MICROBASED 1/4 DIN SINGLE LOOP PROFILE CONTROLLER

AIC 600

Installation, Wiring, Operation Manual
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Product Description 1.1

1.1.1 GENERAL
This instrument is a microprocessor based profiling controller capable of measuring, displaying, and controlling a process variable from a variety of inputs. Applications include temperature, pressure, level, flow, and others.

Control functions, alarm settings and other parameters are easily entered via the front keypad. All user data can be protected from unauthorized changes by the Enable mode security system, and is protected against loss from AC power failure by battery back-up.

The process input is user configurable to directly connect to either thermocouple, RTD, mVDC, VDC, or mADC inputs, depending on the input type specified. Thermocouple and RTD linearization, as well as thermocouple cold junction compensation, is performed automatically. The instrument's process input is isolated from the rest of the instrument.

The instrument can be ordered to operate on either 115VAC or 230VAC power at 50/60Hz. The instrument is housed in an extruded aluminum enclosure suitable for panel mounting.

FIGURE 1-1

1.1.2 DISPLAYS
Each instrument is provided with a digital display and status indicators as shown in Figure 1-1. The digital display is programmable to display the process value only, process and setpoint, deviation from setpoint only, deviation and setpoint, or setpoint continuously.

Status indication is provided for Alarm, Output 1, Output 2, degree C, degree F, engineering units, Manual operation, Segment 1 thru 6, Ramp, and Soak.

Display resolution is programmable for 0.1 or 1 degree for thermocouple and RTD inputs, and 0.001, 0.01, 0.1, or 1 unit for volt, mV input types.
1.1.3 CONTROL
Instruments can be programmed for On-Off, Time Proportioning, Current Proportioning, or Position Proportioning control implementations. Selectable direct or reverse control action is also provided. Proportional control implementations are provided with fully programmable PID parameters.

Automatic to Manual switching is easily accomplished via the Standby mode. Switching is seamless, and while in manual, manipulation of proportional outputs is possible.

Other standard control features include control output limits, setpoint limits, anti-reset windup control, and a unique Automatic Transfer function, which, if configured, allows manual control of the process until setpoint is reached, at which time the unit will automatically transfer from manual to automatic control.

Remote Run-Hold capability can be provided via the Auxiliary Input.

1.1.4 PROGRAMMABLE SETPOINT PROFILES
Up to eight profiles can be programmed on any of these Profile Controllers. Each of the eight profiles can contain up to six segments. Each segment contains a ramp and a soak operation. Profiles can be programmed to run continuously or any number of times up to 9999. A combination of profiles may be combined for back to back execution. This has the affect of acting as a single profile of more than six segments.

Assured Soak is provided with the use of two programmable parameters that will activate an Auto/Hold feature. This feature will place a running profile in the Hold condition and prohibit a Soak operation from starting or completing if an acceptable process value is not reached and then maintained.

Event outputs may also be provided. Up to three events may be assigned and can be turned on or off at the beginning of each ramp and soak.

1.1.5 ALARMS
Alarm settings are fully programmable. Alarm type may be set as Process direct or reverse (High or Low), Deviation direct or reverse (above or below setpoint), or Deviation Band type (closed or open within band).

Alarm outputs can be provided by assigning any specified relays (SPST or SSR driver) to the respective alarm.

1.1.6 DIGITAL COMMUNICATIONS
The instrument can be provided with an RS-422/485 communications port which allows bi-directional multidrop communications with a supervisory computer.
Installation and Wiring 2.1

Read these instructions carefully before proceeding with installation and operation. Electrical code requirements and safety standards should be observed. Installation should be performed by qualified personnel.

CAUTION: The Instrument AC power input is specified in the model number and on the wiring label for either 115VAC or 230VAC. Verify the AC power input required by the instrument prior to proceeding with installation.

Unpacking 2.2

Remove the instrument from the carton and inspect it for any damage due to shipment. If any damage is noticed due to transit, report and file a claim with the carrier. Write the model number and serial number of the instrument on the front cover of this Operation Manual for future reference when corresponding with the factory.

Location 2.3

Locate the instrument away from excessive moisture, oil, dust, and vibration. Do not subject the instrument to operating temperatures outside of 0 to 55° C (32° to 131° F).

Mounting 2.4

Figure 2-1 (page 8) shows installation view and physical dimensions for the panel mounted instrument.

The electronics can be removed from the housing for installation, if so desired. To remove, loosen the locking screw centered on the bottom face of the unit. The instrument pulls straight out. When installing, be sure that the vertically mounted circuit boards are inserted in the correct grooves in the top and bottom of the housing. Also make sure the screw lock is sufficiently tight. When installing multiple instruments, be sure to reinsert the proper instrument into its correct enclosure by matching the serial number with the number inside the housing. This will insure that the accuracy of the control will be within the published specifications. The ambient compensator on the rear of the enclosure is calibrated to the electronics at the factory.

Cut the panel cutout to the dimensions shown in Figure 2-1 (page 8). Insert the instrument housing into the panel cutout and install the mounting bracket. Place the mounting screws on the back of the housing and tighten until the instrument is rigidly mounted. Do not overtighten.

A surface mounting kit is available - part number 64405801. For installation of the instrument in areas subjected to washdowns, a water tight cover option is available (part # 64417801).
Preparation for Wiring  2.5

2.5.1 WIRING GUIDELINES
Electrical noise is a phenomenon typical of industrial environments. The following are guidelines that must be followed to minimize the effect of noise upon any instrumentation.

2.5.1.1 INSTALLATION CONSIDERATIONS
Listed below are some of the common sources of electrical noise in the industrial environment:
• Ignition Transformers
• Arc Welders
• Mechanical contact relay(s)
• Solenoids

Before using any instrument near the devices listed, the instructions below should be followed:

1. If the instrument is to be mounted in the same panel as any of the listed devices, separate them by the largest distance possible. For maximum electrical noise reduction, the noise generating devices should be mounted in a separate enclosure.
2. If possible, eliminate mechanical contact relay(s) and replace with solid state relays. If a mechanical relay being powered by an instrument output device cannot be replaced, a solid state relay can be used to isolate the instrument.

3. A separate isolation transformer to feed only instrumentation should be considered. The transformer can isolate the instrument from noise found on the AC power input.

4. If the instrument is being installed on existing equipment, the wiring in the area should be checked to insure that good wiring practices have been followed.

2.5.1.2 AC POWER WIRING
Earth Ground
The instrument includes noise suppression components that require an earth ground connection to function. To verify that a good earth ground is being attached, make a resistance check from the instrument chassis to the nearest metal water pipe or proven earth ground. This reading should not exceed 100 ohms.

Neutral (For 115VAC)
It is good practice to assure that the AC neutral is at or near ground potential. To verify this, a voltmeter check between neutral and ground should be done. On the AC range, the reading should not be more than 50 millivolts. If it is greater than this amount, the secondary of this AC transformer supplying the instrument should be checked by an electrician. A proper neutral will help ensure maximum performance from the instrument.

2.5.1.3 WIRE ISOLATION
Four voltage levels of input and output wiring may be used with the unit:
* Analog input or output (i.e. thermocouple, RTD, VDC, mVDC or mADC)
* SPST Relays
* SSR driver outputs
* AC power

The only wires that should be run together are those of the same category. If they need to be run parallel with any of the other lines, maintain a minimum 6 inch space between the wires. If wires must cross each other, do so at 90 degrees. This will minimize the contact with each other and reduces "cross talk". "Cross talk" is due to the EMF (Electro Magnetic Flux) emitted by a wire as current passes through it. This EMF can be picked up by other wires running in the same bundle or conduit.

In applications where a High Voltage Transformer is used, (i.e. ignition systems) the secondary of the transformer should be isolated from all other cables.

This instrument has been designed to operate in noisy environments, however, in some cases even with proper wiring it may be necessary to suppress the noise at its source.

2.5.1.4 USE OF SHIELDED CABLE
Shielded cable helps eliminate electrical noise being induced on the wires. All analog signals should be run with shielded cable. Connection lead length should be kept as short as possible, keeping the wires protected by the shielding. The shield should be grounded at one end only. The preferred grounding location is at the sensor, transmitter or transducer.
2.5.1.5 NOISE SUPPRESSION AT THE SOURCE

Usually when good wiring practices are followed, no further noise protection is necessary. Sometimes in severe electrical environments, the amount of noise is so great that it has to be suppressed at the source. Many manufacturers of relays, contactors, etc. supply "surge suppressors" which mount on the noise source.

For those devices that do not have surge suppressors supplied, RC (resistance-capacitance) networks and/or MOV (metal oxide varistors) may be added.

Inductive Coils - MOV's are recommended for transient suppression in inductive coils connected in parallel and as close as possible to the coil. See Figure 2-2. Additional protection may be provided by adding an RC network across the MOV.

Contacts - Arcing may occur across contacts when the contact opens and closes. This results in electrical noise as well as damage to the contacts. Connecting a RC network properly sized can eliminate this arc.

For circuits up to 3 amps, a combination of a 47 ohm resistor and 0.1 microfarad capacitor (1000 volts) is recommended. For circuits from 3 to 5 amps, connect 2 of these in parallel. See Figure 2-3.

---

**FIGURE 2-2**

![Diagram of RC network and MOV across inductive coil]

**FIGURE 2-3**

![Diagram of RC network across contacts with MOV protecting inductive load]
2.5.2 SENSOR PLACEMENT (Thermocouple or RTD)
If the temperature probe is to be subjected to corrosive or abrasive conditions, it should be
protected by the appropriate thermowell. The probe should be positioned to reflect true
process temperature:

- In liquid media - the most agitated area.
- In air - the best circulated area.

THERMOCOUPLE LEAD RESISTANCE
Thermocouple lead length can affect instrument accuracy since the size (gauge) and the
length of the wire affect lead resistance.

To determine the temperature error resulting from the lead length resistance, use the follow-
ing equation:

\[
T_{err} = T_{Le} * L \quad \text{where;} \quad T_{Le} = \text{value from appropriate table below}
\]
\[
L = \text{length of leadwire in thousands of feet}
\]

TABLE 1

<table>
<thead>
<tr>
<th>AWG No.</th>
<th>Thermocouple Type:</th>
<th>Temperature Error in °C per 1000 feet of Leadwire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
<td>K</td>
</tr>
<tr>
<td>10</td>
<td>.34</td>
<td>.85</td>
</tr>
<tr>
<td>12</td>
<td>.54</td>
<td>1.34</td>
</tr>
<tr>
<td>14</td>
<td>.87</td>
<td>2.15</td>
</tr>
<tr>
<td>16</td>
<td>1.37</td>
<td>3.38</td>
</tr>
<tr>
<td>18</td>
<td>2.22</td>
<td>5.50</td>
</tr>
<tr>
<td>20</td>
<td>3.57</td>
<td>8.62</td>
</tr>
<tr>
<td>24</td>
<td>8.78</td>
<td>21.91</td>
</tr>
</tbody>
</table>

TABLE 2

<table>
<thead>
<tr>
<th>AWG No.</th>
<th>Thermocouple Type:</th>
<th>Temperature Error in °F per 1000 feet of Leadwire</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>J</td>
<td>K</td>
</tr>
<tr>
<td>10</td>
<td>.61</td>
<td>1.54</td>
</tr>
<tr>
<td>12</td>
<td>.97</td>
<td>2.41</td>
</tr>
<tr>
<td>14</td>
<td>1.57</td>
<td>3.86</td>
</tr>
<tr>
<td>16</td>
<td>2.47</td>
<td>6.09</td>
</tr>
<tr>
<td>18</td>
<td>4.00</td>
<td>9.90</td>
</tr>
<tr>
<td>20</td>
<td>6.43</td>
<td>15.51</td>
</tr>
<tr>
<td>24</td>
<td>15.80</td>
<td>39.44</td>
</tr>
</tbody>
</table>

Example:
An MIC is to be located in a control room 660 feet away from the process. Using 16 AWG,
type J thermocouple, how much error is induced?

\[
T_{err} = T_{Le} * L
\]
\[
T_{Le} = 2.47 \, (°F/1000 \, ft) \text{ from Table 2}
\]
\[
T_{err} = 2.47 \, (°F/1000 \, ft) * 660 \, ft
\]
\[
T_{err} = 1.6 \, °F
\]
RTD LEAD RESISTANCE

RTD lead length can affect instrument accuracy, since the size (gauge) and length of the wire affect lead resistance.

To determine the temperature error resulting from the lead length resistance, use the following equation:

$$\text{Terr} = T\text{Le} \times L$$

where:  
$T\text{Le} =$ value from Table 3 if 3 wire RTD or Table 4 if 2 wire RTD  
$L =$ length of lead wire in thousands of feet

**TABLE 3 - 3 Wire RTD**

<table>
<thead>
<tr>
<th>AWG No.</th>
<th>Error °C</th>
<th>Error °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+/- 0.04</td>
<td>+/- 0.07</td>
</tr>
<tr>
<td>12</td>
<td>+/- 0.07</td>
<td>+/- 0.11</td>
</tr>
<tr>
<td>14</td>
<td>+/- 0.10</td>
<td>+/- 0.18</td>
</tr>
<tr>
<td>16</td>
<td>+/- 0.16</td>
<td>+/- 0.29</td>
</tr>
<tr>
<td>18</td>
<td>+/- 0.26</td>
<td>+/- 0.46</td>
</tr>
<tr>
<td>20</td>
<td>+/- 0.41</td>
<td>+/- 0.73</td>
</tr>
<tr>
<td>24</td>
<td>+/- 0.65</td>
<td>+/- 1.17</td>
</tr>
</tbody>
</table>

**TABLE 4 - 2 Wire RTD**

<table>
<thead>
<tr>
<th>AWG No.</th>
<th>Error °C</th>
<th>Error °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>+/- 5.32</td>
<td>+/- 9.31</td>
</tr>
<tr>
<td>12</td>
<td>+/- 9.31</td>
<td>+/- 14.6</td>
</tr>
<tr>
<td>14</td>
<td>+/- 13.3</td>
<td>+/- 23.9</td>
</tr>
<tr>
<td>16</td>
<td>+/- 21.3</td>
<td>+/- 38.6</td>
</tr>
<tr>
<td>18</td>
<td>+/- 34.6</td>
<td>+/- 61.2</td>
</tr>
<tr>
<td>20</td>
<td>+/- 54.5</td>
<td>+/- 97.1</td>
</tr>
<tr>
<td>24</td>
<td>+/- 86.5</td>
<td>+/- 155.6</td>
</tr>
</tbody>
</table>

Example:

An application uses 2000 feet of 18 AWG copper lead wire for a 3 wire RTD sensor. What is the worst case error due to this leadwire length?

$$\text{Terr} = T\text{Le} \times L$$

$T\text{Le} = +/- .46 (^°F/1000 \text{ ft})$ from Table 3

$$\text{Terr} = +/- .46 (^°F/1000 \text{ ft}) \times 2000 \text{ ft}$$

$$\text{Terr} = +/- 0.92^°\text{F}$$
Wiring Connections 2.6

All wiring connections are typically made to the instrument with it installed. Terminal connections should be made via the rear panel with 14 gauge wire maximum (see Figure 2-4).

FIGURE 2-4

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>115VAC 5.0A RESISTIVE 230VAC 2.5A RESISTIVE 230VAC 1/8 HP 115/230VAC 250VA</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**INPUT RATINGS:**
115/230 VAC 50/60 HZ 15VA MAX

**RELAY OUTPUT RATINGS:**
- OUT1 4-20MA +
- OUT2 4-20MA +
- RETURN
- SIGNAL +
- CJC
- SIGNAL -

**GROUND**

**MADE IN U.S.A.**

2.6.1 INPUT CONNECTIONS

**WARNING:** Avoid electrical shock. AC power wiring must not be connected at the source distribution panel until all wiring connections are completed.

Consult the model code and the wiring label for the appropriate line voltage for the instrument.
FIGURE 2-5
AC Power
Connect 115 VAC hot and neutral to terminals B and A respectively as illustrated below.
Connect 230 VAC as described below. Connect Earth ground to the ground screw as shown.

115 VAC INSTRUMENT VOLTAGE

230 VAC INSTRUMENT VOLTAGE

*Supplied by customer

FIGURE 2-6
Thermocouple Input
Make thermocouple connections as illustrated below. Connect the positive lead of the
thermocouple to terminal 3, and the negative to terminal 1. For industrial environments with
comparatively high electrical noise levels, shielded thermocouples and extension wire are
recommended. Be sure that the input conditioning jumpers are properly positioned for a
thermocouple input. See Appendix A-2 (page 54) and A-3 (page 65 or 66).

