CN3430 & CN3440 SERIES
Universal Temperature & Process Controllers

Operating Guide
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1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR NON-WARRANTY REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA’s policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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</tbody>
</table>
The instrument documentation is shown in Fig. 1.1. The Standard Manuals, including the specification sheet, are supplied with all instruments. The Modbus Supplement is supplied with instruments configured for Modbus Serial Communications.
## 2 SETTING UP

### 2.1 Instrument Power-up – Fig. 2.1

> **Caution.** Ensure that all connections, especially to the earth stud, are made correctly.

a) Check that the input sensors are installed correctly.

b) Switch on the supply to the instrument, any power-operated control circuits and the input signals.

c) The start-up sequence shown in Fig. 2.1 is displayed when the supply is first switched on.

### 2.2 Simple Fault-finding

If the instrument does not appear to be working satisfactorily, carry out the following checks before contacting the Service Organization:

- Are all connections made correctly?
- Is there power to the instrument?
- Is there a signal at the process variable input and/or the control output terminals?

---

**Instrument Test** identifies the instrument type – see *Table 2.1 in the Installation Guide*.

- **C300** or **C301** or **C310**

  Normal Display

  - 100.3
  - 200.5

  Configuration Check
  
  Indicates configuration error. Acknowledged by pressing the switch.

  Normal Display

  - 100.3
  - 200.5

  Line Failed
  
  Indicates power has been restored after a failure. Cleared by pressing the switch.

**Note.** Acknowledging error clears the display but does not rectify the fault. First check critical parameters. Power down and then power up the instrument. If the fault persists after checking all parameters, contact the Service Organization.
The displays, l.e.d. indicators and operation/programming controls are located on the faceplate on the front of the instrument.

### 3.1 Displays and LED Indicators – Fig. 3.1

The displays comprise 2 rows of 6 characters.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>R</td>
<td>L</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>b</td>
<td>M</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>c</td>
<td>N</td>
<td>n or n</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>d</td>
<td>O</td>
<td>o or o</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>E</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>F</td>
<td>Q</td>
<td>Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>G</td>
<td>R</td>
<td>r</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>h</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>I</td>
<td>T</td>
<td>t</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>K</td>
<td>V</td>
<td>V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3.1 Character Set**

### 3.2 LED Indication – Fig 3.1

LED indications are as follows:

- **A1** Alarm states for alarms 'A' to 'E' – see Section 4.11 in Programming Guide.
- **A2** Alarm states for alarms 'F' to 'K' – see Section 4.11 in Programming Guide.
- **LED Flashing** – alarm active but not acknowledged
- **LED On** – all active alarms acknowledged
- **LED Off** – alarms inactive
- **L** On if the local set point is being used – see Section 4.2 in Programming Guide.
- **R** On if the remote set point is being used – see Section 4.2 in Programming Guide.
  (Both L and R off if dual set point or dual fixed set points are used – see Section 4.2 in Programming Guide).
- **ST** On while the self-tune procedure is being performed (flashes when procedure is complete) – see Section 6.2.
- **M** On when the instrument is in Manual control mode.

---

**Fig. 3.1 Familiarisation with Controls, Displays and Indicators**
3.3 Use of Controls – Fig. 3.2 to 3.6

- **Fig. 3.2 Advancing to Next Page**

- **Fig. 3.3 Moving between Frames**

- **Note.** Continued pressure on the ↑ and ↓ switches causes the rate of change of the displayed value to increase. To make small adjustments operate the switches momentarily.

- **Fig. 3.4 Adjusting a Parameter Value**

- **Fig. 3.5 Selecting a Parameter Choice**

- **Used for selecting Automatic or Manual mode on alternate operations. When Manual mode is selected the displays revert automatically to the process variable values and control output or valve position (if position-proportioning or boundless motorized valve control is selected at Control Type frame in the Set Up Control Page) – See Section 4.10 in the Programming Guide.**

- **Fig. 3.6 Auto/Manual Switch Functions**
Information. The instrument has dedicated Operating Pages. These pages are used for general monitoring of the process measurements and are not affected by the security system which inhibits access to the programming and control pages only – see Section 5.5.

Fig. 4.1 Summary of Operating Levels

*Page hidden if Profile Function is ‘OFF’
†Page hidden if Profile Function is ‘ON’ or ‘Boundless’ control is selected
5 OPERATING LEVEL

5.1 Operating Page Introduction

5.1.1 Set Point Tracking
With set point tracking enabled (in the Set Points Page), the Local set point value tracks the process variable when the controller is in Manual control mode. In this mode of operation the set point limits do not apply. If the set point value is outside its limits when Automatic control mode is selected, the local set point remains outside its limits and can only be adjusted in one direction, towards its limits. Once inside the limits they apply as normal.

With remote set point tracking enabled, the Local set point tracks the remote set point value when in the remote set point mode. In this mode of operation the Local set point limits do not apply. If the set point value is outside its limits when the Local set point value is selected, the Local set point remains outside its limits and can only be adjusted in one direction, towards its limits. Once inside the limits they apply as normal.

5.1.2 Auto/Manual Transfer
All auto-to-manual transfers are bumpless. If the Local set point is used and set point tracking is enabled, all manual-to-auto transfers are bumpless, since the set point is always at the same value as the process variable. Without set point tracking enabled, the response following a manual-to-auto transfer depends on the control settings. With an integral action setting the output is ramped up or down to remove any process variable offset from the set point (providing the process variable is within the proportional band). If the integral action is off, the output may step to a new value when the controller is transferred back to Automatic control mode.

