GETTING STARTED

The COMMANDER 350 can be configured and made ready for operation in three easy steps. This ‘Getting Started’ guide provides an overview of these steps and, where necessary, refers to the relevant section of the manual.

Step 1 – Decide on the Application Template and the Output Configuration required

Step 2 – Connect the process inputs and outputs

Step 3 – Power up the instrument, set the template number and the output configuration details

Your COMMANDER 350 is now ready for operation

Step 1 – Application Template and Output Configuration

- Choose the Template which best suits your application from the list in Table A, located on the rear fold-out.
- Choose the Control Output Type required from the list of options in Table B on the rear foldout.

Step 2 – Electrical Connections

Using the labels on the back of the instrument as a guide, connect the process inputs, outputs and power supplies. Refer to Section 5.2 of this manual (Electrical Installation) for more information.

Continued…
GETTING STARTED

Step 3 – Setting the Parameters (Fig. GS.1)

A. Power-up the instrument. Press the \( \Delta \) and \( \nabla \) keys simultaneously and hold for 3 seconds to advance directly to Level 6 – Basic Configuration.

B. Set the appropriate application template, output type and control action. Use the \( \Delta \) key to advance between frames and upper \( \Delta \) and \( \nabla \) keys to adjust the default values – see Section 4.2 for further information.

Note. When the output type has been selected, the available inputs and outputs default to the settings shown in Table B on the rear fold-out.

C. If you are not using 4 to 20mA inputs, then select Level 7 using the upper \( \Delta \) and \( \nabla \) keys and set up Analog Inputs I/P1 to I/P3 to suit your process – see Section 4.3.

D. Controller templates only:

Select Level 2 using the upper \( \Delta \) and \( \nabla \) keys and set the tune parameters:
- Analog or Motorized Valve Control – set the Proportional, Integral and Derivative terms.
- Time Proportioning Control – set the Cycle Time, Hysteresis and P, I & D Terms
- Heat/Cool Outputs – set the points at which the Output 1 and Output 2 become active.

E. Press \( \Delta \) to return to the Operating displays.

F. Adjust the set point to the required value.

Your COMMANDER 350 is now in operation

---

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:1993 "Safety requirements for electrical equipment for measurement, control, and laboratory use”. If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

- **Warning** – Refer to the manual for instructions
- **Caution** – Risk of electric shock
- **Protective earth (ground) terminal**
- **Earth (ground) terminal**
- **Direct current supply only**
- **Alternating current supply only**
- **Both direct and alternating current supply**
- **The equipment is protected through double insulation**

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

---

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.
This manual is divided into 5 sections which contain all the information needed to install, configure, commission and operate the COMMANDER 351. Each section is identified clearly by a symbol as shown in Fig. 1.

### Displays and Controls
- Displays and Function Keys
- LED Indication
- Error Messages

### Operator Mode (Level 1)
- Single Loop Controller
- Motorized Valve Controller
- Auto/Manual & Backup Stations

### Set Up Mode (Levels 2 to 5)
- Level 2 Tuning
- Level 3 Set Points
- Level 4 Alarm Trip Points
- Level 5 Valve Setup

### Configuration Mode (Levels 6 to E)
- Level 6 Basic Configuration
- Level 7 Input Configuration
- Level 8 Alarm Configuration
- Level 9 Set Point Configuration
- Level A Control Configuration
- Level B Operator Configuration
- Level C Output Configuration
- Level D Serial Communications
- Level E System Calibration

### Installation
- Siting
- Mounting
- Electrical Connections

---

Table A – Template Applications
Table B – Output Sources
Table C – Digital Sources
Table D – Analog Sources

---

**Fig. 1 Overview of Contents**

**Fig. 2 Foldouts**

**Fig. 3 Accessories**

- **Pull-up Resistors**
  - 2 x 100kΩ

- **Shunt Resistors**
  - 3 x 100Ω

- **Panel Clamps**
  - x2

- **CJ Sensor**
  - x2
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</table>
1.1 Introduction
The COMMANDER 351 front panel displays, function keys and l.e.d. indicators are shown in Fig. 1.1.
1.2 Use of Function Keys

A – Raise and Lower Keys

Use to change/set a parameter value… and… move between levels

B – Up and Down Keys

Use to adjust the output value… and… move between frames within a Setup or Configuration level. Any changes made in the current frame are stored when the next frame is selected.