THERMOCOUPLE INPUT

300 OHMS
MAXIMUM
LEAD
FIGURE 2-7
RTD Input
Connections are shown for 3 wire and 2 wire RTD's. If a three wire device is used, install the common wires to terminals 1 and 5. If a two wire device is used, install a jumper between terminals 1 and 5.

2 WIRE RTD INPUT

3 WIRE RTD INPUT

100 OHM* PLATINUM

10 FEET LEAD MAXIMUM

*Supplied by the customer

FIGURE 2-8
Volt, Millivolt and Milliamp Input
Make volt, millivolt or milliamp connections as shown below. Terminal 3 is positive and terminal 1 is negative. Milliamp input requires a shunt resistor be installed across the input terminals as shown. 4-20mA input are accommodated by setting up the instrument for either 10 to 50mVDC or 1 to 5VDC input. Make sure that the appropriate resistor value is used. Terminal 3 is positive and terminal 1 is negative. (.1% resistors recommended.) (Continued on next page)

MILLIAM DC INPUT

MILLIAM DC INPUT

100 OHM* PLATINUM

*Supplied by the customer

MILLIAM DC SOURCE 250 OHM SHUNT RESISTOR REQUIRED

MILLIAM DC SOURCE 25 OHM SHUNT RESISTOR REQUIRED

Shielded Twisted Pair
FIGURE 2-9A
24Volt Transmitter Power Supply (XP Option)
Make connections as shown below. Terminal 3 is positive (+) and terminal 1 is negative (-). Be sure the input conditioning jumpers are properly positioned for the input type selected. See Figure A-2 Processor Board, page 64 and Figure A-3 Option Board, page 65 or 66. Note the 250 ohm shunt resistor is **not** required.

![Diagram of 24Volt Transmitter Power Supply](image)

FIGURE 2-9B
24 Volt Power Supply (XA Option)
Make connections as shown below. Terminal G is positive (+) and terminal H is negative (-). Be sure the input conditioning jumpers are properly positioned. See Figure A-2 Processor Board, page 64 and Figure A-3 Option Board, page 65 or 66.

![Diagram of 24 Volt Power Supply](image)
FIGURE 2-10
Remote Run/Hold Input
If Remote Run/Hold capability has been specified, make connections as shown. Terminal 5 is
the ground and terminal 8 is the input.

![Diagram of Multi-Conductor Cable](image)

FIGURE 2-11
Remote Digital Communications RS-485 Terminals 7 & 8 (Optional)
If the communications network continues on to other units, connect the shields together, but
not to the instrument. A terminating resistor should be installed at the terminals of the last
instrument in the loop. The shield should be grounded at the computer or the convertor box, if
used. See the Protocol Manual (Form 2878) for more details on the use of the digital
communications option.

DIGITAL COMMUNICATIONS
CONNECTIONS - TERMINALS 7 & 8

Terminals 7 & 8 are used for communications when the model number is 6XXXY3X or 6XXXY5X
where X= any valid number
and Y=0, 1, or 2.
FIGURE 2-12
Alternate Remote Digital Communications RS-485 Terminals G & H (Optional)
If the communications network continues on to other units, connect the shields together, but not to the instrument. A terminating resistor should be installed at the terminals of the last instrument in the loop. The shield should be grounded at the computer or the converter box, if used. See the Protocol Manual (Form 2878) for more details on the use of the digital communications option.

Terminals G & H are used for communications when the model number is 6XXX04X or 6XXX06X where X= any valid number and Y=3, 4, or 5.

DIGITAL COMMUNICATIONS CONNECTIONS - TERMINALS G & H

2.6.3 OUTPUT CONNECTIONS
Output connections include SPST relays, SSR drivers, and 4 to 20mADC. Relay outputs may be assigned control, alarm or event functions. Assignment of output function is accomplished via the front keypad and is described in Section 4 (page 38) of this manual.

FIGURE 2-13
Relay Output
Connections are made to relay A as illustrated below. Connect relay(s) B & C (if present) in the same manner. Relay contacts are rated at 5 amp resistive at 130 VAC.
FIGURE 2-14
SSR Driver Output
Connections are made to the solid state relay driver output located in the Relay A position as shown. The solid state relay driver is a 5 VDC current sink output type. Connect the solid state relay driver(s) in the Relay B and C position (if present) in the same manner.

SSR DRIVER (RELAY A)  
SSR DRIVER (RELAY B)  
SSR DRIVER (RELAY C)
FIGURE 2-15
mADC Output
Connections are made to current outputs 1 and 2 as shown. Connect the positive lead to terminal 6 for Output 1 or terminal 7 for Output 2, the negative leads connect to terminal 5. Current outputs will operate up to 650 ohms maximum load. The current output(s) can be selected for either 4-20mADC or 0-20mADC (if EO option is present).

DC CURRENT OUTPUT 1

DC CURRENT OUTPUT 2

FIGURE 2-16
Position Proportioning Control
The relay and slidewire feedback connections are made as illustrated below. The relay assigned to Output 1 will be used to drive the motor in the open direction and the relay assigned to Output 2 will be used to drive the motor in the closed direction. The minimum slidewire feedback resistance is 135 ohms, the maximum resistance is 10K ohms.
Configuration 3.1

After completing installation of the unit, the configuration procedures contained within this section must be performed to prepare the instrument for operation on the intended application. The procedures include selecting specific parameters, entering data and possible jumper positioning.

Parameter selections and data entry are made via the front keypad. To ease configuration and operation, user entered data has been divided up into several modes. Each mode contains a different type of data or may be used for specific operating functions. These modes are as follows:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Display Code</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off</td>
<td>Off</td>
<td>Operation</td>
<td>Outputs and Alarm Off</td>
</tr>
<tr>
<td>Control</td>
<td>Ctrl</td>
<td>Operation</td>
<td>Operates in automatic control; Change local setpoint, Alarms are On</td>
</tr>
<tr>
<td>Manual</td>
<td>Stby</td>
<td>Operation</td>
<td>Manual control of proportional outputs</td>
</tr>
<tr>
<td>Program</td>
<td>Prog</td>
<td>Configuration</td>
<td>Configures operating parameters</td>
</tr>
<tr>
<td>Tune</td>
<td>tunE</td>
<td>Configuration &amp; Operation</td>
<td>Sets alarm settings &amp; tunes the controller to the process</td>
</tr>
<tr>
<td>Profile Continue</td>
<td>PCon</td>
<td>Operation</td>
<td>Provides Profile Continue function</td>
</tr>
<tr>
<td>Profile Entry</td>
<td>PEntl</td>
<td>Configuration</td>
<td>Configures profile Entry parameters</td>
</tr>
<tr>
<td>P1 thru P8</td>
<td>P1 - P8</td>
<td>Operation</td>
<td>Executes any of the 8 profiles</td>
</tr>
<tr>
<td>Test</td>
<td>tEST</td>
<td>Service</td>
<td>Performs instrument tests</td>
</tr>
<tr>
<td>Calibration</td>
<td>CAL</td>
<td>Service</td>
<td>Performs instrument calibration</td>
</tr>
<tr>
<td>Enable</td>
<td>EnAb</td>
<td>Configuration</td>
<td>Locks out or enables access to any modes</td>
</tr>
</tbody>
</table>

(Continued on next page)
Associated with each mode is a series of unique displays which are accessed via the front keypad.

Prior to first time operation of the instrument, the configuration procedures for the Program, Profile Entry and Tune modes must be performed as applicable. The Control, Off, Standby, Profile Continue and Profile execution (P1 thru P8) modes are discussed in Section 4.1 (page 38) of this manual.

Calibration and Test modes are not used as part of instrument configuration or operation. These are used for service and maintenance functions and are discussed in Section 5.2 (page 47) of this manual.

**Shipped Configuration/ Jumper Positioning 3.2**

All configuration parameters in each mode are set to default values. These defaults are shown in tabular form under the description for each mode. Instrument AC power input is as specified in the instrument model number and as shown on the instrument ratings label.

### 3.2.1 JUMPER POSITIONING

Jumpers are used in all instruments to provide a security lockout feature and to condition the process input. All jumpers are typically of the three pin type and have two functions. All jumpers are either located on the Options Board or the Processor Board. Board layouts and jumper locations are shown in Appendix A-2 and A-3 (pages 64 and 65 or 66).

Check the actual jumper position in the instrument to be configured and verify the proper position for the intended application. If the current position is not correct, make changes.

**Start up Procedures 3.3**

Step by step procedures are provided in Tables 3-1 thru 3-4. These tables provide the display sequence, parameter adjustment and factory setting for each step.

The instrument is provided with a "time out" feature. If the instrument is in any mode and no keypad activity takes place for 30 seconds, the instrument will "time out" and exit the mode automatically. The instrument will display the code for the respective mode. If a mode code is displayed for 5 seconds with no activity it will then "time out" and proceed to either the Control or Off mode, depending upon which operational state the instrument was in last.

### 3.3.1 POWER UP PROCEDURE

A. Verify that all electrical connections have been properly made before applying power to the instrument.

*If the instrument is being configured for the first time, it may be desirable to disconnect the controller output connections as the instrument may go into the Control mode automatically following the power up sequence. Upon verification, power may be applied.*
B. Upon power up, "6XXX" will be displayed (X representing digits), then "XXX-", identifying the seven digit model number as defined in the order matrix. Next, the software revision level will be displayed in the format "rXX.XX". Then "1St1", "1St2", and "1St3" will be displayed while Test 1 thru 3 are executed automatically. Upon successful completion of these tests, "Ctrl" (for the Control mode) or "off" (for the Off mode) will be displayed for about three seconds. During this time the operator may select another mode prior to the instrument automatically going into the Control mode.

C. If any error messages are displayed, refer to Section 5.4, page 56 for a definition of these error messages and the required action.

D. If the instrument has been configured or operated previously, the mode that the instrument will go into upon power up, depends on what mode the instrument was in on power-down and how it has been programmed.

Front Panel Operation 3.4

3.4.1 DIGITAL DISPLAY AND STATUS LED's

The digital display provided has 4 digits and a decimal point. Each digit has seven segments and is capable of producing numeric characters from 0-9 and certain alpha characters. The digital display is used to provide indication of process variable as well as displaying codes used for configuration and operation of the instrument. The display includes the following Status Indicator LED's:

<table>
<thead>
<tr>
<th>Label</th>
<th>Color</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAN</td>
<td>Amber</td>
<td>Lights when the Manual StbY mode is on.</td>
</tr>
<tr>
<td>OUT1</td>
<td>Red</td>
<td>Lights when Output 1 is on.</td>
</tr>
<tr>
<td>OUT2</td>
<td>Amber</td>
<td>Lights when Output 2 is on.</td>
</tr>
<tr>
<td>ALRM</td>
<td>Red</td>
<td>Lights when either Alarm is on or active.</td>
</tr>
<tr>
<td>SEG 1</td>
<td>Red</td>
<td>Lights to indicate the profile section segment number that is active.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEG 6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAMP</td>
<td>Red</td>
<td>Lights during the Ramp section of any profile segment.</td>
</tr>
<tr>
<td>SOAK</td>
<td>Red</td>
<td>Lights during the Soak section of any profile segment.</td>
</tr>
<tr>
<td>SP</td>
<td>Green</td>
<td>Indicates that the value displayed is the setpoint.</td>
</tr>
<tr>
<td>C</td>
<td>Red</td>
<td>Lights to indicate that the process value is in terms of degrees C (Celcius)</td>
</tr>
<tr>
<td>F</td>
<td>Red</td>
<td>Lights to indicate that the process value is in terms of degrees F (Fahrenheit)</td>
</tr>
<tr>
<td>U</td>
<td>Red</td>
<td>Lights to indicate that the process value is in terms of engineering units.</td>
</tr>
<tr>
<td>-</td>
<td>Red</td>
<td>Lights to indicate a negative displayed value</td>
</tr>
</tbody>
</table>
3.4.2 KEYPAD CONTROLS

The keys on the keypad functions include:

SCROLL: Used to:
1. Display the enabled modes and programmed profiles.
2. While in a mode, used to sequence the parameter codes and values.
3. Exit some Test and Calibration functions.
4. Work in conjunction with other keys:
   a. With the UP key to display proportional output % when in the Control mode or while a profile is running.
   b. With the DOWN key:
      1) On power up to alter model #
      2) Enter Cal/Test functions
      3) While a profile is running to view the ramp/soak time remaining.

UP: Used to:
1. Exit a mode.
2. Turn a mode On in the Enable mode.
3. Increases a parameter numerical value.
4. View the setpoint.
5. Increase the setpoint value in the Control mode.
6. Work in conjunction with the other keys:
   a. With the SCROLL key to display proportional output %
   b. With the DOWN key:
      1) On power up to reset the instrument
      2) Lamp test
      3) Enter the Enable mode

DOWN: Used for:
1. Enter a mode.
2. Turn a mode Off in the Enable mode.
3. Decrease a parameter numerical value.
4. To start a profile when the profile number is displayed.
5. Decrease the setpoint value in the Control mode.
6. Step display through parameter codes in a mode.
7. Work in conjunction with the other keys:
   a. With the SCROLL key:
      1) On power up to alter the model number displayed.
      2) Enter Cal/Test functions
   b. With the UP key:
      1) On power up resets the instrument
      2) Lamp test
      3) Enter the Enable mode

RUN/HOLD: Used to:
1. To start the profile number being displayed.
2. Change between the profile Run and Hold profile conditions.
Operation Summary 3.5

The configuration and operating modes, the method of moving from one mode to another, and the basic parameter functions are described in each individual section. Data and parameter entry is made by stepping through each mode and making an appropriate response or entry to each step.

3.5.1 MODE SELECTION

If the instrument is in either the Off mode or Control mode, repeated depression of the Scroll key will cause the instrument to display the code corresponding to each mode which is enabled and each profile which has been entered. To enter a mode while its code is displayed, depress the Down key.

To exit the OFF mode, press the SCROLL key until Ctrl is displayed, then press the DOWN key.

Entry into any mode except the Control, Tune, Standby, Enable and Profile execution, will cause the instrument's outputs to turn off. Access to the Tune mode is provided while the instrument continues normal operation if in Control or running a Profile.

3.5.2 CONFIGURATION DISPLAYS

During configuration, the display is used to show the parameter codes and values. During normal operation, these displays are used to indicate process values, setpoints, etc.

TABLE 3-1 PROGRAM MODE CONFIGURATION PROCEDURE

Press and release the SCROLL key until Prog is displayed. Press the DOWN key to enter the Program mode. Press the SCROLL key to advance the display through the parameter codes and their values. Use the Up and DOWN keys to adjust the values. After adjusting a parameter, press the SCROLL key to proceed to the next parameter. Each time the DOWN key is pressed while a parameter code is being displayed, such as dFF, the next parameter code in the sequence will be displayed.

After all selections have been made, to exit the mode, press the UP key with a parameter in the display (not a setting).

For illustration purposes, all available Program mode parameters have been listed. The parameters that will appear on the specific instrument will depend upon the model number (hardware configuration) of the instrument and on the parameter selections previously made.

For future reference, record the parameter selections for the application in the “Your Setting” column and on the Software Reference Sheet in Appendix E (page 75).

To prevent unauthorized changes to the Program mode, the mode can be disabled (turn off) in the Enable mode.