With remote set point tracking enabled, the control set point switches automatically from Remote to Local when Manual mode is selected.

5.1.3 Heat/Cool Control – Fig. 6.3
When in Automatic control mode both the heat and cool outputs are turned off when in the Output Off Hysteresis Band. In Manual control mode the Output Off Hysteresis Band has no effect. If the PID output is within the Off Hysteresis Band when the controller is returned to auto control mode, the Off Hysteresis Band has no effect until either the PID output goes outside the band or becomes equal to the Crossover Value.

![Fig. 5.1 Set Point Type Selection Facility (see Section 5.2 overleaf)](image-url)
5.2 Operating Page Displays

5.2.1 Time Proportioning and Analog Control

Control Set Point
The set point in use is displayed (Local, Remote or Dual). If the Local or Dual set point is displayed it can be adjusted using the ▲ and ▼ switches, providing Set Point Adjust Enable is set to YΕS – see Section 4.2 of the Programming Guide, Set Points Page.

Control Output Value (0 to 100%).
To adjust the output value manually: select Manual control mode using the ‘M’ l.e.d. is illuminated) and then use the ▲ and ▼ switches to set the required value

Manual Reset (0 to 100%).
This frame is not displayed if an Integral Action Time is set or Manual Reset Adjust Enable is set to OFF – see Section 7.2, Control Page.

Use the ▲ and ▼ switches to set a value which eliminates any offset from the set point.

Temperature Units
This frame is not displayed if the Display Units parameter is set to NONE – see Section 4.8 of the Programming Guide Set Up Display Page.

Set Point Type Selection – Fig. 5.1 (previous page)
Use the switch to view the various set point values. If the difference is too great, press the switch and return to the Control Set Point frame and adjust the Local set point to obtain an acceptable difference. The Local set point tracks the Remote set point when the Remote set point is selected, providing Remote Set Point Tracking Enable is set to YΕS – see Section 4.2 of the Programming Guide, Set Points Page.

Remote Set Point Ratio
The remote set point input (in engineering units) is multiplied by the ratio to obtain the control set point value, i.e.

Remote Set Point Value = Input x Ratio + Bias

Use the ▲ and ▼ switches to set the ratio required, between 0.010 and 9.999 in 0.001 increments

Remote Set Point Bias
The bias value is added to the remote set point value (see previous frame) Use the ▲ and ▼ switches to set the bias required. The bias can be set to either a positive or negative value (in engineering units).
5.2.2 Motorized Valve Control

Control Set Point
The set point in use is displayed (Local, Remote or Dual). If the Local or Dual set point is displayed it can be adjusted using the [▲] and [▼] switches, providing Set Point Adjust Enable is set to YES – see Section 4.2 of the Programming Guide, Set Points Page.

Valve Status and Valve Position (%)
- ▼ – valve stopped
- ▲ – valve opening
- ◼ – valve closing

The valve position is displayed as a percentage of its full travel position (not displayed on boundless controllers with position indication disabled). To adjust the valve position manually: select Manual control mode using the [M] l.e.d. is illuminated and then use the [▲] and [▼] switches to set valve position required (the [▲] switch opens the valve and the [▼] switch closes the valve). With neither switch pressed the valve is stopped.

Manual Reset (0 to 100%).
This frame is not displayed if an Integral Action Time is set or Manual Reset Adjust Enable is set to OFF – see Section 7.2, Control Page.

Use the [▲] and [▼] switches to set a value which eliminates any offset from the set point.

Temperature Units
This frame is not displayed if the Display Units parameter is set to NONE – see Section 4.8 of the Programming Guide Set Up Display Page.

Set Point Type Selection – Fig. 5.1 (previous page)
Use the [▲] switch to view the various set point values. If the difference is too great, press the [▲] switch and return to the Control Set Point frame and adjust the Local set point to obtain an acceptable difference. The Local set point tracks the Remote set point when the Remote set point is selected, providing Remote Set Point Tracking Enable is set to YES – see Section 4.2 of the Programming Guide, Set Points Page.

For Remote Set Point Ratio and Remote Set Point Bias settings, refer to opposite page.
5.2.3 Heat/Cool Control

**Control Set Point**
The set point in use is displayed (Local, Remote or Dual). If the Local or Dual set point is displayed it can be adjusted using the \(<\) and \(>\) switches, providing Set Point Adjust Enable is set to \(Y\) – see Section 4.2 of the Programming Guide, *Set Points Page*.

**Percentage Output (Heat, Cool and PID)**
To adjust the output value manually: select Manual control mode using the \(M\) switch (‘M’ l.e.d. is illuminated) and then use the \(<\) and \(>\) switches to set the value required (between 0 and 100%).

**PID Output**
This frame is not displayed if the P.I.D. output is above the Crossover Value.

**Heat Output**
This frame is not displayed if the P.I.D. output is below the Crossover Value.

**Manual Reset, Heat and Cool** (0 to 100%). This frame is not displayed if an Integral Action Time is set or Manual Reset Adjust Enable is set to \(O\) – see Section 7.2, Control Page.

Use the \(<\) and \(>\) switches to set a value which eliminates any offset from the set point.

