NO	Normally Open, Relay Output
4	COMM	Common, Relay Output
5	TC-	(-) TC or (-) RTD or (-) mV or (-) mA*
6	TC+	(+) TC or (-) RTD or (+) mV or (+) mA*
7	N/C	No Connection
8	N/C	No Connection
9		No Connection
10	LOGIC+	(+) Logic (SSR) 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
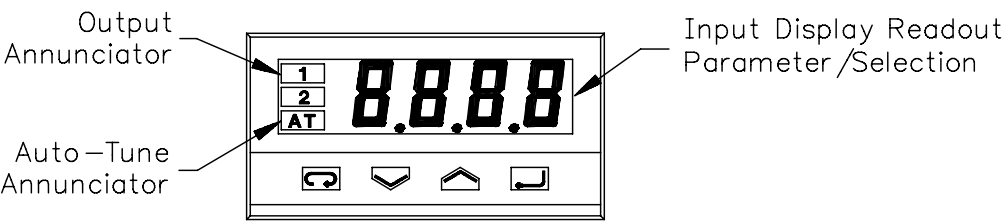
KEY	KEY TERM	OPERATION MODE	SETPOINT MODE	VIEW MODE	PROGRAMMING MODE
	"Module"	Enters Programming Mode	-----	After "Return", steps through Controller View	Advances to next Module, Returns to Operation Mode
	"Down"	Enters Setpoint Mode	Decreases Setpoint	-----	Decreases Parameter Values
	"Up"	Enters Setpoint 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

ConF = 0 0 0 0

IN ◄——————►A2
OA ◄——————►OM
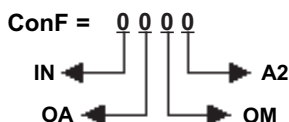
INPUT TYPE	INPUT DEVICE TYPE		IN
RTD Pt100	-99.9 to 100.0 °C	-147.8 to 212.0 °F	0
RTD Pt100	-200 to 400 °C	-328 to 752 °F	1
TC L	0 to 600 °C	32 to 1112 °F	2
TC J	0 to 600 °C	32 to 1112 °F	3
TC T	-200 to 400 °C	-328 to 752 °F	4
TC K	0 to 1200 °C	32 to 2192 °F	5
TC S	0 to 1600 °C	32 to 2912 °F	6
Linear 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.

T32 PROGRAM OVERVIEW
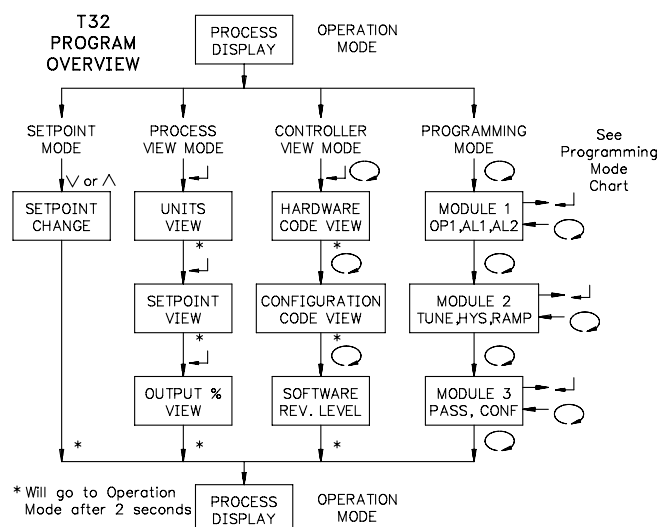
6.0 PROGRAMMING THE CONTROLLER

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

ConF =

IN ◄─────────► A2

OA ◄─────────► OM

6.1 MODULE 1

A1S.P
PRESS ▽

0

ALARM 1 THRESHOLD

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.

A2S.P
PRESS ▽

0

ALARM 2 THRESHOLD

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.
PRESS ▽

5.0

OP1 PROPORTIONAL BAND

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.
PRESS ▽

5.0

OP1 INTEGRAL TIME

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.
PRESS ▽

1.00

OP1 DERIVATIVE TIME

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.
PRESS ▽

20

OP1 CYCLE TIME

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.
PRESS ▽

1.00

OP1 OVERSHOOT CONTROL

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
PRESS ▽

100.0

OP1 % POWER HIGH LIMIT

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.

h.Y.
PRESS ▽

0.5

OP1 ON / OFF HYSTERESIS

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.

tunP — AUTO-TUNING START / STOP

PRESS ▽
StoP   StoP   Strt

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.
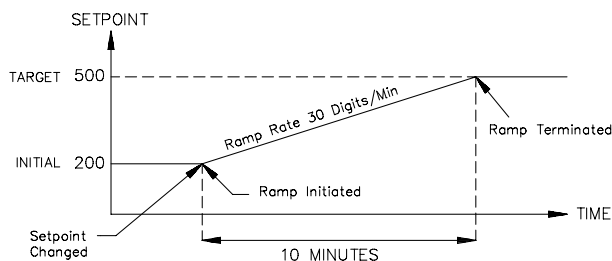
SL. u — SETPOINT RAMP-UP

PRESS ▽
OFF or 0.1 to 999.9 digits/minute
OFF

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 — SETPOINT RAMP-DOWN

PRESS ▽
OFF or 0.1 to 999.9 digits/minute
OFF

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.

SP. L — SETPOINT LOW LIMIT

PRESS ▽
-999 to 9999
OFF

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.

SP. H — SETPOINT HIGH LIMIT

PRESS ▽
-999 to 9999
OFF

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 — ALARM 1 HYSTERESIS

PRESS ▽
0.1 to 10.0 % of the input range
0.5

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 — ALARM 2 HYSTERESIS

PRESS ▽
0.1 to 10.0 % of the input range
0.5

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.

tF iL — INPUT FILTER TIME CONSTANT

PRESS ▽
OFF or 1 to 30 seconds
OFF

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.
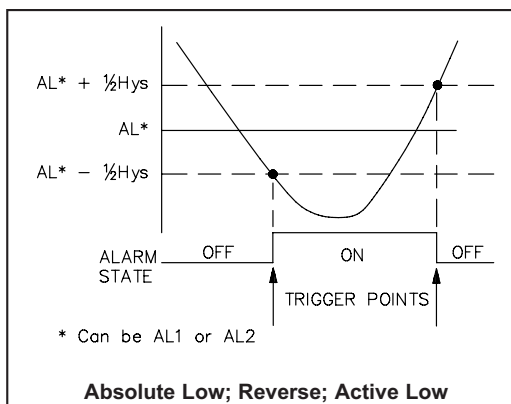
In.Sh — INPUT DISPLAY SHIFT

PRESS ▽
OFF or -60 to 60 digits
OFF

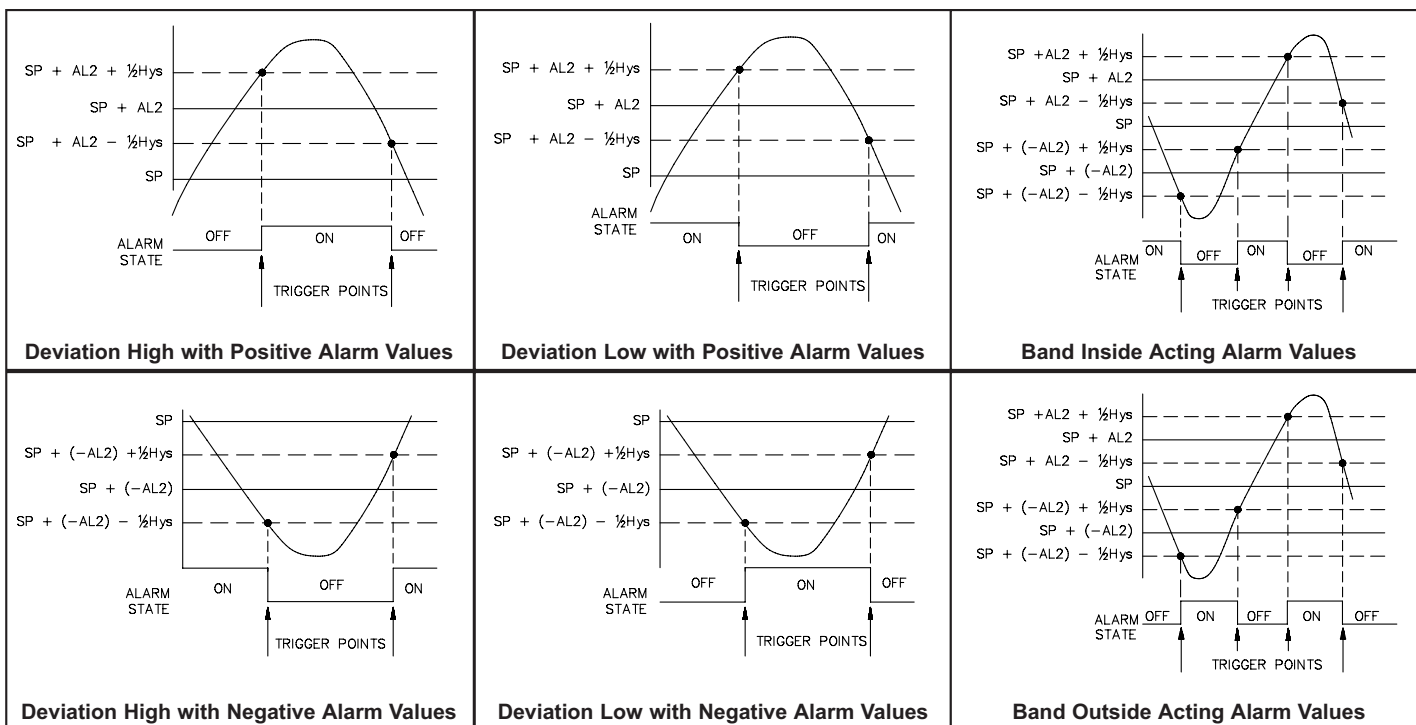| IN	OA	OM	A2
✳	✳	✳	✳

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
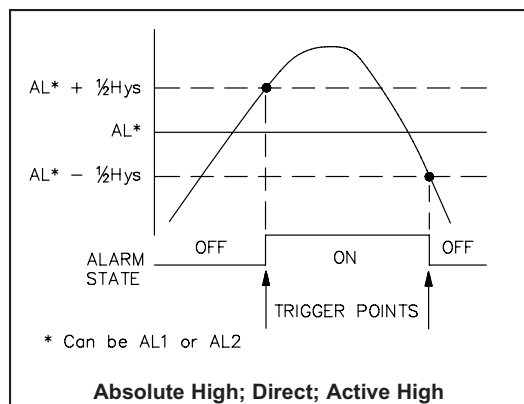
AL2 ALARM ACTION FIGURES

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 CODE VERIFY

PRESS

33

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.

CONFIGURATION CODE

PRESS

2002

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.

ENGINEERING UNITS

PRESS

°F

Selection	Description	ConF: IN
°C	Centigrade	0-8
°F	Fahrenheit	0-8
nonP	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.

DECIMAL POINT

PRESS

0

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.

SCALING VALUE FOR LOW LIMIT

PRESS

0

-999 to 9999

ConF =

IN	OA	OM	A2
7-8	✳	✳	✳

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

SCALING VALUE FOR HIGH LIMIT

PRESS

0

-999 to 9999

ConF =

IN	OA	OM	A2
7-8	✳	✳	✳

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

PASS CODE SETUP

PRESS

33

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.
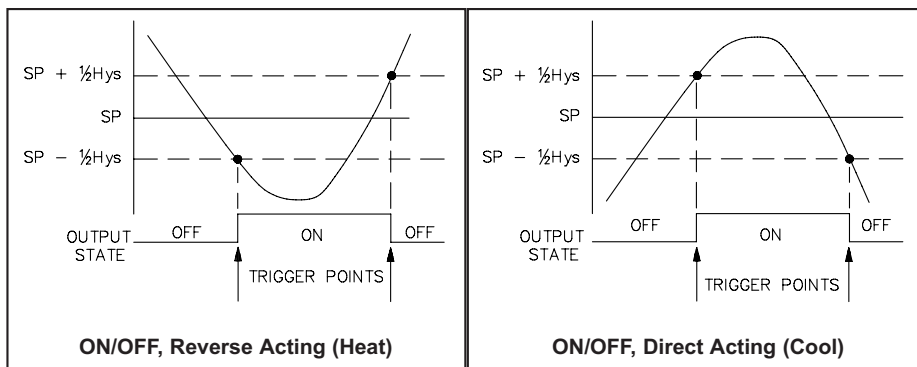
7.0 ON/OFF CONTROL EXPLANATION

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.
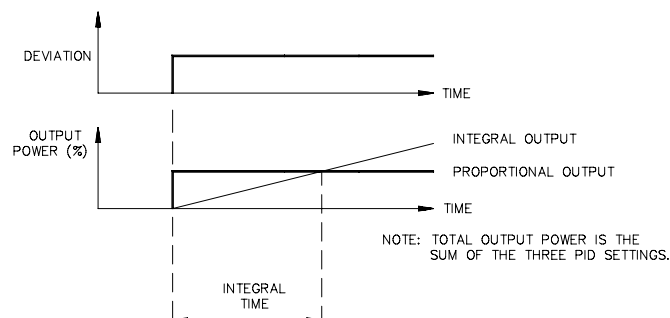
Derivative Time

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.
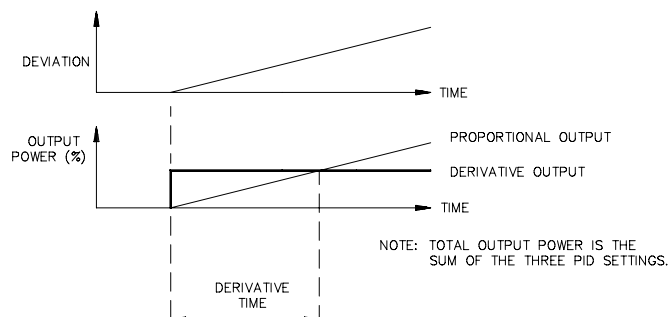
9.0 AUTO-TUNE EXPLANATION

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.
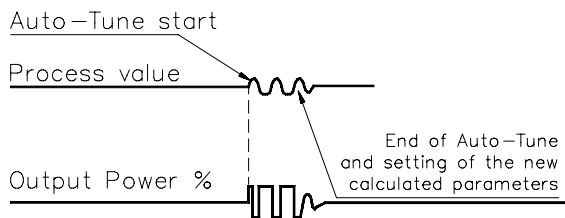
STEP RESPONSE
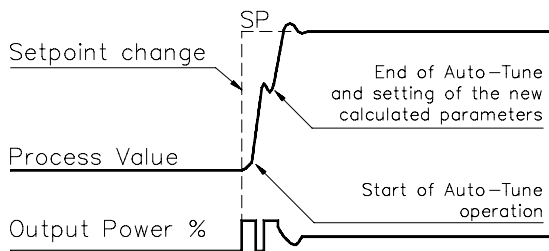
Natural Frequency

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.
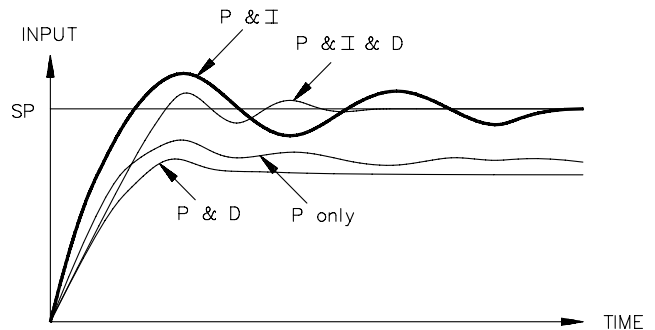
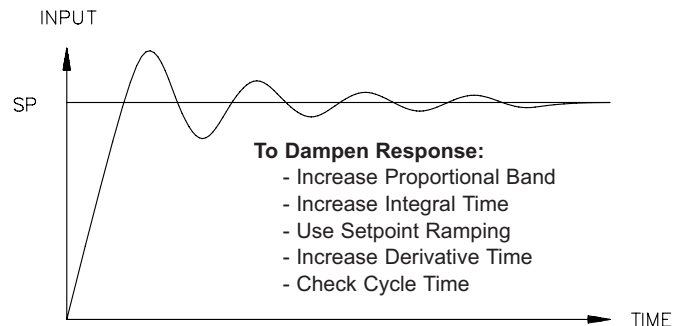### NATURAL FREQUENCY

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

To Dampen Response:
- Increase Proportional Band
- Increase Integral Time
- Use Setpoint Ramping
- Increase Derivative Time
- Check Cycle Time

SLOW RESPONSE

To Quicken Response:
- Decrease Proportional Band
- Decrease Integral Time
- Increase or Defeat Setpoint Ramping
- Decrease Derivative Time
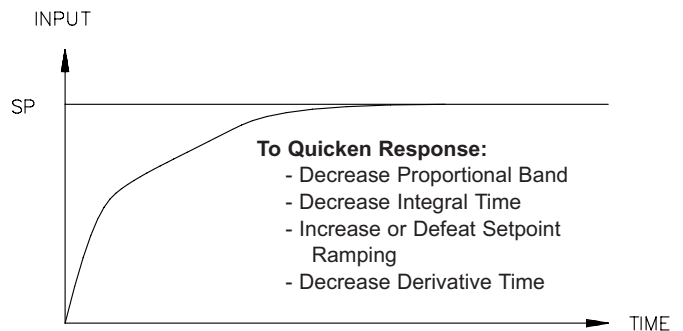
10.0 CALIBRATION

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"	r PL
"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.

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

Module 1

DISPLAY	PARAMETER	USER SETTING
A 1S.P	AL1 THRESHOLD	_____
A2S.P	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	_____
SP. L	SETPOINT LOW LIMIT	_____
SP. H	SETPOINT HIGH LIMIT	_____
A 1hY	AL1 HYSTERESIS	_____
A2hY	AL2 HYSTERESIS	_____
t.F iL	FILTER TIME CONSTANT	_____
In.Sh	INPUT DISPLAY SHIFT	_____

Module 3

DISPLAY	PARAMETER	USER SETTING
ConF	CONFIGURATION CODE	_____
Un it	ENGINEERING UNIT	_____
Sc.d.d	DECIMAL POINT	_____
Sc.Lo	SCALING LOW	_____
Sc.H i	SCALING HIGH	_____
CodE	PASS CODE SETUP	_____

PROGRAMMING MODE CHART

Module starts with first appropriate parameter.

Module 1
For ConF: OA = 0–3

A2.5P — AL2 Threshold — If ConF: A2 = 2–7

P.b. — OP1 Proportional Band — If ConF: OA = 0–1

hY. — OP1 Hysteresis — If ConF: OA = 2–3

t. i. — OP1 Integral Time — If ConF: OA=0–1

t.d. — OP1 Derivative Time — If ConF: OA=0–1

t.c. — OP1 Cycle Time — If ConF: OA=0–1

O.C. — OP1 Overshoot — If ConF: OA=0–1

OP. H — OP1 High Limit — If ConF: OA=0–1

For ConF: OA = 4–5

Module 1
A 1S.P — AL1 Threshold — If ConF: OA = 4–5
A2S.P — AL2 Threshold — If ConF: A2 = 2–7

Module 2
A 1hY — AL1 Hysteresis — If ConF: OA = 4–5
A2hY — AL2 Hysteresis — If ConF: A2 = 1–7
t.F iL — Filter Time Constant
In.Sh — Input Display Shift

Module 2
For ConF: OA = 0–3

tunE — Tuning Start/Stop — If ConF: OA = 0–1
or
SL. u — Setpoint Slope-up
SL. d — Setpoint Slope-down
SP. L — Setpoint Low Limit
SP. H — Setpoint High Limit
A2hY — AL2 Hysteresis — If ConF: A2 = 2–7
t.F iL — Filter Time Constant
In.Sh — Input Display Shift

Module 3
For ConF: OA = 0–5

PASS — Pass Code Verify
ConF — Configuration Code
Un it — Engineering Units
Sc.d.d — Decimal Point — If ConF: IN = 7–8
Sc.Lo — Scaling Low — If ConF: IN = 7–8
Sc.H i — Scaling High — If ConF: IN = 7–8
CodE — Pass Code Setup

red lion

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Fax +1 (717) 764-0839
www.redlion-controls.com

MODEL T48 - 1/16 DIN TEMPERATURE CONTROLLER

- *PID CONTROL WITH REDUCED OVERSHOOT*
- *ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS*
- *NEMA 4X/IP65 BEZEL*
- *DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF TEMPERATURE AND SETPOINT*
- *STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES*
- *ACCEPTS 10 TYPES OF SENSOR INPUTS (Thermocouple or RTD)*
- *OPTIONAL HEATER CURRENT MONITOR AND HEATER BREAK ALARM*
- *OPTIONAL DUAL ALARM OUTPUTS*
- *OPTIONAL TWO LINEAR DC OUTPUTS (0 to 10 V, 0/4 to 20 mA)*
- *MANUAL/AUTOMATIC CONTROL MODES*
- *SETPOINT RAMPING FOR PROCESS STARTUP*
- *PROGRAMMABLE USER INPUT (Digital) FOR ADDED FLEXIBILITY*
- *SENSOR ERROR COMPENSATION (Offset) AND BREAK DETECTION*
- *HEATING AND OPTIONAL COOLING OUTPUTS*
- *PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS*
- *FIELD REPLACEABLE OUTPUT BOARD (Relay or Logic/SSR Drive)*

- *OPTIONAL TRIAC OUTPUT*
- *SECOND SETPOINT SETTING*
- *OPTIONAL REMOTE SETPOINT INPUT (0/4 to 20 mA)*
- *OPTIONAL RS-485 SERIAL COMMUNICATIONS*
- *PC SOFTWARE AVAILABLE FOR CONTROLLER CONFIGURATION*

CE

UL Recognized Component, File # E156876 (M)

DESCRIPTION

The T48 Controller accepts signals from a variety of temperature sensors (thermocouple or RTD elements), precisely displays the process temperature, and provides an accurate output control signal *(time proportional or linear DC)* to maintain the process at the desired temperature. The controller's comprehensive yet simple programming allows it to meet a wide variety of application requirements.

The controller operates in the PID control mode for both heating and cooling, with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis.

A second setpoint is available on select models to allow quick selection of a different setpoint setting.

Dual 4-digit displays allow viewing of the process temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. On many models the main control output and the alarm outputs are field replaceable.

Optional alarm(s) can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT, and Heater Current Break) with adjustable hysteresis. A standby feature suppresses the alarm during power-up until the temperature stabilizes outside the alarm region. The second alarm can be configured as a secondary PID output (heat/cool applications).

Optional Main Linear DC output (10 V or 20 mA) can be used for control or temperature re-transmission purposes. Programmable output update time reduces valve or actuator activity. The output range can be scaled independent of the input range.

Optional Second Linear DC output (10 V or 20 mA) provides an independent temperature re-transmission, while the main Linear DC output is being used for control. The output range can be scaled independent of the input range.
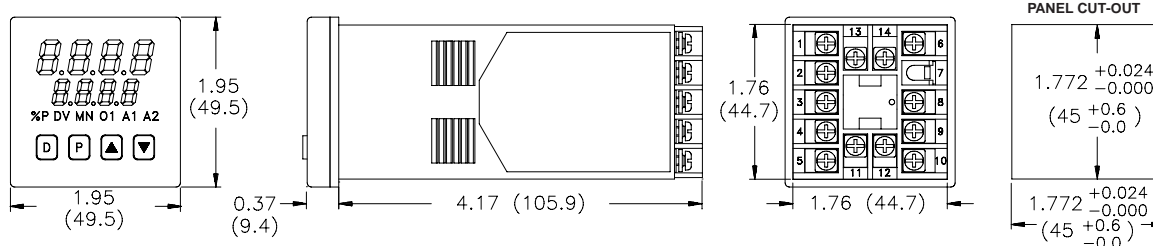

CAUTION: Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

DIMENSIONS "In inches (mm)"

%P DV MN O1 A1 A2

1.95 (49.5)

1.95 (49.5)

0.37 (9.4)

4.17 (105.9)

1.76 (44.7)

1.76 (44.7)

PANEL CUT-OUT

1.772 $^{+0.024}_{-0.000}$

(45 $^{+0.6}_{-0.0}$)

1.772 $^{+0.024}_{-0.000}$

(45 $^{+0.6}_{-0.0}$)

Optional Heater Current Monitor provides a direct readout of process heater current. An alarm can be programmed to signal when the heater has failed. This provides early warning of system failure before product quality is affected.

Optional Remote Setpoint input (0/4 to 20 mA) allows for multiple ganged controller operation for large oven and extruder applications; allows for cascade control loops, where tighter control is required; and allows for remotely driven setpoint signal from computers or other similar equipment. Straightforward end point scaling with independent filtering and local/remote transfer option expand the controller's flexibility.

The optional RS-485 serial communication interface provides two-way communication between a T48 and other compatible equipment such as a printer, PLC, HMI, or a host computer. In multipoint applications (up to thirty-two), the address number of each T48 on the line can be programmed from 0 to 99. Data from the T48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. PC software, SFT48, allows for easy configuration of controller parameters. These settings can be saved to disk for later use or used for multi-controller down loading. On-line help is provided within the software.

The unit is constructed of a lightweight, high impact plastic case with a tinted front panel. The front panel meets NEMA 4X/IP65 specifications when properly installed. Multiple units can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

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 T48 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 controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

SPECIFICATIONS

1. **DISPLAY:** Dual 4-digit
   Upper Temperature Display: 0.4" (10.2 mm) high red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) high green LED
   Display Messages:
   "OLOL" - Appears when measurement exceeds + sensor range.
   "ULUL" - Appears when measurement exceeds - sensor range.
   "OPEN" - Appears when open sensor is detected.
   "SHrt" - Appears when shorted sensor is detected *(RTD only)*
   "..." - Appears when display values exceed + display range.
   "-.." - Appears when display values exceed - display range.
   LED Status Annunciators:
   %P - Lower auxiliary display shows power output in (%).
   MN - Flashing: Controller is in manual mode.
        On: Local Setpoint (Remote Setpoint option)
        Off: Remote Setpoint
   DV - Lower auxiliary display shows deviation *(error)* from temperature setpoint or shows heater current.
   O1 - Main control output is active.
   A1 - Alarm #1 is active *(for A1 option.)*.
   A2 - Alarm #2 is active OR
        - Cooling output (O2) is active
2. **POWER:**
   AC Versions: 85 VAC min. to 250 VAC max., 50 to 60 Hz, 8 VA max.
   DC Versions:
     DC Power: 18 to 36 VDC; 7 W
     AC Power: 24 VAC ± 10%; 50 to 60 Hz, 9 VA
3. **CONTROLS:** Four front panel push buttons for modification and setup of controller functions and one external input user for parameter lockout or other functions.
4. **MEMORY:** Nonvolatile E^2 PROM retains all programmable parameters and values.
5. **MAIN SENSOR INPUT:**
   Sample Period: 100 msec
   Response Time: Less than 300 msec typ., 400 msec max. *(to within 99% of final value w/step input; typically, response is limited to response time of probe)*
   Failed Sensor Response:
     Main Control Output(s): Programmable preset output
     Display: "OPEN"
     Alarms: Upscale drive
   Normal Mode Rejection: 40 dB @ 50/60 Hz (improves with increased digital filtering.)
   Common Mode Rejection: Greater than 120 dB, DC to 60 Hz
   Protection: Input overload 120 VAC max. for 15 seconds max.

6. **THERMOCOUPLE INPUT:**
   Types: T, E, J, K, R, S, B, N, Linear mV, software selectable
   Input Impedance: 20 MΩ all types
   Lead resistance effect: 0.25 µV/Ω
   Cold junction compensation: Less than ±1°C typ., (±1.5°C max), error over 0 to 50°C max. ambient temperature range. Defeated for Linear mV indication mode.
   Resolution: 1° for all types, or 0.1° for T, E, J, K, and N only.

| TC TYPE | RANGE | WIRE COLOR | |
		ANSI	BS 1843
T	-200 to +400°C -328 to +752°F	blue (+) red (-)	white (+) blue (-)
E	-200 to +750°C -328 to +1382°F	violet (+) red (-)	brown (+) blue (-)
J	-200 to +760°C -328 to 1400°F	white (+) red (-)	yellow (+) blue (-)
K	-200 to +1250°C -328 to +2282°F	yellow (+) red (-)	brown (+) blue (-)
R	0 to 1768°C +32 to +3214°F	black (+) red (-)	white (+) blue (-)
S	0 to 1768°C +32 to 3214°F	black (+) red (-)	white (+) blue (-)
B	+149 to +1820°C +300 to +3308°F	grey (+) red (-)	no standard
N	-200 to +1300°C -328 to +2372°F	orange (+) red (-)	orange (+) blue (-)
mV	-5.00 to +56.00	no standard	no standard

7. **RTD INPUT:** 2 or 3 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.0039162
   Excitation: 150 µA typical
   Resolution: 1 or 0.1 degree
   Lead Resistance: 15 Ω max. per input lead

RTD TYPE	RANGE
385	-200 to +600°C -328 to +1100°F
392	-200 to +600°C -328 to +1100°F
OHMS	1.0 to 320.0

8. **INDICATION ACCURACY:** 0.3% of Span ±1°C. (Includes NIST conformity, cold junction effect and A/D conversion errors at 23°C after 20 min. warm-up.)
9. **USER INPUT:** Internally pulled up to +5 VDC (1 MΩ).
   $V_{IN\ MAX}$ = 5.25 VDC, V_{IL} = 0.85 V max., V_{IH} = 3.65 V min., I_{OFF} = 1µA max.
   Response Time: 120 msec max.
   Functions:
Program Lock	Integral Action Lock
Auto/Manual Mode Select	Setpoint Ramp Enable
Reset Alarms	Setpoint 1/Setpoint 2 Select
Local/Remote Setpoint Select	Serial block point
10. **CONTROL AND ALARM OUTPUTS:** (Heating, Cooling or Alarm)
    Relay outputs with Form A contacts:
      Contact Rating: 3 A @ 250 VAC or 30 VDC (resistive load) 1/10 HP @ 120 VAC (inductive load)
      Life Expectancy: 100,000 cycles at max. load rating.
      (Decreasing load and/or increasing cycle time, increases life expectancy.)
    Logic/SSR Drive Outputs:
      Rating: 45 mA @ 4 V min., 7 V nominal
    Triac Outputs:
      Type: Isolated, Zero Crossing Detection
      Rating:
        Voltage: 120/240 VAC
        Max. Load Current: 1 Amp @ 35°C
                               0.75 Amp @ 50°C
        Min Load Current: 10 mA
      Offstate Leakage Current: 7 mA max. @ 60 Hz
      Operating Frequency: 20 to 500 Hz
      Protection: Internal transient snubber
11. **MAIN CONTROL:**
    Control: PID or ON/OFF
    Output: Time proportioning or Linear DC
    Cycle time: Programmable
    Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
    Probe Break Action: Programmable

12. **ALARMS:** 1 or 2 alarms (optional)
   Modes: Absolute high acting
      Absolute low acting
      Deviation high acting
      Deviation low acting
      Inside band acting
      Outside band acting
      Heater break alarm
   Reset Action: Programmable; automatic or latched
   Standby Mode: Programmable; enable or disable
   Hysteresis: Programmable
   Probe Break Action: Upscale
   Annunciator: LED backlight for "A1", "A2"
13. **COOLING:** Software selectable (overrides alarm 2)
   Control: PID or ON/OFF
   Output: Time Proportioning
   Cycle time: Programmable
   Proportional Gain Adjust: Programmable
   Heat/Cool Deadband Overlap: Programmable
14. **MAIN AND SECOND LINEAR DC OUTPUT:** (optional)
   Main: Control or Re-transmission, programmable update rate from 0.1 sec to 250 sec
   Second: Re-transmission only, fixed update rate of 0.1 sec

OUTPUT ** RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	COMPLIANCE	RESOLUTION
0 to 10 V	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	10k ohm min.	1/3500
0 to 20 mA	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	500 ohm max.	1/3500
4 to 20 mA	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	500 ohm max.	1/2800

* Accuracies are expressed as **±** percentages after 20 minutes warm-up. Output accuracy is specified in two ways: Accuracy over an 18 to 28°C range at 10 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide temperature range reflects the temperature coeffecient of the internal circuitry.

** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximately 10% overrange and a small underrange (negative) signal.

15. **REMOTE SETPOINT INPUT:** (optional)
   Input type:
      0/4 to 20 mA
   Input Resistance: 10 Ω
   Overrange: -5% to 105%
   Overload: 100 mA (continuous)
   Scale Range: -999 to 9999 degrees or -99.9 to 999.9 degrees.
   Resolution: 1 part in 10,000.
   Accuracy:
      At 25° C: ±(0.1 % of full scale +½ LSD)
      Over 0 to 50°C range: ±(0.2% of full scale +½ LSD)
   Reading Rate: 10/sec.
   Setpoint Filtering: Programmable Digital
   Setpoint Ramping: Programmable, 0.1 to 999.9 degrees/minute.
16. **HEATER CURRENT MONITOR INPUT:** (optional)
   Type: Single phase, full wave monitoring of load currents controlled by main output (01).
   Input: 100 mA AC output from current transformer (RLC #CT004001) or any CT with 100 mA AC output.
   Display Scale Range: 1.0 to 999.9 Amps or 0.0 to 100.0%
   Input Resistance: 5 Ω
   Accuracy:
      At 25° C: ±(0.5 % of full scale +½ LSD), (5 to 100% of Range)
      Over 0 to 50°C range: ±(1.0% of full scale +½ LSD), (5 to 100% of Range)
   Frequency: 50 to 400 Hz.
   Alarm Mode: Dual acting; heater element fail detect and control device fail detect.
   Overrange: 105% Capacity
   Overload: 200 mA (continuous).
17. **SERIAL COMMUNICATIONS:** (optional)
   Type: RS485 multipoint, balanced interface
   Baud Rate: 300 to 9600
   Data Format: 7 data bits, odd, even or no parity, 1 stop bit
   Node Address: 0-99, max of 32 units per line

   Transmit Delay: 2-100 msec or 100-200 msec
   Data Encoding: ASCII
   Isolation w.r.t Main Input Common: 500 Vrms for 1 min. (50 V working)
      Not isolated w.r.t. Remote Setpoint or Heater Current inputs, or Analog Output common
   Note: RS485 and the Analog Output commons are not internally isolated within the controller. The terminating equipment of these outputs must not share the same common (ie. earth ground).
18. **ENVIRONMENTAL CONDITIONS:**
   Operating Range: 0 to 50°C
   Storage Range: -40 to 80°C
   Span Drift *(max.)*: 130 ppm/°C, main input
   Zero Drift *(max.)*: 1µV/°C, main input
   Operating and Storage Humidity:
      85% max. relative humidity (non-condensing) from 0°C to 50°C.
   Altitude: Up to 2000 meters
19. **ISOLATION BREAKDOWN RATINGS:**
   AC line with respect to all inputs and outputs: 2000 Volts
   Main input with respect to Analog Output, Remote Setpoint Input, Heater Current Input: 500 Volts for 60 sec min.
   All other inputs and outputs with respect to relay contacts: 2000 VAC
20. **CERTIFICATIONS AND COMPLIANCES:**
   UL Recognized Component: File #E156876 (M)
   Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

   ELECTROMAGNETIC COMPATIBILITY

   Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact
		Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [1]
		80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O
		Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms [2]
		150 KHz - 80 MHz
Simulation of cordless telephones	ENV50204	Level 3; 10 V/m
		900 MHz ± 5 MHz
		200 Hz, 50% duty cycle

   Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A
		Power mains class A

   Notes:
   1. No loss of performance during EMI disturbance at 10 V/m.
      Unit is panel mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) that provides at least 20 dB shielding effectiveness. Metal panel is connected to earth ground.
      I/O cables routed in metal conduit connected to earth ground.
      Install power line filter, RLC #LFIL0000 or equivalent.
   2. Permissible loss of performance during EMI disturbance at 10 Vrms:
      Process signal deviation less than 3% of full scale.
      Analog output deviation less than 1% of full scale.
      RSP and HCM signal deviation less than 0.5% of full scale.
      For operation without loss of performance:
         Install power line filter, RLC#LFIL0000 or equivalent.
                  OR
      Install 2 ferrite cores, RLC#FCOR0000 or equivalent, to AC lines at unit for frequencies above 5 MHz.
      I/O cables routed in metal conduit connected to earth ground.

   Refer to the EMC Installation Guidelines section of the manual for additional information.
21. **CONNECTION:** Wire clamping screw terminals
22. **CONSTRUCTION:** Black plastic alloy case and collar style panel latch. Panel latch can be installed for vertical or horizontal instrument stacking. One piece tinted plastic bezel. Bezel assembly with circuit boards can be removed from the case to change the output board without removing the case from the panel or disconnecting wiring. Unit meets NEMA 4X/IP65 requirements for indoor use, when properly installed. Installation Category II, Pollution Degree 2.
23. **WEIGHT:** 0.38 lbs (0.17 kgs)

BASIC OPERATION

The T48 controls a process temperature by measuring the temperature via an input probe, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process temperature at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low temperature overshoot from process disturbances.

FRONT PANEL FEATURES

In the normal operating mode, the unit displays the process temperature in the upper display. One of the following parameters can be viewed in the lower display:

- Setpoint
- % Power Output
- Temperature Deviation
- Heater Current
- Temperature symbol (F or C)
- Blank Display

The user scrolls through these parameters by pressing the D button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the P button and modified by use of the UP and DOWN buttons. Parameters are then entered by the P button, which advances the user to the next parameter. Pressing the D button immediately returns the controller to the normal operating mode without changing the currently selected parameter.

HARDWARE FEATURES

A fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent temperature control. Measurement accuracy of 0.3% of span ±1°C or better, provides close process control conforming to the desired control setpoint value. The T48 accepts a variety of both thermocouple and RTD temperature probes. An output board contains the Main Control output, Alarm 1 output, Alarm 2/Cooling output, and/or Linear DC output. Since the controller is serviceable from the front of the panel, the output board (on some models) may be easily changed or replaced without disturbing the wiring behind the panel. No re-programming is required when changing or replacing the output board for units without the Linear DC output option. Units with the linear output option require calibration procedure for the new linear output.

Low-drift, highly stable circuitry ensures years of reliable and accurate temperature control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

REMOTE SETPOINT INPUT

The remote setpoint input facilitates the use of a remote signal to drive the controller's setpoint. The remote signal can be scaled independent to that of the controller's range. The controller's response to local/remote setpoint transfers can be programmed. Also, the remote signal is filtered by use of an adaptive filter. With this filter, relatively large filtering time constants can be used without suffering from long settling times. The time constant and filter disable band are programmable. Additionally, the remote signal can also be velocity limited (or ramped) to slow the controller's response to changes in setpoint. This results in a steady control response with no overshoot.

HEATER CURRENT MONITOR

The T48 provides a direct readout of process heater current. This provides valuable information regarding single phase heater system integrity. It is especially useful on extruder and large oven applications where adjacent controllers mask the effect of a failed heater. The heater break alarm senses two types of heater system faults:

1) Main control output is "on" and heater current is below alarm value. This indicates failed heater or failed parts of heater, breaker trip, failed power control device, etc.
2) Main control output is "off" and heater current is above 10% of alarm value. This indicates a failed power control device, wiring fault, etc.

LINEAR DC ANALOG OUTPUTS

The Main Linear DC output has independent scaling, programmable output update time and filter (damping) time. These parameters permit flexibility in process configuration. The output can be set for 0 to 10V, 0 to 20 mA or 4 to 20 mA ranges, and can be configured for control or for transmission of temperature or setpoint values.

A Second Linear DC output is dedicated for retransmission of input temperature. The output can be scaled and converted independent of the input and Main Linear DC output. This output is isolated from the input.

SETPOINT FEATURES

The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

A second setpoint value can be programmed which can be made active by a user input and/or through the front panel on selected models.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces thermal shock to the process and helps to minimize temperature overshoot.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control. A programmable temperature shift function can be used to compensate for probe errors or to have multiple T48 units indicate the same nominal temperature.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(*s*), transfer to second setpoint, etc.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). Programmable output cycle time, output hysteresis and dampening can reduce output activity without degrading control accuracy. The main outputs can operate in PID, ON/OFF, or manual control modes.

CONTROL AND ALARM OUTPUTS

In addition to the Linear DC outputs, there are up to three types of ON/OFF outputs.These outputs can be relay, logic, or triac for control or alarm purposes. Relay outputs can switch user applied AC or DC voltages. Logic/SSR drive outputs supply power to external SSR power units, that can switch up to 45 Amps. One Logic/SSR Drive output can control up to four SSR power units at one time. The Triac output supplies one Amp of AC current for control of an external AC relay or triac device.

AUTO-TUNE

The T48 has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into non-volatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampening factor produces various levels of process control and response characteristics.

RS-485 Communications

The RS-485 communications option allows the connection of up to 32 devices on a single pair of wires with a distance of up to 4,000 feet and a maximum baud rate of 9600. Since the same pair of wires are used for both transmit and receive, only one way communication is possible at any given time. The controller has a programmable response time to allow the host device adequate time to release the communication line for a transmission.

Selected parameters from the T48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. It is also possible to invoke Auto-tune through the serial port. Serial communications used with SFT48 software allows for easy controller parameter configuration by computer.

HEATING AND COOLING SYSTEMS

The T48 is available with dual outputs to provide heating and cooling to those processes that require them. For example, many extruder applications require both heating and cooling to maintain accurate extruder barrel and die temperatures. The T48 is easily configured for these types of applications.

CONTROLLER PROGRAMMING

Front Panel Program Disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial set-up.

The following four programming modes allow the controller to adapt to any required user-interface level:

Unprotected Parameter Mode
Protected Parameter Mode
Hidden Function Mode
Configuration Parameter Mode

UNPROTECTED PARAMETERS MODE *

The Unprotected Parameters Mode is accessible from the Normal Display Mode when program disable is inactive or when the proper access code number from the Protected Parameter Mode is entered. The Configuration Parameter Modes can be accessed only from this mode.

"SP"   - Enter setpoint
"OP"   - Enter output power
"ProP"   - Enter proportional band
"Intt"   - Enter integral time
"dErt"   - Enter derivative time
"AL-1"   - Enter value for alarm #1
"AL-2"   - Enter value for alarm #2
"CNFP"   - Select configuration access point
"End"   - Return to normal display mode

PROTECTED PARAMETERS MODE *

The Protected Parameters Mode is enabled when program disable is active. This mode prevents access to the Configuration Parameter Modes without the proper access code number. Only the parameters that are enabled in the Configuration 3 parameter (lock-out section) can be accessed.

"ProP"   - Enter proportional band
"Intt"   - Enter integral time
"dErt"   - Enter derivative time
"AL-1"   - Enter value for alarm #1
"AL-2"   - Enter value for alarm #2
"CodE"   - Enter value to access unprotected parameters and
             configuration parameters

HIDDEN FUNCTION MODE *

The Hidden Function Mode is accessible from the Normal Display Mode. The functions in this mode may be locked-out individually in Configuration 3 parameter (lock-out section).

"SPSL"   - Select local (SP1 or SP2) or remote setpoint
"trnF"   - Transfer between automatic (PID) control and manual control
"tUNE"   - Invoke/cancel PID Auto-tune
"ALrS"   - Reset latched alarms

CONFIGURATION PARAMETER MODE

The Configuration Parameter Mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the Configuration Access Point, allowing the user to return to the Normal Display Mode.

Configuration 1, Inputs (1-IN)

"TYPE"   - Select input probe type
"SCAL"   - Select temperature scale
"dCPt"   - Select temperature resolution
"FLtr"   - Select level of input filtering
"SHFt"   - Enter input correction shift (offset)
"SPLO"   - Enter setpoint lower limit
"SPHI"   - Enter setpoint higher limit
"SPrP"   - Enter setpoint ramp rate
"InPt"   - Select user input function

Configuration 2, Outputs (2-OP) *

"CYCt"   - Enter time proportioning cycle time
"OPAC"   - Select output control action
"OPLO"   - Enter output power low limit
"OPHI"   - Enter output power high limit
"OPFL"   - Enter probe fail power preset
"OPdP"   - Enter output control dampening
"CHYS"   - Enter ON/OFF control hysteresis
"tcod"   - Select auto-tuning dampening
"AntP"   - Main Linear DC analog output range
"ANAS"   - Main Linear DC analog output source
"ANut"   - Main Linear DC analog output update time
"ANLO"   - Main Linear DC analog output scaling low
"ANHI"   - Main Linear DC analog output scaling high

Configuration 3, Parameter Lock-Outs (3-LC) *

"SP"   - Select setpoint access level
"OP"   - Select power access level
"dEv"   - Enable deviation display
"Hcur"   - Enable heater current display
"UdSP"   - Enable temperature scale display
"CodE"   - Enter parameter access code
"PId"   - Select PID access level
"AL"   - Select alarm access level
"ALrS"   - Enable alarm reset access
"SPSL"   - Enable local/remote selection
"trnF"   - Enable auto/manual mode selection
"tUNE"   - Enable auto-tune invocation

Configuration 4, Alarms (4-AL) *

"Act1"   - Select operation mode of alarm #1, or select heat output
"rSt1"   - Select reset mode of alarm #1
"Stb1"   - Enable activation delay of alarm #1
"AL-1"   - Enter value for alarm #1
"Act2"   - Select operation mode of alarm #2, or select cooling output
"rSt2"   - Select reset mode of alarm #2
"Stb2"   - Enable activation delay of alarm #2
"AL-2"   - Enter value for alarm #2
"AHYS"   - Enter hysteresis value for both alarms

Configuration 5, Cooling (5-O2) *

"CYC2"   - Enter cooling time proportioning cycle time
"GAN2"   - Enter cooling relative gain
"db-2"   - Enter heat/cool deadband or overlap

Configuration 6, Serial Communications (6-SC) *

"bAUd"   - Select baud rate
"PArb"   - Select parity bit
"Add"   - Enter address
"Abr"   - Select abbreviated or full transmission
"PoPt"   - Select print options

Configuration 7, Remote Setpoint Input (7-N2) *

"dSP1"   - Enter remote setpoint display scaling value #1
"INP1"   - Enter remote setpoint process scaling value #1
"dSP2"   - Enter remote setpoint display scaling value #2
"INP2"   - Enter remote setpoint process scaling value #2
"FLtr"   - Enter remote setpoint filter time constant
"bAnd"   - Enter remote setpoint filter disable band
"trnF"   - Select Local/Remote setpoint transfer response

Configuration 7 - Heater Current Parameters (7-N2) *

"Hcur"   - Enter full scale rating of CT

Configuration 8, Second Linear DC Analog Output (8-A2) *

"A2tP"   - Second linear DC analog range
"A2LO"   - Second linear DC analog scaling low
"A2HI"   - Second linear DC analog scaling high
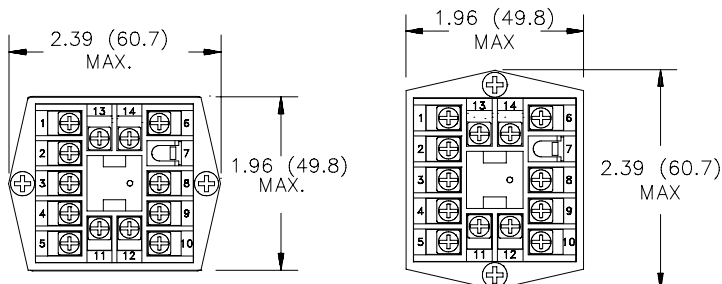
Configuration 9, Factory Service Operations (9-FS)

"Code 48" - Calibrate Instrument
"Code 66" - Reset parameters to factory setting

* *These parameters may not appear due to option configuration or other programming.*

MULTIPLE UNIT STACKING

The T48 is designed for close spacing of multiple units. Units can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the unit. For horizontal stacking, the panel latch screws should be at the top and bottom of the unit. The minimum spacing from center line to center line of units is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.
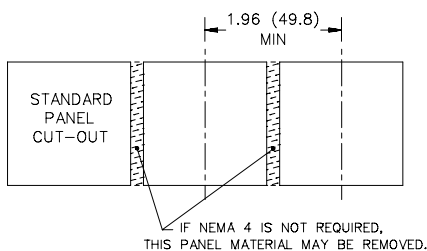
Note: When stacking units, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

PANEL LATCH INSTALLED FOR
VERTICAL UNIT STACKING

PANEL LATCH INSTALLED FOR
HORIZONTAL UNIT STACKING

PANEL CUT-OUT SPACING FOR MULTIPLE UNIT STACKING.
HORIZONTAL ARRANGEMENT SHOWN.

STANDARD
PANEL
CUT-OUT

IF NEMA 4 IS NOT REQUIRED,
THIS PANEL MATERIAL MAY BE REMOVED.

ACCESSORY - CURRENT TRANSFORMER-50A

The external Current Transformer is used when specifying the T48's equipped with the Heater Current Monitor.

Part Number: CT005001
Current Ratio: 50 : 0.1 (Amperes)
Operation Frequency: 50 to 400 Hz
Insulation Class: 0.6 KV BIL, 10 KV full wave.VA 60 H2 Burden 2.5
Terminals: Brass studs No. 8-32 UNC with one flat washer, lockwasher, and hex nut.
Window Diameter: 1.13" (28.7 mm)
Weight: 8 oz (226.0g)

ACCESSORY - EXTERNAL SSR POWER UNIT

The external SSR Power Unit is used with T48's equipped with Logic/SSR Drive outputs to switch loads up to 240 VAC @ 45 Amps, 25°C ambient. The unit is operated by applying a low level DC control signal to the isolated input. The unit features zero cross detection circuits which reduces radiated RFI when switching load currents. With no contacts to wear out, the SSR Power Unit provides virtually limitless operational life. The unit is supplied with an integral heat sink for immediate installation.
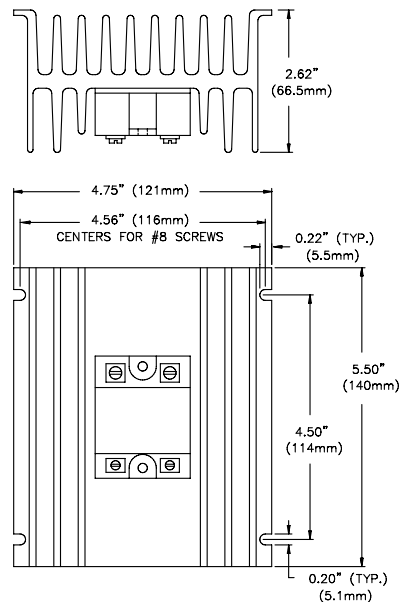
External SSR Power Unit:
Part Number: RLY50000
Switched Voltage Range: 50 to 280 VAC
Load Current: 45 Amps max. @ 25°C ambient temperature
35 Amps max. @ 50°C ambient temperature
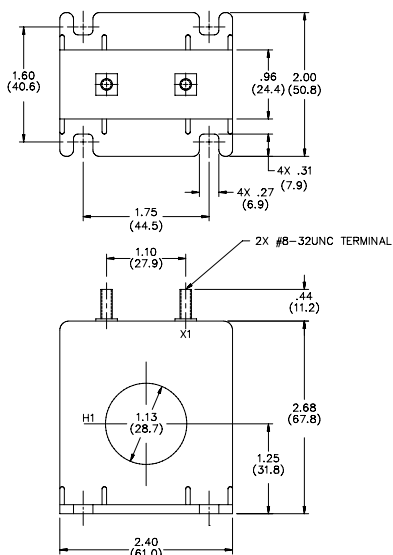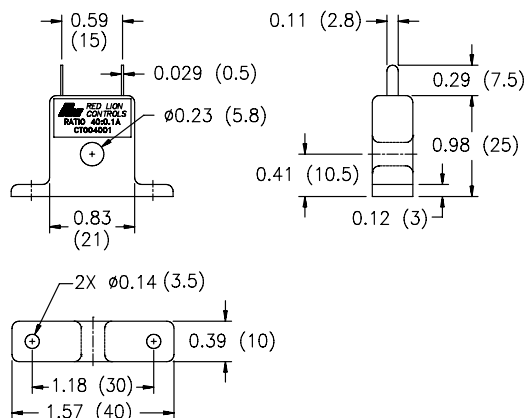**On State Input**: 3 to 32 VDC @ 1500 Ω impedance. *(isolated)*
(Use Logic/SSR drive output .)
Off State Input: 0.0 to 1.0 VDC
Size: 5.5" (14 cm) L x 4.75" (12 cm) W x 2.62" (6.6 cm) H

ACCESSORY - CURRENT TRANSFORMER-40A

The external Current Transformer is used when specifying the T48's equipped with the Heater Current Monitor.

Current Transformers:
Part Number: CT004001
Current Ratio: 40 : 0.1 (Amperes)
Max Heater Current: 50 A
Dielectric Strength: 1000 VAC (For 1 minute)
Vibration Resistance: 50 Hz (Approx 10 G)
**Terminals**: Solder Type
Window Diameter: 0.228" (5.8 mm)
Weight: 0.406 oz (11.5 g)

PLASTICS EXTRUDER APPLICATION

Several T48 controllers are employed to control the temperature of a plastics extruder. Each T48 controls a heating element and a cooling water solenoid to maintain each extruder zone at the desired temperature. The Heater Current Monitor option is used to provide a readout of the heater current. The multi-function User Input can be programmed to allow selection of manual operation when connected to common. This allows the user to hold the control output of the controller during abnormal process conditions.

(Terminal assignments are model number dependent.)
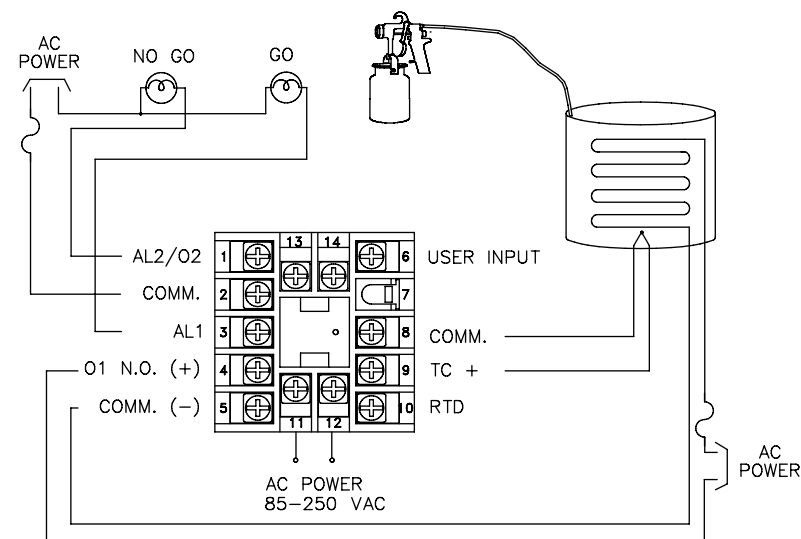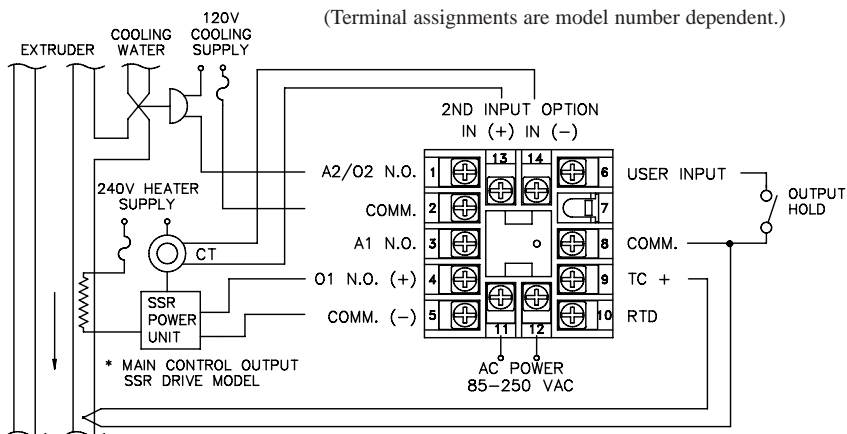
OEM PAINT SPRAYER APPLICATION

An OEM manufacturing spray painting equipment utilizes the T48 to maintain optimum paint temperature. In addition to the low cost, the 1/16 DIN package size permits the OEM to design "time proportioning" control into various sized painting equipment, from small hand sprayers to large paint booths. The heating element used to heat the paint is connected to the Main Control Output (OP1). Alarm 1 is programmed as Band Inside Acting, so that as long as the paint temperature is within manufacturer's specifications for temperature, the "GO" light is on. Alarm 2 is programmed as Band Outside Acting so that the "NO GO" light is on when the paint temperature is outside the manufacturer's specifications.
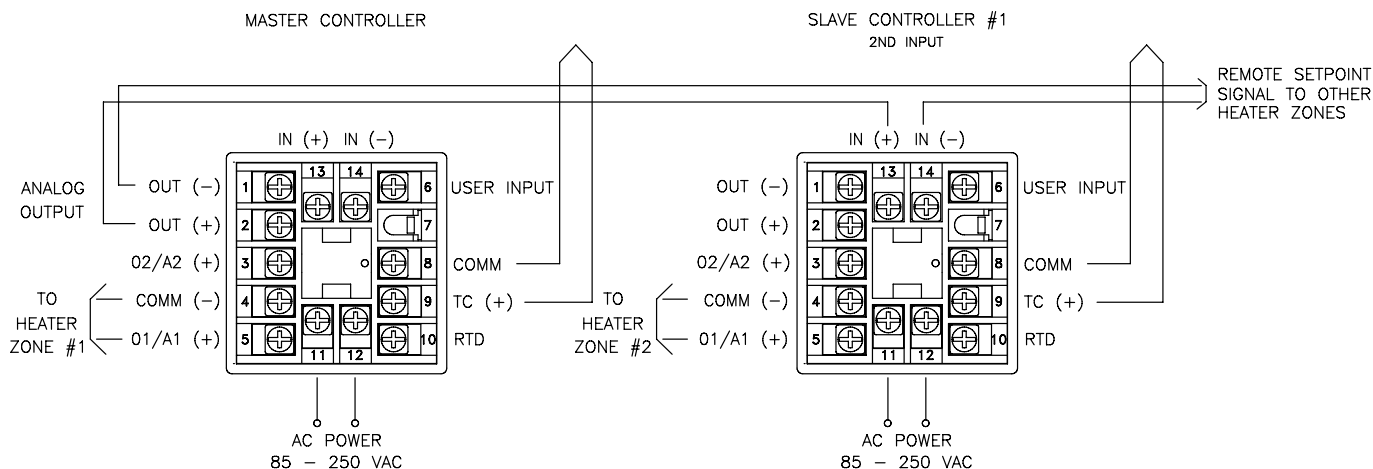
(Terminal assignments are model number dependent.)

MULTIPLE UNIT/REMOTE SETPOINT APPLICATION

Eight T48 controllers are used in a drying oven. Each T48 controls a zone within the oven. Depending upon the material to be dried, and its initial moisture content, the drying setpoint temperature varies. A master T48 controller transmits setpoint via linear DC output. This signal is received as a remote setpoint signal by the other slave controllers.

Whenever the master controller's setpoint is changed, the slave controller's setpoint changes automatically.

The remote setpoint input at each slave controller can be scaled independently.

(Terminal assignments are model number dependent.)

7

ORDERING INFORMATION

Options and Output Boards are factory configured per the part number specified. Part numbers without replacement output boards listed must be returned to the factory for output board replacement.

MODELS WITHOUT RS-485 AND LINEAR DC ANALOG OUTPUT

DEDICATED MAIN CONTROL 01 OUTPUT	DEDICATED ALARM 1 A1 OUTPUT	(ALARM 2) A2 OR 02 (COOL)*	REMOTE SETPOINT INPUT	HEATER CURRENT INPUT@	REPLACEMENT OUTPUT BOARD	PART NUMBERS	
						18-36 VDC/24 VAC	85 TO 250 VAC
Relay					RBD48100	T4810010	T4810000
Relay	Relay				RBD48111	NA	T4811000
Relay	Relay	Relay			RBD48111	T4811110	T4811100
Relay	Relay	Relay	YES		RBD48111	T4811113	T4811103
Relay	Relay	Relay		YES	RBD48111	T4811114	T4811104
Logic/SSR					RBD48200	T4820010	T4820000
Logic/SSR	Relay				RBD48211	NA	T4821000
Logic/SSR	Relay	Relay			RBD48211	T4821110	T4821100
Logic/SSR	Relay	Relay	YES		RBD48211	T4821113	T4821103
Logic/SSR	Relay	Relay		YES	RBD48211	T4821114	T4821104
Triac	Logic/SSR	Logic/SSR			NA	T4832210	T4832200

* - These part numbers have a single output, programmable as either Control (PID) or as an Alarm.
@ - These part numbers are software V4.0 or greater, and are equipped with a second setpoint.

Option Boards are installed at the factory for the appropriate models. These boards are only needed for field replacement.

MODELS WITH RS-485 OR LINEAR DC ANALOG OUTPUT

DEDICATED MAIN CONTROL O1 OUTPUT	MAIN CONTROL O1 OR A1 (ALARM 1) *	DEDICATED ALARM 1 A1 OUTPUT	(ALARM 2) A2 OR O2 (COOL) *	REMOTE SETPOINT INPUT @	HEATER CURRENT INPUT @	RS485 @	MAIN ANALOG OUTPUT** @	SECOND ANALOG OUTPUT** @	PART NUMBERS	
									18-36 VDC/24 VAC	85 TO 250 VAC
Relay						YES [1]			NA	T4810002
	Relay		Relay				YES	YES	T481011A	T481010A
	Relay		Relay				YES		T4810111	T4810101
	Relay		Relay	YES			YES		T4810115	T4810105
	Relay		Relay		YES		YES		T4810116	T4810106
	Relay		Relay			YES	YES		T4810117	T4810107
Relay			Relay	YES		YES			T4810118	T4810108
Relay			Relay		YES	YES			T4810119	T4810109
Relay		Relay	Relay			YES [2]			T4811112	T4811102
	Logic/SSR		Logic/SSR				YES		T4820211	T4820201
	Logic/SSR		Logic/SSR	YES			YES		T4820215	T4820205
	Logic/SSR		Logic/SSR		YES		YES		T4820216	T4820206
Logic/SSR			Logic/SSR	YES		YES			T4820218	T4820208
Logic/SSR			Logic/SSR		YES	YES			T4820219	T4820209
Logic/SSR		Relay	Relay			YES			T4821112	T4821102

* - These part numbers have a single output, programmable as either Control (PID) or as an Alarm.
** - These part numbers are jumper and program selectable for either a current or voltage Linear DC output.
@ - These part numbers are software V4.0 or greater, and are equipped with a second setpoint.
[1] - Replacement Output Board RBD48100 may be used.
[2] - Replacement Output Board RBD48111 may be used.

ACCESSORIES

MODEL	DESCRIPTION	PART NUMBERS
RLY	External SSR Power Unit (for Logic/SSR output models)	RLY50000
CT	40 Ampere Current Transformer (for Heater Current Input models)	CT004001
CT	50 Ampere Current Transformer (for Heater Current Input models)	CT005001
SFT48	PC Configuration Software for Windows 3.x and 95 (3.5" disk) (for RS-485 models)	SFT48

red lion

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Fax +1 (717) 764-0839
www.redlion.net

MODEL TCU - TEMPERATURE CONTROL UNIT

C **UL** US LISTED
IND. CONT. EQ.
51EB

CE

- *100 msec SAMPLING PERIOD WITH 0.15% ACCURACY*
- *ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS*
- *DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF TEMPERATURE AND SETPOINT, SECOND ANALOG INPUT OR HEATER CURRENT*
- *ACCEPTS 10 DIFFERENT TYPES OF SENSOR INPUTS (Thermocouple or RTD)*

- *SELF-DIAGNOSTICS*
- *FULL PID CONTROL WITH REDUCED OVERSHOOT*
- *OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE*
- *OPTIONAL DUAL ALARM OUTPUTS (USES OUTPUT MODULES)*
- *OPTIONAL COOLING OUTPUT (USES OUTPUT MODULE)*
- *OPTIONAL LINEAR 4 to 20 mA or 0 to 10 VDC OUTPUT FOR CONTROL OR TEMPERATURE RE-TRANSMISSION*
- *OPTIONAL HEATER CURRENT MONITOR AND BREAK ALARM*
- *OPTIONAL MOTORIZED VALVE POSITION CONTROL AND VALVE FAIL ALARM*
- *OPTIONAL SECOND ANALOG INPUT FOR REMOTE SETPOINT AND CASCADE CONTROL*
- *OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL*
- *STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES*
- *PROGRAMMABLE USER INPUT (DIGITAL) FOR ADDED FLEXIBILITY*
- *SENSOR ERROR COMPENSATION (Slope and Offset) AND BREAK DETECTION*
- *MANUAL/AUTOMATIC AND LOCAL/REMOTE SETPOINT CONTROL MODES*
- *SETPOINT RAMPING FOR PROCESS STARTUP*
- *PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS*
- *FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR Drive and Triac)*

DESCRIPTION

The TCU Controller accepts signals from a variety of temperature sensors *(thermocouple or RTD elements)*, precisely displays the process temperature, and provides an accurate output control signal *(time proportional or linear)* to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to solve various application requirements.
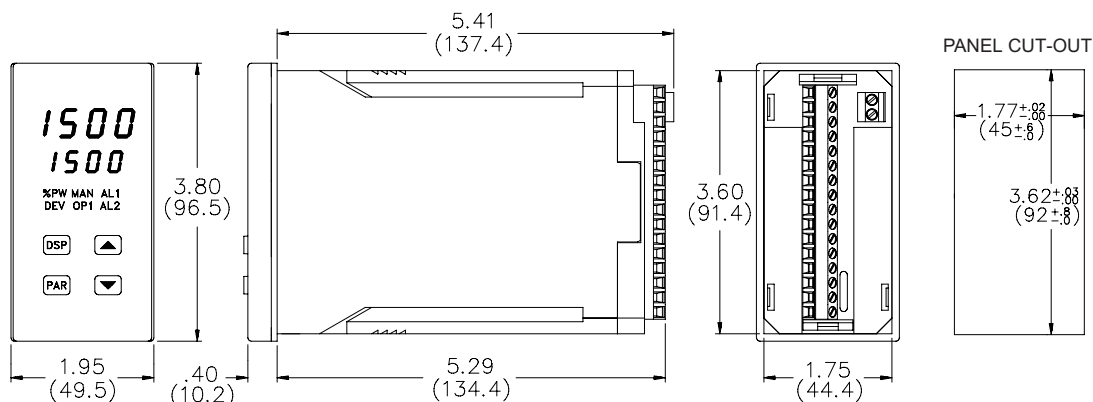
The controller can operate in the PID control mode for both heating and cooling, with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis.

Dual 4-digit displays allow viewing of the process temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. Replaceable and interchangeable output modules *(relay, SSR drive, or triac)* can be installed for the main control output, alarm output(s) and cooling output.

Optional dual alarms can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT, Heater Break and Valve Fail Detect) with adjustable hysteresis. A standby feature suppresses the output during power-up until the temperature stabilizes outside the alarm region. An optional secondary output is available *(for processes that require cooling)* which provides increased control accuracy and response.

DIMENSIONS In inches (mm)

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

5.41 (137.4)

3.80 (96.5)

1.95 (49.5)

.40 (10.2)

5.29 (134.4)

3.60 (91.4)

1.75 (44.4)

PANEL CUT-OUT

1.77 +.02 -.00 (45 +.6 -.0)

3.62 +.02 -.00 (92 +.8 -.0)

DESCRIPTION (Cont'd)

OPTIONS

A linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following: % output power, process temperature value, process temperature value deviation or setpoint value. For Linear DC control applications, the adjustable output demand dampening, output deadband and output update time parameters expand the versatility of the TCU with final control devices.

The optional Heater Current Monitor serves as a digital ammeter for heater current monitoring. Current transformer accessory (CT005001), is required. An alarm event output can be programmed to signal when the heater or heater control devices have failed, before damage to process material occurs. The Heater Break alarm triggers under two conditions:

1) The main output (OP1) is "on" and the heater current is below the heater current alarm value, indicating an aged or failed heater.

2) Output (OP1) is "off" and the heater current is more than 10% of the alarm value, indicating a shorted heater control device or other problem.

The optional Motorized Valve Positioner directly controls the position of a valve by the use of twin outputs *(open and close)* to control the direction of motor rotation. The motor position defines the opening position of the valve. Two control modes are possible: position control, which makes use of the slidewire feedback signal supplied with the positioner and velocity control, in which no slidewire feedback signal is used. Parameters are provided to adjust the operation of the valve. These include:

> Valve activity hysteresis
> Valve update time
> Variable control dampening
> Slidewire signal fail action
> Adjustable valve position limits.

The valve positioner TCU achieves tight process control, yet minimizes unnecessary valve activity. An alarm event output or display alarm can be programmed under loss of slidewire feedback or under valve fail detection.

The optional Second Analog Input (0-20 mA DC) can be configured as a remote setpoint signal or as a secondary process signal. Configuration of the second analog input as a remote setpoint signal allows ratio control, master setpoint/multiple slave operation, and the ability to cascade the TCU with another controller (external cascade). Configuration of the second input as a secondary process signal allows operation as a two-process cascade controller within a single unit (internal cascade). In either control mode, parameters are provided to scale, configure, communicate and monitor the activity of both analog inputs. A square law linearizer function can be used to linearize signals derived from flow transmitters.

The optional RS485 multidrop serial communication interface provides two-way communication between a TCU unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from 0-99. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output*(s)* may also be reset via the serial communications interface option.

An optional NEMA 4X/IP65 rated bezel is available for wash down and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

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 TCU 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 alarm outputs is strongly recommended. Red Lion Controls model IMT (thermocouple) or model IMR (RTD) units may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. **DISPLAY**: Dual 4-digit
   Upper Temperature Display: 0.4" (10.2 mm) high red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) high green LED
   Display Messages (Model dependent):
   "OLOL" - Appears when measurement exceeds + sensor range.
   "ULUL" - Appears when measurement exceeds - sensor range.
   "OPEN" - Appears when open sensor is detected.
   "SHrt" - Appears when shorted sensor is detected *(RTD only)*
   "...." - Appears when display values exceed + display range.
   "-..." - Appears when display values exceed - display range.
   "SLid" - Appears when loss of slidewire signal is detected.
   "VALV" - Appears when valve actuator error is detected.

2. **POWER**: 115/230 VAC (+10%, -15%) no observable line variation effect, 48 to 62 Hz, 10 VA, switch selectable

3. **ANNUNCIATORS**:
   LED Backlight Status Indicators (Model dependent):
   %PW - Lower auxiliary display shows power output in (%).
   DEV - Lower auxiliary display shows deviation *(error)* from temperature setpoint.
   OP1 - Main control output is active.
   AL1 - Alarm #1 is active.
   AL2 - Alarm #2 is active *(for Dual Alarm Option)*.
   OP2 - Cooling output is active *(for Cooling Option)*.
   OPN - Valve positioner OPEN output is active *(for Valve Positioner option)*.
   CLS - Valve positioner CLOSE output is active *(for Valve Positioner option)*.
   CUR - Lower auxiliary display shows heater current *(for Heater Current Monitor option)*.
   SEC - Lower auxiliary display shows second analog input *(For Second Analog Input option)*.
   MAN - Flashing: Controller is in manual mode.
   REM - ON: controller is in remote setpoint mode *(Second Analog Input option)*.
   - OFF: controller is in local setpoint mode *(Second Analog Input option)*.
   - Flashing: controller is in Manual control mode *(Second Analog Input optional)*.

4. **CONTROLS**: Four front panel push buttons for modifying and setup of controller functions and one external input for parameter lockout or other functions.

5. **MAIN SENSOR INPUT**:
   Sample Period: 100 msec
   Response Time: 300 msec *(to within 99% of final value w/step input; typically, response is limited to response time of probe)*
   Failed Sensor Response:
   Main Control Output(s): Programmable preset output
   Display: "OPEN"
   Alarms: Upscale drive
   DC Linear: Programmable preset output
   Normal Mode Rejection: 40 dB @ 50/60 Hz *(improves with increased digital filtering.*
   Common Mode Rejection: 100 dB, DC to 60 Hz
   Protection: Input overload 120 VAC for 30 seconds.

6. **THERMOCOUPLE**:
   Types: T, E, J, K, R, S, B, N, Linear mV
   Input Impedance: 20 M Ω all types
   Lead resistance effect: 20 µV/350 Ω
   Cold junction compensation: Less than ±1°C error over 0 - 50°C ambient temperature range. Disabled for Linear mV type.
   Resolution: 1°C/F all types, or 0.1°C/F for T, E, J, K, and N only.

7. **RTD**: 2, 3 or 4 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.003916
   Excitation: 0.175 mA
   Resolution: 1 or 0.1 degree
   Lead Resistance: 7 Ω maximum

8. **RANGE AND ACCURACY**:
   Errors include NIST conformity and A/D conversion errors at 23°C after 20 min. warm-up. Thermocouple errors include cold junction effect. Errors are expressed as ±percent of reading and ± ¾ LSD unless otherwise noted.

TC TYPE	RANGE	ACCURACY	WIRE COLOR (ANSI)
T	-200 to +400°C -328 to +752°F	0.20% + 1.5°C 0.20% + 2.7°F	blue
E	-200 to 750°C -328 to +1382°F	0.20% + 1.5°C 0.20% + 2.7°F	violet
J	-200 to +760°C -328 to +1400°F	0.15% + 1.5°C 0.15% + 2.7°F	white
K	-200 to +1250°C -328 to +2282°F	0.20% + 1.5°C 0.20% + 2.7°F	yellow
R	0 to +1768°C +32 to +3214°F	0.15% + 2.5°C 0.15% + 4.5°F	black
S	0 to +1768°C +32 to +3214°F	0.15% + 2.5°C 0.15% + 4.5°F	black
B	+200 to +1820°C +300 to +3308°F	0.15% + 2.5°C 0.15% + 4.5°F	grey
N	-200 to +1300°C -328 to +2372°F	0.20% + 1.5°C 0.20% + 2.5°F	orange
mV	-5.00 to 56.00	0.15% + 1 LSD	–
RTD (385)	-200 to +600°C -328 to +1100°F	0.10% + 0.5°C 0.10% + 0.9°F	–
RTD (392)	-200 to +600°C -328 to +1100°F	0.10% + 0.5°C 0.10% + 0.9°F	–
OHMS	1.0 to 320.0	0.15% + 1 LSD	–

9. **OUTPUT MODULES [Optional] (For All Output Channels)**:
   Relay:
   Type: Form-C *(Form-A with some models. See Ordering Information.)*
   Rating: 5 Amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 HP @ 120 VAC *(inductive load)*
   Life Expectancy: 100,000 cycles at max. load rating. *(Decreasing load and/or increasing cycle time, increases life expectancy).*
   Logic/SSR Drive: Can drive multiple SSR Power Units.
   Type: Non-isolated switched DC, 12 VDC typical
   Drive: 45 mA max.
   Triac:
   Type: Isolated, Zero Crossing Detection
   Rating:
   Voltage: 120/240 VAC
   Max. Load Current: 1 Amp @ 35°C
   0.75 Amp @ 50°C
   Min. Load Current: 10 mA max.
   Offstate Leakage Current: 7mA max. @ 60 Hz
   Operating Frequency: 20 to 400 Hz
   Protection: Internal Transient Snubber, Fused

10. **MAIN CONTROL OUTPUT (Heating or Cooling)**:
    Control: PID or ON/OFF
    Output: Time proportioning or linear DC
    Hardware: Plug-in, replaceable output modules
    Cycle time: Programmable
    Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
    Probe Break Action: Programmable

11. **COOLING OUTPUT (Optional)**:
    Control: PID or ON/OFF
    Output: Time proportioning or linear DC
    Hardware: Plug-in, replaceable output modules
    Cycle time: Programmable
    Proportional Gain Adjust: Programmable
    Heat/Cool Deadband Overlap: Programmable

12. **LINEAR DC OUTPUT (Optional)**: With digital scale and offset, programmable deadband and update time.
    4 to 20 mA:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±*(0.1% of reading + 25 µA)*
    Compliance: 10 V *(500 Ω max. loop impedance)*
    0 to 10 VDC:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±*(0.1% of reading + 35 mV)*
    Min. Load Resistance: 10 KΩ *(1 mA max.)*
    Source: % output power, setpoint, deviation, or temperature
    (Available for heat or cool, but not both.)

