Instructions for Tempco Control Enclosure
PCM10005 through PCM10008

There is no disconnect or heater fusing in this enclosure. Heater fusing and disconnect must be supplied by the installer. It is strongly recommended that the process should incorporate a LIMIT CONTROL such as the TEC-910 which will shut down the equipment at a preset process condition in order to preclude possible damage to products or system.

1. Dangerous voltage capable of causing injury or death is present within this enclosure. Power to all equipment must be disconnected before installation or beginning any troubleshooting procedures. All wiring and component replacement must be made by qualified personnel only.

2. To minimize the possibility of fire or shock, do not expose this console to rain or excessive moisture.

3. Do not use this enclosure in areas where hazardous conditions exist such as excessive shock, vibration, dirt, corrosive gases, oil or where explosive gases or vapors are present.

Component Identification

1: TEC-9100 Controller
2: On-Off Rocker Switch
3: 1/2" EMT Conn. For Sensor
4: 3/4" EMT Conn. For Heater Power - For PCM10005 Only
   1" EMT Conn. For Heater Power - For PCM10006-08
5: 3/4" EMT Conn. For Incoming Power - For PCM10005 Only
   1" EMT Conn. For Incoming Power - For PCM10006-08
6: 2 Fuse Holders, see spare parts for fuse replacement on next page

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Input Voltage</th>
<th>Max. Amperage</th>
<th>Required Heater Fusing</th>
<th>Max. Wattage 1ph</th>
<th>Max. Wattage 3ph</th>
<th>Mounting Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCM10005</td>
<td>240VAC</td>
<td>24</td>
<td>30 Amps</td>
<td>5760W</td>
<td>9,970W</td>
<td>10.75&quot;  8&quot;</td>
</tr>
<tr>
<td>PCM10006</td>
<td>480VAC</td>
<td>24</td>
<td>30 Amps</td>
<td>11,520W</td>
<td>19,930W</td>
<td>14.75&quot;  10&quot;</td>
</tr>
<tr>
<td>PCM10007</td>
<td>240VAC</td>
<td>48</td>
<td>60 Amps</td>
<td>11,520W</td>
<td>19,930W</td>
<td>14.75&quot;  10&quot;</td>
</tr>
<tr>
<td>PCM10008</td>
<td>480VAC</td>
<td>48</td>
<td>60 Amps</td>
<td>23,000W</td>
<td>39,900W</td>
<td>14.75&quot;  10&quot;</td>
</tr>
</tbody>
</table>
WIRING (for safety, disconnect all power sources prior to wiring, refer to the appropriate wiring diagram at the end of this manual)

1. Attach the leads from your sensor to the sensor terminal block, terminals 7, 8 & 9. For a thermocouple, most commonly the red lead is negative (-) negative, attach that to terminal 9. The positive lead of the thermocouple should be connected to terminal 8. The TEC-9100 controller is preprogrammed to accept a type J thermocouple. If another sensor is used, the “INPT” setting has to be revised.

2. **Make sure your service power has been disconnected and locked out.**
   - Please note the enclosed wiring diagram.
   - Wire your single phase supply to terminals 1 & 2. If you are using three phase power, wire to terminals 1, 2 & 3.
   - Connect your heater load to terminals 4 & 5 if using single phase, 4, 5 & 6 if using three phase.
   - Follow all local and national codes.
   - Add disconnect and fusing as required.
   - Before applying power, check tightness of all terminals.

3. An optional NO-NC alarm can be connected to terminals 1, 2 & 3 of the TEC-9100 controller. This relay is rated at 2 amps, 240 volts. See Alarm Wiring Diagrams on page 6.

OPERATION

1. Refer to the instruction manual provided for complete operation and auto-tuning instructions for the TEC-9100 temperature controller.

2. Close and secure the door. Switch on the enclosure. Using the up & down pushbuttons on the TEC-9100 controller, start out with the temperature set low to test your system performance. If the set point temperature is being maintained, set your desired temperature setpoint. If your setpoint temperature is not being maintained, please refer to the auto-tuning procedure in the attached manual. If auto-tuning does not produce the required results, manual tuning may be necessary.