C – Parameter Advance Key

Use to advance to the next frame within a level… or… select the top (LEV.x) frame from within a level

Note. This key also stores any changes made in the previous frame

D – Auto/Manual Key

Use to select Auto or Manual control mode

Fig. 1.2a Use of Function Keys
1.2 Use of Function Keys

**E – Alarm Acknowledgement**

(Flash lighting)

Any active, unacknowledged alarms

(On continuously)

All active alarms acknowledged

(Off)

No active alarms present

1. The first active and unacknowledged alarm is displayed (or if no alarms are active, the first enabled alarm is displayed)

   - **HPU**. High Process, PV
   - **LP**. Low Process, PV
   - **HLP**. High Latch, PV
   - **LLP**. Low Latch, PV
   - **Hd**. High Deviation
   - **Ld**. Low Deviation
   - **HP**. High Process I/P1
   - **LP**. Low Process I/P1
   - **HP2**. High Process I/P2
   - **LP2**. Low Process I/P2
   - **HP3**. High Process I/P3
   - **LP3**. Low Process I/P3
   - **HO**. High Output
   - **LO**. Low Output
   - **PF**. Power Failure Time
   - **Hb1**. Math Block 1 High
   - **Lb1**. Math Block 1 Low
   - **Hb2**. Math Block 2 High
   - **Lb2**. Math Block 2 Low
   - **Hb3**. Math Block 3 High
   - **Lb3**. Math Block 3 Low
   - **Hb4**. Math Block 4 High
   - **Lb4**. Math Block 4 Low

*Note. The time of the power failure, PF*t, is shown in the set point display.*

2. The lower display shows alarm status:
   - **RCL**. Alarm active and unacknowledged
   - **RCH**. Alarm active and acknowledged
   - **CLR**. Cleared or Inactive alarm
   - **LRT**. Unacknowledged latched alarm

3. Pressing the key again acknowledges the displayed alarm. Lower display changes to reflect new status.

4. Next active and unacknowledged alarm is displayed. If no alarms are active, the next enabled alarm is displayed.

*Note. If no alarms have been enabled in the Set Up level, pressing the key has no effect.*

*Fig. 1.2b Use of Function Keys*
### 1.2 Use of Function Keys

**F – Local / Remote Key**

**Changing between Local and Remote Set Points**

1. Process variable and local set point displayed on red and green displays.
2. Remote set point value is displayed. The value and \( \text{L/R} \) symbol flash to indicate local set point still selected.
3. Remote set point selected.

**Note.** When an Analog Backup template is selected, the \( \text{L/R} \) key is used to switch between local and remote mode – see Sections 2.4 and 4.2.

**Selecting Local Set Points 1 to 4**

1. Process variable and local set point 1 displayed.
2. Process variable and local set point 2 displayed
3. Process variable and local set point 3 displayed
4. Process variable and local set point 4 displayed

*Fig. 1.2c Use of Function Keys*
1.2 Use of Function Keys

**G – Short-cut Keys**

Press to move from anywhere in the Configuration level to the first frame in the Operator level

Press simultaneously and hold for 3 seconds – see Note

Press to move from anywhere in the Operator or Setup levels to the first page of the Configuration level

**Note.** This Short-cut key combination operates only when the Configuration password is set to '0'.

Press to move from the Operator Level to the Security Code Frame and then to other levels:
- Tune Level – See Section 2.13.3
- Set Up Level – See Fig. 3.1
- Configuration Level – See Fig. 4.1

**Fig. 1.2d Use of Function Keys**
1.3 Secret-til-Lit Indicators

<table>
<thead>
<tr>
<th>Flashing</th>
<th>ON</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>🔴</td>
<td>All active alarms acknowledged</td>
<td>No alarms active</td>
</tr>
<tr>
<td>□ R</td>
<td>Remote or Cascade set point in use</td>
<td>Local set point in use</td>
</tr>
</tbody>
</table>

A – Upper Display

<table>
<thead>
<tr>
<th>Flashing</th>
<th>ON</th>
<th>OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Autotune in progress</td>
<td>Manual control selected</td>
</tr>
<tr>
<td>OP1</td>
<td>Output 1 (heat) value displayed</td>
<td>Auto control selected</td>
</tr>
<tr>
<td>OP2</td>
<td>Output 2 (cool) value displayed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Valve opening</td>
<td>Valve stopped</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valve closing</td>
</tr>
</tbody>
</table>