(Continued on next page)
<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
</table>
| 1    | Input Selection           | InPS         | 0=J T/C degrees C  
1=J T/C degrees F  
2=K T/C degrees C  
3=K T/C degrees F  
4=T T/C degrees C  
5=T T/C degrees F  
6=R T/C degrees C  
7=R T/C degrees F  
8=S T/C degrees C  
9=S T/C degrees F  
10=E T/C degrees C  
11=E T/C degrees F  
12=B T/C degrees C  
13=B T/C degrees F  
14=N T/C degrees C  
15=N T/C degrees F  
16=C T/C degrees C  
17=C T/C degrees F  
20=RTD degrees C  
21=RTD degrees F  
30=0 to 5VDC/0 to 20mA  
31=1 to 5VDC/4 to 20mA  
32=0 to 50mVDC  
33=10 to 50mVDC  
34=0 to 25mVDC | 1               |              |
| 2    | Input Correction          | ICor         | -300 to 300 degrees                  | 0               |              |
| 3    | Output 1                  | out1         | 1=On-Off - Direct (cooling)  
2=On-Off - Reverse (heating)  
3=Time Proportioning - Direct (cooling)  
4=Time Proportioning - Reverse (heating)  
5=Current Proportioning - Direct (cooling)  
6=Current Proportioning - Reverse (heating)  
7=Position Proportioning - Open | 2               |              |
| 4    | Output 1 Percent Limit    | a1PL         | 0 to 100%                            | 100             |              |
| 5    | Output 2                  | out2         | 0=None  
(Position Prop. Direct - Close)  
1=On-Off Direct (cooling)  
2=On-Off - Reverse (heating)  
3=Time Proportioning - Direct (cooling)  
4=Time Proportioning - Reverse (heating)  
5=Current Proportioning - Direct (cooling)  
6=Current Proportioning - Reverse (heating)  
7=Position Proportioning Reverse - Close | 0               |              |
<p>| 6    | Output 2 Percent Limit    | a2PL         | 0 to 100%                            | 100             |              |</p>
<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
</table>
| 7    | Output 3            | out3         | 0=None
1=Process Alarm - Direct
2=Process Alarm - Reverse
3=Deviation Alarm - Direct
4=Deviation Alarm - Reverse
5=Deviation Band Alarm - Open within band
6=Deviation Band Alarm - Closed within band |                | 0            |
| 8    | Relay A Assignment  | rLyA         | 0=Not Assigned
1=Assigned to Output 1
2=Assigned to Output 2
3=Assigned to Output 3
4=Assigned to Event 1
5=Assigned to Event 2
6=Assigned to Event 3 | 1              | 1            |
| 9    | Relay B Assignment  | rLyb         | Same selection as Relay A                                                          | 2              | 2            |
| 10   | Relay C Assignment  | rLyC         | Same selection as Relay A                                                          | 3              | 3            |
| 11   | Display Select      | dISP         | 1=Process Value
2=Process Value & Setpoint
3=Process Value Deviation
4=Process Value Deviation & Setpoint
5=Setpoint | 1              | 1            |
| 12   | Decimal Position    | dPoS         | 0 or 1 decimal place                                                               | 0              | 0            |
|      | (dPoS can be 2, 3, & 4 if Eeu is selected) |              |                                                                                   |                |              |
| 13   | Engineering Units   | Euu          | -9999 to 9999 units                                                               |                | 1000         |
|      | Upper Value         |              |                                                                                   |                |              |
| 14   | Engineering Units   | EuL          | -9999 to 9999 units                                                               | 0              |              |
|      | Lower Value         |              |                                                                                   |                |              |
| 15   | Hysteresis          | HySt         | 0 to 300 degrees
(width of hysteresis band, see Page 68) | 3              |              |
| 16   | Setpoint Upper Limit| SPL          | -9999 to 9999 degrees
(SPuL - EO option) |                | 1400          |
| 17   | Setpoint Lower Limit| SPLL         | -9999 to 9999 degrees
(EO Option) |                | 0            |
| 18   | Automatic Transfer  | AtFr         | 0=No automatic transfer
1=Transfer when temperature goes below setpoint
2=Transfer when temperature goes above setpoint | 0              | 0            |

**NOTE:**
When changing the Decimal position dPoS, the operator MUST ensure that all values previously programmed or tuned are now valid with the entry of a decimal point.
<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
</table>
| 19   | Profile Time Base         | Ptb          | 1=HHH.T - Hours & Tenths  
2=HH/MM - Hours & Min.  
3=MM SS - Minutes & Sec.  
EO Option  
4=XXX X-Units per hour ramp rate  
5=XXX X-Units per ramp rate  
6=XXX X-Units per minute ramp rate | 3              |              |
| 20   | Profile Interrupt Action  | PIA          | 0=Go to Off mode  
1=Continue profile  
2=Go into hold condition  
3=Restart at the beginning of the profile | 1              |              |
| 21   | Remote Run/Hold           | rrH          | 0=Not selected  
1=Selected. Remote Run/Hold will override controller front panel when placed in hold from remote source  
2=Selected. Remote Run/Hold will not override controller front panel when placed in hold from remote source | 0              |              |
| 22   | Process Filter Factor     | PFF          | 1 to 20 (# of scans aver.)  
1=No filtering | 1              |              |
| 23   | Display Filter Factor     | dFF          | 1 to 20 (# of scans aver.)  
1=No filtering | 1              |              |

**Parameters 24 - 28 are for Extended Option (EO) Only**

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
</table>
| 24   | Current Output 1 Range    | Co1r         | 0=0 to 20 mA  
1=4 to 20 mA | 1              |              |
| 25   | Current Output 2 Range    | Co2r         | 0=0 to 20 mA  
1=4 to 20mA | 1              |              |
| 26   | Process Output            | Pout         | 0=Not selected  
1=Process Assigned to Current Output 1  
2=Process Assigned to Current Output 2  
3=Setpoint Assigned to Current Output 1  
4=Setpoint Assigned to Current Output 2 | 0              |              |
<p>| 27   | Process/Setpoint Output Upper Value | Pou          | 9999 to 9999 | 2000           |              |
| 28   | Process/Setpoint Output Lower Value | PoL          | 9999 to 9999 | 0              |              |</p>
<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Communications Configuration</td>
<td>CCon</td>
<td>0=Off</td>
<td></td>
<td>0, 4*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1=Monitor only (read only)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2=Normal mode (read and write)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3=Total Access with Limit Checking</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4=Total Access without Limit Checking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Communication Bit Rate Select</td>
<td>CbS</td>
<td>1=300 bits per second (bps)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2=600 bps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3=1200 bps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4=2400 bps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5=4800 bps</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6=9600 bps</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Communication Address</td>
<td>CAd</td>
<td>0 to 99</td>
<td></td>
<td>0, 1*</td>
</tr>
</tbody>
</table>

*Factory setting for Total Access
TABLE 3-2 TUNE MODE CONFIGURATION PROCEDURE
The Tune mode allows the entry, review or altering of the process control Tune adjustments and the alarm setting.

To enter the Tune mode, press and release the SCROLL key until tune is displayed, then press the DOWN key. Press the SCROLL key to advance the display through the parameters and their values. Use the UP and DOWN keys to select (adjust) the values. Each time the DOWN key is pressed while a parameter code is being displayed, such as dFF, the next parameter code in the sequence will be displayed.

After selecting a parameter, to exit the mode, press the SCROLL key to proceed to the next parameter. After all selections have been made, press the UP key with a parameter in the display (not a setting).

For illustration purposes, all available Tune mode parameters have been listed. The parameters that will appear on the specific instrument will depend upon the parameter selection previously made in the Program mode.

For future reference, record the parameter selections for the application in the "Your Setting" column and on the Software Reference Sheet in Appendix E (page 75).

To prevent unauthorized changes to the Tune mode, the mode can be disabled (turned off) in the Enable mode.

*The Tune mode is adjusted on-line. The instrument will react to changes as they are made.*

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Second Output Position</td>
<td>SPrd</td>
<td>-1000 to 1000 units</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Process Alarm</td>
<td>PAL</td>
<td>-9999 to 9999 units*</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Deviation Alarm</td>
<td>dAL</td>
<td>-3000 to 3000 units*</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Deviation Band Alarm</td>
<td>dbAL</td>
<td>1 to 3000 units*</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1st Output Proportional Band Width</td>
<td>Pb1</td>
<td>1 to 3000 units</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>2nd Output Proportional Band Width</td>
<td>Pb2</td>
<td>1 to 3000 units</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Manual Reset</td>
<td>rSEt</td>
<td>-1500 to 1500 units</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Automatic Reset (integral)</td>
<td>ArSt</td>
<td>0.0 to 100.0 repeats per minute</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9</td>
<td>Rate (or Derivative)</td>
<td>rAIE</td>
<td>0.0 to 10.0 minutes</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cycle Time Output 1</td>
<td>Ct1</td>
<td>1 to 240 seconds</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Cycle Time Output 2</td>
<td>Ct2</td>
<td>1 to 240 seconds</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Position Proportioning Sensitivity</td>
<td>SEnS</td>
<td>0.0 to 50.0%</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>First Output Position</td>
<td>FoP</td>
<td>-1000 to 1000 units</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

* See Section 4 2, page 44 for explanation of setting alarms.
TUNE MODE FLOW CHART

Key:

- Actual Display
- On/Off Display - Use arrow keys to turn on or off
- Scroll Key
- Numeric Display - Use arrow keys to change value
- Up Arrow Key
- Down Arrow
TABLE 3-3 PROFILE ENTRY MODE CONFIGURATION PROCEDURE
Depress and release the SCROLL key until PEn is displayed. Use the DOWN key to enter the Profile Entry mode. Depress the SCROLL key to scroll through the parameters and their values. Use the UP and DOWN keys to adjust the values. After adjusting a parameter, depress the SCROLL key to proceed to the next parameter. After all selections have been made, to exit the mode, depress the UP key with a parameter in the display (not a setting). For assistance in developing the Profile refer to Appendix F (page 78).

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profile Number</td>
<td>Pn</td>
<td>1 to 8</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>2</td>
<td>Number of Segments</td>
<td>nS</td>
<td>0-6 segments</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>Steps 3-11 are repeated for each segment</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ramp Time</td>
<td>rt</td>
<td>0 to 9999 units per Ptb</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ramp Rate</td>
<td>rr</td>
<td>0 to 9999 units per Ptb</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Setpoint</td>
<td>SP</td>
<td>Setpoint at end of Ramp</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Event Output 1</td>
<td>E1</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>7</td>
<td>Event Output 2</td>
<td>E2</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>8</td>
<td>Event Output 3</td>
<td>E3</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>9</td>
<td>Soak Time</td>
<td>St</td>
<td>0 to 9999 units per Ptb</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Event Output 1</td>
<td>E1</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td>11</td>
<td>Event Output 2</td>
<td>E2</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
<tr>
<td></td>
<td>Event Output 3</td>
<td>E3</td>
<td>on or off</td>
<td></td>
<td>**</td>
</tr>
</tbody>
</table>

* Will be displayed instead of Ramp Time rt if Ramp Rate is utilized (see Ptb, EO Option only, page 29).

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Profile Loop Count</td>
<td>PLCt</td>
<td>0 to 9999, 0-continuous</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Deviation Hold after Ramp Up</td>
<td>dhru</td>
<td>0 to 3000 units 0=no auto hold</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Deviation Hold after Ramp Down</td>
<td>dhrd</td>
<td>0 to 3000 units 0=no auto hold</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Profile End control</td>
<td>PEnd</td>
<td>-1=Hold at last setpoint 0=Abort - all outputs off or at 0% Events off 1=Transfer to profile 1 2=Transfer to profile 2 3=Transfer to profile 3 4=Transfer to profile 4 5=Transfer to profile 5 6=Transfer to profile 6 7=Transfer to profile 7 8=Transfer to profile 8</td>
<td>**</td>
<td></td>
</tr>
</tbody>
</table>

After selecting the Profile End Control parameter value, press the SCROLL key to advance the display to Pn. Press the UP key with Pn or any parameter code displayed to exit the Profile Entry Mode. (Continued on next page)
**All values except Profile Loop Count (PLct) are initialized to zero and all event outputs are initialized to OFF, with the exception of the first profile. Profile Loop Count (PLct) is set to 1.**

The first profile has the number of segments initialized to zero, to turn the profile OFF, but the profile has values stored in it for demonstration purposes. By setting the number of segments to two, the profile can be reviewed and/or executed.

**PROFILE 1 VALUES FOR DEMONSTRATION PURPOSES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>rt</td>
<td>.10</td>
</tr>
<tr>
<td>SP</td>
<td>100</td>
</tr>
<tr>
<td>E1</td>
<td>on</td>
</tr>
<tr>
<td>E2</td>
<td>oFF</td>
</tr>
<tr>
<td>E3</td>
<td>oFF</td>
</tr>
<tr>
<td>St</td>
<td>.10</td>
</tr>
<tr>
<td>E1</td>
<td>oFF</td>
</tr>
<tr>
<td>E2</td>
<td>on</td>
</tr>
<tr>
<td>E3</td>
<td>oFF</td>
</tr>
<tr>
<td>rt</td>
<td>.10</td>
</tr>
<tr>
<td>SP</td>
<td>0</td>
</tr>
<tr>
<td>E1</td>
<td>oFF</td>
</tr>
<tr>
<td>E2</td>
<td>oFF</td>
</tr>
<tr>
<td>E3</td>
<td>on</td>
</tr>
<tr>
<td>St</td>
<td>.10</td>
</tr>
<tr>
<td>E1</td>
<td>oFF</td>
</tr>
<tr>
<td>E2</td>
<td>oFF</td>
</tr>
<tr>
<td>E3</td>
<td>oFF</td>
</tr>
<tr>
<td>PLct</td>
<td>1</td>
</tr>
<tr>
<td>dhru</td>
<td>0</td>
</tr>
<tr>
<td>dhrd</td>
<td>0</td>
</tr>
<tr>
<td>PEnd</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE 3-4 ENABLE MODE CONFIGURATION PROCEDURE**

To enter the Enable mode, press and hold the UP and DOWN keys while in CtrL or oFF modes. All the display lamps will light. After 10 seconds, the lamps will go out and EnAb will be displayed. Release the keys and the display will change to ESt. Press and release the DOWN key and each mode to be enabled/disabled will be displayed. With the Enable mode prompt for the desired mode displayed, press the SCROLL key to verify that the displayed mode is either on (enabled) or oFF (disabled). Press the DOWN key to turn off the mode, press the UP key to turn on the mode or press the SCROLL key to advance the display to the next Enable mode prompt. Use the "Your Setting" column in the table to record your programming.

A Hardware jumper located on the Controller Board (See Appendix A-2, page 64) can be used to lock/unlock the Enable mode. When the jumper is moved to the locked position, entry into the Enable mode is not possible until the jumper is moved to the unlock position.

<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>AVAILABLE SETTINGS</th>
<th>FACTORY SETTING</th>
<th>YOUR SETTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Test Mode</td>
<td>ESt</td>
<td>on or oFF</td>
<td>oFF</td>
<td>oFF</td>
</tr>
<tr>
<td>2</td>
<td>Calibration Mode</td>
<td>ECAL</td>
<td>on or oFF</td>
<td>oFF</td>
<td>oFF</td>
</tr>
<tr>
<td>STEP</td>
<td>DESCRIPTION</td>
<td>DISPLAY CODE</td>
<td>AVAILABLE SETTINGS</td>
<td>FACTORY SETTING</td>
<td>YOUR SETTING</td>
</tr>
<tr>
<td>------</td>
<td>----------------------</td>
<td>--------------</td>
<td>--------------------</td>
<td>-----------------</td>
<td>--------------</td>
</tr>
<tr>
<td>3</td>
<td>Program Mode</td>
<td>EPro</td>
<td>on or off</td>
<td>on</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Tune Mode</td>
<td>Etun</td>
<td>on or off</td>
<td>on</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Manual (Stby) Mode</td>
<td>ESby</td>
<td>on or off</td>
<td>on</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Profile Continue Mode</td>
<td>EPC</td>
<td>on or off</td>
<td>on/off</td>
<td>off</td>
</tr>
<tr>
<td>7</td>
<td>Profile Entry Mode</td>
<td>EPE</td>
<td>on or off</td>
<td>on</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Setpoint Change</td>
<td>ESPC</td>
<td>on or off</td>
<td>on</td>
<td></td>
</tr>
</tbody>
</table>

**ENABLE MODE FLOW CHART**

**Key**
- Actual Display
- On/Off Display - Use arrow keys to turn on or off
- Scroll Key
- Numeric Display - Use arrow keys to change value
- Up Arrow Key
- Down Arrow
Operation 4.1

4.1.1 OFF MODE
In the Off Mode, the instrument control, process retransmission signal(s) and alarm function(s) are turned off. The Off mode can be entered by pressing and releasing the SCROLL key until the display reads OFF, then pressing the DOWN key. The display will read OFF and then the current process variable at two second intervals. This sequence will repeat to indicate that the instrument is in the Off mode.

4.1.2 CONTROL MODE
In the Control mode, the instrument control function(s) and alarm(s) are actively responding to the process variable as selected in the Program and Tune modes. The control mode allows setpoint changes from local setpoint (standard) adjustment by an operator at the front keypad. Other operations in the Control mode include a lamp test and proportional output % display.

4.1.2.1 DIRECT/REVERSE OPERATION OF OUTPUTS
Direct operation is typically used with cooling applications. On-Off direct output(s) will turn on when the process variable exceeds setpoint. Proportional direct output(s) will increase the percentage of output as the process value increases within the proportional band.

Reverse operation is typically used with heating applications. On-Off reverse output(s) will turn off when the process variable exceeds setpoint. Proportional reverse output(s) will decrease the percentage of output as the process value increases within the proportional band.