   **Note:** The signal of the output circuit is wired through output 2 of the TEC-9100 which can be used as a cut-out in the event of an over-setpoint temperature condition. This is a deviation contact set to 30° F above the setpoint.
   - In the event of an over-setpoint temperature condition, output 2 will open, cutting the control signal to the output relay.
   - This deviation setpoint can be changed by accessing “SP2” in the TEC-9100 (note following). This is not meant to be a redundant safety controller.
   - Refer to our TEC-910 for a safety controller.

SPARE/REPLACEMENT PARTS

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EHD-124-276</td>
<td>(2) TEC Control fuses rated 1 amp, 250VAC, 1/4&quot; x 1-1/4&quot;, Bussmann ABC-1 or equal (PCM10005/PCM10007)</td>
</tr>
<tr>
<td>EHD-124-253</td>
<td>(2) TEC Control fuses rated 3/10 amp, 600VAC class CC. Littelfuse KLDR-3/10 or equal (PCM10006/PCM10008)</td>
</tr>
</tbody>
</table>
1–5 Menu Overview

Entering these modes will break the control loop and change some of the previously set data. Make sure that the system is able to accept these modes.

*1: This flow chart shows a complete listing of all parameters. For actual application the number of available parameters depends on setup conditions and could be less than that shown in the flow chart.

*2: You can select up to 8 parameters to be placed in the user menu by using SEL1–SEL8 located at the bottom of setup menu.

*3: Release 2, press 2 again for at least 2 but no more than 3 seconds, then release to access the calibration menu.

The user menu shown in the flow chart corresponds to the default setting for SELECT parameters SEL1 to SEL8. SP3 will be hidden if NONE is selected for ALFN. SP2 will be hidden if the alarm function is not selected for OUT2. An unused parameter will be hidden even if it selected by the SEL parameters.
### 1-6 Parameter Descriptions (page 1 of 2)

<table>
<thead>
<tr>
<th>Parameter Notation</th>
<th>Parameter Description (Refer to Page)</th>
<th>Range</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SP1</strong></td>
<td>Set point for output 1</td>
<td>Low: SP1L High: SP1H</td>
<td>(77.0°F)</td>
</tr>
<tr>
<td><strong>SP2</strong></td>
<td>Set point for output 2 when output 2 performs alarm function</td>
<td>Low: -19999 High: 45536</td>
<td>(30.0°F)</td>
</tr>
<tr>
<td><strong>SP3</strong></td>
<td>Set point for alarm or dwell timer output</td>
<td>Low: -19999 High: 45536</td>
<td>(18.0°F)</td>
</tr>
<tr>
<td><strong>LoCL</strong></td>
<td>Lock to be locked out (Page 7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>INPT</strong></td>
<td>Input sensor selection (Page 7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>DEC</strong></td>
<td>Decimal point selection (Page 7)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>LS</strong></td>
<td>Input low scale value (Page 7)</td>
<td>Low: -19999 High: 45536</td>
<td>(–17.8°C (0°F))</td>
</tr>
<tr>
<td><strong>HI</strong></td>
<td>Input high scale value (Page 7)</td>
<td>Low: INLO+50 High: 45536</td>
<td>(538°C (1000°F))</td>
</tr>
<tr>
<td><strong>LP</strong></td>
<td>Low limit of set point (Page 7)</td>
<td>Low: -19999 High: 45536</td>
<td>(–17.8°C (0°F))</td>
</tr>
<tr>
<td><strong>HP</strong></td>
<td>High limit of set point value (Page 11)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>PV</strong></td>
<td>PV shift (offset) value (Page 11)</td>
<td>Low: -200.0°C High: 200.0°C</td>
<td>(–360.0°F High: 360.0°F)</td>
</tr>
<tr>
<td><strong>FILT</strong></td>
<td>Filter damping time constant of PV (Page 11)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Notation</th>
<th>Parameter Description (Refer to Page)</th>
<th>Range</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>0</strong></td>
<td>0: second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>1: second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>2: second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>0.2</strong></td>
<td>0.2 second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>0.5</strong></td>
<td>0.5 second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>1</strong></td>
<td>1: second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong></td>
<td>2: second time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>5: seconds time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>10</strong></td>
<td>10 seconds time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>20</strong></td>
<td>20 seconds time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>30</strong></td>
<td>30 seconds time constant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>60</strong></td>
<td>60 seconds time constant</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