B – Lower Display

Fig. 1.3 Secret-til-lit Indicators

1.4 Character Set – Fig. 1.4

A R I I R r
B b J J S S
C C K K T t
D D L L U U
E E M _ V U
F F N  Y Y
G G O O
H H P P

Fig. 1.4 Character Set
### 1.5 Error Messages

<table>
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<th>Display</th>
<th>Error/Action</th>
<th>To clear the display:</th>
</tr>
</thead>
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<td><img src="image" alt="CAL Err" /></td>
<td>1. <strong>Calibration Error</strong>&lt;br&gt;Turn mains power off and on again (if the error persists contact the Customer Support Organization).</td>
<td>Press the ▲ key</td>
</tr>
<tr>
<td><img src="image" alt="Err NVx" /></td>
<td>2. <strong>Non-volatile Memory Error</strong>&lt;br&gt;x = 1: Processor Board Memory&lt;br&gt;x = 3: Power Supply Board Memory&lt;br&gt;Turn mains power off and on again (if the error persists, check configuration/setup settings).</td>
<td>Press the ▲ key</td>
</tr>
<tr>
<td><img src="image" alt="A-d Err" /></td>
<td>3. <strong>A to D Converter Fault</strong>&lt;br&gt;The analog to digital converter is not communicating correctly.</td>
<td>Contact the Customer Support Organization</td>
</tr>
<tr>
<td><img src="image" alt="Err" /></td>
<td>4. <strong>Input Value Over/Under Range</strong></td>
<td>Restore valid input</td>
</tr>
<tr>
<td><img src="image" alt="Err" /></td>
<td>5. <strong>Auto-tune Error</strong>&lt;br&gt;Number displayed indicates the type of error – see Table 2.1, page 30.</td>
<td>Press the ▲ key</td>
</tr>
<tr>
<td><img src="image" alt="CJF" /></td>
<td>6. <strong>Cold Junction Failed</strong>&lt;br&gt;Cold junction sensor is faulty or has not been fitted correctly.</td>
<td>Check connections or replace if faulty.</td>
</tr>
<tr>
<td><img src="image" alt="rSP.F" /></td>
<td>7. <strong>Remote Set Point Failed</strong>&lt;br&gt;Input value is over or under-range. Only appears if the remote set point is displayed or in use.</td>
<td>Restore valid input</td>
</tr>
<tr>
<td><img src="image" alt="Err" /></td>
<td>8. <strong>Position Feedback Fail</strong>&lt;br&gt;Input value is over- or under-range. Only appears if output type set to 'PFb' – motorized valve with feedback.</td>
<td>Restore valid input</td>
</tr>
<tr>
<td><img src="image" alt="Err" /></td>
<td>9. <strong>Valve Sticking</strong>&lt;br&gt;Motorized valve not moving at the speed expected. Valve may be sticking.</td>
<td>Check that the correct Regulator Travel Time has been set – see Section 3.5. Check the valve.</td>
</tr>
</tbody>
</table>
1.6 Processor Watchdog
The instrument's processor activity is monitored by an independent watchdog device. When the output of the watchdog is assigned to a relay or digital output, the relay/digital output de-energizes if the instrument fails to function correctly.

1.7 Loop Break Monitor
Analog output 1 is monitored continuously to detect a loop break. A warning signal or other action can be initiated by assigning the loop break signal to relays or digital outputs.

1.8 Glossary of Abbreviations

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<th>Description</th>
<th>Abbreviation</th>
<th>Description</th>
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<td>PV</td>
<td>Process Variable</td>
<td>I/P1</td>
<td>Analog Input 1</td>
</tr>
<tr>
<td>LSPt</td>
<td>Local Set Point Value</td>
<td>I/P2</td>
<td>Analog Input 2</td>
</tr>
<tr>
<td>LSP1</td>
<td>Local Set Point 1 Value</td>
<td>I/P3</td>
<td>Analog Input 3</td>
</tr>
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<td>LSP2</td>
<td>Local Set Point 2 Value</td>
<td>di1</td>
<td>Digital Input 1</td>
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<td>Local Set Point 3 Value</td>
<td>di2</td>
<td>Digital Input 2</td>
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<td>Local Set Point 4 Value</td>
<td>di3</td>
<td>Digital Input 3</td>
</tr>
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<td>CSPt</td>
<td>Control Set Point Value</td>
<td>di4</td>
<td>Digital Input 4</td>
</tr>
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<td>RSPt</td>
<td>Remote Set Point Value</td>
<td>ao1</td>
<td>Analog Output 1</td>
</tr>
<tr>
<td>PID O/P</td>
<td>Output of the PID Algorithm</td>
<td>ao2</td>
<td>Analog Output 2</td>
</tr>
<tr>
<td>OP1</td>
<td>Controller Output 1 (heat)</td>
<td>do1</td>
<td>Digital Output 1</td>
</tr>
<tr>
<td>OP2</td>
<td>Controller Output 2 (cool)</td>
<td></td>
<td></td>
</tr>
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Table 1.1 Glossary of Abbreviations
2.1 Introduction
The Operator level (Level 1) is the normal day-to-day mode of the COMMANDER 351. This section describes the operator facilities available on each frame depending on the control template and output type selected.