**Temperature Units**
This frame is not displayed if the Display Units parameter is set to \(N\) – see Section 4.8 of the Programming Guide *Set Up Display Page*.

For Set Point Type Selection, Remote Set Point Ratio and Remote Set Point Bias settings, refer to page 8.
### 5.3 Operating Page Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINE FAILED</td>
<td>Line Failed – indicates power failure.</td>
</tr>
<tr>
<td>S-TUNE FAIL</td>
<td>Self-tune Fail – Self-tune procedure has failed.</td>
</tr>
<tr>
<td>S-TUNE CAU TN</td>
<td>Self-tune Caution – process complete, but values may not be correct.</td>
</tr>
<tr>
<td>F-INP</td>
<td>Failed Input – process variable input failure.</td>
</tr>
<tr>
<td>F-rSPt</td>
<td>Failed Remote Set Point Input – flashes in lower display when remote set point input exceeds its fault detection level.</td>
</tr>
<tr>
<td>F-PSN</td>
<td>Failed Position Feedback Input – flashes in lower display when position feedback exceeds its fault detection level.</td>
</tr>
<tr>
<td>LIN-Or</td>
<td>Failed Linearizer Range – flashes in upper display when lineariser range set exceeds that allowed for the input linearizer selected.</td>
</tr>
<tr>
<td>HPrC</td>
<td>High Process Alarm – flashes when a high process alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td>LPrC</td>
<td>Low Process Alarm – flashes when a low process alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td>HdEU</td>
<td>High Deviation Alarm – flashes when a high deviation alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td>LdEU</td>
<td>Low Deviation Alarm – flashes when a low deviation alarm condition is present and unacknowledged.</td>
</tr>
</tbody>
</table>

Table 5.1A Input Error Messages Displayed in the Operating Page
### 5.3 Operating Page Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="HOUe" alt="Image" /></td>
<td><strong>High Output Alarm</strong> – flashes when a high output alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="LOUE" alt="Image" /></td>
<td><strong>Low Output Alarm</strong> – flashes when a low output alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="FRtE" alt="Image" /></td>
<td><strong>Fast Rate Alarm</strong> – flashes when a fast rate alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="SRtE" alt="Image" /></td>
<td><strong>Slow Rate Alarm</strong> – flashes when a slow rate alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="MOdE" alt="Image" /></td>
<td><strong>Mode Alarm</strong> – flashes when a mode alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="PEvE" alt="Image" /></td>
<td><strong>Program Event Alarm</strong> – flashes when a program event alarm condition is present and unacknowledged.</td>
</tr>
<tr>
<td><img src="SEvE" alt="Image" /></td>
<td><strong>Segment Event Alarm</strong> – flashes when a segment event alarm condition is present and unacknowledged.</td>
</tr>
</tbody>
</table>

Table 5.1B Input Error Messages Displayed in the Operating Page
5.4 Alarm Acknowledge Page

Page Header – Acknowledge Alarms

Upper Display: shows the alarm identity and type when an alarm condition is present.
For example the displays for alarm A are:
- \( A-H.Prc \) – high process
- \( A-L.Prc \) – low process
- \( A-H.dEU \) – high deviation
- \( A-L.dEU \) – low deviation
- \( A-H.OUt \) – high output
- \( A-L.OUt \) – low output
- \( A-F.r\ell E \) – fast rate of change of process variable*
- \( A-S.r\ell E \) – slow rate of change of process variable*
- \( A-MOdE \) – mode

Lower Display: shows the trip level of the alarm identified in the upper display. When the alarm is acknowledged (pressed), \( ACKNGd \) is displayed.
*Rate of change alarms have trip levels expressed in % of span per hour.

Return to top of page or advance to Security Code Page or Profile Operating Page.

5.4.1 Mode Alarm Trips

<table>
<thead>
<tr>
<th>Message</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUTO</td>
<td>In Automatic Control Mode</td>
</tr>
<tr>
<td>MANUAL</td>
<td>In Manual Control Mode</td>
</tr>
<tr>
<td>r-SPt</td>
<td>In Remote Set Point Mode</td>
</tr>
<tr>
<td>d-SPt</td>
<td>In Dual Set Point Mode</td>
</tr>
<tr>
<td>L-SPt</td>
<td>In Local Set Point Mode</td>
</tr>
<tr>
<td>rSFAIL</td>
<td>In Remote Set Point Mode</td>
</tr>
<tr>
<td>PVFAIL</td>
<td>Process Variable Input Failure</td>
</tr>
<tr>
<td>INFAIL</td>
<td>Position Feedback Input Failure</td>
</tr>
<tr>
<td>P-hOLd</td>
<td>Profile in Hold State</td>
</tr>
</tbody>
</table>

Table 5.2 Alarm Types/Mode Trip Values
5.5 Access to Configuration Levels
A security system is used to prevent tampering with the program parameters by utilizing a Tune password and a Configuration password.

The Tune password gives access to the self-tune and control pages.

The Configuration password gives access to all controller settings and programming pages – see Section 4.15 of the Programming Guide.

5.5.1 Security Code Page

Page Header – Security Code Page

Set the security code to the correct Tune or Configuration password using the ▲ and ▼ switches and press the ▶ switch to enter the code.

The passwords are programmed in the Access Page – Refer to Section 4.15 of the Programming Guide.

Software version
The Upper display indicates the EPROM series.