* Indicates Controller Parameter Settings That Are Not Applicable
<table>
<thead>
<tr>
<th>Parameter Notation</th>
<th>Parameter Description (Refer to Page)</th>
<th>Range</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>d9H8 DATA</td>
<td>Data bit count of digital communication</td>
<td>0) b8 : 8 data bits&lt;br&gt;1) b8 : 7 data bits</td>
<td>1</td>
</tr>
<tr>
<td>P8r- PARI</td>
<td>Parity bit of digital communication</td>
<td>0) EYE : Even parity&lt;br&gt;1) ADD : Odd parity&lt;br&gt;2) none : No parity bit</td>
<td>0</td>
</tr>
<tr>
<td>Step STOP</td>
<td>Stop bit count of digital communication</td>
<td>0) b8 : One stop bit&lt;br&gt;1) b8 : Two stop bits</td>
<td>0</td>
</tr>
<tr>
<td>-RELO</td>
<td>Retransmission low scale value</td>
<td>Low: -19999 High: 45536&lt;br&gt; -17.8°C (0°F)</td>
<td>53°C (1000°F)</td>
</tr>
</tbody>
</table>
Alarm Wiring

Figure 2.19 Alarm Output to Drive Load

Figure 2.20 Alarm Output to Drive Contactor

Figure 2.20.1 Dwell Timer Function
Chapter 3 Programming

Press \( \mathfrak{O} \) for 5 seconds and release to enter the setup menu. Press \( \mathfrak{O} \) to select the desired parameter. The upper display indicates the parameter symbol, and the lower display indicates the selected value of the parameter.

3–1 Lockout

There are four security levels that can be selected using the LOCK parameter.

If **NONE** is selected for LOCK, then no parameter is locked.

If **SET** is selected for LOCK, then all setup data are locked.

If **USER** is selected for LOCK, then all setup data as well as user data (refer to section 1-5) except the set point are locked to prevent them from being changed.

If **ALL** is selected for LOCK, then all parameters are locked to prevent them from being changed.

3–2 Signal Input

**INPT:** Selects the sensor type or signal type for signal input.

- **Range:** (thermocouple) J-TC, K-TC, T-TC, E-TC, B-TC, R-TC, S-TC, N-TC, L-TC
  - (RTD) PT.DN, PT.JS

**UNIT:** Selects the process unit

- **Range:** °C, °F

**DP:** Selects the resolution of process value.

- **Range:** (For T/C and RTD) NO.DP, 1-DP

3–3 Control Outputs

There are four kinds of control modes that can be configured as shown in table 3.1.

Table 3.1 Heat-Cool Control Setup Value

<table>
<thead>
<tr>
<th>Control Modes</th>
<th>OUT1</th>
<th>OUT2</th>
<th>O1HY</th>
<th>O2HY</th>
<th>CPB</th>
<th>DB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat only</td>
<td>REVR</td>
<td>×</td>
<td>⭐</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Cool only</td>
<td>DIRT</td>
<td>×</td>
<td>⭐</td>
<td>×</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Heat: PID</td>
<td>REVR</td>
<td>DE.HI</td>
<td>×</td>
<td>O</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>Cool: ON-OFF</td>
<td>REVR</td>
<td>COOL</td>
<td>×</td>
<td>×</td>
<td>O</td>
<td>O</td>
</tr>
</tbody>
</table>

- \( \times \): Does not apply
- \( \bigstar \): Adjust to meet process requirements
- \( \bigstar \): Required if ON-OFF control is configured

**OUT1:**
- Output 1 Type

**OUT2:**
- Output 2 Type

**O1HY:**
- Output 1 Hysteresis

**O2HY:**
- Output 2 Hysteresis

**CPB:**
- Cooling Proportional Band

**DB:**
- Heating Cooling Dead Band
**Heat only ON-OFF control**: Select REVR for OUT1. Set PB (proportional band) to 0. O1HY is used to adjust dead band for ON-OFF control. The output 1 hysteresis (O1HY) is enabled in case PB=0. The heat only on-off control function is shown in the following diagram:

![Diagram of Heat Only ON-OFF Control](image)

**Figure 3.2 Heat Only ON-OFF Control**

The ON-OFF control may introduce excessive process oscillation even if hysteresis is minimized. If ON-OFF control is set (i.e., PB=0), TI, TD, CYC1, OFST, CYC2, CPB, and DB will be hidden and have no function in the system. The auto-tuning and bumpless transfer functions will be disabled as well.