The template types detailed in this section are:
- Single loop controller
- Auto/Manual station
- Analog backup station
- Indicator/manual loader station

**Note.** Only the frames relevant to the selected template are displayed – see Section 4.

In addition, frames used to view the Control Efficiency Monitor and operate motorized valve and heat/cool output types are also described.

**Fig. 2.1 Power-up Displays**

![Power-up Displays](image-url)
2.2 Single Loop Controller (Templates 1 and 2)

The single loop controller is a basic feedback control system using three-term PID or on/off control with either a local set point (template 1) or remote set point (template 2).

![Single Loop Controller Diagram]

**Fig. 2.2 Single Loop Controller**
...2.2 Single Loop Controller (Templates 1 and 2)

- **Process Variable**
  - **Control Set Point**
    - ['SPLO' to 'SPHI' – see Section 4.5]
    - Adjustable in Local Control Only
  - **Control Output**
    - [0 to 100% (digital/relay outputs), –10 to 110% (analog outputs)]
    - Adjustable in manual mode only. With on/off control selected, 0% = control output off, 100% = control output on. In manual mode, intermediate values can be selected. These use ‘time proportioning’ with a 60s cycle time, e.g. 25% = 15s on, 45s off.

- **Remote Set Point Ratio**
  - [0.001 to 9.999]
  - Remote set point value = (ratio x remote set point input) + bias

- **Remote Set Point Bias**
  - [In engineering units]

1. With the Ramping Set Point function enabled (see Section 3.3, Set Points/ Ramp Rate), the bargraph shows the actual (ramping) set point value and the digital display shows the target set point value.

2. Displayed only if template 2 selected and Ratio Display is enabled – see Section 4.2, Basic Configuration and Section 4.7, Operator Configuration.

3. Displayed only if template 2 selected and Bias Display is enabled – see Section 4.2, Basic Configuration and Section 4.7, Operator Configuration.
2.3 Auto/Manual Station (Templates 3 and 4)

The auto/manual station provides a backup for a master controller. In normal operation the COMMANDER 350’s analog output follows the master controller's output value. A fault in the master system can be identified either by detecting a low signal on the master output (template 3) or via a digital signal (template 4). When a fault is detected the COMMANDER 350 goes into manual mode with its output either set to the last valid master output value or to a configured output value – see Section 4.6, Control Configuration/ Configured Output 1. When the master output is restored or the digital input returns to its inactive state, the COMMANDER 350 switches back to auto mode.

Note. The Alarm A1 Trip value must be set when using template 3.

Fig. 2.3 Auto/Manual Station
...2.3 Auto/Manual Station (Templates 3 and 4)

**Auto Mode**

- Process Variable
- Master Output (I/P2)
- Control Output = Master Output
  - [Master Output, 0 to 100%]

**Manual Mode**

- Control Output (under COMMANDER 350 control)
  - [0 to 100%]

1. In template 4 the Auto/Manual key is overridden by the digital input signal.
2. Template 3 only – see Section 4.2, Basic Configuration/ Template Application.
3. Template 4 only – see Section 4.2, Basic Configuration/ Template Application.
2.4 Analog Backup (Templates 5 and 6)

Note. Refer also to Appendix A2.1 – Series and Parallel Operation.

The analog backup station provides a backup for a master controller. In normal operation (remote control mode selected) the COMMANDER 350's current output follows the master controller’s output value. A fault in the master system can be identified either by detecting a low signal on the master output (template 5) or via a digital signal (template 6). When a fault is detected the COMMANDER 350 switches into local control mode and the process is controlled by the PID output of the COMMANDER 350. The COMMANDER 350 PID algorithm tracks the master output value continuously, in order to ensure bumpless transfer from remote to local mode operation. When the master output is restored or the digital input returns to its inactive state, the COMMANDER 350 switches back to remote control mode.

Note. The Alarm A1 Trip value must be set when using template 5.
...2.4 Analog Backup (Templates 5 and 6)

Remote Mode

Process Variable
Set Point
['SPLO' to 'SPHI' – see Section 4.5]
Control Output = Master Output
[Master Output, 0 to 100%]

Local Mode

Control Output (under COMMANDER 350 control)
[0 to 100%]
Adjustable in Manual Mode only.