4.1.2.2 LOCAL SETPOINT OPERATION
The instrument must be in the Control mode to allow the setpoint value to be adjusted. In the Control mode, to view the setpoint, press and release the UP or DOWN key. The green LED under the SP label will light to indicate that the displayed value is the setpoint. To change the setpoint value, press and hold the appropriate key. Press and hold the UP key to increase the setpoint or press and hold the DOWN key to decrease the setpoint. The setpoint will change slowly at first then faster as the key is held pressed. If the setpoint will not increase, check the Program mode (page 25) to see that you are not trying to increase the setpoint above the setpoint limit SPL. Check that the Setpoint Change mode is on in the Enable mode.

4.1.2.3 PROFILE OPERATION
To start a profile, press and release the SCROLL key to sequence the display to the profile number display code P1, P2, etc. With the desired profile number displayed, press either the DOWN or the RUN/HOLD to start the profile. Run will be displayed for about 2 seconds to indicated that the profile is starting. The status lamps will indicate which segment is active and if the profile is in the ramp or soak portion of the segment.

To stop a profile that is running, press the RUN/HOLD key. The display will show hold for about 2 seconds, then the process value for about 2 seconds and then continue to display this sequence. The profile timer will stop but the control, alarm, and event outputs will remain active. The profile can be restarted by pressing the RUN/HOLD key. To exit the profile, go to hold and then press and release the SCROLL key until the display shows OFF or Ctrl, then press the DOWN key. Pressing the DOWN key with OFF displayed will cause the control, alarm, and events to be turned off. (Pressing the DOWN key with Ctrl displayed will leave the events as they were, and the control and alarm outputs will remain active). The setpoint will be the last setpoint seen in the profile.

While a profile is running, it is possible to display additional profile status information. To activate the Profile Execution Status Display sequence, hold the DOWN key and press the SCROLL key. This will cause the display to sequence through the following series of display codes and values:

...
<table>
<thead>
<tr>
<th>Display Code</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pn</td>
<td>Profile Number</td>
<td>Actual Profile Number</td>
</tr>
<tr>
<td>tr</td>
<td>Time remaining in current Ramp or Soak</td>
<td>Actual time remaining value (in whatever units were configured in the program mode for Ptb)</td>
</tr>
<tr>
<td>E1, E2, E3</td>
<td>Event 1-3 status (if applicable)</td>
<td>on or off</td>
</tr>
<tr>
<td>SP</td>
<td>Current Setpoint</td>
<td>Actual Setpoint Value</td>
</tr>
<tr>
<td>Proc</td>
<td>Current Process Value</td>
<td>Actual Process Value</td>
</tr>
<tr>
<td>PLCl</td>
<td>Profile Loop Count remaining</td>
<td>Profile Loop count Value</td>
</tr>
</tbody>
</table>

Each code or value will only be displayed if they are appropriate. Each code or value will be displayed for one second. This sequence will continue until any key is depressed.

To start a profile running at some point within the profile other than start can be accomplished by using the Profile Continue mode. Press and release the SCROLL key until display is PCon, then press the DOWN key. The display will be Pn; adjust the profile parameter values as needed in the Profile Continue Configuration mode, then press the RUN key. The instrument will execute the profile selected as directed by the information entered in the Profile Continue mode. See Table 4-1, page 40. If you are running a profile and it is desired to alter the profile you must go to hold and then scroll to the Off or Control mode before entering Pcon.

Note: Pcon is not available when Profile Time Base (Ptb) in Program mode has been set for Units Ramp Rate (EO Option).

**PROFILE CONTINUE MODE FLOW CHART**

![Flow Chart Diagram]

**Key**

- Actual Display
- On/Off Display - Use arrow keys to turn on or off
- Scroll Key
- Numeric Display - Use arrow keys to change value
- Up Arrow Key
- Down Arrow
<table>
<thead>
<tr>
<th>STEP</th>
<th>DESCRIPTION</th>
<th>DISPLAY CODE</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Profile Number</td>
<td>Pn</td>
<td>Press the SCROLL key to see the number of the last active profile.</td>
</tr>
<tr>
<td>2</td>
<td>Profile Number Value</td>
<td>X</td>
<td>If necessary, use the UP or DOWN key to change the profile number to the desired value, then press the SCROLL key.</td>
</tr>
<tr>
<td>3</td>
<td>Segment Number</td>
<td>Sn</td>
<td>Press the SCROLL key to see the number of the last active segment.</td>
</tr>
<tr>
<td>4</td>
<td>Segment Number Value</td>
<td>X</td>
<td>If necessary, use the Up or Down key to change the segment number to the desired value, then press the SCROLL key. DO NOT SET THIS VALUE TO 0 AND ATTEMPT TO RUN THE PROFILE. AN ERROR 19 WILL DISPLAY AND THE PROFILE WILL NOT RUN.</td>
</tr>
<tr>
<td>5</td>
<td>Ramp Time Remaining</td>
<td>rtr</td>
<td>Press the SCROLL key to see the Ramp Time Remaining value.</td>
</tr>
<tr>
<td>6</td>
<td>Ramp Time Remaining</td>
<td>X</td>
<td>If necessary, use the UP or DOWN key to adjust the Ramp Time Remaining value, then press the SCROLL key. If the time remaining is set to 0 when the SCROLL key is pressed, the Soak Time Remaining code will be displayed. If the time remaining is greater than 0, then the display will advance to the Profile Loop Count code.</td>
</tr>
<tr>
<td>7</td>
<td>Soak Time Remaining</td>
<td>Str</td>
<td>Press the SCROLL key to see the Soak Time Remaining value of the last active profile.</td>
</tr>
<tr>
<td>8</td>
<td>Soak Time Remaining</td>
<td>X</td>
<td>If necessary, use the UP or DOWN key to adjust the Soak Time Remaining value, then press the SCROLL key.</td>
</tr>
<tr>
<td>9</td>
<td>Event(s)</td>
<td>E1-E3</td>
<td>If any event outputs have been selected in the Program mode then each event number selected will be displayed in sequence. Press the SCROLL key to see the status of the event(s).</td>
</tr>
<tr>
<td>10</td>
<td>Event(s) Status</td>
<td>on/off</td>
<td>If necessary, use the UP key to turn on an event that is off or the DOWN key to turn off an event that is on. Press the SCROLL key to see the next event number. After the last event status is selected, pressing the SCROLL key will advance the display to be PLCt.</td>
</tr>
</tbody>
</table>
11  Profile Loop Count Remaining  PLCt  Press the SCROLL key to see the Profile Loop Count Remaining for the last active profile.

12  Profile Loop Remaining  X  If necessary, use the UP and DOWN key to adjust the Profile Loop Count Remaining value.

To start a profile running, press the RUN/HOLD key while in the Profile Continue mode. If no changes were made to any of the Profile Continue parameters, press the RUN/HOLD key twice. The profile selected will start at the point selected.

4.1.2.4 ON-OFF CONTROL
On-Off control can only be implemented on controllers provided with SPST relay or SSR driver output(s). On-Off operation can be assigned to either or both output 1 and 2. The On-Off control can be selected as direct or reverse acting. Direct action is typically used in cooling applications. The output device will turn on when the process value is greater than the setpoint. Reverse action is typically a heating application. The output device will turn on if the process value is below the setpoint. A hysteresis adjustment is provided for On-Off outputs. This adjustment is in terms of degrees/engineering units and defines the width of the hysteresis bandwidth about the setpoint. This parameter may also be referred to as a dead band. Relay chatter can be eliminated by proper adjustment of this parameter. When operating in On-Off control, the control algorithm will turn the output on or off depending upon the setpoint, the relative position of the process value, and the hysteresis adjustment. The respective OUT1 or OUT2 indicator will illuminate to indicate that the output device is on. The hysteresis will also affect the operation of the alarm output if used.

4.1.2.5 TIME PROPORTIONING CONTROL
Time Proportioning Control can be implemented on controllers provided with SPST relay or SSR driver output(s). Time proportioning can be programmed for output 1 and/or 2. Time Proportioning control is accomplished by cycling the output on and off when the process value is within the proportional bandwidth selected at a prescribed time period. The time period is selected in the Tune mode by adjusting Ct1 and/or Ct2. The on time is a percentage of the Cycle Time.

Example:  Calculated output % = 40%;  Cycle Time adjustment = 20 seconds
Output on time = .4 x 20 = 8 seconds
Output off time = .6 x 20 = 12 seconds

4.1.2.6 CURRENT PROPORTIONING CONTROL
Current Proportioning control provides a proportional current output in response to process value and setpoint. The current output can be selected for direct or reverse operation. Direct current output control is typically used for cooling applications. The current output will increase as the process value increases within the proportional bandwidth selected. The reverse current output control is typically used in heating applications. The current output will decrease as the process value increases within the proportional bandwidth selected.

The instrument can be programmed to provide 0 to 20mA or 4 to 20mA (if EO option is present) current output(s). The output selected is dependent upon the final control element being used in the process. The output 1 and/or output 2 LED will be lighted whenever the Current Proportional outputs are selected.
4.1.2.7 POSITION PROPORTIONING CONTROL

Position Proportioning control can be implemented on those controllers provided with two SPST relay outputs or two SSR Driver outputs and Slidewire Feedback option.

Positioning proportioning control permits the use of PID control where the final control element is a modulating device such as a motorized valve. In this form, each of the two required relays or SSR Drivers will be used to control the valve. One output is used to open the valve, the other is used to close the valve. The slidewire feedback is used to provide a signal relative to the valve armature position to the instrument.

As with the other proportioning control forms, the process input, tuning parameters and the setpoint are used by the control algorithm to calculate the output % required to correct for the deviation between setpoint and process.

With Position Proportioning control, it may be necessary to adjust the Sensitivity (SEnS) Tune mode parameter to reduce or eliminate oscillations of the motor around setpoint. If oscillation occurs, increase the SEnS value until the motor stops oscillating. If the differential between the Open and Closed rotation is too large, then decrease the SEnS value. Also, for proper Position Proportioning operation, it is necessary to specify the actuation time of the valve or damper from full open to full closed. If the motor has a stroke duration of 60 seconds, change the value in the Cycle Time parameter C11 to 60. This ensures that the controller will move the motor for the proper amount of time when making adjustments.

4.1.2.8 DUAL OUTPUT CONTROL

Dual output control can be performed when two outputs are specified. The outputs may be programmed for On-Off, Time Proportioning, or Current Proportioning, as applicable.

The output action is dependent upon the setpoint, the process value, and Tune mode parameters. If two proportional outputs are selected, both output proportional bands will be biased so that 0% of output is seen when the process value equals setpoint. The output(s) can be biased by the use of the Tune mode parameters FOP and SPrd as shown in Figure 4-1 (below).

The first output is programmed as a proportional reverse output and the second as a proportional direct output. (See Glossary, page 67, for definitions of these terms). Dual proportioning outputs are provided with separate proportional bands and cycle time adjustments for each output.

![Figure 4-1 Diagram](Image)
4.1.2.9 PROPORTIONAL OUTPUT PERCENTAGE DISPLAY
While in the Control mode, press and hold the UP key and then press the SCROLL key to cause the display to sequence through a series of display codes and values:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Po1</td>
<td>Percent Output 1 (if applicable)</td>
</tr>
<tr>
<td>Po2</td>
<td>Percent Output 2 (if applicable)</td>
</tr>
<tr>
<td>Proc</td>
<td>Process Value</td>
</tr>
</tbody>
</table>

Output 1% value
Output 2% value
Actual Process Value

Each code and output value will be displayed only if the corresponding proportional output is present. Each code or value will be displayed for 1 second. This sequence of displays will continue until the SCROLL key is pressed, which will then return the display to the normal mode.

4.1.3 MANUAL MODE FOR PROPORTIONAL OUTPUTS

Manual adjustments of the proportional output(s) can be used to test the operation of the output(s), while tuning to establish basic process control, or to provide control of the proportional output(s) during the occurrence of certain error conditions.

*Note:* The proportional output(s) do not change automatically in response to changes in the process while in the Manual mode. Be sure to pay close attention to the process to avoid damage.

To enter the Manual mode, press and release the SCROLL key until you see Stby. Then press the DOWN key. The Manual mode status LED will light to indicate that the Manual mode is in use. Shifting from the Control to the Manual mode is bumpless. The proportional output(s) will stay at the last value(s) calculated by the control algorithm. Po1 will appear on the display if output 1 is a proportional output or Po2 if output 1 is not a proportional control. If no keys are pressed, the display will sequence through the following displays:

- Po1 if output 1 is 3, 4, 5, 6, 7 then the output 1 percentage of output value
- Po2 if output 2 is 3, 4, 5, 6 then the output 2 percentage of output value.
- Proc will be displayed, then the current process value.

In order to vary a proportional output percentage value, press and release the SCROLL key until the display code for the output is displayed Po1 or Po2. Press and release the SCROLL key again to see the percentage of output value. Press the UP key to increase the output percentage value. Press the DOWN key to decrease the output percentage value.

To return to the Control mode of operation from the Manual mode, press the SCROLL key until you see Po1 or Po2 then press the UP key. The display will change to Stby. Press the SCROLL key until you see the mode you wish to enter, then press the DOWN key. If the Automatic Transfer feature is selected in the Program mode, the instrument will switch from Manual mode to the Control mode when process value reaches the setpoint value.

4.1.4 PROCESS RE-TRANSMISSION OUTPUT - EO OPTION ONLY

If the instrument is provided with a current output not used for process control, this output may be assigned to provide a linear re-transmission of the process value. This output can be used to provide a process signal to remotely installed recorders, panel meters, or dataloggers. The process output is scaled for the application by using the Program mode parameters process/setpoint value upper Poul and process/setpoint value lower P0L. The current output resolution is @200 steps, so for the best re-transmission accuracy, the span between Poul and P0L should be as small as possible. If a current output is used for re-transmission, the corresponding control output, out1 or out2, cannot be assigned to it.

Upon an error condition, Process Value output will be set to 0 percent if the 1st output control is direct acting. If the control action is reverse acting, the Process Value output will be set to 100 percent.
4.1.5 SETPOINT RE-TRANSMISSION OUTPUT - EO OPTION ONLY
If the instrument is provided with a current output not used for process control, this output
may be assigned to provide a linear re-transmission of the setpoint value. The setpoint
output is scaled for the application by using the Program mode parameters process/setpoint
output value upper Pou and process/setpoint output value lower Pol. The current output
resolution is @ 200 steps, so for the best re-transmission accuracy, the span between Pou
and Pol should be as small as possible. If a current output is used for re-transmission, the
corresponding control output, out1 or out2, cannot be assigned to it.

Alarm Operation 4.2
The type of alarm is selected in the Program mode as follows:

1. Process Alarm Direct - the alarm will be on if the process value is greater than the process
   value selected.

2. Process Alarm Reverse - the alarm will be on if the process value is less than the process
   value selected.

3. Deviation Alarm Direct - the alarm will be on if the process value is greater than the
   setpoint plus the deviation value selected.

4. Deviation Alarm Reverse - the alarm will be on if the process value is less than the
   setpoint plus the deviation value selected.

5. Deviation Band Alarm Open Within - the alarm will be on if the process value is greater
   than one half the deviation band alarm values selected above or below the setpoint.

6. Deviation Band Alarm Closed Within - the alarm will be on if the process value is less than
   one half the deviation band value selected above or below the setpoint.

The alarm will be active while the instrument is in the Control mode or while the profile is
running. Relay and solid state relay drivers can be assigned to provide output capability to
the alarm function.

The alarm value (Process, deviation or bandwidth) is selected in the Tune mode.

Alarm output chatter can be reduced by using the hysteresis parameter in the Program mode
to create a deadband around the alarm point.

Tune Mode Operation 4.3
Proportional output control may require the adjustment (tuning) of the PID and other related
parameters. This provides a means for the instrument's control algorithm to be adjusted to
meet specific application requirements.

4.3.1 SYSTEMATIC TUNING METHOD
1. Changes in tuning parameters should be made one at a time.

2. After making any changes in tuning parameters, a disturbance should be introduced into
   the process so that the process reaction may be observed. This process reaction, or
   recovery, will tell whether the tuning parameters provide the desired control. It is usually
   easiest to make a step change in setpoint to introduce this disturbance.
3. The change in setpoint, or disturbance, referenced above should be large enough to cause an observable deviation of process from setpoint. However, this change should not be so large that it will cause the controller output to proceed to either extreme limit.