**Heat only P (or PD) control**: Select REVR for OUT1, set TI to 0. OFST is used to adjust the control offset (manual reset). **O1HY is hidden** if PB is not equal to 0. **OFST function**: OFST is measured by % with a range of 0–100.0%. In the steady state (i.e., process has been stabilized), if the process value is lower than the set point by a definite value, say 5°C, while 20°C is used for PB, that is lower by 25%, then increase OFST 25%, and vice-versa. After adjusting OFST value, the process value will be varied and eventually coincide with set point.

Refer to section 3-12 “manual tuning” for the adjustment of PB and TD. Manual reset (adjust OFST) is not practical because the load may change from time to time and OFST may need to be adjusted repeatedly. PID control can avoid this situation.

**Heat only PID control**: If REVR is selected for OUT1, PB and TI should not be zero. Perform auto-tuning for the new process, or set PB, TI, and TD with historical values. See section 3-11 for auto-tuning operation. If the control result is still unsatisfactory, then use manual tuning to improve control. See section 3-12 for manual tuning. The unit contains a very advanced PID and Fuzzy Logic algorithm to create a very small overshoot and very quick response to the process if it is properly tuned.

**Cool only control**: ON-OFF control, P (PD) control, and PID control can be used for cool control. Set OUT1 to DIRT (direct action). The other functions for cool only ON-OFF control, cool only P (PD) control, and cool only PID control are the same as for heat only control except that the output variable (and action) for cool control is inverse to heat control.

**NOTE**: ON-OFF control may result in excessive overshoot and undershoot problems in the process. P (or PD) control will result in a deviation of process value from the set point. It is recommended to use PID control for heat-cool control to produce a stable and zero offset process value.

**Other setup required**: O1TY, CYC1, O2TY, CYC2, O1FT and O2FT are set in accordance with the types of OUT1 and OUT2 installed. CYC1 and CYC2 are selected according to the output type (O1TY) and output type (O2TY). Generally, select 0.5–2 seconds for CYC1 if SSRD or SSR is used for O1TY; 10–20 seconds if relay is used for O1TY. CYC1 is ignored if a linear output is used. Similar conditions are applied for CYC2 selection.

You can use the auto-tuning program for the new process or directly set the appropriate values for PB, TI, and TD according to historical records for the repeated systems. If the control behavior is still inadequate, use manual tuning to improve the control. See section 3-12 for manual tuning.
3–4 Alarm

The controller has one alarm output. There are six types of alarm functions and one dwell timer that can be selected, and four kinds of alarm modes (ALMD) are available for each alarm function (ALFN). Output 2 can be configured as another alarm in addition to the alarm output. But output 2 only provides four kinds of alarm functions and only normal alarm mode is available for this alarm. When output 2 is used as an alarm, SP2 sets the trigger point. SP3 sets the trigger point for Alarm.

A **process alarm** sets absolute trigger levels. When the process is higher than SP3, a process high alarm (PV.HI) occurs, and the alarm is off when the process is lower than SP3-ALHY. When the process is lower than SP3, a process low alarm (PV.LO) occurs, and the alarm is off when the process is higher than SP3+ALHY. A process alarm is independent of the set point.

A **deviation alarm** alerts the user when the process deviates from the set point. When the process is higher than SV+SP3, a deviation high alarm (DE.HI) occurs, and the alarm is off when the process is lower than SV+SP3-ALHY. When the process is lower than SV+SP3, a deviation low alarm (DE.LO) occurs, and the alarm is off when the process is higher than SV+SP3+ALHY. The trigger level of the deviation alarm moves with the set point.

A **deviation band alarm** presets two trigger levels relative to the set point. The two trigger levels are SV+SP3 and SV-SP3 for alarm. When the process is higher than (SV+SP3) or lower than (SV-SP3), a deviation band high alarm (DB.HI) occurs. When the process is within the trigger levels, a deviation band low alarm (DB.LO) occurs.