13. **HEATER CURRENT MONITOR (Optional)**:
    Type: Single phase, full wave monitoring of load currents controlled by main output (OP1)
    Input: 100 mA AC output from current transformer RLC part number CT005001 or any current transformer with 100 mA AC output
    Display Scale Range: 1.0 to 999.9 amperes or 100.0%
    Input resistance: 5 Ω
    Accuracy: 1% of full scale ±1 LSD (10 to 100% of range)
    Frequency: 50 to 400 Hz
    Alarm mode: Dual acting; heater element fail detect and control device fail detect
    Overload: 200 mA *(steady state)*
    Min. output "on" time for Heater break alarm detect: 400 msec

14. **MOTORIZED VALVE POSITIONER (Optional)**:
    Two Outputs: Valve open and valve close or Linear DC *(optional)*
    Hardware: Plug-in, replaceable output modules
    Three Inputs: Slidewire feedback, signal fail detect *(Isolated from main input)*
    Slidewire Resistance: 100 to 100 KΩ
    Slidewire Exciting Voltage: 0.9 VDC
    Slidewire Fail Action: programmable
    Control Mode: Position mode *(with slidewire)* and velocity mode *(w/o slidewire)*.
    Control Deadband: 1% to 25.0% *(position mode)*
    0.1 to 25.0 seconds *(velocity mode)*
    Update Time: 1 to 250 seconds
    Motor Time (open, close): 1 to 9999 seconds
    Position Limits: Adjustable 0.0 to 100.0% of valve stroke
    Valve Fail Time: Off to 9999 seconds

    Alarm mode: Dual acting; loss of slidewire feedback signal and valve fail detection

15. **SECOND ANALOG INPUT**:
    Range: 0 to 20 mA (Isolated from main input)
    Overload: 100 mA (steady state)
    Input Resistance: 10 Ω
    Voltage Drop (@ 20 mA): 0.2 V
    Accuracy: 0.15% of reading ±10 µA ±1 LSD
    Scale Range: -999 to 9999

16. **SERIAL COMMUNICATION**:
    Type: RS485 Multi-point, Balanced Interface
    Communication Format:
    Baud Rate: Programmable from 300 to 9600
    Parity: Programmable for odd, even, or no parity
    Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit
    Unit Address: Programmable from 0 to 99, max. of 32 units per line
    Transmit Delay: 100 msec min., 200 msec max.
    RS485 Common: Isolated from signal input common
    Auto Print Time: Off to 9999 seconds between print-outs

17. **USER INPUT (Optional)**: Internally pulled up to +5 VDC.
    $V_{IN\ MAX}$ = 5.25 VDC, V_{IL} = 0.85 V_{MAX}; V_{IH} = 3.0 V_{MIN},
    Available on all second input (HCM, MVP & ANA) models, and on models with RS485.
    Response Time: 100 msec max.
    Functions: Program Lock
    Integral Action Lock
    Auto/Manual Mode Select
    Setpoint Ramp Select
    Reset Alarms
    Print Request
    Local/Remote Setpoint Select

18. **ALARMS (Optional)**:
    Hardware: Plug-in, replaceable output module
    Modes: Absolute high acting
    Absolute low acting
    Deviation high acting
    Deviation low acting
    Inside band acting
    Heater break
    Valve fail
    Second Analog Input monitoring
    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable
    Probe Break Action: Upscale
    Annunciator: LED backlight for "AL1", "AL2", *(Alarm #2 not available with cooling output or motorized valve position option.)*

19. **ENVIRONMENTAL CONDITIONS**:
    Operating Temperature Range: 0 to 50°C
    Storage Temperature Range: -40 to 80°C
    Span Drift *(maximum)*: 100 ppm/°C, main input; 150 ppm/°C, second input
    Operating and Storage Humidity:
    85% max. (non-condensing) from 0 to 50°C
    Zero Drift *(maximum)*: 1 µV/°C, main input; 2 µA/°C, second input
    Altitude: Up to 2000 meters

20. **ISOLATION BREAKDOWN RATINGS**:
    All inputs and outputs with respect to AC line: 2300 V
    Analog Outputs, Second Analog Input, Heater Current Input or Slidewire Input with respect to main input: 500 V

21. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    UL Listed, File #E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    UL Recognized Component, File #E156876, UL873, CSA 22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
    Type 2 or 4X Enclosure rating (Face only), UL50
    IECEE CB Scheme Test Certificate # UL1239-156876/USA,
    CB Scheme Test Report # 96ME50279-070794
    Issued by Underwriters Laboratories, Inc.
    IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
    IP65 Enclosure rating (Face only), IEC 529

Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact
		Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m[1]
		80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O
		Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms[2]
		150 KHz - 80 MHz

Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A
		Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m:
Analog output signal, Heater Current Monitor input and Motorized Valve Positioner input signal may deviate during EMI disturbance.
For operation without loss of performance:
Install power line filter, RLC #LFIL0000 or equivalent.
2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms:
Analog output signal may deviate during EMI disturbance.
For operation without loss of performance:
a. Install power line filter, RLC #LFIL0000 or equivalent.
b. Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to cable at unit.
Refer to the EMC Installation Guidelines section of the manual for additional information.

22. **CONNECTION**: Jaw-type terminal block
    Wire Range: 12-30 AWG copper wire
    Torque: 5-7 inch-lbs (56-79 N-cm)
23. **CONSTRUCTION**: NEMA 2 For Standard Models.
    Front Panel: Flame and scratch resistant tinted plastic
    Case: High impact black plastic. (Mounting collar included)
    NEMA 4X/IP65 model only: Sealed bezel utilizing two captive mounting screws (panel gasket included). This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2
24. **WEIGHT**: 1.3 lbs (0.6 kgs)

ACCESSORIES:
External SSR Power Unit:
Switched Voltage Range: 50 to 280 VAC *(Nominal: 240 VAC)*
Load Current: 45 Amps @ 25°C ambient temperature
  35 Amps @ 50°C ambient temperature
On State Input: 3 to 32 VDC @ 1500 Ω impedance. *(isolated)*
  (Use Logic/SSR drive output module.)
Off State Input: 0.0 to 1.0 VDC
Size: 5.5" (14 cm) L x 4.75" (12 cm) W x 2.62" (6.6 cm) H
Current Transformer:
Current Ratio: 50:0.1 (Amperes)
Accuracy: ±5.0%
Operating Frequency: 50 to 400 Hz
Insulation Class: 0.6 Kv BIL 10 Kv full wave
Terminals: Brass studs No. 8-36, (flat washer, washer, nut)
Weight: 8.0 oz (226 g)
Approvals: UL recognized component

BASIC OPERATION

The TCU controls a process temperature by measuring the temperature via an input probe, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process temperature at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low temperature overshoot from process disturbances.

FRONT PANEL FEATURES

In the normal operating mode, the unit will display the process temperature in the upper display. One of six other parameters can be viewed in the lower display:

- Setpoint
- % Power Output
- Temperature Deviation
- Heater Current
- Second Input Process Value
- Temperature Symbol (F or C)

The six parameters can be scrolled through by pressing the DSP button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter.

Pressing the DSP button immediately returns the controller to the normal operating mode when making a parameter change. The controller's configuration and parameter settings are stored in an internal E[2]PROM device.

HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent temperature control. Measurement accuracy of 0.15% or better, provides closer process control conforming to the desired control setpoint value. One model accepts a variety of both thermocouple or RTD temperature probes. The AC input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel. No re-programming is required when changing or replacing modules.

The optional NEMA 4X/IP65 rated model utilizes two bezel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed. The standard model simply requires pressing a latch to remove the unit.

Low-drift, highly stable circuitry ensures years of reliable and accurate temperature control. The recommended two-year re-calibration interval is easily accomplished via the programming menu.

SETPOINT FEATURES

The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces thermal shock to the process and helps to minimize temperature overshoot.The setpoint may also be transmitted by the optional linear DC output for slave control loops.

The second analog input may be configured as a remote setpoint. As such, the controller is easily switched from local/remote setpoint operation via the front panel or user input. Ratio and bias parameters provide on-line scaling of the remote setpoint. Absolute limit values and maximum rate of change of the remote setpoint further enhance controller flexibility.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control. A programmable temperature shift and slope function can be used to compensate for probe errors or to have multiple TCU units indicate the same nominal temperature.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(s), etc.

The second analog input has independent scaling parameters to match the units of other processes or transmitters, or to match the controller's range.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). With adjustable time proportioning-cycle time, and programmable DC linear output, the controller can satisfy a wide variety of output requirements.

Programmable dampening output hysteresis and output update time parameters can dramatically reduce actuator activity without degrading control accuracy.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE

The TCU has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampening factor produces various levels of process control and response characteristics.

## *OPTIONS*
HEATING AND COOLING CONTROL
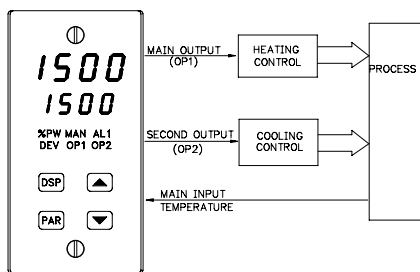
The TCU has dual outputs for providing heating and cooling to those processes that require them. Many extruder applications require both heating and cooling to maintain accurate extruder barrel and die temperatures. The TCU is easily configured for these applications.

Cooling Configuration Parameters

"CYC2"	-	Enter cooling time proportioning cycle time
"GAN2"	-	Enter cooling relative gain
"db-2"	-	Enter heat/cool deadband or overlap

HEATER CURRENT MONITOR
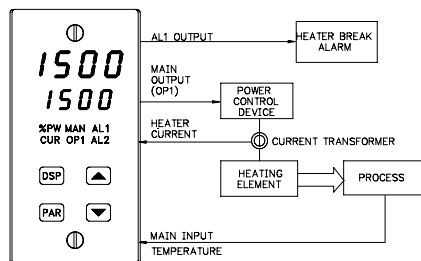
The Heater Current Monitor serves as a heater element fail sentry, so operators can take corrective action before significant process errors occur in the event of a failure. The actual heater current can be viewed in the secondary display and/or a heater break alarm output can be programmed.

Heater Current Monitor Configuration Parameters

"HCur"	-	Enter full scale current of current transformer
ACt1", "ACt2"	-	Program alarm(s) as heater break alarm

MOTORIZED VALVE POSITIONER

The motorized valve positioner controls the position of a valve directly, by use of "open" and "close" control outputs. The slidewire feedback signals of the valve may optionally be connected to the controller. Alternatively, the controller may be configured for linear input valve control using the 4 to 20 mA DC output.

Motorized Valve Positioner Configuration Parameters

Position mode:	"VPS1"	-	Enter or measure valve closed position
	"VPS2"	-	Enter or measure valve open position
	"VUdt"	-	Enter Valve update time
	"VPdb"	-	Enter valve control deadband
	"VFAL"	-	Enter valve fail detect time
	"Act1"	-	Program alarm as valve fail output
Velocity mode:	"VUdt"	-	Enter Valve update time
	"VOPt"	-	Enter valve open time
	"VCLt"	-	Enter valve close time
	"VONt"	-	Enter valve control deadband *(minimum on time)*

INTERNAL CASCADE

Cascade control allows the process to be divided into two control loops: the primary control loop and the secondary control loop. The secondary loop receives it's setpoint from the primary loop to control an intermediate variable (steam pressure). The control level of the intermediate variable is the input to the primary process. The primary loop (temperature) controller maintains loop regulation by manipulating the setpoint of the secondary controller. The setpoint of the secondary controller, in turn, changes the intermediate variable. The secondary loop can react faster to disturbances of the intermediate variable, thereby minimizing the effects to the primary control loop. Control loops cascaded in such a manner provide greater control quality than would be possible with single loop control. A single TCU can accomplish two-process cascade control.
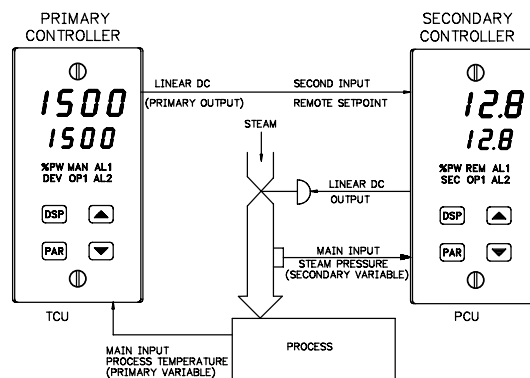
Internal Cascade Configuration Parameters

"OPer"	-	Select cascade mode
"root"	-	Select second input square root linearization
"dPt2"	-	Select second input decimal point
"dSP1"	-	Enter scaling units of second input
"INP1"	-	Enter scaling units of second input
"dSP2"	-	Enter scaling units of second input
"INP2"	-	Enter scaling units of second input
"OPd2"	-	Output dampening of secondary

Internal Cascade Operational Parameters

"SP-2"	-	View secondary setpoint value
"Pb-2"	-	Enter secondary proportional band
"It-2"	-	Enter secondary integral time
"dt-2"	-	Enter secondary derivative time

EXTERNAL CASCADE

Similar to internal cascade control, external cascade control differs by the employment of two controllers, one of which is equipped with a second analog input configured as a remote setpoint. A PCU controls the secondary loop, while a TCU controls the primary loop.

External Cascade Configuration Parameters

"OPEr"	-	Select ratio mode
"root"	-	Select second input square root linearization
"dPt2"	-	Select second input decimal point
"dSP1"	-	Enter scaling units of second input
"INP1"	-	Enter scaling units of second input
"dSP2"	-	Enter scaling units of second input
"INP2"	-	Enter scaling units of second input
"SPtr"	-	Local/Remote select options

External Cascade Operational Parameters

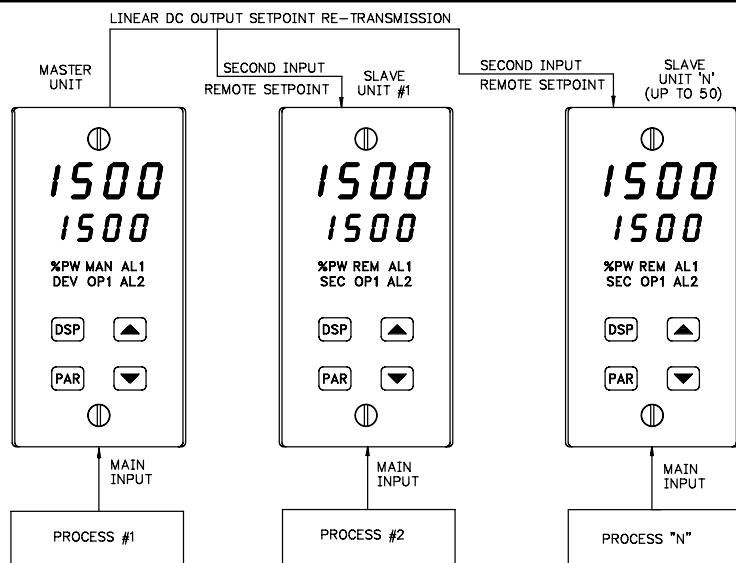|		
"rtio"	-	Remote setpoint ratio
"bIAS"	-	Remote setpoint bias

SETPOINT MASTER CONTROL

Setpoint Master Control allows automatic setpoint changes to slave controller units (up to 50 units total) from a master TCU controller. The linear DC output of the master is looped with the second analog input of the slave TCU controllers. Each slave unit can have unique remote setpoint ratio and bias values.

Setpoint Slave Configuration Parameters

"OPEr" - Select remote setpoint mode
"root" - Select second input square root Linearization
"dPt2" - Select second input decimal point
"dSP1" - Enter scaling units of second input
"INP1" - Enter scaling units of second input
"dSP2" - Enter scaling units of second input
"INP2" - Enter scaling units of second input
"SPLO"
"SPHI" - Limit range of remote setpoint
"SPrP" - Limit rate of change of remote setpoint

Setpoint Slave Operational Parameters

"rtio" - Second input ratio
"bIAS" - Second input bias

CONTROLLER PROGRAMMING

The TCU has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front Panel Program Disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:
Unprotected Parameter Mode
Configuration Parameter Mode
Protected Parameter Mode
Hidden Function Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE *

The unprotected parameter mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered.The configuration parameter modes can be accessed only from this mode.

"SP" - Enter Setpoint
"OP" - Enter output power
"ProP" - Enter proportional band
"Intt" - Enter integral time
"dErt" - Enter derivative time
"rtio" - Enter Remote Setpoint ratio value
"bIAS" - Enter Remote Setpoint bias value
"SP-2" - View internal cascade secondary setpoint demand
"Pb-2" - Enter internal cascade, secondary proportional band
"It-2" - Enter internal cascade, secondary integral time
"dt-2" - Enter internal cascade, secondary derivative time
"AL-1" - Enter value for alarm #1
"AL-2" - Enter value for alarm #2
"CNFP" - Select basic configuration mode
"End" - Return to normal display mode

* *These parameters may not appear due to option configuration or other programming.*

CONFIGURATION PARAMETER MODE

The configuration parameter mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage allowing the user to return to the normal display mode.

Configuration 1, Inputs

"tYPE" - Select input probe type
"SCAL" - Select temperature scale
"dCPt" - Select temperature resolution
"FLtr" - Select level of input filtering
"SPAN" - Enter input correction span (slope)
"SHFt" - Enter input correction shift (offset)
"SPLO" - Enter setpoint lower limit
"SPHI" - Enter setpoint higher limit
"SPrP" - Enter setpoint ramp rate
"InPt" - Select user input function *
"HCur" - Enter full scale heater current *

Configuration 2, Outputs

"CYCt" - Enter time proportioning cycle time
"OPAC" - Select control action
"OPLO" - Enter output power low limit
"OPHI" - Enter output power high limit
"OPFL" - Enter probe fail power preset
"OPdP" - Enter output control dampening
"CHYS" - Enter ON/OFF control hysteresis
"tcod" - Select auto-tuning dampening
"ANAS" - Select linear DC output assignment *
"ANLO" - Enter linear DC output low scaling value *
"ANHI" - Enter linear DC output high scaling value *
"ANdb" - Enter linear DC output control deadband *
"ANUt" - Enter linear DC output update time *

Configuration 3, Parameter lock-outs

"SP" - Select degree of setpoint access
"OP" - Select degree of power access
"dEv" - Enable deviation display *
"IN-2" - Enable second input display *
"HCur" - Enable heater current display
"UdSP" - Enable temperature scale display
"CodE" - Enter parameter access code
"PId" - Select degree of PID access
"PId2" - Select degree of secondary PID access *
"rtbS" - Select degree of ratio/bias access *
"AL" - Select degree of alarm access *
"ALrS" - Enable alarm reset access *
"SPSL" - Enable local/remote setpoint selection *
"trnF" - Enable auto/manual mode selection
"tUNE" - Enable auto-tune invocation

Configuration 4, Alarms *

"Act1" - Select operation mode of alarm #1
"rSt1" - Select reset mode of alarm #1
"Stb1" - Enable activation delay of alarm #1
"AL-1" - Enter value for alarm #1
"Act2" - Select operation mode of alarm #2
"rSt2" - Select reset mode of alarm #2
"Stb2" - Enable activation delay of alarm #2
"AL-2" - Enter value for alarm #2
"AHYS" - Enter hysteresis value for both alarms

Configuration 5, Cooling *

"CYC2" - Enter cooling time proportioning cycle time
"GAN2" - Enter cooling relative gain
"db-2" - Enter heat/cool deadband or overlap

Configuration 6, Serial Communications *

"bAUd" - Select baud rate
"PArb" - Select parity bit
"Addr" - Enter unit address number
"Abrv" - Select abbreviated or full mnemonic transmissions
"PrAt" - Enter automatic print rate
"PoPt" - Select parameters to be included in print-out

Configuration 7, Second Input *

"OPEr" - Select remote setpoint or internal cascade mode
"root" - Select second input square root linearization
"dPt2" - Select second input decimal point
"dSP1" - Enter scaling parameters of second input
"INP1" - Enter scaling parameters of second input
"dSP2" - Enter scaling parameters of second input
"INP2" - Enter scaling parameters of second input
"SPtr" - Enter local/remote select options
"OPd2" - Enter Secondary output control dampening

Configuration 8, Motorized Valve Positioner *

Position mode: "VPS1" - Enter or measure valve closed position
    "VPS2" - Enter or measure valve open position
    "VUdt" - Enter valve update time
    "VPdb" - Enter valve control deadband
    "VFAL" - Enter valve fail detect time
Velocity mode: "VUdt" - Enter valve update time
    "VOPt" - Enter valve open time
    "VCLt" - Enter valve close time
    "VONt" - Enter valve control deadband
                (minimum on time)

HIDDEN FUNCTION MODE *

The hidden function mode is accessible from the normal operating mode. The four functions in this mode may be locked-out individually in configuration 3 parameter lock-out section.

"SPSL" - Select Local/Remote Setpoint
"trnF" - Transfer between automatic (PID) control and manual control
"tUNE" - Invoke/cancel PID Auto-tune
"ALrS" - Reset latched alarms

PROTECTED PARAMETERS MODE *

The protected parameters mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-out section can be accessed.

"ProP" - Enter Proportional band
"Intt" - Enter integral time
"dErt" - Enter derivative time
"rtio" - Enter remote setpoint ratio value
"bIAS" - Enter remote setpoint bias value
"SP-2" - Enter internal cascade, secondary setpoint
"Pb-2" - Enter internal cascade, secondary proportional band
"It-2" - Enter internal cascade, secondary integral time
"dt-2" - Enter internal cascade, secondary derivative time
"AL-1" - Enter value for alarm #1
"AL-2" - Enter value for alarm #2
"CodE" - Enter access value to unprotected parameters & configuration parameters

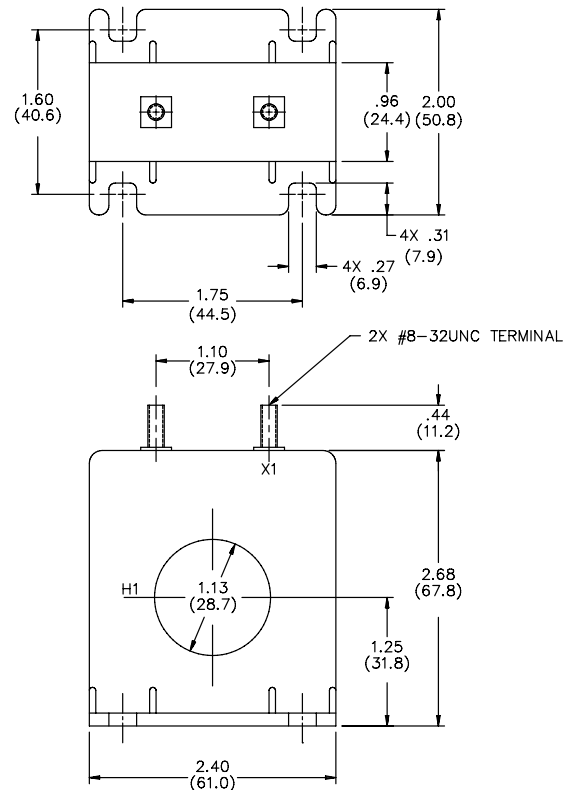* *These parameters may not appear due to option configuration or other programming.*

ACCESSORY - EXTERNAL SSR POWER UNIT

The external SSR Power Unit is used with the Logic/SSR Drive Module (OMD00003) to switch loads up to 240 VAC @ 45 amps, 25°C ambient. The unit is operated by applying a low level DC control signal to the isolated input. The unit features zero cross detection circuits which reduces radiated RFI when switching load currents. With no contacts to wear out, the SSR Power Unit provides virtually limitless operational life. The unit is supplied with an integral heat sink for immediate installation.
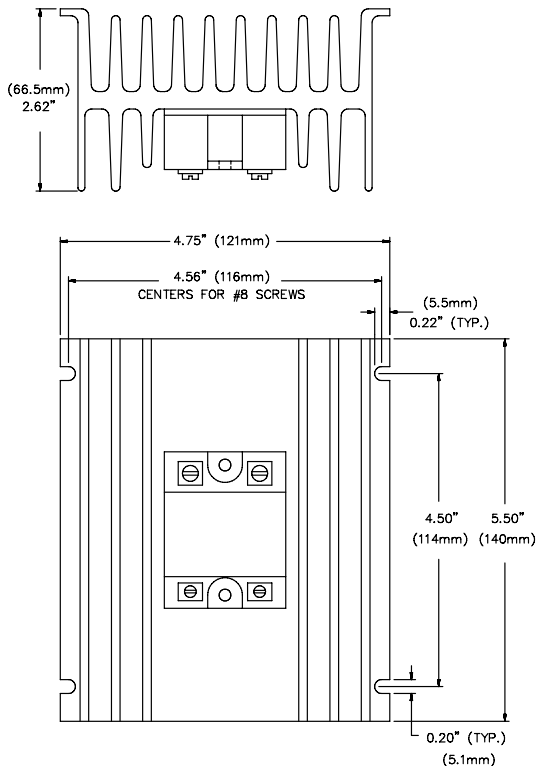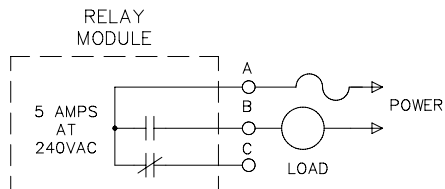

ACCESSORY - CURRENT TRANSFORMER

The external Current Transformer is used when specifying TCUs equipped with the Heater Current Monitor. The primary current rating is 50 amperes.

OUTPUT MODULES

TYPICAL CONNECTIONS

RELAY
MODULE

5 AMPS
AT
240VAC
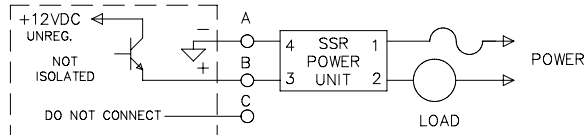
A
B
C

POWER

LOAD

Relay:
    Type: Form-C (Form-A with some models. See ordering information.)
    Rating: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).
    Life Expectancy: 100,000 cycles at maximum load rating.
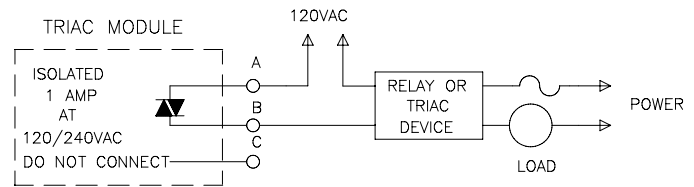   (Decreasing load and/or increasing cycle time, increases life expectancy).

LOGIC/SSR DRIVE
MODULE

+12VDC
UNREG.

NOT
ISOLATED

DO NOT CONNECT

A
B
C

4 SSR 1
POWER
3 UNIT 2

POWER

LOAD

Logic/SSR Drive: Can drive multiple SSR Power Units.
    Type: Non-isolated switched DC, 12 VDC typical
    Drive: 45 mA maximum.

TRIAC MODULE

120VAC

ISOLATED
1 AMP
AT
120/240VAC
DO NOT CONNECT

A
B
C

RELAY OR
TRIAC
DEVICE

POWER

LOAD

Triac:
    Type: Isolated, Zero Crossing Detection
    Rating:
        Voltage: 120/240 VAC
        Max. Load Current: 1 ampere @ 35°C
        0.75 ampere @ 50°C
        Min. Load Current: 10 mA
    Off State Leakage Current: 7 mA max. @ 60 Hz
    Operating Frequency: 20 to 400 Hz
    Protection: Internal Transient Snubber, Fused

EXTRUDER   COOLING WATER   ALARM/COOLING SUPPLY   120 VAC

AC POWER

240V HEATER SUPPLY

HB ALARM

SSR POWER UNIT

CURRENT TRANSFORMER

DATA LOGGER

1	AL1/OP2 COMM	COOLING/ALARM COMMON
2	OP2-A	COOLING OUTPUT
3	AL1-A	HEATER CURRENT FAIL OUTPUT
4	OP1-A	
5	OP1-B	MAIN CONTROL OUTPUT
6	OP1-C	
7	USER INPUT	
8		
9	TC +	
10	COMM	THERMOCOUPLE INPUT
11	OUT +	4 -20 mA LINEAR DC OUTPUT
12	OUT -	TEMPERATURE RETRANSMISSION
13	N/C	
14	N/C	
15	CT	SECOND INPUT
16	CT	(CURRENT TRANSFORMER)

APPLICATION

Several TCU controllers are employed to control the temperature of a plastics extruder. Each TCU controls a heating element and a cooling water solenoid to maintain each extruder zone at a desired temperature. The heater current monitor of the TCU is used for early detection of heater element failure. The linear DC output is used to retransmit the process temperature to a control computer for data logging purposes.

ORDERING INFORMATION

MODELS WITHOUT SECOND INPUT OPTIONS

NEMA 4X/P65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER 115/230 VAC
NO	NO	NO	NO	NO	NO	TCU00000
NO	NO	NO	2	NO	NO	TCU00001
NO	NO	NO	1	YES	NO	TCU00002
NO	YES	NO	2	NO	NO	TCU01001
NO	YES	NO	2	NO	YES	TCU01004
NO	YES	NO	1	YES	YES	TCU01005
YES	NO	NO	NO	NO	NO	TCU10000
YES	NO	NO	2	NO	NO	TCU10001
YES	NO	NO	1	YES	NO	TCU10002
YES	YES	NO	2	NO	NO	TCU11001
YES	YES	NO	1	YES	NO	TCU11002
YES	YES	NO	2	NO	YES	TCU11004
YES	YES	NO	1	YES	YES	TCU11005
YES	NO	YES	2	NO	NO	TCU12001
YES	NO	YES	2	NO	YES	TCU12004
YES	NO	YES	1	YES	YES	TCU12005

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

HEATER CURRENT MONITOR MODELS (HCM)

NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
YES	NO	NO	2	NO	YES	TCU10204
YES	YES	NO	2	NO	NO	TCU11208

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

SECOND ANALOG INPUT MODELS (ANA)

NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
YES	NO	NO	2	NO	YES	TCU10104
YES	YES	NO	2	NO	NO	TCU11108
YES	NO	YES	2	NO	NO	TCU12108

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

MOTORIZED VALVE POSITIONER MODELS (MVP)

NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
YES	NO	NO	1	NO	YES	TCU10307
YES	YES	NO	1	NO	NO	TCU11306
YES	NO	YES	1	NO	NO	TCU12306

ACCESSORIES

DESCRIPTION	PART NUMBER
Relay Module	OMD00000
Triac Module	OMD00001
Logic/SSR Drive Module	OMD00003
SSR Power Unit	RLY50000
Single Phase 25 A DIN Rail Mount SSR	RLY60000
Single Phase 40 A DIN Rail Mount SSR	RLY6A000
Three Phase DIN Rail Mount SSR	RLY70000
50:0.1 Ampere Current Transformer	CT005001
40:0.1 Ampere Current Transformer	CT004001

Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s), the cooling output, and valve positioner outputs. The controller can be fitted with any combination of output modules.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to line voltage.

All output modules are packaged separately and must be installed by the user.

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red lion

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MODEL TP16KIT - T16/P16 PROGRAMMING KIT

- ● ALLOWS PC PROGRAMMING OF ANY T16 & P16
- ● KIT CONTAINS EVERYTHING REQUIRED FOR DIRECT PC LINK
- ● PROGRAM WITHOUT POWERING CONTROLLER
- ● WINDOWS® CONFIGURATION SOFTWARE

Product Features

GENERAL DESCRIPTION

The TP16KIT comes with everything you need to program any T16 or P16 controller with your PC. The kit consists of the T/P16 Programming Module, a 7' length interface cable, T/P16 User Software and DC wall-supply (T/P16KIT1 only). The Windows based software allows easy configuration, file storage, download, upload and calibration of T16 and P16 controllers. The module converts the RS-232 signals from a PC's serial port into the required logic level for the controller's PC link port.

The module is primarily intended for system designers or customers who use T16 and P16 controllers. The kit provides the ability to program multiple controllers quickly and easily, when compared to programming through the front panel keypad.The T16 and P16 controllers can be programmed prior to installation, without having to connect power to the rear terminals. For the end customer, programming changes to multiple controllers can be made quickly and reliably on the factory floor by using the programming module with a laptop computer.

The module kit is available in two versions. T/P16KIT1 includes a 115 VAC wall transformer. This provides power to the module, and in addition, power for the T16 and P16 controllers. This allows the T16 or P16 controller to be programmed prior to installation, without having to make any connections to the controller's rear power terminals. T/P16KIT2 does not come with the power supply. Power has to be supplied either to the controller, or to the module with the customer's own DC supply.

CONSTRUCTION

The module is housed in a plastic enclosure with connectors located on both ends. The RS-232 end has a 9 pin female D-sub connector and is designed to plug directly into the serial port connector on a PC. The opposite end of the module has a 6-position terminal block header and a male pin-type power jack. With the interface cable, the module is connected directly to the T16 or P16 controller PC board through a cut in the controller's case. The 4-wire interface cable consists of the serial "transmit data" and "receive data" signals, along with "DC power" and "common" lines for the T/P16 controller.

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.

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

⚡ **CAUTION: Risk of electric shock.**

General Specifications

1. **POWER**:
   AC to DC Wall Adapter (TP16KIT1):
      Input: 120 VAC, 60 Hz, 5 W
      Output: 9 VDC, 200 mA
   DC Power Input: 7 to 11 VDC, 200 mA
2. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0°C to 50°C
   Storage Temperature Range: -40°C to 80°C
   Operating and Storage Humidity: 85% max relative humidity (non-condensing) from 0°C to 50°C
   Altitude: Up to 2000 meters

3. **CONNECTIONS**:
   To Computer: 9 pin female D-Sub
   To T16/P16: PC board edge connector
   DC Power Jack: Male power jack for mating 2.1 x 5.5 mm female barrel connector.
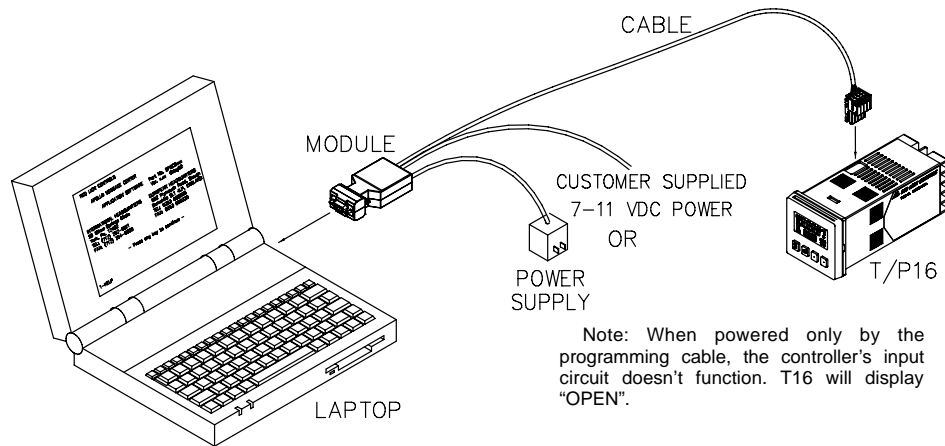   **DC Power Terminals**: Wire clamping screw terminals (alternate power connection)
4. **CONSTRUCTION**: Program Module is housed in a black plastic Case

Ordering Information

MODEL NO.	DESCRIPTION	PART NUMBERS
TP16	Programming Cable, Software, Power Supply (115 VAC)	TP16KIT1
	Programming Cable, Software	TP16KIT2

STEP 1 MAKING THE CONNECTIONS

CABLE

MODULE

CUSTOMER SUPPLIED
7-11 VDC POWER

OR

POWER
SUPPLY

T/P16

LAPTOP

Note: When powered only by the programming cable, the controller's input circuit doesn't function. T16 will display "OPEN".

STEP 2 INSTALLING SOFTWARE

Insert the diskette into the A: or B: drive. Then Run A:\SETUP (or B:\SETUP) to install RLCPro onto the hard drive. An icon labeled RLCPro will be created under the group RLCPro.

STEP 3 PROGRAMMING - Getting Started

Run RLCPro by double-clicking the icon, or use the start menu. Use the FILE pull-down menu to select a NEW file. Select T16/P16 then choose the specific model number for your controller. All configuration settings for the controller can be made by selecting the individual categories.

STEP 4 PC PORT CONFIGURATION

Go to the SETTINGS pull-down menu, and select PC PORT SETTINGS. The Communications Settings window allows you to set up the software properly to perform a download. Select the computer port (COMM 1-4) that the T16/P16 is connected to. Set the following settings to match the T16/P16.

The serial settings are
   Protocol: Modbus RTU
   Unit Address: 247
   Baud Rate: 9600
   Data Bits: 8
   Parity: none

STEP 5 UPLOADING and DOWNLOADING

Uploading: Go to the FILE pull-down menu, and select UPLOAD. The software will automatically detect any controller connected and its configuration will be loaded.

Downloading: Go to the FILE pull-down menu, and select DOWNLOAD. A pop-up screen will prompt you to ensure that the proper file is downloaded to the correct controller. Click "OK" to continue.

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MODEL TSC - TEMPERATURE SETPOINT CONTROLLER

- AUTOMATIC PROGRAM DELAY FOR PROFILE CONFORMITY, PLUS PROGRAM LINKING, REPEATING AND AUTO POWER-ON FUNCTIONS FOR ENHANCED CAPABILITY
- DUAL EVENT OUTPUTS FOR TIMED ACTIVATION OF PROCESS EQUIPMENT SUCH AS STIRRERS, FANS, HEATERS, ETC. (Uses Alarm Output Channels)
- FOUR SETPOINT & PID PARAMETER SETS FOR QUICK RECALL OF SETPOINTS AND/OR GAIN VALUES DURING BATCH OR PROCESS CHANGEOVER
- PROGRAMMABLE USER INPUT FOR CONTROLLER AND SETPOINT PROGRAM CONTROL
- 100 MSEC SAMPLING PERIOD WITH 0.15% ACCURACY
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF TEMPERATURE AND SETPOINT OR TEMPERATURE AND PROFILE STATUS
- ACCEPTS ANY ONE OF 10 DIFFERENT TYPES OF SENSOR INPUTS (Thermocouple or RTD)
- FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR drive, and Triac)
- OPTIONAL DUAL ALARM OUTPUTS (Uses Output Modules)
- OPTIONAL COOLING OUTPUT (Uses Output Module)
- OPTIONAL LINEAR 4 to 20 mA or 0 to 10 VDC OUTPUT FOR CONTROL OR TEMPERATURE RE-TRANSMISSION
- OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE
- OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL

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51EB

CE

- SETPOINT PROGRAM CONTROLLER FOR TIME VS. TEMPERATURE (RAMP/SOAK) AND SPECIAL BATCH/RECIPE APPLICATIONS
- ADVANCED PROGRAM PROFILING IN A 1/8 DIN PACKAGE
- ON-LINE MONITORING AND CONTROL OF PROGRAM STATUS, TIME, AND SETPOINT VALUE (Program Run, Pause, Stop, Advance, Modify Time, & Setpoint Value)

DESCRIPTION

The TSC is a setpoint controller suitable for time vs. temperature, process control applications. The TSC accepts signals from a variety of temperature sensors (thermocouple and RTD elements), precisely displays the process temperature, and provides an accurate output control signal (time proportional or linear) to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to satisfy various applications. The user input can be programmed to perform a variety of controller functions.

Dual 4-digit displays allow viewing of the measured temperature value and setpoint or temperature and profile status simultaneously. Front panel indicators inform the operator of controller status and output states. Replaceable output modules (Relay, logic/SSR drive or Triac) can be fitted to the main control output, alarm output(s) or timed event output(s), and cooling output.

The TSC has been designed to simplify the set-up and operation of a controlled setpoint profile program. The setpoint program is easily entered and controlled through the front panel. Full display capabilities keep the operator informed of the process temperature, profile status, output states, and setpoint value.
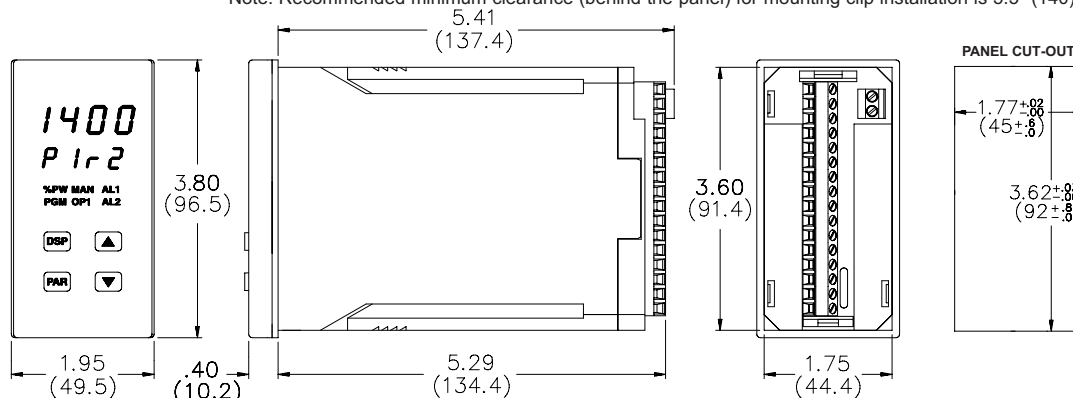
The controller can operate in the standard PID control mode for both heating or cooling with on-demand auto-tune which establishes the PID gain set. The PID gain set can be fine tuned by the operator at any time or may be locked from further modification. The unit can be transferred to the manual control mode providing the operator with direct control of the output.

The TSC features four programs or profile recipes, each with up to eight ramp/soak segments, which can be easily stored and executed at any time. Longer profiles can be achieved by linking one or more profiles together, creating a single profile of up to 32 ramp/soak segments. Temperature profile conformity is assured during either soak (hold) phases or both ramp and hold phases by an adjustable error band parameter. The program repeat function cycles the profile either continuously or a set number of times. Power-on options automatically re-start, stop, or resume a running profile. The profile can be controlled via the front panel buttons, the user input, or the optional serial communications port.

Four control points, each having a setpoint and PID parameter set, are available for instant front panel implementation during batch changeover, or

DIMENSIONS In inches (mm)

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

5.41 (137.4)

3.80 (96.5)

3.60 (91.4)

PANEL CUT-OUT

1.77 +.02/-.00 (45 +.8/-.0)

3.62 +.03/-.00 (92 +.8/-.0)

1.95 (49.5)

.40 (10.2)

5.29 (134.4)

1.75 (44.4)

DESCRIPTION (Cont'd)

other process conditions. A control point may have its PID gain set values disabled when implementing the control point.

The optional RS485 multidrop serial communications interface provides the capability of two-way communication between a TSC unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from 0-99. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output(s) may also be reset via the serial communications interface option.

Optional alarm output(s) may be configured to operate as a timed event output or as a standard alarm output. As an alarm output it may be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, or Band IN or OUT) with adjustable hysteresis. Also, a standby feature suppresses the output(s) on power-up until the temperature stabilizes outside the alarm region. Timed event output(s) allow the controller to activate other equipment while a programmed profile is running. Each profile can define up to 16 event states (phases), for each output(s).

An optional secondary output is available for processes that require cooling which provides increased control accuracy and response.

The optional linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with final actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following:

> % Output Power
> Measurement Value
> Measurement Value Deviation
> Setpoint Value

An optional NEMA 4X/IP65 rated bezel is available for washdown and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference, makes the controller extremely reliable in industrial environments.

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 TSC 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 alarm outputs is strongly recommended. Red Lion Controls model IMT (thermocouple) or model IMR (RTD) units may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. **DISPLAY:** Dual 4-digit
   Upper Temperature Display: 0.4" (10.2 mm) Red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) Green LED
   Display Messages:
   "OLOL" - Appears when measurement exceeds + sensor range.
   "ULUL" - Appears when measurement exceeds - sensor range.
   "OPEN" - Appears when open sensor is detected.
   "SHrt" - Appears when shorted sensor is detected *(RTD only)*.
   "...." - Appears when display value exceeds + display range.
   "-..." - Appears when display value exceeds - display range.
2. **POWER:** 115/230 VAC (+10%, -15%) no observable line variation effect, 48-62 Hz, 10 VA, switch selectable.
3. **ANNUNCIATORS:**
   6 LED Backlight Status Indicators:
   %PW - Lower auxiliary display shows power output in (%).
   PGM - Lower auxiliary display shows profile status or profile time remaining.
   MAN - Controller is in manual mode.
   OP1 - Main control output is active.
   AL1 - Alarm #1 is active.
   AL2 - Alarm #2 is active *(for Dual Alarm Option)*.
   OP2 - Cooling output is active *(for Cooling Option)*.
4. **CONTROLS:** Four front panel push buttons for setup and modification of controller functions and one external input.
5. **SETPOINT PROFILE:**
   Profiles: 4
   Segments Per Profile: 8 ramp/hold segments *(linkable to 32 segments)*.
   Ramp Rate: 0.1 to 999.9 degrees/minute or no ramp.
   Hold Time: Off or from 0.1 to 999.9 minutes, can be extended to 500 hours by linking.
   Error Band Conformity: Off or from 1 to 9999 degrees deviation, + value for hold phases, - value for both ramp and hold phases.
   Power-On Modes: Stop, auto-start, or profile resume.

Start Mode: Ramps from process temperature.
Program Auto Cycle: 1 to 249, or continuous.
Event Outputs: 2, time activated with profile [uses Alarm output(s)].
Control: Front panel buttons, user input, or RS485 communications.
6. **CONTROL POINTS:**
   Setpoints: 4
   PID gain sets: 4
   Control: Front panel buttons or user input.
7. **SENSOR INPUT:**
   Sample Period: 100 msec
   Response Time: 300 msec *(to within 99% of final value w/step input; typically, response is limited to response time of probe)*.
   Failed Sensor Response:
   Main Control Output(s): Programmable preset output.
   Display: "OPEN".
   Alarms: Upscale drive.
   DC Linear: Programmable preset output.
   Normal Mode Rejection: 40 db @ 50/60 Hz *(improves with increased digital filtering)*.
   Common Mode Rejection: 100 db, DC to 50/60 Hz.
   Protection: Input overload voltage; 240 VAC @ 30 sec max.
8. **THERMOCOUPLE:**
   Types: T, E, J, K, R, S, B, N or Linear mV.
   Input Impedance: 20 MΩ, all types.
   Lead Resistance Effect: 20 µV/350 Ω.
   Cold Junction Compensation: Less than ±1°C error over 0-50°C ambient temperature range. Disabled for linear mV type.
   Resolution: 1°C/F all types, or 0.1°C/F for T, E, J, K, and N only.
9. **RTD:** 2, 3 or 4 wire, 100 Ω platinum, alpha = 0.00385 (DIN 43760), alpha = 0.003916
   Excitation: 0.175 mA
   Resolution: 1 or 0.1 degree
   Lead Resistance: 7 Ω max.
10. **RANGE AND ACCURACY:**
    Errors include NIST conformity and A/D conversion errors at 23°C after 20 minutes warm-up. Thermocouple errors include cold junction effect. Errors are expressed as ±(% of reading) and ±3/4 LSD unless otherwise noted.

TC TYPE	RANGE	ACCURACY	WIRE COLOR (ANSI)
T	-200 to +400°C -328 to +752°F	0.20% + 1.5°C 0.20% + 2.7°F	blue
E	-200 to 750°C -328 to +1382°F	0.20% + 1.5°C 0.20% + 2.7°F	violet
J	-200 to +760°C -328 to +1400°F	0.15% + 1.5°C 0.15% + 2.7°F	white
K	-200 to +1250°C -328 to +2282°F	0.20% + 1.5°C 0.20% + 2.7°F	yellow
R	0 to +1768°C +32 to +3214°F	0.15% + 2.5°C 0.15% + 4.5°F	black
S	0 to +1768°C +32 to +3214°F	0.15% + 2.5°C 0.15% + 4.5°F	black
B	+200 to +1820°C +300 to +3300°F	0.15% + 2.5°C 0.15% + 4.5°F	grey
N	-200 to +1300°C -328 to +2372°F	0.20% + 1.5°C 0.20% + 2.5°F	orange
mV	-5.00 to 56.00	0.15% + 1 LSD	–
RTD (385)	-200 to +600°C -328 to +1100°F	0.10% + 0.5°C 0.10% + 0.9°F	–
RTD (392)	-200 to +600°C -328 to +1100°F	0.10% + 0.5°C 0.10% + 0.9°F	–
OHMS	1.0 to 320.0	0.15% + 1 LSD	–

11. **OUTPUT MODULES [Optional] (For All Output Channels):**
    Relay:
    Type: Form-C *(Form-A with RS485 option)*
    Rating: 5 Amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 HP @ 120 VAC *(inductive load)*.
    Life Expectancy: 100,000 cycles at max. rating.*(Decreasing load and/or increasing cycle time, increases life expectancy)*.
    Logic/SSR Drive: Can drive multiple SSR Power Units.
    Type: Non-isolated switched DC, 12 VDC typical.
    Drive: 45 mA max.
    Triac:
    Type: Isolated, Zero Crossing Detection.
    Ratings:
    Voltage: 120/240 VAC
    Max Load Current: 1 AMP @ 35°C
    0.75 AMP @ 50°C
    Min Load Current: 10 mA
    Off State Leakage Current: 7 mA max. @ 60 Hz
    Operating Frequency: 20 to 500 Hz
    Protection: Internal Transient Snubber, Fused.

SPECIFICATIONS (Cont'd)

12. **MAIN CONTROL OUTPUT (Heating or Cooling):**
    Control: PID or ON/OFF.
    Output: Time proportioning or linear DC.
    Hardware: Plug-in, replaceable output modules.
    Cycle time: Programmable.
    Auto-tune: When performed, sets proportional band, integral time, and derivative time values.
    Probe Break Action: Programmable.
13. **COOLING OUTPUT (Optional):**
    Control: PID or ON/OFF.
    Output: Time proportioning or linear DC
    Hardware: Plug-in, replaceable output modules.
    Cycle time: Programmable.
    Proportional Gain Adjust: Programmable.
    Heat/Cool DeadBand: Programmable.
14. **LINEAR DC DRIVE (Optional):** With digital scale and offset, programmable deadband and update time.
    4 to 20 mA:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±(0.1% of reading + 25 μA).
    Compliance: 10 V (500 Ω max. loop impedance).
    0 to 10 VDC:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±(0.1% of reading + 35 mV).
    Min. Load Resistance: 10 KΩ (1 mA max.)
    Source: % output power, setpoint, deviation, or temperature.
    (Available for heat or cool, but not both.)
15. **ALARMS (Optional):**
    Hardware: Plug-in, replaceable output module.
    Modes: Absolute high acting
    Absolute low acting
    Deviation high acting
    Deviation low acting
    Inside band acting
    Outside band acting
    Timed event output(s)
    Reset Action: Programmable; automatic or latched.
    Delay: Programmable; enable or disable.
    Hysteresis: Programmable.
    Probe Break Action: Upscale.
    Annunciator: LED backlight for "AL1", "AL2", (Alarm #2 not available with cooling output).
16. **SERIAL COMMUNICATIONS (Optional):**
    Type: RS485 Multi-point, Balanced Interface.
    Communication Format:
    Baud Rate: Programmable from 300-9600.
    Parity: Programmable for odd, even, or no parity.
    Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit.
    Unit Address: Programmable from 0-99, max. of 32 units per line.
    Transmit Delay: 100 msec min., 200 msec max.
    RS485 Common: Isolated from signal input common.
    Auto Print Time: Off to 9999 seconds between print-outs.
17. **USER INPUT:** V_{IN} max = 5.25 VDC, V_{IL} = 0.85 V_{MAX}; V_{IH} = 2.0 V_{MIN}, Response time 100 msec max.
    Functions:

Program Lock	Print Request
Integral Action Lock	Load Control Point
Auto/Manual Transfer	Run/Hold Profile 1
Setpoint Ramp Select	Run/Stop Profile 1
Reset Alarms	

18. **ENVIRONMENTAL CONDITIONS:**
    Operating Temperature: 0 to 50°C
    Storage Temperature: -40 to 80°C
    Operating and Storage Humidity: 85% max. (non-condensing) from 0°C to 50°C.
    Span Drift: ≤ 100 ppm/°C
    Zero Drift: ≤ 1 μ V/°C
    Altitude: Up to 2000 meters
19. **CERTIFICATIONS AND COMPLIANCES:**
    SAFETY
    UL Listed, File # E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    UL Recognized Component, File # E156876, UL873, CSA C22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
    Type 2 or 4X Enclosure rating (Face only), UL50
    IECEE CB Scheme Test Certificate # UL1239-156876/USA,
    CB Scheme Test Report # 96ME50279-070794
    Issued by Underwriters Laboratories, Inc.

IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
IP65 Enclosure rating (Face only), IEC 529

ELECTROMAGNETIC COMPATIBILITY
Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m[1] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms[2] 150 KHz - 80 MHz

Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A Power mains class A

Notes:

1. Self-recoverable loss of performance during EMI disturbance at 10 V/m:
    Analog output signal may deviate during EMI disturbance.
    For operation without loss of performance:
        Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to power lines at unit.
                    or
        Install power line filter, RLC #LFIL0000 or equivalent.
2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms:
    Analog output signal may deviate during EMI disturbance.
    For operation without loss of performance:
        a. Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to power lines at unit.
                    or
        Install power line filter, RLC #LFIL0000 or equivalent.
        b. Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to analog output cable at unit.
Refer to the EMC Installation Guidelines section of the manual for additional information.

20. **CONNECTION:** Jaw-type terminal block.
21. **CONSTRUCTION:**
    Front Panel: Flame and scratch resistant tinted plastic.
    Case: High impact black plastic. (Mounting collar included).
    NEMA 4X/IP65 model only: Sealed bezel utilizing 2 captive mounting screws (panel gasket included).This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2.
22. **WEIGHT:** 1.3 lbs. (0.6 kgs)

BASIC OPERATION

The TSC controls the temperature profile of a system by measuring the temperature via an input probe, compares the actual temperature to the setpoint profile in progress, and calculates the new output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value so the process temperature conforms to the programmed profile. The PID control algorithm incorporates features which provide minimum overshoot and excellent temperature control accuracy for a process.

FRONT PANEL FEATURES

In the normal display mode, the unit will display the process temperature in the upper display. One of five other parameters may be selected for viewing in the lower display:

Target Setpoint	Profile Phase Time Remaining
% Output Power	Temperature Symbol (F/C)
Profile Status	

The program profile status display indicates the active profile number with the current ramp or hold phase of the profile. The profile can be started, stopped, advanced, etc. from the front panel when the profile status display is viewed, if not locked from access.

The phase time remaining display, shows the time remaining in a ramp or hold phase and, if not locked from access, may be changed on-line to effect temporary changes to the program. Additionally, the target setpoint and % output power (manual mode only) may also be changed on-line or locked from operator access.

From the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode from any parameter module. The controller configuration and parameter settings are stored in an internal E^2PROM device.

CONFIGURATION MODE

The configuration modules serve to provide the basic set-ups required by the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage, which allows the user to return to the normal display mode, or advance to a later configuration stage.

Configuration 1, Inputs
"tYPE" - Select input probe type
"SCAL" - Select temperature scale
"dCPt" - Select temperature resolution
"FLtr" - Select degree of input filtering
"SPAN" - Enter input correction span (slope)
"SHFt" - Enter input correction shift (offset)
"SPLO" - Enter setpoint lower limit
"SPHI" - Enter setpoint higher limit
"SPrP" - Enter setpoint ramp rate
"InPt" - Select user input function

Configuration 2, Outputs
"CYCt" - Enter time proportioning cycle time
"OPAC" - Select control action
"OPLO" - Enter output power low limit
"OPHI" - Enter output power high limit
"OPFL" - Enter probe fail power preset
"CHYS" - Enter ON/OF control hysteresis
"tcod" - Select auto-tuning damping
"ANAS" - Select linear DC output assignment *
"ANLO" - Enter linear DC low scaling value *
"ANHI" - Enter linear DC high scaling value *

Configuration 3, Parameter lock-outs
"SP"   - Select degree of setpoint access
"OP"   - Select degree of power access
"P-CS" - Select degree of profile status access
"P-tr" - Select degree of phase time remaining access
"UdSP" - Enable temperature units display
"CodE" - Enter parameter access code
"PId"   - Select degree of PID access
"AL"   - Select degree of alarm access *
"ALrS" - Enable manual reset of alarms *
"CPAC" - Enable control point access
"PrAC" - Enable ramp/hold program access
"trnF" - Enable automatic/manual transfer
"tUNE" - Enable auto-tune invocation

Configuration 4, Alarms *
"Act 1" - Select operation mode of alarm #1
"rSt1" - Select reset mode of alarm #1
"Stb1" - Enable activation delay of alarm #1
"AL-1" - Enter value for alarm #1
"Act2" - Select operation mode of alarm #2
"rSt2" - Select reset mode of alarm #2
"Stb2" - Enable activation delay of alarm #2
"AL-2" - Enter value for alarm #2
"AHYS" - Enter hysteresis value for both alarms

Configuration 5,.Cooling *
"CYC2" - Enter cooling time proportioning cycle time
"GAN2" - Enter cooling relative gain
"db-2" - Enter heat/cool deadband or overlap

Configuration 6, Serial Communications *
"bAUd" - Select baud rate
"PArb" - Select parity bit
"Addr" - Enter unit address number
"Abrv" - Select abbreviated or full mnemonic transmissions
"PrAt" - Enter automatic print rate
"PoPt" - Select parameters to be included in print-out

Configuration 7, Control Points
"CSEt" - Select control point number for set-up 1, 2, 3, & 4
"SP-x" - Enter setpoint value for selected control point
"PId"   - Select if PID gain set to be loaded with setpoint
"PB-x" - Enter proportional band for selected control point *
"It-x" - Enter integral time for selected control point *
"dt-x" - Enter derivative time for selected control point *

Configuration 8, Profiles
"PSEt" - Select profile or event output for set-up 1, 2, 3, or 4
"PnCC" - Enter program-repeat cycle count for selected profile
"PnLn" - Select link option for selected profile
"PnEb" - Enter error band for temperature conformity for selected profile
"PnPC" - Enter power-down resume status for selected profile
"Pnr1" - Enter ramp rate 1 for selected profile *
"PnL1" - Enter setpoint level 1 for selected profile *
"PnH1" - Enter hold time 1 for selected profile *
.   .
.   .
.   .
"Pnr8" - Enter ramp rate 8 for selected profile *
"PnL8" - Enter setpoint level 8 for selected profile *
"PnH8" - Enter hold time 8 for selected profile *
"Pn 1" - Select event outputs at phase 1 for selected profile *
.   .
.   .
"Pn16" - Select event outputs at phase 16 for selected profile *

Configuration 9, Factory Service Operations
(Detailed in the operator's manual)

* These parameters may not appear due to option configuration or other programming
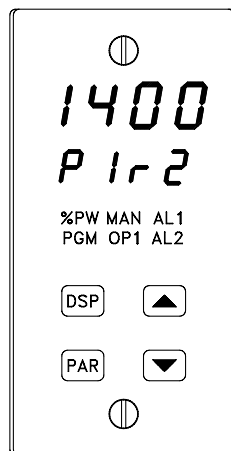

HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a process disturbance for excellent temperature control. Measurement accuracy of 0.15% provides closer process control conforming to the desired control setpoint value.

The unit accepts a variety of both thermocouple or RTD temperature probes. The A.C. input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel and NO re-programming is required. The standard model simply requires pressing a latch to remove the unit. The NEMA 4X/IP65 rated model utilizes two panel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed.

Low-drift, highly stable circuit design ensures years of reliable and accurate temperature control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

NEMA 4X/IP65 BEZEL

SETPOINT FEATURES

The controller's setpoint can be protected from out of range values, by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can also be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate, independent of a programmed profile. This feature reduces thermal shock to the process and also helps to minimize temperature overshoot.

The active setpoint, which can be a running profile, may also be transmitted by the linear DC output for slave control loops.

Four control points are available which can be implemented at any time. Each control point is programmed independently, with each having a setpoint and a PID gain set value. With gain value changes, the output power control signal will not "bump" resulting in a smooth control transition.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating temperature characteristics, helping to provide better temperature control.

A programmable temperature shift and slope function can be used to compensate for probe errors or to have multiple TSC units indicate the same nominal temperature.

A programmable User Input is available to control a variety of controller functions, such as profile control, auto/manual transfer, serial communication print requests, etc.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where too much power can cause damage. Automatic sensor probe break detection, for fail-safe operation, causes the controller to default to a programmed output power *(upscale or downscale burnout)*. With adjustable time proportioning-cycle time and programmable D.C. Linear output, the controller can satisfy a wide variety of output requirements.

During execution of a profile, two independent, timed event outputs are available to control or signal other equipment. The event outputs use the alarm channels.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE

The model TSC has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular thermal process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked at start-up, while ramping, or at setpoint, depending on the process requirements. A programmable auto-tune damping factor produces various levels of process control and response characteristics.

PROFILE PROGRAMMING

Profiles are programmed independently of each other and are separate from the configuration of other controller parameters. Each profile has parameters for error band (profile conformity), linking, auto-start and program repeat cycles. Profiles may be altered during execution, so changes take effect as the programmed profile advances.

CONTROLLER PROGRAMMING

The model TSC has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front panel program disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:

Hidden Mode
Protected Mode
Unprotected Mode
Configuration Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE

The unprotected mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. Only from this mode can the configuration modes be accessed.

"SP"	- Enter setpoint *
"OPOF"	- Enter %output power offset *
"OP"	- Enter output power *
"ProP"	- Enter proportional band
"Intt"	- Enter integral time *
"dErt"	- Enter derivative time *
"AL-1"	- Enter value for alarm #1 *
"AL-2"	- Enter value for alarm #2 *
"CNFP"	- Select basic configuration module
"End"	- Return to normal display mode

PROTECTED PARAMETER MODE *

The protected mode is accessible when program disable is active, also this mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-outs section can be accessed.

"ProP"	- Enter proportional band
"Intt"	- Enter integral time
"dErt"	- Enter derivative time
"AL-1"	- Enter value for alarm #1
"AL-2"	- Enter value for alarm #2
"CodE"	- Enter access value to unprotected mode
"End"	- Return to normal display mode

## HIDDEN FUNCTIONS MODE *

The hidden mode is accessible from the normal operating mode by holding the PAR button for 3 seconds. The five functions in this mode may be locked-out individually in configuration 3 parameter lock-outs section.

|	
" CP"	- Load control point x
"Prun"	- Control ramp/hold profile state
"trnF"	- Transfer between automatic (PID) control and Manual control
"tUNE"	- Invoke/Cancel PID auto-tune
"ALrS"	- Reset latched alarms

OUTPUT VARIATIONS WITHOUT RS485 OPTION

The Dual Alarm or the Cooling with Alarm output, without the RS485 option, has independent outputs. Therefore, the cooling output and/or alarm output*(s)* can be installed with any combination of output modules.
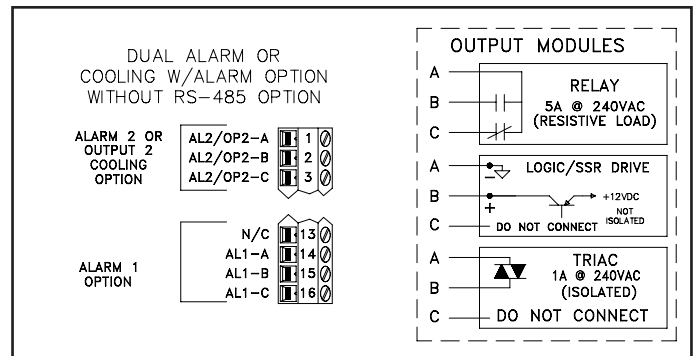
OUTPUT VARIATIONS WITH RS485 OPTION

The Dual Alarm or the Cooling with Alarm output, with RS485 option, does not have independent outputs. In this case, the cooling output and/or alarm output*(s)* must have the same type of output modules installed since they share the common terminal.
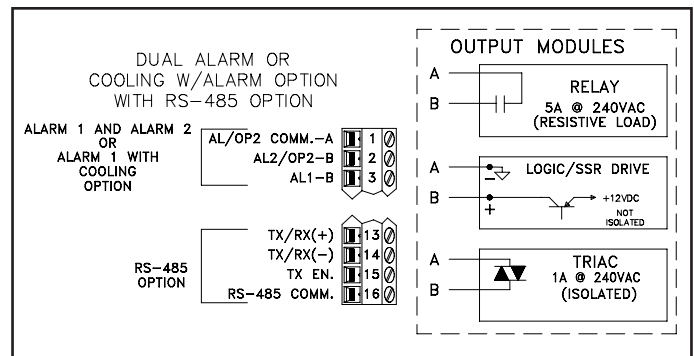
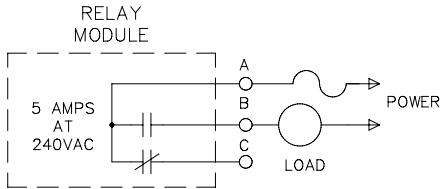* *These parameters may not appear due to option configuration or other programming*

OUTPUT MODULES

Units equipped with RS485 option must have the Dual Alarm or Cooling w/alarm options fitted with the same type of output modules. The controller's main output (OP1) can be fitted with any output module. Output modules are shipped separately and must be installed by the user.
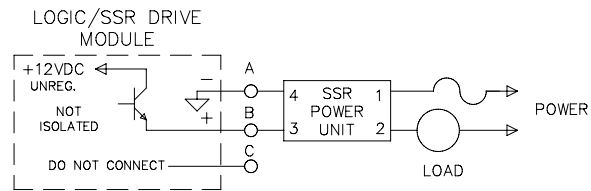
TYPICAL CONNECTIONS

RELAY MODULE

Relay:

Type: Form -C (Form-A with RS485 option only)

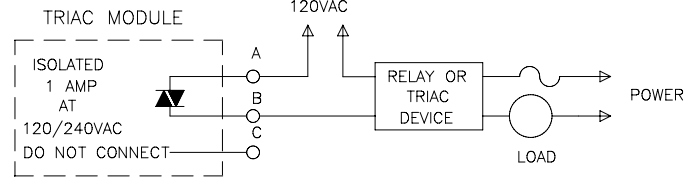**Rating**: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).

Life Expectancy:100,000 cycles at maximum load rating.
(Decreasing load and/or increasing cycle time, increases life expectancy).

LOGIC/SSR DRIVE MODULE

Logic/SSR Drive: can drive multiple SSR Power Units.
Type: Non-isolated switched DC, 12 VDC typical.
Drive: 45 mA max.

TRIAC MODULE

Triac:

Type: Isolated, Zero Crossing Detection.

Rating:
Voltage: 120/240 VAC.
Max. Load Current: 1 Amp @ 35°C
0.75 Amp @ 50°C
Min. Load Current: 10 mA
Off State Leakage Current: 7 mA max. @ 60 Hz
Operating Frequency: 20 to 500 Hz.
Protection: Internal Transient Snubber, Fused.

APPLICATION

TSC GLASS TEMPERING APPLICATION

A manufacturer of glass items needs to anneal *(temper)* their products to reduce the brittleness of the glass structure. The tempering process requires the glass to be heated and subsequently cooled at a controlled rate to change the structure of the glass. Different tempering profiles are required for different types of glass products.

A TSC is employed to control the temperature profile of the annealing oven. Four different temperature profiles are stored in the controller. The 4 to 20 mA analog output option is utilized to cool the annealing oven during the cool down ramp phases. An event output is used to quickly cool the oven at the end of the batch run *(alarm 1)*. Alarm 2 is used to signal the operator whenever the temperature is outside the prescribed program profile.

Note: Units equipped with the RS485 option have different terminal designators. See "Output Variations with or without the RS485 Option".
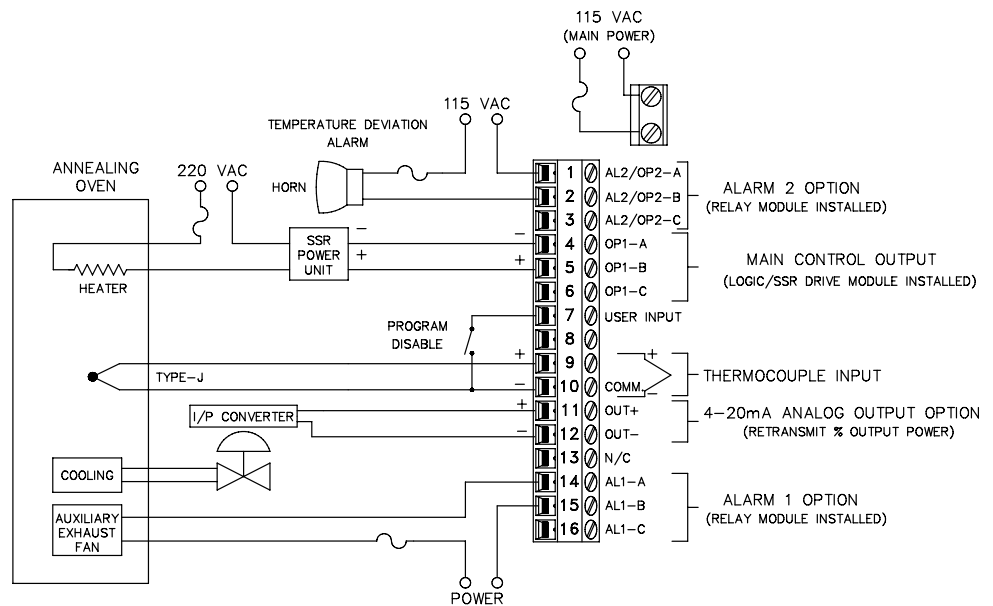
The programming for this profile is as follows:

Parameter	Value	Description
"P1r1"	5.0	Ramp from ambient temp. during heat phase at 5.0°/min.
"P1L1"	300	Target setpoint level 300°
"P1H1"	40.0	Heat at 300° for 40.0 minutes
"P1r2"	3.0	Ramp down 3.0°/min. during cooling phase
"P1L2"	150	Target Setpoint is 150°
"P1H2"	0.0	Do not hold at 150° *(used as "phantom" hold time for triggering event output for auxiliary cooling)*
"P1r3"	-0.1	End Program
"P1 1"	1F2F	Turn off output 1 *(output 2 is alarm)*
"P1 2"	1F2F	Keep off output 1
"P1 3"	1F2F	Keep off output 1
"P1 4"	1N2F	Turn on output 1 for Auxiliary Exhaust Fan

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ORDERING INFORMATION

MODEL NO.	DESCRIPTION	NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
TSC	Temperature Setpoint Controller	NO	YES	NO	2	NO	NO	TSC01001
		YES	YES	NO	2	NO	NO	TSC11001
		YES	YES	NO	1	YES	NO	TSC11002
		YES	YES	NO	2	NO	YES	TSC11004
		YES	YES	NO	1	YES	YES	TSC11005
		YES	NO	YES	2	NO	YES	TSC12004
		YES	NO	YES	1	YES	YES	TSC12005
	Relay Module							OMD00000
	Triac Module							OMD00001
	Logic/SSR Drive Module							OMD00003
PMK5	Panel Mount Adapter Kit (1/4 DIN to 1/8 DIN)							PMK50000
RLY	SSR Power Unit							RLY50000
	Single Phase 25 A DIN Rail Mount Solid State Relay							RLY60000
	Single Phase 40 A DIN Rail Mount Solid State Relay							RLY6A000
	Three Phase DIN Rail Mount Solid State Relay							RLY70000

These models have dual alarm outputs, or single alarm with cooling outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s) and cooling output. The controller can be fitted with any combination of output modules that do not have the RS485 option.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to a line voltage.

All modules are shipped separately and must be installed by the user.

red lion

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MODELS T16 & P16 - TEMPERATURE/PROCESS CONTROLLERS

- PID CONTROL WITH REDUCED OVERSHOOT
- T16 ACCEPTS TC AND RTD
- P16 ACCEPTS 0-10 V AND 0/4-20 mA SIGNALS
- ON DEMAND AUTO-TUNING OF PID SETTINGS
- DC ANALOG OUTPUT (OPTIONAL)
- USER PROGRAMMABLE FUNCTION BUTTON
- PC OR FRONT PANEL PROGRAMMING
- PC CONFIGURABLE WITH TP16KIT

**UL Recognized Component,
File #E156876**

GENERAL DESCRIPTION

The Model T16 Controller accepts signals from a variety of temperature sensors (thermocouple or RTD), while the Model P16 Controller accepts either a 0 to 10 VDC or 0/4 to 20 mA DC input signal. Both controllers can provide an accurate output control signal (time proportional or DC Analog Output) to maintain a process at a setpoint value. Dual 4-digit displays allow viewing of the process/temperature and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. The comprehensive programming allows these controllers to meet a wide variety of application requirements.

MAIN CONTROL

The controller operates in the PID Control Mode for both heating and cooling, with on-demand auto-tune, that establishes the tuning constants. The PID tuning constants may be fine-tuned through the front panel and then locked out from further modification. The controller employs a unique overshoot suppression feature, that allows the quickest response without excessive overshoot. Switching to Manual Mode provides the operator direct control of the output. The controller may also be programmed to operate in On/Off mode with adjustable hysteresis.

ALARMS

Optional alarm(s) can be configured independently for absolute high or low acting with balanced or unbalanced hysteresis. They can also be configured for deviation and band alarm. In these modes, the alarm trigger values track the setpoint value. Adjustable alarm hysteresis can be used for delaying output response. The alarms can be programmed for Automatic or Latching operation. A selectable standby feature suppresses the alarm during power-up until the temperature stabilizes outside the alarm region.

ANALOG OUTPUT OPTION

The optional DC Analog Output (10 V or 20 mA) can be configured and scaled for control or re-transmission purposes. The programmable output update time reduces valve or actuator activity.

PC PROGRAMMING KIT

The optional TP16KIT contains a programming module with a 9 pin RS232 connector, cable and Crimson, a Windows® based configuration software. The software allows downloading, uploading and storage of T16 and P16 program files. All controllers have a communications port that allows configuration by PC even without controller power connected. Controller calibration is also possible using the software when the proper calibration equipment and controller power is connected.