4. Controller tuning for optimal control is not hard and fast, BE PATIENT. The process will take a certain amount of time to react to the setpoint changes during tuning. The amount of time depends upon the specific process, however, a period of 8 to 12 minutes should be allowed between changes. The important point to remember is to allow the process to react completely, do not rush through tuning of the controller. If the complete process reaction is not observed, optimum control may never be achieved.

5. Time Proportioning control output(s) require(s) the cycle time to be adjusted for the application. Short cycle times typically result in the most accurate process control, but will cause the quickest wear out of any mechanical components.

6. Leave all other tuning parameters (except for the alarm settings, if used) at the factory default settings. Obtain the best possible process reaction by adjusting the Proportional Bandwidth parameter. The setting that achieves the best response for the process should be left in the controller programming, and should be noted on the Software Reference Sheet in Appendix E (page 75).

7. If there are to be no setpoint or load changes in the process, the Proportional Band adjustment may be all that is necessary for proper control. If an offset still exists (the process does not settle out at setpoint with the best possible proportional band adjustment) Manual Reset may be added to eliminate this offset.

8. Auto Reset may be added to eliminate offsets and improve response to setpoint and load changes. Increase Auto Reset from 0 in 0.2 increments. Start with a small amount. Increase this increment if there is no apparent reaction. Remember to allow the process 8 to 12 minutes to react.

9. If necessary, Rate may be added. Rate is a dynamic tuning parameter. Rate may be required to compensate for process lags or to help inhibit reset windup when a large amount of Auto Reset (4 or 5 repeats per minute) is being used.

10. Controller tuning is not hard and fast. It may be necessary to adjust the tuning parameters over a period of time to obtain optimal control of the process.

4.3.2 ZIEGLER NICHOLS TUNING METHOD
This procedure has been determined empirically to yield 1/4 amplitude decay tuning parameters that are determined by watching the system in a sustained oscillation (curve C, page 46) the ultimate proportional band and ultimate time period) and then using these values from this sustained oscillation to calculate ideal parameters.

Determining Ultimate Proportional Band and Ultimate Time Period

1. Set Manual Reset rSet to 0.0, set ArSt to 0.0 and set rAtIE to 0.0

2. Enter the Control mode of operation, observe the process reaction.

3. Set the Proportional Band (PB) at 100 and upset the process and observe the response. One easy method for imposing the upset is to move the setpoint for a few seconds and then return it to its original value.

(Continued on next page)
4. Achieve a response curve similar to the sustained oscillation (curve C), this is the Ultimate Proportional Band (UPB) and Ultimate Time Period (UTP).

   a) If the response curve from step 3 does not damp out, as in Curve A from the drawing, the PB is too low. The PB should be increased and step 3 repeated.

   b) If the response in step 3 damps out, the PB is too high. The PB should be decreased and step 3 repeated.

These values obtained for Ultimate Proportional Band (UPB) and Ultimate Time Period (UTP) are used to calculate ideal P, PI, PD, PID tuning parameters using the following Ziegler-Nichols equations:

Proportional only control (P) -

\[ P(P_b) = 2 \times \text{UPB (degrees or units)} \]

Proportional plus automatic reset (PI) -

\[ P(P_b) = 2.2 \times \text{UPB (degrees or units)} \]
\[ I(\text{ArSt}) = 1.2 / \text{UTP (repeats per minute)} \]

Proportional plus derivative (or rate) (PD) -

\[ P(P_b) = 1.7 \times \text{UPB (degrees or units)} \]
\[ D(\text{iAtE}) = \text{UTP / 8 (minutes)} \]

Proportional plus automatic reset plus derivative (PID)

\[ P(P_b) = 1.7 \times \text{UPB (degrees or units)} \]
\[ I(\text{ArSt}) = 2 / \text{UTP (repeats per minute)} \]
\[ D(\text{iAtE}) = \text{UTP / 8 (minutes)} \]

If an overdamped response is desired, multiply the proportional band by two.

---

**Period**

Curve A: unstable
Curve B: stable
Curve C: continuously cycling, ultimate PB and period
Service 5.1
This section contains Calibration, Test and Trouble-shooting procedures that can be performed by the user. Instruments are calibrated to all input type specified when ordered at the factory prior to shipment. Re-calibration should not be necessary under normal operating conditions.

Calibration 5.2
Caution: Do not attempt any of these calibrations without the proper test equipment with specifications equal to or better than those listed.

Press and release the SCROLL key to sequence the display until CAL appears. If CAL does not appear, refer to Section 3 for instructions on how to enable the Calibration mode. When CAL appears on the display, press the DOWN key. The display will read CAL 1. CAL 1 can be initiated at this time or press the SCROLL key to advance the display to other calibrations available.

CALIBRATION FLOW CHART

Key

- Actual Display
- On/Off Display - Use arrow keys to turn on or off
- Scroll Key
- Numeric Display Use arrow keys to change value
- Up Arrow Key
- Down Arrow
TABLE 5-1  CALIBRATION PROCEDURES

<table>
<thead>
<tr>
<th>Calibration Procedure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL 1</td>
<td>Re-initialization of Program and Tune mode values.</td>
</tr>
<tr>
<td>CAL 2</td>
<td>Main Calibration used by all inputs. This is the only calibration required for voltage and millivolt inputs.</td>
</tr>
<tr>
<td>CAL 3</td>
<td>Cold Junction Compensation calibration used to correct for component variation in CJC circuit.</td>
</tr>
<tr>
<td>CAL 4</td>
<td>Cold Junction utility. The temperature of the cold junction is displayed. No adjustment is made with this procedure.</td>
</tr>
<tr>
<td>CAL 5</td>
<td>RTD input calibration used to correct for component differences in the RTD input circuit.</td>
</tr>
<tr>
<td>CAL 6</td>
<td>CJC turn on/off.</td>
</tr>
<tr>
<td>CAL 7</td>
<td>Factory Use Only.</td>
</tr>
<tr>
<td>CAL 8</td>
<td>Re-initialization of all profile information</td>
</tr>
</tbody>
</table>

5.2.1 CAL 1 PARAMETER INITIALIZATION
This procedure is performed to erase the information that was entered in the Program and Tune modes. All parameters will be reset to default values. Prior to beginning this procedure record the Program and Tune mode parameters so that they can be re-entered. No special test equipment is required.

With CAL 1 displayed, depress and hold the DOWN key, then press the SCROLL key. The display will momentarily go blank. Release the keys. CAL 1 will reappear on the display. This calibration can be done again or another may be selected.

5.2.2 CAL 2 MAIN CALIBRATION
This procedure determines and saves calibration values which correct for component variations relating to the input measuring function of the instrument. This is the only calibration required for the volt and millivolt inputs. Additional calibration procedures are required for thermocouple and RTD inputs.

A 50.00 ± 01 mVDC source is required for calibrating. In addition, make sure that JU1 on the Processor board is in the "non volt" position. See Appendix A-2 (page 64).

Make sure all input wiring is disconnected. Short the input terminals 1 and 3 or apply 0.00 ± 01 mV to the input. With CAL2 displayed, press and hold the DOWN key, then press the SCROLL key. Release both keys and the instrument will display hLd1. Depress the DOWN key; dELy will appear for up to ten seconds, then SCAN will appear for up to ten seconds. If the calibration reference number which appears is not between -50 and +50, proceed per note below. Otherwise, connect a 50.00 ± 01 mV source to the input terminals. Press the DOWN key and dELy will be displayed for ten seconds and the SCAN for ten seconds. Then CAL2 will reappear. If there is a problem, the appropriate error code will be displayed. Restore JU1 to the position necessary for the input type.
NOTE: If the calibration reference number falls outside the -50 to +50 range, depress the SCROLL key and CAL2 will be displayed. Depress the DOWN key and perform the calibration once more. Repeat the calibration until the number falls within the tolerance limits. If the calibration number remains outside these limits, check the connections to the test equipment and try the calibration again. If the number still does not approach the tolerance limits contact an Applications Service Engineer at the factory or a local representative.

Error Recover - see 5.4 (page 55) for details. However, be sure that the millivolt source is securely connected, functioning properly and the polarity is correct. Press the DOWN key to bring the instrument back to dELY and try the calibration again. The calibration can be exited at anytime. hLd1 or the reference number is displayed by pressing the SCROLL key.

CAL 2 QUICK CALIBRATION
This routine will allow the operator to execute a rough calibration on their unit via the keypad with no other equipment or disturbance to established wiring. It is intended to provide a partial recovery from a calibration corruption where the necessary equipment indicated in Cal 2-5 may not be available. It should be noted that this is not intended as a substitution to the main calibration procedure described earlier and may considerably deter from the accuracy of the instrument.

With CAL2 displayed, press and hold the DOWN ARROW key, then press the SCROLL key. Release both keys and the instrument will display hLd1. Press and hold the UP ARROW key, then press the SCROLL key. The display will momentarily blank and then CAL1 will be displayed. Release both keys and depress the UP ARROW key. CAL will be displayed.

5.2.3 CAL 3 COLD JUNCTION COMPENSATION
This procedure determines and saves calibration values which correct for component variations relating to the cold junction compensation. This calibration must be preceded by CAL2 the main calibration, to properly calibrate the instrument. These two calibrations are all that is needed for proper operation with thermocouple inputs.

Test equipment: one type J thermocouple and one mercury thermometer, accurate to ± .25 degrees C or equivalent are required.

Make sure all input wiring is disconnected and connect the J thermocouple to the input. Place the thermometer next to the thermocouple and allow the controller to warm up for 30 minutes, before proceeding with the calibration.

With CAL3 displayed, press and hold the DOWN key, then press the SCROLL key and the unit will display hoLd. Release both keys. Press the DOWN key and dELY will be displayed for ten seconds, then SCAN for ten seconds. If SCAN remains in the display for much longer than ten seconds, refer to the note below. The instrument will compute and display the cold junction temperature to the nearest tenth of a degree C. Compare reading with thermometer and use the UP and DOWN keys to correct the reading, if necessary. To end procedure, press the SCROLL key and CAL3 will be displayed again.

NOTE: If the instrument continues to display in SCAN, proceed as follows. With SCAN displayed, press the SCROLL key. The instrument will display hoLd. Press the UP key. The instrument will begin the calibration procedure with a default value and proceed to dELY. Complete calibration as described above.

Error recovery - see section 5.4 (page 56) for details on specific errors. The calibration can be exited at any time. hoLd is displayed by pressing the SCROLL key.
5.2.4 CAL4 COLD JUNCTION UTILITY
This procedure displays the temperature the cold junction compensator is sensing. No test equipment is required.

With CAL4 displayed, press and hold the DOWN key, then press the SCROLL key. Release both keys and SCAN will be displayed for 10 seconds while the instrument senses the CJC temperature. The result will then be displayed to a tenth of a degree C. The input terminals must be shorted. CAL3 must first be performed. The displayed temperature is not the ambient temperature. It is the temperature of the CJC. To exit, press the SCROLL key and CAL4 will be displayed.

5.2.5 CAL5 RTD INPUT
This procedure determines and saves calibration values relating to RTD inputs. This calibration must be preceded by CAL2 to properly calibrate the instrument. A decade resistance substitution box with .01% resolution or equivalent is required. Make sure that the Processor board jumper JU1 is in the non-volt position (Appendix A-2, page 64) and that the Option board jumpers JU2 and JU3 are in the proper positions (Appendix A-3, page 65).

With CAL5 displayed, press and hold the DOWN key and then press the SCROLL key. The display will now be hLd1 to indicate that the instrument is set to calibrate the RTD input. Connect the decade box at 100 ohm setting across the input terminals 1 and 3 and a jumper wire from terminal 1 to 5. Press the DOWN key and dELy will be displayed for 10 seconds, then SCAN for ten seconds. When hLd2 is displayed, change the decade box setting to 277 ohms to the input terminals (do not disturb the wiring) and press the DOWN key. The display will change to dELy for 10 seconds, followed by SCAN for ten more seconds. CAL5 will be displayed after the calibration is completed.

Error recovery: See section 5.4 (page 56) for details on specific errors.

The calibration can be exited when the instrument displays hLd1 or hLd2 by pressing the SCROLL key.

5.2.6 CAL6 COLD JUNCTION COMPENSATION
This routine provides selection of operating modes for the cold junction compensation used for thermocouple inputs.

With CAL6 displayed, press and hold the DOWN key, then press the SCROLL key. The instrument will display C6 and the number of the mode in effect. Press the UP or DOWN key to change the mode selection, indicated by the number to the right of the C6. Pressing the SCROLL key will exit the calibration with the last number displayed in effect.

The selected mode will remain in effect if power is interrupted. To return the instrument to normal operation, CAL6 must be exited, with mode zero selected, or CAL1 must be executed to initialize all parameters.

Mode 0: Normal operating mode.

Mode 1: Cold Junction Compensation temperature will be internally fixed at 0 degrees C by the software to facilitate linearization testing when using an uncompensated millivolt source to simulate thermocouple millivolt input signal.

Note: If the Process Value exceeds 999.9, the leftmost digit will be the letter 0 with a bar over it. The other digits will be valid.
5.2.7 CAL8 PROFILE REINITIALIZATION

This procedure is used to erase all profiles that have been entered in the instrument. Be sure to record any profile information on the Profile Recording Sheets (Appendix F, pages 78 and 79) so that they can be re-entered.

With CAL8 displayed, press and hold the DOWN key, then press the SCROLL key. The display will blank momentarily and then CAL8 will be displayed.
**Test Mode Procedures 5.3**

To enter the Test mode, press and release the SCROLL key until tEST appears on the display, then press the DOWN key. tST1 will be displayed, press and release the SCROLL key to advance the display to the desired test. Test 1, 2 and 3 are performed as a unit so the display will advance directly to tST4 from tST1. Listed below in Table 5-2 are the test procedures available. Test 1, 2 and 3 are performed on start up, periodically during operation, and on entry into the Test mode. Test 4 is executed on entry into and periodically during the Operation mode. These tests can be used as a trouble shooting aid.

---

**TEST MODE FLOW CHART**

---

**Key**

- Actual Display
- On/Off Display - Use arrow keys to turn on or off
- Scroll Key
- Numeric Display - Use arrow keys to change value
- Up Arrow Key
- Down Arrow
TABLE 5-2 TEST PROCEDURES AND DESCRIPTION

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test 1</td>
<td>Microprocessor internal RAM test. Used to check the processor RAM to make sure it is functioning correctly.</td>
</tr>
<tr>
<td>Test 2</td>
<td>External RAM test, used to test the RAM chip for proper function.</td>
</tr>
<tr>
<td>Test 3</td>
<td>EPROM checksum test, used the check that the EPROM program is correct.</td>
</tr>
<tr>
<td>Test 4</td>
<td>External RAM checksum test; instrument test and identifies how many times Errors 16, 17 and 18 have occurred.</td>
</tr>
<tr>
<td>Test 5</td>
<td>Verifies that all keys are functional and all LEDs are working.</td>
</tr>
<tr>
<td>Test 6</td>
<td>Used to verify that all relays and solid state relay driver outputs are working correctly.</td>
</tr>
<tr>
<td>Test 7</td>
<td>This procedure will allow operator to adjust the current output value to check the output and to test the operation of the external device.</td>
</tr>
<tr>
<td>Test 8</td>
<td>This is the same as Test 7 except it is for Output 2.</td>
</tr>
<tr>
<td>Test 9</td>
<td>Auxiliary Input Test. Allows for the viewing of the optional auxiliary input voltage level.</td>
</tr>
<tr>
<td>Test A</td>
<td>Communications Hardware Test</td>
</tr>
</tbody>
</table>

5.3.1 TEST 1 INTERNAL RAM TEST
Tests the Random Access Memory internal to the microprocessor. No special test equipment is required.

With tS1 displayed, press and hold the DOWN key, then press the SCROLL key. tS1 will be displayed momentarily while the test is in progress. Upon successful completion, the instrument will proceed to Test 2.

5.3.2 TEST 2 EXTERNAL RAM TEST
Tests the battery backed-up RAM external to the microcomputer. No special test equipment is required.

After completion of Test 1, tS12 will be displayed momentarily while the test is in progress. Upon successful completion, the instrument will proceed to Test 3.

5.3.3 TEST 3 PROGRAM EPROM TEST
This is a checksum test to verify data integrity of the stored program. No special test equipment is required.

After completion of Test 2, tS13 will be displayed momentarily while the test is in progress. Upon successful completion of Test 3, tS11 will be displayed.
5.3.4 TEST 4 EXTERNAL RAM CHECKSUM TEST

This is a checksum test to verify the integrity of data stored in RAM and indicate the number of times the instrument has had an Error 16, 17 and 18. The unit may have automatically recovered from these errors. No special test equipment is required.