There are four types of alarm modes available for each alarm function. These are: normal alarm, latching alarm, holding alarm and latching/holding alarm. They are described as follows:

**Normal alarm: ALMD=NORM**

When a normal alarm is selected, the alarm output is de-energized in the non-alarm condition and energized in an alarm condition.

**Latching alarm: ALMD=LTCH**

If a latching alarm is selected, once the alarm output is energized, it will remain unchanged even if the alarm condition is cleared. The latching alarm is reset when the RESET key is pressed after the alarm condition is removed.

**Holding alarm: ALMD=HOLD**

A holding alarm prevents an alarm when the control is powering up. The alarm is enabled only when the process reaches the set point value. Afterwards, the alarm performs the same function as a normal alarm.

**Latching/holding alarm: ALMD=LT.HO**

A latching/holding alarm performs both holding and latching functions. The latching alarm is reset when the RESET key is pressed after the alarm condition is removed.

**Alarm failure transfer** is activated as the unit enters failure mode. The alarm will go on if ALFT is set for ON and go off if ALFT is set for OFF. The unit will enter failure mode when a sensor break occurs or if the A-D converter of the unit fails.
3–5 Configuring User Menu

Most conventional controllers are designed with a fixed order in which the parameters scroll. The x100 series have the flexibility to allow you to select those parameters which are most significant to you and put these parameters at the front of the display sequence.

SEL1–SEL8: Selects the parameter for view and change in the user menu.

Range: LOCK, INPT, UNIT, DP, SHIF, PB, TI, TD, O1HY, CYC1, OFST, RR, O2HY, CYC2, CPB, DB, ADDR, ALHY

When using the up and down keys to select the parameters, you may not see all of the above parameters. The number of visible parameters is dependent on the setup condition. The hidden parameters for the specific application are also blocked from the SEL selection.

Example:

OUT2 set for DE.LO     PB = 100.0     SEL1 set for INPT
SEL2 set for UNIT     SEL3 set for PB      SEL4 set for TI
SEL5–SEL8 set for NONE

Now, the upper display scrolling becomes:

3–6 Ramp

Ramp

The ramping function is performed during power up as well as any time the set point is changed. If MINR or HRR is chosen for RAMP, the unit will perform the ramping function. The ramp rate is programmed by adjusting RR. The ramping function is disabled as soon as failure mode, manual control mode, auto-tuning mode or calibration mode is entered.

Example without dwell timer

Select MINR for RAMP, select °C for UNIT, select 1-DP for DP, set RR = 10.0. SV is set to 200°C initially, and changed to 100°C 30 minutes after power-up. The starting temperature is 30°C. After power-up, the process runs like the curve shown below:

Note: When the ramp function is used, the lower display will show the current ramping value. The ramping value is an artificially determined setpoint created and updated by the control to match the ramp rate set by the user. However, it will revert to show the set point value as soon as the up or down key is touched for adjustment. The ramping value is initiated to process value either on power-up or when RR and/or the set point are changed. Setting RR to zero means no ramp function.

3–7 Dwell Timer

The alarm output can be configured as a dwell timer by selecting TIMR for ALFN (alarm function). As the dwell timer is configured, the parameter SP3 is used for dwell time adjustment. The dwell time is measured in minutes ranging from 0.1 to 4553 minutes. Once the process reaches the set point the dwell timer starts to count down to zero (time out). The timer relay will remain unchanged until time out. For the dwell timer to control the heater, the heater circuit (or contactor) must be wired in series with the alarm relay. Note the following diagram located below and also Figure 2.20.1 on page 11. When the dwell timer times out, the heater will be turned off. The dwell timer operation is shown in the following diagram.

After time out, the dwell timer can be restarted by pressing the RESET key.

The timer stops counting during manual control mode, failure mode, the calibration period and the auto-tuning period.

If the alarm is configured as a dwell timer, ALHY and ALMD are hidden.

![Figure 3.5 RAMP Function](image)

![Figure 3.6 Dwell Timer Function](image)

![Dwell Timer Function Wiring Diagram](image)
3–8 PV Shift
In certain applications it is desirable to shift the controller display value (PV) from its actual value. This can easily be accomplished by using the PV shift function. The SHIF function will alter PV only.