CONSTRUCTION

The controller is constructed of a lightweight, high impact, black plastic textured case and bezel with a clear display window. The front panel meets NEMA 4X/IP65 specifications when properly installed. In applications that do not require protection to NEMA 4X, multiple controllers can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

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 controller 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 controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.
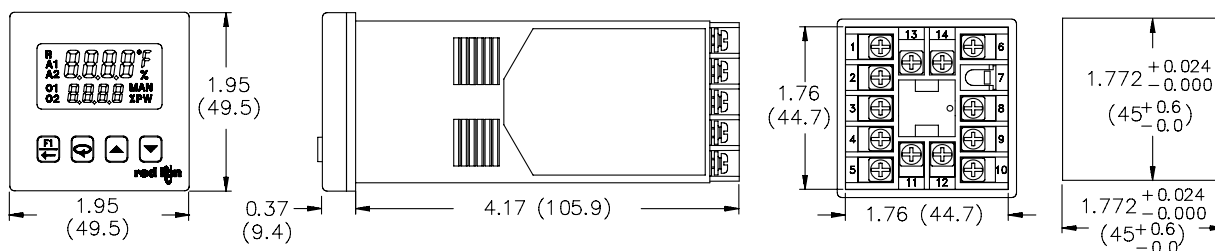
CAUTION: Risk of Danger.
Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

PANEL CUT-OUT

1.95
(49.5)

1.95
(49.5)

0.37
(9.4)

4.17 (105.9)

1.76
(44.7)

1.76 (44.7)

$1.772 {+0.024 \atop -0.000}$

$(45 {+0.6 \atop -0.0})$

$1.772 {+0.024 \atop -0.000}$

$(45 {+0.6 \atop -0.0})$

GENERAL SPECIFICATIONS

1. **DISPLAY**: 2 Line by 4-digit, LCD negative image transmissive with backlighting.
   Top (Process) Display: 0.3" (7.6 mm) high digits with red backlighting.
   Bottom (Parameter) Display: 0.2" (5.1 mm) high digits with green backlighting.
2. **ANNUNCIATORS**:
   Status Annunciators:
   O1 - Main control output is active.
   O2 - Cooling output is active (when Alarm 2 is used for cooling).
   A1 - Alarm 1 output is active.
   A2 - Alarm 2 output is active.
   °F, °C - Temperature units.
   %PW - Output power percentage is shown in Bottom display.
   MAN - Controller is in Manual Mode.
   R - Ramping Setpoint indicator.
   % - Percent indicator (P16 models only).
   Display Messages:
   OLOL - Measurement exceeds + sensor range
   ULUL - Measurement exceeds - sensor range
   OPEN - Open sensor is detected (T16 only)
   Shrt - Shorted sensor is detected (RTD only)
   SENS - Measurement exceeds controller limits (P16 only)
   dddd - Display value exceeds + display range
   -ddd - Display value exceeds - display range
3. **POWER**:
   Line Voltage Models:
   85 to 250 VAC, 50/60 Hz, 8 VA
   Low Voltage Models:
   DC Power: 18 to 36 VDC, 4 W
   AC Power: 24 VAC, ±10%, 50/60 Hz, 7 VA
4. **CONTROLS**: Three rubber push buttons for modification and setup of controller parameters. One additional button (F1) for user programmable function. One external user input (models with alarms) for parameter lockout or other user programmable functions.
5. **MEMORY**: Nonvolatile E^{2}PROM retains all programmable parameters.
6. **ISOLATION LEVEL**:
   AC power with respect to all other I/O: 250 V working (2300 V for 1 min.)
   Sensor input to analog output: 50 V working (500 V for 1 minute)
   Relay contacts to all other I/O: 300 V working (2300 V for 1 minute)
   DC power with respect to sensor input and analog output: 50 V working (500 V for 1 minute)
7. **CERTIFICATIONS AND COMPLIANCES**:
   SAFETY
   UL Recognized Component, File #E156876, UL873, CSA 22.2 No. 24 Recognized to US and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

Type 4X Enclosure rating (Face only), UL50
  IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I
  IP65 Enclosure rating (Face only), IEC 529

ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 kV contact Level 3; 8 kV air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [1] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 kV I/O Level 3; 2 kV power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms [2] 150 KHz - 80 MHz

Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m: Measurement input signal may deviate during EMI disturbance.
   For operation without loss of performance:
   Install one ferrite core one turn, RLC #FCOR0000 or equivalent, to I/O cables at unit.
2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms: Process and analog output signal may deviate during EMI disturbance.
   For operation without loss of performance:
   Install one ferrite core one turn, RLC #FCOR0000 or equivalent, to I/O cables and power cable at unit.

Refer to the EMC Installation Guidelines section of this bulletin for additional information.

8. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50°C
   Storage Temperature Range: -40 to 80°C
   Operating and Storage Humidity: 85% max relative humidity (non-condensing) from 0°C to 50°C
   Vibration According to IEC 68-2-6: 5 to 150 Hz, in X, Y, Z direction for 1.5 hours, 2 g's.
   Shock According to IEC 68-2-27: Operational 20 g (10 g relay), 11 msec in 3 directions.
   Altitude: Up to 2000 meters
9. **CONNECTION**: Wire-clamping screw terminals
10. **CONSTRUCTION**: Black plastic alloy case and collar style panel latch. Panel latch can be installed for vertical or horizontal instrument stacking. Black plastic textured bezel with transparent display window. Controller meets NEMA 4X/IP65 requirements for indoor use when properly installed. Installation Category II, Pollution Degree 2.
11. **WEIGHT**: 6.3 oz (179 g)

INPUT SPECIFICATIONS

1. **SENSOR INPUT**:
   Sample Period: 100 msec (10 Hz rate)
   Step Response Time: 300 msec typical, 400 msec max to within 99% of final value with step input.
   Failed Sensor Response:
   Main Control Output(s): Programmable preset output
   Display: "OPEN"
   Alarms: Upscale drive
   Analog Output: Upscale drive when assigned to retransmitted input.
   Normal Mode Rejection: >40 dB @ 50/60 Hz
   Common Mode Rejection: >120 dB, DC to 60 Hz
   Overvoltage Protection: 120 VAC @ 15 sec max
2. **RTD INPUTS**: (T16 only)
   Type: 2 or 3 wire
   Excitation: 150 µA typical
   Lead Resistance: 15 Ω max per input lead
   Resolution: 1° or 0.1° for all types

TYPE	INPUT TYPE	RANGE	STANDARD
385	100 Ω platinum, Alpha = .00385	-200 to +600°C -328 to +1112°F	IEC 751
392	100 Ω platinum, Alpha = .003919	-200 to +600°C -328 to +1112°F	No official standard
672	120 Ω nickel, Alpha = .00672	-80 to +215°C -112 to +419°F	No official standard
Ohms	Linear Resistance	0.0 to 320.0 Ω	N/A

3. **THERMOCOUPLE INPUTS**: (T16 only)
   Types: T, E, J, K, R, S, B, N, C, and Linear mV
   Input Impedance: 20 MΩ for all types
   Lead Resistance Effect: 0.25 µV/Ω
   Cold Junction Compensation: Less than ±1°C typical (1.5°C max) error over ambient temperature range.
   Resolution: 1° for types R, S, B and 1° or 0.1° for all other types

TYPE	DISPLAY RANGE	WIRE COLOR		STANDARD
		ANSI	BS 1843	
T	-200 to +400°C -328 to +752°F	(+) Blue (-) Red	(+) White (-) Blue	ITS-90
E	-200 to +750°C -328 to +1382°F	(+) Violet (-) Red	(+) Brown (-) Blue	ITS-90
J	-200 to +760°C -328 to +1400°F	(+) White (-) Red	(+) Yellow (-) Blue	ITS-90
K	-200 to +1250°C -328 to +2282°F	(+) Yellow (-) Red	(+) Brown (-) Blue	ITS-90
R	0 to +1768°C +32 to +3214°F	No standard	(+) White (-) Blue	ITS-90
S	0 to +1768°C +32 to +3214°F	No standard	(+) White (-) Blue	ITS-90
B	+149 to +1820°C +300 to +3308°F	No standard	No standard	ITS-90
N	-200 to +1300°C -328 to +2372°F	(+) Orange (-) Red	(+) Orange (-) Blue	ITS-90
C W5/W6	0 to +2315°C +32 to +4199°F	No standard	No standard	ASTM E988-96
mV	-5.00 mV to 56.00 mV	N/A	N/A	N/A

INPUT SPECIFICATIONS (Cont'd)

4. SIGNAL INPUT: (P16 only)

INPUT RANGE	ACCURACY *	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
10 VDC (-1 to 11)	0.30 % of reading +0.03V	1 MΩ	50 V	10 mV
20 mA DC (-2 to 22)	0.30 % of reading +0.04mA	10 Ω	100 mA	10 µA

* Accuracies are expressed as ± percentages over 0 to 50 °C ambient range after 20 minute warm-up.

OUTPUT SPECIFICATIONS

1. **CONTROL AND ALARM OUTPUTS**:
   Relay Output:
   Type: Form A
   Contact Rating: 3 A @ 250 VAC or 30 VDC; 1/10 HP @ 120 VAC (inductive load)
   Life Expectancy: 100,000 cycles at max. load rating (Decreasing load and/or increasing cycle time, increases life expectancy)
   Logic/SSR Output (main control output only):
   Rating: 45 mA max @ 4 V min., 7 V nominal
2. **MAIN CONTROL**:
   Control: PID or On/Off
   Output: Time proportioning or DC Analog
   Cycle Time: Programmable
   Auto-Tune: When selected, sets proportional band, integral time, derivative time, and output dampening time. Also sets input filter and (if applicable) cooling gain.
   Probe Break Action: Programmable
3. **ALARMS**: (optional) 2 relay alarm outputs.
   Modes:
   None
   Absolute High Acting (Balanced or Unbalanced Hysteresis)
   Absolute Low Acting (Balanced or Unbalanced Hysteresis)
   Deviation High Acting
   Deviation Low Acting
   Inside Band Acting
   Outside Band Acting
   Heat (Alarm 1 on Analog Output models only)
   Cool (Alarm 2)

5. TEMPERATURE INDICATION ACCURACY: (T16 only)
± (0.3% of span, +1°C) at 23 °C ambient after 20 minute warm up. Includes NIST conformity, cold junction effect, A/D conversion errors and linearization conformity.
Span Drift (maximum): 130 PPM/°C
6. **USER INPUT**: (Only controllers with alarms have a user input terminal.)
Internally pulled up to +7 VDC (100 KΩ), $V_{IN\ MAX} = 35$ V, $V_{IL} = 0.6$ V max, $V_{IH} = 1.5$ V min, $I_{OFF} = 40$ µA max
Response Time: 120 msec max
Functions: Programmable

Reset Action: Programmable; automatic or latched
Standby Mode: Programmable; enable or disable
Hysteresis: Programmable
Sensor Fail Response: Upscale
Annunciator: "A1" and "A2" programmable for normal or reverse acting
4. **COOLING**: Software selectable (overrides Alarm 2).
   Control: PID or On/Off
   Output: Time proportioning
   Cycle Time: Programmable
   Proportional Gain Adjust: Programmable
   Heat/Cool Deadband Overlap: Programmable
5. **ANALOG DC OUTPUT**: (optional)
   Action: Control or retransmission
   Update Rate: 0.1 to 250 sec

OUTPUT RANGE **	ACCURACY *	COMPLIANCE	RESOLUTION
0 to 10 V	0.3% of FS + ½ LSD	10 kΩ min	1/8000
0 to 20 mA	0.3% of FS + ½ LSD	500 Ω max	1/8000
4 to 20 mA	0.3% of FS + ½ LSD	500 Ω max	1/6400

* Accuracies are expressed as ± percentages over 0 to 50 °C ambient range after 20 minute warm-up.

** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximately 5% overrange and a small underrange (negative) signal.
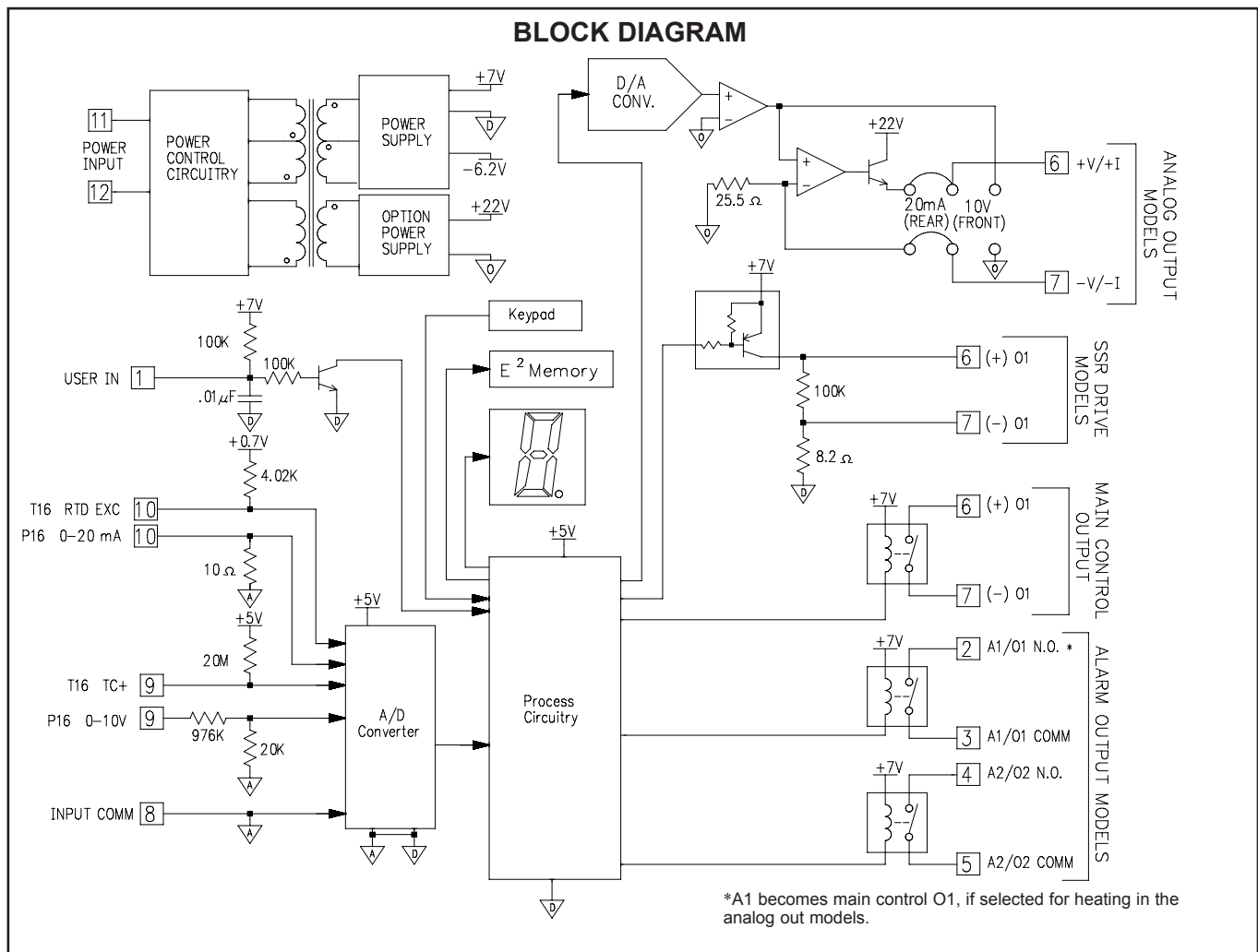

ORDERING INFORMATION

MODEL NO.	MAIN CONTROL	2 ALARMS & USER INPUT	PART NUMBERS	
			18-36 VDC/24 VAC	85 to 250 VAC
T16	Relay	—	T1610010	T1610000
	Relay	Yes	T1611110	T1611100
	Logic/SSR	—	T1620010	T1620000
	Logic/SSR	Yes	T1621110	T1621100
	Analog Out *	Yes	T1641110	T1641100
P16	Relay	—	P1610010	P1610000
	Relay	Yes	P1611110	P1611100
	Logic/SSR	—	P1620010	P1620000
	Logic/SSR	Yes	P1621110	P1621100
	Analog Out *	Yes	P1641110	P1641100

* Analog out may be used for retransmitted signals. When using analog output for retransmitted signals, AL1 becomes main control O1, if selected for heating in the analog out models.

ACCESSORIES

MODEL NO.	DESCRIPTION	PART NUMBERS
TP16	Programming Kit 1 : Includes Software, Comms Module w/ 9-pin connector and cable, and 115 VAC Power Adapter	TP16KIT1
	Programming Kit 2 : Includes Software, Comms Module w/ 9-pin connector and cable	TP16KIT2
RLY	External SSR Power Unit (for Logic/SSR models)	RLY50000
	25 A Single Phase Din Rail Mount Solid State Relay	RLY60000
	40 A Single Phase Din Rail Mount Solid State Relay	RLY6A000
	Three Phase Din Rail Mount Solid State Relay	RLY70000

BLOCK DIAGRAM

POWER INPUT 11 12 — POWER CONTROL CIRCUITRY — POWER SUPPLY +7V, −6.2V — OPTION POWER SUPPLY +22V

D/A CONV.

+22V

25.5 Ω   20mA (REAR)   10V (FRONT)

ANALOG OUTPUT MODELS
6 +V/+I
7 −V/−I

Keypad
E² Memory

+7V
100K
USER IN 1
100K
.01 μF
+0.7V
4.02K

+7V
100K
8.2 Ω

SSR DRIVE MODELS
6 (+) O1
7 (−) O1

T16 RTD EXC 10
P16 0−20 mA 10
10 Ω
+5V
20M

T16 TC+ 9
P16 0−10V 9
976K   20K

INPUT COMM 8

+5V

A/D Converter

Process Circuitry

MAIN CONTROL OUTPUT
+7V
6 (+) O1
7 (−) O1

ALARM OUTPUT MODELS
+7V
2 A1/O1 N.O. *
3 A1/O1 COMM
+7V
4 A2/O2 N.O.
5 A2/O2 COMM

*A1 becomes main control O1, if selected for heating in the analog out models.

EMC INSTALLATION GUIDELINES

Although this controller is designed with a high degree of immunity to Electromagnetic Interference (EMI), proper installation and wiring methods must be followed to ensure electromagnetic compatibility (EMC) in each application. The type of the electrical noise, source or coupling method into the controller may be different for various installations. The controller becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed 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 controller 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 more than 1 MHz.
   c. Connect the shield to common of the controller 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 through 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 controller 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 controller 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 (Red Lion Controls # FCOR0000)
   TDK # ZCAT3035-1330A
   Steward # 28B2029-0A0

   Line Filters for input power cables:
   Schaffner # FN610-1/07 (Red Lion Controls # LFIL0000)
   Schaffner # FN670-1.8/07
   Corcom # 1 VR3

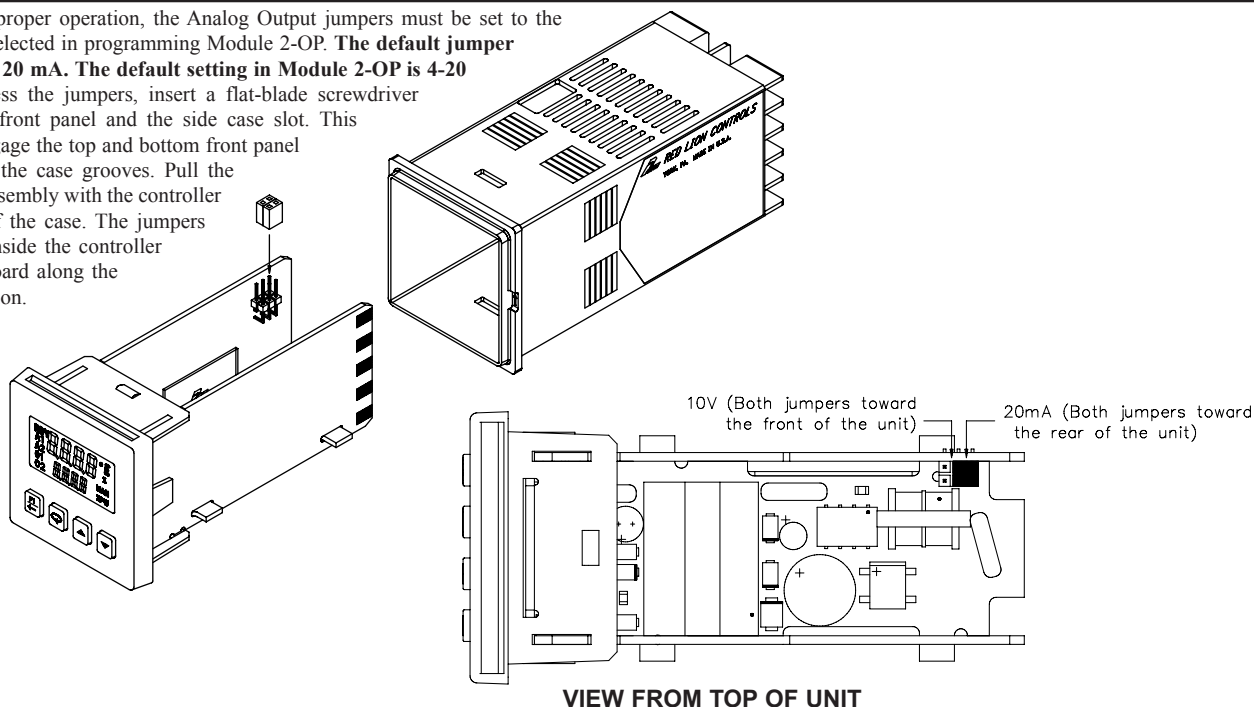   Note: Reference manufacturer's instructions when installing a line filter.
6. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
7. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.

   Snubber: Red Lion Controls # SNUB0000.

1.0 SETTING THE JUMPERS (ANALOG OUTPUT MODELS ONLY)

To insure proper operation, the Analog Output jumpers must be set to the same range selected in programming Module 2-OP. **The default jumper setting is for 20 mA. The default setting in Module 2-OP is 4-20 mA.** To access the jumpers, insert a flat-blade screwdriver between the front panel and the side case slot. This should disengage the top and bottom front panel latches from the case grooves. Pull the front panel assembly with the controller boards out of the case. The jumpers are located inside the controller on the left board along the back top section.

10V (Both jumpers toward the front of the unit)

20mA (Both jumpers toward the rear of the unit)

VIEW FROM TOP OF UNIT

2.0 INSTALLING THE CONTROLLER

The T16 and P16 controllers meet NEMA 4X/IP65 requirements for indoor use to provide a watertight seal in steel panels with a minimum thickness of 0.09", or aluminum panels with a minimum thickness of 0.12". The controllers are designed to be mounted into an enclosed panel. The bezel assembly must be in place during installation of the controller.

PANEL GASKET

BEZEL

PANEL

PANEL MOUNTING SCREW

LATCHING SLOTS

LATCHING TABS
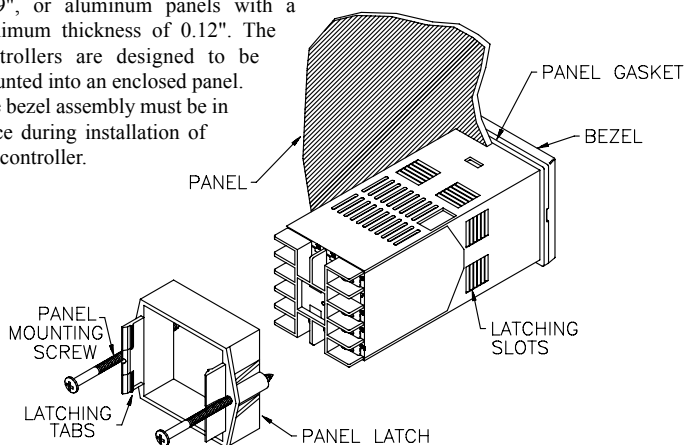
PANEL LATCH

Instructions:
1. Prepare the panel cutout to the proper dimensions.
2. Remove the panel latch from the controller. Discard the cardboard sleeve.
3. Carefully remove the center section of the panel gasket and discard. Slide the panel gasket over the rear of the controller, seating it against the lip at the front of the case.
4. Insert the controller into the panel cutout. While holding the controller in place, push the panel latch over the rear of the controller, engaging the tabs of the panel latch in the farthest forward slot possible.
5. To achieve a proper seal, tighten the panel latch screws evenly until the controller is snug in the panel, torquing the screws to approximately 7 in-lb (79 N-cm). Overtightening can result in distortion of the controller, and reduce the effectiveness of the seal.
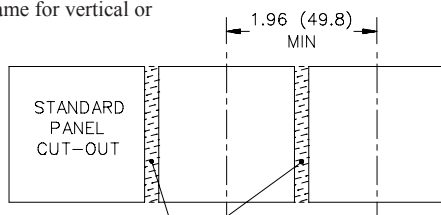
Note: The installation location of the controller is important. Be sure to keep it away from heat sources (ovens, furnaces, etc.) and away from direct contact with caustic vapors, oils, steam, or any other process by-products in which exposure may affect proper operation.

$1.772 \begin{smallmatrix} +0.024 \\ -0.000 \end{smallmatrix}$
$\left[45 \begin{smallmatrix} +0.6 \\ -0.0 \end{smallmatrix} \right]$

$1.772 \begin{smallmatrix} +0.024 \\ -0.000 \end{smallmatrix}$
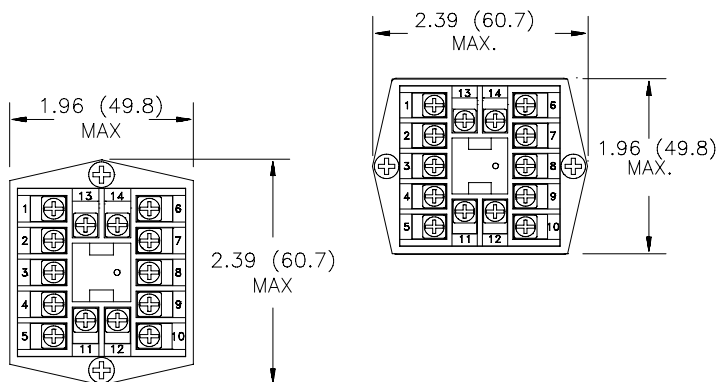$\left[45 \begin{smallmatrix} +0.6 \\ -0.0 \end{smallmatrix} \right]$
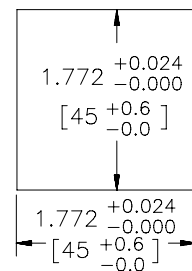
Multiple Controller Stacking

The controller is designed to allow for close spacing of multiple controllers in applications that do not require protection to NEMA 4X. Controllers can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the controller. For horizontal stacking, the panel latch screws should be at the top and bottom of the controller. The minimum spacing from centerline to centerline of controllers is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Note: When stacking controllers, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

STANDARD PANEL CUT-OUT

1.96 (49.8) MIN

IF NEMA 4 IS NOT REQUIRED, THIS PANEL MATERIAL MAY BE REMOVED.

1.96 (49.8) MAX

2.39 (60.7) MAX

2.39 (60.7) MAX

1.96 (49.8) MAX.

3.0 WIRING THE CONTROLLER

WIRING CONNECTIONS

All wiring connections are made to the rear screw terminals. When wiring the controller, use the numbers on the label and those embossed on the back of the case, to identify the position number with the proper function.

All conductors should meet voltage and current ratings for each terminal. Also, cabling should conform to appropriate standards of good installation, local codes and regulations. It is recommended that power (AC or DC) supplied to the controller be protected by a fuse or circuit breaker. Strip the wire, leaving approximately 1/4" (6 mm) bare wire exposed (stranded wires should be tinned with solder). Insert the wire under the clamping washer and tighten the screw until the wire is clamped tightly.

CONTROLLER POWER CONNECTIONS

For best results, the power should be relatively "clean" and within the specified limits. Drawing power from heavily loaded circuits or from circuits that also power loads that cycle on and off should be avoided. It is recommended that power supplied to the controller be protected by a fuse or circuit breaker.

VDC

DC+ [11]   DC− [12]

VAC

~AC [11]   ~AC [12]
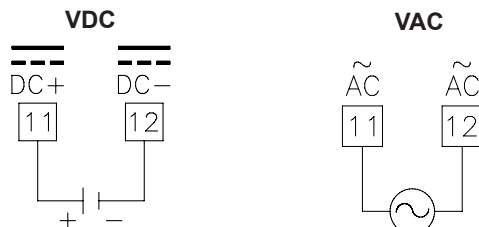
INPUT CONNECTIONS

For two wire RTDs, install a copper sense lead of the same gauge and length as the RTD leads. Attach one end of the wire at the probe and the other end to input common terminal. Complete lead wire compensation is obtained. This is the preferred method. If a sense wire is not used, then use a jumper. A temperature offset error will exist. The error may be compensated by programming a temperature offset.
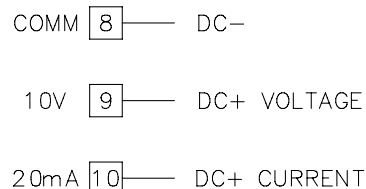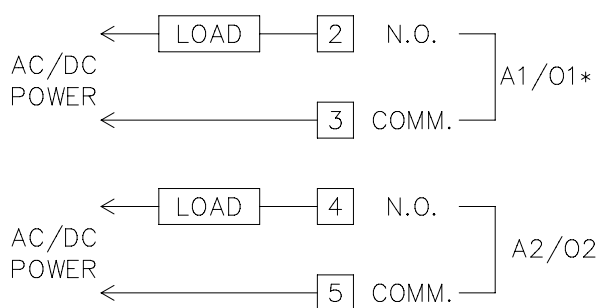
RTD and Resistance

COMM [8]
TC+ [9]
RTD [10]

Thermocouple and Millivolt

COMM [8] — TC−
TC+ [9] — TC+
RTD [10]
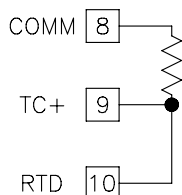
Voltage and Current
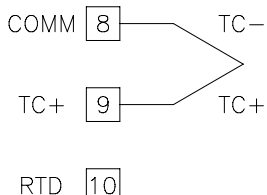
COMM [8] — DC−
10V [9] — DC+ VOLTAGE
20mA [10] — DC+ CURRENT

CONTROL AND ALARM OUTPUT CONNECTIONS

Alarm Models

AC/DC POWER — LOAD — [2] N.O.
[3] COMM. — A1/O1*

AC/DC POWER — LOAD — [4] N.O.
[5] COMM. — A2/O2

*A1 becomes main control O1, if selected for heating in the analog out models.

Main Control Relay Models

(+) O1 [6] — LOAD — AC/DC POWER
(−) O1 [7] —
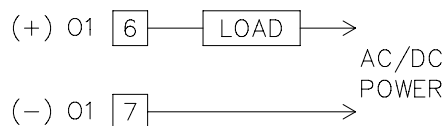
Main Control Logic/SSR Models

(+) O1 [6] — + SSR POWER UNIT AC — AC POWER
(−) O1 [7] — − AC —

ANALOG DC OUTPUT CONNECTIONS

+ V/I [6] — CONTROLLER, RECORDER
− V/I [7]
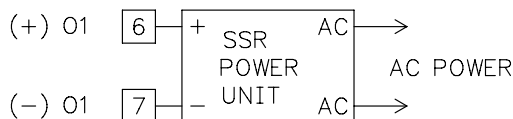
USER INPUT CONNECTIONS

USER INPUT [1] — o o — [8] COMM.

4.0 REVIEWING THE FRONT KEYS AND DISPLAY

FLASHES WHEN RAMPING
SETPOINT IS ACTIVE.

ILLUMINATES WHEN ALARM 1
OUTPUT IS ACTIVE.

ILLUMINATES WHEN ALARM 2
OUTPUT IS ACTIVE.

ILLUMINATES WHEN MAIN
CONTROL OUTPUT IS ACTIVE.

ILLUMINATES WHEN COOLING
(SECONDARY) OUTPUT IS ACTIVE.

TOP DISPLAY
DISPLAYS TEMPERATURE/PROCESS VALUE.
ALSO DISPLAYS PARAMETER NAME IN
CONFIGURATION LOOP.

ILLUMINATES WHEN °F or °C
IS SELECTED. (T16 ONLY)

ILLUMINATES WHEN PERCENT
IS SELECTED. (P16 ONLY)

ILLUMINATES WHEN CONTROLLER
IS IN MANUAL MODE.

ILLUMINATES WHEN OUTPUT POWER
PERCENTAGE IS SHOWN.

BOTTOM DISPLAY
DISPLAYS SETPOINT OR % OUTPUT POWER.
ALSO DISPLAYS PARAMETER NAME AND VALUE
IN DISPLAY AND HIDDEN LOOPS OR
PARAMETER VALUE IN CONFIGURATION LOOP.

FRONT PANEL KEYS

The F1 key is pressed to exit (or escape) directly to the start of the Display Loop. While in the Display Loop, the F1 key can be pressed to activate its programmed function.

The Loop key is pressed to advance to the next parameter, to activate a changed selection/value, and when held for three seconds, enter the Hidden Loop.

The Arrow keys are used to scroll through parameter selections/values and in the Configuration Loop they are used to scroll to the appropriate Parameter Module.

5.0 PROGRAMMING: DISPLAY LOOP

DISPLAY LOOP

5P	OP %PW	ProP	Intt	dErt	AL-1	AL-2
SETPOINT VALUE	OUTPUT POWER	PROPORTIONAL BAND	INTEGRAL TIME	DERIVATIVE TIME	ALARM1 VALUE	ALARM2 VALUE
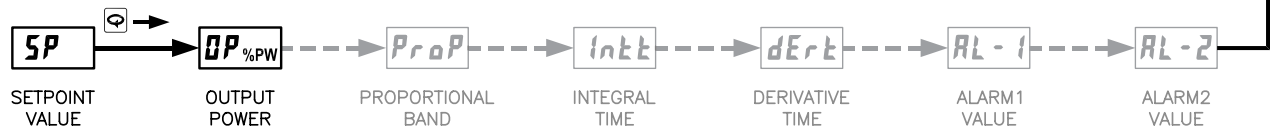
Note: Setpoint and Output Power are the only parameters visible in the Display Loop with Factory Settings. The remaining parameters can be selected for the Display Loop within Module 3.
Parameter availability is model and programming dependent.

FRONT DISPLAY

TOP DISPLAY
TEMP/PROCESS   240 °F

BOTTOM DISPLAY   AL-1
PARAMETER
SELECTION/VALUE   0
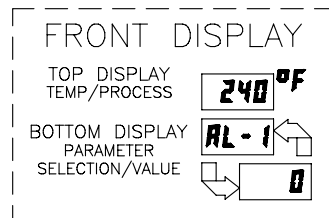
F1 ENDS AND RETURNS TO START OF DISPLAY LOOP.
    AT START PERFORMS F1 FUNCTION.

    ADVANCES TO NEXT PARAMETER.

    CHANGES SELECTION/VALUE.

DISPLAY LOOP

At power up, all display segments light, and then the programmed input type and the controller's software version will flash. Then the Temperature/Process Value is shown in the top display, and the Setpoint Value is shown in the bottom display. This is the Display Loop. If the Setpoint is hidden or locked, the Display Loop will default to Output Power. If Output Power is also hidden or locked out, the bottom display is blank. During programming, the F1 key can be pressed to return the controller to this point. (Only in the Display Loop will the F1 key perform the user *F1 In* function programmed in Input Module *1- In*.)

When the Loop key is pressed the controller advances to the next parameter in the Display Loop. Except for Setpoint and % Output Power, the bottom display alternates between the parameter name and its selection/value. The arrow keys are pressed to change the selection/value for the shown parameter. The new selection/value is activated when the Loop key is pressed. Display Loop parameters may be locked out or hidden in Lockout Module *3-LC*. Some parameters are model and programming dependent.

The values shown for the displays are the factory settings.

SETPOINT VALUE (SP1) *

```
 SP
    0  T16
  0.0  P16
```

-999 to 9999

SETPOINT VALUE (SP2) *

```
 SP
   20  T16
  2.0  P16
```

-999 to 9999

Typically, the controller is operating with the Setpoint value in the bottom display. There is no annunciator nor parameter indication for Setpoint in the Display Loop. The parameter name alternates with the setpoint value in the Hidden Loop. The Setpoint value can be changed, activated and stored by pressing the arrow keys. This is the only parameter that can be configured as read only in the Display Loop, but read/write in the Hidden Loop. It is possible to store a second Setpoint value that can be selected in the Hidden Loop, by the F1 key or the user input. Both Setpoint values are limited by the Setpoint Low and High Limits in Input Module 1-in.

% OUTPUT POWER *

```
 OP
  0.0
```

-100 to 100.0

The % Output Power is shown with the %PW annunciator. The parameter name alternates with the % Output Power value in the Hidden Loop. While the controller is in Automatic Mode, this value is read only. When the controller is placed in Manual Mode, the value can be changed, activated and stored by pressing the arrow keys. For more details on % Output Power, see Control Mode Explanations.

OUTPUT POWER OFFSET

```
OPOF
  0.0
```

-100 to 100.0

When the Integral Time is set to zero and the controller is in the Automatic Mode, this parameter will appear after % Output Power. It is also shown with the %PW annunciator illuminated. The power offset is used to shift the proportional band to compensate for errors in the steady state. If Integral Action is later invoked, the controller will re-calculate the internal integral value to provide "bumpless" transfer and Output Power Offset will not be necessary.

PROPORTIONAL BAND

```
ProP
  4.0
```

0.0 to 999.9
(% of full input range)

The proportional band should be set to obtain the best response to a process disturbance while minimizing overshoot. A proportional band of 0.0% forces the controller into On/Off Control with its characteristic cycling at Setpoint. For more information, see Control Mode and PID Tuning Explanations.

INTEGRAL TIME

```
Intt
  120
```

0 to 9999 seconds

Integral action shifts the center point position of the proportional band to eliminate error in the steady state. The higher the integral time, the slower the response. The optimal integral time is best determined during PID Tuning. If time is set to zero, the previous Integral output power value is maintained. Offset Power can be used to provide Manual Reset.

DERIVATIVE TIME

```
dErt
   30
```

0 to 9999 seconds per repeat

Derivative time helps to stabilize the response, but too high of a derivative time, coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. Setting the time to zero disables derivative action.

ALARM 1 VALUE

```
AL-1
    0  T16
  0.0  P16
```

-999 to 9999

On models with alarms, the value for Alarm 1 can be entered here. The value is either absolute (absolute alarm types) or relative to the Setpoint value (deviation and band alarm types.) When Alarm 1 is programmed for HEAt or nonE, this parameter is not available. For more details on alarms, see Alarm Module 4-AL.

ALARM 2 VALUE

```
AL-2
    0  T16
  0.0  P16
```

-999 to 9999

On models with alarms, the value for Alarm 2 can be entered here. The value is either absolute (absolute alarm types) or relative to the Setpoint value (deviation and band alarm types.) When Alarm 2 is programmed for Cool or nonE, this parameter is not available. For more details on alarms, see the Alarm Module 4-AL.

* Alternating indication only used in the Hidden Loop.

# 6.0 PROGRAMMING: HIDDEN LOOP

To enter Hidden Loop, press ⊘ for 3 seconds.

HIDDEN LOOP
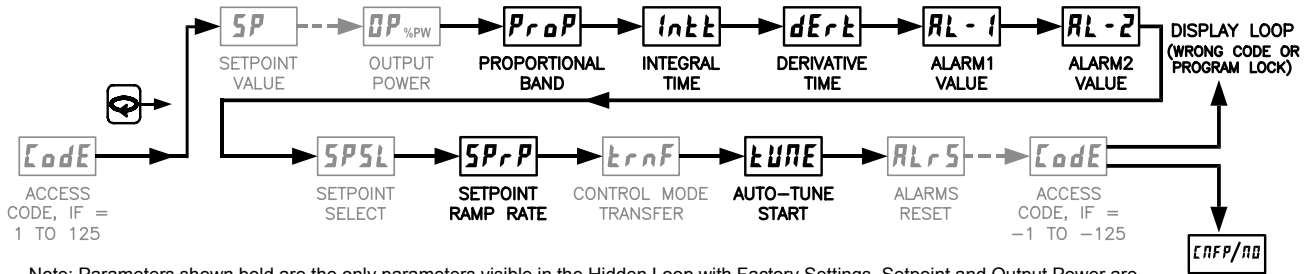
Note: Parameters shown bold are the only parameters visible in the Hidden Loop with Factory Settings. Setpoint and Output Power are factory set for the Display Loop. The remaining parameters can be selected for the Hidden Loop within Module 3.
Parameter availability is model and programming dependent.
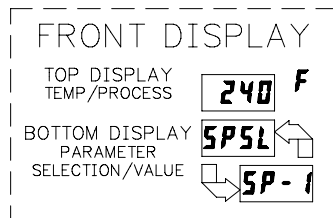

F1 ⟵ ENDS AND RETURNS TO START OF DISPLAY LOOP.

⊘ ADVANCES TO NEXT PARAMETER.

▲ ▼ CHANGES SELECTION/VALUE.

HIDDEN LOOP

When ⊘ is pressed and held for three seconds, the controller advances to the Hidden Loop. The Temperature/Process Value is shown in the top display. The bottom display alternates between the parameter and its selection/value. ▲ or ▼ is pressed to change the selection/value for the shown parameter. The new selection/value is activated after ⊘ is pressed. When ⟵ is pressed, the controller returns to the Display Loop and stores changed selection/values to permanent memory. Hidden Loop parameters may be locked out in Lockout Module 3-LC. Some parameters are model and programming dependent.

ACCESS CODE

CodE / 0   1 to 125

If the Access Code is set from 1 to 125, in Lockout Module 3-LC, Access Code will appear here. By entering the proper Code, access to the Hidden Loop is permitted. With the factory setting of 0, Access Code will not appear in the Hidden Loop. A universal code of 111 can be entered to gain access, independent of the programmed code number.

SETPOINT SELECT

SPSL / SP1   SP1 or SP2

The SPSL function allows the operator to switch from or to, setpoint 1 and setpoint 2. In the Display Loop, there is no annunciator indicating the selected Setpoint, however, the selected Setpoint value is displayed and activated.

SETPOINT RAMP RATE

SPrP / 0.0   0.0 to 999.9

The setpoint ramp rate can reduce sudden shock to the process and reduce overshoot on startup or after setpoint changes, by ramping the setpoint at a controlled rate. R annunciator flashes while ramping. With the T16, the ramp rate is always in tenths of degrees per minute, regardless of the resolution chosen for the process display. With the P16, the ramp rate is in least-significant (display units) digits per minute. A value of 0.0 or 0 disables setpoint ramping. Once the ramping setpoint reaches the target setpoint, the setpoint ramp rate disengages until the setpoint is changed again. If the ramp value is changed during ramping, the new ramp rate takes effect. If the setpoint is ramping prior to starting Auto-Tune, the ramping is suspended during Auto-Tune and then resumed afterward. Deviation and band alarms are relative to the target setpoint, not the ramping setpoint. A slow process may not track the programmed setpoint rate. At power up, the ramping setpoint is initialized at the ambient temperature/process value.

CONTROL MODE TRANSFER

trnF / Auto   Auto USEr

In Automatic Mode, the percentage of Output Power is automatically determined by the controller. In Manual/User USEr Mode, the percentage of Output Power is adjusted manually while in the Display Loop. The Control Mode can also be transferred through the F1 Key or User Input. For more information, see Control Mode Explanations.

`tUNE` ⬆
⬇ `NO`

`NO` `YES`

The Auto-Tune procedure of the controller sets the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Output Dampening Time, and Relative Gain (Heat/Cool) values appropriate to the characteristics of the process. This parameter allows front panel starting `YES` or stopping `NO` of Auto-Tune. For more information, see PID Tuning Explanations.

ALARMS RESET

`ALrS` ⬆
⬇ `1-2`

`1-2`

With alarm models, the alarms can be manually reset. The up key resets Alarm 1 and the down key resets Alarm 2.

ACCESS CODE

`CodE` ⬆
⬇ `0`

`-1` to `-125`

If the Access Code is set from -1 to -125, in Lockout Module `3-LC`, Access Code will appear here. By entering the proper Code, access to the Configuration Loop is permitted (with a negative Code value, the Hidden Loop can be accessed without the use of a code). With the factory setting of 0 or with an active User Input configured for Program Lock (`PLOC`), Access Code will not appear here. An active user input configured for Program Lock (`PLOC`) always locks out the Configuration Loop, regardless of Access Code.
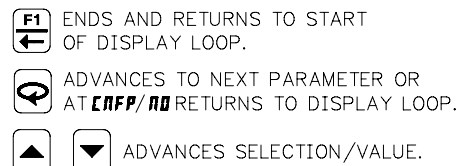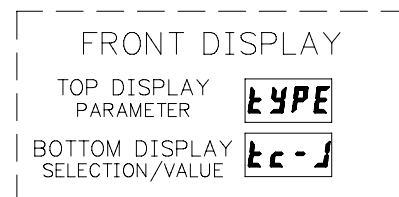
7.0 PROGRAMMING: CONFIGURATION LOOP

CONFIGURATION LOOP
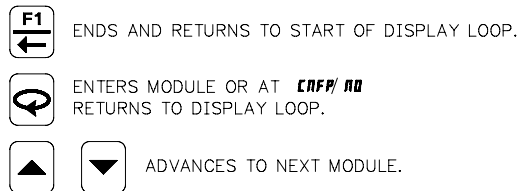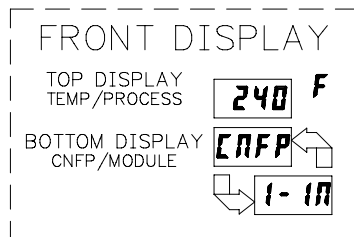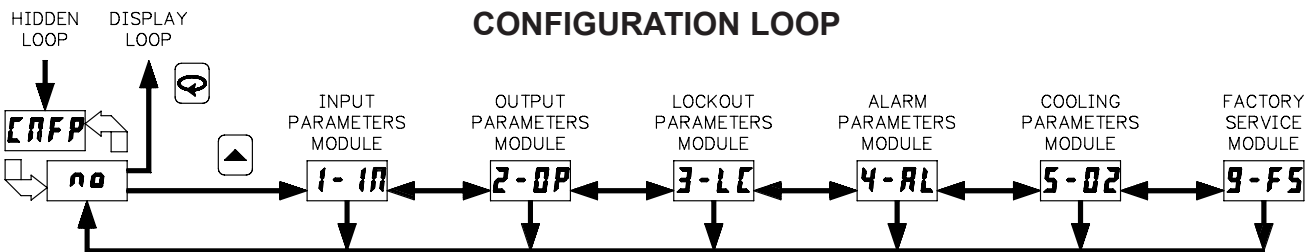
To access the Configuration Loop, press the up key when `CNFP/NO` is displayed in the Hidden Loop. The arrow keys are used to select the parameter module (1-9). To enter a specific module press ⟳ while the module number is displayed. In the Configuration Loop, `CNFP` will alternate with the parameter number in the bottom display. The Temperature/Process Value is shown in the top display.
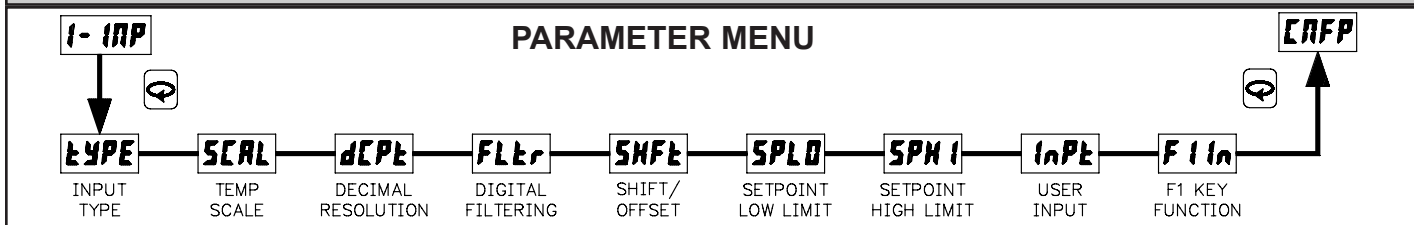
After entering a parameter module, press ⟳ to advance through the parameter names in the module. To change a parameter's selection/value, press the arrow keys while the parameter is displayed. In the modules, the top display shows the parameter name, and the bottom display shows the selection/value. Use ⟳ to enter any selection/values that have been changed. The change is not committed to permanent memory until the controller is returned to the Display Loop. If a power loss occurs before returning to the Display Loop, the new values must be entered again.

At the end of each module, the controller returns to `CNFP/NO`. At this location, pressing ⟳ again returns the display to the the Display Loop. Pressing the Up key allows re-entrance to the Configuration Loop. Whenever ⬅ is pressed, `End` momentarily appears as the parameters are stored to permanent memory and the controller returns to the Display Loop.

PARAMETER MENU

| `1- INP` | | | | | | | | | `CNFP` |

`tYPE` — `SCAL` — `dCPt` — `FLtr` — `SHFt` — `SPLO` — `SPH1` — `InPt` — `F1 In`

| INPUT TYPE | TEMP SCALE | DECIMAL RESOLUTION | DIGITAL FILTERING | SHIFT/ OFFSET | SETPOINT LOW LIMIT | SETPOINT HIGH LIMIT | USER INPUT | F1 KEY FUNCTION |

INPUT TYPE

`tYPE`
`tc-J`

SELECTION	TYPE	SELECTION	TYPE
`tc-t`	T TC	`tc-N`	N TC
`tc-E`	E TC	`tc-C`	C TC
`tc-J`	J TC	`L IN`	Linear mV
`tc-Y`	K TC	`r385`	RTD 385
`tc-r`	R TC	`r392`	RTD 392
`tc-5`	S TC	`r672`	RTD 672
`tc-b`	B TC	`rL IN`	Linear Ohms

Select the input type that corresponds to the input sensor.

TEMPERATURE SCALE

`SCAL`
`oF`

°F Fahrenheit
°C Celsius

Select either degrees Fahrenheit or Celsius. For linear mV and ohms input types, this has no effect. If changed, adjust related parameter values, as the controller does not automatically convert them.

DECIMAL RESOLUTION

`dCPt`
`0`

`0` to `0.0` for temperature and resistance inputs
`0.00` for mV inputs

Select whole degrees, or tenths of degrees for Temperature display, Setpoint values, and related parameters. For Linear Resistance inputs `rL IN`, the same parameter selections apply in ohms or tenths of an ohm. For mV inputs `L IN`, only hundredths of a mV resolution is available.

DIGITAL FILTERING

`FLtr`
`1`

`0` = least to `4` = most

The filter is an adaptive digital filter that discriminates between measurement noise and actual process changes. If the signal is varying too greatly due to measurement noise, increase the filter value. If the fastest controller response is needed, decrease the filter value.

SHIFT/OFFSET

`SHFt`
`0`

`-999` to `9999` degrees

This value offsets the controller's temperature display value by the entered amount. This is useful in applications in which the sensor cannot provide the actual temperature signal due to mounting constraints, inaccuracy, etc.

SETPOINT LOW LIMIT

`SPLO`
`0`

`-999` to `9999`

The controller has a programmable low setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set below the safe operating area of the process.

SETPOINT HIGH LIMIT

`SPH1`
`9999`

`-999` to `9999`

The controller has a programmable high setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set above the safe operating area of the process.

USER INPUT FUNCTION (OPTIONAL)

`InPt`
`PLOC`

SELECTION	FUNCTION	SELECTION	FUNCTION
`NONE`	No Function	`SPt`	Setpoint 1 or 2 Select
`PLOC`	Program Lock	`SPrP`	Setpoint Ramp Disable
`ILOC`	Integral Action Lock	`ALr5`	Reset Both Alarms
`trnF`	Auto/Manual Select		

The controller performs the selected User Input function (User Input available only on models with alarms), when the User terminal 1 is connected (pulled low) to Common terminal 8.

No Function: No function is performed.

Program Lock: The Configuration Loop is locked, as long as activated (maintained action).

Integral Action Lock: The integral action of the PID computation is disabled (frozen), as long as activated (maintained action).

Auto/Manual Select: This function selects (maintained action) Automatic (open) or Manual Control (activated).

Setpoint 1 or 2 Select: This function selects (maintained action) Setpoint 1(open) or Setpoint 2 (activated) as the active setpoint.

Setpoint Ramp Disable: The setpoint ramping feature is disabled, as long as activated (maintained action). Any time the user input is activated with a ramp in process, ramping is aborted.

Reset Alarms: Active alarms are reset, as long as activated (maintained action). Active alarms are reset until the alarm condition is cleared and triggered again (momentary action).

F1 KEY FUNCTION

```
F 1 In
NONE
```

SELECTION	FUNCTION	SELECTION	FUNCTION
NONE	No Function	A 1r5	Reset Alarm 1
trnF	Auto/Manual Select	A2r5	Reset Alarm 2
SPt	Setpoint 1 or 2 Select	ALr5	Reset Both Alarms

The controller performs the selected F1 Key Function, when [F1] is pressed while in the Display Loop. In any other loop or module location, pressing [F1] will perform an escape to the Display Loop.
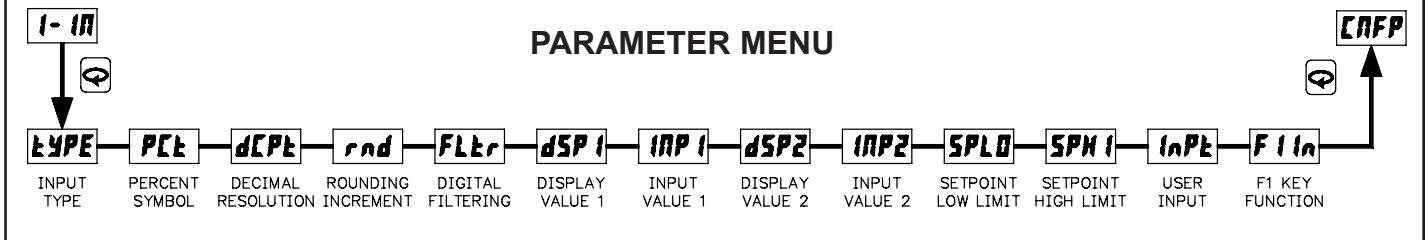
No Function: No function is performed.

Auto/Manual Select: This function toggles (momentary action) the controller between Automatic and Manual Control.

Setpoint 1 or 2 Select: This function toggles (momentary action) the controller between Setpoint 1 and Setpoint 2.

Reset Alarms: This function can be used to reset one or both of the alarms when activated (momentary action) The alarm will remain reset until the alarm condition is cleared and triggered again.

7.1 MODULE 1 - INPUT PARAMETERS (1- IN) P16 ONLY

```
1- IN                    PARAMETER MENU                    CNFP
```

tYPE — PCt — dCPt — rnd — FLtr — dSP 1 — INP 1 — dSP2 — INP2 — SPLO — SPH 1 — InPt — F 1 In

| INPUT TYPE | PERCENT SYMBOL | DECIMAL RESOLUTION | ROUNDING INCREMENT | DIGITAL FILTERING | DISPLAY VALUE 1 | INPUT VALUE 1 | DISPLAY VALUE 2 | INPUT VALUE 2 | SETPOINT LOW LIMIT | SETPOINT HIGH LIMIT | USER INPUT | F1 KEY FUNCTION |

INPUT TYPE

```
tYPE
Curr
```

SELECTION	TYPE
Curr	Current
UOLt	Voltage

Select the input type that corresponds to the input signal.

PERCENT ANNUNCIATOR

```
PCt
NO
```

YES On
NO Off

This only illuminates the % annunciator. It does not perform any type of percent function, but is useful in applications that have been scaled in percent.

DECIMAL RESOLUTION

```
dCPt
0,0
```

0   0,0   0,00   0,000

This selection affects the decimal point placement for the Process value, and related parameters.

ROUNDING INCREMENT

```
rnd
0,1
```

1 to 100

In steps of 1 least significant digit, regardless of decimal point.

Rounding selections other than 1 cause the process value display to round to the nearest rounding increment selected. (For example, rounding of 5 causes 122 to round to 120 and 123 to round to 125.) Rounding starts at the least significant digit of the process value. Setpoint values, Setpoint limits, Alarm values, Input Scaling values, and Analog Scaling values are not affected by rounding.

DIGITAL FILTERING

```
FLtr
1
```

0 = least to 4 = most

The filter is an adaptive digital filter that discriminates between measurement noise and actual process changes. If the signal is varying too greatly due to measurement noise, increase the filter value. If the fastest controller response is needed, decrease the filter value.

SCALING

To scale the controller, two scaling points are necessary. Each scaling point has a coordinate pair of Display Values and Input Values. It is recommended that the two scaling points be at the low and high ends of the input signal being measured. Process value scaling will be linear between and continue past the entered points to the limits of the input range. (Factory settings example will display 0.0 at 4.00 mA input and display 100.0 at 20.00 mA input.) Reverse acting indication can be accomplished by reversing the two signal points or the Display value points, but not both. If both are reversed, forward (normal) acting indication will occur. In either case, do not reverse the input wires to change the action.

DISPLAY VALUE SCALING POINT 1

```
dSP 1
0,0
```

-999 to 9999

Enter the first coordinate Display Value by using the arrow keys.

INPUT VALUE SCALING POINT 1

```
INP 1
4,00
```

0,00 to 20,00 mA
0,00 to 10,00 V

For Key-in Method, enter the first coordinate Input Value by using the arrow keys. To allow the P16 to "learn" the signal, use the Applied Method. For Applied Method, press [F1]. The ° annunciator is turned on to indicate the applied method. Adjust the applied signal level externally until the appropriate value appears under INP 1. Using either method, press [↻] to store the value for INP 1. (The controller can be toggled back to the Key-in Method by pressing [F1] before [↻].)

DISPLAY VALUE SCALING POINT 2

```
dSP2
100,0
```

-999 to 9999

Enter the second coordinate Display Value by using the arrow keys.

INPUT VALUE SCALING POINT 2

`INP2`	0.00 to 20.00 mA
`20.00`	0.00 to 10.00 V

For Key-in Method, enter the second coordinate Input Value by using the arrow keys. To allow the P16 to "learn" the signal, use the Applied Method. For Applied Method, press ⏎. The ° annunciator is turned on to indicate the applied method. Adjust the applied signal level externally until the appropriate value appears under `INP2`. Using either method, press ⊙ to store the value for `INP2`. (The controller can be toggled back to the Key-in Method by pressing ⏎ before ⊙.)

SETPOINT LOW LIMIT

`SPLO`	-999 to 9999
`0.0`	

The controller has a programmable low setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set below the safe operating area of the process.

SETPOINT HIGH LIMIT

`SPHI`	-999 to 9999
`999.9`	

The controller has a programmable high setpoint limit value to restrict the setting range of the setpoint. Set the limit so that the setpoint value cannot be set above the safe operating area of the process.

USER INPUT FUNCTION (OPTIONAL)

`InPt`
`PLOC`

SELECTION	FUNCTION	SELECTION	FUNCTION
`NONE`	No Function	`SPt`	Setpoint 1 or 2 Select
`PLOC`	Program Lock	`SPrP`	Setpoint Ramp Disable
`ILOC`	Integral Action Lock	`ALrS`	Reset Both Alarms
`trnF`	Auto/Manual Select		

The controller performs the selected User Input function (User Input available only on models with alarms), when the User terminal 1 is connected (pulled low) to Common terminal 8.

No Function: No function is performed.
Program Lock: The Configuration Loop is locked, as long as activated (maintained action).
Integral Action Lock: The integral action of the PID computation is disabled (frozen), as long as activated (maintained action).
Auto/Manual Select: This function selects (maintained action) Automatic (open) or Manual Control (activated).
Setpoint 1 or 2 Select: This function selects (maintained action) Setpoint 1(open) or Setpoint 2 (activated) as the active setpoint.
Setpoint Ramp Disable: The setpoint ramping feature is disabled, as long as activated (maintained action). Any time the user input is activated with a ramp in process, ramping is aborted.
Reset Alarms: Active alarms are reset, as long as activated (maintained action). Active alarms are reset until the alarm condition is cleared and triggered again (momentary action).

F1 KEY FUNCTION

`F1In`
`NONE`

SELECTION	FUNCTION	SELECTION	FUNCTION
`NONE`	No Function	`A1rS`	Reset Alarm 1
`trnF`	Auto/Manual Select	`A2rS`	Reset Alarm 2
`SPt`	Setpoint 1 or 2 Select	`ALrS`	Reset Both Alarms

The controller performs the selected F1 key function, when ⏎ is pressed while in the Display Loop. In any other loop or module location, pressing ⏎ will perform an escape to the Display Loop.
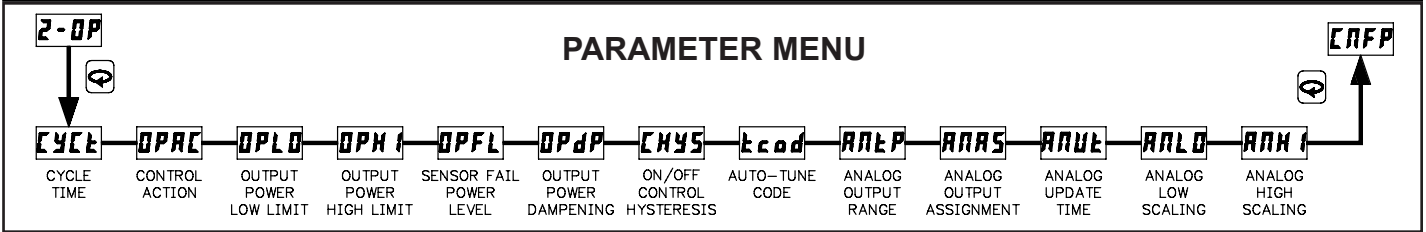
No Function: No function is performed.
Auto/Manual Select: This function toggles (momentary action) the controller between Automatic and Manual Control.
Setpoint 1 or 2 Selection: This function toggles (momentary action) the controller between Setpoint 1 and Setpoint 2.
Reset Alarms: This function can be used to reset one or both of the alarms when activated (momentary action). The alarm will remain reset until the alarm condition is cleared and triggered again.

2-OP →

PARAMETER MENU

CNFP

CYCL	OPAC	OPLO	OPHI	OPFL	OPdP	CHYS	tcod	ANtP	ANAS	ANUt	ANLO	ANHI
CYCLE TIME	CONTROL ACTION	OUTPUT POWER LOW LIMIT	OUTPUT POWER HIGH LIMIT	SENSOR FAIL POWER LEVEL	OUTPUT POWER DAMPENING	ON/OFF CONTROL HYSTERESIS	AUTO−TUNE CODE	ANALOG OUTPUT RANGE	ANALOG OUTPUT ASSIGNMENT	ANALOG UPDATE TIME	ANALOG LOW SCALING	ANALOG HIGH SCALING

CYCLE TIME

CYCL / **2.0**

0.0 to 250.0 seconds

The Cycle Time is entered in seconds with one tenth of a second resolution. It is the total time for one on and one off period of the time proportioning control output O1. With time proportional control, the percentage of power is converted into an output on-time relative to the cycle time value set. (If the controller calculates that 65% power is required and a cycle time of 10.0 seconds is set, the output will be on for 6.5 seconds and off for 3.5 seconds.) For best control, a cycle time equal to one-tenth or less, of the natural period of oscillation of the process is recommended. When using the Analog Output signal for control, the Cycle Time setting has no effect. If the O1 output is not being used, a cycle time of 0 can be entered to prevent the output and indicator from cycling.

CONTROL ACTION

OPAC / **rEu**

drct Direct (cooling)
rEu Reverse (heating)

This determines the control action for the PID loop. Programmed for direct action (cooling), the output power will increase if the Process value is above the Setpoint value. Programmed for reverse action (heating), the output power decreases when the Process Value is above the Setpoint Value. For heat and cool applications, this is typically set to reverse. This allows O1 or A1 (models with Analog Output) to be used for heating, and A2/O2 to be used for cooling.

OUTPUT POWER LOWER LIMIT

OPLO / **0**

0 to 100 percent O1
-100 to 100 percent O1/O2

This parameter may be used to limit controller power at the lower end due to process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. When the controller is in Manual Control Mode, this limit does not apply.

OUTPUT POWER UPPER LIMIT

OPHI / **100**

0 to 100 percent O1
-100 to 100 percent O1/O2

This parameter may be used to limit controller power at the upper end due to process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. When the controller is in Manual Control Mode, this limit does not apply.

SENSOR FAIL POWER LEVEL

OPFL / **0**

0 to 100 percent O1
-100 to 100 percent O1/O2

This parameter sets the power level for the control outputs in the event of a sensor failure. If Alarm 2 is not selected for cooling, the range is from 0% (O1 output full off) to 100% (O1 output full on). If A2 is selected for cooling, the range is from -100 to +100%. At 0%, both O1 and O2 are off; at 100%, O1 is on; and at -100%, O2 is on. The alarm outputs are upscale drive with an open sensor, and downscale drive with a shorted sensor (RTD only), independent of this setting. Manual Control overrides the sensor fail preset.

OUTPUT POWER DAMPENING

OPdP / **3** T16 / **1** P16

0 to 250 seconds

The Dampening Time, entered as a time constant in seconds, dampens (filters) the calculated output power. Increasing the value increases the dampening effect. Generally, dampening times in the range of one-twentieth to one-fiftieth of the controller's integral time (or process time constant) are effective. Dampening times longer than these may cause controller instability due to the added lag effect.

ON/OFF CONTROL HYSTERESIS

CHYS / **2** T16 / **0.2** P16

1 to 250

The controller can be placed in the On/Off Control Mode by setting the Proportional Band to 0.0%. The On/Off Control Hysteresis (balanced around the setpoint) eliminates output chatter. In heat/cool applications, the control hysteresis value affects both Output O1 and Output O2 control. It is suggested to set the hysteresis band to Factory Setting prior to starting Auto-Tune. After Auto-Tune, the hysteresis band has no effect on PID Control. On/Off Control Hysteresis is illustrated in the On/Off Control Mode section.

AUTO-TUNE CODE

tcod / **0**

0 fastest to 2 slowest

Prior to starting Auto-Tune, this code should be set to achieve the necessary dampening level under PID Control. This value allows customization of the PID values that Auto-Tune will calculate. For the process to be controlled aggressively (fastest process response with possible overshoot), set the Auto-Tune Code to 0. For the process to be controlled conservatively (slowest response with the least amount of overshoot), set this value to 2. If the Auto-Tune Code is changed, Auto-Tune needs to be reinitiated for the changes to affect the PID settings. For more information, see PID Tuning Explanations Section.

ANALOG OUTPUT RANGE (OPTIONAL)

ANtP	0-10 V 0-20 mA
4-20	4-20 mA

Select the type of output and range. The Analog output jumpers are factory set to current. They must be changed if voltage output is desired. The Analog output can be calibrated to provide up to approximately 5% over range operation (0 mA current can only go slightly negative).

ANALOG OUTPUT ASSIGNMENT (OPTIONAL)

ANAS	**OP** Main Control % Output Power
OP	**InP** Input Signal Retransmission
	SP Active Setpoint

This setting selects the parameter that the Analog Output will retransmit or track.

ANALOG UPDATE TIME (OPTIONAL)

ANUt	0 to 250 seconds
0	0 = update rate of 0.1 second

The update time of the Analog Output can be used to reduce excess valve actuator or pen recorder activity.

ANALOG LOW SCALING (OPTIONAL)

ANLO	-999 to 9999
0.0	

The Analog Output assignment value that corresponds to 0 V, 0 mA or 4 mA output as selected.

ANALOG HIGH SCALING (OPTIONAL)

ANH1	-999 to 9999
100.0	

The Analog Output assignment value that corresponds to 10 V or 20 mA output as selected. An inverse acting output can be achieved by reversing the low and high scaling points.

7.3 MODULE 3 - LOCKOUT PARAMETERS (3-LC)

PARAMETER MENU

| 3-LC | | | | | | | | | CNFP |

SP	OP	P Id	AL	CodE	SPSL	SPrP	trnF	tUNE	ALrS
SETPOINT ACCESS	OUTPUT POWER ACCESS	PID VALUES ACCESS	ALARM VALUES ACCESS	ACCESS CODE	SETPOINT SELECT ACCESS	SETPOINT RAMP ACCESS	CONTROL TRANSFER ACCESS	AUTO-TUNE START ACCESS	RESET ALARMS ACCESS
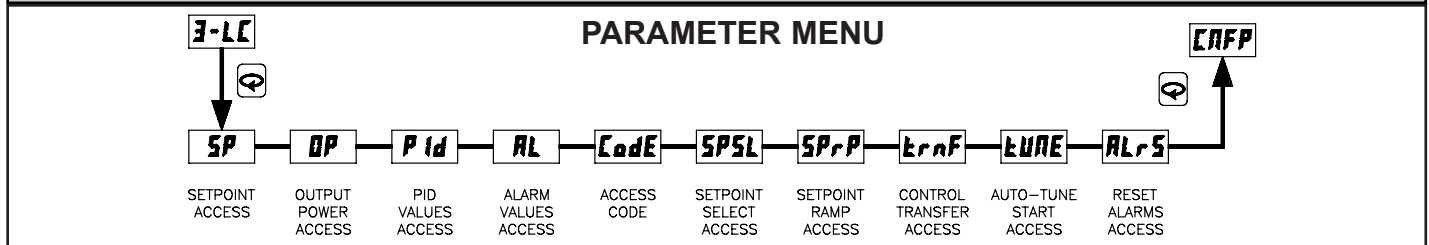
SELECTION	DESCRIPTION
d ISP	Display: accessible in Display Loop.
H IdE	Hide: accessible in Hidden Loop.
LOC	Locked: not accessible in either loop.
dSPr (SP only)	Display/read: read only in Display Loop, but read/write in Hidden Loop.

The following parameters can be configured for **LOC**, **H IdE**, and **d ISP**.

SETPOINT ACCESS	OUTPUT POWER ACCESS	PID VALUES ACCESS	ALARM VALUES ACCESS
SP	OP	P Id	AL
d ISP	d ISP	H IdE	H IdE

ACCESS CODE

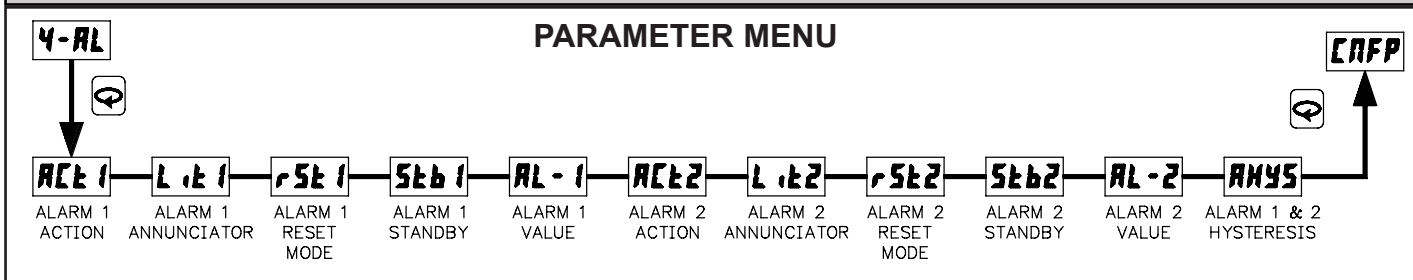|	
CodE	-125 to 125
0	

0	Full access to Display, Hidden, and Configuration Loops
-1 to -125	Code necessary to access Configuration Loop only.
1 to 125	Code necessary to access Hidden and Configuration Loops.

The following parameters can be configured for **LOC** or **H IdE** only.

SETPOINT SELECT ACCESS	SETPOINT RAMP ACCESS	CONTROL TRANSFER ACCESS
SPSL	SPrP	trnF
LOC	H IdE	LOC

AUTO-TUNE START ACCESS	RESET ALARMS ACCESS
tUNE	ALrS
H IdE	LOC

7.4 MODULE 4 - ALARM PARAMETERS (4-AL) (OPTIONAL)

PARAMETER MENU

`4-AL` → → `CNFP`

`ACt1`	`L it1`	`rSt1`	`Stb1`	`AL-1`	`ACt2`	`L it2`	`rSt2`	`Stb2`	`AL-2`	`AHYS`
ALARM 1 ACTION	ALARM 1 ANNUNCIATOR	ALARM 1 RESET MODE	ALARM 1 STANDBY	ALARM 1 VALUE	ALARM 2 ACTION	ALARM 2 ANNUNCIATOR	ALARM 2 RESET MODE	ALARM 2 STANDBY	ALARM 2 VALUE	ALARM 1 & 2 HYSTERESIS

AVAILABLE ALARM ACTIONS

`NONE`	None	No action, the remaining Alarm parameters are not available.
`AbH1`	Absolute High (balanced hysteresis)	The alarm energizes when the Process Value exceeds the alarm value + 1/2 the hysteresis value.
`AbLO`	Absolute Low (balanced hysteresis)	The alarm energizes when the Process Value falls below the alarm value -1/2 the hysteresis value.
`AuH1`	Absolute High (unbalanced hysteresis)	The alarm energizes when the Process Value exceeds the alarm value.
`AuLO`	Absolute Low (unbalanced hysteresis)	The alarm energizes when the Process Value falls below the alarm value.

`d-H1`	Deviation High	Alarm 1 and 2 value tracks the Setpoint value
`d-LO`	Deviation Low	Alarm 1 and 2 value tracks the Setpoint value
`b-1N`	Band Acting (inside)	Alarm 1 and 2 value tracks the Setpoint value
`b-ot`	Band Acting (outside)	Alarm 1 and 2 value tracks the Setpoint value
`HEAt`	Heat (A1 Analog models only)	If heating is selected, the remaining Alarm 1 parameters are not available.
`CooL`	Cool (A2 only)	If cooling is selected, the remaining Alarm 2 parameters are not available.

ALARM ACTION FIGURES

Absolute High Acting (Unbalanced Hys)

Absolute Low Acting (Balanced Hys)

Deviation High Acting (AL< 0)

Absolute Low Acting (Unbalanced Hys)

Deviation High Acting (AL > 0)

Band Outside Acting

Absolute High Acting (Balanced Hys)

Deviation Low Acting (AL > 0)

Band Inside Acting
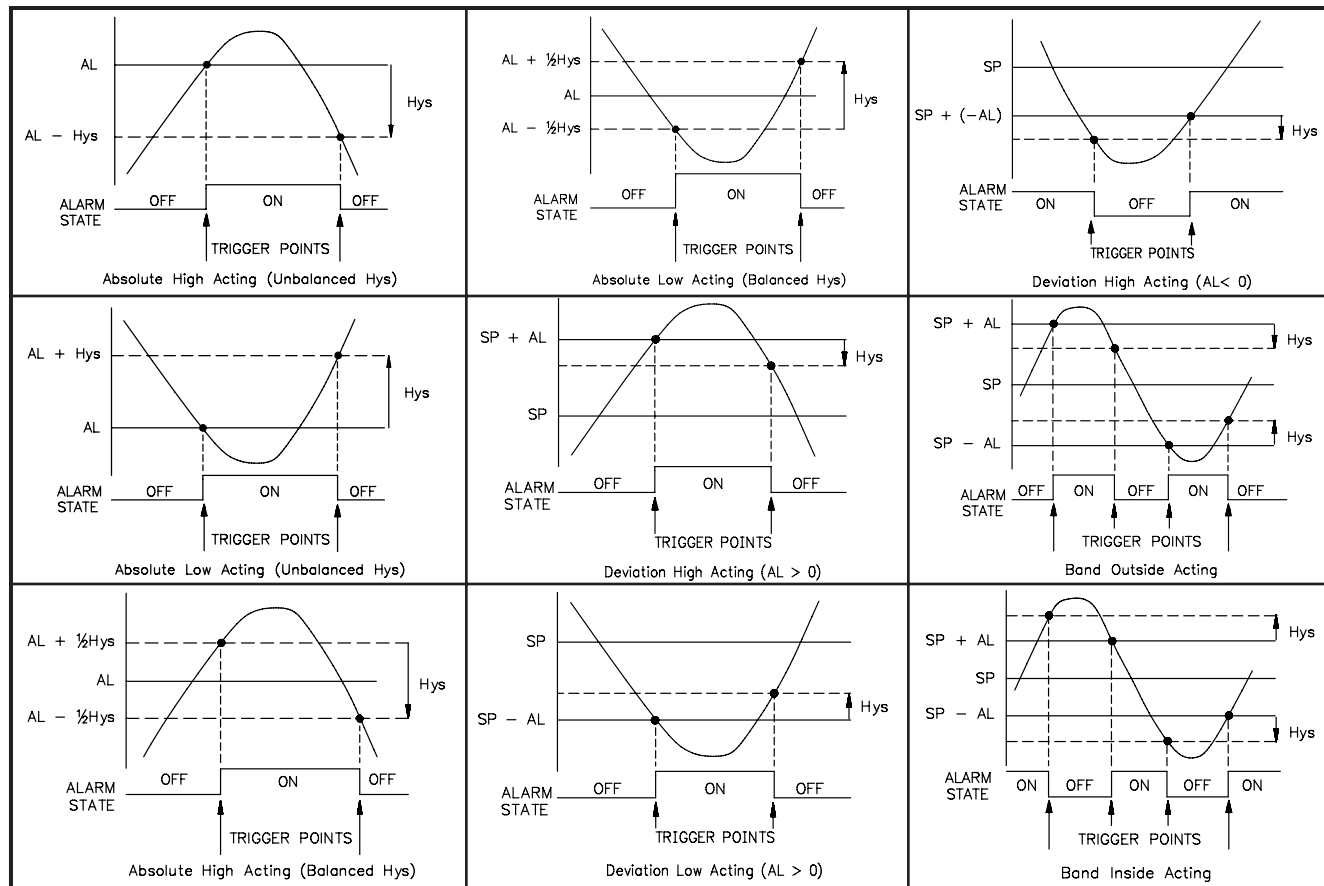
Note: Hys in the above figures refers to the Alarm Hysteresis.