2201 is displayed for the standard 3430 EPROM, 2202 for the standard 3431 EPROM, 2203 for the standard 3432 EPROM and 2101 for the standard 3440 EPROM. The lower display indicates the version number.
6 TUNING LEVEL

6.1 Introduction to Self-tuning

Information.
- On demand user-activated tuning.
- Two types of self-tuning – initial 'Start-up' and when close to 'Set Point'.
- Tuning for P, PI or PID control can be selected.
- Tuning for ¼ wave damped or minimum overshoot (start-up tuning only) can be selected.
- Error and Caution messages – indicate reason for tuning problems.
- Self-tune facility – not available on Heat/Cool Control and Boundless.

Fig. 6.1 'Start Up' Self-tuning

Information. The noise level of the process is monitored and then a step is applied to the control output value. The response of the process is recorded and these results are used to calculate the control terms.
6.1 Introduction to Self-tuning

Information. 'At Set Point' self-tuning automatically calculates the P.I.D. terms based on the process reaction during a self-tuning cycle. The controller output is manipulated to give six process oscillations which are used to determine the tuning parameters.

Fig. 6.2 'At Set Point' Self-tuning

Information.
On initial conditions:
• 'Start-up' Tuning – the controller is placed in the Manual control mode with the control output value set to give a stable process variable at least 10% of the engineering range below the control set point.
• 'At Set Point' Tuning – may be initialized in the automatic mode but the process variable must be close to the required set point and stable. The control output must also be stable. However, for best results the Manual control mode can be used to stabilize the output and the process value. The output must be adjusted slowly to allow process response to the change, to bring the process variable to the required control set point. The closer the process is to the set point, the more effective the self-tuning cycle.

6.2 Self-tuning Page

Page Header – Self-tune.

Note. This page is not displayed if the Profile Function is 'ON' or Control Type is set to 'bNdLSS'

Error and Diagnostic Messages
If there are errors during self-tune, flashing error and diagnostic messages are displayed. To clear message, press the switch – see Table 6.1.

Continued on next page
...6.2 Self-tuning Page

**Self tune Type**
Select the Self-tune type required:

- **At SPt** (At Set Point) use when the process is close to the required set point.
- **Strt UP** (Start-up) use for self-tune from initial start-up, or for self-tune when there is a large change in set point value.

**Output Step Size**
The output step size is a percentage of the control output.

- **'Start-up' Tuning** – the larger the step size used the quicker the self-tuning process is performed, but the greater the overshoot (above the calculated trip point). If too small a step size is used, the response may be too slow for the self-tuning to operate correctly. In practice, use as large a step size as can be tolerated up to a maximum of 100%.

- **'At Set Point' Tuning** – the controller output changes by plus and minus the output step size from its initial starting value when self-tuning is executed. If the output step size is too large to allow this its value is reduced. Maximum is 50%.

**Example** – If the controller output value = 30% and the selected step size = 50%. The step size is reduced to 30%.

The step size should be large enough so that the amplitude of the process variable excursions are at least four times larger than the hysteresis parameter to allow the best possible response data. The output step size must be small enough to avoid the process variable crossing either of the self-tune limits (see following frames).

**Hysteresis Value**
The hysteresis value is entered in engineering units and is used to determine when to change the controller output value.

- **'At Set Point' Tuning only** – when the process variable crosses the hysteresis band (plus and minus the hysteresis value), the controller output changes by plus and minus the Step value from its initial starting value. The hysteresis value should be set as small as possible but larger than the noise in the process variable signal, to allow the best possible response data.

Set the hysteresis value required (in engineering units).

Continued on next page
6.2 Self-tuning Page

**Self-tune High Limit**
The process variable must be between the high and low limits during the self-tuning process. If the process value exceeds one of these, the self-tuning process is shut off automatically by reverting to the Manual control mode and returning the controller output to the value set when the self-tuning was carried out. The high and low values are the limits for cancelling self-tune execution.

Set the value required (in engineering units), the decimal point is set automatically.

**Self-tune Low Limit**
If the process variable value exceeds this adjustable limit during the self-tuning process, the self-tuning process is stopped automatically. The display is in engineering units.

**Control Terms**
Select the Proportional, Integral and Derivative terms required.

**Control Type**
- \( R \) for quickest response with \( 1/4 \) wave damping.
- \( b \) for quickest response with minimum overshoot.

**Self-tune Mode Selection**
With the self-tune mode enabled the 'ST' l.e.d. is illuminated while the controller calculates the control terms, selected above. On completion of the self-tune sequence the 'ST' l.e.d. flashes. Select ON to enable, OFF to disable.

The time taken for completion of self-tuning is dependent on the speed of response of the process being controlled.

If Self-tune is OFF return to the top of the Self-tune Page.

Wait for the 'ST' l.e.d. to flash.
Other pages can be accessed while the controller carries out the self-tune sequence. The sequence is automatically disabled on completion or can be manually disabled at any time, i.e. by selecting OFF.

Advance to next parameter (view advisory values) or, if self-tuning process not completed, return to top of Self-tune Page.