Example: A process is equipped with a heater, a sensor, and a subject to be warmed up. Due to the design and position of the components in the system, the sensor could not be placed any closer to the part. Thermal gradient (differing temperatures) is common and necessary to an extent in any thermal system for heat to be transferred from one point to another. If the difference between the sensor and the subject is 35°C, and the desired temperature at the subject to be heated is 200°C, the temperature at the sensor should be 235°C. You should enter -35°C to subtract 35°C from the actual process display. This in turn will cause the controller to energize the load and bring the process display up to the set point value.

3–9 Digital Filter
In certain applications, the process value is too unstable to be read due possibly to electrical noise. A programmable low-pass filter incorporated in the controller is used to improve this. It is a first-order filter with the time constant specified by the FILT parameter. The default value of FILT is set at 0.5 seconds before shipping. Adjust FILT to change the time constant from 0 to 60 seconds. 0 seconds means no filter is applied to the input signal. The filter is characterized by the following diagram:

Note
The filter is available only for PV, and is performed for the displayed value only. The controller is designed to use unfiltered signal for control even if the filter is applied. A lagged (filtered) signal, if used for control, may produce an unstable process.

3–10 Failure Transfer
The controller will enter failure mode if one of the following conditions occurs:
1. SBER occurs due to input sensor break or input current below 1mA if 4–20 mA is selected or input voltage below 0.25V if 1–5V is selected.
2. ADER occurs due to the A-D converter of the controller failing.
Output 1 and output 2 will perform the failure transfer function as the controller enters failure mode.

Output 1 failure transfer, if activated, will perform:
1. If output 1 is configured as proportional control (PB≠0), and BPLS is selected for O1FT, then output 1 will perform bumpless transfer. Thereafter, the previous averaging value of MV1 will be used for controlling output 1.
2. If output 1 is configured as proportional control (PB≠0), and a value of 0 to 100.0% is set for O1FT, then output 1 will perform failure transfer. Thereafter, the value of O1FT will be used for controlling output 1.
3. If output 1 is configured as ON-OFF control (PB=0), then output 1 will be driven OFF if OFF is set for O1FT and will be driven ON if ON is set for O1FT.

Output 2 failure transfer, if activated, will perform:
1. If OUT2 is configured as COOL, and BPLS is selected for O1FT, then output 2 will perform bumpless transfer. Thereafter, the previous averaging value of MV2 will be used for controlling output 2.
2. If OUT2 is configured as COOL, and a value of 0 to 100.0% is set for O2FT, then output 2 will perform failure transfer. Thereafter, the value of O1FT will be used for controlling output 2.
3. If OUT2 is configured as alarm function, and O2FT is set to OFF, then output 2 will go off. Otherwise, output 2 will go on if O2FT is set to ON.

Alarm failure transfer is activated as the controller enters failure mode. Thereafter, the alarm will transfer to the ON or OFF state preset by ALFT.
3–11 Auto-tuning

The auto-tuning process is performed near the set point. The process will oscillate around the set point during the tuning process. Set the set point at a lower value if overshooting beyond the normal process value is likely to cause damage.

Auto-tuning is applied in cases of:

- **Initial setup for a new process**
- **The set point is changed substantially from the previous auto-tuning value**
- **The control result is unsatisfactory**

**Operation:**

1. The system has been installed normally.
2. Set the correct values for the setup menu of the unit, but don’t set a zero value for PB and TI, or the auto-tuning program will be disabled. The LOCK parameter should be set at NONE.
3. Set the set point to a normal operating value, or a lower value if overshooting beyond the normal process value is likely to cause damage.
4. Press □ and hold until □E appears on the display.
5. Then press □ again for at least 5 seconds. The AT indicator will begin to flash and the auto-tuning procedure begins.

**NOTE:** The ramping function, if used, will be disabled when auto-tuning is taking place.

Auto-tuning mode is disabled as soon as either failure mode or manual control mode is entered.

**Procedures:**

Auto-tuning can be applied either as the process is warming up (cold start), or when the process has been in a steady state (warm start). After the auto-tuning procedures are completed, the AT indicator will cease to flash and the unit will revert to PID control using its new PID values. The PID values obtained are stored in the nonvolatile memory.