ALARM ACTION ALARM 1

| `ACt1` | `NONE` `AbH1` `AbLO` `AuH1` `AuLO` |
| `AuH1` | `d-H1` `d-LO` `b-1N` `b-ot` `HEAt` |

Select the action for the alarms. See Alarm Action Figures for a visual explanation.

ALARM ANNUNCIATOR ALARM 1

| `L it1` | `nor` Normal |
| `nor` | `rEu` Reverse |

With normal selection, the alarm annunciator indicates "on" alarm output 1. With reverse selection, the alarm annunciator indicates "off" alarm output.

ALARM RESET MODE ALARM 1

| `rSt1` | `Auto` Automatic |
| `Auto` | `LAtc` Latched |

In Automatic mode, an energized alarm turns off automatically after the Temperature/Process value leaves the alarm region. In Latched mode, an energized alarm requires an F1 key or user input alarm reset to turn off. After an alarm reset, the alarm remains reset off until the trigger point is crossed again.

ALARM STANDBY ALARM 1

| `Stb1` | `YES` Standby on |
| `NO` | `NO` Standby off |

Standby prevents nuisance (typically low level) alarms after a power up or setpoint change. After powering up the controller or changing the setpoint, the process must leave the alarm region (enter normal non-alarm area of operation). After this has occurred, the standby is disabled and the alarm responds normally until the next controller power up or setpoint change.

ALARM VALUE ALARM 1

`AL - 1`	`-999` to `9999`
`0` T16	
`0.0` P16	

The alarm values are entered as process units or degrees. They can also be entered in the Display or Hidden Loops. When the alarm is configured as deviation or band acting, the associated output tracks the Setpoint as it is changed. The value entered is the offset or difference from the Setpoint.
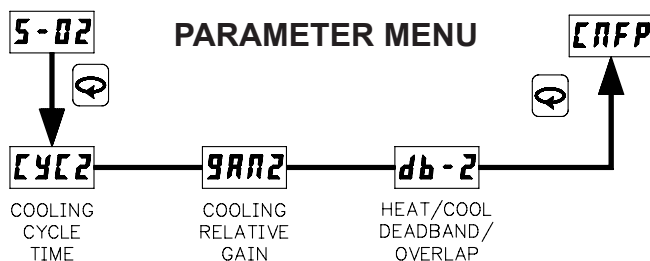
ALARM ACTION ALARM 2

| `ACt2` | `NONE` `AbH1` `AbLO` `AuH1` `AuLO` |
| `AuH1` | `d-H1` `d-LO` `b-1N` `b-ot` `Cool` |

Select the action for the alarms. See Alarm Action Figures for a visual explanation.

ALARM ANNUNCIATOR ALARM 2

| `L it2` | `nor` Normal |
| `nor` | `rEu` Reverse |

With normal selection, the alarm annunciator indicates "on" alarm output 2. With reverse selection, the alarm annunciator indicates "off" alarm output.

ALARM RESET MODE ALARM 2

| `rSt2` | `Auto` Automatic |
| `Auto` | `LAtc` Latched |

In Automatic mode, an energized alarm turns off automatically after the Temperature/Process value leaves the alarm region. In Latched mode, an energized alarm requires an F1 key or user input alarm reset to turn off. After an alarm reset, the alarm remains reset off until the trigger point is crossed again.

ALARM STANDBY ALARM 2

| `Stb2` | `YES` Standby on |
| `NO` | `NO` Standby off |

Standby prevents nuisance (typically low level) alarms after a power up or setpoint change. After powering up the controller or changing the setpoint, the process must leave the alarm region (enter normal non-alarm area of operation). After this has occurred, the standby is disabled and the alarm responds normally until the next controller power up or setpoint change.

ALARM VALUE ALARM 2

`AL - 2`	`-999` to `9999`
`20` T16	
`2.0` P16	

The alarm values are entered as process units or degrees. They can also be entered in the Display or Hidden Loops. When the alarm is configured as deviation or band acting, the associated output tracks the Setpoint as it is changed. The value entered is the offset or difference from the Setpoint.

ALARM HYSTERESIS

`AHYS`	`0` to `250`
`1` T16	
`0.1` P16	

The Hysteresis Value is either added to or subtracted from the alarm value, depending on the alarm action selected. The same value applies to both alarms. See the Alarm Action Figures for a visual explanation of how alarm actions are affected by the hysteresis.

7.5 MODULE 5 - COOLING (SECONDARY) PARAMETERS (5-02)

`5-02` → PARAMETER MENU → `CNFP`

```
CYC2        9AN2        db-2
COOLING     COOLING     HEAT/COOL
CYCLE       RELATIVE    DEADBAND/
TIME        GAIN        OVERLAP
```

To enable Cooling in Heat/Cool applications, the Alarm 2 Action must first be set for Cooling. (For P16 Controllers, the cooling output is sometimes referred to as secondary output.) When set to cooling, the output no longer operates as an alarm but operates as a cooling output. The O2 terminals are the same as A2, however a separate O2 annunciator indicates Cooling Operation. Cooling output power ranges from -100% (full cooling) to 0% (no cooling, unless a heat/cool overlap is used). The Power Limits in Output Module `2-0P` also limit the cooling power. In applications requiring only a Cooling output, the main 01 output should be used.

CYCLE TIME

`CYC2`
`2.0`

0.0 to **250.0** seconds

This cycle time functions like the O1 Output Cycle Time but allows independent cycle time for cooling. A setting of zero will keep output O2 off.

RELATIVE GAIN

`9AN2`
`1.0`

0.0 to **10.0**

This defines the gain of the cooling relative to the heating. It is generally set to balance the effects of cooling to that of heating. This is illustrated in the Heat/Cool Relative Gain Figures. A value of 0.0 places the cooling output into On/Off Control.

DEADBAND/OVERLAP

`db-2`
`0`

-999 to **9999**

This defines the overlap area in which both heating and cooling are active (negative value) or the deadband area between the bands (positive value). If a heat/cool overlap is specified, the percent output power is the sum of the heat power (O1) and the cool power (O2). If Relative Gain is zero, the cooling output operates in the On/Off Control Mode, with the On/Off Control Hysteresis `CHYS` in Output Module `2-0P` becoming the cooling output hysteresis. The function of Deadband is illustrated in the Control Mode Explanations. For most applications, set this parameter to 0.0 prior to starting Auto-Tune. After the completion of Auto-Tune, this parameter may be changed.

HEAT/COOL RELATIVE GAIN FIGURES

Heat/Cool Deadband = 0

Heat/Cool Deadband < 0

Heat/Cool Deadband > 0

18
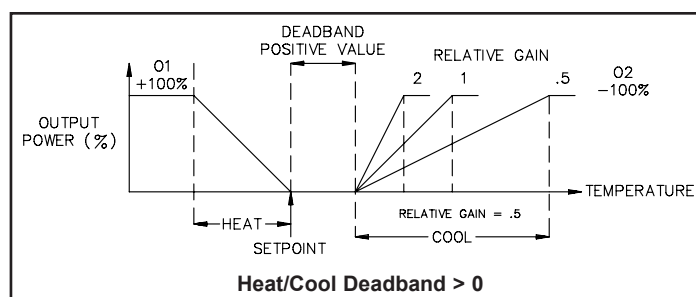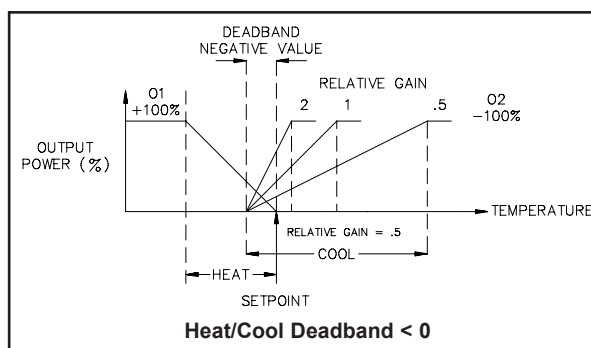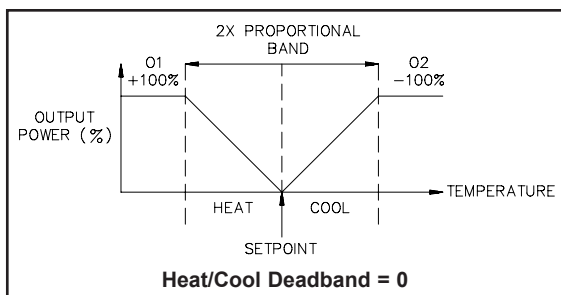
7.5 MODULE 9 FACTORY SERVICE OPERATIONS (9-FS)

9-FS	CNFP		PARAMETER MENU

FACTORY
SERVICE CODE

CALIBRATION

CodE
48

The controller is fully calibrated from the factory. Recalibration is recommended every two years by qualified technicians using appropriate equipment. Calibration may be performed by using the front panel or with the TP16KIT. The front panel method is explained below. (Refer to the TP16KIT bulletin for calibration instructions using TP16KIT cable and software.)

Calibration may be aborted by disconnecting power to the controller before exiting Factory Service Module 9-FS. In this case, the existing calibration settings remain in effect.

Note: Allow the controller to warm up for 30 minutes minimum and follow the manufacturer's warm-up recommendations for the calibration source or measuring device.

Millivolt Calibration (T16)

Millivolt calibration requires a precision voltage source with an accuracy of 0.03% (or better) connected to terminals 8 (comm.) and 9 (+). When calibrating the input, the millivolt calibration must be performed first, then the Cold Junction or RTD Resistance.

PROMPT	APPLY	FRONT PANEL ACTION
CodE		Press ▼ until 48, press ⊝.
CAL		Press ▲ for YES, press ⊝.
StP1	0.0 mV	After 5 seconds (minimum), press ⊝.
StP2	14.0 mV	After 5 seconds (minimum), press ⊝.
StP3	28.0 mV	After 5 seconds (minimum), press ⊝.
StP4	42.0 mV	After 5 seconds (minimum), press ⊝.
StP5	56.0 mV	After 5 seconds (minimum), press ⊝.

Cold Junction (T16)

Cold Junction calibration requires a thermocouple of known accuracy of types T, E, J, K, C or N (connected to terminals 8 and 9) and a calibrated external reference thermocouple probe measuring in °C with resolution to tenths. The two probes should be brought in contact with each other or in some way held at the same temperature. They should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the T16 thermocouple may be placed in a calibration bath of known temperature.) If performing the millivolt calibration prior, verify that the correct input type is configured in Input Module t-in before performing the following procedure. (After the millivolt calibration the controller will default to type J.) If using RTD only, the cold junction calibration need not be performed.

PROMPT	COMPARE	FRONT PANEL ACTION
CodE		Press ▼ until 48, press ⊝.
CAL		Press ⊝.
CJC		Press ▲ for YES, press ⊝.
	Top display to external reference	Press ▲ or ▼ to adjust the bottom display until the top process display matches the external reference then press ⊝.

RTD Resistance (T16)

RTD calibration requires a precision 277.0 ohm resistor with an accuracy of 0.1 Ω (or better). Connect a jumper between terminals 9 and 10 with a 0 ohm jumper between 9 and 8 at StP1 and the 277.0 ohm resistor between 9 and 8 at StP2. If using thermocouple only, the RTD calibration need not be performed.

PROMPT	APPLY	FRONT PANEL ACTION
CodE		Press ▼ until 48, press ⊝.
CAL		Press ⊝.
CJC		Press ⊝.
rtd		Press ▲ for YES, press ⊝.
StP1	0.0 ohm	After 5 seconds (minimum), press ⊝.
StP2	277.0 ohm	After 5 seconds (minimum), press ⊝.

Input Calibration (P16)

Process calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 10.0 V connected to terminals 8 (COMM) and 9 (+10V) and 20.00 mA connected to terminals 8 (COMM) and 10 (20mA). The current calibration can be skipped by pressing ⊝ at the not applicable prompts if using the controller for process voltage only.

PROMPT	APPLY	FRONT PANEL ACTION
CodE		Press ▼ until 48, press ⊝.
CAL		Press ▲ for YES, press ⊝.
StP1	0.0 V	After 5 seconds (minimum), press ⊝.
StP2	2.5 V	After 5 seconds (minimum), press ⊝.
StP3	5.0 V	After 5 seconds (minimum), press ⊝.
StP4	7.5 V	After 5 seconds (minimum), press ⊝.
StP5	10.0 V	After 5 seconds (minimum), press ⊝.
StPA	0.0 mA	After 5 seconds (minimum), press ⊝.
StPb	20.0 mA	After 5 seconds (minimum), press ⊝.

Analog Output Calibration (T16 and P16)

Set the controller Analog jumpers to the output type being calibrated. Connect an external meter with an accuracy of 0.05% (or better) that is capable of measuring 10.00 V or 20.00 mA to terminals 6 (+V/I) and 7 (-V/I). The voltage or current calibration that is not being used must be skipped by pressing ⊙ until End appears.

PROMPT	EXTERNAL METER	FRONT PANEL ACTION
CodE		Press ▼ until 48, press ⊙.
CAL		Press ⊙.
CJC		Press ⊙. (T16 only)
rtd		Press ⊙. (T16 only)
AACL		Press ▲ for YES, press ⊙.
C 0u	0.00 V	Press ▲ or ▼ until external meter matches listing, press ⊙.
C 10u	10.00 V	Press ▲ or ▼ until external meter matches listing, press ⊙.
C 0c	0.00 mA	Press ▲ or ▼ until external meter matches listing, press ⊙.
C 20c	20.00 mA	Press ▲ or ▼ until external meter matches listing, press ⊙.

RESTORE FACTORY SETTINGS

CodE
66

Press and hold ▲ to display CodE 66. Press ⊙. The controller will display rSEt and then return to CNFP. Press ⇄ to return to the Display Loop. This will overwrite all user settings with Factory Settings.

NOMINAL CALIBRATION SETTINGS

CodE
77

Press and hold ▲ to display CodE 77. Press ⊙. Press and hold ▲ to display CodE 77 again. Press ⊙. The controller will then return to CNFP. Press ⇄ to return to the Display Loop. This will not overwrite any user settings but will erase the controller calibration values. This procedure does not require any calibration signals nor external meters. This can be used to clear calibration error flag E-CL.

CAUTION: This procedure will result in up to ±10% reading error and the controller will no longer be within factory specifications. For this reason, this procedure should only be performed if meter error is outside of this range to temporarily restore operation until the unit can be accurately calibrated.

TROUBLESHOOTING

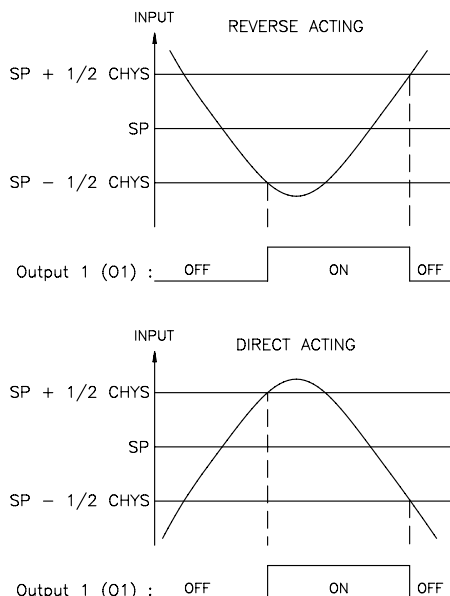For further technical assistance, contact technical support.

PROBLEM	CAUSE	REMEDIES
NO DISPLAY	1. Power off. 2. Brown-out condition. 3. Loose connection or improperly wired. 4. Bezel assembly not fully seated into rear of controller.	1. Check power. 2. Verify power reading. 3. Check connections. 4. Check installation.
CONTROLLER NOT WORKING	1. Incorrect setup parameters.	1. Check setup parameters.
E-E2 IN DISPLAY	1. Loss of setup parameters due to noise spike or other EMI event.	1. Press F1 to escape, then check all setup parameters. a. Check sensor input and AC line for excessive noise. b. If fault persists, replace controller.
E-CL IN DISPLAY	1. Loss of calibration parameters due to noise spike or other EMI event.	1. Press F1 to escape, then check controller accuracy. a. Recalibrate controller. (See Factory Service Module code 77.) b. Reset parameters to factory default settings.
dddd or -ddd IN DISPLAY	1. Display value exceeds 4 digit display range. 2. Defective or miscalibrated cold junction circuit. 3. Loss of setup parameters. 4. Internal malfunction.	1. Change resolution to display whole number and verify reading. 2. Perform cold junction calibration. 3. Check setup parameters. 4. Perform Input calibration.
OPEA IN DISPLAY (T16)	1. Probe disconnected. 2. Broken or burned-out probe. 3. Corroded or broken terminations. 4. Excessive process temperature.	1. Connect probe. 2. Replace probe. 3. Check connections. 4. Check process parameters.
SEAS IN DISPLAY (P16)	1. Input exceeds range of controller. 2. Incorrect input wiring. 3. Defective transmitter. 4. Internal malfunction.	1. Check input parameters. 2. Check input wiring. 3. Replace transmitter. 4. Perform input calibration.
OLOL IN TOP DISPLAY	1. Input exceeds range of controller. 2. Temperature exceeds range of input probe. 3. Defective or incorrect transmitter or probe. 4. Excessive high temperature for probe. 5. Loss of setup parameters.	1. Check input parameters. 2. Change to input sensor with a higher temperature range. 3. Replace transmitter or probe. 4. Reduce temperature. 5. Perform input calibration.
ULUL IN TOP DISPLAY	1. Input is below range of controller. 2. Temperature below range of input probe. 3. Defective or incorrect transmitter or probe. 4. Excessive low temperature for probe. 5. Loss of setup parameters.	1. Check input parameters. 2. Change to input sensor with a lower temperature range. 3. Replace transmitter or probe. 4. Raise temperature. 5. Perform input calibration.
SHrt IN DISPLAY (T16)	1. RTD probe shorted.	1. Check wiring and/or replace RTD probe.
CONTROLLER SLUGGISH OR NOT STABLE	1. Incorrect PID values. 2. Incorrect probe location.	1. See PID control. 2. Evaluate probe location.

CONTROL MODE EXPLANATIONS

ON/OFF CONTROL

The controller operates in On/Off Control when the Proportional Band is set to 0.0%. In this control mode, the process will constantly oscillate around the setpoint value. The On/Off Control Hysteresis (balanced around the setpoint) can be used to eliminate output chatter. Output O1 Control Action can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications.
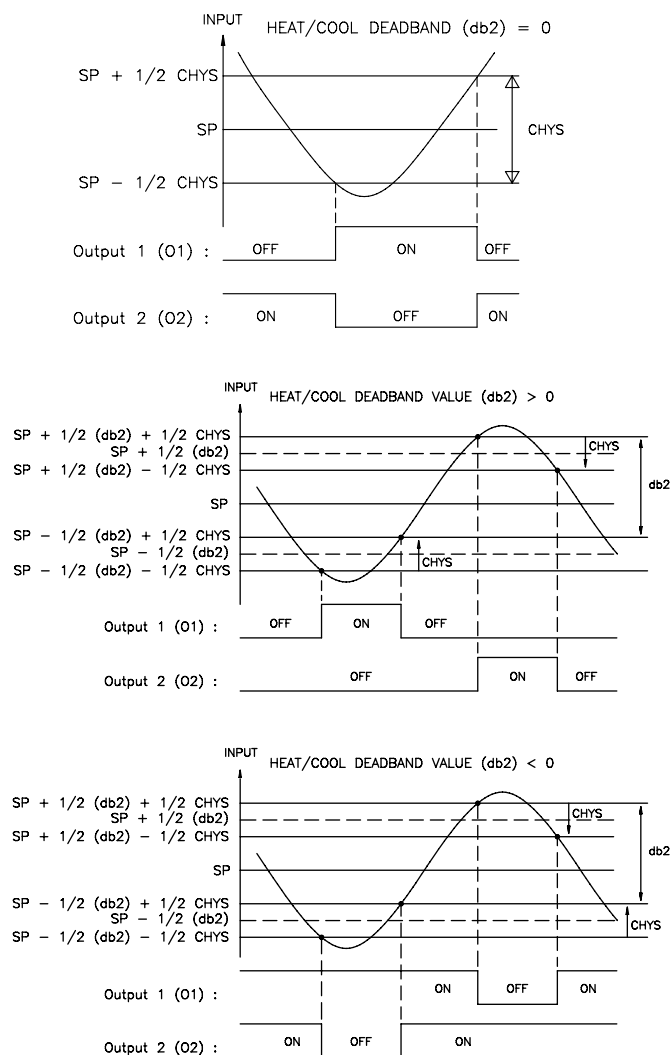
**ON/OFF CONTROL -
REVERSE OR DIRECT ACTING FIGURES**

REVERSE ACTING

INPUT

SP + 1/2 CHYS

SP

SP − 1/2 CHYS

Output 1 (O1) : OFF   ON   OFF

DIRECT ACTING

INPUT

SP + 1/2 CHYS

SP

SP − 1/2 CHYS

Output 1 (O1) : OFF   ON   OFF

Note: CHYS in the On/Off Control Figures refers to the On/Off Control Hysteresis (CHYS) in parameter Module 2.

For heat and cool systems, O1 Control Action is set to reverse (heat) and the Alarm 2 Action is set to cooling (O2). The Proportional Band is set to 0.0 and the Relative Gain in Cooling to 0.0. The Deadband in Cooling sets the amount of operational deadband or overlap between the outputs. The setpoint and the On/Off Control Hysteresis applies to both O1 and O2 outputs. The hysteresis is balanced in relationship to the setpoint and deadband value.

ON/OFF CONTROL - HEAT/COOL OUTPUT FIGURES

HEAT/COOL DEADBAND (db2) = 0

INPUT

SP + 1/2 CHYS

SP

SP − 1/2 CHYS

CHYS

Output 1 (O1) : OFF   ON   OFF

Output 2 (O2) : ON   OFF   ON

HEAT/COOL DEADBAND VALUE (db2) > 0

INPUT

SP + 1/2 (db2) + 1/2 CHYS
SP + 1/2 (db2)
SP + 1/2 (db2) − 1/2 CHYS

SP

SP − 1/2 (db2) + 1/2 CHYS
SP − 1/2 (db2)
SP − 1/2 (db2) − 1/2 CHYS

CHYS
db2
CHYS

Output 1 (O1) : OFF   ON   OFF

Output 2 (O2) : OFF   ON   OFF

HEAT/COOL DEADBAND VALUE (db2) < 0

INPUT

SP + 1/2 (db2) + 1/2 CHYS
SP + 1/2 (db2)
SP + 1/2 (db2) − 1/2 CHYS

SP

SP − 1/2 (db2) + 1/2 CHYS
SP − 1/2 (db2)
SP − 1/2 (db2) − 1/2 CHYS

CHYS
db2
CHYS

Output 1 (O1) : ON   OFF   ON

Output 2 (O2) : ON   OFF   ON

PID CONTROL

In PID Control, the controller processes the input and then calculates a control output power value by use of a modified Proportional Band, Integral Time, and Derivative Time control algorithm. The system is controlled with the new output power value to keep the process at the setpoint. The Control Action for PID Control can be set to reverse for heating (output on when below the setpoint) or direct for cooling (output on when above the setpoint) applications. For heat and cool systems, the heat (O1) and cool (O2) outputs are both used. The PID parameters can be established by using Auto-Tune, or they can be Manually tuned to the process.

TYPICAL PID RESPONSE CURVE

INPUT

P & I

P & I & D

SP

P & D   P only
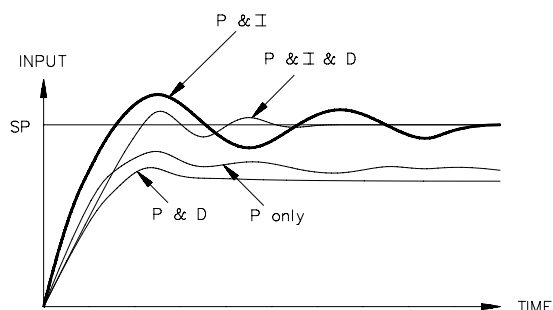
TIME

TIME PROPORTIONAL PID CONTROL

In Time Proportional applications, the output power is converted into output On time using the Cycle Time. For example, with a four second cycle time and 75% power, the output will be on for three seconds (4 × 0.75) and off for one second.

The cycle time should be no greater than 1/10 of the natural period of oscillation for the process. The natural period is the time it takes for one complete oscillation when the process is in a continuously oscillating state.

LINEAR PID CONTROL

In Linear PID Control applications, the Analog Output Assignment $RRRS$ is set to % Output Power, OP. The Analog Low Scaling, $RRLO$, is set to 0.0 and the Analog High Scaling, $RRH t$, is set to 100.0. The Analog Output will then be proportional to the PID calculated % output power for Heat or Cooling per the Control Action $OPRC$. For example, with 0 VDC to 10 VDC (scaled 0 to 100%) and 75% power, the analog output will be 7.5 VDC.

MANUAL CONTROL MODE

In Manual Control Mode, the controller operates as an open loop system (does not use the setpoint and process feedback). The user adjusts the percentage of power through the % Power display to control the power for Output O1. When Alarm 2 is configured for Cooling (O2), Manual operation provides 0 to 100% power to O1 (heating) and -100 to 0% power to O2 (Cooling). The Low and High Output Power limits are ignored when the controller is in Manual.

MODE TRANSFER

When transferring the controller mode between Automatic and Manual, the controlling outputs remain constant, exercising true "bumpless" transfer. When transferring from Manual to Automatic, the power initially remains steady, but Integral Action corrects (if necessary) the closed loop power demand at a rate proportional to the Integral Time.

AUTOMATIC CONTROL MODE

In Automatic Control Mode, the percentage of output power is automatically determined by PID or On/Off calculations based on the setpoint and process feedback. For this reason, PID Control and On/Off Control always imply Automatic Control Mode.

PID TUNING EXPLANATIONS

AUTO-TUNE

Auto-Tune is a user-initiated function that allows the controller to automatically determine the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Output Dampening Time, and Relative Gain (Heat/Cool) values based upon the process characteristics. The Auto-Tune operation cycles the controlling output(s) at a control point three-quarters of the distance between the present process value and the setpoint. The nature of these oscillations determines the settings for the controller's parameters.

Prior to initiating Auto-Tune, it is important that the controller and system be first tested. (This can be accomplished in On/Off Control or Manual Control Mode.) If there is a wiring, system or controller problem, Auto-Tune may give incorrect tuning or may never finish. Auto-Tune may be initiated at start-up, from setpoint or at any other process point. However, ensure normal process conditions (example: minimize unusual external load disturbances) as they will have an effect on the PID calculations.

AUTO-TUNE CODE FIGURE

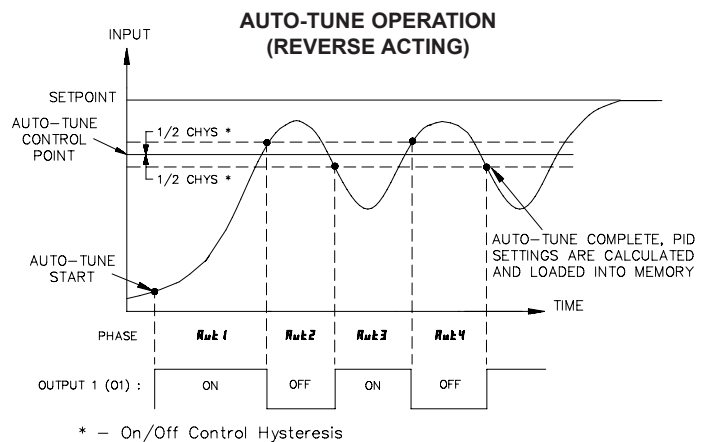TYPICAL RESPONSE CURVES WITH AUTO-TUNE CODES 0 TO 2.
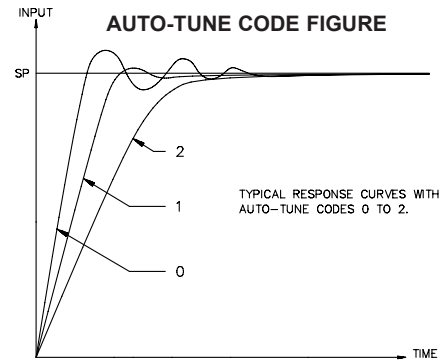
Start Auto-Tune

Below are the parameters and factory settings that affect Auto-Tune. If these setting are acceptable then Auto-Tune can be started just by performing two steps. If changes are needed, then they must be made before starting Auto-Tune.

DISPLAY	PARAMETER	FACTORY SETTING	MODULE
$tYPE$	Input Type	$tc-J$ T16 $Curr$ P16	$1-1R$
$FLtr$	Digital Filtering	1	$1-1R$
$CHYS$	On/Off Control Hysteresis	2 T16 0.2 P16	$2-OP$
$tcod$	Auto-Tune Code	0	$2-OP$
$db-2$	Deadband	0	$5-O2$
$tUnE$	Auto-Tune Access	$H idE$	$3-LC$

1. Enter the Setpoint value in the Display Loop.
2. Initiate Auto-Tune by changing Auto-Tune Start $tUnE$ to YES in the Hidden Loop.

Auto-Tune Progress

The controller will oscillate the controlling output(s) for four cycles. The bottom display will flash the cycle phase number. Parameter viewing is permitted during Auto-Tune. The time to complete the Auto-Tune cycles is process dependent. The controller should automatically stop Auto-Tune and store the calculated values when the four cycles are complete. If the controller remains in Auto-Tune unusually long, there may be a process problem. Auto-Tune may be stopped by entering nO in Auto-Tune Start $tUnE$.

AUTO-TUNE OPERATION (REVERSE ACTING)

SETPOINT
AUTO-TUNE CONTROL POINT
1/2 CHYS *
1/2 CHYS *
AUTO-TUNE START
AUTO-TUNE COMPLETE, PID SETTINGS ARE CALCULATED AND LOADED INTO MEMORY

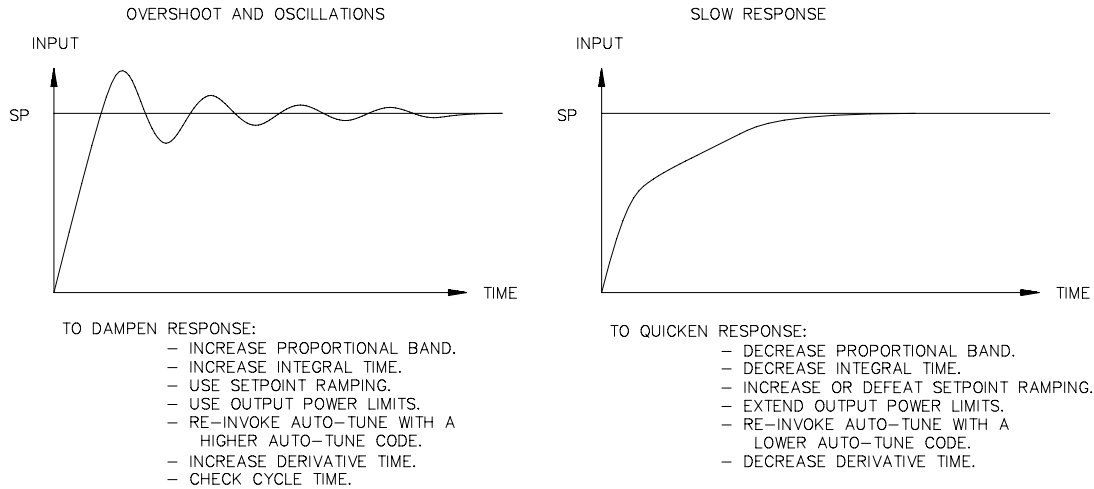| PHASE | $Rut1$ | $Rut2$ | $Rut3$ | $Rut4$ |
| OUTPUT 1 (O1) : | ON | OFF | ON | OFF |

* — On/Off Control Hysteresis

PID Adjustments

In some applications, it may be necessary to fine tune the Auto-Tune calculated PID parameters. To do this, a chart recorder or data logging device is needed 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.

In some unusual cases, the Auto-Tune function may not yield acceptable control results or induced oscillations may cause system problems. In these applications, Manual Tuning is an alternative.

PROCESS RESPONSE EXTREMES

OVERSHOOT AND OSCILLATIONS

INPUT

SP

TIME

TO DAMPEN RESPONSE:
- INCREASE PROPORTIONAL BAND.
- INCREASE INTEGRAL TIME.
- USE SETPOINT RAMPING.
- USE OUTPUT POWER LIMITS.
- RE–INVOKE AUTO–TUNE WITH A HIGHER AUTO–TUNE CODE.
- INCREASE DERIVATIVE TIME.
- CHECK CYCLE TIME.

SLOW RESPONSE

INPUT

SP

TIME

TO QUICKEN RESPONSE:
- DECREASE PROPORTIONAL BAND.
- DECREASE INTEGRAL TIME.
- INCREASE OR DEFEAT SETPOINT RAMPING.
- EXTEND OUTPUT POWER LIMITS.
- RE–INVOKE AUTO–TUNE WITH A LOWER AUTO–TUNE CODE.
- DECREASE DERIVATIVE TIME.

MANUAL TUNING

A chart recorder or data logging device is necessary to measure the time between process cycles. This procedure is an alternative to the controller's Auto-Tune function. It will not provide acceptable results if system problems exist.

1. Set the Proportional Band (*ProP*) to 10.0% for temperature models (T16) and 100.0% for process models (P16).
2. Set both the Integral Time (*Intt*) and Derivative Time (*dErt*) to 0 seconds.
3. Set the Output Dampening Time (*OPdP*) in Output Module *2-OP* to 0 seconds.
4. Set the Output Cycle Time [CYCt] in Output Module *2-OP* to no higher than one-tenth of the process time constant (when applicable).
5. Place the controller in Manual *USEr* Control Mode *trnF* in the Hidden Loop and adjust the % Power to drive the process value to the Setpoint value. Allow the process to stabilize after setting the % Power. Note: *trnF* must be set to *HidE* in Parameter Lockouts Module *3-LC*.
6. Place the controller in Automatic (*Auto*) Control Mode *trnF* in the Hidden Loop. If the process will not stabilize and starts to oscillate, set the Proportional Band two times higher and go back to Step 5.

7. If the process is stable, decrease Proportional Band setting by two times and change the Setpoint value a small amount to excite the process. Continue with this step until the process oscillates in a continuous nature.
8. Fix the Proportional Band to three times the setting that caused the oscillation in Step 7.
9. Set the Integral Time to two times the period of the oscillation.
10. Set the Derivative Time to 1/8 (0.125) of the Integral Time.
11. Set the Output Dampening Time to 1/40 (0.025) the period of the oscillation.

PARAMETER VALUE CHART

Programmer:_____ Date:_____

Controller Number:_____ Security Code:_____

DISPLAY LOOP

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
5P	SETPOINT VALUE SP1	0 T16 / 0.0 P16	_____
5P	SETPOINT VALUE SP2	20 T16 / 2.0 P16	_____
OP	OUTPUT POWER PERCENT	0.0	_____
ProP *	PROPORTIONAL BAND	4.0 T16 / 100.0 P16	_____
IntE *	INTEGRAL TIME	120 T16 / 40 P16	_____
dErE *	DERIVATIVE TIME	30 T16 / 4 P16	_____
AL-1 *	ALARM 1 VALUE	0	_____
AL-2 *	ALARM 2 VALUE	0	_____

* Factory Setting places these parameters in the Hidden Loop (set to HIdE in Lockout Module 3-LC).

HIDDEN LOOP

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
5P5L	SETPOINT SELECT	5P1	_____
5PrP	SETPOINT RAMP RATE	0.0	_____
trnF	CONTROL MODE TRANSFER	Auto	_____
tUNE	AUTO-TUNE START	NO	_____

INPUT MODULE (1-IN) T16 ONLY

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
tYPE	INPUT TYPE	tc-J	_____
SCAL	TEMPERATURE SCALE	°F	_____
dCPt	DECIMAL RESOLUTION	0	_____
FLtr	DIGITAL FILTERING	1	_____
SHFt	SHIFT/OFFSET	0	_____
5PLO	SETPOINT LOW LIMIT	0	_____
5PH1	SETPOINT HIGH LIMIT	9999	_____
InPt	USER INPUT FUNCTION	PLOC	_____
F1In	F1 KEY FUNCTION	NONE	_____

INPUT MODULE (1-IN) P16 ONLY

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
tYPE	INPUT TYPE	Curr	_____
PCt	PERCENT ANNUNCIATOR	NO	_____
dCPt	DECIMAL RESOLUTION	0.0	_____
rnd	ROUNDING INCREMENT	0.1	_____
FLtr	DIGITAL FILTERING	1	_____
d5P1	DISPLAY VALUE SCALING 1	0.0	_____
InP1	INPUT VALUE SCALING 1	4.00	_____
d5P2	DISPLAY VALUE SCALING 2	100.0	_____
InP2	INPUT VALUE SCALING 2	20.00	_____
5PLO	SETPOINT LOW LIMIT	0.0	_____
5PH1	SETPOINT HIGH LIMIT	999.9	_____
InPt	USER INPUT FUNCTION	PLOC	_____
F1In	F1 KEY FUNCTION	NONE	_____

OUTPUT MODULE (2-OP)

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
CYCt	CYCLE TIME	2.0	_____
OPAC	CONTROL ACTION	rEu	_____
OPLO	OUTPUT POWER LOWER LIMIT	0	_____
OPH1	OUTPUT POWER UPPER LIMIT	100	_____
OPFL	SENSOR FAIL POWER PRESET	0	_____
OPdP	OUTPUT POWER DAMPENING	3 T16 / 1 P16	_____
CHY5	ON/OFF CONTROL HYSTERESIS	2 T16 / 0.2 P16	_____
tcod	AUTO-TUNE CODE	0	_____
AntP	ANALOG OUTPUT RANGE	4-20	_____
ANAS	ANALOG OUTPUT ASSIGNMENT	OP	_____
ANUt	ANALOG UPDATE TIME	0	_____
ANLO	ANALOG LOW SCALING	0.0	_____
ANH1	ANALOG HIGH SCALING	100.0	_____

LOCKOUT MODULE (3-LC)

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
5P	SETPOINT ACCESS	dISP	_____
OP	OUTPUT POWER ACCESS	dISP	_____
PId	PID VALUE ACCESS	HIdE	_____
AL	ALARM VALUE ACCESS	HIdE	_____
CodE	ACCESS CODE	0	_____
5P5L	SETPOINT SELECT ACCESS	LOC	_____
5PrP	SETPOINT RAMP ACCESS	HIdE	_____
trnF	TRANSFER CONTROL ACCESS	LOC	_____
tUNE	AUTO-TUNE ACCESS	HIdE	_____
ALr5	RESET ALARMS ACCESS	LOC	_____

ALARM MODULE (4-AL)

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
ACt1	ALARM 1 ACTION	AuH1	_____
Lit1	ALARM 1 ANNUNCIATOR	nor	_____
r5t1	ALARM 1 RESET MODE	Auto	_____
5tb1	ALARM 1 STANDBY	NO	_____
AL-1	ALARM 1 VALUE	0	_____
ACt2	ALARM 2 ACTION	AuH1	_____
Lit2	ALARM 2 ANNUNCIATOR	nor	_____
r5t2	ALARM 2 RESET MODE	Auto	_____
5tb2	ALARM 2 STANDBY	NO	_____
AL-2	ALARM 2 VALUE	0	_____
AHY5	ALARM 1 & 2 HYSTERESIS	1 T16 / 0.1 P16	_____

COOLING MODULE (5-O2)

DISPLAY	PARAMETER	FACTORY SETTING	USER SETTING
CYC2	CYCLE TIME	2.0	_____
9An2	RELATIVE GAIN	1.0	_____
db-2	DEADBAND	0	_____

T16 & P16 PROGRAMMING QUICK OVERVIEW

Parameter availability is model and program dependent.

⊙ Enters displayed module, then advances to the next parameter.

▶ ◀ Advances to the next module, then changes parameter selection/value.

F1 ↓ Ends and returns to start of Display Loop.

* - T16 only
** - P16 only

HIDDEN LOOP

DISPLAY LOOP

`ConFP`
`no`

1-In
- `tYPE` — Input Type
- `PCt` ** — Percent Symbol
- `SCAL` * — Temp Scale
- `dCPt` — Decimal Resolution
- `rnd` ** — Rounding Increment
- `FLtr` — Digital Filtering
- `dSP1` ** — Display Value 1
- `InP1` ** — Input Value 1
- `dSP2` ** — Display Value 2
- `InP2` ** — Input Value 2
- `SHFt` * — Shift/Offset
- `SPLo` — Setpoint Low Limit
- `SPH1` — Setpoint High Limit
- `InPt` — User Input Function
- `F1In` — F1 Key Function

2-OP
- `CYCt` — Cycle Time
- `OPAC` — Control Action
- `OPLo` — Output Power Low Limit
- `OPH1` — Output Power High Limit
- `OPFL` — Sensor Fail Power Preset
- `OPdP` — Output Power Dampening
- `CHYS` — On/Off Control Hysteresis
- `tCod` — Auto-Tune Code

3-LC
- `AntP` — Analog Output Range
- `AnAS` — Analog Output Assignment
- `Anut` — Analog Output Update Time
- `AnLo` — Analog Low Scaling
- `AnH1` — Analog High Scaling
- `SP` — Setpoint Access
- `OP` — Output Power Access
- `P id` — PID Values Access
- `AL` — Alarm Values Access
- `CodE` — Access Code
- `SPSL` — Setpoint Select Access
- `SPrP` — Setpoint Ramp Rate Access
- `trnF` — Auto/Manual Transfer Access
- `tUnE` — Auto-Tune Off/On Access
- `ALrS` — Reset Alarms Access

4-AL
- `ACt1` — Alarm 1 Action
- `L it1` — Alarm 1 Annunciator
- `rSt1` — Alarm 1 Reset Mode
- `Stb1` — Alarm 1 Standby
- `AL-1` — Alarm 1 Value
- `ACt2` — Alarm 2 Action
- `L it2` — Alarm 2 Annunciator
- `rSt2` — Alarm 2 Reset Mode
- `Stb2` — Alarm 2 Standby
- `AL-2` — Alarm 2 Value
- `AHYS` — Alarm 1 & 2 Hysteresis

5-O2
- `CYC2` — Cooling Cycle Time
- `gAn2` — Cooling Relative Gain
- `db-2` — Heat/Cool Deadband/Overlap

6-FS
- `CodE` — Factory Service Code

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MODEL DLCD – DUAL LOOP CONTROLLER w/ DH-485

GENERAL DESCRIPTION

The Model DLCD, Dual Loop Controller with DH-485, has a similar feature set and specifications as the standard Dual Loop Controller. The DLCD provides a connection into an Allen Bradley DH-485 network allowing a fully featured dual loop PID controller to be controlled and monitored by an Allen Bradley PLC (SLC 500 controller, or similar), over a DH-485 network.

The DLCD communications port may be configured for DH-485, or as a programming port allowing complete programming by our Windows® based RLCPro configuration software.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
DLCD	Dual Loop Controller w/ DH-485	DLCD0001
	Dual Loop Controller w/ 2 Analog Outputs w/ DH-485	DLCD1001
CBJ	SLC 500 (RJ45) to RJ11 Cable	CBJ11C07
DRRJ11	RJ11 Connector to Terminal Adapter	DRRJ11T6

USING THIS DOCUMENT

This document is an addendum to the bulletin describing the standard DLC and describes the use of the DH-485 connection of the DLCD. This document should be read in conjunction with the DLC Bulletin.

1.0 Using the DLCD on a DH-485 Network

Overview

The DLCD rapidly exchanges blocks of control and status information for each PID loop with an Integer File that has been allocated in the PLC. Each DLCD is assigned an Integer File by setting the appropriate DIP Switches on the DLCD. By accessing this Integer File, the PLC is able to control and monitor the operation of each PID loop within each DLCD. Most applications will only require information contained in these Control and Status blocks. The ability has been included to upload and download Parameter and Configuration blocks on demand for each PID loop.

Integer File Structure

The Integer File for each DLCD is structured to include Control, Status, Parameter and Configuration blocks for each PID Loop. Control and Status blocks contain data that is transferred automatically by the DLCD on alternate communication scans. Parameter Blocks contain DLCD operating parameters and may be occasionally changed. Configuration Blocks contain system configuration parameters and are rarely changed.

Table 1 gives the overall structure of the Integer File giving the location of the various blocks for each PID loop or channel. The tables in the following sections show the structure of each block and provide a cross-reference from the Allen Bradley Integer File register to the equivalent MODBUS Holding Register in the DLCD.

When using the Integer File tables in the following sections, refer to the Register Table in the DLC Bulletin for register details such as factory setting, limits and description.

Note: Modbus registers provided for reference only.

Nx:	Block	Reference
0..3	Control Block – Channel A	Table 2
4..7	Control Block – Channel B	Table 2
8..11	Status Block – Channel A	Table 5
12..15	Status Block – Channel B	Table 5
16..23	Parameter Block – Channel A	Table 8
24..31	Parameter Block – Channel B	Table 9
32..63	Configuration Block – Channel A	Table 10
64..95	Configuration Block – Channel B	Table 13

Table 1 - Overview of Integer File Structure

Control Block

The Control block contains control values and commands, such as Set Point and Control Mode. The DLCD continually reads the Control Blocks for each PID loop from the PLC providing a means whereby the PLC program can control the DLCD.

Nx:	BIT POSITION 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0	REFERENCE/ MODBUS REGISTER
0	Setpoint Channel A	40002
1	Output Power Channel A	40005
2	15 14 13 ... 7 6..5 ... 1 0	Table 3
3	... 3 2 1 0	Table 4
4	Setpoint Channel B	40018
5	Output Power Channel B	40021
6	15 14 13 ... 7 6..5 ... 1 0	Table 3
7	... 3 2 1 0	Table 4

Table 2 - Control Block - Channel A and B

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15	Control Mode	40041	40049
14	Disable Integral Action	40044	40052
13	Disable Setpoint Ramping	40042	40050
12	Not Used	-	-
11	Not Used	-	-
10	Not Used	-	-
9	Not Used	-	-
8	Not Used	-	-
7	Auto-tune Request (See Note 2)	-	-
6..5	Auto-tune Code	40013	40029
4	Not Used	-	-
3	Not Used	-	-
2	Not Used	-	-
1	Alarm Output AL2 (See Note 1)	40016	40032
0	Alarm Output AL1 (See Note 1)	40015	40031

Table 3 - Control Block for Nx:2 and Nx:6 Flags

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15	Not Used	-	-
14	Not Used	-	-
13	Not Used	-	-
12	Not Used	-	-
11	Not Used	-	-
10	Not Used	-	-
9	Not Used	-	-
8	Not Used	-	-
7	Not Used	-	-
6	Not Used	-	-
5	Not Used	-	-
4	Not Used	-	-
3	Parameter Read Strobe (See Note 3)	-	-
2	Configuration Read Strobe (See Note 3)	-	-
1	Parameter Write Strobe (See Note 3)	-	-
0	Configuration Write Strobe (See Note 3)	-	-

Table 4 - Control Block for Nx:3 and Nx:7 Flags

Status Block

The Status block contains current operating values and status such as Process Value and Input Status. The DLCD continually writes the Status Block for each PID channel providing a means whereby the PLC can monitor the operating status of the DLCD.

Nx:	BIT POSITION 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0	REFERENCE/ MODBUS REGISTER
8	Process Value Channel A	40001
9	Output Power Channel A	40005
10	15..8 7..5 4 3 2 1 0	Table 6
11	15 ... 7 6 ... 3 2 1 0	Table 7
12	Process Value Channel B	40017
13	Output Power Channel B	40021
14	15..8 7..5 4 3 2 1 0	Table 6
15	15 ... 7 6 ... 3 2 1 0	Table 7

Table 5 - Status Block - Channel A and B

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15..8	Input Error Status Register	40504	40504
7..5	Auto-Tune Phase	40012	40028
4	Control Output OP2	40016	40032
3	Control Output OP1	40014	40030
2	Set Point Ramping In Progress	40043	40051
1	Alarm Output AL2	40016	40032
0	Alarm Output AL1	40015	40031

Table 6 - Status Block for Nx:10 and Nx:14 Flags

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15	Bus Active (See Note 5)	-	-
14	Not Used	-	-
13	Not Used	-	-
12	Not Used	-	-
11	Not Used	-	-
10	Not Used	-	-
9	Not Used	-	-
8	Not Used	-	-
7	Auto-Tune In Progress (See Note 4)	-	-
6	Auto-Tune Done (See Note 4)	-	-
5	Not Used	-	-
4	Not Used	-	-
3	Parameter Block Read Acknowledge (See Note 6)	-	-
2	Configuration Block Read Acknowledge (See Note 6)	-	-
1	Parameter Block Write Acknowledge (See Note 6)	-	-
0	Configuration Block Write Acknowledge (See Note 6)	-	-

Table 7 - Status Block for Nx:11 and Nx:15 Flags

Notes:

1. *Alarm Output Control*
   The Control flags Alarm Output AL1 and AL2 must set TRUE (1) for correct Alarm operation when Control Mode is Automatic (0). Set to 0 to reset an Alarm.

2. *Auto-tune Request*
   Setting the Auto-tune Request flag forces the DLCD to start the auto-tune process. Refer to section Auto-tune Request for more detail on how the PLC program may auto-tune a PID loop in the DLCD.

3. *Read/Write Strobes*
   Setting the Read/Write Strobe flags forces the DLCD to upload or download the appropriate Parameter or Configuration block. Refer to section Transferring Parameter and Configuration Data for more detail on how to transfer these blocks between the PLC and the DLCD.

4. *Auto-tune Status*
   Monitoring the Auto-Tune Done and Auto-Tune In Progress flags allows the PLC program to detect the completion of the Auto-tune process in the DLCD. Refer to section Auto-tune Request for more detail on how the PLC program may auto-tune a PID loop in the DLCD.

5. *Bus Active*
   Each DLCD toggles the Bus Active flag on each communication scan.

6. *Read/Write Acknowledge*
   The DLCD sets the appropriate acknowledge flag once the requested upload or download of the Parameter or Configuration block is complete. Refer to section Transferring Parameter and Configuration Data for more detail on how to transfer these blocks between the PLC and the DLCD.

7. *Data flow is described with respect to the DLCD in exchanges with the PLC. Thus, Read data is data transferred from the PLC to the DLCD and Write data is data transferred from the DLCD to the PLC.*

Parameter Block

The Parameter blocks contain values that may need to be changed while the DLCD is operating, such as PID parameters. Each Parameter Block may be uploaded to or downloaded from the PLC on demand by setting the appropriate request bit in the Control Block. Refer to section Transferring Parameter and Configuration Data to see how this is done.

Nx:	BIT POSITION 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0		REFERENCE/ MODBUS REGISTER	
16	Proportional Band		40007	
17	Integral Time		40008	
18	Derivative Time		40009	
19	Cycle Time (Cooling)	Relative Gain (Cooling)	40141	40142
20	Deadband (Cooling)		40143	
21	Alarm 1 Value		40003	
22	Alarm 2 Value		40004	
23	*Not Used*		-	

Table 8 - Parameter Block – Channel A

Nx:	BIT POSITION 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0		REFERENCE/ MODBUS REGISTER	
24	Proportional Band		40023	
25	Integral Time		40024	
26	Derivative Time		40025	
27	Cycle Time (Cooling)	Relative Gain (Cooling)	40241	40242
28	Deadband (Cooling)		40243	
29	Alarm 1 Value		40019	
30	Alarm 2 Value		40020	
31	*Not Used*		-	

Table 9 - Parameter Block – Channel B

Configuration Block

The Configuration blocks contain values that describe the DLCD setup such as Input configuration and as such will not need to be changed during normal operation. These blocks may be uploaded to and downloaded from the PLC on demand by setting the appropriate request bit in the Control Block. Refer to section Transferring Parameter and Configuration Data to see how this is done.

Nx:	BIT POSITION	REFERENCE/ MODBUS REGISTER
32	Offset Power	40010
33	Span Correction	40106
34	Offset Correction	40107
35	Low Limit (Setpoint)	40108
36	High Limit (Setpoint)	40109
37	Ramp Rate (Setpoint)	40110
38	Process Low (Scaling Points)	40111
39	Process High (Scaling Points)	40112
40	Input Low (Scaling Points)	40113
41	Input High (Scaling Points)	40114
42	Cycle Time (OP1)	40116
43	On Delay (AL1)	40135
44	On Delay (AL2)	40140
45	Scaling Value Low (Analog Output)	40303
46	Scaling Value High (Analog Output)	40304
47	Direct Entry Value (Analog Output)	40307
48	Ramping Setpoint Value	40045
49	15 | 14..8 | (unused)	Table 11
50	Sensor Failure Power Preset (OP1)	40120
51	Power Low Limit (OP1)	40118
52	Power High Limit (OP1)	40119
53	Dampening Time (OP1) | On/Off Control Hysteresis (OP1)	40121 40122
54	Hysteresis (AL1) | Hysteresis (AL2)	40134 40139
55	Deadband (Analog Output) | Update Time (Analog Output)	40305 40306
56	15 14 13 12 | 11..8 | 7 6 5 | 4..0	Table 12
57	15..14 | 13..11 | 10..0	Table 14
58	15 | 14..0	Table 15
59	Action (AL1) | Action (AL2)	40131 40136
60	*Not Used*	-
61	*Not Used*	-
62	*Not Used*	-
63	*Not Used*	-

Table 10 - Configuration Block – Channel A

Nx:	BIT POSITION	REFERENCE/ MODBUS REGISTER
64	Offset Power	40026
65	Span Correction / Remote Setpoint Ratio Multiplier	40206
66	Offset Correction / Remote Setpoint Bias Offset	40207
67	Low Limit (Setpoint)	40208
68	High Limit (Setpoint)	40209
69	Ramp Rate (Setpoint)	40210
70	Process Low (Scaling Points)	40211
71	Process High (Scaling Points)	40212
72	Input Low (Scaling Points)	40213
73	Input High (Scaling Points)	40214
74	Cycle Time (OP1)	40216
75	On Delay (AL1)	40235
76	On Delay (AL2)	40240
77	Scaling Value Low (Analog Output)	40311
78	Scaling Value High (Analog Output)	40312
79	Direct Entry Value (Analog Output)	40315
80	Ramping Setpoint Value	40053
81	15 | 14..8 | (unused)	Table 11
82	Sensor Failure Power Preset (OP1)	40220
83	Power Low Limit (OP1)	40218
84	Power High Limit (OP1)	40219
85	Dampening Time (OP1) | On/Off Control Hysteresis (OP1)	40221 40222
86	Hysteresis (AL1) | Hysteresis (AL2)	40234 40239
87	Deadband (Analog Output) | Update Time (Analog Output)	40313 40314
88	15 14 13 12 | 11..8 | 7 6 5 | 4..0	Table 12
89	15..14 | 13..11 | 10..0	Table 14
90	15 | 14..0	Table 15
91	Action (AL1) | Action (AL2)	40231 40236
92	*Not Used*	-
93	*Not Used*	-
94	*Not Used*	-
95	*Not Used*	-

Table 13 - Configuration Block – Channel B

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15	Remote/Local Setpoint Select	40046	-
	Channel B Assignment (Input)	-	40198
14..8	Rounding (Input)	40104	40204

Table 11 - Configuration Block for Nx:49 and Nx:81 Flags

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15..14	Local/Remote Set Point Transfer Mode (Input)	-	40199
13..11	Mode (Analog Output)	40302	40310
10..0	Assignment (Analog Output)	40301	40309

Table 14 - Configuration Block for Nx:57 and Nx:89 Flags

BITS	REGISTER NAME	MODBUS REGISTER Ch. A	MODBUS REGISTER Ch. B
15	Reset (AL2)	40137	40237
14	Reset (AL1)	40132	40232
13	Enable Standby (AL2)	40138	40238
12	Enable Standby (AL1)	40133	40233
11..8	Digital Input Filter (Input)	40105	40205
7	Temperature Scale (Input)	40102	40202
6	Control Action (OP1)	40117	40217
5	Filter (Analog Output)	40308	40316
4..0	Process Decimal Point (Scaling Points)	40115	40215

Table 12 - Configuration Block for Nx:56 and Nx:88 Flags

BITS	REGISTER NAME	MODBUS REGISTER CH. A	MODBUS REGISTER CH. B
15	Resolution (Input)	40103	40203
14..0	Input Type (Input)	40101	40201

Table 15 - Configuration Block for Nx:58 and Nx:90 Flags

2.0 Setting the DIP Switches

Overview

The DIP Switches and the Default Serial Terminal set the DLCD serial communication operating mode to either DH-485 mode or MODBUS mode. DH-485 mode allows the DLCD to be connected to a DH-485 network. MODBUS mode allows programming of the DLCD using RLCPro.

DH-485 Mode

Integer File

Each DLCD is assigned a unique Integer File in the PLC that the DLCD uses to transfer data. Switch A (SWA) sets the target Integer file in the range N7..N70.

Note N8 and N9 are invalid Integer File numbers and therefore cannot be used.

INTEGER FILE	SWITCH POSITION						COMMENT
	1	2	3	4	5	6	
N7	DN	DN	DN	DN	DN	DN	Valid File Number
N8	DN	DN	DN	DN	DN	UP	*Invalid File Number*
N9	DN	DN	DN	DN	UP	DN	*Invalid File Number*
N10	DN	DN	DN	DN	UP	UP	Valid File Number
N11	DN	DN	DN	UP	DN	DN	Valid File Number
..							Valid File Number
N70	UP	UP	UP	UP	UP	UP	Valid File Number

Table 16 - Integer File settings using DIP Switch A

DLCD Address

Each device on a DH-485 network must have a unique address. Switch B (SWB) allows the DLCD address to be set in the range 0..31.

DLCD Address	Switch Position				
	1	2	3	4	5
0	DN	DN	DN	DN	DN
1	DN	DN	DN	DN	UP
2	DN	DN	DN	UP	DN
3	DN	DN	DN	UP	UP
..					
31	UP	UP	UP	UP	UP

Table 17 - Selections for DLCD Address using DIP Switch B

PLC Address

The DLCD transfers data with a target PLC. Switch B (SWB) allows the address of the target PLC on the DH-485 network to be set in the range 0..7.

PLC ADDRESS	SWITCH POSITION		
	6	7	8
0	DN	DN	DN
1	DN	DN	UP
2	DN	UP	DN
..			
7	UP	UP	UP

Table 18 - Selections for PLC Address using DIP Switch B

Example 1

This example shows the DIP Switch settings for a DLCD operating in DH-485 mode with the following configuration.

    PLC Address   : 1
    DLCD Address   : 8
    Integer File   : 10 (N10)

1	2	3	4	5	6		1	2	3	4	5	6	7	8
				UP	UP			UP						UP
DN	DN	DN	DN				DN		DN	DN	DN	DN	DN	

```
INTEGER FILE          DLCD           PLC

    SWA          SWB:   ADDRESS
```

Communication Settings

The DLCD has a fixed baud rate of 19200 when used in DH-485 mode.

MODBUS Mode

In MODBUS mode, the DLCD responds to MODBUS RTU frames and therefore allows programming using RLCPro (refer to DLC Bulletin for detailed information on using RLCPro with the DLCD). To configure the DLCD for MODBUS without changing the DIP switches, use the Default Serial Setting Terminal.

DEFAULT SERIAL SETTING CONNECTIONS
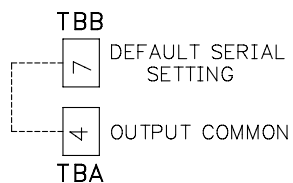
```
TBB
   ┌─┐
   │7│  DEFAULT SERIAL
   └─┘     SETTING
   ┌─┐
   │4│  OUTPUT COMMON
   └─┘
TBA
```

If using software selectable serial settings and the serial settings are unknown or forgotten, they can be temporarily reset to the defaults by connecting the "Default Serial Setting" terminal 7 to "Output Common" terminal 4 with a jumper.

Serial Communication Defaults:

Protocol: RTU **Data Bits:** 8
Address: 247 **Parity:** none
Baud Rate: 9600

Alternatively, set all DIP switches Down as shown in Example 2. The DLCD leaves the factory in this state, and is therefore ready to be programmed using RLCPro.

Example 2

This example shows the DIP Switch settings for a DLCD operating in MODBUS mode with the default serial settings.

1	2	3	4	5	6		1	2	3	4	5	6	7	8
DN	DN	DN	DN	DN	DN		DN	DN	DN	DN	DN	DN	DN	DN

```
INTEGER FILE          DLCD           PLC

    SWA          SWB:   ADDRESS
```

EXAMPLE APPLICATIONS

Transferring Parameter and Configuration Data

Parameter and Configuration blocks can be uploaded to and downloaded from the PLC Integer File by setting the appropriate read/write strobe in the relevant Control block. On completion of the data transfer the DLCD sets the corresponding acknowledge bit in the Status block.

Figure 1 shows a fragment of a Program File, captured from Rockwell's RSLogix 500 that shows how the strobe and acknowledge flags may be used to download a configuration block to the DLCD.
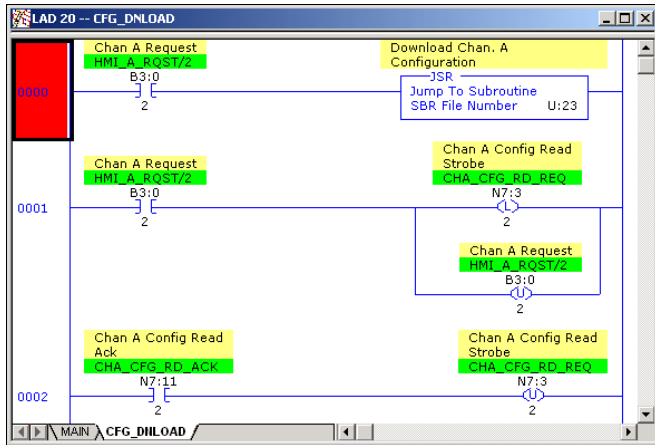
Figure 1 - Configuration Block Download

Figure 2 shows a fragment of a program file, captured from RSLogix 500 that shows how the strobe and acknowledge flags may be used to upload a configuration block from the DLCD.
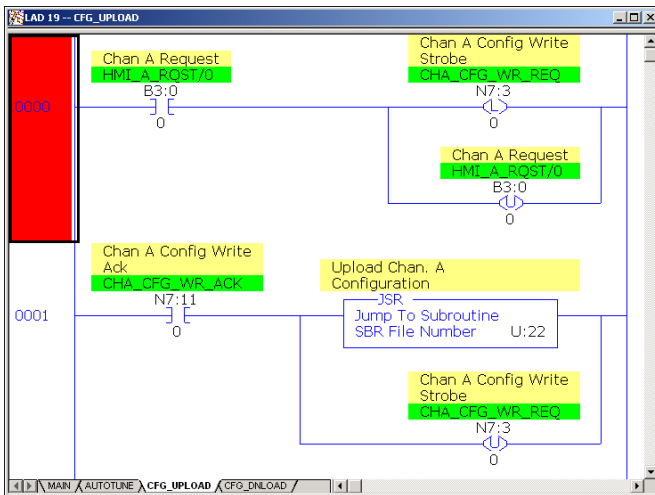
Figure 2 - Configuration Block Upload

Auto-tune Request

The Auto-tune Request flag allows the PLC program to start the auto-tune process in the DLCD. While auto-tuning, the DLCD sets the Auto-tune In Progress bit and when complete, sets the Auto-tune Done bit. By monitoring this bit, the PLC program is able to detect when the auto-tune process is complete.

Figure 3 shows a fragment of a program file, captured from RSLogix 500 that shows how the request flag and done flag may be used to start the auto-tune process in the DLCD.
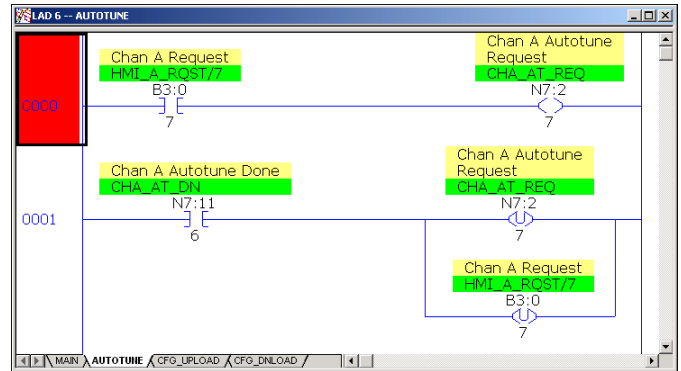
Figure 3 - Auto-tune Request

APPLICATION 1: SLC 5/03 AND DLCD

POWER
18−36VDC/
24VAC

2 DLCD UNITS
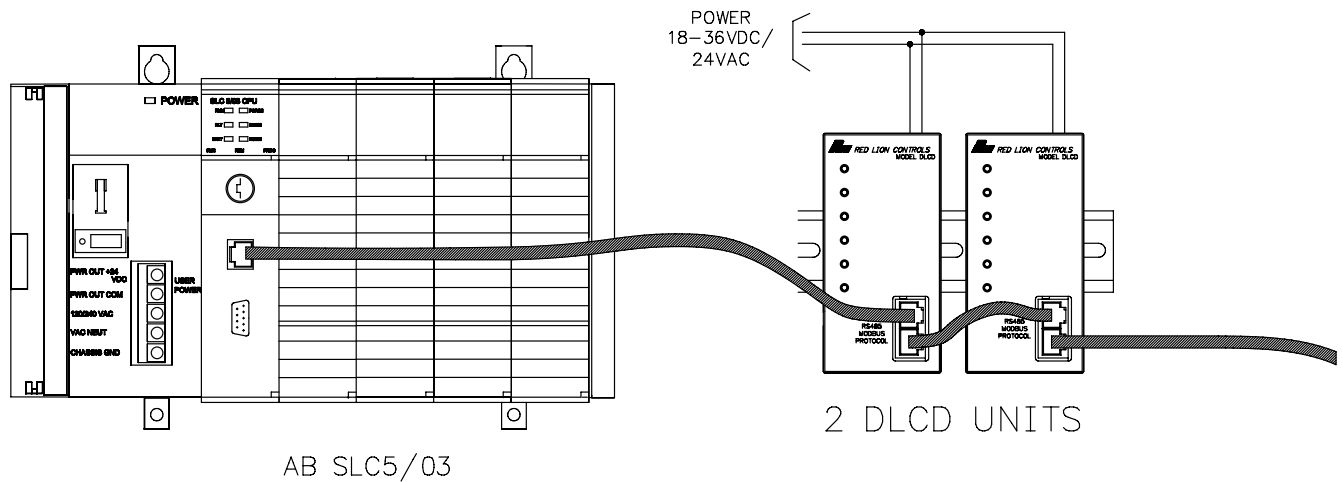
AB SLC5/03

Example showing direct connection of multiple DLCD units and a SLC 5/03, using Red Lion Cable Jumper (CBJ11BD5) and SLC 500 to RJ11 Cable (CBJ11C07).

APPLICATION 2: DLCD with AIC MODULE

DRR TERMINALS		AIC TERMINALS
		TERM
4		A
5		B
3		COM

POWER
18−36VDC/
24VAC

2 DLCD UNITS

DRRJ11T6

CBJ JUMPER
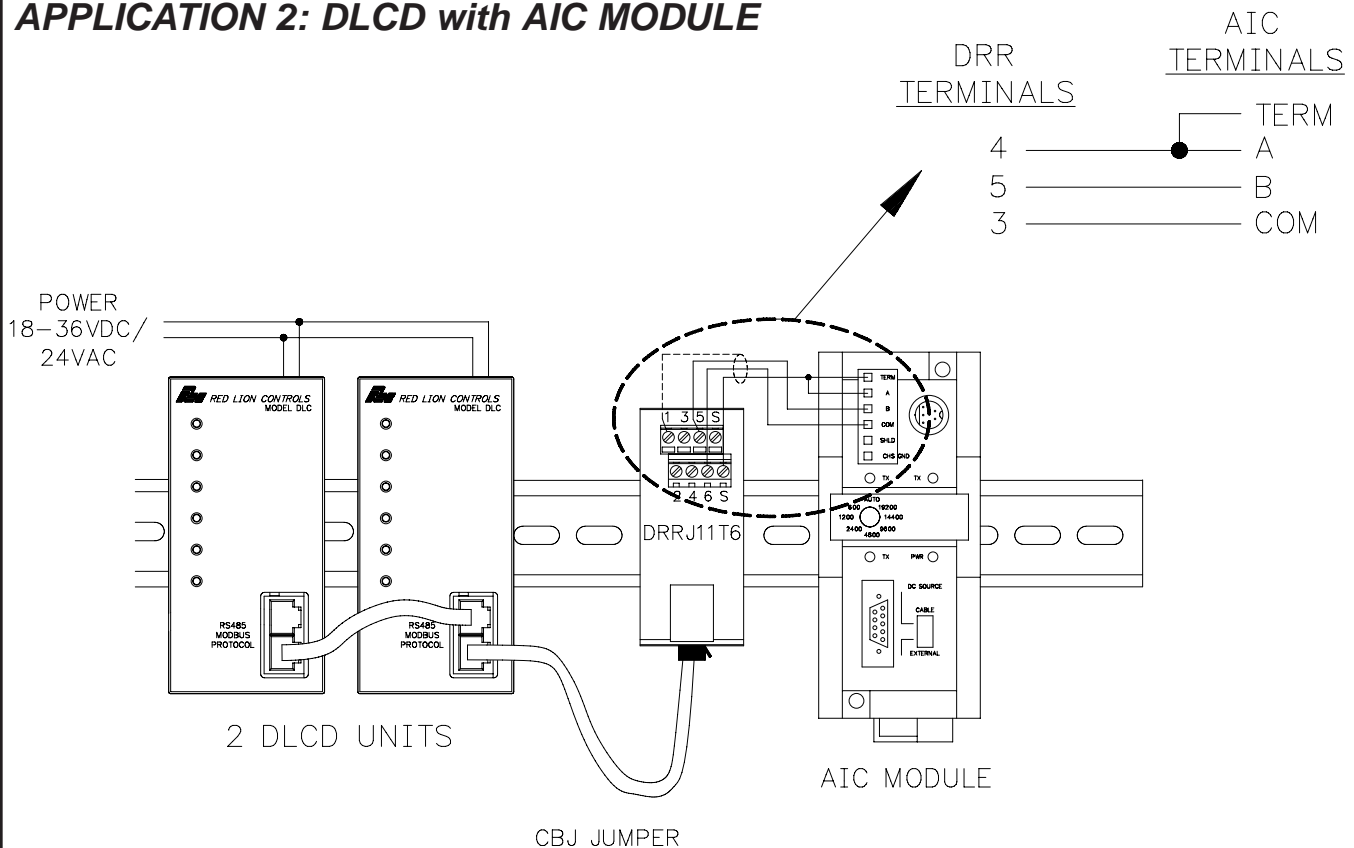
AIC MODULE

Example showing direct connection of multiple DLCD units to Red Lion DIN Rail Mounted Terminal Connector (DRJ11T6) allowing a variety of connection options using the AIC Module from Allen Bradley.

red lion

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion-controls.com

DLC & IAMS/ITMS CABLES

MODEL CBPRO - PROGRAMMING AND INTERFACE CABLE

DESCRIPTION

The CBPRO007 Programming Interface Cable is a port-powered device that can be used to download or interface with Red Lion Controls products that have an RS485 RJ-11 port. The cable converts the RS-232 TD and RD lines to balanced half-duplex RS-485 signals which can transmit up to 4,000 feet at 19,200 baud. It is powered from the RS-232 data and handshake lines whether the lines are high or low. An external 12 V power supply can be connected to two terminals on the connector if handshake lines are not available.

The CBPRO has a DB-9 female connector on the RS-232 side for connection to a PC COM port. The RS485 side, has a terminal block where the 7' long RJ11 cable is connected.
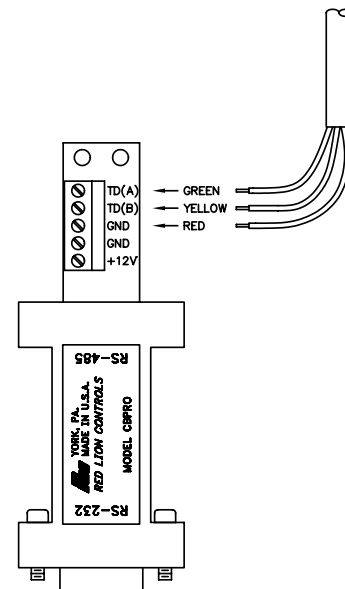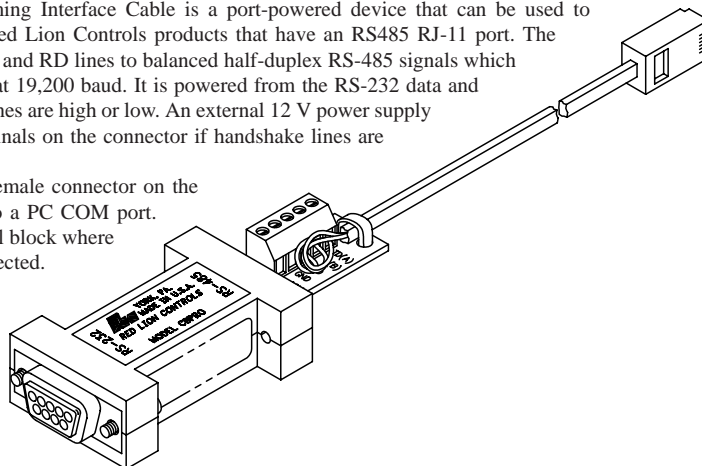
SPECIFICATIONS

1. **POWER REQUIREMENTS**: Port powered *

   * An external 12 VDC (unit draw @ 35 mA max.) can be applied if RS-232 output handshake lines are not available.

   Note: When using an external supply, the supply should be connected only to specifically labeled terminal block power inputs. Connecting an external supply to the handshake lines may damage the unit.

2. **BAUD RATE**: 19200 Baud max.