Continued on next page.
...6.2 Self-tuning Page

### Advisory Proportional Band
Advisory value displayed (cannot be changed).

### Advisory Integral Action Time
Advisory value displayed (cannot be changed).

### Advisory Derivative Action Time
Advisory value displayed (cannot be changed).

#### Acceptance/Rejection of Advisory Values
Before accepting or rejecting the calculated values, alternative control combinations can be viewed without repeating the Self-tune process.

a) To view alternative control combinations, return to the **Control terms** and **Control type** (if applicable) frames and set to the required alternative settings.

b) Set the **Self-tune Mode** to ON. It reverts automatically to OFF to indicate that the new advisory values have been calculated.

c) View the re-calculated advisory values.

Select:

- **YES** to accept the advisory values. The values automatically replace those in the **Control Page** – see Section 7.2.

- **NO** to reject the advisory values and retain those set in the **Control Page**.

Return to top of **Self-Tune Page**.

or

Advance to **Control Page**.
6.3 Self-tune Diagnostic Messages

<table>
<thead>
<tr>
<th>Message</th>
<th>Explanation</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flasing with</td>
<td>The self-tune process has selected a proportional band or integral action time above the high limits of these parameters so the high limit has been used.</td>
<td>Because of the process characteristics, re-trying the self-tuning process is unlikely to improve the calculated control parameters.</td>
</tr>
<tr>
<td>or</td>
<td>With 'Start-up' tuning, although the control set point was &gt;10% of the display range above the process variable, it may still be too close to allow the self-tune facility to determine the process characteristics accurately.</td>
<td>If desired, allow the process variable to move further below the control set point (by changing the control output in the manual control mode) before re-trying 'Start-up' self-tuning. Alternatively, use the 'At Set Point' self-tune facility.</td>
</tr>
<tr>
<td>or</td>
<td>With 'At Set Point' tuning, the ratio of process oscillation to hysteresis value is too small for best results.</td>
<td>Restart self-tune with a larger output step size or a smaller hysteresis value. Hysteresis must be at least equal to and preferably greater than process noise.</td>
</tr>
<tr>
<td>Flasing with</td>
<td>The process is too slow for the self-tuning to work correctly.</td>
<td>If possible, use a larger output step value.</td>
</tr>
<tr>
<td>or</td>
<td>The process variable signal is excessively 'noisy'.</td>
<td>Check input wiring to try and find the source of the problem. If the process is changing rapidly then allow it to settle before re-trying the self-tuning process.</td>
</tr>
<tr>
<td>or</td>
<td>With 'Start-up' tuning, the process variable is &lt;10% of the display range, below the control set point.</td>
<td>Allow the process variable to move further below the control set point before re-trying the 'Start-up' self-tuning facility. Alternatively, use the 'At Set Point' self-tune facility.</td>
</tr>
<tr>
<td>or</td>
<td>The input failure level has been exceeded, possibly due to a broken sensors or the process has exceeded one of the self-tune limits.</td>
<td>Check input wiring to find the cause of the failure or restart self-tuning with a smaller output step size.</td>
</tr>
</tbody>
</table>

Table 6.1 Self-tune Error/Diagnostic Messages
7 CONTROL LEVEL

7.1 Introduction to Standard Control

**Information.**
- **On/Off Control** – use for applications where precise control is not required, or where frequent switching of a contactor using time proportioning control causes premature wear.

- **Proportional Control** – use where:
  - cycling action of on/off control is unacceptable,
  - load changes are small or infrequent,
  - offset can be tolerated or eliminated using manual reset.

- **Integral Action** – introduce to the control system:
  - to eliminate offset automatically,
  - if set point or load changes frequently.

- **Derivative Action** – introduce to the control system:
  - to enable faster approach to the set point (by enabling use of a smaller proportional band),
  - to minimize overshoot.

---

**Fig. 7.1 Manual Tuning**

<table>
<thead>
<tr>
<th>Process Variable</th>
<th>Time</th>
<th>Initial Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Time</td>
<td></td>
<td>Proportional Band = 100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Integral Action Time = OFF</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Derivative Action Time = OFF</td>
</tr>
</tbody>
</table>

**Decrease Proportional Band**
- Adjust the set point a small amount
- Hold the set point at the new value until the process begins to move
- Reset the set point to the original value

**Increase Proportional Band**

**Observe response of process**
- Note Critical Proportional Band value (PBc)
- Measure the critical cycle time (tc)

**Calculate Terms**

<table>
<thead>
<tr>
<th></th>
<th>P</th>
<th>P+I</th>
<th>P+D</th>
<th>P+I+D</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>2 x PBc</td>
<td>2.2 x PBc</td>
<td>1.6 x PBc</td>
<td>1.6 x PBc</td>
</tr>
<tr>
<td>I</td>
<td>—</td>
<td>tc/1.2</td>
<td>tc/2</td>
<td>tc/2</td>
</tr>
<tr>
<td>D</td>
<td>—</td>
<td>—</td>
<td>tc/12</td>
<td>tc/8</td>
</tr>
</tbody>
</table>
### 7.1 Introduction to Standard Control

<table>
<thead>
<tr>
<th>Response</th>
<th>Contributions</th>
<th>Effect Of Response Settings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On/Off Hysteresis</strong></td>
<td>Helps to prevent rapid switching of output</td>
<td>Process swings too far above and below set point</td>
</tr>
</tbody>
</table>
| **Proportional Band** | Stable control with the minimum offset and minimum period of oscillation consistent with stability. | • More stable  
• Longer period  
• Larger offset | Stability decreases |
| **Integral**      | Eliminates offset between Process and Set Point.                              | Time for variable to return to set point increases | • Stability decreases  
• Period of oscillation increases |
| **Derivative**    | Increases stability, permitting smaller proportional band and larger integral action times to be used.  
Reduces height of first peak.  
Reduces period of oscillation. | • Stability decreases  
• Process noise is amplified  
Max contribution not realized | Derivative Action Time too Low  
Derivative Action Time too High |

Fig. 7.2 Effect of Control Responses on Processes
7.2 Control Page

Page Header – Control Page.
If Heat/Cool Control is selected, refer to Section 7.3.