With **TST4** displayed, press and hold the DOWN key, then press the SCROLL key. The display will blank momentarily, then momentarily display three numbers, and then **TST4** will be displayed. These numbers indicate the number of times Error 16, 17, and 18 have occurred respectively. Test 4 can be executed again, or another test may be selected.

5.3.5 TEST 5 KEYPAD/DISPLAY TEST

This test allows the operator to verify that the keys work and that all display elements can be lit. No special test equipment is required.

With **TST5** displayed, press and hold the DOWN key, then press the SCROLL key and then release both keys. The display will go blank. The following code will be displayed while the corresponding key is pressed:

<table>
<thead>
<tr>
<th>Key</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCROLL</td>
<td>SCrL</td>
</tr>
<tr>
<td>UP</td>
<td>uAro</td>
</tr>
<tr>
<td>DOWN</td>
<td>dAro</td>
</tr>
<tr>
<td>RUN/HOLD</td>
<td>run</td>
</tr>
<tr>
<td>UP and DOWN</td>
<td>(All LED's and segments III)</td>
</tr>
</tbody>
</table>

To exit, press the SCROLL and UP key simultaneously, **TST5** will be displayed.

5.3.6 TEST 6 RELAY/SOLID STATE RELAY DRIVER OUTPUT TEST

Allows the operator to verify that the Relay and/or the Solid State Relay Driver output(s) are working. A volt/ohm meter will be required to test the output.

With **TST6** displayed, press and hold the DOWN key, then press the SCROLL key. **OFF** will be displayed. For SPST Relay outputs, connect the meter across the relay output in the ohm scale. The meter should read continuity with the relay on and infinity when the relay is off. For SSR Driver outputs, connect the meter across the output in the Volt DC scale. The meter should read 5 VDC when the SSR driver is on and 0 VDC when the driver is off. Press and release the DOWN key to advance through the following sequence:

<table>
<thead>
<tr>
<th>Display</th>
<th>Relay On</th>
</tr>
</thead>
<tbody>
<tr>
<td>rLYA</td>
<td>A Only</td>
</tr>
<tr>
<td>rLYb</td>
<td>B Only</td>
</tr>
<tr>
<td>rLYC</td>
<td>C Only</td>
</tr>
<tr>
<td>OFF</td>
<td>None</td>
</tr>
</tbody>
</table>

To exit, press the SCROLL key and **TST6** will be displayed. The existence of Relay and Solid State Relay Driver output(s) is dependent upon the hardware configuration.

5.3.7 TEST 7 CURRENT 1 OUTPUT TEST

This test allows the operator to verify that the current output(s) are functioning properly or will allow the selection of an output value for testing of associated equipment. A milliamp meter is required for testing.

With **TST7** displayed, press and hold the DOWN key, then press the SCROLL key. The display will indicate 4 milliamps. Use the UP and/or DOWN key to increase or decrease the current output in 1 mADC steps from 4 to 20mA DC. The current output reading should be ± 0.5 mADC at any output value. To exit the test, press the SCROLL key and **TST7** will be displayed. The existence of mADC current output is dependent upon the hardware configuration. See Appendix A-3 (page 65 or 66) to make sure hardware is present.
5.3.8 TEST 8 CURRENT OUTPUT 2 TEST
This test is the same as Test 7 except that it is for Output 2.

5.3.9 TEST 9 AUXILIARY INPUT TEST
This test allows the operator to verify that the auxiliary inputs used for motor modulation feedback and remote Run/Hold contact closure are functioning properly. A variable voltage source, 5VDC, is required for testing.

With tS19 displayed, press and hold the DOWN key, then press the SCROLL key. The Auxiliary input voltage will be displayed to the nearest hundredth of a volt. Connect the +5V source across the Auxiliary input terminals (terminals 8 and 5) and adjust the supply up and down to verify that it changes on the display. The displayed voltage should typically be 0-5VDC +/- 0.3 volts. To terminate the test, press the SCROLL key. The display will show tS19. Test 9 can be initiated again or another may be selected. The existence of the auxiliary inputs tested in Test 9 depends upon the hardware configuration.

5.3.10 TEST A COMMUNICATION HARDWARE TEST
(Communications Option)
This test allows the operator to verify that the communications hardware is functioning properly.

With tS1A displayed, press and hold the DOWN key then press the SCROLL key. The display will indicate sEnd. Each time the DOWN key is depressed, the unit will toggle between sEnd and rEC (receive). With the desired function selected, depress the SCROLL key. The unit will perform as described below.

In the sEnd (send or transmit) mode, the unit will repeat the following sequence. First it will enable the transmitter and put a logic 1 on the line for one second. Second, with the transmitter still enabled, it will change the logic level to 0 for one second. Third, it will disable the transmitter for one second. In the rEC mode, the unit will have its transmitter continuously disabled. In either mode, the unit will monitor the line and display rEC1 or rEC0 when it senses a logic 1 or 0 on the line respectively. In the sEnd mode, the unit will display rEC when the transmitter is disabled.

To perform an internal test and verify the basic operation of the hardware, place the unit in the sEnd mode and verify that the display cycles through rEC1, rEC0 and rEC. To verify that the transmitter functions properly, two LED's, each with a current limiting resistor, can be connected to the communications terminals, with their polarities connected oppositely, and it should be observed that the following states are produced: one LED on, then the other LED on, then both off. Alternately, a load resistor can be placed on the terminals and it can be observed that the voltage generated across the load resistor is as follows: >+3 VDC, then >-3 VDC, and then 0 VDC.

Another method, which would also apply to an applications network, would be to connect one or more units in the Receive mode to a first unit in the Send mode. All of the units in the Receive mode should have their display alternating in sync with the first unit which is in the Send mode. When the sending unit displays rEC, the receiving units should display rEC1. To terminate the test, press the SCROLL key for one second. Upon exit, tS1A will be displayed. Test A can now be initiated again or another test selected.
## Trouble-shooting and Diagnostics  5.4

This section consists of two columns. The first column is a list of some possible instrument conditions. The second column is a list of steps that should improve the condition. The steps should be performed in order until the condition improves or all the steps have been completed. If the instrument condition has not improved, contact the nearest representative or factory for assistance.

Trouble-shooting should be performed by qualified personnel using the proper equipment and following all safety precautions. Whenever possible, the trouble-shooting should be accomplished with the electrical power disconnected. The instrument contains static sensitive components so care should be taken to observe anti-static procedures.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Correction Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Display is blank</strong></td>
<td>1. Verify that the correct instrument power, as indicated on the wiring label on the housing, is supplied to terminals A &amp; B. If the voltage is not correct, check the power source.</td>
</tr>
<tr>
<td></td>
<td>2. Turn off the instrument power. Wait about 5 seconds then turn the power on again.</td>
</tr>
<tr>
<td></td>
<td>3. Turn off the instrument power, loosen the front panel screw and remove the instrument from the housing. Inspect the instrument for poor connections.</td>
</tr>
<tr>
<td></td>
<td>a. The white ribbon cable that connects the Processor board (Appendix A-2, page 64) to the Power Supply Board (Appendix A-1, page 63), must be properly aligned and seated.</td>
</tr>
<tr>
<td></td>
<td>b. The Front Display board pins should be properly aligned and seated in the sockets on the Processor board (Appendix A-2, page 64) and the Power Supply board (Appendix A-1, page 63).</td>
</tr>
<tr>
<td></td>
<td>c. The EPROM and RAM chips, located on the Processor board (Appendix A-2, page 64) must be free from corrosion and firmly seated in the socket. Also check the Display Driver chip U1 located on the display board for the same. Reinsert the instrument in the housing, tighten the panel screw, and turn on the power.</td>
</tr>
<tr>
<td></td>
<td>4. Turn off the instrument power. Press and hold the UP and DOWN keys. Turn on the power. Hold the keys depressed for about 10 seconds. If the display lights the model number, Program, Tune and Profile mode parameters will need to be re-entered (pages 25 - 35, or the Software Ref. Sheet, pages 75-77, if already filled out).</td>
</tr>
<tr>
<td><strong>Model Number Displayed</strong></td>
<td></td>
</tr>
<tr>
<td>is incorrect</td>
<td>1. Turn off the instrument power, wait 5 seconds then reapply power. Verify that the number displayed during the power up sequence is the same as indicated on the label affixed to the lower front of the display bezel.</td>
</tr>
</tbody>
</table>
2. Turn off the power to the instrument. Press and hold the UP and DOWN keys and turn on the power. Keep the keys depressed until the model number resets to 6100-000. Release the keys and turn off the power.

3. To enter the correct model number press and hold the SCROLL and DOWN keys and turn on the instrument power, 6100 should be displayed. Wait about 5 seconds and release the SCROLL key first and then release the DOWN key. The display should remain 6100. Use the UP/DOWN keys as necessary to change the displayed number to match the first 4 digits of the model number. After adjusting the first 4 digits to the proper values, press the SCROLL key and the display will change to 000-. Use the UP/DOWN keys to set the last 3 digits of the model number to the correct values. Press the SCROLL key and the power up sequence will complete. The Program, Tune and Profile mode parameters will need to be re-entered (pages 25-35, or the Software Ref. Sheet, pages 75-77, if already filled out).

### Relay/SSR Driver Output(s)

#### Malfunction

1. Verify that the Progam and Tune mode parameters are correctly set (pages 25-32 or the Software Ref. Sheet, page 75, if already filled out).

2. Turn off the power to the instrument. Wait about 5 seconds and turn the power on again. Confirm that the model number displayed during the power up sequence indicates that the output(s) is/are present in the instrument. This number should match the number on the label affixed to the bottom of the front display bezel. If the model # is incorrect, follow the steps for "Model # displayed is incorrect".

3. Turn off the power to the instrument. Loosen the front panel screw and remove the unit from the housing. Inspect the Power Supply board (Appendix A-1, page 63) for the presence of the output device(s). Relay A is located at K1, Relay B at K2, and Relay C at K3. A relay output will appear to be a cube. The SSR Driver will appear as a resistor and a jumper wire. The output will not work if the hardware is not present.

4. Check the output operation by performing Test 6 as described in the Test section (page 54). If the output(s) function(s) in the Test mode, re-examine the Program and Tune mode parameter settings (pages 25-32, or the Software Ref. Sheet, page 75, if already filled out).

5. If the output appears not to turn off, remove the power to the instrument. Loosen the front panel screw and take the unit out of the housing. Clip the resistor located on the Power Supply board (Appendix A-1, page 63) for the output(s) that seem to stay on. A .01 microfarad, 1 KV should be connected from the terminal listed below, for the output where the resistor indicated was removed, to the AC ground.

(Continued on next page)
(Continued from page 57)

<table>
<thead>
<tr>
<th>Relay A</th>
<th>R12</th>
<th>Terminal C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay B</td>
<td>R13</td>
<td>Terminal E</td>
</tr>
<tr>
<td>Relay C</td>
<td>R14</td>
<td>Terminal G</td>
</tr>
</tbody>
</table>

Return the instrument to the case and tighten the front panel screw. Turn the power on to the instrument and check the operation of the output(s).

1. Verify that the Program and Tune mode parameters are correctly set (page 25 & 32 or the Software Ref. Sheet, page 75, if already filled out).

2. Turn off the power to the instrument. Wait about 5 seconds and turn the power on again. Confirm that the model number displayed during the power up sequence indicates that the output is present in the instrument. The number should match the model number on the label located on the bottom of the front display bezel. If the model # is incorrect, follow the steps for "Model # displayed is incorrect" (page 57).

3. Verify that the hardware is present on the Option board (Appendix A-3, page 65 or 66).

4. Check the output operation in the Test mode. Use Test 7 for Output 1 and Test 8 for Output 2. If the output works in the Test mode, re-check the Program & Tune mode parameter settings (pages 25 - 32, or the Software Ref. Sheet, page 75, if already filled out).

---

**mADC Output(s) Malfunction**

---

**Error Code Displayed**

<table>
<thead>
<tr>
<th>SnSr</th>
<th>Sensor Break or out of range</th>
</tr>
</thead>
</table>

1. Inspect the sensor for proper operation and connection to the instrument. Acceptable sensor ranges for the instrument are listed in the Specifications section of Appendix D (page 71).

2. Verify that the Program mode input selection matches the sensor input connected.

3. Check that the input conditioning jumpers on the Processor board (Appendix A-2, page 64) and the Option Board (Appendix A-3, page 65 or 66) are in the proper position for the sensor input.

4. Perform the calibration procedure(s), as described in the Calibration section (page 47) for the sensor input type.

---

<table>
<thead>
<tr>
<th>FbEr</th>
<th>Slidewire Feedback Error</th>
</tr>
</thead>
</table>

1. Inspect the Slidewire Feedback connections at terminals 8, 7 and 5. Be sure that the connections are the same as shown in the position proportioning illustration (page 20).
2. Measure the resistance of the Slidewire segment. The minimum resistance must be 135 ohms, the maximum 10 K ohms.

3. Perform the Auxiliary Input Test, Test 9 as described in the Test section (page 55). The voltage indicated should be between 0 and 5 VDC.

4. Turn off the power to the instrument. Loosen the front panel screw and take the instrument out of the housing. Verify that the jumper JU-1 on the Option board (Appendix A-3, page 65) is in the Motor Modulation position.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>HI</td>
<td>Input more than 10% Over Span</td>
<td>1. Perform the steps listed for the SnSr error condition (page 58).</td>
</tr>
<tr>
<td>Lo</td>
<td>Input more than 10% Under Span</td>
<td>1. Perform the steps listed for the SnSr error condition (page 58).</td>
</tr>
</tbody>
</table>
| 0    | display overranged (the "broken 6" appears on the left side of the display) | 1. If this error code is displayed as a Program or Tune mode parameter value, perform CAL1 procedure as described in the Calibration section (page 48).  
  2. If this error code appears as part of the model number during the power up sequence, follow the steps listed for the "Model # is Incorrect" condition (page 57).  
  3. If this error appears in the process reading and dPoS equals 1, then it means the process is greater than 999.9. |
| Er1  | Microprocessor RAM Failure | 1. Turn off the power to the instrument.  
  2. Loosen the front panel screw and remove the instrument from the housing. Inspect that the microprocessor (U1) is properly seated in the socket located on the Processor board (Appendix A-2, page 64). Return the instrument to the housing and tighten the front panel screw. Turn the power on. |
<p>| Er2  | External RAM Failure | 1. Turn off the power to the instrument. Wait 5 seconds and turn the power on. |
| Er3  | EPROM Checksum Failure | 1. Perform the steps listed for Er1 except that the EPROM (U2) on the Processor board (Appendix A-2, page 64) should be inspected. |
| Er4  | RTD Mismatch Error | 1. Check the connections to the instrument for the RTD Input Calibration procedure (page 50). Repeat the RTD Input Calibration. |</p>
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
<th>Instructions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Er5 - No Zero Crossings Detected</td>
<td>1. Turn off the power to the instrument. Wait 5 seconds and turn the power on.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Turn off the power to the instrument. Loosen the front panel screw and remove the instrument from the housing. Inspect the white ribbon cable that connects the Processor board to the Power Supply board. Be sure that the cable is properly aligned and seated in the socket on the Power Supply board. Return the instrument to the housing and tighten the front panel screw. Turn the power on to the instrument.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Connect the instrument to another AC power source.</td>
<td></td>
</tr>
<tr>
<td>Er6 - AC line below 45 HZ</td>
<td>1. Turn off the power to the instrument. Wait 5 seconds and turn the power on.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Turn off the power to the instrument. Loosen the front panel screw and remove the instrument from the housing. Inspect the white ribbon cable that connects the Processor board to the Power Supply board. Be sure that the cable is properly aligned and seated in the socket on the Power Supply board. Return the instrument to the housing and tighten the front panel screw. Turn the power on to the instrument.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Connect the instrument to another AC power source.</td>
<td></td>
</tr>
<tr>
<td>Er7 - AC line over 65 HZ</td>
<td>1. Turn off the power to the instrument. Wait 5 seconds and turn the power on.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Turn off the instrument power. Loosen the front panel screw and remove the instrument from the housing. Inspect the white ribbon cable that connects the Processor board to the Power Supply board. Be sure that the cable is properly aligned and seated in the socket on the Power Supply board.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Connect the instrument to another AC power source.</td>
<td></td>
</tr>
<tr>
<td>Er8 - Cal 2 Volt Input Error</td>
<td>1. Check that 50 mVDC is properly connected to the instrument and is within the tolerance limits as indicated in the CAL2 procedure of the Calibration section (page 48).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Loosen the front panel screw and remove the instrument from the housing. Inspect the Processor board (Appendix A-2, page 64) to insure that the input conditioning jumper JU1 is in the non-volt position.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Perform the CAL2 procedure as described in the Calibration section (page 48).</td>
<td></td>
</tr>
<tr>
<td>Er9 - ADC Reference Number Error</td>
<td>1. Perform the CAL2 procedure as described in the Calibration section (page 48).</td>
<td></td>
</tr>
</tbody>
</table>
**Er10 - ADC Reference Voltage Error**

1. Perform the CAL2 procedure as described in the Calibration section (page 48).

**Er11 - Cold Junction Compensation Error**

1. Be sure the Cold Junction Sensor is firmly attached to terminals 2 and 4.

2. Perform the CAL3 procedure as described in the Calibration section (page 49).

**Er12 - CAL2 Voltage Error**

1. Check that 50mVDC is properly connected to the instrument and is within the tolerance limits as indicated in the CAL2 procedure of the Calibration section (page 48).