3. **RS-232 SIDE**:

   Connector: DB-9 female

SIGNAL	PIN	JUMPERED
TD	2	
RD	3	
GND	5	
RTS	7	to pin 8
CTS	8	to pin 7
DTR	4	to pin 6, 1
DSR	6	to pin 4, 1
CD	1	to pin 4, 6

4. **RS485 SIDE:**

   Connector: terminal block

TERMINAL	RJ11 CABLE
TD(A)	Green
TD(B)	Yellow
GND	Red
GND	*
+12V	*

   * External 12 VDC supply optional.

5. **CERTIFICATIONS AND COMPLIANCE**:

   Immunity to EN 500082-1 Residential, Commercial and Light Industry (IEC 801-2, IEC 801-3, IEC 801-4)

   Emissions to EN 500081-1 Residential, Commercial and Light Industry (EN 55022)

6. **CONVERTER DIMENSIONS**: L = 3.50" (88.9 mm) x W = 1.34" (34 mm) x H = 0.67" (17 mm)

7. **CABLE LENGTH**: 7 feet (2.13 meters)

PARADIGM TO RS485 RJ-11 INTERFACE CABLE

DESCRIPTION

The Paradigm to RJ-11 Interface Cable allows the Paradigm operator interfaces to be easily connected to any Red Lion Controls DIN rail module with an RS485 RJ-11 port. Both ends of this 7-foot cable are pre-wired to provide a reliable RS485 connection.
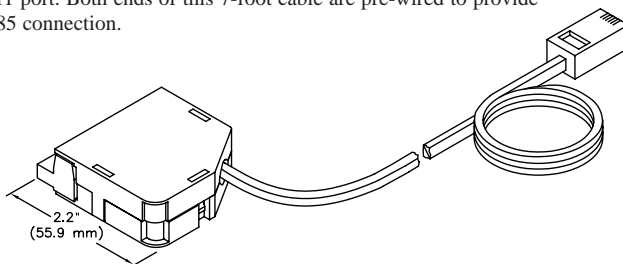
ORDERING INFORMATION

MODEL	DESCRIPTION	PART NUMBER
CBPRO	Programming Interface Cable	CBPRO007
	Paradigm to RJ-11 Interface Cable	P893805Z

2.2"
(55.9 mm)

red lion

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion-controls.com

DeviceNet
CONFORMANCE TESTED

MODEL DLCN - DUAL LOOP CONTROLLER / DATA ACQUISITION MODULE w/DEVICENET™

USING THIS DOCUMENT

This document is an addendum to the standard DLC bulletin and describes the use of the DeviceNet™ connection to the DLCN. This document should be read in conjunction with the DLC bulletin.

GENERAL DESCRIPTION

The Model DLCN, Dual Loop Controller with DeviceNet, has a similar feature set and specifications as the standard Dual Loop Controller. The DLCN operates as a DeviceNet Slave, providing a connection to a standard DeviceNet network. Once a valid MAC ID and Baud Rate have been established, the supported attributes (see table: **DLCN DeviceNet SUPPORTED ATTRIBUTES**) can be accessed by a Master, providing control and status functions for each PID loop. The DLCN can also be fully programmed via the built-in RS485 communications port using our Windows® based RLCPro configuration software (refer to the DLC bulletin).

In addition, the model DLCN can be used as a simple analog data acquisition device for monitoring T/C's, RTD's, voltage and current over a DeviceNet network.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
DLCN	Dual Loop Controller, w/ 5 Pin Male M12 connector	DLCN0001
	Dual Loop Controller, w/ 2 analog outputs, 5 Pin Male M12 connector	DLCN1001
	Dual Loop Setpoint Controller, w/ 2 analog outputs, 5 Pin Male M12 connector	DLCN1101
	Dual Loop Controller, w/ COMBICON screw flange connector	DLCN0011
	Dual Loop Controller, w/ 2 analog outputs, COMBICON screw flange connector	DLCN1011
	Dual Loop Setpoint Controller, w/ 2 analog outputs, COMBICON screw flange connector	DLCN1111

PROGRAMMING THE DLCN via RLCPro

In order to program the DLCN via RLCPro, the DeviceNet bus cable must be disconnected from the unit. This causes the internal DLCN communication bus to automatically switch to the front panel Modbus programming port. When programming is complete, the unit may be attached to the DeviceNet bus, thus disabling the front panel port and enabling DeviceNet communications. The DLCN Modbus communication parameters are fixed at 19200 baud, unit address of 247, 8 data bits, no parity, RTU mode. The DIP and Rotary Switches, as described below, are used for DeviceNet settings only.

SETTING THE MAC ID and BAUD RATE

The DLCN DeviceNet MAC ID is set using two rotary switches allowing the ID to be set in standard decimal notation (e.g. MAC ID = 27, SWC = 2, SWB = 7) from 0 to 63. (64-99 are not used.) The baud rate is set with DIP switches. The following table explains the baud rate settings.

DIP SWITCH SETTING TABLE

SWITCH SWA	SETTING
1 off, 2 off	Force 125 K baud
1 on, 2 off	Force 250 K baud
1 off, 2 on	Force 500 K baud
1 on, 2 on	Autobaud Detect (factory default)

Autobaud will match the DLCN DeviceNet baud rate to the network baud rate within 5 seconds every time the DLCN power is cycled. The DLCN must be connected to a bus carrying valid message traffic. In noisy environments autobaud may not be able to properly detect the network baud rate. In this case, manually set the baud rate as required.

Note: Configuration of MAC ID and baud rate is not supported over DeviceNet.

MOD/NET STATUS LED

The MOD/NET Status LED provides a visual indication to the operator of the current status of the DeviceNet interface. The DLCN primary power and DeviceNet power must be applied for correct LED function.

What to look for:
A. Startup:
  LED flashes Green for 0.25 sec, then Red for 0.25 sec, then Off.
B. LED Off:
  This device is the only device on the network (waiting for an acknowledgment to its duplicate MAC ID check), or this device is not powered.
C. Flashing Red LED:
  An I/O connection has timed out, or a recoverable error has occurred.
D. Flashing Green LED:
  The device is functioning correctly and is waiting to be commissioned by a bus master.
E. Solid Red LED:
  The device has encountered a non-recoverable fault, such as a duplicate MAC ID response, and has removed itself from the bus.
F. Solid Green LED:
  The device is on line, functioning correctly and has been commissioned by a bus master.

DeviceNet™ SPECIFICATIONS

POWER SUPPLY
Source: Supplied by DeviceNet bus. The bus does not power the host.
Voltage: 11 to 25 VDC.
Current:
Nominal: 40 mA at 25 VDC.
Inrush: 550 mA for 5 msec at 25 VDC.

NETWORK SPECIFICS
Compatibility: Group 2 Server Only, not UCMM capable.
Baud Rates: 125 Kbaud, 250 Kbaud, and 500 Kbaud.
Bus Interface: Phillips 82C250 or equivalent with mis-wiring protection per DeviceNet Volume 1 Section 10.2.2.
Node Isolation: Bus powered, isolated node.
Host Isolation: 500 Vrms for 1 minute (50 V working) between DeviceNet and DLC input common.

INSTALLATION INFORMATION
Factory Settings:
Baud rate: Autobaud
MAC ID: 63
Strobe Register: 03h
Swap data flag: Off.

Bus Connection - based on model chosen. See ORDERING INFORMATION, Page 1. For Connection Options, See Diagram on Page 4.

M12		COMBICON	
1 = SHIELD		V	1
2 = V+	③	CAN L	2
3 = V	④ ⑤ ②	SHIELD	3
4 = CAN H	①	CAN H	4
5 = CAN L		V+	5
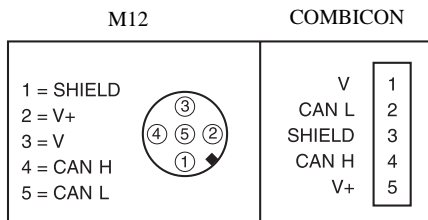
Note: Shield has no internal connection in the DLCN.

Standard Wire Colors:

V+	Red
V-	Black
CAN_H	White
CAN_L	Blue
SHIELD	Bare

CONNECTION SIZES
Device Profile: This product conforms to the DeviceNet specification Volumes I and II of version 2.0.
Device Configuration: No DeviceNet configuration is supported. However, some DLC configuration is supported.

MESSAGE	PRODUCED	CONSUMED
Explicit	4 Bytes	2 Bytes
Polled	4 Bytes	2 Bytes
Bit Strobe	8 Bytes	2 Bytes

SUPPORT CONNECTIONS

Polled Command: The Polled Command produces 4 bytes of data, and is used to get, or set attributes. The device attribute is determined by the value in byte 0 of the data field. Refer to the Supported Attributes table for the appropriate value. Byte 1 determines the action: 0 = get, 1 = set. The next 2 bytes are the new attribute value for the set command. For get commands, enter 2 zeros. The data response from the Polled Command is in the format of a 2 byte hexadecimal number. For the get command (0), the response is the attribute value. For the set command (1), the response is an echo of the data input.

Bit Strobe Command: The data response from the Bit Strobe Command is in the format of a 2 byte hexadecimal number. The register that will be read using the Bit Strobe command is determined by setting Attribute 2, Instance 1, Class 100* (decimal) with a value that represents the desired attribute. Refer to the Supported Attributes table for the appropriate value.

EXPLICIT MESSAGE COMMAND
Get Attribute: The attribute that will be read using the Get Attribute command is determined by setting Service Code 14, Instance 1, Class 100* (decimal), and the attribute with a value that represents the desired meter attribute. Refer to the Supported Attributes table for the appropriate value. The data response from the Get Attribute Command is in the format of a 2 byte hexadecimal number.

Set Attribute: The attribute that will be set using the Set Attribute command is determined by setting Service Code 16, Instance 1, Class 100* (decimal), and the attribute with a value that represents the desired meter attribute. Refer to the Supported Attributes table for the appropriate value. The data field for the Set Attribute Command is entered as a 2 byte hexadecimal number.

OTHER EXPLICIT MESSAGE ATTRIBUTES
Data Byte Swap: (1 byte), Attribute 1, Instance 1, Class 100* (decimal). Data is normally sent and entered as follows: DLC value = 50000 (C350h). 2 byte value sent would be 50C3. Setting the data swap value to 1 would result in the data being sent as C350. This attribute can only be set to 0 or 1, all other values are ignored. The factory setting value is 0. Data byte is saved in EEPROM memory.

Data Update: The DeviceNet interface is continually requesting values from the DLC main processor and updating buffer registers. As such, valid attribute values are always available over DeviceNet at the maximum bus rate.

Vendor Specific Error Responses

CODE ERROR #	ERROR CODE MEANING
1F (General Code)	Vendor Specific Error
1 (Additional Code)	Device Response Time-out
2 (Additional Code)	Vendor Service Not Supported
3 (Additional Code)	Command String Syntax Error

Class 100 (decimal) is a vendor specific class.

DLCN DeviceNet SUPPORTED ATTRIBUTES

This subset of registers is supported via DeviceNet communications. Modbus registers are provided for reference only. See the DLC bulletin for complete register and Modbus programming details.
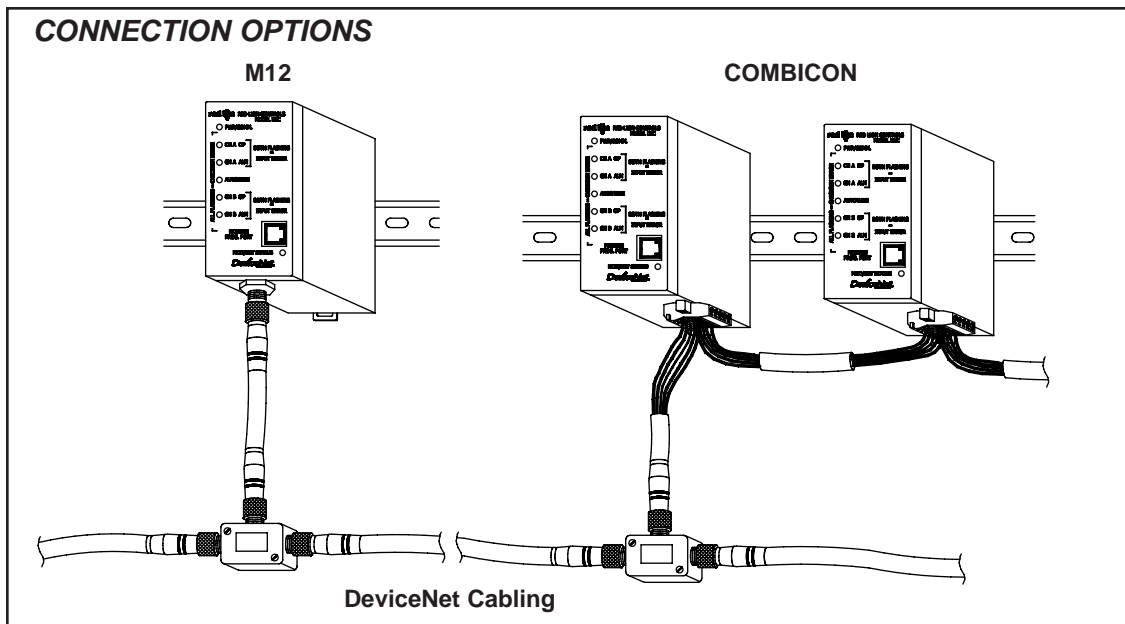
REGISTERS				REGISTER NAME	LOW LIMIT	HIGH LIMIT	FACTORY SETTING	SERVICE CODES SUPPORTED
CHA		CHB						
Modbus Register	Attribute	Modbus Register	Attribute	**DEVICENET SPECIFIC ATTRIBUTES**				
	1	-	-	Data Byte Swap	See description under *OTHER EXPLICIT MESSAGE ATTRIBUTES*			
	2	-	-	Bit Strobe	See description under *SUPPORT CONNECTIONS*			
				CONTROLLING VALUES				
40001	3	40017	8	Process Value	N/A	N/A	N/A	G
40002	4	40018	9	Setpoint Value	-32000	32000	0	G, S
40003	5	40019	10	Alarm 1 Value	-32000	32000	0	G, S
40004	6	40020	11	Alarm 2 Value	-32000	32000	0	G, S
				PID PARAMETERS				
40005	7	40021	12	Output Power	0 or -1000	1000	0	G, S
40007	13	40023	22	Proportional Band	0	9999	40	G, S
40008	14	40024	23	Integral Time	0	9999	120	G, S
40009	15	40025	24	Derivative Time	0	9999	30	G, S
40011	16	40027	25	Auto-Tune Start	0	1	0	G, S
40012	17	40028	26	Auto-Tune Phase	N/A	N/A	N/A	G
40013	18	40029	27	Auto-Tune Code	0	2	0	G, S
				OUTPUT STATUS				
40014	19	40030	28	Control Output OP1	N/A	N/A	N/A	G
40015	20	40031	29	Alarm Output AL1	0	1	0	G, S
40016	21	40032	30	Alarm Output AL2 / OP2	0	1	0	G, S
				CONTROL STATUS				
40041	31	40049	37	Control Mode	0	1	0	G, S
40042	32	40050	38	Disable Setpoint Ramping	0	1	0	G, S
40043	33	40051	39	Setpoint Ramping In Process	N/A	N/A	N/A	G
40044	34	40052	40	Disable Integral Action	0	1	0	G, S
40045	35	40053	41	Ramping Setpoint Value	N/A	N/A	N/A	G, S
40046	36	-	-	Remote / Local Setpoint Select	0	1	0	G, S
				PROFILE OPERATION - SETPOINT CONTROLLER MODEL ONLY				
40065	42	40073	48	Profile Operating Status	0	3	0	G, S
40066	43	40074	49	Profile Phase	N/A	N/A	N/A	G
40067	44	40075	50	Profile Segment	N/A	N/A	N/A	G
40068	45	40076	51	Profile Phase Time Remaining	1	9999	N/A	G, S
40069	46	40077	52	Profile Cycle Count Remaining	1	250	0	G, S
40070	47	40078	53	Advance Profile Phase	0	1	0	G, S
				COOLING (OP2) PARAMETERS				
40141	54	40241	57	Cycle Time	0	250	20	G, S
40142	55	40242	58	Relative Gain	0	100	10	G, S
40143	56	40243	59	Deadband	-32000	32000	0	G, S
				CALIBRATION				
40504	60	-	-	Input Error Status Register (See COILS TABLE for bit definitions)	N/A	N/A	N/A	G
40505	61	-	-	Checksum Error Status Register (See COILS TABLE for bit definitions)	0	N/A	0	G, S

DLCN DeviceNet SUPPORTED ATTRIBUTES, Setpoint Controller Model Only

REGISTERS				REGISTER NAME	LOW LIMIT	HIGH LIMIT	FACTORY SETTING	SERVICE CODES SUPPORTED
CHA		CHB						
Modbus Register	Attribute	Modbus Register	Attribute	SETPOINT CONTROLLER PROFILE SEGMENTS - SETPOINT CONTROLLER MODEL ONLY				
40601 to 40620	62-81	40701 to 40720	122-141	Setpoint Value Segment 1-20	-32000	32000	-	G,S
40621 to 40640	82-101	40721 to 40740	142-161	Ramp Rate Segment 1-20	0	32000	-	G, S
40641 to 40660	102-121	40741 to 40760	162-181	Hold Time Segment 1-20	0	9999	-	G, S

COILS TABLE (Cross-Reference to attributes 60 and 61)

COIL ADDRESS		COIL NAME	MIRROR REGISTER	SERVICE CODES SUPPORTED
1		Calibration Checksum Error	40505 (bit 0)	G, S
2		Parameter Checksum Error	40505 (bit 1)	G, S
3		Integral and Offset/Manual Power Checksum Error	40505 (bit 2)	G, S
CH A	CH B			
5	17	Shorted RTD Input Error	40504 (bit 0 / 4)	G
6	18	Open Thermocouple, RTD, or Extreme Process Input Over/Under Range Input Error	40504 (bit 1 / 5)	G
7	19	Signal or Sensor Under Range Input Error	40504 (bit 2 / 6)	G
		Process Value (<-32000) Under Range Input Error	40504 (bit 2 / 6)	G
8	20	Signal or Sensor Over Range Input Error	40504 (bit 3 / 7)	G
		Process Value (>32000) Over Range Input Error	40504 (bit 3 / 7)	G

CONNECTION OPTIONS

M12   **COMBICON**

DeviceNet Cabling

red lion

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www.redlion.net

MODEL DSP – DATA STATION PLUS

- *PROTOCOL CONVERSION FEATURE CONVERTS NUMEROUS PROTOCOLS SIMULTANEOUSLY*
- *COMPACTFLASH® SLOT ALLOWS PROCESS DATA TO BE LOGGED DIRECTLY TO CSV FILES*
- *VIRTUAL HMI OFFERS BUILT-IN PC-BASED SCADA FUNCTIONALITY*
- *WEBSERVER PROVIDES WORLDWIDE ACCESS TO DATA LOGS AND VIRTUAL HMI*
- *EXTENSIVE BUILT-IN DRIVER LIST ALLOWS EASY DATA MAPPING TO PLCs, PCs, AND SCADA SYSTEMS*
- *ALARM NOTIFICATIONS CAN BE SENT VIA EMAIL OR TEXT MESSAGES*
- *10 BASE-T/100 BASE-TX ETHERNET CONNECTION CAN CONNECT TO AN UNLIMITED NUMBER OF DEVICES VIA FOUR PROTOCOLS SIMULTANEOUSLY*

GENERAL DESCRIPTION

The Data Station Plus was designed to act as a nexus for industrial data collection and management. The unit offers multiple protocol conversion, data logging and remote machine access. With three built in serial ports and a 10 Base-T/100 Base-TX Ethernet port, the unit performs protocol conversion, allowing disparate devices to communicate seamlessly with one another. The Ethernet port supports up to four protocols simultaneously so even Ethernet to Ethernet protocols can be converted.

The CompactFlash card allows data to be collected and stored for later review. The files are stored in simple CSV file format allowing common applications, such as Microsoft Excel and Access, to view and manage the data. The free Websync utility provides a means to synchronize the files with a PC's hard drive for permanent storage. The CompactFlash card may also be used to load new configuration files into the Data Station.

The built-in web server allows log files to be retrieved manually, and also provides access to the unique "virtual HMI". The virtual HMI is programmed just like Red Lion's G3 series of HMI. Any standard web browser such as Internet Explorer or Netscape may be used to monitor or control the HMI from a PC anywhere in the world.

The USB port may be used for blazing fast file downloads, or to mount the Data Station's CompactFlash card as an external drive to your PC.

The Data Station's DIN rail mounting saves time and panel space and snaps easily onto standard top hat (T) profile DIN rail.

SOFTWARE

The Data Station is programmed with Windows® compatible Crimson 2.0 software. The software is an easy to use graphical interface which can be purchased as part of a kit that includes a manual and cables, or downloaded free of charge from www.redlion.net.

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 controller 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 controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

> ⚠ **CAUTION: Risk of Danger.**
> Read complete instructions prior to installation and operation of the unit.

CompactFlash is a registered trademark of CompactFlash Association.

DIMENSIONS In inches (mm)

3.09 (78.5)

4.15 (105.4)

5.30 (134.7)

SPECIFICATIONS

1. **POWER**: 24 VDC ± 10%
   200 mA min., without expansion card
   4 Amps maximum with expansion card fitted
   Must use Class 2 or SELV rated power supply.

2. **COMMUNICATIONS**:
   USB/PG Port: Adheres to USB specification 1.1. Device only using Type B connection.
   Serial Ports: Format and Baud Rates for each port are individually software programmable up to 115,200 baud.
   RS232/PG Port: RS232 port via RJ12
   COMMS Ports: RS422/485 port via RJ45, and RS232 port via RJ12
   DH485 TXEN: Transmit enable; open collector, V_{OH} = 15 VDC, V_{OL} = 0.5 V @ 25 mA max.
   Ethernet Port: 10 BASE-T / 100 BASE-TX
   RJ45 jack is wired as a NIC (Network Interface Card).

3. **LEDs**:
   STS – Status LED indicates condition of Data Station.
   TX/RX – Transmit/Receive LEDs show serial activity.
   Ethernet – Link and activity LEDs.
   CF – CompactFlash LED indicates card status and read/write activity

4. **MEMORY**:
   On-board User Memory: 4 Mbytes of non-volatile Flash memory.
   On-board SDRAM:
   DSPSX: 2 Mbytes
   DSPGT: 8 Mbytes
   Memory Card: CompactFlash Type II slot for Type I and Type II cards.

5. **REAL-TIME CLOCK**: Typical accuracy is less than one minute per month drift. Crimson 2.0's SNTP facility allows synchronization with external servers.
   Battery: Lithium Coin Cell. Typical lifetime of 10 years at 25 ºC.
   A "Battery Low" system variable is available so that the programmer can choose specific action(s) to occur when the battery voltage drops below its nominal voltage.

6. **ENVIRONMENTAL CONDITIONS**:
   Operating Temperature Range: 0 to 50°C
   Storage Temperature Range: -30 to +70°C
   Operating and Storage Humidity: 80% max relative humidity, non-condensing, from 0 to 50°C
   Altitude: Up to 2000 meters

7. **CONSTRUCTION**: Case body is burgundy high impact plastic and stainless steel. Installation Category I, Pollution Degree 2.

8. **POWER CONNECTION**: Removable wire clamp screw terminal block.
   Wire Gage Capacity: 24 AWG to 12 AWG
   Torque: 4.45 to 5.34 in/lb (0.5 to 0.6 N-m)

9. **MOUNTING**: Snaps onto standard DIN style top hat (T) profile mounting rails according to EN50022 -35 x 7.5 and -35 x 15.

10. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    IEC 61010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
    ELECTROMAGNETIC COMPATIBILITY
    Emissions and Immunity to EN 61326: Electrical Equipment for Measurement, Control and Laboratory use.

Immunity to Industrial Locations:

Electrostatic discharge	EN 61000-4-2	Criterion A [2] 4 kV contact discharge 8 kV air discharge
Electromagnetic RF fields	EN 61000-4-3	Criterion A 10 V/m
Fast transients (burst)	EN 61000-4-4	Criterion A 2 kV power 2 kV signal
Surge	EN 61000-4-5	Criterion A 1kV L-L,2 kV L&N-E power
RF conducted interference	EN 61000-4-6	Criterion A 3 V/rms

Emissions:

Emissions	EN 55011	Class A

Notes:
1. Criterion A: Normal operation within specified limits.
2. This device was designed for installation in an enclosure. To avoid electrostatic discharge to the unit in environments with static levels above 4 kV precautions should be taken when the device is mounted outside an enclosure. When working in an enclosure (ex. making adjustments, setting jumpers etc.) typical anti-static precautions should be observed before touching the unit.

11. **WEIGHT**: 15.1 oz (456.4 g)
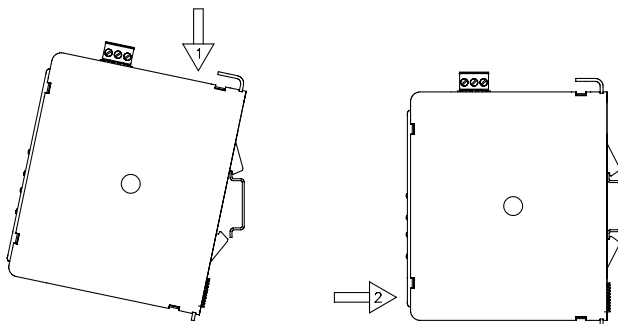
HARDWARE
INSTALLATION

Figure 1 - Attach Data Station To DIN Rail

COMPACTFLASH® CARD

CompactFlash socket is a Type II socket that can accept either Type I or II cards. Use cards with a minimum of 4 Mbytes with the Data Station's CompactFlash socket. Cards are available at most computer and office supply retailers. CompactFlash can be used for configuration transfers, data logging, and trending.

CompactFlash—
Insert Top Side
Towards Left
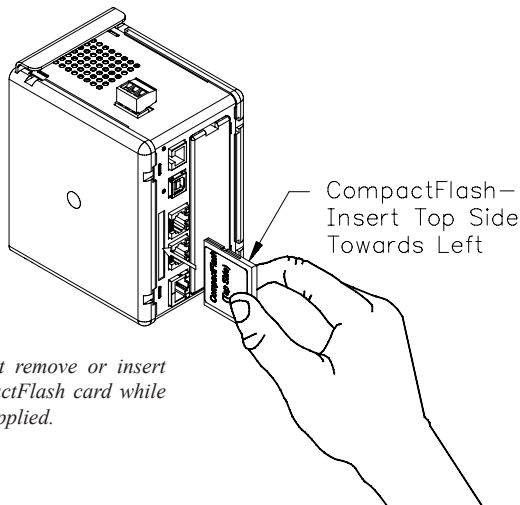
Note: Do not remove or insert the CompactFlash card while power is applied.

Information stored on a CompactFlash card can be read by a card reader attached to a PC. This information is stored in IBM (Windows®) PC compatible FAT16 file format.

NOTE

For reliable operation in all of our products, Red Lion recommends the use of SanDisk® and SimpleTech brands of CompactFlash cards.

Industrial grade versions that provide up to two million write/erase cycles minimum are available from Red Lion.

POWER SUPPLY REQUIREMENTS

It is very important that the power supply is mounted correctly if the unit is to operate reliably. Please take care to observe the following points:

– The power supply must be mounted close to the unit, with usually not more than 6 feet (1.8 m) of cable between the supply and the Data Station. Ideally, the shortest length possible should be used.

– The wire used to connect the Data Station's power supply should be at least 22-gage wire. If a longer cable run is used, a heavier gage wire should be used. The routing of the cable should be kept away from large contactors, inverters, and other devices which may generate significant electrical noise.

– A power supply with a Class 2 or SELV rating is to be used. A Class 2 or SELV power supply provides isolation to accessible circuits from hazardous voltage levels generated by a mains power supply due to single faults. SELV is an acronym for "safety extra-low voltage." Safety extra-low voltage circuits shall exhibit voltages safe to touch both under normal operating conditions and after a single fault, such as a breakdown of a layer of basic insulation or after the failure of a single component has occurred.

Visit www.redlion.net for a complete list of our PSDR Series of Class 2 power supplies.

EMC INSTALLATION GUIDELINES

Although Red Lion Controls Products are designed with a high degree of immunity to Electromagnetic 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 a 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 are some EMI guidelines for a successful installation in an industrial environment.

1. To reduce the chance of noise spikes entering the unit via the power lines, connections should be made to a clean source. Connecting to circuits that also power loads such as contactors, relays, motors, solenoids etc. should be avoided.
2. The unit should be mounted in a metal enclosure, which is properly connected to protective earth.
3. 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 to earth ground (protective earth) at one end where the unit is mounted.
   b. Connect the shield to earth ground at both ends of the cable, usually when the noise source frequency is over 1 MHz.
   c. Connect the shield to common of the Data Station and leave the other end of the shield unconnected and insulated from earth ground.

4. 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 through 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. Also, 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. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.
6. In extremely high EMI environments, the use of external EMI suppression devices is effective. The following EMI suppression devices (or equivalent) are recommended:
   Ferrite Suppression Cores for signal and control cables:
      Fair-Rite part number 0443167251 (RLC part number FCOR0000)
      TDK part number ZCAT3035-1330A
      Steward part number 28B2029-0A0
   Line Filters for input power cables:
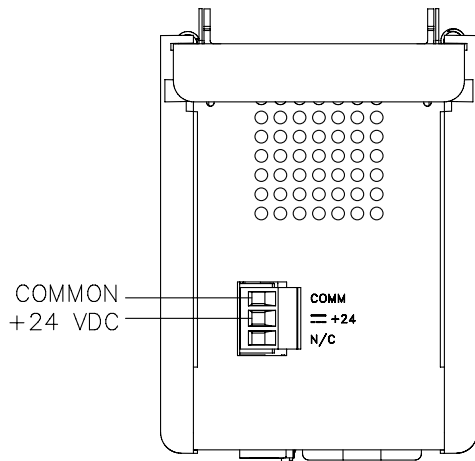   Schaffner part number FN610-1/07 (RLC part number LFIL0000)
      Schaffner part number FN670-1.8/07
      Corcom part number 1 VR3

Visit RLC's web site at www.redlion.net for more information on EMI guidelines, Safety and CE issues as they relate to Red Lion Controls products.

WIRING
POWER CONNECTION
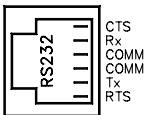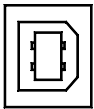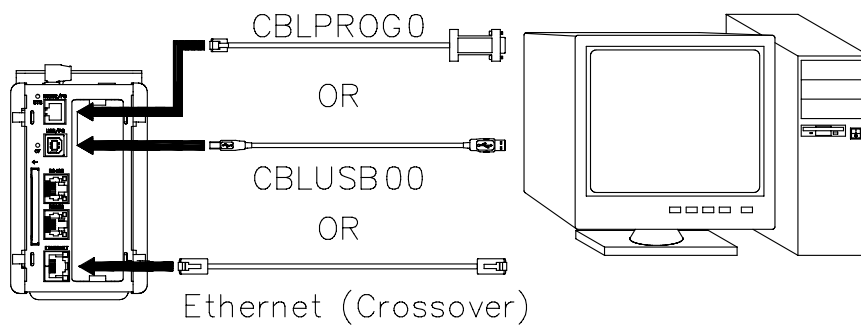

COMMON
+24 VDC

COMM
+24
N/C

PROGRAMMING PORTS

RS232/PG

RS232
CTS
Rx
COMM
COMM
Tx
RTS

USB/PG

ETHERNET

GREEN/AMBER LED

YELLOW LED

CBLPROG0

OR

CBLUSB00

OR

Ethernet (Crossover)

COMMUNICATION PORTS

RS232/PG

RS232
CTS
Rx
COMM
COMM
Tx
RTS

CBLPROG0

OR

CBLxxxxx*

RS232


```
RTS
Tx
COMM
COMM
Rx
CTS
```
RS232

CBLxxxxx*
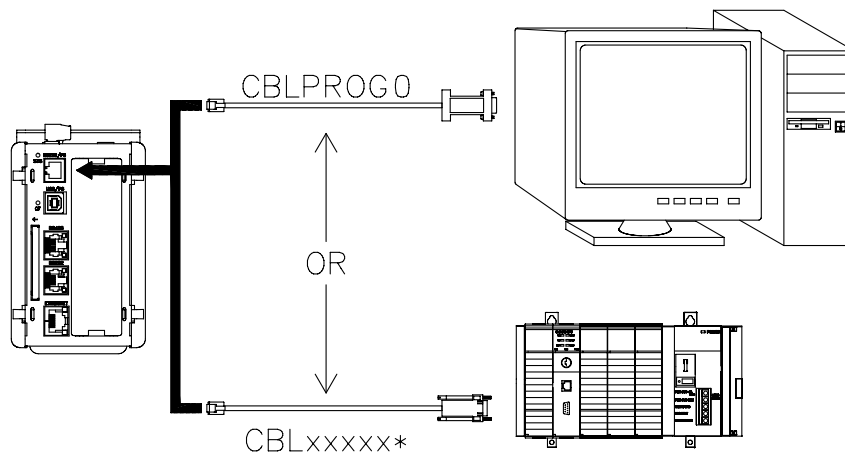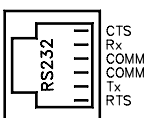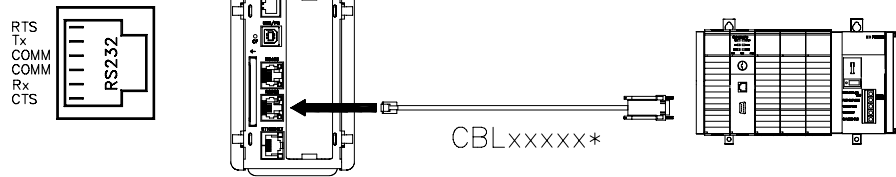
* Use appropriate communications cable. See Ordering Information for descriptions of the available cables.

RS485


```
TxA
TxB
COMM
TxEN
RxB
RxA
TxA
TxB
```
RS485

CBLxxxxx*
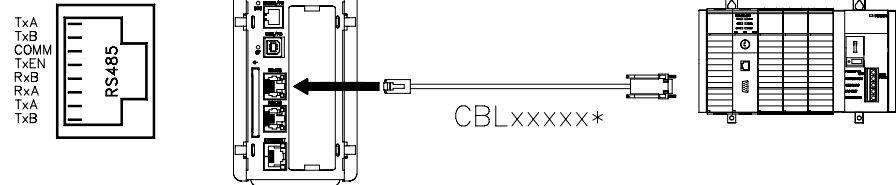
WARNING: Do **NOT** use a standard DH-485 cable to connect this port to Allen Bradley equipment.

PORT 3 - ETHERNET CONNECTION

GREEN/AMBER LED

YELLOW LED

Standard Ethernet cable

DATA STATION PORT PIN OUTS

1 COMMON
2 24VDC ±10%
3 N/C

POWER CONNECTOR

CTS (PIN 1)
Rx
COMM
Tx
RTS (PIN 6)

RS232

RS232/PG PORT

USB/PG

TxB (PIN 1)
RxA
RxB
TxEN
COMM
TxA (PIN 8)

RS485

COMMS PORT

CTS (PIN 1)
Rx
COMM
Tx
RTS (PIN 6)

RS232

COMMS PORT

GREEN/AMBER LED
YELLOW LED

ETHERNET (NIC)
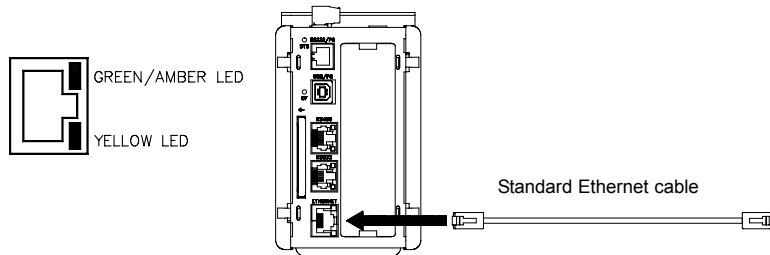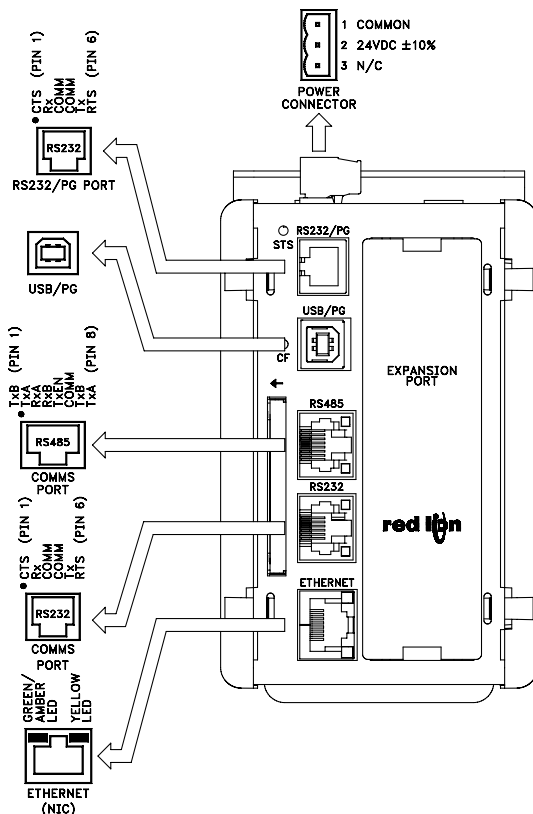
TROUBLESHOOTING

If for any reason you have trouble operating, connecting, or simply have questions concerning your new Data Station, contact Red Lion's technical support. For contact information, refer to the back page of this bulletin for phone and fax numbers.

EMAIL: techsupport@redlion.net
Web Site: http://www.redlion.net

COMMUNICATING WITH THE DATA STATION

CONFIGURING A DATA STATION

The Data Station is configured using Crimson 2.0 software. Crimson 2.0 is available as a free download from Red Lion's website, or it can be ordered on CD. Updates to Crimson 2.0 for new features and drivers are posted on the website as they become available. By configuring the Data Station using the latest version of Crimson 2.0, you are assured that your unit has the most up to date feature set. Crimson 2.0 software can configure the Data Station through the RS232/PG port, USB/PG port, Ethernet, or CompactFlash. The USB/PG port is connected using a standard USB cable with a Type B connector.

The driver needed to use the USB port will be installed with Crimson 2.0. The RS232/PG port uses a programming cable made by Red Lion to connect to the DB9 COM port of your computer. If making your own cable, refer to the "Data Station Port Pin Outs" for wiring information.

The CompactFlash can be used to program a Data Station by placing a configuration file and firmware on the CompactFlash card. The card is then inserted into the target Data Station and powered. Refer to the Crimson 2.0 literature for more information on the proper names and locations of the files.

CABLES AND DRIVERS

Red Lion has a wide range of cables and drivers for use with many different communication types. A list of these drivers and cables along with pin outs is available from Red Lion's website. New cables and drivers are added on a regular basis. If making your own cable, refer to the "Data Station Port Pin Outs" for wiring information.

USB, DATA TRANSFERS FROM THE COMPACTFLASH CARD

In order to transfer data from the CompactFlash card via the USB port, a driver must be installed on your computer. This driver is installed with Crimson 2.0 and is located in the folder C:\Program Files\Red Lion Controls\Crimson 2.0\Device\ after Crimson 2.0 is installed. This may have already been accomplished if your Data Station was configured using the USB port.

Once the driver is installed, connect the Data Station to your PC with a USB cable, and follow "Mounting the CompactFlash" instructions in the Crimson 2.0 user manual.

Note that using the USB port for frequent data transfers is not recommended. For frequent data transfers it is recommended that the Ethernet connection be used. Through the Ethernet connection a web page can be set up to view logged data. Refer to the Crimson 2.0 manual for details.

Note: The USB port is for system set-up and diagnostics and is not intended for permanent connection.

ETHERNET COMMUNICATIONS

Ethernet communications can be established at either 10 BASE-T or 100 BASE-TX. The Data Station's RJ45 jack is wired as a NIC (Network Interface Card). For example, when wiring to a hub or switch use a straight-through cable, but when connecting to another NIC use a crossover cable.

The Crimson 2.0 manual contains additional information on Ethernet communications.

RS232 PORTS

The Data Station has two RS232 ports. There is the RS232/PG port and the COMMS port. Although only one of these ports can be used for programming, both ports can be used for communications with a PLC. The RS232/PG port can be used for either master or slave protocols.

RS422/485 PORT

The Data Station has one RS422/485 port. This port can be configured to act as either RS422 or RS485.
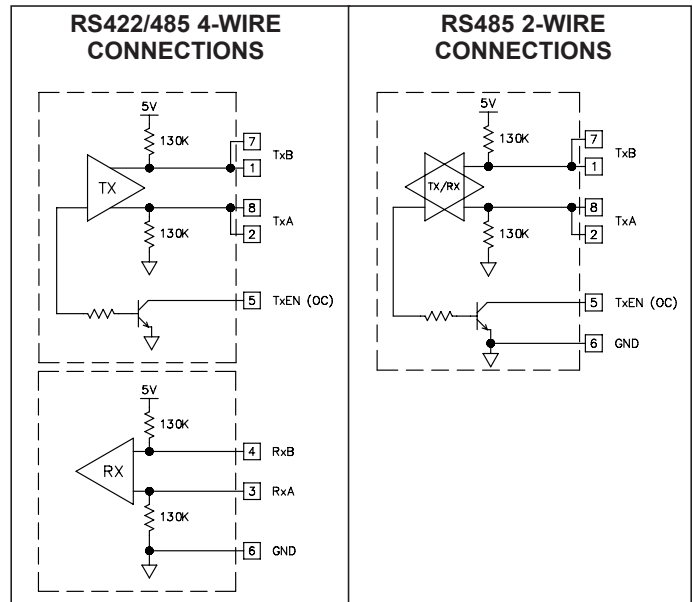
Note: All Red Lion devices connect A to A and B to B, except for Paradigm devices. Refer to www.redlion.net for additional information.

DH485 COMMUNICATIONS

The Data Station's RS422/485 COMMS port can also be used for Allen Bradley DH485 communications.

WARNING: DO NOT use a standard DH485 cable to connect this port to Allen Bradley equipment. A cable and wiring diagram are available from Red Lion.

LEDS

STS – STATUS LED

The green Status LED provides information regarding the state of the Data Station. This includes indication of the various stages of the start-up routine (power-up), and any errors that may occur.

Startup Routine

	INDICATION
Rapidly Flashing	Data Station is currently running the boot loader and/or being flash upgraded by Crimson.
Steady	Data Station is operating properly.

CF – COMPACTFLASH LED

LED	INDICATION
Off	No CompactFlash Card is present.
Steady	Valid CompactFlash card is present.
Flashing Rapidly	CompactFlash card is being checked.
Flickering	Unit is writing to the CompactFlash, either because it is storing data, or because the PC connected via the USB port has locked the drive. [1]
Flashing Slowly	Incorrectly formatted CompactFlash card present.

1. *Do not turn off power to the unit while this light is flickering. The unit writes data in two minute intervals. Later Microsoft operating systems will not lock the drive unless they need to write data; Windows 98 may lock the drive any time it is mounted, thereby interfering with logging. Refer to "Mounting the CompactFlash" in the Crimson 2.0 User Manual.*

USER COMMUNICATION PORTS - TX/RX LEDS

LED	INDICATION
GREEN	Transmitting
RED	Receiving

Note: LEDs are not available on the Programming Port: RS232/PG.

ETHERNET LEDS

LED	INDICATION
YELLOW (Solid)	Link Established
YELLOW (Flashing)	Network Activity
GREEN	10 BASE-T Communications
AMBER	100 BASE-TX Communications

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBER
Data Station Plus	Data Station with multiple protocol converter, data logger, web server and expansion slot.	DSPSX000
	Data Station with multiple protocol converter, data logger, web server and expansion slot with increased SDRAM.	DSPGT000
G3CF	64 MB CompactFlash Card [4]	G3CF064M
	256 MB CompactFlash Card [4]	G3CF256M
	512 MB CompactFlash Card [4]	G3CF512M
PSDR	DIN Rail Power Supply	PSDRxxxx
SFCRM2	Crimson 2.0 [2], Manual and Download Cable	SFCRM200
CBL	RS-232 Programming Cable	CBLPROG0
	USB Cable	CBLUSB00
	Communications Cables [1]	CBLxxxxx
DR	DIN Rail Mountable Adapter Products [3]	DRxxxxxx

[1] Visit www.redlion.net for a list of communication drivers and cables.

[2] Use this part number to purchase Crimson on CD with a printed manual, USB cable, and RS-232 cable. Otherwise, download free of charge from www.redlion.net.

[3] Red Lion offers RJ modular jack adapters. Refer to the DR literature for complete details.

[4] Industrial grade two million write cycles.

red lion

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion-controls.com

MODEL DLC - DUAL LOOP CONTROLLER

- MODULAR BUILDING BLOCK FOR MULTI-ZONE PROCESS CONTROL
- TWO INDEPENDENT PID CONTROL LOOPS
- PID CONTROL WITH REDUCED OVERSHOOT
- UNIVERSAL INPUTS ACCEPT TC, RTD, 0-10 V and 0/4-20 mA SIGNALS
- ON DEMAND AUTO-TUNING OF PID SETTINGS
- INPUT CHANNELS FULLY ISOLATED
- TWO DC ANALOG OUTPUTS (OPTIONAL)
- WINDOWS® CONFIGURATION SOFTWARE
- RS485 MODBUS™ PROTOCOL
- CHANNEL B CAN BE ASSIGNED AS A SECOND ANALOG INPUT TO CHANNEL A FOR REMOTE SETPOINT OPERATION
- SETPOINT CONTROLLER OPTION FOR TIME VS. TEMPERATURE/PROCESS (RAMP/SOAK) AND SPECIAL BATCH/RECIPE APPLICATIONS

UL Recognized Component, File #E156876

CE

GENERAL DESCRIPTION

The Model DLC, Dual Loop Controller, is a full featured, DIN rail mounted, dual input PID controller. The DLC is designed as a modular building block for multi-zone process control applications. The controller has two independent "A" & "B" input channels. Each channel's input can be configured to accept a wide range of thermocouple, RTD, 0-10 V, 0/4-20 mA, or resistive signals. Channel B can be also assigned as a Remote Setpoint for Channel A. The two time-proportioning or DC Analog outputs can be programmed to control two independent processes. The two alarms per channel can be configured for various alarm modes, or provide a secondary control output for heat/cool applications.

The control and alarm outputs are N channel open drain MOSFETs capable of switching up to 1 Amp DC. For applications requiring larger loads or A/C loads, several DIN rail mount relays are available.

The controller operates in the PID Control Mode for both heating and cooling, with on-demand auto-tune, that establishes the tuning constants. The PID tuning constants may be fine-tuned through the serial interface. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The controller can be transferred to operate in the Manual Mode, providing the operator with direct control of the output, or the On/Off Control Mode with adjustable hysteresis.

The controller's high density packaging and DIN rail mounting saves time and panel space. The controller snaps easily onto standard top hat (T) profile DIN rails.

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 controller 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 controller. An independent and redundant temperature limit indicator with alarm outputs is strongly recommended.

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

ALARMS

The DLC's two solid-state alarms can be configured independently for absolute high or low acting with balanced or unbalanced hysteresis. They can also be configured for deviation and band alarm. In these modes, the alarm trigger values track the setpoint value. Adjustable alarm trip delays can be used for delaying output response. The alarms can be programmed for Automatic or Latching operation. Latched alarms must be reset with a serial command. A standby feature suppresses the alarm during power-up until the temperature stabilizes outside the alarm region. The outputs can also be manually controlled with Modbus register or coil commands.

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	PART NUMBERS
DLC	Dual Loop Controller	DLC00001
	Dual Loop Controller w/ 2 Analog Outputs	DLC01001
	Dual Setpoint Controller w/ 2 Analog Outputs	DLC11001
SF	PC Configuration Software for Windows	SFDLC
CBPRO	Programming Interface Cable	CBPRO007
CBJ	Cable RJ11 to RJ11 (6 inch jumper)	CBJ11BD5
DRR	RJ11 to Terminal Adapter	DRRJ11T6
P89	Paradigm to RJ11 Cable	P893805Z
See our RSRLYB, RLY6, and RLY7 literature for details on DIN rail mountable relays.		

DIMENSIONS In inches (mm)

4.02 (102)

4.06 (103)

1.97 (50)
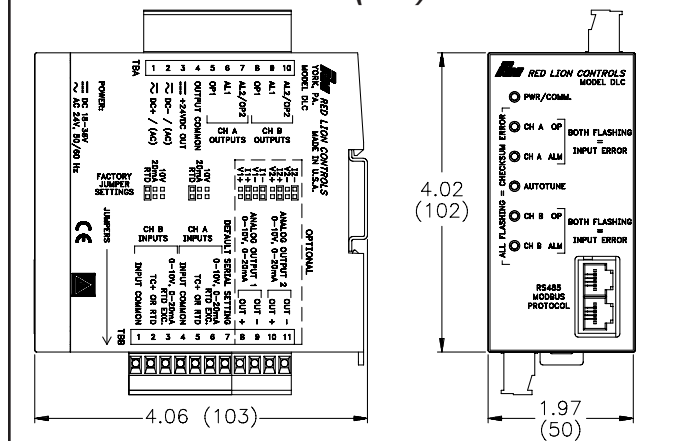
SETPOINT CONTROLLER OPTION

The Setpoint Controller option is suitable for time vs. temperature/process control applications. The controller allows a profile of up to 20 ramp/soak segments. Profile conformity is assured by using the Error Band Mode and Error Band parameter. The Profile Cycle Count allows the profile to run continuously or a fixed number of cycles. Power-on options automatically stop, abort, start, resume, or pause a running profile.

COMMUNICATIONS

The RS485 serial communications allows the DLC to be multi-dropped, with Baud rates up to 38400. The CBPRO007 programming cable converts the RS232 port of a PC to RS485 and is terminated with an RJ11 connector. The bi-directional capability of the CBPRO007 allows it to be used as a permanent interface cable as well as a programming cable.

SOFTWARE

The DLC is programmed with Windows® based SFDLC software. The software allows configuration and storage of DLC program files, as well as calibration. Additionally, all setup and control parameters can be interrogated and modified through MODBUS™ register and coil commands.

ANALOG OUTPUT OPTION

The optional dual DC Analog Output (10 V or 20 mA) can be independently configured and scaled for control or re-transmission purposes. These outputs can be assigned to separate channels, or both outputs can be assigned to the same channel. Programmable output update time reduces valve or actuator activity.

SPECIFICATIONS

1. **POWER**:
   18 to 36 VDC, 13 W
   (4 W if +24 VDC Output excitation is unused)
   24 VAC, ±10% 50/60 Hz, 15 VA
   (7 VA if +24 VDC Output excitation is unused)
   Must use a Class 2 or SELV rated power supply.
2. **+24 VDC OUTPUT POWER**: 24 VDC, +15%, -5%, 200 mA max
3. **MEMORY**: Non-volatile memory retains all programmable parameters.
4. **INPUT**:
   Sample Time: 100 msec (9.5 Hz)
   Failed Sensor Response: Open or shorted (RTD only) sensor coils indication, error code returned in Process Value
   Common Mode Rejection: >110 dB, 50/60 Hz
   Normal Mode Rejection: >40 dB, 50/60 Hz
   Temperature Coefficient: 0.013%/°C
   Overvoltage: 50 VDC max
   Step Response Time: 300 msec typ., 400 msec max
5. **THERMOCOUPLE INPUTS**:
   Types: T, E, J, K, R, S, B, N, C, linear mV
   Input Impedance: 20 MΩ
   Lead Resistance Effect: 0.25 µV/Ω
   Cold Junction Compensation: Less than ±1°C typical (±1.5°C max) over 0 to 50°C ambient temperature range or less than ±1.5°C typical (2°C max) over -20 to 65°C maximum ambient temperature range.
   Resolution: 1° or 0.1° for all types except linear mV (0.1 or 0.01 mV)

TYPE	MEASUREMENT RANGE	WIRE COLOR	
		ANSI	BS 1843
T	-200 to +400°C -328 to +752°F	(+) Blue (-) Red	(+) White (-) Blue
E	-200 to +750°C -328 to +1382°F	(+) Violet (-) Red	(+) Brown (-) Blue
J	-200 to +760°C -328 to +1400°F	(+) White (-) Red	(+) Yellow (-) Blue
K	-200 to +1250°C -328 to +2282°F	(+) Yellow (-) Red	(+) Brown (-) Blue
R	0 to +1768°C +32 to +3214°F	No Standard	(+) White (-) Blue
S	0 to +1768°C +32 to +3214°F	No Standard	(+) White (-) Blue
B	+149 to +1820°C +300 to +3308°F	No Standard	No Standard
N	-200 to +1300°C -328 to +2372°F	(+) Orange (-) Red	(+) Orange (-) Blue
C W5/W6	0 to +2315°C +32 to +4199°F	No Standard	No Standard
mV	-5 mV to 56 mV	N/A	N/A

6. **RTD INPUTS**:
   Type: 2 or 3 wire
   Excitation: 150 µA
   Lead Resistance: 15 Ω max
   Resolution: 1 or 0.1° for all types

TYPE	INPUT TYPE	RANGE
385	100 Ω platinum, Alpha = .00385	-200 to +600°C -328 to +1100°F
392	100 Ω platinum, Alpha = .003919	-200 to +600°C -328 to +1100°F
672	120 Ω nickel, Alpha = .00672	-80 to +215°C -112 to +419°F
ohms	Linear Resistance	0 to 320 Ω

7. **TEMPERATURE INDICATION ACCURACY**: ± (0.3% of span, +1°C). Includes NIST conformity, cold junction effect, A/D conversion errors, temperature coefficient and linearization conformity at 23 °C after 20 minute warm up.

8. **PROCESS INPUT**:

INPUT RANGE	ACCURACY * (18 to 28°C) (10 to 75% RH)	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
10 VDC (-1 to 11)	0.10% of reading +0.02 V	1 MΩ	50 V	1 mV
20 mA DC (-2 to 22)	0.10% of reading +0.03 mA	10 Ω	100 mA	1 µA

* Accuracies are expressed as ± percentages after 20 minute warm-up.

9. **ISOLATION LEVEL**: 500 V @ 50/60 Hz, for one minute (50 V working) between the following groups:
   Ch A Input
   Ch B Input
   Control and Alarm Outputs
   RS485/Analog Output [1]
   Power Supply
   Note:
   [1] RS485 and Analog Outputs are not internally isolated. Their commons must not be connected together externally for proper unit function (i.e., earth ground).

10. **SERIAL COMMUNICATIONS**:
    Type: RS485; RTU and ASCII MODBUS modes
    Baud: 300, 600, 1200, 2400, 4800, 9600, 19200, and 38400
    Format: 7/8 bits, odd, even, and no parity
    Transmit Delay: Programmable: See Transmit Delay explanation.
    Transmit Enable (TXEN): (primarily for 20 mA loop converter) open collector V_{OH} = 10 VDC max, V_{OL} = 0.5 VDC @ 5 mA max current limit

11. **A/D CONVERTER**: 16 bit resolution

12. **CONTROL AND ALARM OUTPUTS**:
    Type: Non-isolated switched DC, N Channel open drain MOSFET
    Current Rating: 1 A max
    $V_{DS ON}$: 0.3 V @ 1 A
    $V_{DS MAX}$: 30 VDC
    Offstate Leakage Current: 0.5 mA max

13. **MAIN CONTROL**:
    Control: PID or On/Off
    Output: Time proportioning or DC Analog
    Cycle Time: Programmable
    Auto-Tune: When selected, sets proportional band, integral time, derivative time values, and output dampening time
    Probe Break Action: Programmable

14. **ALARM**: 1 or 2 alarms
    Modes:
    Manual (through register/coil)
    Absolute High Acting (Balanced or Unbalanced Hysteresis)
    Absolute Low Acting (Balanced or Unbalanced Hysteresis)
    Deviation High Acting
    Deviation Low Acting
    Inside Band Acting
    Outside Band Acting
    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable
    Sensor Fail Response: Upscale

15. **COOLING**: Software selectable (overrides Alarm 2).
   Control: PID or On/Off
   Output: Time proportioning or DC Analog
   Cycle Time: Programmable
   Proportional Gain Adjust: Programmable
   Heat/Cool Deadband Overlap: Programmable
16. **ANALOG DC OUTPUTS**: (optional)
   Control or retransmission, programmable update rate from 0.1 sec or 1 to 250 sec

   Step Response Time: 100 msec

OUTPUT RANGE**	ACCURACY * (18 to 28°C) (10 to 75% RH)	COMPLIANCE	RESOLUTION (TYPICAL)
0 to 10 V	0.10% of FS + 1/2 LSD	10 KΩ min	1/18000
0 to 20 mA	0.10% of FS + 1/2 LSD	500 Ω max	1/18000
4 to 20 mA	0.10% of FS + 1/2 LSD	500 Ω max	1/14400

   * Accuracies are expressed as ± percentages after 20 minute warm-up.
   ** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximate 10% overrange and a small underrange (negative) signal.
17. **ENVIRONMENTAL CONDITIONS:**
   Operating Temperature Range: -20 to +65°C
   Storage Temperature Range: -40 to +85°C
   Operating and Storage Humidity: 85% max relative humidity, noncondensing, from -20 to +65°C
   Altitude: Up to 2000 meters

18. **CERTIFICATIONS AND COMPLIANCE**:
   SAFETY
      UL Recognized Component, File # E156876, UL873, CSA 22.2 No. 24 Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
      IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part I
   ELECTROMAGNETIC COMPATIBILITY
      Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 3; 8 kV air [1]
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 kV I/O Level 3; 2 kV power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms 150 KHz - 80 MHz

   Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A Power mains class A

[1] This controller was designed for installation in an enclosure. To avoid electrostatic discharge to the unit in environments with static levels above 6 kV, precautions should be taken when the device is mounted outside an enclosure. When working in an enclosure (ex. making adjustments, setting switches etc.), typical anti-static precautions should be observed before touching the controller.
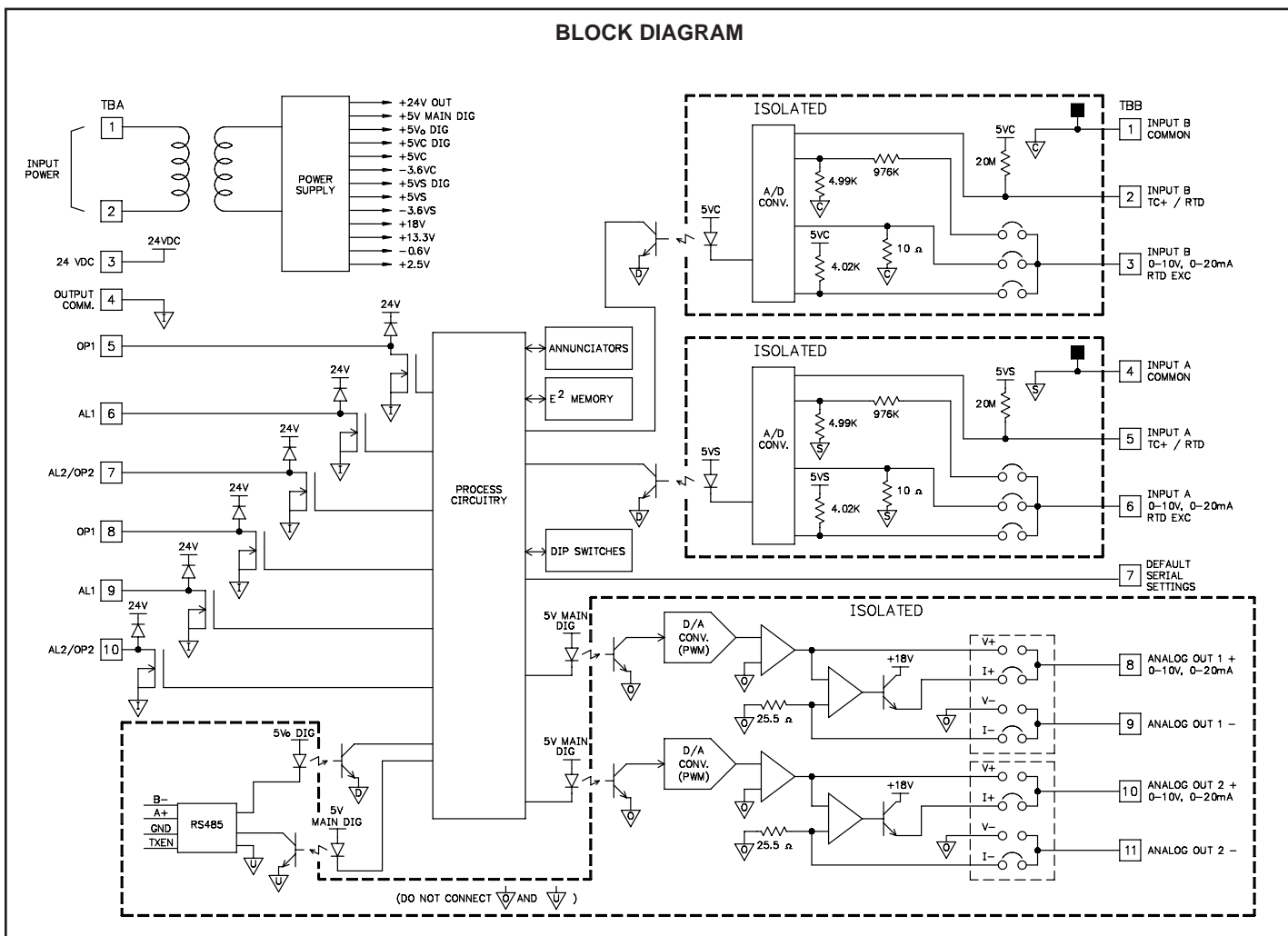
19. **CONSTRUCTION**: Case body is black high impact plastic. Installation Category I, Pollution Degree 2.
20. **CONNECTIONS**: Wire clamp screw terminals. Removable terminal blocks.
21. **MOUNTING**: Snaps on to standard DIN style top hat (T) profile mounting rails according to EN50022 -35 x 7.5 and -35 x 15.
22. **WEIGHT**: 10.5 oz. (298 g.)

BLOCK DIAGRAM

EMC INSTALLATION GUIDELINES

Although this controller is designed with a high degree of immunity to Electromagnetic 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 controller may be different for various installations. The controller becomes more immune to EMI with fewer I/O connections. Cable length, routing, and shield termination are very important and can mean the difference between a successful or troublesome installation. Listed are some EMC guidelines for successful installation in an industrial environment.

1. 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 DIN rail where the controller 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 over 1 MHz.
   c. Connect the shield to common of the controller and leave the other end of the shield unconnected and insulated from earth ground.

2. 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 through 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.

3. Signal or Control cables within an enclosure should be routed as far away as possible from contactors, control relays, transformers, and other noisy components.

4. 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 controller 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 controller to suppress power line interference. The following EMI suppression devices (or equivalent) are recommended:

   Ferrite Suppression Cores for signal and control cables:
     Fair-Rite # 0443167251 (Red Lion Controls # FCOR0000)
     TDK # ZCAT3035-1330A
     Steward # 28B2029-0A0
   Line Filters for input power cables:
     Schaffner # FN610-1/07 (Red Lion Controls # LFIL0000)
   Schaffner # FN670-1.8/07
     Corcom # 1 VR3
Note: Reference manufacturer's instructions when installing a line filter.

5. Long cable runs are more susceptible to EMI pickup than short cable runs. Therefore, keep cable runs as short as possible.

6. Switching of inductive loads produces high EMI. Use of snubbers across inductive loads suppresses EMI.
   Snubber: Red Lion Controls # SNUB0000.

STEP 1 SETTING THE JUMPERS AND DIP SWITCHES

The jumpers are accessible from the bottom of the controller. Needle-nose pliers are needed to remove the jumpers. They should be set prior to installation. To insure proper operation, the jumpers must match the controller software configuration.
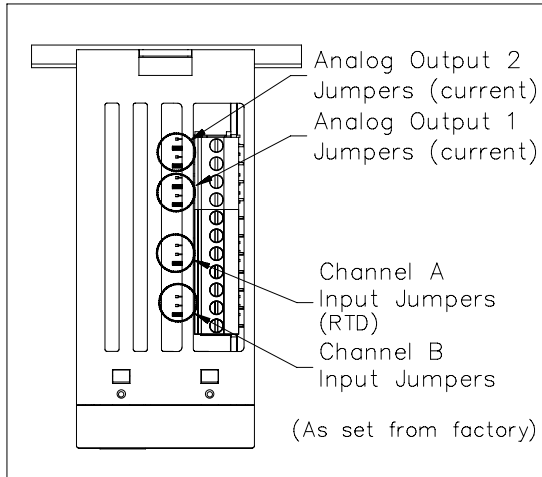

ANALOG DC OUTPUTS (OPTIONAL)

Analog Output 1 and Analog Output 2 can be configured for voltage (V) or current (I), independent of each other. Both V/I + and V/I - jumpers of the same channel must be set for the same type of output signal.
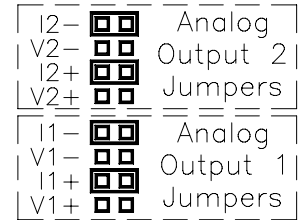

INPUTS

Channel A and Channel B can be configured independent of each other. Jumper position can be ignored for thermocouple and millivolt inputs.
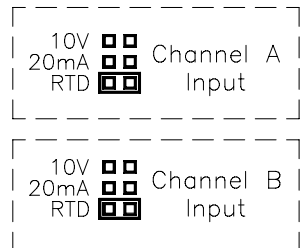
SERIAL DIP SWITCH SETTINGS

The DLC Serial Communications Settings can be set via DIP Switches or through the serial communications port (software selectable). The software selectable serial settings method using the serial communications port must be set using "RLCPRO" or another software program to write to the DLC Modbus registers (40401-40407). When using the DIP switches to configure the serial settings, the Modbus mode is limited to "RTU" mode only.
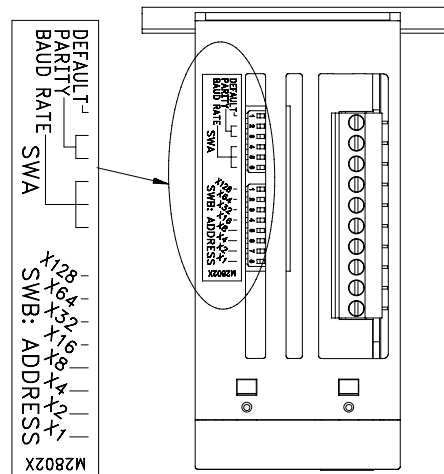
SWA

DEFAULT SERIAL SETTINGS	SWITCH POSITION
	1
Use DIP Switch or Software Serial Settings	DN
Use Default Serial Settings	UP

PARITY	SWITCH POSITION	
	2	3
None	DN	DN
None	DN	UP
Even	UP	DN
Odd	UP	UP

BAUD RATE	SWITCH POSITION		
	4	5	6
300	DN	DN	DN
600	DN	DN	UP
1200	DN	UP	DN
2400	DN	UP	UP
4800	UP	DN	DN
9600	UP	DN	UP
19200	UP	UP	DN
38400	UP	UP	UP

Serial Communication Defaults:

Protocol:	RTU	**Stop Bit:**	1
Address:	247	**Parity:**	none
Baud Rate:	9600	**Start Bit**	1

SWB

UNIT ADDRESS	SWITCH POSITION / (BIT WEIGHT)							
	1 (128)	2 (64)	3 (32)	4 (16)	5 (8)	6 (4)	7 (2)	8 (1)
Software Selectable Serial Settings	DN	DN	DN	DN	DN	DN	DN	DN
1	DN	DN	DN	DN	DN	DN	DN	UP
2	DN	DN	DN	DN	DN	DN	UP	DN
3	DN	DN	DN	DN	DN	DN	UP	UP
4	DN	DN	DN	DN	DN	UP	DN	DN
5	DN	DN	DN	DN	DN	UP	DN	UP
6	DN	DN	DN	DN	DN	UP	UP	DN
7	DN	DN	DN	DN	DN	UP	UP	UP
8	DN	DN	DN	DN	UP	DN	DN	DN
…								
247*	UP	UP	UP	UP	DN	UP	UP	UP
*- Unit will use address 247 for binary switch settings above 247								

# STEP 2 INSTALLING THE CONTROLLER

INSTALLATION

The controller is designed for attachment to standard DIN style top hat (T) profile mounting rails according to EN50022 -35 x 7.5 and -35 x 15. 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.

T Rail Installation

To install the DLC on a "T" style rail, angle the controller so that the top groove of the mounting recess is located over the lip of the top rail. Push the controller toward the rail until it snaps into place. To remove a controller from the rail, insert a screwdriver into the slot on the bottom of the controller, and pry upwards until it releases from the rail.
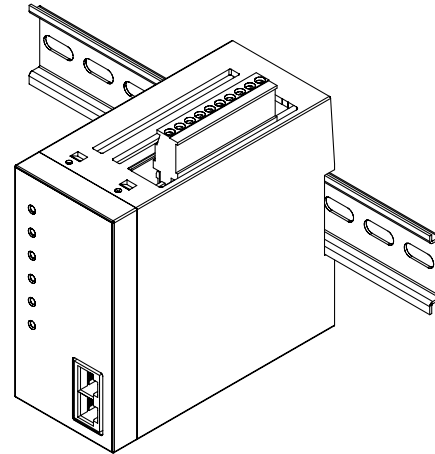
STEP 3 IDENTIFYING THE LEDs - LED FUNCTIONALITY

On power-up, all LEDs are turned on briefly in an alternating pattern to allow visual check of LED functionality.

CONDITION	PRIORITY	PWR/COMM	CH A OP	CH A ALM	AUTOTUNE	CH B OP	CH B ALM
Power Applied	1	On	-------	-------	-------	-------	-------
Communicating	1	Flashing	-------	-------	-------	-------	-------
OP1 On (Channel A) **	4	-------	On	-------	-------	-------	-------
OP1 On (Channel B) **	4	-------	-------	-------	-------	On	-------
AL1 On (Channel A) *	4	-------	-------	On	-------	-------	-------
AL1 On (Channel B) *	4	-------	-------	-------	-------	-------	On
AL2 On (Channel A) *	4	-------	-------	Fast Flashing	-------	-------	-------
AL2 On (Channel B) *	4	-------	-------	-------	-------	-------	Fast Flashing
OP2 On [Cool](Channel A)	5	-------	Fast Flashing	-------	-------	-------	-------
OP2 On [Cool](Channel B)	5	-------	-------	-------	-------	Fast Flashing	-------
Auto-Tune On (Channel A)	3	-------	-------	-------	On	-------	-------
Auto-Tune On (Channel B)	3	-------	-------	-------	Fast Flashing	-------	-------
Input Error (Channel A)	3	-------	Slow Flashing	Slow Flashing	-------	-------	-------
Input Error (Channel B)	3	-------	-------	-------	-------	Slow Flashing	Slow Flashing
Calibration Mode	2	-------	On	On	On	On	On
Checksum Error	1	-------	Slow Flashing	Slow Flashing	Slow Flashing	Slow Flashing	Slow Flashing

* If AL1 & AL2 outputs are on at the same time, the ALM annunciator will alternate between On and Fast Flashing every ½ second.
** If OP1 and AL2/OP2 (configured for cool) outputs are on at the same time, the annunciator will only show the OP1 state. The OP2 state is only shown when OP1 is off.
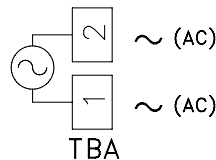
STEP 4   WIRING THE CONTROLLER

WIRING CONNECTIONS

All conductors should meet voltage and current ratings for each terminal. Also, cabling should conform to appropriate standards of good installation, local codes and regulations. When wiring the controller, use the numbers on the label to identify the position number with the proper function. Strip the wire, leaving approximately 1/4" (6 mm) of bare wire exposed. Insert the wire into the terminal, and tighten the screw until the wire is clamped tightly. (Pull wire to verify tightness.) Each terminal can accept up to one #14 AWG (2.55 mm), two #18 AWG (1.02 mm), or four #20 AWG (0.61 mm) wires.

CONTROLLER POWER CONNECTIONS

For best results, the power should be relatively "clean" and within the specified limits. Drawing power from heavily loaded circuits or from circuits that also power loads that cycle on and off should be avoided. It is recommended that power supplied to the controller be protected by a fuse or circuit breaker.