Cycle Time
This frame appears only if the Time Proportioning function is selected in the Set Up Control Page. Set the required cycle time between 1.0 and 300 in 0.1 second increments, or if ‘ON/OFF’ mode is required, select cycle time below 1.0 second.

Hysteresis
This frame appears only if ON/OFF is selected in Cycle Time. The output turns off at the set point value but does not turn on again until it has moved into the safe region by an amount equal to the hysteresis value. This is only applicable to ‘ON/OFF’ control. Set the required hysteresis between 0.0% and 5.0% of the engineering span. The display is in engineering units.

Information. Hysteresis is used with ON/OFF control to give acceptable control without causing the output to switch too rapidly.

Proportional Band
Set the proportional band value required, between 0.1 and 999.9% in 0.1% increments.

Continued on next page.
...7 CONTROL LEVEL

...7.2 Control Page

Time Units
Time units for the integral and derivative action times (see below) can be set to minutes MINS or seconds SECS.

Integral Action Time
Set the required time between 1 and 7200 in 1 second increments (0.1 and 120 minutes in 0.1 minute increments). OFF is displayed in place of 7201 (120.1)

* Note. An Integral Action Time must be set when the Control Type is set to bLdLSS.

Manual Reset
Manual reset is only operable with Integral Action Time set to OFF. Set the required proportional band offset between 0.0 and 100.0% of the display (engineering) span in 0.1% increments.

Derivative Action Time
Set the required time between 0.0 and 999.9 in 0.1 second increments (0.1 and 16.67 minutes in 0.01 minute increments). OFF is displayed in place of zero.

Approach Band
Set the required value between 0.1 and 3.0 in 0.1 increments. (Set 1.0 initially.)

Manual Reset Adjust Enable
This display and adjustment in the Operating Page can be enabled or disabled. Select YES to enable or NO to disable.

Control Algorithm Offset
This frame is only applicable if Integral Action Time is set, (i.e. is not set to OFF). Set the required offset, either 0.0 or 50.0%.

Return to the top of the Control Page or advance to the next page.
7.3 Introduction to Heat/Cool Control

Information.
- **P.I.D. Output** – is the output value calculated by the controller. The output is divided into two different control elements, one for raising the product temperature (heat output) and one for lowering the product temperature (cool output).
- **Transition Bandwidth** – used to transfer smoothly from one set of control terms to the other.
- **Crossover Value** – defines the changeover point between heat output active and cool output active. The crossover value is also the centre of the transition and off hysteresis bands.
- **Output Off Hysteresis Band** – for the majority of applications the heat and cool outputs have opposing control actions, i.e. one is direct acting and the other is reverse. In this configuration both outputs are at 0% within the off hysteresis band. The band setting is used to prevent oscillation of control changes.
- **Heat/Cool Outputs** – refer to P.I.D. Output, above.

* Note. Refer to Sections 7.3.2 and 7.3.3 for Crossover Value and Transition Bandwidth Value examples.

Fig. 7.3 Heat/Cool Control – Principle of Operation
7.3.1 Control Page (Heat/Cool Control)
The following parameters appear only if Heat/Cool is selected at Control Mode frame in the Set Up Control Page.

- **Cycle Time (Heat)**
  This frame appears only if Time Proportioning Control is selected in the Set Up Control Page. Set the required cycle time between 1.0 and 300 in 0.1 second increments. For Heat/Cool Control, 'ON/OFF' mode must not be selected.

- **Cycle Time (Cool)**
  This frame appears only when the Second Output Type in the Set Up Control Page is time proportioning. Set the required cycle time between 1.0 and 300 in 0.1 second increments.

- **Proportional Band (Heat)**
  Set the proportional band value required, between 0.1 and 999.9% in 0.1% increments.

- **Proportional Band (Cool)**
  Set the proportional band value required, between 0.1 and 999.9% in 0.1% increments.

- **Time Units**
  The time units for the integral and derivative action times (see below) can be set to minutes $\text{MINS}$ or seconds $\text{SECS}$.

- **Integral Action Time (Heat)**
  Set the required time between 1 and 7200 in 1 second increments (0.1 and 120 minutes in 0.1 minute increments). $\text{OFF}$ is displayed in place of 7201 (120.1).

- **Manual Reset (Heat)**
  This is only operable with Integral Action Time (Heat) set to $\text{OFF}$. Set the required proportional band offset between 0.0 and 100.0% of the display span in 0.1% increments.

- **Proportional Band (Cool)**
  Set the proportional band value required, between 0.1 and 999.9% in 0.1% increments.

Continued on next page.
7.3.1 Control Page (Heat/Cool Control)

Integral Action Time (Cool)
Set the required time between 1 and 7200 in 1 second increments (0.1 and 120 minutes in 0.1 minute increments). OFF is displayed in place of 7201 (120.1).