2. Loosen the front panel screw and remove the instrument from the housing. Inspect the Processor board (Appendix A-2, page 64) to insure that the input conditioning jumper JU1 is in the non-volt position.

3. Perform the CAL2 procedure as described in the Calibration section (page 48).

**Er13 - RTD CAL5 Input Error**

1. Check that the resistance device is of the correct value and properly connected to the instrument and is within the tolerance limits as indicated in the CAL5 procedure of the Calibration section (page 50).

2. Loosen the front panel screw and remove the instrument from the housing. Inspect the Processor board (Appendix A-2, page 64) to insure that the input conditioning jumper JU1 is in the non-volt position and that the Option board jumpers (Appendix A-3, page 65) JU2 and JU3 are in the RTD position.

3. Perform the CAL5 procedure as described in the Calibration section (page 50).

**Er14 - Cold Junction Compensation Error**

1. Be sure the Cold Junction Sensor is firmly attached to terminals 2 and 4.

2. Perform the CAL3 procedure as described in the Calibration section (page 49).

**Er15 - Ground Reference Tolerance Error**

1. Perform the CAL2 procedure as described in the Calibration section (page 48).

**Er16 - Program/Tune Mode Checksum Error**

1. Record all Program and Tune mode parameters. Perform the CAL1 procedure as described in the Calibration section (page 48). Re-enter the Program and Tune mode parameters.

**Er17 - Calibration Checksum Error**

1. Perform the calibration procedures that are needed for the input sensors that will be used (page 48).
<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Er18</td>
<td>Profile Data Checksum Error: 1. Record all Profile data that was entered. Perform the CAL8 procedure as described in the Calibration section (page 51). Re-enter the Profile data as needed.</td>
</tr>
<tr>
<td>Er19</td>
<td>Tried to run profile with 0 segments: 1. Press the RUN/HOLD key, then press and release the SCROLL key until off or Ctrl are displayed, then press the DOWN key. This error occurs if a profile number is selected in a Profile Continue mode for a profile that has not been developed.</td>
</tr>
<tr>
<td>Er20</td>
<td>Setpoint Error: 1. Use the UP or DOWN key to change the setpoint value. 2. Record all Program and Tune mode parameters. Perform the CAL1 procedure as described in the Calibration section (page 48). Re-enter the Program and Tune mode parameters.</td>
</tr>
<tr>
<td>Er36</td>
<td>Incorrect Cystal For Digital Comm.: 1. Turn off the power to the instrument, wait 5 seconds then turn the power on. 2. Check the crystal for 11 MHZ Y1 (see Appendix A-2, page 64)</td>
</tr>
<tr>
<td>Er37</td>
<td>Incorrect Micro. For Digital Comm.: 1. Turn off the power to the instrument, wait 5 seconds then turn the power on. 2. Check to make sure U1 is a 8032 (see Appendix A-2, page 64)</td>
</tr>
</tbody>
</table>

Errors 70 through 73 are communication errors that are briefly displayed when they occur.

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Er70</td>
<td>The Controller was unable to respond within 250 milliseconds: When the unit receives a complete message, the controller has 250 milliseconds to respond to the request. If for any reason the controller is unable to respond within 250 milliseconds, the error is posted and the request ignored.</td>
</tr>
<tr>
<td>Er71</td>
<td>A byte was received by the controller before the response was transmitted: While the unit is processing a message, no data should be on the communication link until the unit has responded. If the unit receives data before a response is transmitted, the error is posted and the message aborted.</td>
</tr>
<tr>
<td>Er72</td>
<td>An incorrect Block Check character was received: After the complete message has been received, if the Block Check Character (BCC) transmitted does not match the calculated BCC, the error is posted and the unit will send a Negative Acknowledge (NAK).</td>
</tr>
<tr>
<td>Er73</td>
<td>A byte was received with incorrect parity: If incoming data has incorrect Parity, the unit will post the error and ignore the rest of the message. The number of ones in the transmitted byte is expected to be even (Even Parity).</td>
</tr>
</tbody>
</table>
Appendix A
Board Layout - Jumper Positioning

FIGURE A-1 - Power Supply Board

230 VAC UNITS MAY BE FIELD CONVERTED TO 115 VAC BY MOVING JUMPERS AS SHOWN ABOVE.
(115 VAC UNITS CANNOT BE FIELD CONVERTED TO 230 VAC!!)
FIGURE A-2 - Processor Board

TOP

MICRO U1

EPROM U2

BATTERY

Ram U3

COMPONENT SIDE

JU1
T/C, mV, RTD, CAL2
VOLT

JU2
ENABLE MODE LOCKED
ENABLE MODE UNLOCKED

JU12
IF NO OPTION BOARD
FIGURE A-3 - Option Board - Revision D and below

TOP

REV

FRONT OF UNIT

For 2nd 4-20mA, U5 is populated

U5

For 1st 4-20mA, U1 is populated

U1

COMPONENT SIDE

JU1

2ND 4-20 mA DC

MOTOR MODULATION/
POSITION PROPORTIONING
POTENTIOMETER REMOTE
SETPOINT

DIGITAL COMMUNICATIONS
422/485

JU2

RTD

T/C, mV, VOLT
(NON-RTD)

JU3

RTD

T/C, mV, VOLT
(NON-RTD)
FIGURE A-3 - Option Board - Revision E and above

JU1
- 2nd 4-20
- Position Prop.
- Com
- RS-485
- Com & 2nd 4-20
- Pos. Prop. & Alt. Com
- RSP & Com
- RRH & Com
- Alt. Com

JU2
- T/C, mV, V
- RTD

JU3
- T/C, mV, V
- RTD
- XPS

JU12
- No XPS
- XPS

JU14
- No XPS
- XPS

J15: AC Input XPS cable from transformer
J16: XPS to Relay C
Appendix B
Glossary

Assured Soak
Assured Soak refers to the ability of the instrument to be programmed to interrupt the Soak segment time down if the process value exceeds a deviation value selected in the Profile Entry mode from the setpoint. The Soak timer will restart from where it was stopped when the process value does not exceed the deviation value selected from setpoint.

Automatic Reset (Integral)
This parameter is used so that the instrument will compensate for process variable deviations from setpoint that occur when the process load characteristics change. Instructions for determining the automatic reset settings are given in Section 4.3 (page 44). Factory default is 0.0. Display code ArSt.

Automatic Transfer
This feature, if configured, allows manual control of the process until setpoint is reached, at which point the controller automatically transfers from manual to automatic control. Factory default value is 0 = no auto transfer. Display code AtFr.

Balanceless Transfer
This feature prevents changes in proportional output when changing from the Manual to Control mode of operation. When transferring from the manual mode to the control mode, the proportional outputs will be "Balanceless" regardless of whether the unit is inside or outside the proportional band. This only holds true if the Auto Reset (ArSt) value is greater than 0.

Bumpless Transfer
This feature prevents step changes in proportional outputs when changing from automatic to manual control only.

Control Algorithm
A pre-programmed series of instructions that are used by the instrument when determining the status of the output(s).

Cycle Time
This Tune mode parameter is used to select the on/off cycle time for time proportioning outputs (Ct1 for Output 1 and/or Ct2 for Output 2).

When using the Position Proportioning option, Ct1 must be selected for the stroke time of the motor.

Display Filter Factor
This parameter is adjustable from 1 to 20 which represents the number of scans of the process variable that are averaged together before updating the displayed value. The factory default value is 1 = no filtering. Display code dFF.

Engineering Units Upper and Engineering Units Lower
These Program mode parameters are used with volt, millivolt, and milliamp inputs. The Engineering Units Upper EUU should be selected as the value to be displayed when the input is at maximum. The Engineering Units Lower EUU should be selected as the value to be displayed when the input is at minimum.

First Output Position
This parameter is adjustable from -1000 to 1000 units and represents a shift or offset of the on-off actuation points or proportional band for the first output relative to the normal position. For example, a negative value could be used to offset an expected overshoot. First Output Position also shifts the proportional band with respect to the process value range outside of which integral action is inhibited. Factory default is 0. Display code FoP.
**Hysteresis**
This parameter is adjustable from 0 to 300 units representing the width of the band (half above and half below setpoint). Used with On-Off or Alarm outputs to reduce cycling. For instance, with a value of 4 and a setpoint of 70, the output will turn On when the process variable drops to 67 and stay On until 73 is reached, then turn Off the output. Factory default is 3. Display code is **HySt**.

**Input Correction**
This parameter is used to adjust the process variable value to compensate for sensor errors. This Program mode parameter is selectable from -300 to +300 degrees/units. The factory default is 0. Display code is **ICor**.

**Manual Reset**
This parameter is adjustable from -1500 to 1500 units representing a manual shift of proportional band(s) relative to the normal position. Manual reset is intended to be used when automatic reset is not used to allow compensation for deviations from setpoint which remain after the process has stabilized. Factory default is 0. Increasing the value increases the process variable, i.e., if the process variable stabilized too low, increase the manual set. Integral action, and conversely reset windup inhibit apply over the same process value range regardless of the manual reset value. Display code **rSet**.

**Position Proportioning Sensitivity**
A percentage of the first output proportional band width (Pb1).

**Process Filter Factor**
This Program mode parameter is used to dampen the process value used to calculate output action. The process value is averaged to dampen the control outputs. This parameter is adjustable from 1 to 20. Factory default is 1. Display code **PFF**.

**Process Retransmission Output (EO Software Option)**
Allows retransmission of the process variable. Factory default is 0 = not selected. Display code **Pout**. If selected, must be assigned to a current output and scaled using Process/Setpoint upper and lower values.

**Process/Setpoint Output Upper and Lower Values (Used in conjunction with process or setpoint retransmission output)**
The parameters specify the process or setpoint value range over which the assigned current output will vary in a linear manner from 100% to 0%. If the process value or setpoint is greater than **Pou** the output will be 100%. If the process or setpoint value is less than **Pol** the output will be 0%. Factory default values are 2000 for the upper value and 0 for the lower value. Display codes **Pou** (upper) and **Pol** (lower).

**Process Variable**
The process variable refers to the condition of the process being measured (sensed). The instrument will accept process inputs other than temperature (pressure, level, flow, etc.).

**Proportional Band (PB)**
This Tune mode parameter selects the span of the proportional output range. This parameter is adjustable from 1 to 3000 degrees/units. Factory default is 100. If Output 1 is selected as a proportional output, a display code of **Pb1** will be seen. If Output 2 is selected as a proportional output, the display code will be **Pb2**.

**Ramp**
A Ramp is the section of profile segment where the setpoint value is being changed from the initial value to the value selected over the time period selected. The first Ramp of a profile will take the process value at the time the profile was started as the initial setpoint value.
Rate (Derivative)
This parameter is adjustable from 0.0 to 10.0 minutes and specifies how the control action responds to the rate of change in the process variable. For example, if the process variable is rising rapidly to setpoint, power is turned off sooner than it would be if the rise were slow. In effect, derivative action anticipates lags within the system and shifts the proportioning band by an amount determined by the rate of change of the input sensor. Magnitude of the shift is determined by a derivative time constant. If the time constant is, say, .1 minute (6 seconds), for every unit per second rate of change of the process variable at the sensor, the proportioning band is moved 7 units in the direction that helps control. Likewise, if the time constant is 1 minute (60 seconds), for every unit per second rate of change of the process variable at the sensor, the proportioning band is moved 60 units in the direction that helps control. Instructions for determining rate is given in Section 4.3 (page 44). Factory is 0.0. Display code rATE.

Rate of Change (EO Software Option)
This parameter is used to provide ramp changes based upon a selectable rate of change. Degrees per hours, minutes, seconds.

Second Output Position
This parameter is adjustable from -1000 to 1000 units and represents a shift or offset of the on-off actuation points or proportional band for the second output relative to the normal position. A positive value creates a gap where no control outputs are on, a negative value creates an overlap of control outputs (if the first output position is at the normal position). Second Output Position also shifts the proportional band with respect to the process value range outside of which integral action is highlighted (reset-windup inhibit). Factory default is 0. Display code Sprd.

Segment
A segment refers to a part of a profile. A segment consists of a Ramp and a Soak section.

Setpoint Re-Transmission Output (EO Software Option)
Allows for re-transmission of the setpoint value. Factory default is 0 = not selected. Display code Pout. If selected, must be assigned to a current output and scaled using Process/ Setpoint upper and lower values.

Soak
A Soak is the section of a profile segment where the setpoint value is at a constant value for the time period selected.
Appendix C - Order Matrix

Input
1 T/C or mV
2 Volts/mA
3 RTD
4 All Inputs

Output Group 1
Control Output 1
and/or Event
1 Relay
2 SSR Driver
3 4-20 mA & Relay
4 4-20 mA & SSR Driver

Output Group 2
Control Output 2
and/or Event
0 None
1 Relay
2 SSR Driver
3 4-20 mA
4 4-20 mA & Relay
5 4-20 mA & SSR Driver

Output Group 3/Alarm or Event
0 None
1 Relay
2 SSR Driver

Remote
0 None
1 Position Proportioning*
2 Remote Run/Hold
3 RS-485 Std. Com.**
4 RS-485 Std. Com.***
5 RS-485 Total Access Com.**
6 RS-485 Total Access Com.***

Voltage
1 115VAC Input & Relays
2 230VAC Input & Relays
3 115VAC Input & 230VAC Relays

Option Suffix
(Blank) None
EO Extended Features Software Option
XP 24VDC Transmitter Power Supply
XA 24VDC Power Supply***

Application Suffix
W Standard package with NEMA 4 type enclosure

* Output Group 2 cannot be 0 or 3.
** Cannot be included when Output Group 2 selections 3, 4, or 5.
***Cannot be included when Output Group 3 selection is 1 or 2.
Appendix D
Product Specifications

Measurement Error Limit

- Type J, K, T, E, N, C, T/C's and RTD +/- .25% of reading plus 1 degree @ 25 degrees C
- Type R, S, B T/C's +/- .25% of span @ 25 degrees C
- mA, mV and VDC +/- .25% of scaled span plus 1 Least Significant Digit @ 25 degrees C

Ambient Temperature Error

0.01% of span per degree C deviation from 25 degrees C

Scan Rate

1 scan/second

Display Resolution

0 to 3 decimal places (depending upon input type selected)

Noise Rejection

Normal mode, 85 dB minimum at 60 Hz or greater. Common mode, 90 dB minimum, 115 VAC maximum.