24 VAC POWER

18 to 36 VDC POWER
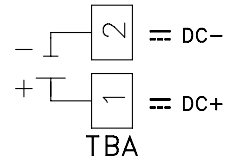
INPUT CONNECTIONS

RTD and Resistance *

CH A = Terminals 4, 5 & 6
CH B = Terminals 1, 2 & 3

Thermocouple and Millivolt

CH A = Terminals 4, 5 & 6
CH B = Terminals 1, 2 & 3

Voltage or Current

CH A = Terminals 4, 5 & 6
CH B = Terminals 1, 2 & 3
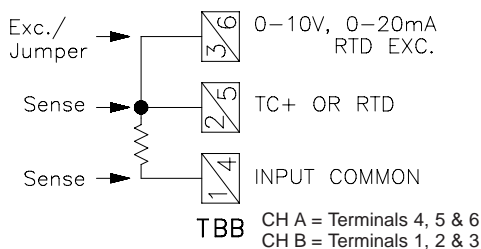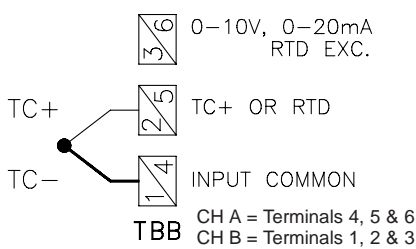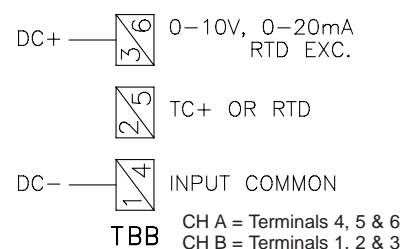
2 Wire Current Signal Requiring DLC Excitation **

CH A = Terminals 4, 5 & 6
CH B = Terminals 1, 2 & 3
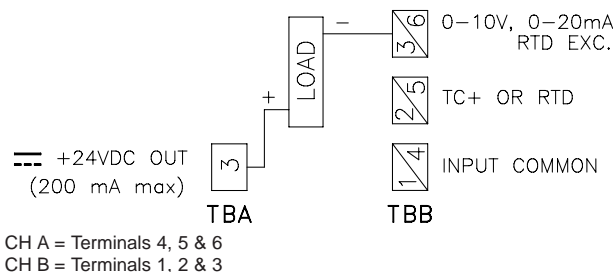
3 Wire Current or Voltage Signal Requiring DLC Excitation **
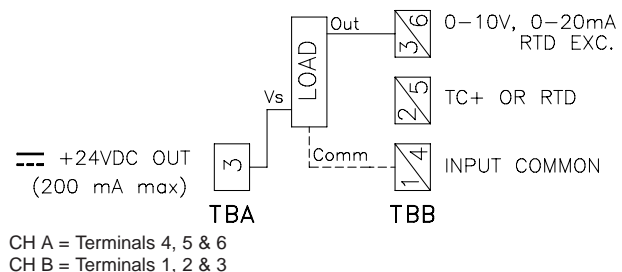
CH A = Terminals 4, 5 & 6
CH B = Terminals 1, 2 & 3

* For two wire RTDs, install a copper sense lead of the same gauge and length as the RTD leads. Attach one end of the wire at the probe and the other end to input common terminal. Complete lead wire compensation is obtained. This is the preferred method. If a sense wire is not used, then use a jumper. A temperature offset error will exist. The error may be compensated by programming a temperature offset.
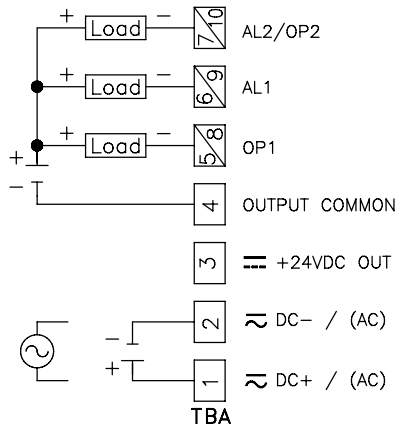
** +24 VDC OUT (Terminal 3) shares common with Ch A Inputs & All Control/Alarm Outputs.
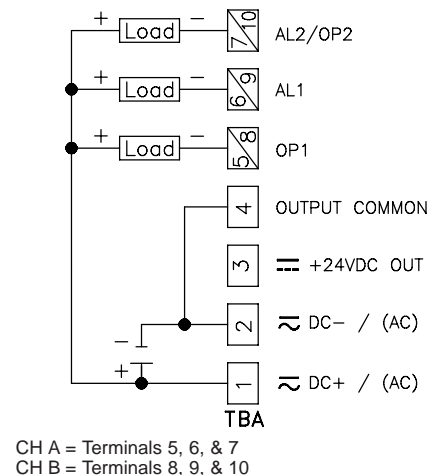
CONTROL AND ALARM OUTPUT CONNECTIONS
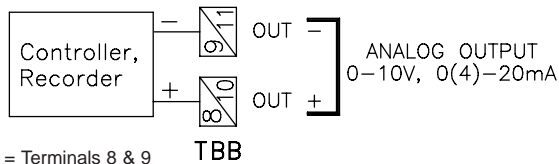

**Load Power from DLC
External Controller Power**

CH A = Terminals 5, 6, & 7
CH B = Terminals 8, 9, & 10
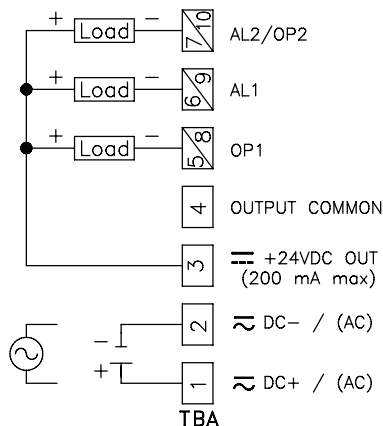
**Separate External Power
For Load and Controller**

CH A = Terminals 5, 6, & 7
CH B = Terminals 8, 9, & 10

**Combined External Power
For Load and Controller**

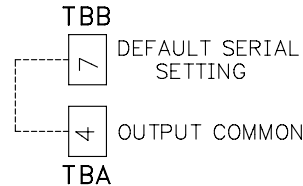CH A = Terminals 5, 6, & 7
CH B = Terminals 8, 9, & 10

ANALOG DC OUTPUT CONNECTIONS

Output 1 = Terminals 8 & 9
Output 2 = Terminals 10 & 11

Note: Analog Outputs & RS485 are not internally isolated and must not share the same common (i.e., earth ground).

DEFAULT SERIAL SETTING CONNECTIONS

If using software selectable serial settings and the serial settings are unknown or forgotten, they can be temporarily reset to the defaults by connecting the "Default Serial Setting" terminal 7 to "Output Common" terminal 4 with a jumper.

Defaults:	Protocol:	RTU	Data Bits:	8
	Address:	247	Parity:	none
	Baud Rate:	9600		

RS485 SERIAL CONNECTIONS

There are two modular connectors located on the front for paralleling communications. For single device communications, either connector can be used. Reverse A+ and B- wiring for Red Lion Controls Paradigm products.

The CBPRO007 programming cable converts the RS232 port of a PC to RS485 and is terminated with an RJ11 connector. The bi-directional capability of the CBPRO007 allows it to be used as a permanent interface cable as well as a programming cable.

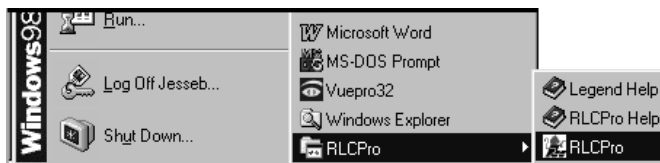| RJ11	DLC
1	Not used
2	B-
3	A+
4	COMM
5	TXEN
6	Not used

DLC CONNECTOR
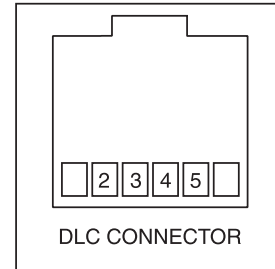
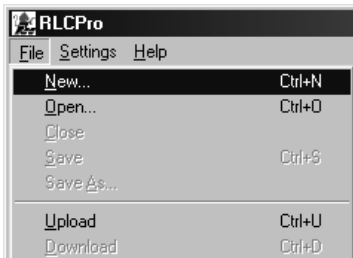## STEP 5 INSTALLING SFDLC (Software for DLC)

Insert the SFDLC diskette into the A: or B: drive. Then Run A:\SETUP (or B:\SETUP) to install RLCPro onto the hard drive. An icon labeled RLCPro will be created under the group RLCPro.
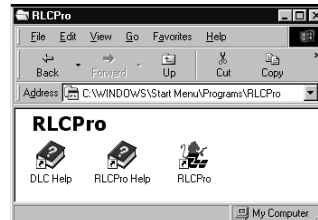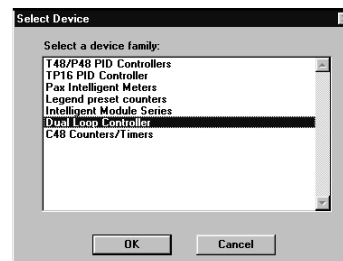

STEP 6 PROGRAMMING - Getting Started

Run RLCPro by double-clicking the icon, or use the start menu.

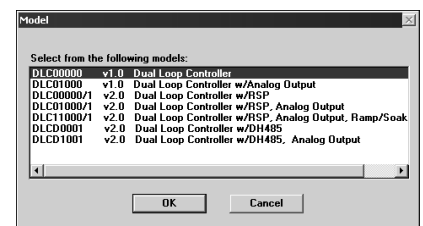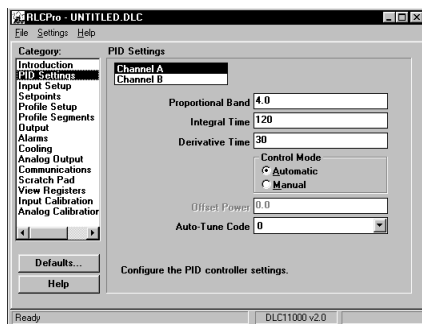

Use the FILE pull-down menu to select a NEW file.

You will be prompted to select the proper device,

and then the model.

STEP 7 PROGRAMMING THE PID SETTINGS

Note: The register numbers correspond to (Channel A/Channel B).Channel B PID control is not functional when the input is assigned as a Remote Setpoint.

The Auto-Tune procedure of the controller sets the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Ouput Dampening Time, and Relative Gain (Heat/Cool) values appropriate to the characteristics of the process.

Proportional Band (40007/40023): Proportional band, entered as percent of full input range, is the band from the setpoint where the controller adjusts the percent output power based on how close the process value is to the setpoint. For temperature inputs, the input range is fixed per the entered thermocouple or RTD type. For process inputs, the input range is the difference between the entered Process Low Scaling Value and the Process High Scaling Value. The proportional band should be set to obtain the best response to a process disturbance while minimizing overshoot. A proportional band of 0.0% forces the controller into On/Off Control with its characteristic cycling at setpoint.

Integral Time (40008/40024): Integral time is defined as the time, in seconds, it takes the output power due to integral action alone to equal the output power due to proportional action alone during a constant process error. As long as the 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 higher the integral time, the slower the response. The optimal integral time is best determined during PID Tuning. If time is set to zero, the previous Integral output power value is maintained. Offset Power can be used to provide Manual Reset. Integral Action can be disabled by writing a '1' to the Disable Intergral Action register (40044/40052).

Derivative Time (40009/40025): Derivative time, entered as seconds per repeat, is the time that the controller looks ahead at the ramping error to see what the proportional contribution will be and it matches that value every Derivative time. As long as the ramping error exists, the Derivative action is repeated by Proportional action every derivative time. Increasing the derivative time helps to stabilize the response, but too high of a derivative time, coupled with noisy signal processes, may cause the output to fluctuate too greatly, yielding poor control. Setting the time to zero disables Derivative Action.

Control Mode (40041/40049): In Automatic Mode, the percentage of Output Power is automatically determined by PID or On/Off Control. In Manual Mode, the percentage of Output Power is entered manually. For more information, see Control Mode Explanations Section.

Output Power (40005/40021): This parameter can only be changed by direct entry in Manual Mode. For more details on this parameter, see the Control Mode Explanations Section.

Offset Power (Manual Reset) (40010/40026): If the Integral Time is set to zero (Automatic Reset is off), it may be necessary to modify the output power to eliminate errors in the steady state. The offset power is used to shift the proportional band to compensate for errors in the steady state. If Integral Action is later invoked, the controller will re-calculate the internal integral value to provide "bumpless" transfer.

Auto-Tune Code (40013/40029): Prior to starting Auto-Tune, this code should be set to achieve the necessary dampening level under PID Control. When set to zero, it yields the fastest process response with possible overshoot. A setting of 2 yields the slowest response with the least amount of overshoot. If the Auto-Tune Code is changed, Auto-Tune needs to be reinitiated for the changes to affect the PID settings. Auto-tune is initiated by writing a '1' to the Auto-Tune start register (40011/40027). The Auto-Tune phase will be shown in register (40012/40028). For more information, see PID Tuning Explanations Section.

STEP 8 PROGRAMMING THE INPUT SETUP
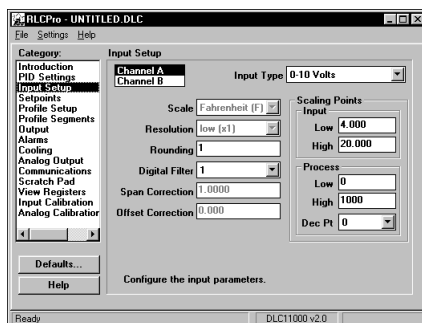
Input Type (40101/40201): Select the proper input type from the pull down menu. Make sure the input jumpers are set to match the input signal selection.

Scale (40102/40202): Select either degrees Fahrenheit or Celsius. For mV, resistance, voltage or current types, this has no effect. If changed, check all temperature related values, as the DLC does not automatically convert these values.

Resolution (40103/40203): For all temperature and ohms Input Types low (x1) resolution selects whole units of measure. In these same modes, high (x10) resolution selects tenth of units of measure. For mV mode, low selects tenths of mV and high selects hundredths of mV. If changed, be sure to check all parameters because the controller does not automatically convert related parameter values. For voltage or current types, this has no effect.

Rounding (40104/40204): Rounding selections other than 1 cause the process value to round to the nearest rounding increment selected. (For example, rounding of 5 causes 122 to round to 120 and 123 to round to 125.) Rounding starts at the least significant digit of the process value. If the signal is inherently jittery, the process value may be rounded to a value higher than 1. If the range of the signal exceeds the required resolution (for example, 0-1000 psi, but only 10 psi resolution is required), a rounding increment of 10 will effectively make the reading more stable.

Digital Filtering (40105/40205): The filter is an adaptive digital filter that discriminates between measurement noise and actual process changes. If the signal is varying too greatly due to measurement noise, increase the filter value. If the fastest controller response is needed, decrease the filter value.

Span Correction (40106/40206): This value is the correction slope. A span of 1.0000 applies no correction. Span only applies to temperature sensor, millivolt, and ohms inputs.

Offset Correction (40107/40207): This value offsets the temperature value by the entered amount. Offset only applies to temperature sensor, millivolt, and ohms inputs

Channel B Assignment (40198): This is used to configure Channel B to operate as a Remote Setpoint to Channel A. Channel B PID control is not functional when the input is assigned as a Remote Setpoint.
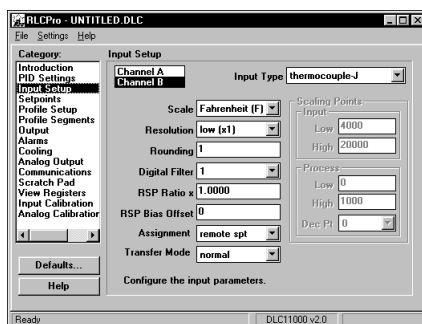
Local/Remote Setpoint Transfer Mode (40199): When cycling from/to Local or Remote Setpoint (register 40046), the response of the controller can be programmed to act in a variety of ways. The table summarizes the responses for Setpoint transfer options.

LOCAL/REMOTE SETPOINT TRANSFER MODE	LOCAL TO REMOTE	REMOTE TO LOCAL
0 - Normal	Output may bump.	Output may bump.
1 - Auto	No output bump. Process error eliminated at rate of integral action. Ramping disabled during transfer.	No output bump. Process error eliminated at rate of integral action. Ramping disabled during transfer.
2 - Track	Output may bump.	Local Setpoint (40002) assumes value of Remote Setpoint (tracks). No output bump.

Note: In situations where an output bump may occur, the Setpoint ramp function can be used to reduce or eliminate bumping when switching Setpoint modes. The setpoint ramp feature ramps the setpoint from the old setpoint to the new Setpoint.

Remote Setpoint Ratio Multiplier (40206): This value is used for channel B when it is assigned as a Remote Setpoint Input. The Ratio Multiplier applies to all input types (0-15).

Remote Setpoint Bias Offset (40207): This value is used for channel B when it is assigned as a Remote Setpoint Input.

Scaling Points (40111-40114/40211-40214): Low and high scaling points are necessary to scale the controller for process voltage and current inputs. Each scaling point has a coordinate pair of input and process value entries. The process value will be linear between and continue past the entries up to the limit of the input range. Reverse acting measurement can be accomplished by reversing the Input or Process entries, but not both. (Do not reverse the input wires to change the action.) To scale a 4-20 mA Input signal to provide process values of 0 to 100.00 (% in hundredths), the Input Low (40113/40213) and Input High (40114/40214) values would be 4000 and 20000 (0.001 mA resolution), and the Process Low (40111/40211) and Process High (40112/40212) values would be 0 and 10000.

Process Decimal Point (Dec Pt) (40115/40215): The decimal point position is used to enable SFDLC display in desired engineering units for voltage and current Process values. It is not used internally by the DLC.

STEP 9   PROGRAMMING THE SETPOINTS
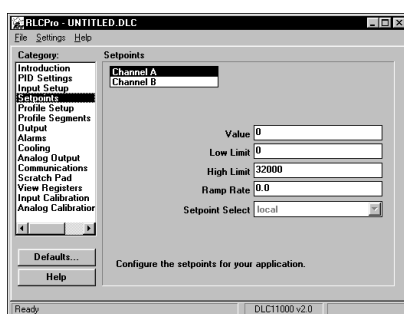
Setpoint (40002/40018): Enter the setpoint value. Deviation of Process Value (40001/40017) from setpoint value can be viewed in the Setpoint Deviation register (40006/40022).

Low Limit (40108/40208); **High Limit (40109/40209)**: The controller has programmable high and low setpoint limit values to restrict the setting range of the setpoint. Set the limits so that the setpoint value cannot be set outside the safe operating area of the process.

Ramp Rate (40110/40210): The setpoint ramp rate can reduce sudden shock to the process and reduce overshoot on startup or after setpoint changes, by ramping the setpoint at a controlled rate. The ramp rate is 0.1° for input types 0-11, 0.1 Ω for input type 12, 0.01 for input type 13, and 0.1 unit for input types 14-15 per minute. Writing a '0' disables setpoint ramping. The Disable Setpoint Ramping register (40042/40050) can also be used to disable ramping. The Setpoint Ramping In-Process register (40043/40051) will be a '1' during setpoint ramping. While ramping is enabled, the Ramping Setpoint can be viewed in register (40045/40053). The Ramp Rate for CHB is not functional when it is assigned as a Remote Setpoint Input.

Once the ramping setpoint reaches the target setpoint, the setpoint ramp rate disengages until the setpoint is changed again. If the ramp value is changed during ramping, the new ramp rate takes effect. If the setpoint is ramping prior to starting Auto-Tune, the ramping is suspended during Auto-Tune and then resumed afterward using the present Process value as a starting value. Deviation and band alarms are relative to the target setpoint, not the ramping setpoint. A slow process may not track the programmed setpoint rate. At power-up, the ramping setpoint is initialized to the starting process value.

Remote/Local Setpoint Select (40046): Channel A setpoint mode can be switched between Local Setpoint operation and Remote Setpoint operation. The Channel B input must be assigned as a remote setpoint (register 40198).

STEP 10   PROGRAMMING PROFILE SETUP (Optional)
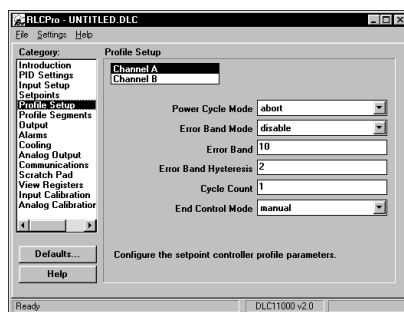
Profile Power Cycle Mode (40321/40421): Upon controller power-on several profile operating modes exist.

Stop: If the Profile was running when powered down, upon power-up, "Stop" places the profile into the stop or off mode, regardless of the mode prior to the power-down. The active Setpoint is the setpoint of the last segment that ran before power-down.

Abort: If the Profile status was running, paused, or in Error Delay when powered down, upon power-up, "Abort" will place the controller in manual mode at 0% Output Power. The Setpoint and Ramp Rate are the values they were prior to running the profile. If the Setpoint Controller was 'paused,' they will be set to the values that they were at power-down.

Start: The Start power cycle mode causes the controller to automatically start the profile at Power-up. This will occur if the unit was in manual or automatic control mode. During maintenance or at other times when this action is not desired, the Profile Power Cycle mode should be changed appropriately.

Resume: At Power-up, Resume causes the profile to continue from the point and phase when power was removed. If the unit was in ramp phase, the ramping setpoint will start ramping from the initial process value at power-up.

Pause: Upon Power-up, the controller pauses and maintains control at the initial process value (on power-up), at the phase where the controller was powered down. The user can then determine how to proceed based on the process that is being controlled.

Profile Error Band Mode (Guaranteed Soak) (40322/40422): Profile conformity can be assured by using the profile Error Band Mode and Error Band parameter. If the process value deviates outside the error band value while a profile is running, the controller enters the delay mode. In the delay mode, the profile phase timer is held (delayed) until the process value is within the deviation error band value - the Error band hysteresis value. At this time, the profile continues running unless the process value again deviates. These actions assure that the actual process value conforms to the profile.

    Disable Error Band: Error band operation is disabled.

    Ramp Phase Only Error Band: The Profile Error Band only applies to the ramp phases of the running profile.

    Hold Phase Only Error Band: The Profile Error Band only applies to hold phases of the running profile.

    Ramp & Hold Phase Error Band: The Profile Error Band applies to both ramp and hold phases of the running profile.

Profile Error Band (40323/40423): During a hold phase, the profile is paused when the process error is >= the Profile Error Band. The profile will remain paused until the process error (deviation) is within the Profile Error Band (Error Band-Error Band Hysteresis).

Profile Error Band Hysteresis (40324/40424): Controls the process value at which the profile will come out of an error band delay. If in error band delay, the profile phase timer is held (delayed) until the process value is within the deviation error band value - the Error band hysteresis value.

Profile End Segment (40325/40425): The Profile End Segment indicates the last segment (i.e., the number of segments to be used in a profile) that is to be ran in the profile before it stops or re-starts (dependent on Profile Cycle Count/Profile Cycle Count remaining).

Profile Cycle Count (40326/40426): Once a profile is started, it runs the number of cycles programmed in this register and then automatically defaults to the Profile End Control Mode. If this parameter is changed while the profile is active, the new value (if less than 250) will not take effect until the profile is stopped and re-started. If the Profile Cycle Count is set to 250 (continuous profile cycling), the change will take affect immediately.

Profile End Control Mode (40327/40427): This parameter sets the type of control action that will be used when the number of profile cycles as programmed in the Profile Cycle Count parameter has run to completion.
    Control Outputs Off : Control is turned off by putting the controller in manual mode at 0% Power. Control can be resumed by changing the Control Mode (40041/40049) to Automatic.
    Automatic: When configured for Automatic the controller will continue controlling at the last setpoint value.
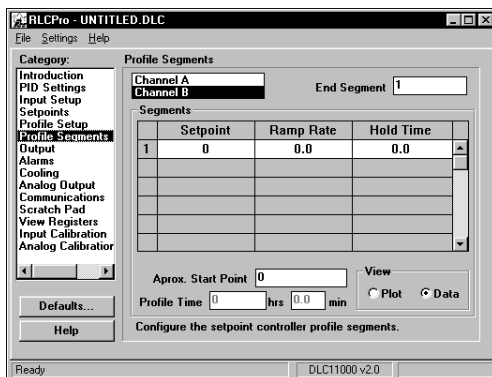
Setpoint Controller Setpoint Segment Registers 1-20 (40601-40620[ChA]/40701-40720[ChB]): The setpoints for the profile are written in these registers. The values are limited by the Setpoint Lo and Setpoint Hi limits registers. Register (40601/40701) is the Setpoint for the 1st segment of the profile.

Setpoint Controller Ramp Rate Segment Registers 1-20 (40621-40640[ChA]/40721-40740[ChB]): The Ramp Rates for the profile are written in these registers. Register (40621/40721) is the Ramp Rate for the 1st segment of the profile. A ramp rate of 0 disables setpoint ramping.

Setpoint Controller Hold Time Segment Registers 1-20 (40641-40660[ChA]/40741-40760[ChB]): The Hold Times for the profile are written in these registers. Register (40641/40741) is the Hold Time for the 1st segment of the profile. Segment Hold times of 0 can be used to achieve a ramp with multiple slopes.

STEP 11 MONITORING PROFILE OPERATION (Optional)

Profile Operating Status/Mode (40065/40073)
    Stop/Off: The Stop/Off status indicates the profile is dormant or off. A profile can be stopped by setting this register to 0, by allowing a profile to run to completion, or by removing and re-applying power when the Power Cycle Mode is configured for stop. If the profile was terminated during a ramp phase, the unit will continue to ramp to the active setpoint.

    Abort: Abort is a command action that can be used quickly to stop the profile and turn off the control outputs. The controller is placed into manual mode at 0% output power. Following the abort command the Profile Operating Status will go to 0 (Stop/Off).

    Run/Start: The profile is in the run mode when it is executing. While running, the profile can be stopped (0), paused (3), or advanced to the next phase. A profile can be started and placed into the Run mode automatically when the controller is powered-up (see Profile Power Cycle Mode). If the profile was previously stopped, when it is placed in to the Run/Start mode (2), the controller will be put into automatic control (if it was in manual) and start the profile at the first segment. If the controller was in manual mode prior to starting the profile, the controller will start ramping from the current process value. If the profile was "paused," it will resume operation. The advancement of the profile can be viewed in the Profile Phase (40066/40074) and Profile Segment register (40067/40075).

Pause: Pause signifies that a profile is active but the time base (Profile Phase Timer) is paused. The pause mode can only be invoked by writing a 3 in the Profile Operating Status register. Pausing a profile during a ramp phase pauses the ramp and the controller maintains control at the ramping setpoint value (40045/40053) at the instant of the pause action. The use of pause, effectively lengthens the total run time of a profile. The unit will remain in pause mode until it is placed back in the run mode by writing a 2 (Run/Start) into the Profile Operating Status Register.

Error Delay (Guaranteed Soak): The Error Delay Setting is used only as a status indication. It indicates that a profile is active but the phase timer or profile advancement has stopped. This is caused by automatic action of the controller when the process deviates more than a specified amount from the active profile segment. The Error Delay is similar to pause, except the error delay status can only be invoked automatically. See "Profile Error Band Mode (40322/40422)." Do not write a "4 - Error Delay," to the Profile Operating Status Register. Doing so will instead put the controller in pause mode (3).

Profile Phase (40066/40074): When the profile is active, this register indicates whether the controller is in a ramp (0) or hold (1) phase.

Profile Segment (40067/40075): Indicates the current active segment while the profile is running. A zero indicates that the profile is stopped or off.

Profile Phase Timer (40068/40076): This register shows the remaining segment phase time in 10ths of minutes. The remaining phase time can be changed "on the fly" to accelerate or decelerate the phase time. The change in phase time will only affect the running profile and not the stored parameters. If the phase time is changed during the ramp phase, a new ramp rate will be calculated which will achieve the desired phase time. The Profile Phase Timer will stop while the unit is paused or during an error delay caused by Profile Error Band operation (guaranteed soak).

Profile Cycle Count Remaining (40069/40077): Indicates the number of profile cycles that are yet to be run. If the Profile Cycle Count register (40326/40426) is set to 250, the Profile Cycle Count Remaining Register will run continuously, resetting to "250" when reaching "0". This register value can be changed, however, it will only affect the current run cycle. When the profile is stopped and re-started, the Profile Cycle Count Remaining Register will be reloaded based on the "Profile Cycle Count (40326/40426)" value.

Advance Profile Phase (40070/40078): Writing a "1" to this register while the profile is running will cause the controller to advance immediately to the beginning of the next ramp or hold phase. Using the advance operation shortens the total run time of the profile. If the profile is "paused," the profile will advance but the profile will remain paused. The Profile can also be advanced while in the error delay mode.

STEP 12 PROGRAMMING THE OUTPUTS
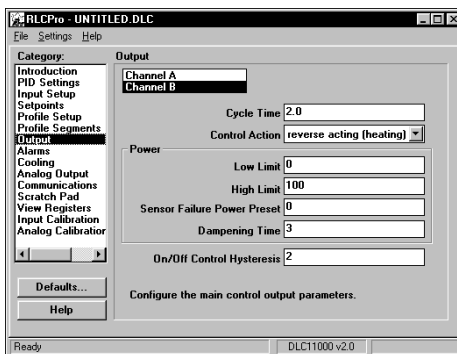
Cycle Time (40116/40216): The cycle time, entered in seconds, is the combined time of an on and off cycle of a time proportioning control output OP1/OP2. With time proportional output, the percentage of control power is converted into output on time of the cycle time value. (If the controller calculates that 65% power is required and has a cycle time of 10 seconds, the output will be on for 6.5 seconds and off for 3.5 seconds.) For best control, a cycle time equal to one-tenth of the process time constant, or less, is recommended. When using the DC Analog output signal for control, a setting of zero will keep output OP1 off. The status of OP1 can be read through registers 40014/40030.

Control Action (40117/40217): This determines the control action for the PID loop. Programmed for direct action (cooling), the DLC output power will increase if the Process value is above the Setpoint value. Programmed for reverse action (heating), the output power decreases when the Process Value is above the Setpoint Value. For heat and cool applications, this is typically set to reverse. This allows OP1 to be used for heating, and AL2/OP2 to be used for cooling.

Power Low Limit (40118/40218); **High Limit (40119/40219)**: These parameters may be used to limit controller power due to process disturbances or setpoint changes. Enter the safe output power limits for the process. If Alarm 2 is selected for cooling, the range is from -100 to +100%. At 0%, both OP1 and OP2 are off; at 100%, OP1 is on; and at -100%, OP2 is on. When the controller is in Manual Control Mode, these limits do not apply.

Sensor Fail Power Preset (40120/40220): This parameter sets the power level for the control outputs in the event of a sensor failure or extreme overdriven/underdriven input. If Alarm 2 is not selected for cooling, the range is from 0% (OP1 output full off) to 100% (OP1 output full on). If AL2 is selected for cooling, the range is from -100 to +100%. At 0%, both OP1 and OP2 are off; at 100%, OP1 is on; and at -100%, OP2 is on. The alarm outputs are upscale drive with an open sensor, and downscale drive with a shorted sensor (RTD only), independent of this setting. Manual Control overrides the sensor fail preset.

Dampening Time (40121/40221): The dampening time, entered as a time constant in seconds, dampens (filters) the calculated output power. Increasing the value increases the dampening effect. Generally, dampening times in the range of one-twentieth to one-fiftieth of the controller's integral time (or process time constant) is effective. Dampening times longer than these may cause controller instability due to the added lag effect.

On/Off Control Hysteresis (40122/40222): The controller can be placed in the On/Off Control Mode by setting the Proportional Band to 0.0%. The On/Off Control Hysteresis (balanced around the setpoint) eliminates output chatter. In heat/cool applications, the control hysteresis value affects both Output OP1 and Output OP2 control. It is suggested to set the hysteresis band to 2 (Factory Setting) prior to starting Auto-Tune. After Auto-Tune, the hysteresis band has no effect on PID Control. On/Off Control Hysteresis is illustrated in the the On/Off Control Mode section.

STEP 13 PROGRAMMING THE ALARMS
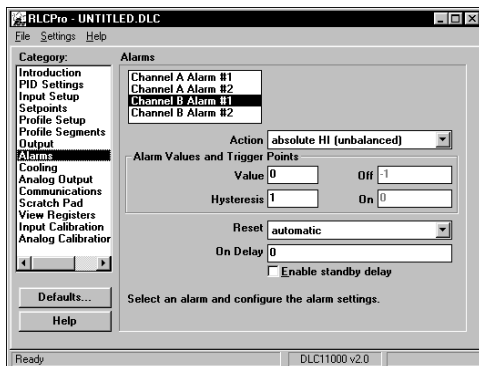
Alarm 1 and 2: The controller is equipped with two alarms for each channel. The status of these alarms can be read through AL1 registers 40015/40031 and AL2 registers 40016/40032.

Action (40131/40231), (40136/40236): Select the action for the alarms. See Alarm Action Figures for a visual explanation.

Manual: In Manual mode, the alarms are forced on and off by writing '0' or '1' to the appropriate alarm output register. In this mode, the alarms will not respond to Alarm and Hysteresis Values.

Absolute HI (balanced or unbalanced hysteresis): The alarm energizes when the Process Value exceeds the alarm.

Absolute LO (balanced or unbalanced hysteresis): The alarm energizes when the Process Value falls below the alarm.

Deviation HI, Deviation LO, Band Acting: In these actions, Alarm 1 and 2 value tracks the Setpoint value.

Cooling (OP2): For heat/cool applications, select Cool for Alarm 2. The controller then utilizes the Alarm 2 output as the Cooling Output (OP2). If cooling is selected, the remaining Alarm 2 parameters are not available.

ALARM ACTION FIGURES
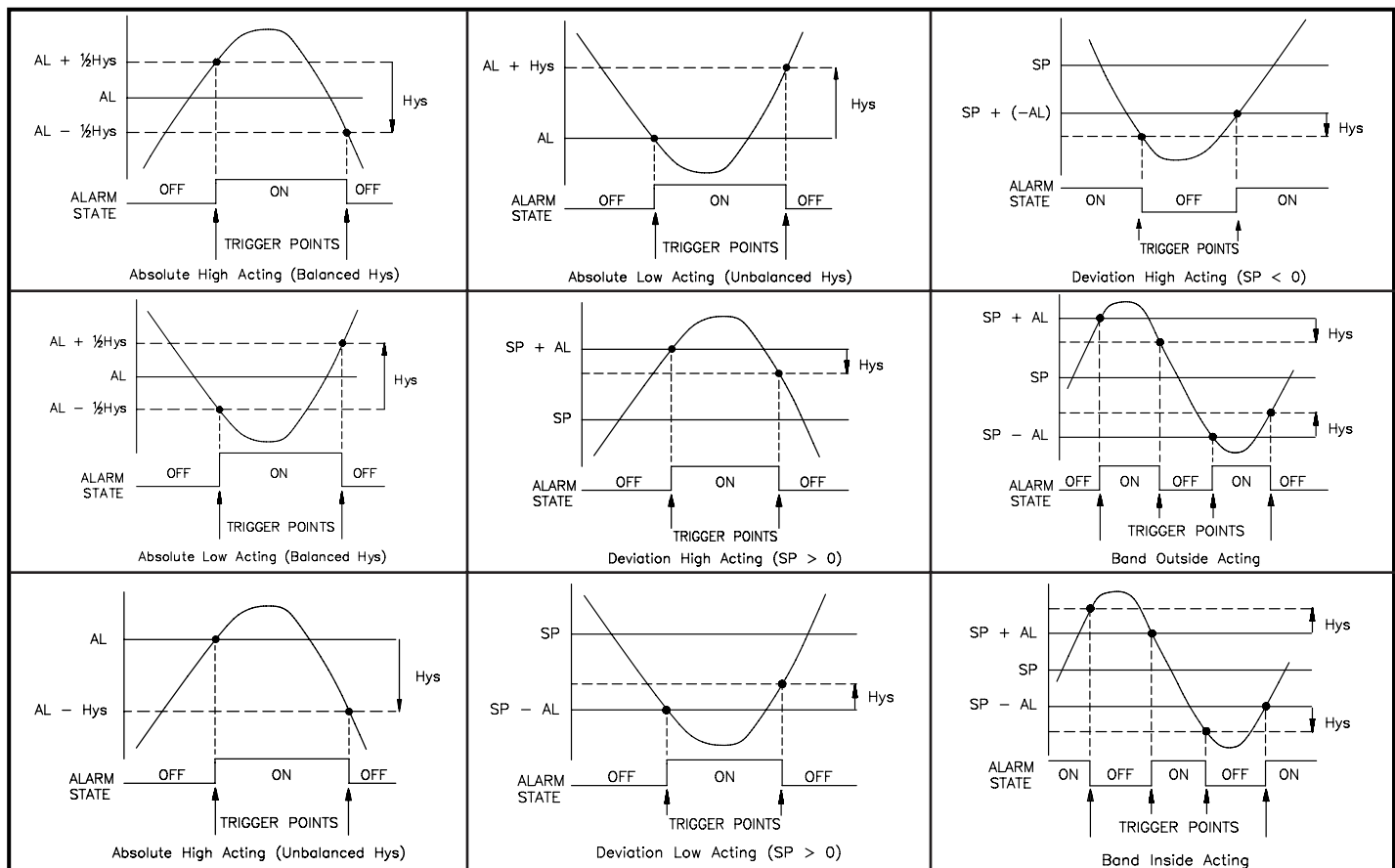
Note: Hys in the above figures refers to the Alarm Hysteresis.

Value (40003/40019), (40004/40020): The alarm values are entered as process units or degrees.

Hysteresis (40134/40234), (40139/40239): The Hysteresis Value is either added to or subtracted from the alarm value, depending on the alarm action selected. See the Alarm Action Figures for a visual explanation of how alarm actions are affected by the hysteresis.

Trigger Points: Trigger points are the Process Values where the alarm state changes. Their values cannot be entered directly, but are shown as a reference in the SFDLC software. The alarm value, hysteresis value, and setpoint alarm type determine the trigger points. With Deviation or Band actions, the alarm value and setpoint value are combined to determine the trigger points. Trigger points must not be greater than +32000 or less than -32000. If these limits are exceeded, the alarm may not function properly.

Reset (40132/40232), (40137/40237): The alarms can be programmed for Automatic or Latched. In Automatic mode, an energized alarm turns off automatically once the Process Value leaves the alarm region. In Latched mode, an energized alarm requires a manual reset. This is done by writing '0' to the appropriate output status register. After writing '0', the Automatic or Latched alarm will not turn on again until after the Process Value first returns to the alarm off region. Only alarms configured for Manual action can be energized by writing a '1' to its' alarm output status register.

On Delay (40135/40235), (40140/40240): The time, in seconds, required for the Process Value to be in the alarm region before the alarm will activate. It is used to allow temporary or short excursions into the alarm region without tripping the alarm.

Enable Standby Delay (40133/40233), (40138/40238): Standby prevents nuisance (typically low level) alarms after a power up or setpoint change. After powering up the controller or changing the setpoint, the process must leave the alarm region. Once this has occurred, the standby is disabled and the alarm responds normally until the next controller power up or setpoint change.

STEP 14 PROGRAMMING THE COOLING
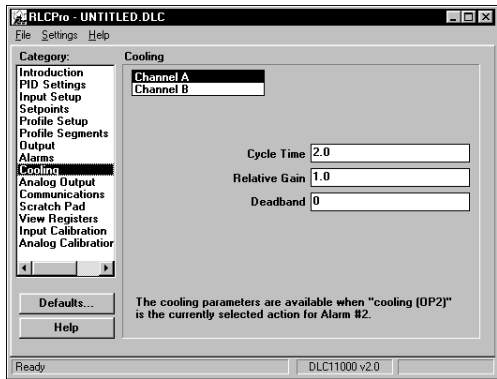
To enable Cooling in Heat/Cool applications, the Alarm 2 Action must first be set for Cooling. When set to cooling, the output no longer operates as an alarm but operates as an independent cooling output. The OP2 terminals are the same as AL2. Cooling output power ranges from -100% (full cooling) to 0% (no cooling, unless a heat/cool deadband overlap is used). The Power Limits in the Output category also limits the cooling power.

Cycle Time (40141/40241): This cycle time functions like the OP1 Output Cycle Time but allows independent cycle time for cooling. A setting of zero will keep output OP2 off. The status of OP2 can be read through registers (40016/40032).

Relative Gain (40142/40242): This defines the gain of the cooling relative to the heating. It is generally set to balance the effects of cooling to that of heating. This is illustrated in the Heat/Cool Relative Gain Figures. A value of 0.0 places the cooling output into On/Off Control. This may be done independent of the OP1 Output PID or On/Off Control Modes.

Deadband (40143/40243): This defines the area in which both heating and cooling are active (negative value) or the deadband area between the bands (positive value). If a heat/cool overlap is specified, the percent output power is the sum of the heat power (OP1) and the cool power (OP2). If Relative Gain is zero, the cooling output operates in the On/Off Control Mode, with the Deadband value becoming the cooling output hysteresis (positive value only). This is illustrated in the On/Off Control Mode section. For most applications, set this parameter to 0.0 prior to starting Auto-Tune. After the completion of Auto-Tune, this parameter may be changed.

HEAT/COOL RELATIVE GAIN FIGURES

Heat/Cool Deadband = 0

Heat/Cool Deadband > 0

Heat/Cool Deadband < 0
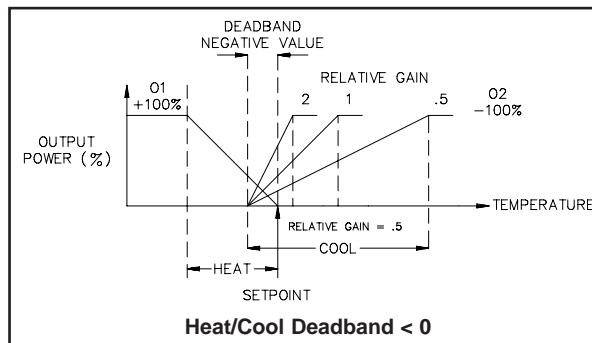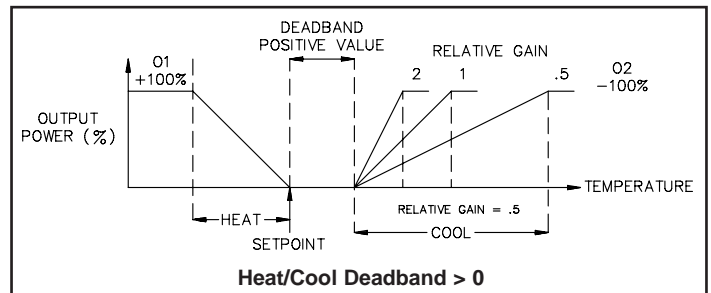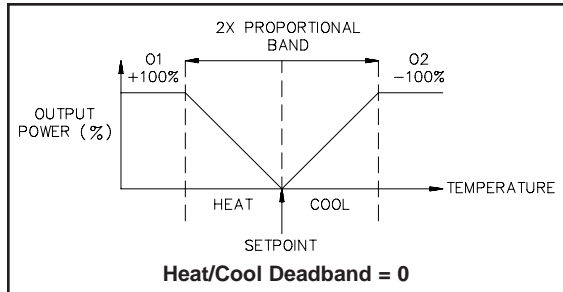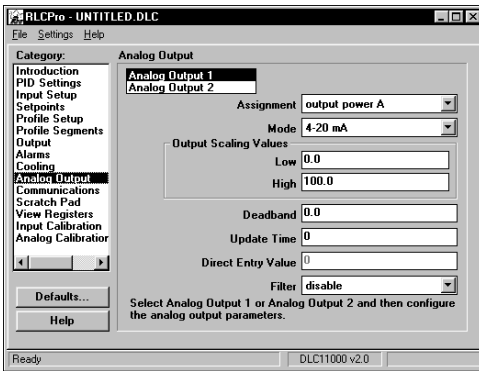
Note: The register numbers correspond to (Analog Output 1/Output 2).

Assignment (40301/40309): This setting selects the value that the Analog Output will retransmit, or track. The Analog output can be assigned for the following:

SELECTION	DESCRIPTION
Output Power A	Transmits the Output Power demand of Channel A. Used if linear control is desired.
Process Value A	Retransmits Process Value Channel A
Setpoint A	Retransmits Setpoint Value Channel A
Ramping Setpoint A	Retransmits Ramping Setpoint Channel A
Deviation A	Retransmits Deviation (difference of Setpoint Value - Process Value) Channel A
Direct Entry Value 1	Retransmits Direct Entry Value 1 (Manual Analog Control)
Output Power B	Transmits the Output Power demand of Channel B. Used if linear control is desired.
Process Value B	Retransmits Process Value Channel B
Setpoint B	Retransmits Setpoint Value Channel B
Ramping Setpoint B	Retransmits Ramping Setpoint Channel B
Deviation B	Retransmits Deviation (difference of Setpoint Value - Process Value) Channel B
Direct Entry Value 2	Retransmits Direct Entry Value 2 (Manual Analog Control)

Mode (40302/40310): Select the type of output and range. The Analog output jumpers must be set to match the output type and range selected. The Analog output can be calibrated to provide up to 5% of over range operation.

Output Scaling Values: The Scaling Low value (40303/40311) corresponds to 0 V, 0 mA or 4 mA, depending on the range selected. The Scaling High value (40304/40312) corresponds to 10 V or 20 mA depending on the range selected. An inverse acting output can be achieved by reversing the Scaling Low and Scaling High points.

Deadband (40305/40313): The output power change must be greater than the deadband value in order for the Analog output to update. This only applies when the Analog Output is assigned to Output Power. This setting can be used to reduce actuator activity.

Update Time (40306/40314): To reduce excess valve actuator or pen recorder activity, the update time of the analog output can be set in seconds. A value of zero seconds results in an update time of 0.1 second.

Direct Entry Value (40307/40315): If the analog output is programmed for Direct Entry, it retransmits this value. This value may be controlled by the host.

Filter (40308-40316): Entering a 1 will apply averaging when the Update Time >=1.

STEP 16 PROGRAMMING THE DLC COMMS PORT
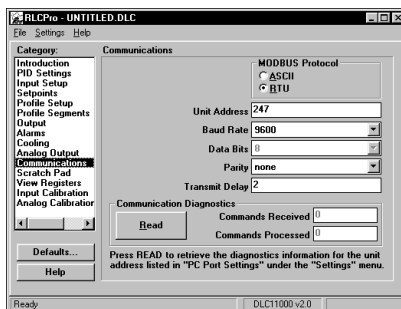
Note: If the software selectable communication settings are changed and then a download is performed, the controller will immediately respond to the new settings. Any further attempts to communicate to the controller must target the new address, with the new settings.

SERIAL SETTINGS

MODBUS Protocol (40405): RTU or ASCII

Unit Address (40401): 1-247

Baud Rate (40402): 300 to 38400

Data Bits (40404): 7 or 8

Parity (40403): odd, even, or none

Transmit Delay (40406): Programmable from 2-250 milliseconds. The Transmit Delay is the time the DLC waits to respond to a serial command, UNLESS the values in the table are larger.

Note: Changing the above parameters by writing to their registers directly will not update the DLC until Load Serial Settings register 40407 is a '1'. After a write, this register will return to '0'.

MINIMUM TRANSMIT DELAY		
BAUD	RTU	ASCII
38400	2 msec	2 msec
19200	3 msec	2 msec
9600	5 msec	2.3 msec
4800	9 msec	4.6 msec
2400	17 msec	9.2 msec
1200	33 msec	18.4 msec
600	65 msec	36.7 msec
300	129 msec	73.4 msec

DIP Switch Serial Settings: The DIP switches can be used to select the baud rate, parity, and unit address. When using the DIP switches to configure the serial settings, the Modbus communications mode will be RTU only. There is also a "Default Serial Settings" switch to quickly configure the DLC for use with the "RLCPRO" Programming Software.

Software Selectable Serial Settings: Setting all of the DIP switches to the "off" position and having the "Default Serial Setting" terminal un-connected, enables Software Selectable Serial settings. When leaving the factory the Software Selectable serial settings are set to the Serial Communication Defaults. Software Selectable Serial Settings allows set-up of all serial settings including the choice of RTU or ACSII communications modes and the number of data bits. If the Software Selectable Serial Settings are changed, the load serial register must be used or power to the DLC must be removed and re-applied in order for the settings to take effect. The use of RLCPRO Programming software or another software program supporting Modbus protocol is required to write to the DLC serial settings registers (40401-40407)**.**

Default Serial Settings: The DLC serial port can be temporarily set to the factory defaults by setting the Default serial communications DIP switch to the "up" position OR by placing a jumper from the "Default Serial Setting" terminal 7 (TBB) to Output common terminal 4 (TBA). Both of these have precedence over the DIP switch serial settings and the software selectable serial settings. Once the serial default DIP switch is set to the "off" position or the jumper is removed, the DLC serial settings will immediately change as programmed by the DIP switches or the software selectable serial settings if all of the DIP switches are in the "off" position. The Default Serial Settings are NOT loaded into the software selectable serial registers when the serial default setting switch/terminal is active, they must be explicitly changed.

Serial Communication Defaults: 9600 baud, 1 start bit, no Parity, 1 stop bit, address 247, and RTU mode.

Communications Diagnostics: The Communications Diagnostics function (MODBUS Function Code 08) can be used to troubleshoot systems that are experiencing communication errors. Press the Read button to retrieve the diagnostics information. The Commands Received and the Commands Processed values are automatically reset when the values are read, at each controller power-up, and when the Commands Received reaches 65536.

Commands Received: The total number of messages received that started with the controller's own address since the last reset or power up.

Commands Processed: The number of "good" messages received. A "good" message is considered one that contained the correct unit address, parity, and checksum (CRC or LRC).

STEP 17 PC PORT CONFIGURATION

Go to the SETTINGS pull-down menu, and select PC PORT SETTINGS.

The Communications Settings window allows you to set up the software properly to perform a download.

Connection: Select the computer port (COMM 1-4) that the DLC is connected to.

Note: *The following settings must match the DLC. If you do not know or cannot recall the DLC settings, they can be temporarily set to factory defaults. Simply jumper the Default Serial Setting terminal 7 to Input Common terminal 4 or put the Default Serial Settings DIP switch in the "UP" position. The serial settings will default to RTU mode, 9600 baud, 8 data bits, no parity, with an address of 247.*

Protocol: RTU or ASCII
Unit Address: 1-247
Baud Rate: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400
Data Bits: 7 or 8
Parity: odd, even, or none

Connect the DLC to the computer with the CBPRO007 interface cable (or any suitable RS232/RS485 converter). Apply power to the supply terminals of the DLC.

Note: The CBPRO007 download cable DOES NOT typically require power. In most cases it will derive its power from the PC. If communications can not be established, follow the troubleshooting guide. If it is determined that the converter requires power, attach a 12 VDC power supply to the VDC and common terminals of the cable.
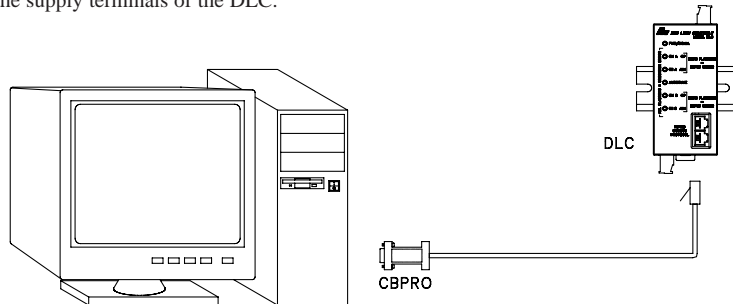
STEP 18 DOWNLOADING
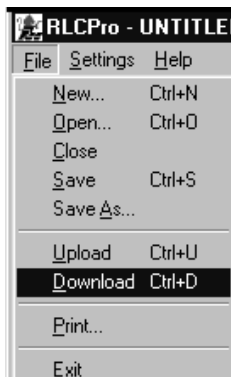
Go to the FILE pull-down menu, and select DOWNLOAD.

The following screen prompts you to ensure that the proper file is downloaded to the correct controller. Click "OK" to continue.

OK to download 'UNTITLED.DLC' to the device at address 0 on COM1?
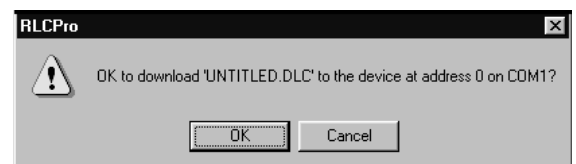
STEP 19 SCRATCH PAD MEMORY
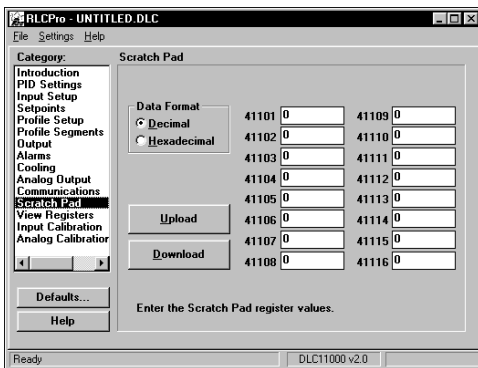
The Scratch Pad category can be used to read or write to the Scratch Pad memory locations (41101-41116). The Scratch Pad locations can be used to store user information.

Data Format: Allows registers to be viewed in decimal or hexadecimal format.

Upload: The Upload button causes SFDLC software to read the Scratch Pad registers from the controller.

Download: The Download button causes SFDLC software to write to the Scratch Pad registers in the controller.

Note: Downloading new values to the controller Scratch Pad locations overwrites the information that is currently stored in those registers.

Defaults: For this category, there are no controller factory defaults. The defaults for this category are only SFDLC software basic default values.

STEP 20 VIEW REGISTERS

The View Registers category can be used as a method of diagnostics. Use the DLC Register Table as a reference of register assignments and data.

First Register: This specifies the first register to be read in a block.

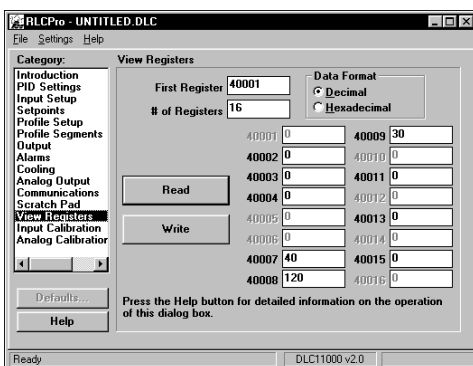**# of Registers**: This is the length of the block to be read. The controller supports block read and write commands up to 32 registers in length. The SFDLC software only allows 16 to be read in a block.

Data Format: Allows registers to be viewed in decimal or hexadecimal format.

Read: Clicking the Read button causes SFDLC software to read the selected registers from the controller.

Write: Clicking the Write button causes SFDLC software to write the selected registers to the controller.

Note: The Write button overwrites the existing register values, and may change the module setup and operation.

Defaults: For this category, there are no controller factory defaults. By clicking Defaults, the present entries from the other SFDLC software category screens will be displayed.

STEP 21 CALIBRATION

The DLC is fully calibrated from the factory. Recalibration is recommended every two years. Each channel is calibrated separately. All calibration settings are stored in the non-volatile memory. Calibration may be performed by using SFDLC software or MODBUS commands. When using SFDLC for calibration, connect the signal or measuring source to the proper DLC terminals, verify the input or output jumper positions, select the type of calibration to be performed, and click the Calibrate button. Follow the calibration procedures in the software.

Note: Allow the DLC to warm up for 30 minutes minimum and follow the manufacturer's warm-up recommendations for the calibration source.
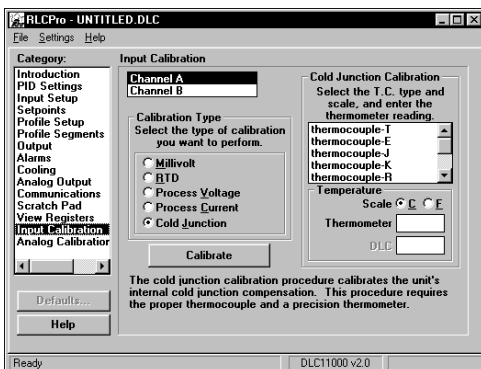
INPUT CALIBRATION

When calibrating the input, the millivolt calibration must be performed first. All other input types use the millivolt points. Each input range (non-thermocouple) also has its own internal references that are recalled when the range is selected. Non-used types need not be calibrated.

Calibration Type: This specifies the type of calibration to be performed.

Millivolt: Millivolt calibration requires a precision voltage source with an accuracy of 0.03% or better. It is used for thermocouple inputs and as a basis for all other input calibration types.

RTD: RTD calibration requires a 0.1% (or better) precision 277.0 ohm resistor.

Process Voltage: Process calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 10.00 V.

Process Current: Process current calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 20.00 mA.

Cold Junction: Cold Junction calibration requires a thermocouple of known accuracy of types T, E, J, K, C or N only and a calibrated external reference thermocouple probe.

TC Type: This selects the type of TC that is being used to calibrate the cold junction.
Scale: This selects the scale in which the Thermometer temperature is entered and the controller temperature is displayed.
Thermometer: Enter the reference thermometer temperature here.
DLC: This displays the DLC process temperature value after a cold junction calibration is completed to verify the accuracy.

Calibrate: The Calibrate button initiates the calibration process after the appropriate settings are selected.
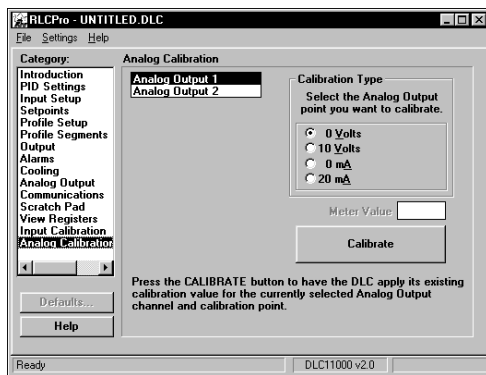
ANALOG OUTPUT CALIBRATION

Calibration Type: This specifies the Analog Output point to be calibrated.

Volts: Analog Output Voltage calibration requires a precision meter with an accuracy of 0.05% (or better) that is capable of measuring 10.00 V.

mA: Analog Output Current calibration requires a precision meter with an accuracy of 0.05% (or better) that is capable of measuring 20.00 mA.

Meter Value: After pressing the Calibrate button, this shows the value the DLC is outputting. Measure the actual output with an external meter and enter that value here. Press the Calibrate button again and follow the prompts.

Calibrate: The Calibrate button initiates the calibration process after the appropriate settings are selected.

APPLICATION
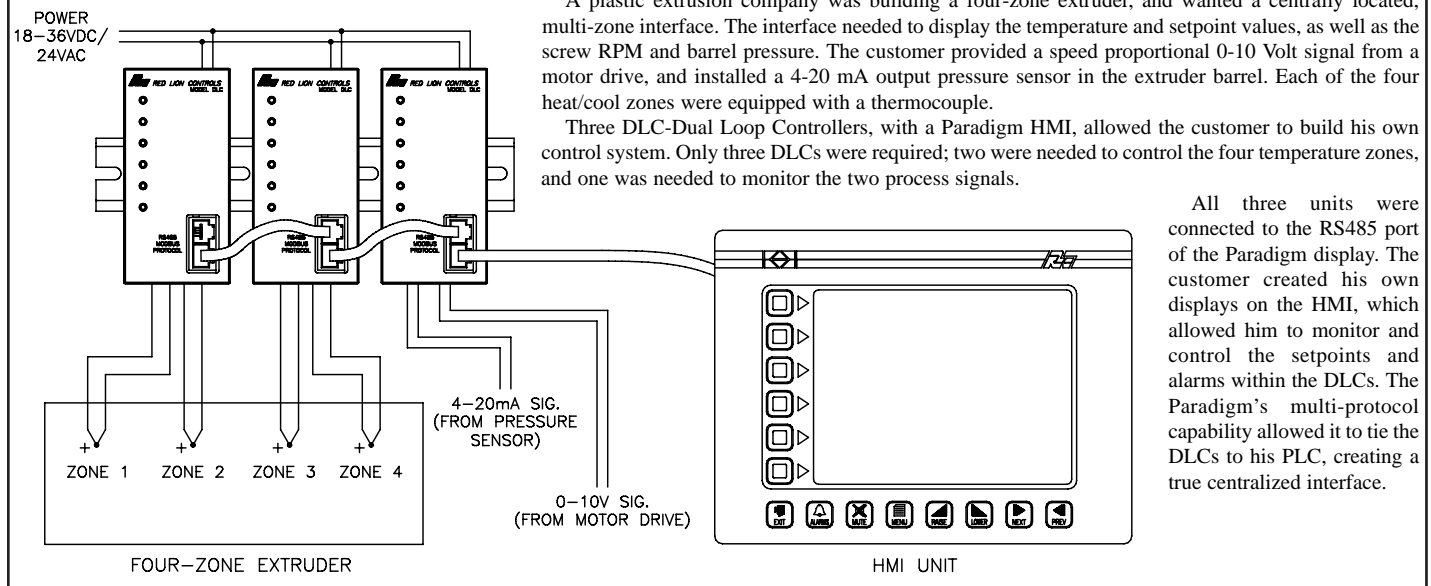
A plastic extrusion company was building a four-zone extruder, and wanted a centrally located, multi-zone interface. The interface needed to display the temperature and setpoint values, as well as the screw RPM and barrel pressure. The customer provided a speed proportional 0-10 Volt signal from a motor drive, and installed a 4-20 mA output pressure sensor in the extruder barrel. Each of the four heat/cool zones were equipped with a thermocouple.

Three DLC-Dual Loop Controllers, with a Paradigm HMI, allowed the customer to build his own control system. Only three DLCs were required; two were needed to control the four temperature zones, and one was needed to monitor the two process signals.

All three units were connected to the RS485 port of the Paradigm display. The customer created his own displays on the HMI, which allowed him to monitor and control the setpoints and alarms within the DLCs. The Paradigm's multi-protocol capability allowed it to tie the DLCs to his PLC, creating a true centralized interface.

CONTROL MODE EXPLANATIONS

MANUAL CONTROL MODE

In Manual Control Mode, the controller operates as an open loop system (does not use the setpoint and process feedback). The user enters a percentage of power through the Output Power register (40005/40021) to control the heat (reverse) or cool (direct) for Output OP1. When Alarm 2 is configured for Cooling (OP2), Manual operation provides 0 to 100% power to OP1 (heating) and -100 to 0% power to OP2 (Cooling). The Low and High Power limits are ignored when the controller is in Manual.

For time proportional outputs, the output power is converted into output On time using the Cycle Time. For example, with a four second cycle time and 75% power, the output will be on (4×0.75) for three seconds and off for one second. For Analog Outputs (0-10 VDC or 0/4-20 mA), the percent output power is converted into a linear value according to the Percent Low and High scaling set for the analog output. For example, with 0 VDC (scaled 0.0%) to 10 VDC (scaled 100%) and 75% power, the analog output will be 7.5 VDC.

MODE TRANSFER

When transferring the controller mode from or to Automatic, the controlling outputs remain constant, exercising true bumpless transfer. When transferring from Manual to Automatic, the power initially remains steady, but Integral Action corrects (if necessary) the closed loop power demand at a rate proportional to the Integral Time. The Control Mode can be changed through the Control Mode register (40041/40049).
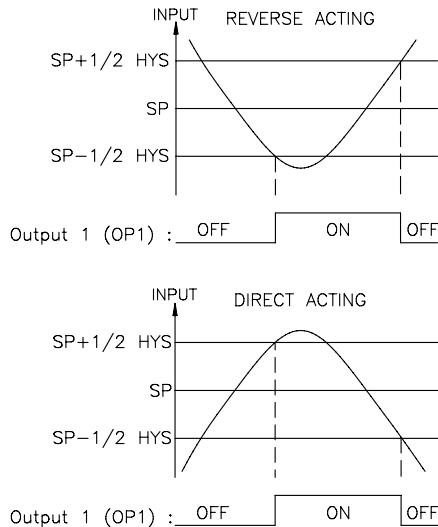
AUTOMATIC CONTROL MODE

In Automatic Control Mode, the percentage of output power is automatically determined by PID or On/Off calculations based on the setpoint and process feedback. For this reason, PID Control and On/Off Control always imply Automatic Control Mode.

ON/OFF CONTROL

The controller operates in On/Off Control when the Proportional Band is set to 0.0%. In this control, the process will constantly oscillate around the setpoint value. The On/Off Control Hysteresis (balanced around the setpoint) can be used to eliminate output chatter. Output OP1 Control Action 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 CONTROL - REVERSE OR DIRECT ACTING FIGURES

INPUT   REVERSE ACTING

SP+1/2 HYS

SP

SP−1/2 HYS

Output 1 (OP1) :   OFF   ON   OFF

INPUT   DIRECT ACTING

SP+1/2 HYS

SP

SP−1/2 HYS

Output 1 (OP1) :   OFF   ON   OFF

For heat and cool systems, OP1 Control Action is set to reverse (heat) and the Alarm 2 Action is set to cooling (OP2). The Proportional Band is set to 0.0 and the Relative Gain in Cooling to 0.0. The Deadband in Cooling sets the amount of operational deadband or overlap between the outputs. The setpoint and the On/Off Control Hysteresis applies to both OP1 and OP2 outputs. The hysteresis is balanced in relationship to the setpoint and deadband value.

Note: HYS in the On/Off Control Figures refers to the On/Off Control Hysteresis.

ON/OFF CONTROL - HEAT/COOL OUTPUT FIGURES

INPUT   HEAT/COOL DEADBAND VALUE (db) = 0

SP + 1/2 HYS

SP

SP − 1/2 HYS

HYS

Output 1 (OP1) :   OFF   ON   OFF

Output 2 (OP2) :   ON   OFF   ON

INPUT   HEAT/COOL DEADBAND VALUE (db) > 0

SP + 1/2 (db) + 1/2 HYS
SP + 1/2 (db)
SP + 1/2 (db) − 1/2 HYS

SP

SP − 1/2 (db) + 1/2 HYS
SP − 1/2 (db)
SP − 1/2 (db) − 1/2 HYS

HYS

db

HYS

Output 1 (OP1) :   OFF   ON   OFF

Output 2 (OP2) :   OFF   ON   OFF

INPUT   HEAT/COOL DEADBAND VALUE (db) < 0

SP + 1/2 (db) + 1/2 HYS
SP + 1/2 (db)
SP + 1/2 (db) − 1/2 HYS

SP

SP − 1/2 (db) + 1/2 HYS
SP − 1/2 (db)
SP − 1/2 (db) − 1/2 HYS

HYS

db

HYS

Output 1 (OP1) :   ON   OFF   ON

Output 2 (OP2) :   ON   OFF   ON

PID CONTROL

In PID Control, the controller processes the input and then calculates a control output power value by use of a modified Proportional Band, Integral Time, and Derivative Time control algorithm. The system is controlled with the new output power value to keep the process at the setpoint. The Control Action for PID Control can be set to reverse for heating (output on when below the setpoint) or direct f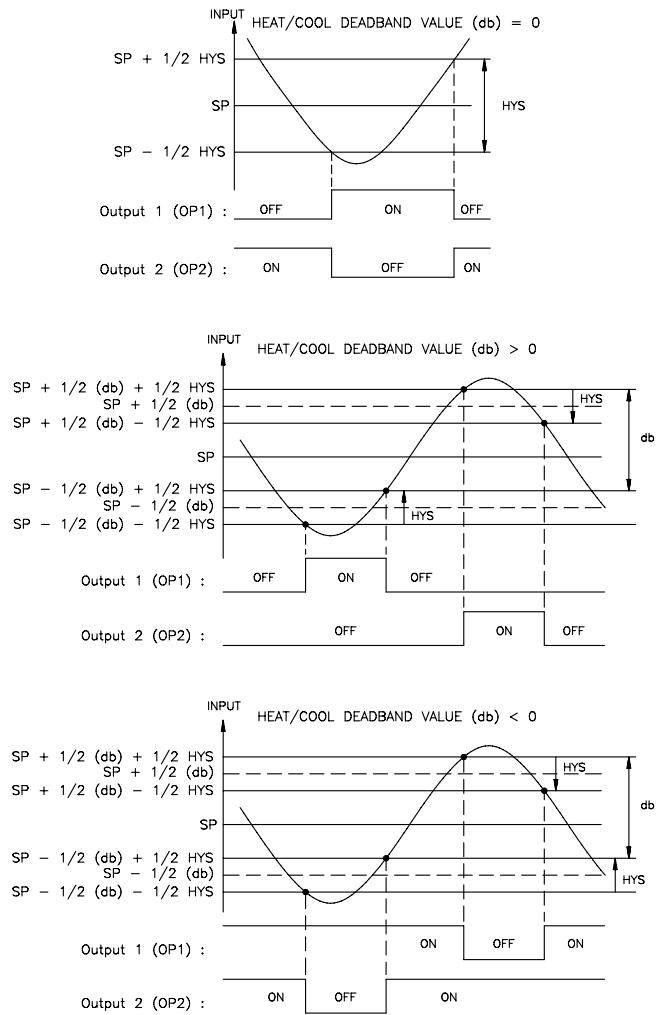or cooling (output on when above the setpoint) applications. For heat and cool systems, the heat (OP1) and cool (OP2) outputs can be used together in the PID Control. The PID parameters can be Auto-Tune or Manual Tune to the process.

TYPICAL PID RESPONSE CURVE

INPUT

P & I

P & I & D

SP

P & D   P only

TIME
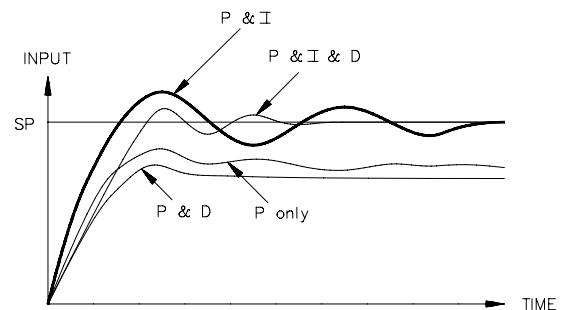
REMOTE SETPOINT

Channel B can operate as a Remote Setpoint Input to Channel A. Channel B PID control is not functional when the input is assigned as a Remote Setpoint. This mode of operation enables Cascade control (external), Ratio control, and Temperature Setpoint Slave control, among others.

The Remote Setpoint value used internally by the controller is:

Remote Setpoint = (Scaled CHB Input * Remote Setpoint Ratio Multiplier) + Remote Setpoint Bias Offset
  where Ratio Multiplier   = 0.0001 to 3.2000
  Bias Offset   = -32000 to 32000

The Ratio Multiplier and Bias Offset parameters offer on-line scaling of the Remote Setpoint to adjust control ratios or biases among related processes.

The Remote Setpoint is restricted to the setpoint low and high limit values for channel B. These parameters may be used to limit the range of the Remote Setpoint to a safe or more stable control range. For Remote Setpoint signal sources that change wildly or are too sensitive to process upsets, the CHA Setpoint Ramp Rate parameter (40110) can be used to ramp (rate limit) the Remote Setpoint reading. This can subsequently reduce the fluctuations of the secondary control loop.

PID TUNING EXPLANATIONS

AUTO-TUNE

Auto-Tune is a user-initiated function where the controller automatically determines the Proportional Band, Integral Time, Derivative Time, Digital Filter, Control Ouput Dampening Time, and Relative Gain (Heat/Cool) values based upon the process characteristics. The Auto-Tune operation cycles the controlling output(s) at a control point three-quarters of the distance between the present process value and the setpoint. The nature of these oscillations determines the settings for the controller's parameters.

Prior to initiating Auto-Tune, it is important that the controller and system be first tested. (This can be accomplished in On/Off Control or Manual Control Mode.) If there is a wiring, system or controller problem, Auto-Tune may give incorrect tuning or may never finish. Auto-Tune may be initiated at start-up, from setpoint or at any other process point. However, insure normal process conditions (example: minimize unusual external load disturbances) as they will have an effect on the PID calculations. Auto-Tune cannot be initiated while running a profile.
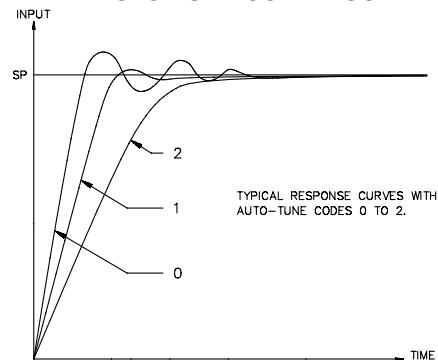
Start Auto-Tune

1. Enter the On/Off Control Hysteresis value.
 (For most applications, 10 is a suggested value.)
2. Enter the Deadband value, if using OP2.
 (For most applications, 0 is a suggested value.)
3. Enter the Setpoint value.
 (If Auto-Tune overshoot is unacceptable, then lower the value and restart.)
4. Enter the Auto-Tune Code. (See Figure for details)
5. Enter '1' in the Auto-Tune Start register . (Channel A 40011/Channel B 40027).
6. The Auto-Tune LED will come on.

Auto-Tune Progress

The controller will oscillate the controlling output(s) for four cycles. The cycling phase can be monitored from the Auto-Tune Phase Register (Channel A 40012/Channel B 40028). The time to complete the Auto-Tune cycles is process dependent. The controller should automatically stop Auto-Tune and store the calculated values when the four cycles are complete. If the controller remains in Auto-Tune unusually long, there may be a process problem. Auto-Tune may be stopped by entering '0' in Auto-Tune Start Register (Channel A 40011/Channel B 40027).

AUTO-TUNE CODE FIGURE

TYPICAL RESPONSE CURVES WITH AUTO-TUNE CODES 0 TO 2.

AUTO-TUNE OPERATION (REVERSE ACTING)

* – On/Off Control Hysteresis

PID Adjustments

In some applications, it may be necessary to fine tune the Auto-Tune calculated PID parameters. To do this, a chart recorder or data logging device is needed 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.

In some unusual cases, the Auto-Tune function may not yield acceptable control results or induced oscillations may cause system problems. In these applications, Manual Tuning is an alternative.

PROCESS RESPONSE EXTREMES

OVERSHOOT AND OSCILLATIONS

TO DAMPEN RESPONSE:
- INCREASE PROPORTIONAL BAND.
- INCREASE INTEGRAL TIME.
- USE SETPOINT RAMPING.
- USE OUTPUT POWER LIMITS.
- RE-INVOKE AUTO-TUNE WITH A
    HIGHER AUTO-TUNE CODE.
- INCREASE DERIVATIVE TIME.
- CHECK CYCLE TIME.

SLOW RESPONSE

TO QUICKEN RESPONSE:
- DECREASE PROPORTIONAL BAND.
- DECREASE INTEGRAL TIME.
- INCREASE OR DEFEAT SETPOINT RAMPING.
- EXTEND OUTPUT POWER LIMITS.
- RE-INVOKE AUTO-TUNE WITH A
    LOWER AUTO-TUNE CODE.
- DECREASE DERIVATIVE TIME.

MANUAL TUNING

A chart recorder or data logging device is necessary to measure the time between process cycles. This procedure is an alternative to the controller's Auto-Tune function. It will not provide acceptable results if system problems exist. This procedure should be performed by directly accessing the controller's registers. The register numbers correspond to (Channel A/Channel B).

1. Set the Proportional Band (40007/40023) to 10.0% for temperature inputs and 100.0% for process inputs.

2. Set both the Integral Time (40008/40024) and Derivative Time (40009/40025) to 0 seconds.

3. Set the Output Dampening Time (40121/40221) to 0 seconds.

4. Set the Output Cycle Time (40116/40216) to no higher than one-tenth of the process time constant (when applicable).

5. Place the controller in Manual Control Mode (40041/40049) and adjust the Output Power (40005/40021) to drive the process value to the Setpoint value. Allow the process to stabilize after setting the Output Power.

6. Place the controller in Automatic Control Mode (40041/40049). If the process will not stabilize and starts to oscillate, set the Proportional Band two times higher and go back to Step 5.

7. If the process is stable, decrease Proportional Band setting by two times and change the setpoint value a small amount to excite the process. Continue with this step until the process oscillates in a continuous nature.

8. Fix the Proportional Band to three times the setting that caused the oscillation in Step 7.

9. Set the Integral Time to two times the period of the oscillation.

10. Set the Derivative Time to one-eighth (0.125) of the Integral Time.

11. Set the Output Dampening Time to one-fortieth (0.025) the period of the oscillation.

MODBUS INFORMATION

The remaining sections of this bulletin list information for MODBUS conformity with DLC registers and coils data.

MODBUS SUPPORTED FUNCTION CODES

FC01: Read Coils

1. Valid coil addresses are 1-33.
2. All coils can be requested.
3. Block starting point can not exceed coil 33.

FC05: Force Single Coil

1. Valid write (force) coil addresses are 1-4, 10-13, 15-16, 22-25, 27-33.
2. HEX <8001> is echoed back for a request to write to a read only coil, to indicate that the coil did not change.

FC15: Force Multiple Coils

1. Valid write (force) coil addresses are 1-4, 10-13, 15-16, 22-25, 27-33.
2. Block starting point can not exceed coil 33.
3. If a multiple write includes read only coils, then only the write coils will change.

FC03: Read Holding Registers

1. Valid register addresses are 40001-40032, 40041-40046, 40049-40053, 40065-40070, 40073-40078, 40100-40122, 40131-40143, 40198-40222, 40231-40243, 40301-40308, 40309-40316, 40321-40327, 40401-40407, 40421-40427, 40501-40505, 40601-40660, 40701-40760, 41001-41010, 41101-41116.
2. Up to 32 registers can be requested at one time.
3. Block starting point can not exceed the register boundaries.
4. HEX <8000> is returned in registers beyond the boundaries.
5. Holding registers are a mirror of Input registers.

FC06: Preset Single Register

1. Valid write (preset) register addresses are 40002-40005, 40007-40011, 40013, 40015-40016, 40018-40021, 40023-40027, 40029, 40031-40032, 40041-40042, 40044, 40046, 40049-40050, 40052-40053, 40065, 40068-40070, 40073, 40076-40078, 40100-40122, 40131-40143, 40198-40222, 40231-40243, 40301-40316, 40321-40327, 40401-40407, 40421-40427, 40501-40505, 40601-40660, 40701-40760, 41101-41116.
2. HEX <8001> is echoed back that the register did not change during the request to write to a read only register.
3. If the write value exceeds the register limit (see Register Table), then that register value changes to its high or low limit. It is also returned in the response.