Manual Reset (Cool)
This is only operable with Integral Action Time (Cool) set to OFF. Set the required proportional band offset between 0.0 and 100.0% of the display span in 0.1% increments.

Derivative Action Time
Set the required time between 0.0 and 999.9 in 0.1 second increments (0.1 and 16.67 minutes in 0.01 minute increments). The same derivative action time is used for both heating and cooling. OFF is displayed in place of zero.

Approach Band
Set the required value between 0.1 and 3.0 in 0.1 increments. (Set 1.0 initially.)

Manual Reset Adjust Enable
Manual Reset display and adjustment in the Operating Page (see Section 5.2.) can be enabled or disabled. Select YES to enable or no to disable.

Crossover Output Value
Set the required crossover output value, between 0.0% and 100.0% of P.I.D. output in 0.1% increments – see Section 7.3.2.

Transition Bandwidth
Set the required value, between 0.0% and 100.0% of P.I.D. output in 0.1% increments – see Section 7.3.3.

Output Off Hysteresis
The hysteresis is set to prevent oscillation of control changes. Set the required value, ±25.0% (of P.I.D. output) from the crossover output value, in 0.1% increments.

Control Algorithm Offset
The offset is only applicable if Integral Action Time is set. Set the required offset either 0.0 or 50.0%.

Continued on next page.
7.3.2 Calculating the Crossover Value – Fig 7.3
The crossover value is calculated from the expression:

\[
\text{Crossover Value} = \frac{100}{\frac{Gh}{Gc} + 1}
\]

Where \(\frac{Gh}{Gc}\) is the ratio of the two output driver gains.

The most common method for determining the \(\frac{Gh}{Gc}\) term is by using 'nameplate' values from the heat/cool device(s).

**Example** – if a heat/cool application can produce a maximum of 1.5kW and absorb 0.75kW:

\[
\text{Output Gain Ratio} = \frac{1.5}{0.75} = 2
\]

\[
\text{Crossover Value} = \frac{100}{2 + 1} = 33.3\%
\]

7.3.3 Calculating the Transition Bandwidth Value – Fig. 7.3
The Transition Bandwidth is the percentage difference of the proportional band settings.

**Example** – if the proportional band settings for the heat output is 20% and for the cool output is 25%:

\[
\text{Transition Bandwidth (\%)} = \frac{25 - 20}{25} \times 100
\]

Transition Bandwidth = 20%

If the proportional band settings for both outputs are equal, the bandwidth is 0%. As a general rule, the Transition Bandwidth should not exceed 30%.
8 PROFILE OPERATION

8.1 Profile Operating Page
This only appears if the Profile Enable frame is set to on in the Profile Program Page – see Section 4.1 in the Programming Guide. Parameters displayed in this page cannot be modified.

Profile Status
The current status of the selected profile is displayed:
- **$t:\OP** – Waiting for operator action
- **$t:\SOAK** – Soak function, the set point is at a constant value is the current segment.
- **$t:\rAMP** – Ramp function, the set point is either rising or falling in the current segment.
- **$t:\C-dN** – Countdown, there is a time delay before the profile starts.
- **$t:\Hb-HLd** – Holdback Hold – the profile is on Hold due to the Holdback feature, i.e. the measured variable has deviated beyond the hysteresis value.
- **$t:\OP-HLd** – Operator Hold, the profile has been suspended by the operator.
- **$t:\MN-HLd** – Manual Hold, the instrument is in Manual mode. The profile cannot run in this mode.
- **$t:\ENd** – A profile run started from an external switch is complete and the switch is still in the Start Profile position.

Countdown Time
This is only accessed if a Time Delay for the profile start has been set in the Profile States Page – see next page. The countdown time remaining is displayed in minutes. Return to top of the Profile Operating Page.

Current Program and Segment
The current program and segment number is shown. The program of segments is set-up in the Profile Program Page – see Section 4.1 in the Programming Guide.

Segment Time
The time remaining before the current segment stops/next segment starts is displayed (0 to 999.9 minutes). The segment time is set in the Profile Program Page – see Section 4.1 in the Programming Guide.

Program Repeat Count
The number of outstanding repeats for the current program is displayed at this parameter. The repeat number is set in the Profile Program Page (between 0 and 99 or continuous – $t:\InFr$tE is displayed).

Return to top of Profile Operating Page or advance to the Security Code Page.
8.2 Profile States Page

The Profile States Page is only present if the Profile Enable frame is set to on in the Profile Program Page – see Section 4.1 in the Programming Guide.

---

**Page Header – Profile States.**

Advance to the next parameter.

---

**Program Select**

Up to four programs can be selected. The programs are selected in the order that they are required to run. The flashing character on the lower display indicates the currently selected program and its position in the program running order.

**Example** — if the programs 1, 3, 5, and 7 are required to run in the order 1, 5, 7 and 3, then:

- Select 1, press the switch
- Select 5, press the switch
- Select 7, press the switch
- Select 3, press the switch

If less than four programs are required, end by selecting and storing the terminator 'W'.

Select a program, or the terminator 'W'.

Press the switch to advance to the next program in the running order (character flashing), or if the selection is complete, advance to the next parameter.

---

**Time Delay**

A countdown time may be set to provide a controlled delay before the start of the profile run.

Set the delay time from 0.0 to 999.9 minutes.