**Auto-Tuning Error**

If auto-tuning fails an ATER message will appear on the upper display in the following cases:

- If PB exceeds 9000 (9000 PU, 900.0°F or 500.0°C),
- if TI exceeds 1000 seconds,
- if the set point is changed during the auto-tuning procedure.

**Solutions to ATER**

1. Try auto-tuning once again.
2. Don’t change the set point value during the auto-tuning procedure.
3. Don’t set a zero value for PB and TI.
4. Use manual tuning instead of auto-tuning (see section 3-12).
5. Touch RESET key to reset ATER message.

3–12 Manual Tuning

In certain applications auto-tuning may be inadequate for the control requirements. You can try manual tuning for these applications.

If the control performance using auto-tuning is still unsatisfactory, the following rules can be applied for further adjustment of PID values:

<table>
<thead>
<tr>
<th>ADJUSTMENT SEQUENCE</th>
<th>SYMPTOM</th>
<th>SOLUTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Proportional Band (PB)</td>
<td>High overshoot or Oscillations</td>
<td>Decrease PB</td>
</tr>
<tr>
<td>(2) Integral Time (TI)</td>
<td>Instability or Oscillations</td>
<td>Increase TI</td>
</tr>
<tr>
<td>(3) Derivative Time (TD)</td>
<td>Slow Response or Oscillations</td>
<td>Decrease TD</td>
</tr>
<tr>
<td></td>
<td>High Overshoot</td>
<td>Increase TD</td>
</tr>
</tbody>
</table>

**Figure 3.9 Effects of PID Adjustment**

Figure 3.9 shows the effects of PID adjustment on process response.
3–13 Manual Control

Operation
To enable manual control, the LOCK parameter should be set to NONE, then press [Hand] for 6.2 seconds; [Hand] (hand control) will appear on the display. Press [Hand] for 5 seconds, then the MAN indicator will begin to flash and the lower display will show [H]. The controller is now in manual control mode. [H] indicates output control variable for output 1, and [F] indicates control variable for output 2. Now you can use the up and down keys to adjust the percentage values for the heating or cooling output.

The controller performs open loop control as long as it stays in manual control mode.

Exit Manual Control
Pressing the [R] key will cause the controller to revert to its normal display mode.
## Table A.1 Error Codes and Corrective Actions

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Display Symbol</th>
<th>Error Description</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td><strong>Er 04</strong></td>
<td>Illegal setup values being used: Before COOL is used for OUT2, DIRT (cooling action) has already been used for OUT1, or PID mode is not used for OUT1 (that is, PB=0 and/or TI=0)</td>
<td>Check and correct setup values of OUT2, PB, TI and OUT1. If OUT2 is required for cooling control, the control should use PID mode (PB=0, TI=0) and OUT1 should use reverse mode (heating action). Otherwise, don’t use OUT2 for cooling control.</td>
</tr>
<tr>
<td>10</td>
<td><strong>Er 10</strong></td>
<td>Communication error: bad function code</td>
<td>Correct the communication software to meet the protocol requirements.</td>
</tr>
<tr>
<td>11</td>
<td><strong>Er 11</strong></td>
<td>Communication error: register address out of range</td>
<td>Don’t issue an over-range register address to the slave.</td>
</tr>
<tr>
<td>14</td>
<td><strong>Er 14</strong></td>
<td>Communication error: attempt to write a read-only data or a protected data</td>
<td>Don’t write a read-only data or a protected data to the slave.</td>
</tr>
<tr>
<td>15</td>
<td><strong>Er 15</strong></td>
<td>Communication error: write a value which is out of range to a register</td>
<td>Don’t write an over-range data to the slave register.</td>
</tr>
<tr>
<td>26</td>
<td><strong>RtEr</strong></td>
<td>Fail to perform auto-tuning function</td>
<td>1. The PID values obtained after auto-tuning procedure are out of range. Retry auto-tuning.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2. Don’t change set point value during auto-tuning procedure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4. Don’t set a zero value for PB.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5. Don’t set a zero value for TI.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. Press RESET key.</td>
</tr>
<tr>
<td>29</td>
<td><strong>EEPE</strong></td>
<td>EEPROM can’t be written correctly</td>
<td>Return to factory for repair.</td>
</tr>
<tr>
<td>30</td>
<td><strong>CEEr</strong></td>
<td>Cold junction compensation for thermocouple malfunction</td>
<td>Return to factory for repair.</td>
</tr>
<tr>
<td>39</td>
<td><strong>5bEr</strong></td>
<td>Input sensor break, or input current below 1 mA if 4-20 mA is selected, or input voltage below 0.25V if 1-5V is selected</td>
<td>Replace input sensor.</td>
</tr>
<tr>
<td>40</td>
<td><strong>RdeEr</strong></td>
<td>A to D converter or related component(s) malfunction</td>
<td>Return to factory for repair.</td>
</tr>
</tbody>
</table>
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RETURNS
No product returns can be accepted without a completed Return Material Authorization (RMA) form.