FC16: Preset Multiple Registers

1. Valid write (preset) register addresses are are 40002-40005, 40007-40011, 40013, 40015-40016, 40018-40021, 40023-40027, 40029, 40031-40032, 40041-40042, 40044, 40046, 40049-40050, 40052-40053, 40065, 40068-40070, 40073, 40076-40078, 40100-40122, 40131-40143, 40198-40222, 40231-40243, 40301-40316, 40321-40327, 40401-40407, 40421-40427, 40501-40505, 40601-40660, 40701-40760, 41101-41116.
2. No response is given with an attempt to write to more than 32 registers at a time.
3. Block starting point can not exceed the read and write boundaries.
4. If a multiple write includes read only registers, then only the write registers will change.
5. If the write value exceeds the register limit (see Register Table), then that register value changes to its high or low limit.

FC04: Read Input Registers

1. Valid register addresses are 30001-30032, 30041-30046, 30049-30053, 30065-30070, 30073-30078, 30100-30122, 30131-30143, 30198-30222, 30231-30243, 30301-30308, 30309-30316, 30321-30327, 30401-30407, 30421-30427, 30501-30505, 30601-30660, 30701-30760, 31001-31010, 31101-31116.
2. Up to 32 registers can be requested at one time.
3. Block starting point can not exceed register boundaries.
4. HEX <8000> is returned in registers beyond the boundaries.
5. Input registers are a mirror of Holding registers.

FC08: Diagnostics

The following is sent upon FC08 request:

Module Address, 08 (FC code), 04 (byte count), "Total Comms" count,

"Total Good Comms" count, checksum of the string

"Total Comms" is the total number of messages received that were addressed to the DLC. "Total Good Comms" is the total messages received by the DLC with good address, parity and checksum. Both counters are reset to 0 upon response to FC08, on power-up, and when Total Comms register rolls over.

FC17: Report Slave ID

The following is sent upon FC17 request:

Unit Address, 17 (FC code), RLC-DLCxx000 (model number), 0200 (for code version 2.00), 32 (number of read supported registers), 32 (number of writes supported registers), 16 (number of registers available for GUID/Scratch pad memory), checksum of the string.

SUPPORTED EXCEPTION CODES

01: Illegal Function
Issued whenever the requested function is not implemented in the controller.

02: Illegal Data Address
Issued whenever an attempt is made to access a single register or coil that does not exist (outside the implemented space) or to access a block of registers or coils that falls completely outside the implemented space.

03: Illegal Data Value
Issued when an attempt is made to read or write more registers or coils than the controller can handle in one request.

07: Negative Acknowledge
Issued when a write to coil or register is attempted with an invalid string length.

CHECKSUM ERRORS
1. Calibration checksum covers the area that contains calibration values for all ranges. When a calibration checksum error occurs, coil 1 becomes a "1".
2. Parameter checksum covers the area that contains the stored Holding register settings. When this checksum error occurs, coil 2 becomes a "1".
3. Integral and Offset/Manual Power checksum covers the area that contains the stored Integral register settings. When this checksum error occurs, coil 3 becomes a "1".
4. Setpoint Controller Segment Memory checksum covers the memory area that contains the profile segments for channel A and B. When this checksum error occurs, coil 29 becomes a "1".
5. Setpoint Controller Status Memory checksum covers the memory area that contains the profile operating status. When this checksum error occurs, coil 30 becomes a "1" and aborts the profile putting channel in manual control at 0% power.
6. All LEDs except PWR/COMMS will flash as long as one of the errors exist.
7. The control and alarm outputs are disabled as long as one of the errors exist.
8. These errors can be cleared or activated manually by writing to the appropriate coil. (This does not correct the reason for the error. It may be necessary to reconfigure or calibrate.)
9. The checksums are verified at power up.

CALIBRATION USING MODBUS COMMANDS

The DLC is fully calibrated from the factory. Recalibration is recommended every two years. Each channel is calibrated separately. All calibration settings are stored in the non-volatile memory. The DLC may be calibrated using MODBUS. However, the preferred method of calibrating the controller is through the SFDLC software.

When calibrating the input, a successful millivolt calibration must be performed first. All other input types use the millivolt points. Each input range (non-thermocouple) also has its own internal references that are recalled when the range is selected. Non-used types need not be calibrated.

Each of the procedures below show the calibration steps/register numbers for both channels A & B, however, only one channel can be calibrated at a time.

Note: Allow the DLC to warm up for 30 minutes minimum and follow the manufacturer's warm-up recommendations for the calibration or measuring source.

mV Calibration
Millivolt calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating the range to be calibrated. It is used for thermocouple inputs and as a basis for all other input calibration types.
1. Connect the signal source to the proper DLC terminals.
2. Enter 13 (for mV input) into register 40101 (Ch A) or 40201 (Ch B).
3. To open calibration mode, enter 48 into register 40501.
4. To start mV calibration, enter 1 (Ch A) or 101 (Ch B) into register 40501.
5. Apply the appropriate calibration voltage for a minimum of 10 seconds.
6. To store the mV calibration reading, enter the corresponding range number into register 40501:

RANGE	Ch A	Ch B
0 mV	2	102
14 mV	3	103
28 mV	4	104
42 mV	5	105
56 mV	6	106

7. Repeat steps 5 and 6 for each range to be calibrated for that channel.
8. To save the calibration results and end calibration, enter 0 into register 40501.

Cold Junction Calibration *
Cold Junction calibration requires a thermocouple of known accuracy of types T, E, J, K, C or N only and a calibrated external reference thermocouple probe.
1. Connect the thermocouple probe source to the proper DLC terminals.
2. Enter the connected thermocouple type into register 40101 (Ch A) or 40201 (Ch B).
3. Enter the scale (F or C) that matches the thermometer and the controller temperature, preferably °C into register 40102 (Ch A) or 40202 (Ch B).
4. Enter 1 for high resolution into register 40103 (Ch A) or 40203 (Ch B).
5. Place an external reference thermometer probe at the end of the DLC probe. The two probes should be shielded from air movement and allowed sufficient time to equalize in temperature. (As an alternative, the DLC probe may be placed in a calibration bath of known temperature.)
6. To open calibration mode, enter 48 into register 40501.
7. To start CJ calibration, enter 10 (Ch A) or 110 (Ch B) into register 40501.
8. Read the Process Value register 40001 (Ch A) or 40017 (Ch B).
9. Subtract the external reference reading from the Process Value register reading. Adjust the results to tenths position, drop decimal point, and maintain the results sign. (If the difference is -2 degrees, then adjust to -2.0 and remove decimal point yielding a value of -20.)
10. Add the value from step 9 (maintain the sign) to the value existing in register 40502.
11. If necessary, continue to adjust the register 40502 value until the Process Value register 40001 (Ch A) or 40017 (Ch B) matches the external reference reading.
12. To exit CJ calibration, enter 11 (Ch A) or 111 (Ch B) into register 40501.
13. To save the calibration results and close calibration mode, enter 0 into register 40501.

RTD Calibration *
RTD calibration requires a 0.1% (or better) precision 277.0 ohm resistor.
1. Connect a precision 277.0 ohm resistor, and a short, to terminals 1 & 2 (Ch B) or 4 & 5 (Ch A). During the complete procedure, short terminals 2 & 3 (Ch B) or 5 & 6 (Ch A).
2. Verify the input jumper is in the RTD position.
3. Enter 12 (ohms mode) into register 40101 (Ch A) or 40201 (Ch B).
4. To open calibration mode, enter 48 into register 40501.
5. To start RTD calibration, enter 20 (Ch A) or 120 (Ch B) into register 40501.
6. Leave 0 ohms (short) on terminals 1 & 2 (Ch B) or 4 & 5 (Ch A) for 10 seconds.
7. To store 0 ohm results, enter 21 (Ch A) or 121 (Ch B) into register 40501.
8. Apply 277 ohms by removing the short from terminal 1 & 2 (Ch B) or 4 & 5 (Ch A) for 10 seconds.
9. To store 277 ohm results, enter 22 (Ch A) or 122 (Ch B) into register 40501.
10. To save the calibration results and close calibration mode, enter 0 into register 40501.

Process Voltage Calibration *
Process calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 10.00 V.

1. Connect the signal source to the proper DLC terminals.
2. Verify the input jumper is in the 10 V position.
3. Enter 14 (for voltage input) into register 40101 (Ch A) or 40201 (Ch B).
4. To open calibration mode, enter 48 into register 40501.
5. To start voltage calibration, enter 12 (Ch A) or 112 (Ch B) into register 40501.
6. Apply 0.00 V for a minimum of 10 seconds.
7. To store 0.00 V reading, enter 13 (Ch A) or 113 (Ch B) into register 40501.
8. Apply 10.00 V for a minimum of 10 seconds.
9. To store 10.00 V reading, enter 14 (Ch A) or 114 (Ch B) into register 40501.
10. To save the calibration results and close calibration mode, enter 0 into register 40501.

* - Dependent on successful mV calibration.

Process Current Calibration *

Process current calibration requires a precision signal source with an accuracy of 0.03% (or better) that is capable of generating 20.00 mA.

1. Connect the signal source to the proper DLC terminals.
2. Verify the input jumper is in the 20 mA position.
3. Enter 15 (for current input) into register 40101 (Ch A) or 40201 (Ch B).
4. To open calibration mode, enter 48 into register 40501.
5. To start current calibration, enter 15 (Ch A) or 115 (Ch B) into register 40501.
6. Apply 0.00 mA for a minimum of 10 seconds.
7. To store 0.00 mA reading, enter 16 (Ch A) or 116 (Ch B) into register 40501.
8. Apply 20.00 mA for a minimum of 10 seconds.
9. To store 20.00 mA reading, enter 17 (Ch A) or 117 (Ch B) into register 40501.
10. To save the calibration results and close calibration mode, enter 0 into register 40501.

Analog Output Voltage Calibration

Analog Output Voltage calibration requires a precision meter with an accuracy of 0.05% (or better) that is capable of measuring 10.00 V.

1. Connect the meter to the proper DLC terminals.
2. Verify the output jumpers are in the V positions.
3. To open calibration mode, enter 48 into register 40501.
4. To start 0 volt calibration, enter 30 (Out 1) or 130 (Out 2) into register 40501.
5. Adjust register 40502 value until the external meter displays 0.00 V.
6. To start 10 volt calibration, enter 31 (Out 1) or 131 (Out 2) into register 40501.
7. Adjust register 40502 value until the external meter displays 10.00 V.
8. To save the calibration results and close calibration mode, enter 0 into register 40501.

Analog Output Current Calibration

Analog Output Current calibration requires a precision meter with an accuracy of 0.05% (or better) that is capable of measuring 20.00 mA.

1. Connect the meter to the proper DLC terminals
2. Verify the output jumpers are in the I position.
3. To open calibration mode, enter 48 into register 40501.
4. To start 0 mA calibration, enter 32 (Out 1) or 132 (Out 2) into register 40501.

5. Adjust register 40502 value until the external meter displays 0.00 mA.
6. To start 20 mA calibration, enter 33 (Out 1) or 133 (Out 2) into register 40501.
7. Adjust register 40502 value until the external meter displays 20.00 mA.
8. To save the calibration results and close calibration mode, enter 0 into register 40501.

Restore Factory Settings

The Factory Settings are listed in the DLC Register Table. This restore does not affect the calibration or communication settings of the DLC but may change all other settings for the channel.

1. To open calibration mode, enter 48 into register 40501.
2. To restore Factory Settings, enter 66 (Input Ch A and Analog Out 1) or 166 (Input Ch B and Analog Out 2) into register 40501.
3. To save the restore results and close calibration mode, enter 0 into register 40501.

Clear Setpoint Controller Segment Memory

1. To open calibration mode, enter 48 into register 40501.
2. To clear Setpoint Controller Segment memory, enter 67 (CHA Segment memory) or 167 (CHB Segment Memory) into register 40501.
3. To save the Clear results and close calibration mode, enter 0 into register 40501.

Nominal Calibration Settings

Nominal Calibration Settings does not require any calibration signals nor meters. This calibration should not be performed under normal circumstances.

Caution: This procedure results in up to ±10% reading error and the DLC will no longer be within factory specifications.

1. To open calibration mode, enter 48 into register 40501.
2. To enter Nominal Calibration Settings, enter 77 (Input Ch A and Analog Out 1) or 177 (Input Ch B and Analog Out 2) into register 40501.
3. To save the Nominal Calibration Settings and close calibration mode, enter 0 into register 40501.

* - Dependent on successful mV calibration.

DLC REGISTER TABLE

The below limits are shown as Integers or HEX < > values. Read and write functions can be performed in either Integers or Hex as long as the conversion was done correctly. Negative numbers are represented by two's complement.

Note 1: The DLC should not be powered down while parameters are being changed. Doing so may corrupt the non-volatile memory resulting in checksum errors.

REGISTER ADDRESS [1]		REGISTER NAME	LOW LIMIT [2]	HIGH LIMIT [2]	FACTORY SETTING [3]	ACCESS	COMMENTS
CH A	CH B	CONTROLLING VALUES					
40001	40017	Process Value	N/A	N/A	N/A	Read Only	Process value of present input level. This value is affected by Input Type, Resolution, & Scaling.
40002	40018	Setpoint Value	-32000	32000	0	Read/Write	Limited by Setpoint Limit Low and Setpoint Limit High.
40003	40019	Alarm 1 Value	-32000	32000	0	Read/Write	
40004	40020	Alarm 2 Value	-32000	32000	0	Read/Write	
		PID PARAMETERS					
40005	40021	Output Power	0 or -1000	1000	0	Read/Write	1 = 0.1%, 0.0 = Off; Limited by Power Low Limit and Power High Limit in Automatic Control Mode. Negative percent is cooling (direct) available when AL2 is Cooling. Write only possible during Manual mode.
40006	40022	Setpoint Deviation	N/A	N/A	N/A	Read Only	Deviation = Process Value - Setpoint Value; During Auto-Tune: Process Value - Auto-Tune Setpoint Value
40007	40023	Proportional Band	0	9999	40	Read/Write	0 = On/Off Control, 1 = 0.1%
40008	40024	Integral Time	0	9999	120	Read/Write	0 = Off, 1= 1 second
40009	40025	Derivative Time	0	9999	30	Read/Write	0 = Off, 1= 1 second
40010	40026	Offset Power	-1000	1000	0	Read/Write	1 = 0.1%; Applied when Integral Time is 0.
40011	40027	Auto-Tune Start	0	1	0	Read/Write	0 = Stop, 1 = Start; Mirror of Coil 16/28.
40012	40028	Auto-Tune Phase	N/A	N/A	N/A	Read Only	0 = Off, 4 = Last phase during Auto-Tune
40013	40029	Auto-Tune Code	0	2	0	Read/Write	0 = Fastest response, 2 = Slowest response
		OUTPUT STATUS					
40014	40030	Control Output OP1	N/A	N/A	N/A	Read Only	0 = Off, 1 = On; Mirror of Coil 9/21.
40015	40031	Alarm Output AL1	0	1	0	Read/Write	0 = Off, 1 = On; A write of 1 is only possible when alarm is set for Manual. Mirror of Coil 10/22.
40016	40032	Alarm Output AL2 / OP2	0	1	0	Read/Write	0 = Off, 1 = On; A write of 1 is only possible when alarm is set for Manual. Mirror of Coil 11/23.
		CONTROL STATUS					
40041	40049	Control Mode	0	1	0	Read/Write	0 = Automatic, 1 = Manual; Mirror of Coil 12/24.
40042	40050	Disable Setpoint Ramping	0	1	0	Read/Write	0 = Enabled, 1 = Disabled; Mirror of Coil 13/25.
40043	40051	Setpoint Ramping In Process	N/A	N/A	N/A	Read Only	0 = No, 1 = Yes; Mirror of Coil 14/26.
40044	40052	Disable Integral Action	0	1	0	Read/Write	0 = Enabled, 1 = Disabled; Mirror of Coil 15/27
40045	40053	Ramping Setpoint Value	N/A	N/A	N/A	Read/Write	Actual Setpoint Value used for control (ramps when ramping enabled.) Limited by Setpoint Limit Low and Setpoint Limit High.
40046		Remote / Local Setpoint Select	0	1	0	Read/Write	0 = Local Setpoint, 1= Remote Setpoint
		PROFILE OPERATION					SETPOINT CONTROLLER MODEL ONLY
40065	40073	Profile Operating Status	0	3	0	Read/Write (0-3 only)	0 = Off; 1 = Abort; 2 = Run/Start, 3 = Pause, 4 = Error Delay (status only - writing a "4" will revert unit to mode "3" Pause)
40066	40074	Profile Phase	N/A	N/A	N/A	Read Only	0 = Ramp; 1 = Hold
40067	40075	Profile Segment	N/A	N/A	N/A	Read Only	(0 = Stop, 1-20 = Current Segment)
40068	40076	Profile Phase Time Remaining	1	9999	N/A	Read/Write	1= 0.1 Minute; Can make temporary change on the fly Value Over-range = 32003 (may occur on extremely slow ramp; Ramp will function properly)
40069	40077	Profile Cycle Count Remaining	1	250	0	Read/Write	0-250; If Cycle Count (40326/40426) is 250 (Continuous operation), value will reset to 250 at 0.
40070	40078	Advance Profile Phase	0	1	0	Read/Write	1 = Advances "running" Profile to next ramp or hold phase
		INPUT PARAMETERS					
	40198	Ch B Assignment	0	1	0	Read/Write	0 = PID, 1 = Remote Setpoint
	40199	Local / Remote Setpoint Transfer Mode	0	2	0	Read/Write	0 = Normal (Output may bump) 1 = Auto (Output may bump) 2 = Track (Local Setpoint assumes value of Remote SP for Remote to Local Transfer)
40101	40201	Input Type	0	15	2	Read/Write	See Input Listing
40102	40202	Temperature Scale	0	1	0	Read/Write	0 = °F, 1 = °C, For Input Types 0-11.
40103	40203	Resolution	0	1	0	Read/Write	Input Types 0-12 0=Low (x1) whole input units, 1 = High (x10) tenth of input units, Input Type 13 0 = 0.1 mV, 1 = 0.01 mV, Input Types 14-15, N/A
40104	40204	Rounding	1	100	1	Read/Write	Greater than 1 causes rounding starting at least significant digit.

[1] For Input Registers, replace the 4xxxx with a 3xxxx in the above register address. The 3xxxx are a mirror of the 4xxxx Holding Registers.
[2] An attempt to exceed a limit will set the register to its high or low limit value.
[3] See MODBUS Calibration for procedure on restoring Factory Settings.

REGISTER ADDRESS [1]		REGISTER NAME	LOW LIMIT [2]	HIGH LIMIT [2]	FACTORY SETTING [3]	ACCESS	COMMENTS
CH A	CH B	INPUT PARAMETERS					
40105	40205	Digital Input Filter	0	4	1	Read/Write	0 = Least, 4 = Highest
40106	40206	Span Correction / Remote Setpoint Ratio Multiplier	1	32000	10000	Read/Write	10000 = 1.0000 (applies no correction), 1 = 0.0001, For Input Types 0-11. Applies to all inputs (0-15) for ChB when ChB is configured for Remote Setpoint (40198).
40107	40207	Offset Correction / Remote Setpoint Bias Offset	-32000	32000	0	Read/Write	For Input Types 0-13/ Applies to all inputs (0-15) for ChB when ChB is configured for Remote Setpoint (40198).
		SETPOINT PARAMETERS					
40108	40208	Low Limit	-32000	32000	0	Read/Write	ChB value also applies to Remote Setpoint
40109	40209	High Limit	-32000	32000	32000	Read/Write	ChB value also applies to Remote Setpoint
40110	40210	Ramp Rate	0	32000	0	Read/Write	1 = 0.1° per minute for input types 0-11, 0.1 ohms for input type 12, 0.01 mV for input type 13, 0.1 process units for input types 14-15, 0 = off (ChB Ramp Rate is Non-functional in remote setpoint mode)
		SCALING POINTS PARAMETERS					
40111	40211	Process Low	-32000	32000	0	Read/Write	For Input Types 14-15
40112	40212	Process High	-32000	32000	1000	Read/Write	For Input Types 14-15
40113	40213	Input Low	-32000	32000	4000	Read/Write	1 = 0.001 V or 0.001 mA, For Input Types 14-15.
40114	40214	Input High	-32000	32000	20000	Read/Write	1 = 0.001 V or 0.001 mA For Input Types 14-15.
40115	40215	Process Decimal Point	0	5	3	Read/Write	Can be used by host to determine resolution of input. For Input Types 14-15.
CH A	CH B	CONTROL (OP1) PARAMETERS					NON-FUNCTIONAL IN REMOTE SETPOINT MODE (SEE 40198)
40116	40216	Cycle Time	0	2500	20	Read/Write	1 = 0.1 second
40117	40217	Control Action	0	1	0	Read/Write	0 = Reverse Acting, 1 = Direct Acting
40118	40218	Power Low Limit	0 or -100	100	0	Read/Write	1 = 1%; Negative percent is only available to OP2 when AL2 is set for Cooling.
40119	40219	Power High Limit	0 or -100	100	100	Read/Write	1 = 1%; Negative percent is only available to OP2 when AL2 is set for Cooling.
40120	40220	Sensor Failure Power Preset	0 or -100	100	0	Read/Write	1 = 1%; Negative percent is only available to OP2 when AL2 is set for Cooling.
40121	40221	Dampening Time	0	250	3	Read/Write	1 = 1 second
40122	40222	On/Off Control Hysteresis	1	250	2	Read/Write	
		ALARM 1 (AL1) OUTPUT PARAMETERS					
40131	40231	Action	0	8	3	Read/Write	See Alarm Action Register Table.
40132	40232	Reset	0	1	0	Read/Write	0 = Automatic, 1 = Latched
40133	40233	Enable Standby Delay	0	1	0	Read/Write	0 = Disable, 1 = Enable
40134	40234	Hysteresis	1	250	1	Read/Write	
40135	40235	On Delay	0	32000	0	Read/Write	1 = 1 second
		ALARM 2 (AL2) OUTPUT PARAMETERS					
40136	40236	Action	0	9	3	Read/Write	See Alarm Action Register Table.
40137	40237	Reset	0	1	0	Read/Write	0 = Automatic, 1 = Latched; Not for Cooling Action.
40138	40238	Enable Standby	0	1	0	Read/Write	0 = Disable, 1 = Enable; Not for Cooling Action.
40139	40239	Hysteresis	1	250	1	Read/Write	Not for Cooling Action.
40140	40240	On Delay	0	32000	0	Read/Write	1 = 1 second; Not for Cooling Action.
		COOLING (OP2) PARAMETERS					NON-FUNCTIONAL IN REMOTE SETPOINT MODE (SEE 40198)
40141	40241	Cycle Time	0	2500	20	Read/Write	1 = 0.1 second; 0 = OP2 Off
40142	40242	Relative Gain	0	100	10	Read/Write	1 = 0.1; 0 = On/Off Control
40143	40243	Deadband	-32000	32000	0	Read/Write	
OUT 1	OUT 2	ANALOG OUTPUT PARAMETERS					ANALOG MODEL ONLY
40301	40309	Assignment	0	11	0(Out 1) 6(Out 2)	Read/Write	See Analog Output Assignment Register Table.
40302	40310	Mode	1	3	3	Read/Write	1 = 0-10 V, 2 = 0-20 mA, 3 = 4-20 mA
40303	40311	Scaling Value Low	-32000	32000	0	Read/Write	Corresponds with 0 V, 0 mA or 4 mA output.
40304	40312	Scaling Value High	-32000	32000	1000	Read/Write	Corresponds with 10 V or 20 mA output.
40305	40313	Deadband	0	250	0	Read/Write	1 = 0.1%; Applies when Assignment is Output Power.
40306	40314	Update Time	0	250	0	Read/Write	0 = scan rate (10 updates/ sec) 1 = 1 second
40307	40315	Direct Entry Value	-32000	32000	0	Read/Write	Applies when Assignment is Direct Entry Value.
40308	40316	Filter	0	1	0	Read/Write	1 = Applies averaging when Update Time is >=1

[1] For Input Registers, replace the 4xxxx with a 3xxxx in the above register address. The 3xxxx are a mirror of the 4xxxx Holding Registers.
[2] An attempt to exceed a limit will set the register to its high or low limit value.
[3] See MODBUS Calibration for procedure on restoring Factory Settings.

DLC REGISTER TABLE Continued

REGISTER ADDRESS [1]		REGISTER NAME	LOW LIMIT [2]	HIGH LIMIT [2]	FACTORY SETTING [3]	ACCESS	COMMENTS
CH A	CH B	SETPOINT CONTROLLER PROFILE PARAMETERS					SETPOINT CONTROLLER MODEL ONLY
40321	40421	Profile Power Cycle Mode	0	4	1	Read/Write	0 = Stop (control at current active SP); 1 = Abort (manual control, 0% power); 2 = Start; 3 = Resume; 4 = Pause
40322	40422	Profile Error Band Mode	0	3	0	Read/Write	0 = Disable Error Band, 1 = Error Band applies to Ramp Phase 2 = Error Band applies to Hold Phase 3 = Error Band applies to Both Ramp and Hold Phase
40323	40423	Profile Error Band	1	32000	10	Read/Write	1 = 1 process unit; During Hold phase, profile is paused when process error >= error band until process error (deviation) is within the Error band (Error Band - Error Band Hysteresis)
40324	40424	Profile Error Band Hysteresis	0	250	2	Read/Write	1 = 1 Process Unit
40325	40425	Profile End Segment	1	20	1	Read/Write	Segment that ends the profile
40326	40426	Profile Cycle Count	1	250	1	Read/Write	1 - 249 = Number of times to run profile 250 = Run Profile continuously
40327	40427	Profile End Control Mode	0	1	0	Read/Write	0 = Manual Mode, 0% power; 1 = Automatic Control at last Setpoint
		SERIAL COMMUNICATION SETTINGS					
40401		Unit (Node) Address	1	247	247	Read/Write	Node serial DLC address.
40402		Baud Rate	0	7	5	Read/Write	See Serial Baud Rate Register Table.
40403		Parity	1	3	1	Read/Write	1 = None, 2 = Even, 3 = Odd
40404		Data Bits	0	1	1	Read/Write	0 = 7 bits, 1 = 8 bits
40405		MODBUS Protocol	0	1	1	Read/Write	0 = ASCII Mode, 1 = RTU Mode
40406		Transmit Delay	2	250	2	Read/Write	2 = 2 msec; See Transmit Delay explanation.
40407		Load Serial Settings	0	1	0	Read/Write	Changing 40401-40406 will not update the DLC until 40407 is 1. After a write, the communicating device must be changed to the new DLC settings and 40407 returns to 0.
		CALIBRATION					
40501		Unit Calibration	N/A	N/A	N/A	Read/Write	See MODBUS Calibration explanation.
40502		Calibration Data Register	N/A	N/A	N/A	Read/Write	See MODBUS Calibration explanation.
40503		Non-Volatile Memory Write Disable	0	1	0	Read/Write	0 = Enable writes, 1 = Disable writes; Returns to 0 at power cycle. Mirror of Coil 4.
40504		Input Error Status Register	N/A	N/A	N/A	Read Only	Bits 0-7 are mirror of Coils 5-8/17-20, See Coils Table.
40505		Checksum Error Status Register	0	N/A	0	Read/Write	Bits 0-3 are mirror of Coils 1-3, See Coils Table.
CHA	CHB	SETPOINT CONTROLLER PROFILE SEGMENTS					SETPOINT CONTROLLER MODEL ONLY
40601 to 40620	40701 to 40720	Setpoint Value Segment 1 - 20	-32000	32000		Read/Write	Limited by Setpoint Limit Low and Setpoint Limit High.
40621 to 40640	40721 to 40740	Ramp Rate Segment 1 - 20	0	32000		Read/Write	1 = 0.1° per minute for input types 0-11, 0.1 ohms for input type 12, 0.01 mV for input type 13, 0.1 process units for input types 14-15, 0 = Off
40641 to 40660	40741 to 40760	Hold Time Segment 1 - 20	0	9999		Read/Write	1 = 0.1 minute
41001-41010		Slave ID	N/A	N/A	N/A	Read Only	RLC-DLC1xx00 (model) 2.00 version (maybe higher) 32 reads, 32 writes 16 scratch. See FC17 explanation.
41101-41116		GUID/Scratch Pad	N/A	N/A	N/A	Read/Write	This area is for the user to store any related information. This register area does not affect DLC operations.

[1] For Input Registers, replace the 4xxxx with a 3xxxx in the above register address. The 3xxxx are a mirror of the 4xxxx Holding Registers.
[2] An attempt to exceed a limit will set the register to its high or low limit value.
[3] See MODBUS Calibration for procedure on restoring Factory Settings.

COILS TABLE

COIL ADDRESS		COIL NAME	MIRROR REGISTER	ACCESS	COMMENTS
1		Calibration Checksum Error	40505 (bit 0)	Read/Write	1 = Error; Causes Process Value to be 32100, Disables control and alarm outputs, causes flashing LEDs. Writing a zero clears the error.
2		Parameter Checksum Error	40505 (bit 1)	Read/Write	1 = Error; Causes Process Value to be 32100, Disables control and alarm outputs, causes flashing LEDs. Writing a zero clears the error.
3		Integral and Offset/Manual Power Checksum Error	40505 (bit 2)	Read/Write	1 = Error; Causes Process Value to be 32100, Disables control and alarm outputs, causes flashing LEDs. Writing a zero clears the error.
4		Non-Volatile Memory Write Disable	40503	Read/Write	1 = Disables writes to the non-volatile memory; Returns to 0(writes are enabled) at power cycle.
CH A	CH B				
5	17	Shorted RTD Input Error	40504	Read Only	1 = Shorted RTD; Causes process value to be -32002, disables alarms, sets control output(s) to sensor failure power preset level, causes flashing LEDs.
6	18	Open Thermocouple, RTD, or Extreme Process Input Over/Under Range Input Error	40504	Read Only	1 = Input Error; Causes process value to be 32002, disables alarms, sets control output(s) to sensor failure power preset level, causes flashing LEDs.
7	19	Signal or Sensor Under Range Input Error	40504	Read Only	1 = Under Range Error; Causes process value to be -32001, maintains control output at present level, causes flashing LEDs.
		Process Value (<-32000) Under Range Input Error	40504	Read Only	1 = Under Range Error; Causes process value to be -32003, maintains control output at present level until input causes Sensor FailurePower Preset Level, causes flashing LEDs.
8	20	Signal or Sensor Over Range Input Error	40504	Read Only	1 = Over Range Error; Causes process value to be 32001, maintains control output at present level, causes flashing LEDs.
		Process Value (>32000) Over Range Input Error	40504	Read Only	1 = Over Range Error; Causes process value to be 32003, maintains control output at present level until input causes Sensor FailurePower Preset Level, causes flashing LEDs.
9	21	Control Output OP1 State	40014/40030	Read Only	0 = Off, 1 = On
10	22	Alarm 1 Output AL1 State	40015/40031	Read/Write	0 = Off, 1 = On; A write of 1 is only possible when alarm is set for Manual.
11	23	Alarm 2 Output AL2/OP2 State	40016/40032	Read/Write	0 = Off, 1 = On; A write of 1 is only possible when alarm is set for Manual.
12	24	Control Mode	40041/40049	Read/Write	0 = Automatic Mode, 1 = Manual Mode
13	25	Disable Setpoint Ramping	40042/40050	Read/Write	0 = Enabled, 1 = Disabled
14	26	Setpoint Ramping In Process	40043/40051	Read Only	0 = No, 1 = Yes
15	27	Disable Integral Action	40044/40052	Read/Write	0 = Enabled, 1 = Disabled
16	28	Auto-Tune Start	40011/40027	Read/Write	0 = Stop, 1 = Start
		SETPOINT CONTROLLER MODEL ONLY			
29		Setpoint Controller Segment Memory Checksum Errror	40505 (bit 4)	Read/Write	1 = Checksum Error in A or B Setpoint Controller Segment memory (40601-40760), causes process value to be 32100 disables control and alarm outputs, causes flashing LEDs.
30		Setpoint Controller Status Memory Checksum Error	40505 (bit 5)	Read/Write	1 = Checksum Error in A or B Setpoint Controller Operating Status memory, disables control and alarm outputs, causes flashing LEDs, and aborts profile putting channel in manual control at 0% power.
31	32	Advance Profile Phase	40070/40078	Read/Write	1 = Advance running Profile to next phase
33		Local/Remote Setpoint Select	40046	Read/Write	0 = Local Setpoint; 1 = Remote Setpoint

INPUT TYPE REGISTER (40101/40201) TABLE

MODE	TYPE
0	Thermocouple - T
1	Thermocouple - E
2	Thermocouple - J
3	Thermocouple - K
4	Thermocouple - R
5	Thermocouple - S
6	Thermocouple - B
7	Thermocouple - N

MODE	TYPE
8	Thermocouple - C
9	RTD platinum 385
10	RTD platinum 392
11	RTD nickel 672
12	Linear Ohms
13	Linear mV (1 = 10mV)
14	Process Voltage
15	Process Current

ANALOG OUTPUT ASSIGNMENT REGISTER (400301/40309) TABLE

MODE	ASSIGNMENT
0	Output Power A
1	Process Value A
2	Setpoint A
3	Ramping Setpoint A
4	Deviation A
5	Direct Entry Value 1
6	Output Power B
7	Process Value B
8	Setpoint B
9	Ramping Setpoint B
10	Deviation B
11	Direct Entry Value 2

ALARM 1 (40131/40231) AND ALARM 2 (40136/40236) ACTION REGISTER TABLE

MODE	ACTION
0	Manual
1	Absolute HI (Balanced)
2	Absolute LO (Balanced)
3	Absolute HI (Unbalanced)
4	Absolute LO (Unbalanced)
5	Deviation HI
6	Deviation LO
7	Band Inside Acting
8	Band Outside Acting
9	Cooling (Alarm 2 only)

SERIAL BAUD RATE REGISTER (40402) TABLE

MODE	BAUD
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400

TROUBLESHOOTING

PROBLEM	CAUSE	REMEDIES
Power LED will not light	Controller power	Check controller power connections and voltage level
Process Value not changing or incorrect	Input signal Incorrect channel Incorrect programming	Check input signal connections and signal level Check proper channel setup, reading and connections Check input setup, scaling values, and re-download
Alarms not functioning properly	Calculated trigger points are over +32000 or below -32000	Adjust alarm value, alarm hysteresis, and setpoint value to ensure valid trigger points
Process Value stays at -32001 or +32001	Input Signal (sensor) under-range or over-range *	Check input type, level, channel, jumpers and re-download. Replace sensor. Perform calibration.
Process Value stays at -32002	Shorted RTD sensor *	Check input sensor, level, channel, jumpers and re-download. Replace probe.
Process Value stays at +32002	Open TC or RTD sensor *	Check input sensor, level, channel, jumpers and re-download. Replace probe.
Process Value stays at -32003 or +32003	Process Value underrange (<-32000) or overrange (>+32000)	Check input level, scaling, jumpers and re-download
Process Value stays at +32100, All LEDs Flashing, Alarms disabled	Parameter checksum error † Calibration checksum error † Integral and Offset/Manual Power checksum error † Setpoint Controller Segment Memory checksum error † Setpoint Controller Status Memory checksum error †	Re-download SFDLC file Perform calibration procedure Consult Factory Check A & B Setpoint Ramp Rate and Hold Time Segments. Change minimum of 1 segment register for each channel to cause a new checksum to be written Consult Factory
Will not communicate (Comm. LED not flashing)	Incorrect serial settings (DLC port) Incorrect serial settings (computer port) Incorrect wiring	Verify DLC communications setup Go to pull down menu SETTINGS,PC PORT SETTING Try switching A+ and B- lines
	Note: *The DLC serial settings must match the device that it is communicating with. If you do not know or cannot recall the DLC settings, they can be reset back to factory defaults. Simply jumper the Default Serial terminal to Input Common or by putting the Default Serial setting DIP switch in the "UP" position.*	

* Can also be monitored by accessing coils 5-8 and 17-20, or register 40504.
† Can also be monitored by accessing coils 1-3, 29-30 or register 40505.
For further technical assistance, contact technical support.

LIMITED WARRANTY

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MODEL P48 - 1/16 DIN PROCESS CONTROLLER

- PID CONTROL WITH REDUCED OVERSHOOT
- ACCEPTS 0 to 10 VDC or 0/4 to 20 mA DC INPUTS
- OPTIONAL TWO LINEAR DC OUTPUTS (0 to 10 V, 0/4 to 20 mA)
- OPTIONAL DUAL ALARM OUTPUTS
- OPTIONAL REMOTE SETPOINT INPUT (0/4 to 20 mA)
- OPTIONAL RS485 SERIAL COMMUNICATIONS
- SECOND SETPOINT SETTING
- SETPOINT RAMPING FOR PROCESS STARTUP
- PROGRAMMABLE USER INPUT (Digital) FOR ADDED FLEXIBILITY
- PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS
- MANUAL/AUTOMATIC CONTROL MODES
- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS
- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF PROCESS AND SETPOINT

- STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES
- PC SOFTWARE AVAILABLE FOR CONTROLLER CONFIGURATION
- NEMA 4X/IP65 BEZEL

**UL Recognized Component,
File # E156876**

DESCRIPTION

The P48 Controller accepts either a 0 to 10 VDC or a 0/4 to 20 mA DC signal, precisely displays the input process signal according to the programmable scaling points, and provides an accurate output control signal *(time proportional or linear DC)* to maintain the process at the desired control point. The controller's comprehensive yet simple programming allows it to meet a wide variety of application requirements.

In the PID control mode the controller operates with on-demand auto-tune, which will establish the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also operate in the ON/OFF control mode with adjustable hysteresis. a second setpoint is available to allow quick selection of a different setpoint setting.

Dual 4-digit displays allow viewing of the process and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. On some models, the main control output and the alarm outputs are field replaceable.

Optional alarm(s) can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, and Band IN or OUT) with

adjustable hysteresis. A standby feature suppresses the alarm during power-up until the process stabilizes outside the alarm region. The second alarm can be configured as a secondary PID output (heat/cool applications).

Optional Main Linear DC output (10 V or 20 mA) can be used for control or process re-transmission purposes. Programmable output update time reduces valve or actuator activity. The output range can be scaled independent of the input range.

Optional Second Linear DC output (10 V or 20 mA) provides an independent process re-transmission, while the main Linear DC output is being used for control. The output range can be scaled independent of the input range.

Optional Remote Setpoint input (0/4 to 20 mA) allows for cascade control loops; and allows for remotely driven setpoint signal from computers or other similar equipment. Straightforward end point scaling with independent filtering and local/remote transfer option expand the controller's flexibility.

The optional RS485 serial communication interface provides two-way communication between a P48 and other compatible equipment such as a printer, PLC, HMI, or a host computer. In multipoint applications (up to thirty-two), the address number of each P48 on the line can be programmed separately from 0 to 99. Data from the P48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. PC software, SFCRM, allows for easy configuration of controller parameters. These settings can be saved to disk for later use or used for multi-controller down loading. On-line help is provided within the software.

The unit is constructed of a lightweight, high impact plastic case with a tinted front panel. The front panel meets NEMA 4X/IP65 specifications when properly installed. Multiple units can be stacked horizontally or vertically. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.
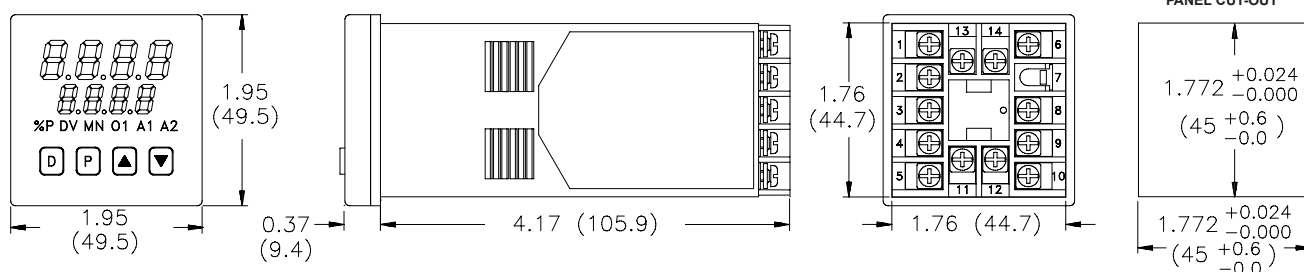
CAUTION: Risk of Danger.
Read complete instructions prior to installation and operation of the unit.

CAUTION: Risk of electric shock.

DIMENSIONS In inches (mm)

%P DV MN O1 A1 A2

1.95 (49.5)

1.95 (49.5)

0.37 (9.4)

4.17 (105.9)

1.76 (44.7)

1.76 (44.7)

PANEL CUT-OUT

1.772 +0.024/−0.000

(45 +0.6/−0.0)

1.772 +0.024/−0.000

(45 +0.6/−0.0)

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 P48 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 controller. An independent and redundant process limit indicator with alarm outputs is strongly recommended.

SPECIFICATIONS

1. **DISPLAY:** Dual 4-digit
   Upper Process Display: 0.4" (10.2 mm) high red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) high green LED
   Display Messages:
   "OLOL" - Appears when measurement exceeds + input range.
   "ULUL" - Appears when measurement exceeds - input range.
   "SENS" - Appears when measurement exceeds controller limits.
   "..." - Appears when display values exceed + display range.
   "-.." - Appears when display values exceed - display range.

   LED Status Annunciators:
   %P - Lower auxiliary display shows power output in (%).
   MN - Flashing: Controller is in manual mode.
       On: Local Setpoint (Remote Setpoint option)
       Off: Remote Setpoint
   DV - Lower auxiliary display shows deviation *(error)* from setpoint.
   O1 - Main control output is active.
   A1 - Alarm #1 is active *(for A1 option)*.
   A2 - Alarm #2 is active OR
       - Secondary output (02) is active.

2. **POWER:**
   AC Versions: 85 VAC min. to 250 VAC max., 50 to 60 Hz, 8 VA max.
   DC Versions:
       DC Power: 18 to 36 VDC; 7 W
       AC Power: 24 VAC ±10%; 50 to 60 Hz, 9 VA

3. **CONTROLS:** Four front panel push buttons for modification and setup of controller functions and one external user input for parameter lockout or other functions.

4. **MEMORY:** Nonvolatile E^2 PROM retains all programmable parameters and values.

5. **RANGE AND ACCURACY:**

INPUT RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	IMPEDANCE	MAX CONTINUOUS OVERLOAD	RESOLUTION
10 VDC (-1 to 11)	0.10% of reading +0.02 V	0.30% of reading +0.03 V	1 M ohm	300 V	10 mV
20 mA DC (-2 to 22)	0.10% of reading +0.03 mA	0.30% of reading +0.04 mA	10 ohm	100 mA	10 μA

* Accuracies are expressed as ± percentages after 20 minutes warm-up. The controller's accuracy is specified in two ways: accuracy over an 18 to 28°C range at 10 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide sensor range reflects the coefficient of the internal circuitry.

6. **MAIN SIGNAL INPUT:**
   Sample Period: 100 msec
   Response Time: Less than 300 msec typ., 400 msec max. *(to within 99% of final value w/step input; typically, response is limited to response time of sensor)*
   Normal Mode Rejection: 40 dB @ 50/60 Hz (improves with increased digital filtering.)
   Common Mode Rejection: Greater than 120 dB, DC to 60 Hz
   Protection: Input overload 120 VAC max. for 15 sec. max.

7. **USER INPUT:** Internally pulled up to +5 VDC (1 MΩ).
   $V_{IN\ MAX}$ = 5.25 VDC; V_{IL} = 0.85 V max.; V_{IH} = 3.65 V min.; I_{OFF} = 1μA max.
   Response Time: 120 msec max.
   Functions:
Program Lock	Integral Action Lock
Auto/Manual Mode Select	Setpoint Ramp Enable
Reset Alarms	Setpoint 1/Setpoint 2 Select
Local/Remote Setpoint Select	Serial block print

8. **CONTROL AND ALARM OUTPUTS:**
   Relay outputs with Form A contacts:
       Contact Rating: 3 A @ 250 VAC or 30 VDC (resistive load)
       1/10 HP @ 120 VAC (inductive load)
       Life Expectancy: 100,000 cycles at max. load rating.
       (Decreasing load and/or increasing cycle time, increases life expectancy.)

9. **MAIN CONTROL:**
   Control: PID or ON/OFF
   Output: Time proportioning or Linear DC
   Cycle time: Programmable
   Auto-tune: When selected, sets proportional band, integral time, and derivative time values.

10. **ALARMS:** 1 or 2 alarms (optional)
    Modes:
Absolute high acting	Absolute low acting
Deviation high acting	Deviation low acting
Inside band acting	Outside band acting

    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable
    Annunciator: LED backlight for "A1", "A2"

11. **SECONDARY OUTPUT:** Software selectable (overrides alarm 2)
    Control: PID or ON/OFF
    Output: Time Proportioning
    Cycle time: Programmable
    Proportional Gain Adjust: Programmable
    Deadband /Overlap: Programmable

12. **MAIN AND SECOND LINEAR DC OUTPUT:** (optional)
    Main: Control or re-transmission, programmable update rate from 0.1 sec to 250 sec
    Second: Re-transmission only, fixed update rate of 0.1 sec

OUTPUT ** RANGE	ACCURACY * (18 to 28°C)	ACCURACY * (0 to 50°C)	COMPLIANCE	RESOLUTION
0 to 10 V	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	10k ohm min.	1/3500
0 to 20 mA	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	500 ohm max.	1/3500
4 to 20 mA	0.10% of FS + 1/2 LSD	0.30% of FS + 1/2 LSD	500 ohm max.	1/2800

* Accuracies are expressed as ± percentages after 20 minutes warm-up. Output accuracy is specified in two ways: Accuracy over an 18 to 28°C range at 10 to 75% RH environment; and accuracy over a 0 to 50°C range at 0 to 85% RH (non-condensing) environment. Accuracy over the wide sensor range reflects the coeffecient of the internal circuitry.

** Outputs are independently jumper selectable for either 10 V or 20 mA. The output range may be field calibrated to yield approximately 10% overrange and a small underrange (negative) signal.

13. **REMOTE SETPOINT INPUT:** (optional)
    Input type: 0/4 to 20 mA
    Input Resistance: 10Ω
    Overrange: -5% to 105%
    Overload: 100 mA (continuous)
    Scale Range: -999 to 9999
    Resolution: 1 part in 10,000.
    Accuracy:
        At 25° C: ±(0.1 % of full scale +½ LSD)
        Over 0 to 50°C range: ±(0.2% of full scale +½ LSD)
    Reading Rate: 10/sec.
    Setpoint Filtering: Programmable Digital
    Setpoint Ramping: Programmable, 1 to 9999 units/minute.

14. **SERIAL COMMUNICATIONS:** (optional)
    Type: RS485 multipoint, balanced interface
    Baud Rate: 300 to 9600
    Data Format: 7O1, 7E1, 7N2, 8N1
    Node Address: 0 to 99, max of 32 units per line
    Transmit Delay: 2 to 100 msec or 100 to 200 msec
    Data Encoding: ASCII
    Isolation w.r.t Main Input Common: 500 Vrms for 1 min. (50 V working)
        Not isolated w.r.t. Remote Setpoint or Analog Output common
    Note: RS485 and the Analog Output commons are not internally isolated within the controller. The terminating equipment of these outputs must not share the same common (ie. earth ground).

15. **ENVIRONMENTAL CONDITIONS:**
    Operating Range: 0 to 50°C
    Storage Range: -40 to 80°C
    Operating and Storage Humidity:
        85% max. relative humidity (non-condensing) from 0°C to 50°C.
    Altitude: Up to 2000 meters

16. **ISOLATION BREAKDOWN RATINGS:**
    AC line with respect to all Inputs and outputs: 250 V working (2300 V for 1 minute).
    Main input with respect to Analog Outputs and Remote Setpoint Input: 50 V working (2300 V for 1 minute).
    All other inputs and outputs with respect to relay contacts: 2000 VAC
    Not isolated between Analog Output and Remote Setpoint commons.

17. CERTIFICATIONS AND COMPLIANCES:

SAFETY

UL Recognized Component, File #E156876, UL873, CSA 22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

Type 4X Enclosure rating (Face only), UL50

IECEE CB Scheme Test Certificate # UL1369-156876/USA,
    CB Scheme Test Report # 96ME50224-040396
        Issued by Underwriters Laboratories, Inc.
      IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
      IP65 Enclosure rating (Face only), IEC 529

ELECTROMAGNETIC COMPATIBILITY

Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact
		Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m [1]
		80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O
		Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms [2]
		150 KHz - 80 MHz
Power frequency magnetic fields	EN 61000-4-8	Level 4; 30 A/m
Simulation of cordless telephones	ENV 50204	Level 3; 10 V/m
		900 MHz ± 5 MHz
		200 Hz, 50% duty cycle

Emissions to EN 50081-2

RF interference	EN 55011	Enclosure class A
		Power mains class A

Notes:

1. No loss of performance during EMI disturbance at 10 V/m.
   Unit is panel mounted in a metal enclosure (Buckeye SM7013-0 or equivalent) that provides at least 20 dB shielding effectiveness. Metal panel is connected to earth ground.
   Power Line and I/O cables routed in metal conduit connected to earth ground.

2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms:
   Analog output may deviate during EMI disturbance.
   For operation without loss of performance:
   Install power line filter, RLC#LFIL0000 or equivalent.
               OR
   Install 2 ferrite cores, RLC#FCOR0000 or equivalent, to AC lines at unit for frequencies above 5 MHz.
   I/O cables routed in metal conduit connected to earth ground.
   Refer to the EMC Installation Guidelines section of the manual for additional information.

18. CONNECTION: Wire clamping screw terminals

19. CONSTRUCTION: Black plastic alloy case and collar style panel latch. Panel latch can be installed for vertical or horizontal instrument stacking. One piece tinted plastic bezel. Bezel assembly with circuit boards can be removed from the case to change the output board without removing the case from the panel or disconnecting wiring. Unit meets NEMA 4X/IP65 requirements for indoor use, when properly installed. Installation Category II, Pollution Degree 2.

20. WEIGHT: 0.38 lbs (0.17 kgs)

BASIC OPERATION

The P48 controls a process by receiving a linear DC signal representing the process value, then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process at setpoint. The PID control algorithm incorporates features which provide for high control accuracy and low overshoot from process disturbances.

FRONT PANEL FEATURES

In the normal operating mode, the unit displays the process value in the upper display. One of the following parameters can be viewed in the lower display:

- Setpoint
- % Power Output
- Process Deviation
- Blank Display

The user scrolls through these parameters by pressing the D button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the P button and modified by use of the UP and DOWN buttons. Parameters are then entered by the P button, which advances the user to the next parameter. Pressing the D button immediately returns the controller to the normal operating mode without changing the currently selected parameter.

HARDWARE FEATURES

A fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent process control. Measurement accuracy of 0.1% or better, provides close process control conforming to the desired control setpoint value.

Low-drift, highly stable circuitry ensures years of reliable and accurate process control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

REMOTE SETPOINT INPUT

The remote setpoint input facilitates the use of a remote signal to drive the controller's setpoint. The remote signal can be scaled independent to that of the controller's range. The controller's response to local/remote setpoint transfers can be programmed. Also, the remote signal is filtered by use of an adaptive filter. With this filter, relatively large filtering time constants can be used without suffering from long settling times. The time constant and filter disable band are programmable. Additionally, the remote signal can also be velocity limited (or ramped) to slow the controller's response to changes in setpoint. This results in a steady control response with no overshoot.

LINEAR DC ANALOG OUTPUTS

The Main Linear DC output has independent scaling, programmable output update time and filter (damping) time. These parameters permit flexibility in process configuration. The output can be set for 0 to 10 V, 0 to 20 mA or 4 to 20 mA ranges and can be configured for control or for re-transmission of input or setpoint values.

A Second Linear DC output is dedicated for the re-transmission of the process input signal. The output can be scaled and converted independent of the input signal and Main Linear DC output. This output is isolated from the input.

SETPOINT FEATURES

The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

A second setpoint can be selected by the user input and/or through the front panel.

The setpoint ramp feature can be used to control the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces shock to the process and helps to minimize overshoot.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating process characteristics, helping to provide better control.

The programmable user input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output*(s)*, etc.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where excessive power can cause damage. Programmable output cycle time, output hysteresis, and dampening can reduce output activity without degrading control accuracy. The main outputs can operate in PID, ON/OFF, or manual control modes.

CONTROL AND ALARM OUTPUTS

In addition to the Linear DC output, there are up to three relay outputs available. Relay outputs can switch user applied AC or DC voltages for control or alarm purposes.

AUTO-TUNE

The P48 has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into non-volatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampening factor produces various levels of process control and response characteristics.

RS485 SERIAL COMMUNICATIONS

The RS485 communications option allows the connection of up to 32 devices on a single pair of wires with a distance of up to 4,000 feet and a maximum baud rate of 9600. Since the same pair of wires are used for both transmit and receive, only one way communication is possible at any given time. The controller has a programmable response time to allow the host device adequate time to release the communication line for a transmission.

Selected parameters from the P48 can be interrogated or changed, and alarm output(s) may be reset by sending the proper command code via serial communications. It is also possible to invoke Auto-tune through the serial port. Serial communications used with SFCRM software allows for easy controller parameter configuration by computer.

DUAL TIME PROPORTIONAL SYSTEMS

The P48 is available with dual time proportional outputs. The dual outputs can be used for level or heat/cool applications. The A2 output can be configured for Secondary (cool) control. This allows for dual PID control or ON/OFF control with unbalanced hysteresis.

CONTROLLER PROGRAMMING

Front Panel Program Disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial set-up.

The following four programming modes allow the controller to adapt to any required user-interface level:

> Unprotected Parameter Mode
> Protected Parameter Mode
> Hidden Function Mode
> Configuration Parameter Mode

UNPROTECTED PARAMETER MODE *

The Unprotected Parameter Mode is accessible from the Normal Display mode when program disable is inactive or when the proper access code number from the Protected Parameter Mode is entered. The Configuration Parameter Modes can be accessed only from this mode.

"SP"   - Enter setpoint
"OP"   - Enter output power
"ProP"   - Enter proportional band
"Intt"   - Enter integral time
"dErt"   - Enter derivative time
"AL-1"   - Enter value for alarm #1
"AL-2"   - Enter value for alarm #2
"CNFP"   - Select configuration access point
"End"   - Return to normal display mode

PROTECTED PARAMETERS MODE *

The Protected Parameters Mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are enabled in the Configuration 3 parameter (lock-out section) can be accessed.

"ProP"   - Enter proportional band
"Intt"   - Enter integral time
"dErt"   - Enter derivative time
"AL-1"   - Enter value for alarm #1
"AL-2"   - Enter value for alarm #2
"CodE"   - Enter value to access unprotected parameters and
            configuration parameters

HIDDEN FUNCTION MODE *

The Hidden Function Mode is accessible from the Normal Display Mode. The functions in this mode may be locked-out individually in Configuration 3 parameter (lock-out section).

"SPSL"   - Select local (SP1 or SP2) or remote setpoint
"trnF"   - Transfer between automatic (PID) control and manual control
"tUNE"   - Invoke/cancel PID Auto-tune
"ALrS"   - Reset latched alarms

CONFIGURATION PARAMETER MODE

The Configuration Parameter Mode allows the operator to set-up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the Configuration Access Point allowing the user to return to the Normal Display Mode.

Configuration 1, Inputs (1-IN)

"tYPE"   - Select input signal type
"dCPt"   - Select scaled display decimal point position
"rnd"   - Enter rounding increment and trailing zeros for scaled display
"FLtr"   - Select level of input filtering
"dSP1"   ⎫
"InP1"   ⎬ - Scale main input
"dSP2"   ⎪
"InP2"   ⎭
"SPLO"   - Enter setpoint lower limit
"SPHI"   - Enter setpoint higher limit
"SPrP"   - Enter setpoint ramp rate
"InPt"   - Select user input function

Configuration 2, Outputs (2-OP) *

"CYCt"   - Enter time proportioning cycle time
"OPAC"   - Select output control action
"OPLO"   - Enter output power low limit
"OPHI"   - Enter output power high limit
"OPdP"   - Enter output control dampening
"CHYS"   - Enter ON/OFF control hysteresis
"tcOd"   - Select auto-tuning dampening
"ANtP"   - Main Linear DC analog output range
"ANAS"   - Main Linear DC analog output source
"ANut"   - Main Linear DC analog output update time
"ANLO"   - Main Linear DC analog output scaling low
"ANHI"   - Main Linear DC analog output scaling high

Configuration 3, Parameter Lock-Outs (3-LC) *

"SP"   - Select setpoint access level
"OP"   - Select power access level
"dEv"   - Enable deviation display
"bdSP"   - Enable blank display
"CodE"   - Enter parameter access code
"PId"   - Select PID access level
"AL"   - Select alarm access level
"ALrS"   - Enable alarm reset access
"SPSL"   - Enable local/remote selection
"trnF"   - Enable auto/manual mode selection
"tUNE"   - Enable auto-tune invocation

Configuration 4, Alarms (4-AL) *

"ACt1"   - Select operation mode of alarm #1, or select main output
"rSt1"   - Select reset mode of alarm #1
"Stb1"   - Enable activation delay of alarm #1
"AL-1"   - Enter value for alarm #1
"ACt2"   - Select operation mode of alarm #2, or select second output
"rSt2"   - Select reset mode of alarm #2
"Stb2"   - Enable activation delay of alarm #2
"AL-2"   - Enter value for alarm #2
"AHYS"   - Enter hysteresis value for both alarms

Configuration 5, Second Output (5-O2) *

"CYC2"   - Enter time proportioning cycle time
"GAN2"   - Enter relative gain
"db-2"   - Enter deadband or overlap

Configuration 6, Serial Communications (6-SC) *

"bAUd"   - Select baud rate
"ConF"   - Select character frame format
"Addr"   - Enter address
"Abrv"   - Select abbreviated or full transmission
"PoPt"   - Select print options

Configuration 7, Remote Setpoint Input (7-N2) *

"dSP1"   - Enter remote setpoint display scaling value #1
"INP1"   - Enter remote setpoint process scaling value #1
"dSP2"   - Enter remote setpoint display scaling value #2
"INP2"   - Enter remote setpoint process scaling value #2
"FLtr"   - Enter remote setpoint filter time constant
"bAnd"   - Enter remote setpoint filter disable band
"trnF"   - Select Local/Remote setpoint transfer response

Configuration 8, Second Linear DC Analog Output (8-A2) *

"A2tP"   - Second linear DC analog range
"A2LO"   - Second linear DC analog scaling low
"A2HI"   - Second linear DC analog scaling high
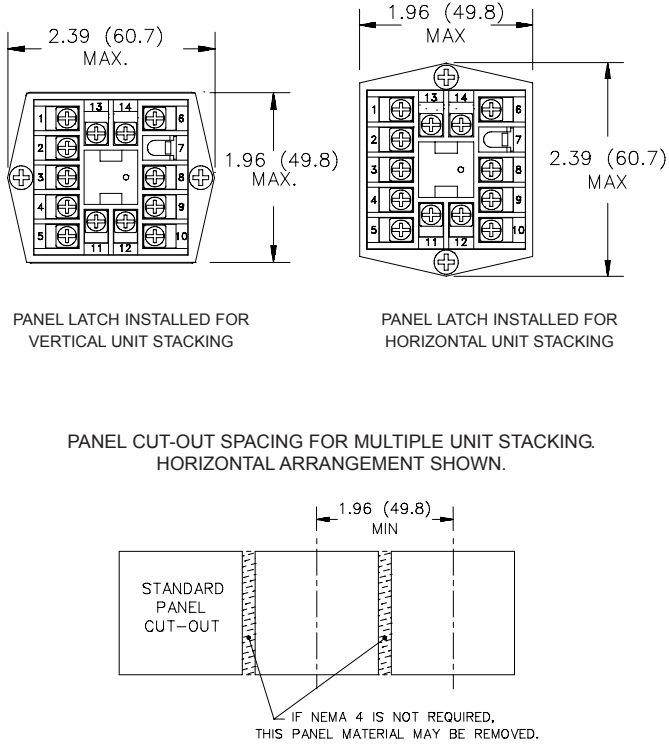
Configuration 9, Factory Service Operations (9-FS)

"Code 48" - Calibrate Instrument
"Code 66" - Reset parameters to factory setting

* *These parameters may not appear due to option configuration or other programming.*

MULTIPLE UNIT STACKING

The P48 is designed for close spacing of multiple units. Units can be stacked either horizontally or vertically. For vertical stacking, install the panel latch with the screws to the sides of the unit. For horizontal stacking, the panel latch screws should be at the top and bottom of the unit. The minimum spacing from center line to center line of units is 1.96" (49.8 mm). This spacing is the same for vertical or horizontal stacking.

Note: When stacking units, provide adequate panel ventilation to ensure that the maximum operating temperature range is not exceeded.

PANEL LATCH INSTALLED FOR VERTICAL UNIT STACKING

PANEL LATCH INSTALLED FOR HORIZONTAL UNIT STACKING

PANEL CUT-OUT SPACING FOR MULTIPLE UNIT STACKING. HORIZONTAL ARRANGEMENT SHOWN.

APPLICATION
WATER PROCESSING APPLICATION

A city water company needs to maintain a steady flow of water for their customer needs. They have an existing 0 to 10 VDC flow transmitter to measure the water flow. They need to control the water flow, have a high and low alarm, and keep a recorded chart of the flow for later reference. The Main Linear DC output of the P48 can be used to control the position of water output values per the desired flow setpoint value. The P48 relay outputs can be programmed to give a high flow alarm and a low flow alarm. With the Second Linear DC output model, the flow measurement to the P48 can be converted from 0-10 V to 4-20 mA and retransmitted to a 4-20 mA chart recorder.
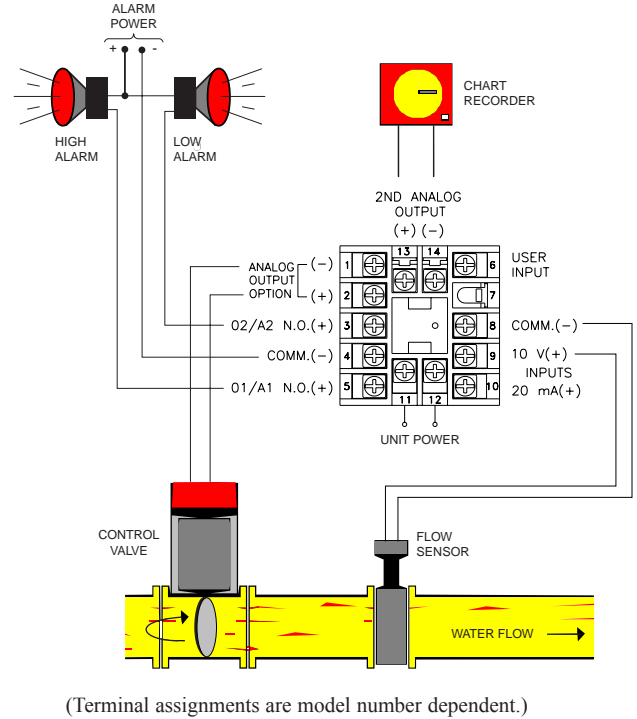
(Terminal assignments are model number dependent.)

ORDERING INFORMATION

Options and Output Boards are factory configured per the part number specified. Part numbers without replacement output boards listed must be returned to the factory for output board replacement.

DEDICATED MAIN CONTROL O1 OUTPUT	MAIN CONTROL O1 or A1(ALARM 1)*	DEDICATED ALARM 1 A1 OUTPUT	A2 (ALARM 2) OR O2 (SECONDARY)*	REMOTE SETPOINT INPUT @	RS485 @	MAIN ANALOG OUTPUT** @	SECOND ANALOG OUTPUT** @	REPLACEMENT OUTPUT BOARD	PART NUMBERS	
									18-36 VDC/24 VAC	85 to 250 VAC
				YES				NA	P4800011	P4800001
Relay								RBD48100	P4810010	P4810000
	Relay		Relay			YES		NA	P4810111	P4810101
	Relay		Relay	YES		YES		NA	P4810115	P4810105
	Relay		Relay		YES	YES		NA	P4810117	P4810107
	Relay		Relay			YES	YES	NA	P481011A	P481010A
Relay		Relay	Relay					RBD48111	P4811110	P4811100
Relay		Relay	Relay		YES			RBD48111	P4811112	P4811102

* These part numbers have a single output programmable as either Control (PID) or as an Alarm.
** These part numbers are jumper and program selectable for either a current or a voltage Linear DC output.
@ These part numbers are equipped with a second setpoint.

Option Boards are installed at the factory for the appropriate models. These boards are only needed for field replacement.

ACCESSORIES

MODEL NO.	DESCRIPTION	PART NUMBERS
SFCRM	Crimson 2 PC Configuration Softwware for Windows 98, ME, 2000 and XP (for RS485 models)	SFCRM
ICM4	RS232/RS485 Serial Converter Module	ICM40030
ICM5	Three Way Isolated RS232/RS485 Serial Converter Module	ICM50000

*Crimson Software is available for download from http://www.redlion.net

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LIMITED WARRANTY

red lion

Tel +1 (717) 767-6511
Fax +1 (717) 764-0839
www.redlion.net

MODEL PCU - PROCESS CONTROL UNIT

c UL US LISTED
IND. CONT. EQ.
51EB

- *100 MSEC SAMPLING PERIOD WITH 0.15% ACCURACY*
- *ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS*
- *DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF PROCESS VALUE AND SETPOINT OR SECOND ANALOG INPUT*
- *ACCEPTS EITHER 0 to 10 VDC OR 0 to 20 mA DC INPUTS*

- *SELF-DIAGNOSTICS*
- *FULL PID CONTROL WITH REDUCED OVERSHOOT*
- *OPTIONAL RS485 SERIAL COMMUNICATIONS INTERFACE*
- *OPTIONAL DUAL ALARM OUTPUTS (USES OUTPUT MODULES)*
- *OPTIONAL SECONDARY OUTPUT (USES OUTPUT MODULE)*
- *OPTIONAL LINEAR 4 to 20 mA OR 0 to 10 VDC OUTPUT FOR CONTROL OR PROCESS VALUE RE-TRANSMISSION*
- *OPTIONAL MOTORIZED VALVE POSITION CONTROL AND VALVE FAIL ALARM*
- *OPTIONAL SECOND ANALOG INPUT FOR REMOTE SETPOINT AND CASCADE CONTROL*
- *OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL*
- *STATUS INDICATORS FOR OUTPUTS AND CONTROL MODES*
- *PROGRAMMABLE USER INPUT (DIGITAL) FOR ADDED FLEXIBILITY*
- *MANUAL/AUTOMATIC AND LOCAL/REMOTE SETPOINT CONTROL MODES*
- *SETPOINT RAMPING FOR PROCESS STARTUP*
- *PARAMETER SECURITY VIA PROGRAMMABLE LOCKOUTS*
- *FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR Drive and Triac)*
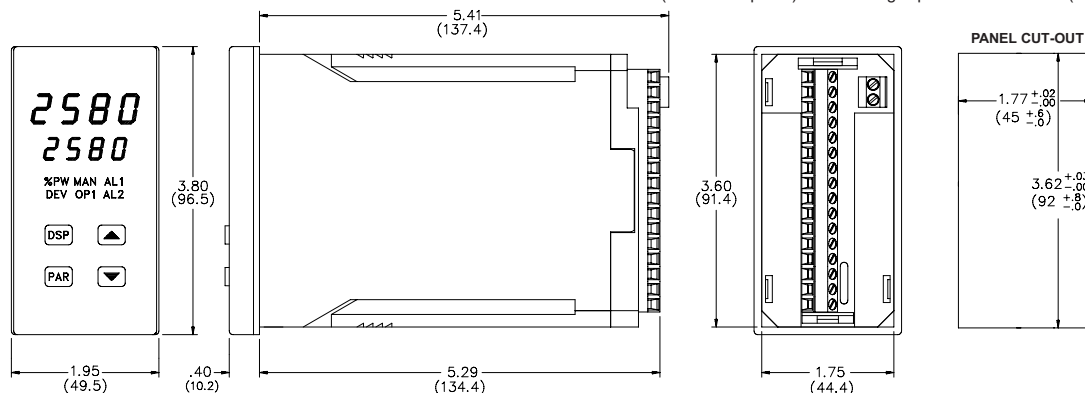
DESCRIPTION

The PCU Controller accepts either 0 to 10 VDC or a 0 to 20 mA DC input signal, precisely scales the process signal according to programmable scaling points, and provides an accurate output control signal *(time proportional, linear, or valve position)* to maintain a process at the desired control point. A comprehensive set of easy to use program instructions allows the controller to solve various applications.

The controller can operate in the PID control mode for both the main output and optional secondary output, with on-demand auto-tune, that establishes the tuning constants. The PID tuning constants may be fine-tuned by the operator at any time and then locked-out from further modification. The controller employs a unique overshoot suppression feature, which allows the quickest response without excessive overshoot. The unit can be transferred to operate in the manual mode, providing the operator with direct control of the output. The controller may also be programmed to operate in the ON/OFF control mode with adjustable hysteresis.

Dual 4-digit displays allow viewing of the process value and setpoint simultaneously. Front panel indicators inform the operator of the controller and output status. Replaceable and interchangeable output modules *(Relay, Logic/SSR Drive, or Triac)* can be installed for the main control output, alarm output(s) and secondary output.

DIMENSIONS In inches (mm)

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

5.41
(137.4)

3.80
(96.5)

3.60
(91.4)

1.95
(49.5)

.40
(10.2)

5.29
(134.4)

1.75
(44.4)

PANEL CUT-OUT

1.77 +.02/-.00
(45 +.6/-.0)

3.62 +.03/-.00
(92 +.8/-.0)

%PW MAN AL1
DEV OP1 AL2

OPTIONS

Optional dual alarms can be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, Band IN or OUT and Valve Fail Detect) with adjustable hysteresis. A standby feature suppresses the output during power-up until the process stabilizes outside the alarm region. An optional secondary output is available *(for processes that require cooling)* that provides increased control accuracy and response.

A linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following: % output power, measurement value, process measurement value deviation or setpoint value. Valve Positioner and Second Analog Input Models have the adjustable output demand dampening, output deadband and output update time parameters to expand the versatility of the PCU to control devices.

The optional Motorized Valve Positioner directly controls the position of a valve by the use of twin outputs (open and close) to control the direction of motor rotation. The motor position defines the opening position of the valve. Two control modes are possible: position control, that makes use of the slidewire feedback signal supplied with the positioner and velocity control, in which no slidewire feedback signal is used. Parameters are provided to adjust the operation of the valve. These include:

- Valve activity hysteresis
- Valve update time
- Variable control dampening
- Slidewire signal fail action
- Adjustable valve position limits

The Valve Positioner PCU achieves tight process control, yet minimizes unnecessary valve activity. An alarm event output or display alarm can be programmed under loss of slidewire feedback or under valve fail detection.

The optional Second Analog Input (0 to 20 mA DC) can be configured as a remote setpoint signal or as a secondary process signal. Configuration of the second analog input as a remote setpoint signal allows ratio control, master setpoint/multiple slave operation, and the ability to cascade the PCU with another controller (external cascade). Configuration of the second input as a secondary process signal allows operation as a two-process cascade controller within a single unit (internal cascade). In either control mode, parameters are provided to scale, configure, communicate and monitor the activity of both analog inputs. A square law linearizer function can be used to linearize signals derived from flow transmitters.

The optional RS485 multidrop serial communication interface provides two-way communication between a PCU unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from zero to ninety-nine. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output(s) may also be reset via the serial communications interface option.

An optional NEMA 4X/IP65 rated bezel is available for wash down and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference makes the controller extremely reliable in industrial environments.

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 PCU 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 limit indicator with alarm outputs is strongly recommended. Red Lion Controls offers various units (such as an IMP, IMD1 or IMD2) that may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. **DISPLAY**: Dual 4-digit
   Upper Process Display: 0.4" (10.2 mm) high red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) high green LED
   Display Messages (Model dependent):
   "OLOL" - Appears when measurement exceeds +105% input range.
   "ULUL" - Appears when measurement exceeds -5% input range.
   "SENS" - Appears when measurement exceeds "OLOL" & "ULUL" range.

"...." - Appears when display values exceed + display range.
"-..." - Appears when display values exceed - display range.
"SLid" - Appears when loss of slidewire signal is detected.
"VALV" - Appears when valve actuator error is detected.

2. **POWER**: Switch selectable 115/230 VAC (+10%, -15%) no observable line variation effect, 48 to 62 Hz, 10 VA.

3. **ANNUNCIATORS**:
   LED Backlight Status Indicators (Model dependent):
   %PW - Lower auxiliary display shows power output in (%).
   DEV - Lower auxiliary display shows deviation *(error)* from process setpoint.
   OP1 - Main control output is active.
   AL1 - Alarm #1 is active.
   AL2 - Alarm #2 is active *(for Dual Alarm Option)*.
   OP2 - Secondary output is active *(for Secondary Output Option)*.
   OPN - Valve positioner OPEN output is active *(for Valve Positioner Option)*.
   CLS - Valve positioner CLOSE output is active *(for Valve Positioner Option)*.
   SEC - Lower auxiliary display shows second analog input *(for Second Analog Input Option)*.
   MAN - Flashing: Controller is in Manual control mode.
   REM - ON: controller is in remote setpoint mode *(Second Analog Input Option)*.
   - OFF: controller is in local setpoint mode *(Second Analog Input Option)*.
   - Flashing: controller is in Manual control mode *(Second Analog Input Optional)*.

4. **CONTROLS**: Four front panel push buttons for modifying and setup of controller functions and one external input for parameter lockout or other functions.