Line Voltage

115/230 VAC ± 10% 50/60 Hz

Power Consumption

15VA maximum

Operating Temperature

0 to 55° C
32 to 131° F

Storage Temperature

-40 to 65° C
-40 to 149° F

Humidity

0 to 90% RH, non condensing

Dimensions

1/4 DIN front panel (96mm x 96mm) and 5.8 inches deep

Weight

3 pounds maximum

Vibration

0.5 to 100 Hz @ 0.5g

Agency Approvals

UL and CSA pending

Warranty

3 years, see inside back page.
## Thermocouple

<table>
<thead>
<tr>
<th>TYPE</th>
<th>RANGE</th>
<th>TYPE</th>
<th>RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>J</td>
<td>-130 to 760°C</td>
<td>E</td>
<td>0 to 750°C</td>
</tr>
<tr>
<td></td>
<td>-200 to 1400°F</td>
<td></td>
<td>0 to 1400°F</td>
</tr>
<tr>
<td>K</td>
<td>-130 to 1370°C</td>
<td>B</td>
<td>200 to 1800°C</td>
</tr>
<tr>
<td></td>
<td>-200 to 2500°F</td>
<td></td>
<td>400 to 3300°F</td>
</tr>
<tr>
<td>T</td>
<td>-200 to 400°C</td>
<td>N</td>
<td>0 to 1300°C</td>
</tr>
<tr>
<td></td>
<td>-330 to 750°F</td>
<td></td>
<td>0 to 2370°F</td>
</tr>
<tr>
<td>R</td>
<td>200 to 1650°C</td>
<td>C</td>
<td>200 to 2300°C</td>
</tr>
<tr>
<td></td>
<td>400 to 3000°F</td>
<td></td>
<td>390 to 4170°F</td>
</tr>
<tr>
<td>S</td>
<td>200 to 1650°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>400 to 3000°F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## RTD

<table>
<thead>
<tr>
<th>OHM</th>
<th></th>
<th>VOLTS</th>
<th></th>
<th>MILLIVOLTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100 OHM</td>
<td>0 to 5VDC</td>
<td>0 to 25mVDC</td>
<td></td>
</tr>
<tr>
<td>-140</td>
<td>-140 to 440°C</td>
<td>1 to 5VDC</td>
<td>0 to 50mVDC</td>
<td></td>
</tr>
<tr>
<td>-220</td>
<td>-220 to 750°F</td>
<td></td>
<td>10 to 50mVDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 25mVDC</td>
<td></td>
</tr>
</tbody>
</table>

## Milliamps

4-20mA input is accommodated via
10-50mV or 1-5V with the addition
of the appropriate external shunt resistor

## Sensor Fault Detection

Displays Hi or Lo process input for thermocouple or RTD inputs (10% above or below range) and sensor break, SnSr. On/Off outputs and events go off, proportional outputs go to 0% output. Sensor fault detection is not functional for 0 to 5 VDC.

## Control Adjustments

- **On/Off Hysteresis**: 0 to 300 units
- **Proportional Band**: 1 to 3000 units
- **Manual Reset**: -1500 to 1500 units
- **Auto Reset**: 0.0 to 100 repeats/min.
- **Rate**: 0.0 to 10.0 min.
- **Cycle Time**: 1 to 240 sec.
- **Position Proportioning Sensitivity**: 0.0 to 50.0%
- **First Output Position**: -1000 to 1000 units
- **Spread (Second Output Position)**: -1000 to 1000 units
### ALARM ADJUSTMENTS
- Process Alarm: -9999 to 9999 units
- Deviation Alarm: -3000 to 3000 units
- Deviation Band Alarm: 1 to 3000 units

### CONTROL OUTPUTS
- Relay: SPST
  - 115VAC: 5.0A Resistive; 1/8HP or 250VA
  - 230VAC: 2.5A Resistive; 1/8HP or 250VA
- SSR Driver: Open collector output
  - Short circuit protected @ 100mA maximum.
  - 4VDC at 20mA or 3VDC at 40mA.
- Current: 4-20mA into 650 ohms maximum

### ALARM OUTPUT
- Relay: SPST
  - 115VAC: 5.0A Resistive; 1/8HP or 250VA
  - 230VAC: 2.5A Resistive; 1/8HP or 250VA
- SSR Driver: Open collector output
  - Short circuit protected @ 100mA maximum
  - 4VDC at 20mA or 3VDC at 40mA

### DISPLAY
- Digital Display: Four (4) .56 inch high, 7 segment LED's
- Status Indicators: LED indicators for Setpoint, Output 1, Output 2, Manual, Alarm, Degrees C, Degrees F, U (engineering units), Seg1 thru Seg 6, Ramp and Soak

### DIGITAL COMMUNICATIONS
- Type: RS-485 serial communications port. Half duplex bi-directional communications
- Character Format: ASCII
- Protocol: Per ANSI X3.28 subcategories 2.5 and A4
- Configuration: User configurable to Monitor (read only) or Normal (read and write)
- Bit Rate: User configurable to 300, 600, 1200, 2400, 4800, or 9600 bits per second
- Address: User configurable 0 to 99
<table>
<thead>
<tr>
<th><strong>PROFILE PARAMETERS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable Profiles</td>
<td>8 user programmable profiles</td>
</tr>
<tr>
<td>Segments</td>
<td>1 to 6 segments per profile</td>
</tr>
<tr>
<td>Ramp and Soak</td>
<td>1 ramp and soak per segment</td>
</tr>
<tr>
<td>Profile Time Base</td>
<td>Selectable:</td>
</tr>
<tr>
<td></td>
<td>HHH.T (hours and tenths)</td>
</tr>
<tr>
<td></td>
<td>HH.MM (hours and minutes)</td>
</tr>
<tr>
<td></td>
<td>MM.SS (minutes and seconds)</td>
</tr>
<tr>
<td></td>
<td>EO Option:</td>
</tr>
<tr>
<td></td>
<td>Units per hour ramp rate, HHH.T soak time</td>
</tr>
<tr>
<td></td>
<td>Units per hour ramp rate, HH.MM soak time</td>
</tr>
<tr>
<td></td>
<td>Units per minute ramp rate, MM.SS soak time</td>
</tr>
<tr>
<td>Profile Interrupt Action</td>
<td>Upon return of AC power either:</td>
</tr>
<tr>
<td></td>
<td>Go to OFF mode</td>
</tr>
<tr>
<td></td>
<td>Continue profile</td>
</tr>
<tr>
<td></td>
<td>Go into HOLD</td>
</tr>
<tr>
<td></td>
<td>Restart profile at beginning</td>
</tr>
<tr>
<td>Profile Loop Count</td>
<td>1 to 9999, 0=continuous</td>
</tr>
<tr>
<td>Profile End Control</td>
<td>Selectable:</td>
</tr>
<tr>
<td></td>
<td>Hold at last setpoint</td>
</tr>
<tr>
<td></td>
<td>Abort (all outputs off or 0%)</td>
</tr>
<tr>
<td></td>
<td>Transfer to another profile</td>
</tr>
<tr>
<td>Assured Soak</td>
<td>Deviation Hold after Ramp Up;</td>
</tr>
<tr>
<td></td>
<td>1 to 3000 units, 0=no auto hold</td>
</tr>
<tr>
<td></td>
<td>Deviation Hold after Ramp Down;</td>
</tr>
<tr>
<td></td>
<td>1 to 3000 units, 0=no auto hold</td>
</tr>
<tr>
<td>Remote Run/Hold</td>
<td>Selectable:</td>
</tr>
<tr>
<td></td>
<td>Override RUN/HOLD key</td>
</tr>
<tr>
<td></td>
<td>Allow RUN/HOLD key to function</td>
</tr>
<tr>
<td>Event Outputs</td>
<td>3 possible event outputs. Each event can be set on or off for each ramp and soak.</td>
</tr>
</tbody>
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## Appendix E
Software Reference/Record Sheet

<table>
<thead>
<tr>
<th>PROGRAM MODE</th>
<th>TUNE MODE</th>
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<tbody>
<tr>
<td>InPs</td>
<td>SPrd</td>
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<tr>
<td>Icor</td>
<td>PAL</td>
</tr>
<tr>
<td>out 1</td>
<td>dAL</td>
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<tr>
<td>o1PL</td>
<td>dBAL</td>
</tr>
<tr>
<td>out 2</td>
<td>Pb 1</td>
</tr>
<tr>
<td>o2PL</td>
<td>Pb 2</td>
</tr>
<tr>
<td>out 3</td>
<td>rSET</td>
</tr>
<tr>
<td>rLyA</td>
<td>ArSt</td>
</tr>
<tr>
<td>rLyb</td>
<td>rAlE</td>
</tr>
<tr>
<td>rLyC</td>
<td>Ct 1</td>
</tr>
<tr>
<td>dISP</td>
<td>Ct 2</td>
</tr>
<tr>
<td>dPOS</td>
<td>SEns</td>
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<td>Euu</td>
<td>FoP</td>
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</tr>
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<td>HySt</td>
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<td>SPL</td>
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<td></td>
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<td>AtFr</td>
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</tr>
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<td>PIA</td>
<td></td>
</tr>
<tr>
<td>rrH</td>
<td></td>
</tr>
<tr>
<td>PFF</td>
<td></td>
</tr>
<tr>
<td>dFF</td>
<td></td>
</tr>
<tr>
<td>Co1r</td>
<td></td>
</tr>
<tr>
<td>Co2r</td>
<td></td>
</tr>
<tr>
<td>Pout</td>
<td></td>
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<td>Pou</td>
<td></td>
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<td>PoL</td>
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<tr>
<td>CCon</td>
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</tr>
<tr>
<td>Cbs</td>
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<tr>
<td>Cad</td>
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<table>
<thead>
<tr>
<th>ENABLE MODE</th>
<th>ENAB</th>
<th>ON</th>
<th>OFF</th>
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<tr>
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<td>EtSt</td>
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</tr>
<tr>
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<td>ECAL</td>
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</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>ESby</td>
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<td></td>
</tr>
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<td></td>
<td>EPC</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>EPE</td>
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</tr>
<tr>
<td></td>
<td>ESPC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>nS</td>
<td>Seg</td>
<td>1</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>-----</td>
<td>---</td>
</tr>
<tr>
<td>rt</td>
<td>rr</td>
<td>SP</td>
<td>E1</td>
</tr>
<tr>
<td>PLCt</td>
<td>dhru</td>
<td>dhrd</td>
<td>PEnd</td>
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<table>
<thead>
<tr>
<th>Pn</th>
<th>nS</th>
<th>Seg</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
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<tbody>
<tr>
<td>rt</td>
<td>rr</td>
<td>SP</td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
<td>St</td>
<td>E1</td>
<td>E2</td>
</tr>
<tr>
<td>PLCt</td>
<td>dhru</td>
<td>dhrd</td>
<td>PEnd</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pn</td>
<td>nS</td>
<td>Seg</td>
<td>1</td>
<td>2</td>
<td>3</td>
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<td>Seg</td>
<td>1</td>
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</tr>
<tr>
<td>Pn</td>
<td>nS</td>
<td>Seg</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
Appendix F
Profile Development Sheet

The Profile Development Worksheet is intended to assist the Profile Controller customers. By filling in the worksheet with the application requirements, profile information can easily be obtained for entry into the instrument. The worksheet is a convenient record of the profile for future use.

A profile is a programmed sequence of setpoint changes over a period of time (or at a rate of change with the EO option) (Ramp) and a constant setpoint (Soak). A sequence of a ramp and a soak is referred to as a Segment. A profile can contain from 1 to 6 segments. The instrument can store in memory up to 8 profiles.

The profile controllers can provide timed output relay action while running a profile, this is called an Event. Events may be selected as on or off as needed during each Ramp and/or Soak segment of the profile.

The first step to completing the worksheet is to determine the range of the setpoints necessary for the application. Fill out the setpoint scale along the left side of the worksheet. Remember that the profile ramp will start at the process value indicated when the profile is initiated.

The next step is to sketch the profile outline on the worksheet. Use the setpoint scale to determine the setpoint level. Be sure to fill in the time periods for each part of the segment in the boxes provided at the top of each column. The Ramp and Soak time boxes are located at the top of each column below the setpoint box for the segment. There are boxes at the bottom of each column to indicate the status of events, if used. If more than six segments are needed for the profile, individual profiles can be linked to preform sequentially. Linked profiles operate like one long profile.

Profile program information is easily determined by completing the Profile Developmental Worksheet (page 78) for the application. The information derived within the worksheet is directly related to the profile entry parameters of the profile controller.
### Profile Worksheet

Profile Number __________
Number of Segments __________

<table>
<thead>
<tr>
<th>Segments</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
<td>SP</td>
</tr>
<tr>
<td>Ramp</td>
<td>Time</td>
<td>Soak</td>
<td>Time</td>
<td>Soak</td>
<td>Time</td>
<td>Soak</td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>Time</td>
<td>Time</td>
<td>Time</td>
<td>Time</td>
<td>Time</td>
</tr>
</tbody>
</table>

Setpoint Scale

Event 1
Event 2
Event 3

Profile End Action ____________________________
Profile Loop Count ____________________________
Deviation Hold After Ramp Up __________________
Deviation Hold After Ramp Down ________________
Profile Time Base _____________________________
Profile Interrupt Action ______________________
Sample Profile

The following is a sample profile intended to assist in understanding how the profile controller functions. Be sure to disconnect all control outputs before running this profile.

Press and release the SCROLL key until Prog appears on the display then press the DOWN key. Press and release the DOWN key until dISp appears then press the SCROLL key. Press and hold the UP key until the display shows a 5 then press the SCROLL key. Press and release the Down key until Pt appears then press the SCROLL key. Press and hold the UP key until a 3 appears then press the SCROLL key. Press the UP key and Prog will appear. Press and release the SCROLL key until PENt appears then press the DOWN key. Perform the following keystrokes:

<table>
<thead>
<tr>
<th>Display</th>
<th>Keystroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>SCROLL</td>
</tr>
<tr>
<td>1</td>
<td>DOWN</td>
</tr>
<tr>
<td>nS</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP</td>
</tr>
<tr>
<td>rt</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>0.10</td>
<td>SCROLL</td>
</tr>
<tr>
<td>SP</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/Down</td>
</tr>
<tr>
<td>100</td>
<td>SCROLL</td>
</tr>
<tr>
<td>St</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>0.10</td>
<td>SCROLL</td>
</tr>
<tr>
<td>rt</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>0.10</td>
<td>SCROLL</td>
</tr>
<tr>
<td>SP</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>150</td>
<td>SCROLL</td>
</tr>
<tr>
<td>St</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>rt</td>
<td>SCROLL</td>
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<tr>
<td>X</td>
<td>UP/DOWN</td>
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<tr>
<td>0.10</td>
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</tr>
<tr>
<td>SP</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
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<td>300</td>
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<tr>
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<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>0.10</td>
<td>SCROLL</td>
</tr>
<tr>
<td>rt</td>
<td>SCROLL</td>
</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>0.10</td>
<td>SCROLL</td>
</tr>
<tr>
<td>SP</td>
<td>SCROLL</td>
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<tr>
<td>X</td>
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<td>200</td>
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<td>SCROLL</td>
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<tr>
<td>X</td>
<td>UP/DOWN</td>
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<tr>
<td>0.10</td>
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<td>X</td>
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</tr>
<tr>
<td>X</td>
<td>UP/DOWN</td>
</tr>
<tr>
<td>100</td>
<td>SCROLL</td>
</tr>
</tbody>
</table>

With PENt on the display, press and release the SCROLL key until P 1 appears in the display then press RUN/ HOLD key. The display will show run, then display the ramping setpoint of the profile. This is to demonstrate how the profile controller functions.
Warranty and Return Statement

These products are sold by The Anderson Instrument Company (Anderson) under the warranties set forth in the following paragraphs. Such warranties are extended only with respect to a purchase of these products, as new merchandise, directly from Anderson or from an Anderson distributor, representative or reseller, and are extended only to the first buyer thereof who purchases them other than for the purpose of resale.

Warranty

These products are warranted to be free from functional defects in materials and workmanship at the time the products leave the Anderson factory and to conform at that time to the specifications set forth in the relevant Anderson instruction manual or manuals, sheet or sheets, for such products for a period of three years.

THERE ARE NO EXPRESSED OR IMPLIED WARRANTIES WHICH EXTEND BEYOND THE WARRANTIES HEREIN AND ABOVE SET FORTH. ANDERSON MAKES NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE PRODUCTS.

Limitations

Anderson shall not be liable for any incidental damages, consequential damages, special damages, or any other damages, costs or expenses excepting only the cost or expense of repair or replacement as described above.

Products must be installed and maintained in accordance with Anderson instructions. Users are responsible for the suitability of the products to their application. There is no warranty against damage resulting from corrosion, misapplication, improper specifications or other operating condition beyond our control. Claims against carriers for damage in transit must be filed by the buyer.

This warranty is void if the purchaser uses non-factory approved replacement parts and supplies or if the purchaser attempts to repair the product themselves or through a third party without Anderson authorization.

Returns

Anderson's sole and exclusive obligation and buyer's sole and exclusive remedy under the above warranty is limited to repairing or replacing (at Anderson's option), free of charge, the products which are reported in writing to Anderson at its main office indicated below.

Anderson is to be advised of return requests during normal business hours and such returns are to include a statement of the observed deficiency. The buyer shall pre-pay shipping charges for products returned and Anderson or its representative shall pay for the return of the products to the buyer.

Approved returns should be sent to: ANDEHRON INSTRUMENT COMPANY INC.
156 AURIESVILLE ROAD
FULTONVILLE, NY 12072 USA
ATT: REPAIR DEPARTMENT