TECHNICAL SUPPORT
Technical questions and troubleshooting help is available from Tempco. When calling or writing please give as much background information on the application or process as possible.

E-mail: techsupport@tempco.com
Phone: 630-350-2252
800-323-6859

Note: Information in this manual was deemed correct at the time of printing. The policy of Tempco is one of continuous development and product improvement, and we reserve the right to modify specifications and designs without prior notice. Not responsible for typographical errors.
NOTE: TEC-9100 SETTIONS

- 3-WIRE CONNECTION
- SINGLE-HEAD CONNECTION
- WHITE THERMOCOUPLE
- RED THERMOCOUPLE
- BLACK THERMOCOUPLE
- POWER WIRE
- GROUND WIRE

AT 60 AMPS MAXIMUM.

THE INSTALLER IS RESPONSIBLE FOR DISCONNECTING THE HEATER FUSE AND REFRIGERATOR.

NOTE:

- 1/2 AND 3 PHASE TERMINALS
- 1 AND 2 PHASE TERMINALS
- CUSTOMER HEADERS
- 3-PHASE CONNECTION
- 240V 48A NOMINAL
- 11250 WATTS 3-PHASE
- 19.250 WATTS 3-PHASE
- 3-PHASE CONNECTION
- 240V 48A NOMINAL
- 90C THHN CONDUCTOR
- MIN. #6 AWG COPPER
- #MWH COPPER GREEN
- #4AWG #0 COPPER
- #4AWG #0 COPPER
- #4AWG #0 COPPER
NOTE: TE-C-9100 SETTINGS

- The Z wire color is to Term 6 and 9.
- With jumper between Term 8 and 9.
- T & 0 Rtd. with Term 10 & 8. Non-polarized. (1)

The recommended red lead is negative.

TYPE “C” Fusing.
4/60 AMPS MAX USE.
The installer is responsible for disconnecting the power source.

NOTE: HEATER FUSING AND TERMINALS.

PHASE 1, 2, AND 3.
6 AND 5.
4 AND 6.
3.

BETTER EXCEPTED.
THHN CONNECTOR OR.
MIN. #6AWG. COPPER.

3.9/0.06 WATTS 3-PHASE.
2.3/0.04 WATTS 1-PHASE.
4/0.48 NORMAL.

THHN CONNECTOR.

MAIN POWER CABLE:

CONTROL TRANS.

3-POLE 100 COIL.
6000 ohm RESISTOR.

CONTROL CONDUCTOR:

THHN COPPER BLACK.

CONTROL POWER WIRE:

#14AWG. 90°C WIRE.

SECONDARY POWER CABLE:

THHN COPPER BLACK.

CONTROL POWER WIRE:

#18AWG. 90°C WIRE.

GROUNDED WIRE:

MTW COPPER BLACK.

CONTROL POWER WIRE:

#18AWG. 90°C WIRE.

GROUND WIRE:

MTW COPPER GREEN/WHITE.

GROUND WIRE:

MTW COPPER BLACK.

GROUND WIRE:

MTW COPPER BLACK.

GROUND WIRE:

MTW COPPER BLACK.

GROUND WIRE:

MTW COPPER BLACK.
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Flexible Heaters  Tubular Heaters
Process Heaters  Instrumentation
Temperature Control  Temperature Sensors

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