5. **SIGNAL INPUT**:
   Sample Period: 100 msec typ.
   Response Time: 300 msec typ. *(to within 99% of final value w/step input)*
   Signal Overdrive Threshold:
   10 V Range: 13 V typ.
   20 mA Range: 26 mA typ.
   Signal Overdrive Response:
   Main Control Output: Programmable preset output
   Display: "SENS"
   Alarms: Upscale drive
   DC Linear: Programmable preset output
   Normal Mode Rejection: 40 dB typ. @ 50/60 Hz *(improves with increased digital filtering)*.
   Common Mode Rejection: 100 dB typ., DC to 60 Hz
   Protection: Input overload 120 VAC for 30 seconds.
   Range And Accuracy:

SIGNAL RANGE	ACCURACY (% OF UNSCALED READING)	MAXIMUM INPUT	INPUT IMPEDANCE	RESOLUTION
0 to 10 VDC	±(0.15% + 3 mV)	300 VDC	1 MΩ	10 mV
0 to 20 mA DC	±(0.15% + 6 μA)	200 mA DC	10 Ω	10 μA

6. **OUTPUT MODULES [Optional] (For All Output Channels)**:
   Relay:
   Type: Form-C *(Form-A with some models. See Ordering Information.)*
   Rating: 5 Amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 HP @ 120 VAC *(inductive load)* max.
   Life Expectancy: 100,000 cycles at max. load rating. *(Decreasing load and/or increasing cycle time, increases life expectancy)*.
   Logic/SSR Drive: Can drive multiple SSR Power Units.
   Type: Non-isolated switched DC, 12 VDC typ.
   Drive: 45 mA max.
   Triac:
   Type: Isolated, Zero Crossing Detection
   Rating:
   Voltage: 120/240 VAC
   Max. Load Current: 1 Amp @ 35°C
   0.75 Amp @ 50°C
   Min. Load Current: 10 mA
   Off State Leakage Current: 7 mA max. @ 60 Hz
   Operating Frequency: 20 to 400 Hz
   Protection: Internal Transient Snubber, Fused

7. **MAIN CONTROL OUTPUT**:
   Control: PID or ON/OFF
   Output: Time proportioning or linear DC
   Hardware: Plug-in, replaceable output modules
   Cycle time: Programmable
   Auto-tune: When selected, sets proportional band, integral time, and derivative time values.
   Signal Overdrive Action: Programmable

SPECIFICATIONS (Cont'd)

8. **SECONDARY OUTPUT (Optional)**:
   Control: PID or ON/OFF
   Output: Time proportioning or linear DC
   Hardware: Plug-in, replaceable output modules
   Cycle time: Programmable
   Proportional Gain Adjust: Programmable
   Deadband Overlap: Programmable
9. **LINEAR DC OUTPUT (Optional)**: With digital scale and offset, programmable deadband and update time.
   4 to 20 mA:
   Resolution: 1 part in 3500 typ.
   Accuracy: ±*(0.1% of reading + 25 µA)*
   Compliance: 10 V *(500 Ω max. loop impedance)*
   0 to 10 VDC:
   Resolution: 1 part in 3500 typ.
   Accuracy: ±*(0.1% of reading + 35 mV)*
   Min. Load Resistance: 10 KΩ *(1 mA max.)*
   Source: % output power, setpoint, deviation, or process value *(Available for OP1 or OP2, but not both.)*
10. **MOTORIZED VALVE POSITIONER (Optional)**:
    Two Outputs: Valve open and valve close or Linear DC *(optional)*
    Hardware: Plug-in, replaceable output modules
    Three Inputs: Slidewire feedback, signal fail detect *(Isolated from main input)*
    Slidewire Resistance: 100 Ω to 100 KΩ
    Slidewire Exciting Voltage: 0.9 VDC typ.
    Slidewire Fail Action: programmable
    Control Mode: Position mode *(with slidewire)* and velocity mode *(w/o slidewire)*.
    Control Deadband: 1% to 25.0% (position mode)
    0.1 to 25.0 seconds (velocity mode)
    Update Time: 1 to 250 seconds
    Motor Time (open, close): 1 to 9999 seconds
    Position Limits: Adjustable 0.0 to 100.0% of valve stroke
    Valve Fail Time: Off to 9999 seconds
    Alarm mode: Dual acting; loss of slidewire feedback signal and valve fail detection
11. **SECOND ANALOG INPUT**:
    Range: 0 to 20 mA (Isolated from main input)
    Overload: 100 mA $_{MIN}$ (steady state)
    Input Resistance: 10 Ω typ.
    Voltage Drop (@ 20 mA): 0.2 V typ.
    Accuracy: 0.15% of reading ±10 µA ±1 LSD
    Scale Range: -999 to 9999
12. **SERIAL COMMUNICATION**:
    Type: RS485 Multi-point, Balanced Interface
    Communication Format:
    Baud Rate: Programmable from 300 to 9600
    Parity: Programmable for odd, even, or no parity
    Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit
    Unit Address: Programmable from 0 to 99, max. of 32 units per line
    Transmit Delay: 100 msec min., 200 msec max.
    RS485 Common: Isolated from signal input common
    Auto Print Time: Off to 9999 seconds between print-outs
13. **USER INPUT (Optional)**: Internally pulled up to +5 VDC.
    $V_{IN} = 5.25$ VDC $_{MAX}$, $V_{IL} = 0.85$ V_{MAX}; $V_{IH} = 3.0$ V_{MIN},
    Available on all second input (MVP & ANA) models, and on models with RS485.
    Response Time: 100 msec max.
    Functions: Program Lock
    Integral Action Lock
    Auto/Manual Mode Select
    Setpoint Ramp Select
    Reset Alarms
    Print Request
    Local/Remote Setpoint Select
14. **ALARMS (Optional)**:
    Hardware: Plug-in, replaceable output module
    Modes: Absolute high acting
    Absolute low acting
    Deviation high acting
    Deviation low acting
    Inside band acting
    Outside band acting
    Valve fail
    Second Analog Input monitoring
    Reset Action: Programmable; automatic or latched
    Standby Mode: Programmable; enable or disable
    Hysteresis: Programmable

Signal Overdrive Action: Upscale
Annunciator: LED backlight for "AL1", "AL2", *(Alarm #2 not available with secondary output or motorized valve position option.)*

15. **ENVIRONMENTAL CONDITIONS**:
    Operating Temperature Range: 0 to 50°C
    Storage Temperature Range: -40 to 80°C
    Span Drift *(maximum)*: 100 ppm/°C, main input; 150 ppm/°C, second input
    Zero Drift *(maximum)*:
    4 to 20 mA DC Range: 0.5 µA/°C
    0 to 10 VDC Range: 0.2 mV/°C
    Second Input: 2 µA/°C
    Relative Humidity: Less than 85% RH (non-condensing)
    Altitude: Up to 2000 meters
16. **ISOLATION BREAKDOWN RATINGS**:
    All inputs and outputs with respect to AC line: 2300 V_{MIN}
    Analog Outputs, Second Analog Input or Slidewire Input with respect to main input: 500 V_{MIN}
17. **CERTIFICATIONS AND COMPLIANCES**:
    SAFETY
    UL Listed, File #E137808, UL508, CSA C22.2 No. 14-M95
    LISTED by Und. Lab. Inc. to U.S. and Canadian safety standards
    UL Recognized Component, File # E156876, UL873, CSA C22.2 No. 24
    Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.
    Type 2 or 4X Enclosure rating (Face only), UL50
    IECEE CB Scheme Test Certificate #UL1239-156876/USA,
    CB Scheme Test Report #96ME50279-070794
    Issued by Underwriters Laboratories, Inc.
    IEC 1010-1, EN 61010-1: Safety requirements for electrical equipment for measurement, control, and laboratory use, Part 1.
    IP65 Enclosure rating (Face only), IEC 529
    ELECTROMAGNETIC COMPATIBILITY:
    Immunity to EN 50082-2

Electrostatic discharge	EN 61000-4-2	Level 2; 4 Kv contact Level 3; 8 Kv air
Electromagnetic RF fields	EN 61000-4-3	Level 3; 10 V/m[1] 80 MHz - 1 GHz
Fast transients (burst)	EN 61000-4-4	Level 4; 2 Kv I/O Level 3; 2 Kv power
RF conducted interference	EN 61000-4-6	Level 3; 10 V/rms[2] 150 KHz - 80 MHz
Power frequency magnetic fields	EN 61000-4-8	Level 4; 30 A/m
Emissions to EN 50081-2		
RF interference	EN 55011	Enclosure class A Power mains class A

Notes:
1. Self-recoverable loss of performance during EMI disturbance at 10 V/m:. Process and/or analog output signals may deviate during EMI disturbance.
For operation without loss of performance:
Install power line filter, RLC #LFIL0000 or equivalent.
2. Self-recoverable loss of performance during EMI disturbance at 10 Vrms: Process and/or analog output signals may deviate during EMI disturbance.
For operation without loss of performance:
Install power line filter, RLC #LFIL0000 or equivalent and 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to cable at unit.
Refer to the EMC Installation Guidelines section of the manual for additional information.

18. **CONNECTION**: Jaw-type terminal block
    Wire Range: 12-30 AWG copper wire
    Torque: 5-7 inch-lbs (56-79 N-cm)
19. **CONSTRUCTION**: NEMA 2 For Standard Models.
    Front Panel: Flame and scratch resistant tinted plastic
    Case: High impact black plastic. (Mounting collar included)
    NEMA 4X/IP65 model only: Sealed bezel utilizing two captive mounting screws (panel gasket included) This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2
20. **WEIGHT**: 1.3 lbs (0.6 kgs)

BASIC OPERATION

The PCU controls a process by measuring the input signal and then calculating a control output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value to keep the process at setpoint. The PID control algorithm incorporates features that provide for high control accuracy and low overshoot from process disturbances.

FRONT PANEL FEATURES

In the normal operating mode, the unit displays the scaled process value in the upper display. One of four other parameters can be viewed in the lower display:
- Setpoint
- % Power Output
- Deviation
- Second Input Process Value

The parameters can be scrolled through by pressing the DSP button. If enabled, the control setpoint or power output (manual mode only) can be directly modified in this mode.

In the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode when making a parameter change. The controller's configuration and parameter settings are stored in an internal E^{2}PROM device.

HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a process disturbance, thus providing excellent process control. Measurement accuracy of 0.15% or better, provides closer process control conforming to the desired control setpoint value. The unit accepts either a 0 to 10 VDC or a 0 to 20 mA DC input signal. The AC input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel. No re-programming is required when changing or replacing modules.

The optional NEMA 4X/IP65 rated model utilizes two bezel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed. The standard model simply requires pressing a latch to remove the unit.

Low-drift, highly stable circuitry ensures years of reliable and accurate process control. The recommended two-year re-calibration interval is easily accomplished via the programming menu.

SETPOINT FEATURES

The controller setpoint can be protected from out of range values by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate. This feature reduces shock to the process and helps to minimize overshoot. The setpoint may also be transmitted by the optional linear DC output for slave control loops.

The second analog input may be configured as a remote setpoint. As such, the controller is easily switched from local/remote setpoint operation via the front panel or user input. Ratio and bias parameters provide on-line scaling of the remote setpoint. Absolute limit values and maximum rate of change of the remote setpoint further enhance controller flexibility.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating characteristics, helping to provide better process control. Programmable scaling points allow the controller to display in any engineering unit; flow, level, pressure, etc. Scaling points are used in conjunction with the programmable rounding increment to stabilize a jittery or otherwise hard to read process signal for better indication.

The programmable User Input can be used to control a variety of functions, such as auto/manual transfer of the controller, reset alarm output(s), etc.

The second analog input has independent scaling parameters to match the units of other processes or transmitters, or to match the controller's range.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where excessive power can cause damage. Automatic signal overdrive detection, for fail-safe operation, causes the controller to default to a programmed output power (upscale or downscale burnout). With adjustable time proportioning cycle time, and programmable DC linear output, the controller can satisfy a wide variety of output requirements.

Programmable dampening output hysteresis and output update time parameters can dramatically reduce actuator activity without degrading control accuracy.

The RS485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be set up to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE

The PCU has an auto-tune feature that, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked either at start-up or at setpoint, depending on the process requirements. An auto-tune programmable dampening factor produces various levels of process control and response characteristics.

OPTIONS
RATIO CONTROL
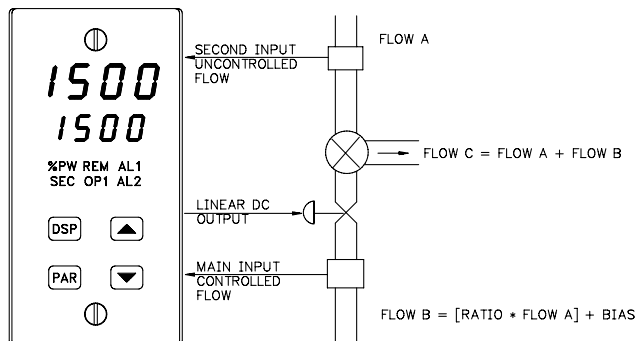
The PCU configured for ratio operation controls a process as a ratio of another process or to another variable. Ratio control is commonly used for flow applications, however, any two process variables can be controlled in a ratio mode.
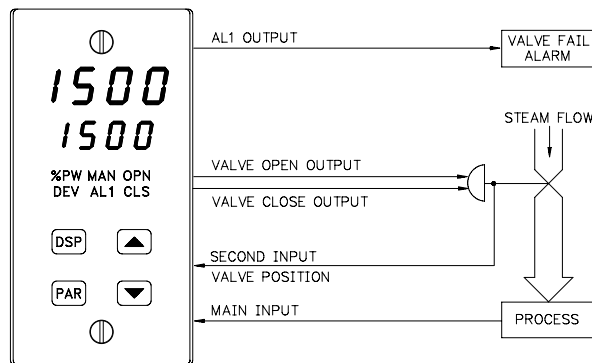
Ratio Control Configuration Parameters

"OPEr"	- Select ratio mode
"root"	- Select second input square root linearization
"dPt2"	- Select second input decimal point
"dSP1" "INP1" "dSP2" "INP2"	- Enter scaling units of second input
"SPtr"	- Local/Remote Select options
"InPt"	- Program User Input for Local/Remote Setpoint selection

Ratio Control Operational Parameters

"rtio"	- Remote setpoint ratio
"bIAS"	- Remote setpoint bias

MOTORIZED VALVE POSITIONER

The motorized valve positioner controls the position of a valve directly, by use of *"open"* and *"close"* control outputs. The slidewire feedback signals of the valve may optionally be connected to the controller. Alternatively, the controller may be configured for linear input valve control using the 4 to 20 mA DC output.
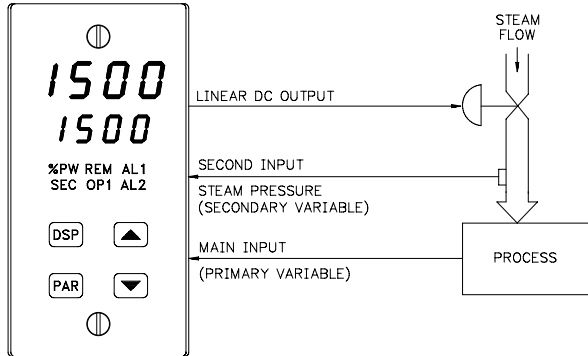
Motorized Valve Positioner Configuration Parameters

Position mode:
- "VPS1" - Enter or measure valve closed position
- "VPS2" - Enter or measure valve open position
- "VUdt" - Enter Valve update time
- "VPdb" - Enter valve control deadband
- "VFAL" - Enter valve fail detect time
- "Act1" - Program alarm as valve fail output

Velocity mode:
- "VUdt" - Enter Valve update time
- "VOPt" - Enter valve open time
- "VCLt" - Enter valve close time
- "VOnt" - Enter valve control deadband *(minimum on time)*
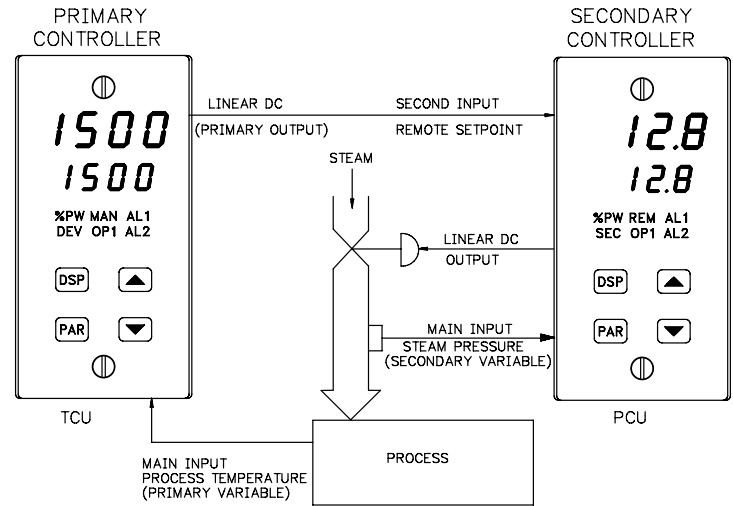
INTERNAL CASCADE

Cascade control allows the process to be divided into two control loops: the primary control loop and the secondary control loop. The secondary loop receives its setpoint from the primary loop to control an intermediate variable (steam pressure). The control level of the intermediate variable is the input to the primary process. The primary loop (main input) controller maintains loop regulation by manipulating the setpoint of the secondary controller. The setpoint of the secondary controller, in turn, changes the intermediate variable. The secondary loop can react faster to disturbances of the intermediate variable, thereby minimizing the effects to the primary control loop. Control loops cascaded in such a manner provide greater control quality than would be possible with single loop control. A single PCU can accomplish two-process cascade control.

Internal Cascade Configuration Parameters

- "OPEr" - Select cascade mode
- "root" - Select second input square root linearization
- "dPt2" - Select second input decimal point
- "dSP1" ⎫
- "INP1" ⎪
- "dSP2" ⎬ - Enter scaling units of second input
- "INP2" ⎭
- "OPd2" - Output dampening of secondary

Internal Cascade Operational Parameters

- "SP-2" - View secondary setpoint value
- "Pb-2" - Enter secondary proportional band
- "It-2" - Enter secondary integral time
- "dt-2" - Enter secondary derivative time

EXTERNAL CASCADE

Similar to internal cascade control, external cascade control differs by the employment of two controllers, one of which is equipped with a second analog input configured as a remote setpoint. A PCU controls the secondary loop, while a TCU controls the primary loop.

External Cascade Configuration Parameters

- "OPEr" - Select ratio mode
- "root" - Select second input square root linearization
- "dPt2" - Select second input decimal point
- "dSP1" ⎫
- "INP1" ⎪
- "dSP2" ⎬ - Enter scaling units of second input
- "INP2" ⎭
- "SPtr" - Local/Remote select options

External Cascade Operational Parameters

- "rtio" - Remote setpoint ratio
- "bIAS" - Remote setpoint bias
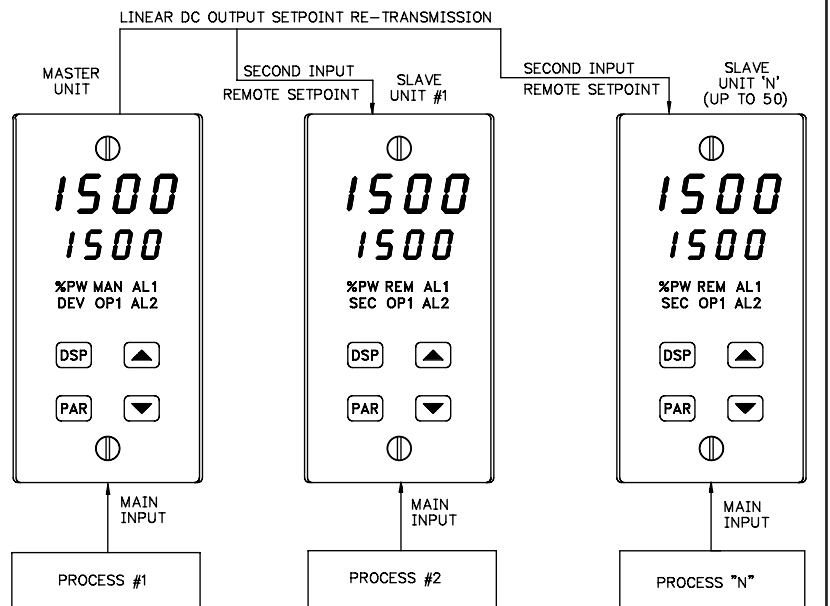
SETPOINT MASTER CONTROL

Setpoint Master Control allows automatic setpoint changes to slave controller units (up to 50 units total) from a master PCU controller. The linear DC output of the master is looped with the second analog input of the slave PCU controllers. Each slave unit can have unique remote setpoint ratio and bias values.

Setpoint Slave Configuration Parameters

- "OPEr" - Select remote setpoint mode
- "root" - Select second input square root linearization
- "dPt2" - Select second input decimal point
- "dSP1" ⎫
- "INP1" ⎪
- "dSP2" ⎬ - Enter scaling units of second input
- "INP2" ⎭
- "SPLO" ⎫
- "SPHI" ⎬ - Limit range of remote setpoint
- "SPrP" - Limit rate of change of remote setpoint

Setpoint Slave Operational Parameters

- "rtio" - Second input ratio
- "bIAS" - Second input bias

CONTROLLER PROGRAMMING

The PCU has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front Panel Program Disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:

Unprotected Parameter Mode
Configuration Parameter Mode
Protected Parameter Mode
Hidden Function Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE *

The unprotected parameter mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. The configuration parameter modes can be accessed only from this mode.

"SP"	- Enter Setpoint
"OP"	- Enter output power
"Prop"	- Enter proportional band
"Intt"	- Enter integral time
"dErt"	- Enter derivative time
"rtio"	- Enter Remote Setpoint ratio value
"bIAS"	- Enter Remote Setpoint bias value
"SP-2"	- View internal cascade secondary setpoint demand
"Pb-2"	- Enter internal cascade, secondary proportional band
"It-2"	- Enter internal cascade, secondary integral time
"dt-2"	- Enter internal cascade, secondary derivative time
"AL-1"	- Enter value for alarm #1
"AL-2"	- Enter value for alarm #2
"CNFP"	- Select basic configuration mode
"End"	- Return to normal display mode

CONFIGURATION PARAMETER MODE

The configuration parameter mode allows the operator to set up the basic requirements of the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage allowing the user to return to the normal display mode.

Configuration 1, Inputs

"tYPE"	- Select input signal type
"root"	- Select square root linearization of main input *
"dCPt"	- Select scaled display decimal point position
"rnd"	- Enter rounding increment and trailing zeroes for scaled display
"FLtr"	- Select level of input filtering
"dSP1" "INP1" "dSP2" "INP2"	- Scale main input
"SPLO"	- Enter setpoint lower limit
"SPHI"	- Enter setpoint higher limit
"SPrP"	- Enter setpoint ramp rate
"InPt"	- Select user input function *

Configuration 2, Outputs

"CYCt"	- Enter time proportioning cycle time
"OPAC"	- Select control action
"OPLO"	- Enter output power low limit
"OPHI"	- Enter output power high limit
"OPFL"	- Enter signal overdrive power preset
"OPdP"	- Enter output control dampening
"CHYS"	- Enter ON/OFF control hysteresis
"tcod"	- Select auto-tuning dampening
"ANAS"	- Select linear DC output assignment *
"ANLO"	- Enter linear DC output low scaling value *
"ANHI"	- Enter linear DC output high scaling value *
"ANdb"	- Enter linear DC output control deadband *
"ANUt"	- Enter linear DC output update time *

Configuration 3, Parameter lock-outs

"SP"	- Select degree of setpoint access
"OP"	- Select degree of power access
"dEv"	- Enable deviation display *
"IN-2"	- Enable second input display *
"bdSP"	- Enable blank display
"CodE"	- Enter parameter access code
"PId"	- Select degree of PID access
"PId2"	- Select degree of secondary PID access *
"rtbS"	- Select degree of ratio/bias access *
"AL"	- Select degree of alarm access *
"ALrS"	- Enable alarm reset access *
"SPSL"	- Enable local/remote setpoint selection *
"trnF"	- Enable auto/manual mode selection
"tUNE"	- Enable auto-tune invocation

Configuration 4, Alarms *

"Act1"	- Select operation mode of alarm #1
"rSt1"	- Select reset mode of alarm #1
"Stb1"	- Enable activation delay of alarm #1
"AL-1"	- Enter value for alarm #1
"Act2"	- Select operation mode of alarm #2
"rSt2"	- Select reset mode of alarm #2
"Stb2"	- Enable activation delay of alarm #2
"AL-2"	- Enter value for alarm #2
"AHYS"	- Enter hysteresis value for both alarms

Configuration 5, Secondary Output *

"CYC2"	- Enter time proportioning cycle time
"GAN2"	- Enter relative gain
"db-2"	- Enter deadband or overlap

Configuration 6, Serial Communications *

"bAUd"	- Select baud rate
"PArb"	- Select parity bit
"Addr"	- Enter unit address number
"Abrv"	- Select abbreviated or full mnemonic transmissions
"PrAt"	- Enter automatic print rate
"PoPt"	- Select parameters to be included in print-out

Configuration 7, Second Input *

"OPEr"	- Select remote setpoint or internal cascade mode
"root"	- Select second input square root linearization
"dPt2"	- Select second input decimal point
"dSP1" "INP1" "dSP2" "INP2"	- Entering scaling parameters of second input
"SPtr"	- Enter local/remote select options
"OPd2"	- Enter Secondary output control dampening

Configuration 8, Motorized Valve Positioner *

Position mode:	"VPS1"	- Enter or measure valve closed position
	"VPS2"	- Enter or measure valve open position
	"VUdt"	- Enter valve update time
	"VPdb"	- Enter valve control deadband
	"VFAL"	- Enter valve fail detect time
Velocity mode:	"VUdt"	- Enter valve update time
	"VOPt"	- Enter valve open time
	"VCLt"	- Enter valve close time
	"VOnt"	- Enter valve control deadband *(minimum on time)*

HIDDEN FUNCTION MODE *

The hidden function mode is accessible from the normal operating mode. The four functions in this mode may be locked-out individually in configuration 3 parameter lock-out section.

"SPSL"	- Select Local/Remote Setpoint
"trnF"	- Transfer between automatic (PID) control and manual control
"tUNE"	- Invoke/cancel PID Auto-tune
"ALrS"	- Reset latched alarms

* These parameters may not appear due to option configuration or other programming.

PROTECTED PARAMETERS MODE ∗

The protected parameters mode is enabled when program disable is active. This mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-out section can be accessed.
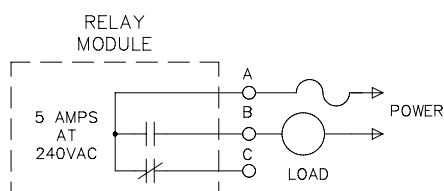
"ProP" - Enter Proportional band
"Intt" - Enter integral time
"dErt" - Enter derivative time
"rtio" - Enter remote setpoint ratio value
"bIAS" - Enter remote setpoint bias value
"SP-2" - Enter internal cascade, secondary setpoint
"Pb-2" - Enter internal cascade, secondary proportional band
"It-2" - Enter internal cascade, secondary integral time
"dt-2" - Enter internal cascade, secondary derivative time

"AL-1" - Enter value for alarm #1
"AL-2" - Enter value for alarm #2
"CodE" - Enter access value to unprotected parameters & configuration parameters

∗ *These parameters may not appear due to option configuration or other programming.*
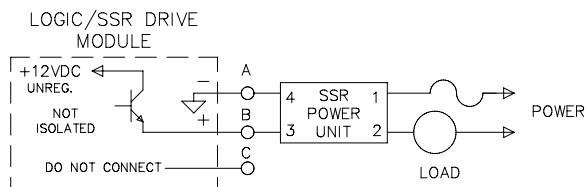

OUTPUT MODULES

TYPICAL CONNECTIONS

Relay:
   Type: Form-C (Form-A with some models. See ordering information.)
   Rating: 5 amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive) maximum.
   Life Expectancy: 100,000 cycles at maximum load rating.
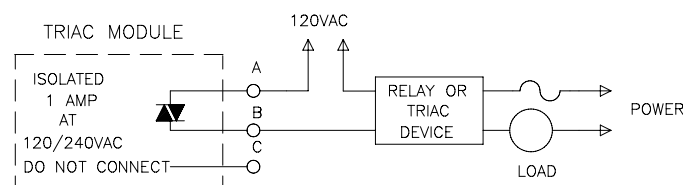   (Decreasing load and/or increasing cycle time, increases life expectancy).

Logic/SSR Drive: Can drive multiple SSR Power Units.
   Type: Non-isolated switched DC, 12 VDC typical
   Drive: 45 mA maximum.

Triac:
   Type: Isolated, Zero Crossing Detection
   Rating:
     Voltage: 120/240 VAC
     Max. Load Current: 1 ampere @ 35°C
      0.75 ampere @ 50°C
     Min. Load Current: 10 mA
   Off State Leakage Current: 7 mA max. @ 60 Hz
   Operating Frequency: 20 to 400 Hz
   Protection: Internal Transient Snubber, Fused

APPLICATION

A chemical company would like to maintain the level of an acid solution tank to insure constant availability for their process. They have chosen a PCU controller which has a continuous level probe with a 4 to 20 mA output proportional to tank level, connected to the input terminals. The tank is filled by controlling the position of a proportional control valve. The control valve is controlled by a 3 to 15 PSI air signal.

The PCU uses the level control input as its feedback. The 4 to 20 mA input signal is scaled so that 4 mA equals 0% and 20 mA equals 100%.

The 4 to 20 mA output of the PCU is taken to an I/P converter to convert the 4 to 20 mA output to a 3 to 15 PSI signal for the control valve. The relay outputs of the PCU are used for high and low level alarms.
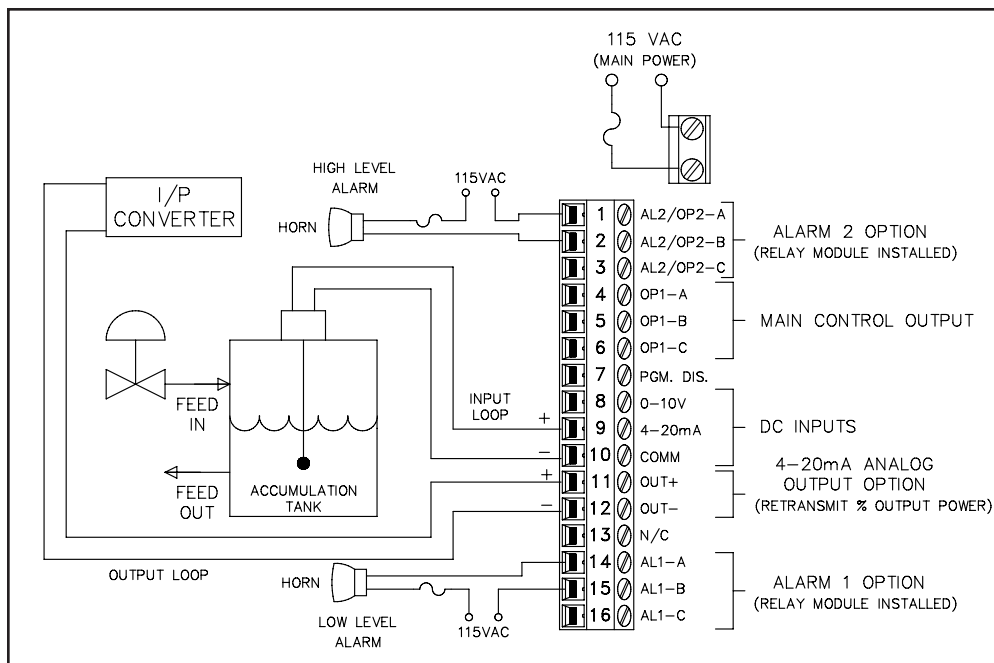
ORDERING INFORMATION

MODELS WITHOUT SECOND INPUT OPTIONS

NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
NO	YES	NO	NO	NO	NO	PCU01000
NO	YES	NO	2	NO	NO	PCU01001
YES	NO	NO	NO	NO	NO	PCU10000
YES	NO	NO	2	NO	NO	PCU10001
YES	NO	NO	1	YES	NO	PCU10002
YES	YES	NO	NO	NO	NO	PCU11000
YES	YES	NO	2	NO	NO	PCU11001
YES	YES	NO	1	YES	NO	PCU11002
YES	YES	NO	2	NO	YES	PCU11004
YES	YES	NO	1	YES	YES	PCU11005
YES	NO	YES	2	NO	NO	PCU12001
YES	NO	YES	2	NO	YES	PCU12004
YES	NO	YES	1	YES	YES	PCU12005

These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

SECOND ANALOG INPUT MODELS (RSP)

NEMA 4/XIP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
YES	NO	NO	2	NO	YES	PCU10104
YES	YES	NO	2	NO	NO	PCU11108
YES	NO	YES	2	NO	NO	PCU12108

These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

MOTORIZED VALVE POSITIONER MODELS (MVP)

NEMA 4/XIP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	ALARM OUTPUTS	COOLING OUTPUT	RS485 COM	PART NUMBER
YES	NO	NO	1	NO	YES	PCU10307
YES	YES	NO	1	NO	NO	PCU11306
YES	NO	YES	1	NO	NO	PCU12306

ACCESSORIES

DESCRIPTION	PART NUMBER
Relay Module	OMD00000
Triac Module	OMD00001
Logic/SSR Drive Module	OMD00003
SSR Power Unit	RLY50000
Single Phase 25 A DIN Rail Mount Solid State Relay	RLY60000
Single Phase 40 A DIN Rail Mount Solid State Relay	RLY6A000
Three Phase DIN Rail Mount Solid State Relay	RLY70000

Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s), the secondary output, and valve positioner outputs.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to line voltage.

All modules are packaged separately and must be installed by the user.

MODEL PSC - PROCESS SETPOINT CONTROLLER

- SETPOINT PROGRAM CONTROLLER FOR TIME VS. PROCESS (RAMP/SOAK) AND SPECIAL BATCH/RECIPE APPLICATIONS

- ADVANCED PROGRAM PROFILING IN A 1/8 DIN PACKAGE

- ON-LINE MONITORING AND CONTROL OF PROGRAM STATUS, TIME, AND SETPOINT VALUE (Profile Run, Pause, Stop, Advance, Modify Time, & Setpoint Value)

- AUTOMATIC PROGRAM DELAY FOR PROFILE CONFORMITY, PLUS PROGRAM LINKING, REPEATING AND AUTO POWER-ON FUNCTIONS FOR ENHANCED CAPABILITY

- DUAL EVENT OUTPUTS FOR TIMED ACTIVATION OF PROCESS EQUIPMENT SUCH AS STIRRERS, FANS, HEATERS, ETC. (Uses Alarm Output Channels)

- FOUR SETPOINT & PID PARAMETER SETS FOR QUICK RECALL OF SETPOINTS AND/OR GAIN VALUES DURING BATCH OR PROCESS CHANGEOVER

- PROGRAMMABLE USER INPUT FOR CONTROLLER AND SETPOINT PROGRAM CONTROL

- 100 MSEC SAMPLING PERIOD WITH 0.15% ACCURACY

- ON DEMAND AUTO-TUNING OF PID CONTROL SETTINGS

- DUAL LED DISPLAYS FOR SIMULTANEOUS INDICATION OF PROCESS AND SETPOINT OR PROCESS AND PROFILE STATUS

- ACCEPTS EITHER 0 to 10 VDC OR 4 to 20 mA DC INPUT SIGNAL

- FIELD REPLACEABLE AND INTERCHANGEABLE OUTPUT MODULES (Relay, Logic/SSR drive, and Triac)

- OPTIONAL DUAL ALARM OUTPUTS (Uses Output Modules)

- OPTIONAL SECONDARY OUTPUT (Uses Output Module)

- OPTIONAL LINEAR 4 to 20 mA OR 0 to 10 VDC OUTPUT FOR CONTROL OR PROCESS RE-TRANSMISSION

- OPTIONAL RS-485 SERIAL COMMUNICATIONS INTERFACE

- OPTIONAL NEMA 4X/IP65 SEALED FRONT BEZEL

and UL Recognized Component, File #E156876

DESCRIPTION

The PSC is a setpoint controller suitable for time vs. process control applications. The PSC Controller accepts either a 0 to 10 VDC or a 4 to 20 mA DC input signal, precisely scales the process signal, according to programmable scaling points, and provides an accurate output control signal *(time proportional or linear)* to maintain a process at the desired control point. A comprehensive set of easy to use steps allows the controller to satisfy various applications. The user input can be programmed to perform a variety of controller functions.

Dual 4-digit displays allow viewing of the measured process value and setpoint or the process and profile status simultaneously. Front panel indicators inform the operator of controller status and output states. Replaceable output modules (Relay, logic/SSR drive or Triac) can be fitted to the main control output, alarm output(s) or timed event output(s), and secondary output.

The PSC has been designed to simplify the set-up and operation of a controlled setpoint profile program. The setpoint program is easily entered and controlled through the front panel. Full display capabilities keep the operator informed of the process value, profile status, output states, and setpoint value.

The controller can operate in the standard PID control mode for both Output 1 and Output 2 with on-demand auto-tune which establishes the PID gain set. The PID gain set can be fine tuned by the operator at any time or may be locked from further modification. The unit can be transferred to the manual control mode providing the operator with direct control of the output.

The PSC features four programs or profile recipes, each with up to eight ramp/soak segments, which can be easily stored and executed at any time. Longer profiles can be achieved by linking one or more profiles together, creating a single profile of up to 32 ramp/soak segments. Process profile conformity is assured during either soak (hold) phases or both ramp and hold phases by an adjustable error band parameter. The program repeat function cycles the profile either continuously or a set number of times. Power-on options automatically re-start, stop, or resume a running profile. The profile can be controlled via the front panel buttons, the user input, or the optional serial communications port.

DIMENSIONS "In inches (mm)"

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

PANEL CUT-OUT
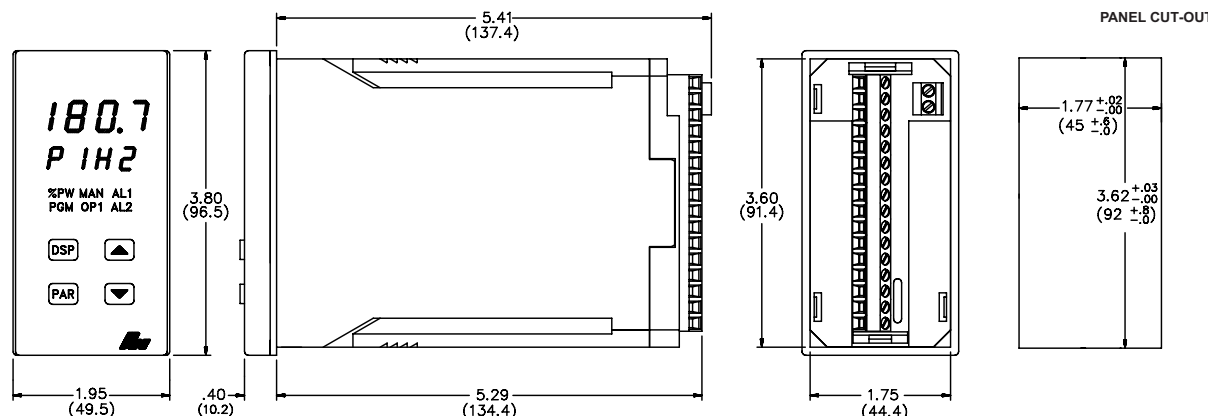
DESCRIPTION (Cont'd)

Four control points, each having a setpoint and PID parameter set, are available for instant front panel implementation during batch changeover, or other process conditions. A control point may have its PID gain set values disabled when implementing the control point.

The optional RS-485 multidrop serial communications interface provides the capability of two-way communication between a PSC unit and other compatible equipment such as a printer, a programmable controller, or a host computer. In multipoint applications the address number of each unit on the line can be programmed from 0 to 99. Up to thirty-two units can be installed on a single pair of wires. The Setpoint value, % Output Power, Setpoint Ramp Rate, etc. can be interrogated or changed by sending the proper command code via serial communications. Alarm output*(s)* may also be reset via the serial communications interface option.

Optional alarm output*(s)* may be configured to operate as a timed event output or as a standard alarm output. As an alarm output it may be configured to activate according to a variety of actions (Absolute HI or LO, Deviation HI or LO, or Band IN or OUT) with adjustable hysteresis. Also, a standby feature suppresses the output*(s)* on power-up until the process stabilizes outside the alarm region. Timed event output*(s)* allow the controller to activate other equipment while a programmed profile is running. Each profile can define up to 16 event states (phases), for each output*(s)*.

An optional secondary output is available for processes that require cooling which provides increased control accuracy and response.

The optional linear 4 to 20 mA or 0 to 10 VDC output signal is available to interface with final actuators, chart recorders, indicators, or other controllers. The output signal can be digitally scaled and selected to transmit one of the following:

> % Output Power
> Measurement Value
> Measurement Value Deviation
> Setpoint Value

An optional NEMA 4X/IP65 rated bezel is available for washdown and/or dirty environments, when properly installed. Modern surface-mount technology, extensive testing, plus high immunity to noise interference, makes the controller extremely reliable in industrial environments.

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 PSC 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 alarm outputs is strongly recommended. Red Lion Controls offers various units (such as an IMP, IMD1 or IMD2) that may be used for this purpose. The indicators should have input sensors and AC power feeds independent from other equipment.

SPECIFICATIONS

1. **DISPLAY:** Dual 4-digit
   Upper Process Display: 0.4" (10.2 mm) Red LED
   Lower Auxiliary Display: 0.3" (7.6 mm) Green LED
   Display Messages:
   "OLOL" - Appears when measurement exceeds +105% of input range.
   "ULUL" - Appears when measurement exceeds -5% of input range.
   "SENS" - Appears when measurement exceeds "OLOL" & "ULUL" range.
   "...." - Appears when display value exceeds + display range.
   "-..." - Appears when display value exceeds - display range.
2. **POWER:** 115/230 VAC (+10%, -15%) no observable line variation effect, 48-62 Hz, 10 VA, switch selectable.
3. **ANNUNCIATORS:**
   6 LED Backlight Status Indicators:
   %PW - Lower auxiliary display shows power output in (%).
   PGM - Lower auxiliary display shows profile status or profile time remaining.
   MAN - Controller is in manual mode.
   OP1 - Main control output is active.
   AL1 - Alarm #1 is active.
   AL2 - Alarm #2 is active *(for Dual Alarm Option)*.
   OP2 - Secondary output is active *(for Secondary Option)*.
4. **CONTROLS:** Four front panel push buttons for modifying and setup of controller functions and one external input.
5. **SETPOINT PROFILE:**
   Profiles: 4
   Segments Per Profile: 8 ramp/hold segments (linkable to 32 segments).

Ramp Rate: 0.1 to 999.9 units/minute or no ramp.
Hold Time: Off or from 0.1 to 999.9 minutes, can be extended to 500 hours by linking.
Error Band Conformity: Off or from 1 to 9999 units deviation, + value for hold phases, - value for both ramp and hold phases.
Power-On Modes: Stop, auto-start, or profile resume.
Start Mode: Ramps from process value.
Program Auto Cycle: 1 to 249, or continuous.
Event Outputs: 2, time activated with profile [uses Alarm output(s)].
Control: Front panel buttons, user input, or RS-485 communications.
6. **CONTROL POINTS:**
   Setpoints: 4
   PID gain sets: 4
   Control: Front panel buttons or user input.
7. **SIGNAL INPUT:**
   Sample Period: 100 msec
   Response Time: 300 msec (to within 99% of final value w/step input).
   Signal Overdrive Threshold:
   10V Range: 13 V
   20mA Range: 26 mA
   Signal Overdrive Response:
   Main Control Output: Programmable preset output.
   Display: "SENS"
   DC Linear: Programmable preset output.
   Normal Mode Rejection: 40 db @ 50/60 Hz (improves with increased digital filtering).
   Common Mode Rejection: 100 db, DC to 50/60 Hz.
8. **RANGE AND ACCURACY:**

Signal Range	Accuracy (% of Unscaled Reading)	Max. Input	Input Impedance	Resolution
0 to 10 VDC	±(0.15% + 3 mV)	300 VDC	1M Ω	10 mV
0 to 20 mADC	±(0.15% + 6 µA)	200 mADC	10 Ω	10 µA

9. **OUTPUT MODULES (For All Output Channels):**
   (Optional - Must be ordered separately)
   Relay:
   Type: Form-C *(Form-A with RS-485 option)*
   Rating: 5 Amps @ 120/240 VAC or 28 VDC *(resistive load)*, 1/8 HP @ 120 VAC *(inductive load)*.
   Life Expectancy: 100,000 cycles at max. rating. (Decreasing load and/or increasing cycle time, increases life expectancy).
   Logic/SSR Drive: Can drive multiple SSR Power Units.
   Type: Non-isolated switched DC, 12 VDC typical
   Drive: 45 mA max.
   Triac:
   Type: Isolated, Zero Crossing Detection.
   Ratings: Voltage: 120/240 VAC
   Max Load Current: 1 AMP @ 35ºC
   0.75 AMP @ 50ºC
   Min Load Current: 10 mA
   Off State Leakage Current: 7 mA max. @ 60 Hz
   Operating Frequency: 20 to 500 Hz
   Protection: Internal Transient Snubber, Fused.
10. **MAIN CONTROL OUTPUT:**
    Control: PID or ON/OFF.
    Output: Time proportioning or linear DC.
    Hardware: Plug-in, replaceable output modules.
    Cycle time: Programmable.
    Auto-tune: When performed, sets proportional band, integral time, and derivative time values.
    Probe Break Action: Programmable.
11. **SECONDARY OUTPUT (Optional):**
    Control: PID or ON/OFF.
    Output: Time proportioning or linear DC.
    Hardware: Plug-in, replaceable output modules.
    Cycle time: Programmable.
    Proportional Gain Adjust: Programmable.
    DeadBand Overlap: Programmable.
12. **LINEAR DC DRIVE (Optional):** With digital scale and offset, programmable deadband and update time.
    4 to 20 mA:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±*(0.1% of reading + 25 µA)*.
    Compliance: 10 V *(500 Ω max. loop impedance)*.
    0 to 10 VDC:
    Resolution: 1 part in 3500 typ.
    Accuracy: ±*(0.1% of reading + 35mV)*.
    Min. Load Resistance: 10 K Ω (1 mA max.)
    Source: % output power, setpoint, deviation, or process value.
    (Available for OP1 or OP2, but not both.)

SPECIFICATIONS (Cont'd)

13. ALARMS (Optional):

Hardware: Plug-in, replaceable output module.

Modes: Absolute high acting
Absolute low acting
Deviation high acting
Deviation low acting
Inside band acting
Outside band acting
Timed event output(s)

Reset Action: Programmable; automatic or latched.

Delay: Programmable; enable or disable.

Hysteresis: Programmable.

Annunciator: LED backlight for "AL1", "AL2", *(Alarm #2 not available with secondary output)*.

14. SERIAL COMMUNICATIONS (Optional):

Type: RS-485 Multi-point, Balanced Interface.

Communication Format:

Baud Rate: Programmable from 300 to 9600.

Parity: Programmable for odd, even, or no parity.

Frame: 1 start bit, 7 data bits, 1 or no parity bit, 1 stop bit.

Unit Address: Programmable from 0-99, max. of 32 units per line.

Transmit Delay: 100 msec min., 200 msec max.

RS-485 Common: Isolated from signal input common.

Auto Print Time: Off to 9999 seconds between print-outs.

15. USER INPUT: $V_{IN\ MAX} = 5.25$ VDC, $V_{IL} = 0.85\ V_{MAX}$; $V_{IH} = 2.0\ V_{MIN}$

Response time: 100 msec max.

Functions:

Program Lock	Print Request
Integral Action Lock	Load Control Point
Auto/Manual Transfer	Run/Hold Profile 1
Setpoint Ramp Select	Run/Stop Profile 1
Reset Alarms	

16. ENVIRONMENTAL CONDITIONS:

Operating Temperature Range: 0° to 50°C

Storage Temperature Range: -40° to 80°C

Span Drift: 90 ppm/°C

Zero Drift: 0 to 10 VDC Range - 0.2 mV/°C
4 to 20 mA DC Range - 0.5 µA/°C

Relative Humidity: Less than 85% RH (non-condensing)

Altitude: Up to 2000 meters

17. CERTIFICATIONS AND COMPLIANCES:

UL Recognized Component, File #E156876

Recognized to U.S. and Canadian requirements under the Component Recognition Program of Underwriters Laboratories, Inc.

EMC EMISSIONS:

Meets EN 50081-2: Industrial Environment.
CISPR 11 Radiated and conducted emissions

EMC IMMUNITY:

Meets EN 50082-2: Industrial Environment.
ENV 50140 - Radio-frequency radiated electromagnetic field [1]
ENV 50141 - Radio-frequency conducted electromagnetic field [2]
EN 61000-4-2 - Electrostatic discharge (ESD)
EN 61000-4-4 - Electrical fast transient/burst (EFT)

Notes:

1. No loss of performance during EMI disturbance at 7 V/m.
Permissible loss of performance during EMI disturbance at 10 V/m:
Process signal deviation less than 1 % of full scale
Analog output deviation less than 3 % of full scale
For operation without loss of performance:
Install power line filter, RLC #LFIL0000 or equivalent.
OR
Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to power lines at unit.

2. Permissible loss of performance during EMI disturbance at 10 Vrms:
Process signal deviation less than 1 % of full scale
Analog output deviation less than 3 % of full scale
For operation without loss of performance:
a. Install power line filter, RLC #LFIL0000 or equivalent.
OR
Install 1 ferrite core 1 turn, RLC #FCOR0000 or equivalent, to power lines at unit.
b. Install 1 ferrite core, RLC #FCOR0000 or equivalent, to analog out cable at unit.

Refer to the EMC Installation Guidelines section of the manual for additional information.

18. CONNECTION: Jaw-type terminal block.

19. CONSTRUCTION:

Front Panel: Flame and scratch resistant tinted plastic.

Case: High impact black plastic. (Mounting collar included).

NEMA 4X/IP65 model only: Sealed bezel utilizing 2 captive mounting screws (panel gasket included). This unit is rated for NEMA 4X/IP65 indoor use. Installation Category II, Pollution Degree 2.

20. WEIGHT: 1.3 lbs. (0.6 kgs)

ACCESSORY:

External SSR Power Unit:

Switched Voltage Range: 50 to 280 VAC (Nominal: 240 VAC)

Load Current: 45 Amps @ 25°C ambient temperature
35 Amps @ 50°C ambient temperature

On State Input: 3 to 32 VDC @ 1500 Ω impedance. *(isolated)*
(Use Logic/SSR drive output module)

Off State Input: 0.0 to 1.0 VDC

Size: 5.5" (14 cm)L x 4.75" (12 cm)W x 2.62" (6.6 cm)H

BASIC OPERATION

The PSC controls the process profile of a system by measuring the input signal, comparing it to the setpoint value of the profile in progress, and calculates the new output power value by use of a modified PID control algorithm. The unit controls the system with the new output power value so the process value conforms to the profile. The PID control algorithm incorporates features which provide high control accuracy and low disturbance overshoot.

FRONT PANEL FEATURES

In the normal display mode, the unit will display the scaled process value in the upper display. One of five other parameters may be selected for viewing in the lower display:

Target setpoint
% Output Power
Profile Status
Profile phase time remaining
Blank the lower display.

The profile status display indicates the active program number with the current ramp or hold phase of the program. The profile can be started, stopped, advanced, etc., from the front panel when the profile status display is viewed, if not locked from access.

The phase time remaining display, shows the time remaining in a ramp or hold phase and, if not locked from access, may be changed on-line to effect temporary changes to the profile. Additionally, the target setpoint and % output power (manual mode only) may also be changed on-line or locked from operator access.

From the normal operating mode, parameters are selected by use of the PAR button and modified by use of the UP and DOWN buttons. Parameters are then entered by the PAR button, which advances the user to the next parameter. Pressing the DSP button immediately returns the controller to the normal operating mode from any parameter module. The controller configuration and parameter settings are stored in an internal E^{2}PROM device.
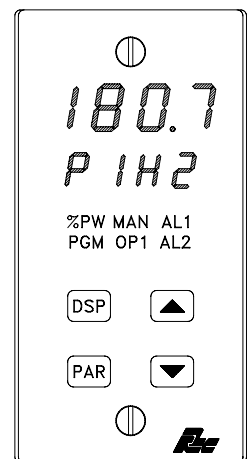
HARDWARE FEATURES

The fast 100 msec input sampling rate provides quick controller response to a process disturbance for excellent process control. Measurement accuracy of 0.15% provides closer process control conforming to the desired control setpoint value.

The unit will accept either a 0 to 10 VDC or a 4 to 20 mADC input signal. The A.C. input power is switch selectable, allowing the unit to operate from either 115 VAC or 230 VAC. Since the controller is serviceable from the front of the panel, the output modules may be easily changed or replaced without disturbing the wiring behind the panel and NO re-programming is required. The standard model simply requires pressing a latch to remove the unit. The NEMA 4X/IP65 rated model utilizes two panel securing screws and a neoprene gasket to guarantee a water tight seal, when properly installed.

Low-drift, highly stable circuit design ensures years of reliable and accurate process control. The recommended two year re-calibration interval is easily accomplished via the programming menu.

NEMA 4X/IP65 BEZEL

CONFIGURATION MODE

The configuration modules serve to provide the basic set-ups required by the controller. It is divided into sections which group together related programming steps, such as inputs, outputs, alarms, etc. Upon completion of each section, the program returns to the configuration selection stage, which allows the user to return to the normal display mode, or advance to a later configuration stage.

Configuration 1, Inputs
"TYPE" - Select current or voltage
"dCPt" - Select scaled display decimal point position
"rnd" - Enter rounding increment and trailing zeros for scaled display
"FLtr" - Select degree of input filtering
"dSP1" - Enter display reading for scaling point #1
"INP1" - Key-in or apply signal level for scaling point #1
"dSP2" - Enter display reading for scaling point #2
"INP2" - Key-in or apply signal level for scaling point #2
"SPLO" - Enter setpoint lower limit
"SPHI" - Enter setpoint higher limit
"SPrP" - Enter setpoint ramp rate
"InPt" - Select user input function

Configuration 2, Outputs
"CYCt" - . Enter time proportioning cycle time
"OPAC" - . Select control action
"OPLO" - . Enter output power low limit
"OPHI" - . Enter output power high limit
"OPFL" - . Enter signal overdrive power preset
"CHYS" - . Enter ON/OFF control hysteresis
"tcod" - . Select auto-tuning damping
"ANAS" - . Select linear DC output assignment ∗
"ANLO" - . Enter linear DC low scaling value ∗
"ANHI" - . Enter linear DC high scaling value ∗

Configuration 3, Parameter lock-outs
"SP" - Select degree of setpoint access
"OP" - Select degree of power access
"P-CS" - Select degree of profile status access
"P-tr" - Select degree of phase time remaining access
"bdSP" - Enable blank display
"Code" - Enter parameter access code
"PId" - Select degree of PID access
"AL" - Select degree of alarm access ∗
"ALrS" - Enable manual reset of alarms ∗
"CPAC" - Enable control point access
"PrAC" - Enable ramp/hold program access
"trnF" - Enable automatic/manual transfer
"tUNE" - Enable auto-tune invocation

∗ *These parameters may not appear due to option configuration or other programming*

Configuration 4, Alarms ∗
"Act 1" - Select operation mode of alarm #1
"rSt1" - Select reset mode of alarm #1
"Stb1" - Enable activation delay of alarm #1
"AL-1" - Enter value for alarm #1
"Act2" - Select operation mode of alarm #2
"rSt2" - Select reset mode of alarm #2
"Stb2" - Enable activation delay of alarm #2
"AL-2" - Enter value for alarm #2
"AHYS" - Enter hysteresis value for both alarms

Configuration 5, Secondary Output ∗
"CYC2" - Enter time proportioning cycle time
"GAN2" - Enter relative gain
"db-2" - Enter deadband or overlap

Configuration 6, Serial Communications ∗
"bAUd" - Select baud rate
"PArb" - Select parity bit
"Addr" - Enter unit address number
"Abrv" - Select abbreviated or full mnemonic transmissions
"PrAt" - Enter automatic print rate
"PoPt" - Select parameters to be included in print-out

Configuration 7, Control Points
"CSEt" - Select control point number for set-up 1, 2, 3, & 4
"SP-x" - Enter setpoint value for selected control point
"PID" - Select if PID gain set to be loaded with setpoint
"PB-x" - Enter proportional band for selected control point ∗
"It-x" - Enter integral time for selected control point ∗
"dt-x" - Enter derivative time for selected control point ∗

Configuration 8, Profiles
"PSEt" - Select profile or event output for set-up 1, 2, 3, or 4
"PnCC" - Enter program-repeat cycle count for selected profile
"PnLN" - Select link option for selected profile
"PnSt" - Enter power-down resume status for selected profile
"PnEb" - Enter error band for process conformity for selected profile
"Pnr1" - Enter ramp rate 1 for selected profile ∗
"PnL1" - Enter setpoint level 1 for selected profile ∗
"PnH1" - Enter hold time 1 for selected profile ∗
.   -
.   -
"Pnr8" - Enter ramp rate 8 for selected profile ∗
"PnL8" - Enter setpoint level 8 for selected profile ∗
"PnH8" - Enter hold time 8 for selected profile ∗
"Pn 1" - Select event outputs at phase 1 for selected profile ∗
.   -
.   -
"Pn16" - Select event outputs at phase 16 for selected profile ∗

Configuration 9, Factory Service Operations
(Detailed in the operator's manual)

SETPOINT FEATURES

The controller's setpoint can be protected from out of range values, by programming the setpoint range limit values. Additionally, safeguards from inadvertent data entry can also be programmed.

The setpoint ramp feature ramps the setpoint value at start-up or any time a setpoint change is made, at a user programmable rate, independent of a programmed profile. This feature reduces shock to the process and also helps to minimize overshoot.

The active setpoint, which can be a running profile, may also be transmitted by the linear DC output for slave control loops.

Four control points are available which can be implemented at any time. Each control point is programmed independently, with each having a setpoint and a PID gain set value. With gain value changes, the output power control signal will not "bump" resulting in a smooth control transition.

INPUT FEATURES

A programmable input filter can be used to stabilize readings from a process with varying or oscillating characteristics, helping to provide better process control.

Scaling points allow the controller to display in any engineering unit; flow, level, pressure temperature, etc. Scaling points are used in conjunction with the programmable rounding increment to stabilize a jittery or otherwise hard to read process signal for better indication.

A programmable User Input is available to control a variety of controller functions, such as profile control, auto/manual transfer, serial communication print requests, etc.

OUTPUT FEATURES

Programmable output power limits provide protection for processes where too much power can cause damage. Automatic signal overdrive detection can be used to define the state of the output channels, when this situation occurs. With adjustable time proportioning-cycle time and programmable D.C. Linear output, the controller can satisfy a wide variety of output requirements.

During execution of a profile, two independent timed event outputs are available to control or signal other equipment. The event outputs use the alarm channels.

The RS-485 Communication option allows the user to access various controller parameters such as the setpoint, % output power, % proportional band, etc. The controller may be setup to transmit various parameters at a programmable automatic print rate.

AUTO-TUNE

The model PSC has an auto-tune feature which, on demand, automatically determines the PID control parameters for a particular process. After completion of auto-tune, the PID parameters are automatically optimized for that process and loaded into nonvolatile memory. The operator may view and modify the parameters as desired.

Auto-tune may be invoked at start-up, while ramping, or at setpoint, depending on the process requirements. A programmable auto-tune damping factor produces various levels of process control and response characteristics.

PROFILE PROGRAMMING

Profiles are programmed independently of each other and are separate from the configuration of other controller parameters. Each profile has parameters for error band (profile conformity), linking, auto-start and program repeat cycles. Profiles may be altered during execution, so changes take effect as the profile advances.

CONTROLLER PROGRAMMING

The model PSC has been designed to reduce the operator interaction with the controller while still maintaining a high degree of control accuracy and user flexibility. Front panel program disable allows all of the controller's set-ups to be locked-out from further operator intervention after the initial parameter set-up.

The programming of the controller is divided into four sections:

      Hidden Mode
      Protected Mode
      Unprotected Mode
      Configuration Mode

These four programming modes allow the controller to adapt to any required user-interface level.

UNPROTECTED PARAMETER MODE

The unprotected mode is accessible when program disable is inactive or when the proper access code number from the protected mode is entered. Only from this mode can the configuration modes be accessed.

"SP"	- Enter setpoint ∗
"OPOF"	- Enter %output power offset ∗
"OP"	- Enter output power ∗
"ProP"	- Enter proportional band
"Intt"	- Enter integral time ∗
"dErt"	- Enter derivative time ∗
"AL-1"	- Enter value for alarm #1 ∗
"AL-2"	- Enter value for alarm #2 ∗
"CNFP"	- Select basic configuration module
"End"	- Return to normal display mode

PROTECTED PARAMETER MODE ∗

The protected mode is accessible when program disable is active, also this mode prevents access to the configuration modes without the proper access code number. Only the parameters that are selected in the configuration 3 parameter lock-outs section can be accessed.

"ProP"	- Enter proportional band
"Intt"	- Enter integral time
"dErt"	- Enter derivative time
"AL-1"	- Enter value for alarm #1
"AL-2"	- Enter value for alarm #2
"Code"	- Enter access value to unprotected mode

∗ *These parameters may not appear due to option configuration or other programming*

HIDDEN FUNCTIONS MODE ∗

The hidden mode is accessible from the normal operating mode by holding the PAR button for 3 seconds. The five functions in this mode may be locked-out individually in configuration 3 parameter lock-outs section.

" CP"	- Invoke control point x
"Prun"	- Control ramp/hold profile state
"trnF"	- Transfer between automatic (PID) control and Manual control
"tUNE"	- Invoke/Cancel PID auto-tune
"ALrS"	- Reset latched alarms

∗ *These parameters may not appear due to option configuration or other programming*

OUTPUT VARIATIONS WITHOUT RS-485 OPTION

The Dual Alarm or the Secondary with Alarm output, without the RS-485 option, has independent outputs. Therefore, the secondary output and/or alarm output(s) can be installed with any combination of output modules.
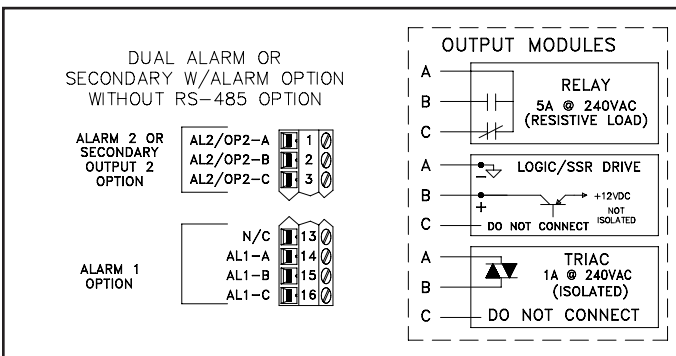
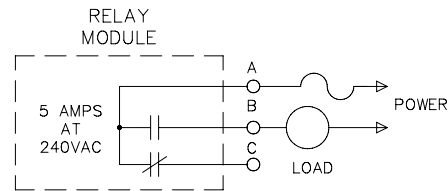

OUTPUT VARIATIONS WITH RS-485 OPTION

The Dual Alarm or the Secondary with Alarm output, with RS-485 option, does not have independent outputs. In this case, the secondary output and/or alarm output(s) must have the same type of output modules installed since they share the common terminal.
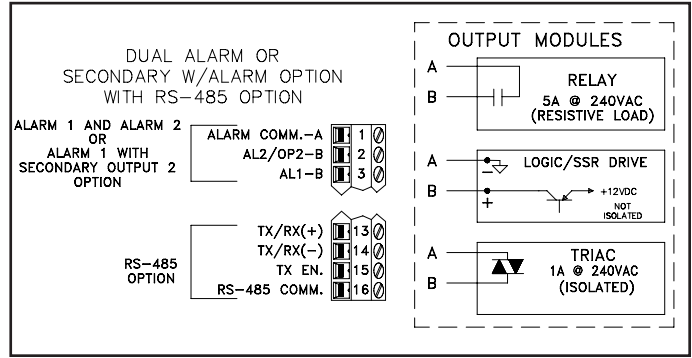
OUTPUT MODULES

Units equipped with RS-485 option must have the Dual Alarm or Secondary w/alarm options fitted with the same type of output modules. The controller's main output (OP1) can be fitted with any output module. Output modules are shipped separately and must be installed by the user.
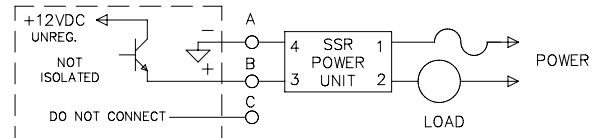
TYPICAL CONNECTIONS

Relay:
    Type: Form -C (Form-A with RS-485 option only)
    Rating: 5 Amps @ 120/240 VAC or 28 VDC (resistive load), 1/8 HP @ 120 VAC (inductive).
    Life Expectancy: 100,000 cycles at maximum load rating.
    (Decreasing load and/or increasing cycle time, increases life expectancy).

Logic/SSR Drive: can drive multiple SSR Power Units.
    Type: Non-isolated switched DC, 12 VDC typical.
    Drive: 45 mA max.

Triac:
    Type: Isolated, Zero Crossing Detection.
    Rating:
        Voltage: 120/240 VAC.
        Max. Load Current: 1 Amp @ 35°C
                       0.75 Amp @ 50°C
        Min. Load Current: 10 mA
    Off State Leakage Current: 7 mA max @ 60 Hz.
    Operating Frequency: 20 to 500 Hz.
    Protection: Internal Transient Snubber, Fused.

APPLICATION

A chemical treatment process requires the PH level of a solution be ramped at staged levels over specific time periods during start-up. The PSC unit is installed to meet this requirement.

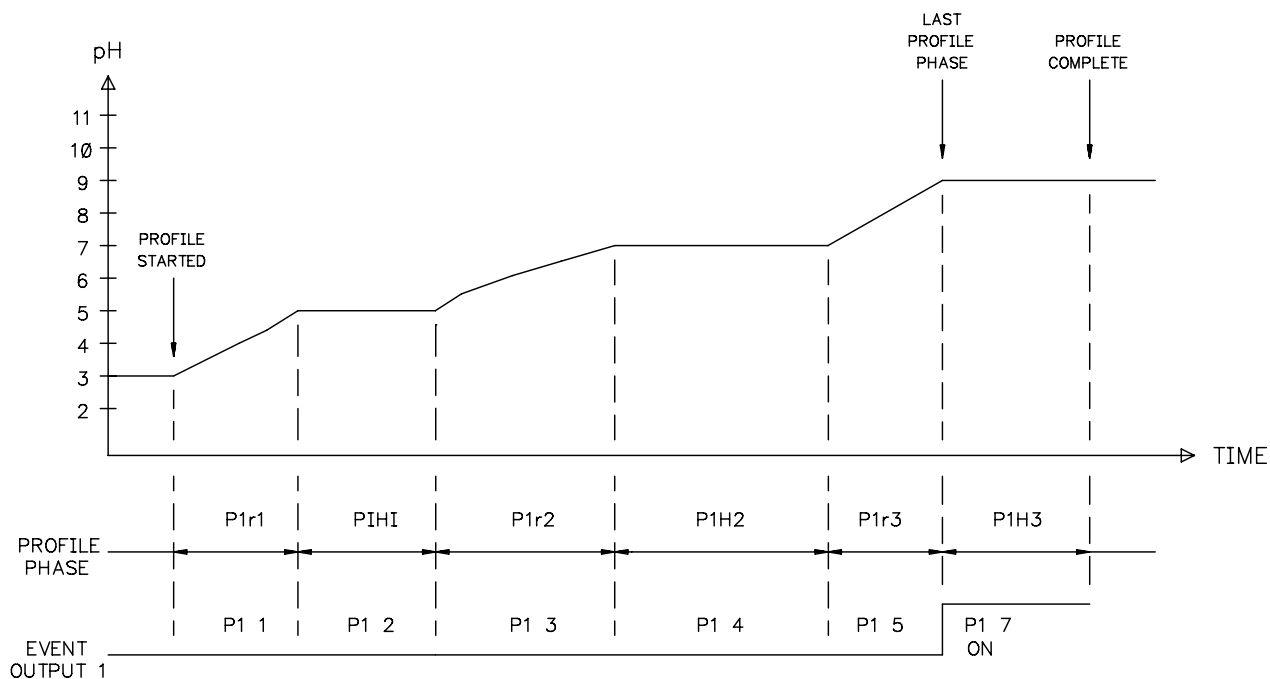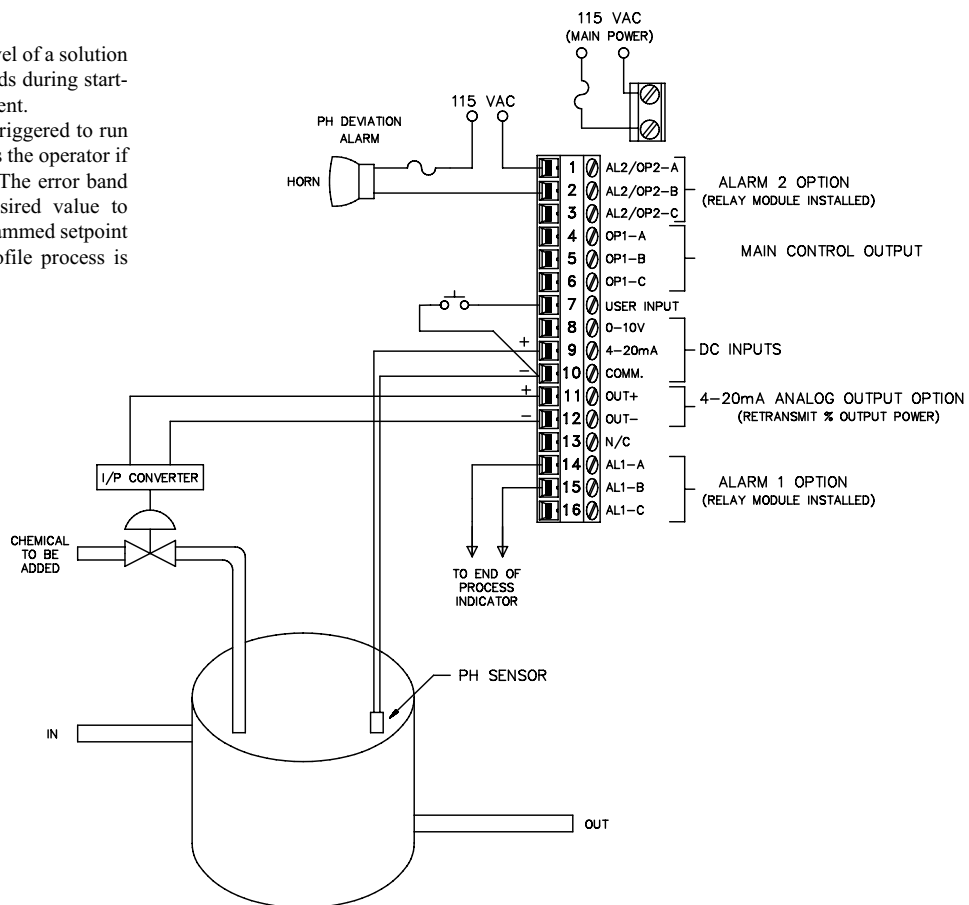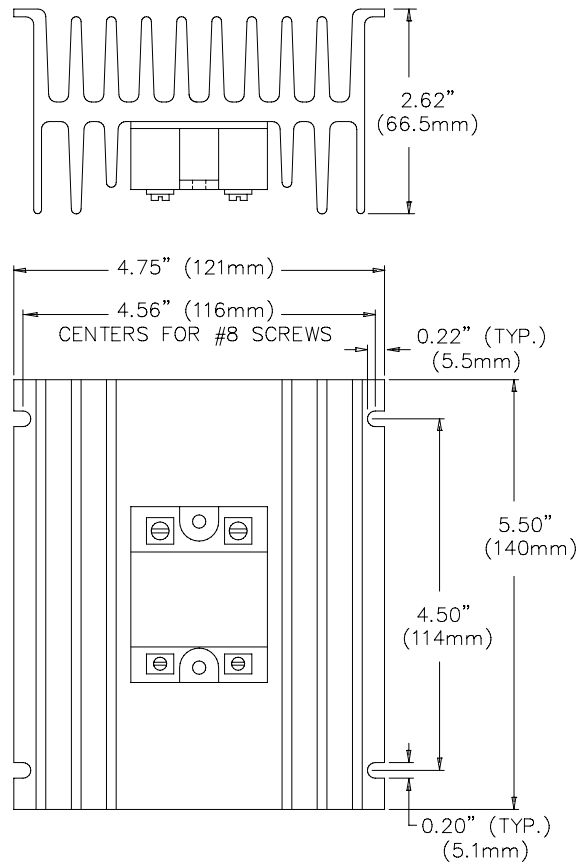After the tank is filled, the PSC's user input is triggered to run profile 1 to start the process. Alarm output 2 signals the operator if the PH level deviates outside the running profile. The error band (profile conformance) is programmed to the desired value to prevent the PH level from deviating from the programmed setpoint profile. Timed event output 1 signals that the profile process is complete.

115 VAC (MAIN POWER)

115 VAC

PH DEVIATION ALARM

HORN

1	AL2/OP2-A	ALARM 2 OPTION (RELAY MODULE INSTALLED)
2	AL2/OP2-B	
3	AL2/OP2-C	
4	OP1-A	MAIN CONTROL OUTPUT
5	OP1-B	
6	OP1-C	
7	USER INPUT	
8	0-10V	DC INPUTS
9	4-20mA	
10	COMM.	
11	OUT+	4-20mA ANALOG OUTPUT OPTION (RETRANSMIT % OUTPUT POWER)
12	OUT-	
13	N/C	
14	AL1-A	ALARM 1 OPTION (RELAY MODULE INSTALLED)
15	AL1-B	
16	AL1-C	

TO END OF PROCESS INDICATOR

I/P CONVERTER

CHEMICAL TO BE ADDED

PH SENSOR

IN

OUT

pH

LAST PROFILE PHASE

PROFILE COMPLETE

PROFILE STARTED

TIME

PROFILE PHASE: P1r1 | PIHI | P1r2 | P1H2 | P1r3 | P1H3

EVENT OUTPUT 1: P1 1 | P1 2 | P1 3 | P1 4 | P1 5 | P1 7 ON

ACCESSORY - EXTERNAL SSR POWER UNIT

The external SSR Power Unit is used with the Logic/SSR Drive Module (OMD00003) to switch loads up to 240VAC @ 45amps, 25°C ambient. The unit is operated by applying a low level DC control signal to the isolated input. The unit features zero cross detection circuits, which reduce radiated RFI when switching load currents. With no contacts to wear out, the SSR power unit provides virtually limitless operational life. The unit is supplied with an integral heat sink for immediate installation.

2.62" (66.5mm)

4.75" (121mm)

4.56" (116mm)
CENTERS FOR #8 SCREWS

0.22" (TYP.) (5.5mm)

5.50" (140mm)

4.50" (114mm)

0.20" (TYP.) (5.1mm)

ORDERING INFORMATION

MODEL NO.	DESCRIPTION	NEMA 4X/IP65 BEZEL	4 to 20 mA ANALOG OUTPUT	0 to 10 VDC ANALOG OUTPUT	DUAL ALARM	SECONDARY OUTPUT W/ALARM	RS485 COM W/USER INPUT	PART NUMBER
PSC	Process Setpoint Controller	NO	YES	NO	2	NO	NO	PSC01001
		NO	YES	NO	1	YES	NO	PSC01002
		NO	YES	NO	2	NO	YES	PSC01004
		NO	YES	NO	1	YES	YES	PSC01005
		NO	NO	YES	2	NO	NO	PSC02001
		NO	NO	YES	1	YES	NO	PSC02002
		NO	NO	YES	2	NO	YES	PSC02004
		NO	NO	YES	1	YES	YES	PSC02005
		YES	YES	NO	2	NO	NO	PSC11001
		YES	YES	NO	1	YES	NO	PSC11002
		YES	YES	NO	2	NO	YES	PSC11004
		YES	YES	NO	1	YES	YES	PSC11005
		YES	NO	YES	2	NO	NO	PSC12001
		YES	NO	YES	1	YES	NO	PSC12002
		YES	NO	YES	2	NO	YES	PSC12004
		YES	NO	YES	1	YES	YES	PSC12005
–	Relay Module							OMD00000
–	Triac Module							OMD00001
–	Logic/SSR Drive Module							OMD00003
PMK5	Panel Mount Adapter Kit (1/4 DIN to 1/8 DIN)							PMK50000
–	SSR Power Unit							RLY50000

These models have dual alarm outputs, or single alarm with secondary outputs, with shared common terminals (Form A Type). As a result, these outputs should be fitted with the same type of output module. The main output (OP1) may be fitted with any type of output module.

Note: Output Modules are NOT supplied with the controller. When specifying the controller, be sure to purchase the appropriate output module for the Main Control Output and if necessary, the alarm output(s) and secondary output. The controller can be fitted with any combination of output modules that do not have the RS-485 option.

The Logic/SSR Drive Module is a switched DC source, intended to drive the DC input of an SSR power unit. It should never be connected to a line voltage.

All modules are shipped separately and must be installed by the user.