---

**Start Profile Run**

no is displayed when the profile is not running.

Press the switch to start the run. The display changes to YES.

Advance to the next parameter if the profile is running or return to top of Profile States Page.

---

Continued on next page.
Program Hold

The program may be put on hold (suspended) by any of three conditions. The lower display shows the type of hold condition or OFF:

- **H-h** – hysteresis action, the process variable has deviated beyond hysteresis value.
- **OPErAt** – [ ] pressed or placed in hold mode by a logic input.
- **MN-HLd** – the instrument has been switched to manual control mode.
- **OFF** – hold function is off.

Press the [ ] switch to change the hold state.

If a logic input has been assigned to the Start/Hold Profile function, i.e. **P–Strt** has been selected (see Section 4.10 of the Programming Guide), the [ ] switch is disabled.

Reset the Profile

This frame is omitted if a logic input has been assigned to the Profile Reset function, i.e. **P–rSEt** has been selected – see Section 4.10 of the Programming Guide.

[ ] is displayed on entry to this parameter. When the [ ] switch is pressed to reset the profile the display changes to **YES** then reverts to [ ]. If the profile is reset and a hold condition does not exist (see next parameter) the profile returns to the beginning of the program and continues to run. If in a hold condition the profile being performed is stopped and the local set point takes the value of the first level of the selected profile.

Press the [ ] switch to reset the profile, or advance to the next parameter.

Continued on next page.
...8 PROFILE OPERATION

...8.2 Profile States Page

Skip Segment
This frame is omitted if a logic input has been assigned to the Skip Current Segment function, i.e. P - 5K.IP has been selected, see Section 4.10 in the Programming Guide.

A segment may be skipped by pressing the [.Skip Segment] switch. When the [.Skip Segment] switch is pressed the profile immediately abandons the current segment and executes the next segment. Normally, the Current Segment number is displayed on the lower display.

C - d is displayed during a countdown time – see Time Delay which can also be skipped if required. If the segment being skipped is the last segment then END is displayed.

Press the [.Skip Segment] switch to skip the next segment.

Return to top of Profile States Page or advance to the Programming Guide.
OMEGA®

OMEGAnet® On-Line Service
http://www.omega.com

Internet e-mail
info@omega.com

Servicing North America:

USA:
One Omega Drive, Box 4047
Stamford, CT 06907-0047
Tel: (203) 359-1660
FAX: (203) 359-7700
e-mail: info@omega.com

Canada:
976 Bergar
Laval (Quebec) H7L 5A1
Tel: (514) 856-6928
FAX: (514) 856-6886
e-mail: info@omega.ca

For immediate technical or application assistance:

USA and Canada:
Sales Service: 1-800-826-6342 / 1-800-TC-OMEGA™
Customer Service: 1-800-622-2378 / 1-800-622-BEST™
Engineering Service: 1-800-872-9436 / 1-800-USA-WHEN™
TELEX: 996404 EASYLINK: 62968934 CABLE: OMEGA

Mexico and Latin America:
Tel: (95) 800-826-6342
En Español: (95) 203-359-7803
e-mail: espanol@omega.com

Servicing Europe:

Benelux:
Postbus 8034, 1180 LA Amstelveen, The Netherlands
Tel: (31) 20 6418405
FAX: (31) 20 6434643
e-mail: nl@omega.com
Toll Free in Benelux: 0800 0993344

Czech Republic:
ul. Rude armady 1868, 733 01 Karvina-Hranice
Tel: 420 (69) 6311899
FAX: 420 (69) 6311114
e-mail: czech@omega.com
Toll Free: 0800-1-66342

France:
9, rue Denis Papin, 78190 Trappes
Tel: (33) 130-621-400
FAX: (33) 130-699-120
e-mail: france@omega.com
Toll Free in France: 0800-4-06342

Germany/Austria:
Daimlerstrasse 26, D-75392 Deckenpfronn, Germany
Tel: 49 (07056) 3017
FAX: 49 (07056) 8540
e-mail: info@omega.de
Toll Free in Germany: 0130 11 21 66

United Kingdom:
One Omega Drive, River Bend Technology Centre
Northbank, Irlam, Manchester
M44 5EX, United Kingdom
Tel: 44 (161) 777-6611
FAX: 44 (161) 777-6622
e-mail: info@omega.co.uk
Toll Free in the United Kingdom: 0800-488-488

It is the policy of OMEGA to comply with all worldwide safety and EMC/EMI regulations that apply. OMEGA is constantly pursuing certification of its products to the European New Approach Directives. OMEGA will add the CE mark to every appropriate device upon certification.

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WARNING: These products are not designed for use in, and should not be used for, patient-connected applications.
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- Recorders, Controllers & Process Monitors
- Infrared Pyrometers

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- Transducers & Strain Gauges
- Load Cells & Pressure Gauges
- Displacement Transducers
- Instrumentation & Accessories

FLOW/LEVEL
- Rotameters, Gas Mass Flowmeters & Flow Computers
- Air Velocity Indicators
- Turbine/Paddlewheel Systems
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pH/CONDUCTIVITY
- pH Electrodes, Testers & Accessories
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- Controllers, Calibrators, Simulators & Pumps
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- Data Acquisition & Engineering Software
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- Heating Cable
- Cartridge & Strip Heaters
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- Industrial Water & Wastewater Treatment
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