• 1 Template 5 only – see Section 4.2, Basic Configuration/Template Application.
• 2 Template 6 only – see Section 4.2, Basic Configuration/Template Application.
### 2.5 Indicator/Manual Loader Station (Templates 7 and 8)

One or two process variables can be displayed on the digital and bargraph displays. If the control output is assigned to an analog output, the lower display indicates its value which can be adjusted by the user.

- **1** Displayed only if template 8 selected – see Section 4.2, Basic Configuration/ Template Application.
- **2** Displayed only if control output type is ‘analog’ (output is assigned to Analog Output 1).
2.6 Heat/Cool Output Types

2.6.1 Reverse (Heat)/Direct (Cool) or Direct (Heat)/Reverse (Cool)
The active output, either OP1 (Heat) or OP2 (Cool) is displayed and may be adjusted in manual mode. The OP1 and OP2 l.e.d.s indicate which output is changing.

**Output Positive (Heat Output Active)**

Heat Output
[0 to 100% (0 to 110% in manual mode with analog outputs)]. Adjustable in manual mode only.

**Output Negative (Cool Output Active)**

Cool Output
[−100 to 0% (−110 to 0% in manual mode with analog outputs)]. Adjustable in manual mode only.

Fig. 2.5 Typical Response – Reverse/Direct or Direct/Reverse Control Action
2.6.2 Reverse (Heat)/Reverse (Cool) or Direct (Heat)/Direct (Cool)
It is not possible to view or adjust the heat/cool outputs directly. The PID output (0 to 100%), used to calculate the heat (OP1) and cool (OP2) outputs, is displayed and may be adjusted in manual mode. The OP1 and OP2 l.e.d.s indicate which output is changing.

2.7 Motorized Valve Output Types
2.7.1 Motorized Valve with Feedback

Valve Position Display

Note. In manual mode, the [△] and [▽] keys can be used to drive the valve open and valve close relays directly.

2.7.2 Motorized Valve without Feedback (Boundless)

Valve State Display

Note. In manual mode, the [△] and [▽] keys can be used to drive the valve open and valve close relays directly.
2.8 Auto-tune

Notes.
- Auto-tune is not available for Auto/Manual Station or Indicator templates, or when boundless or heat/cool control types are selected.
- Auto-tune optimizes process control by manipulating the COMMANDER 350 output and then monitoring the process response.
- At the end of an auto-tune, the control parameters are updated automatically.
- Before starting auto-tune, the process variable must be stable.
- The COMMANDER 350 monitors the noise level of the process variable for 30 seconds and if it is greater than 2% of the engineering range the auto-tune is aborted.
- The COMMANDER 350 selects either ‘start-up’ or ‘at set point’ tuning automatically, depending upon the level of the process variable relative to the control set point.

2.8.1 Start-up Auto-tune
If the process variable is more than ±10% from the set point, ‘start-up’ tuning is carried out.

- ‘Start-up’ tuning – steps the output to drive the process towards the set point. The process response to this step change is monitored and PID parameters are calculated.
- The output step applied = % deviation from the set point x 1.5.
- If no errors exist, the COMMANDER 350 enters auto mode and begins to control the process using the new PID parameters.
- If an error occurs during the auto-tune, the COMMANDER 350 reverts to manual mode with the control output set to the default output value. An error message is displayed in the operator level – see Table 2.1.

![Fig 2.7a Typical 'Start-up' Auto-tune Cycles](image)

<table>
<thead>
<tr>
<th>Error</th>
<th>Description</th>
<th>Error</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PV failed during auto-tune</td>
<td>7</td>
<td>A resultant P, I or D value was calculated out of range</td>
</tr>
<tr>
<td>2</td>
<td>Auto-tune has timed out during an auto-tune step</td>
<td>8</td>
<td>PV limit exceeded ('Start up' auto-tune)</td>
</tr>
<tr>
<td>3</td>
<td>Process too noisy to auto-tune</td>
<td>9</td>
<td>Controller put into configuration mode</td>
</tr>
<tr>
<td>4</td>
<td>Process too fast to auto-tune</td>
<td>10</td>
<td>Auto-tune terminated by user</td>
</tr>
<tr>
<td>5</td>
<td>Process too slow to auto-tune (max 12 hours between half-cycles).</td>
<td>11</td>
<td>PV is changing in the wrong direction during step test</td>
</tr>
<tr>
<td>6</td>
<td>PV deviated from set point by &gt;25% eng. span during frequency response test</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2.1 Auto-tune Error Codes
2.8.2 'At Set Point' Auto-tune
If the process variable is within 10% of the set point, 'at set point' tuning is carried out.

- 'At set point' tuning – manipulates the control output to produce a controlled oscillation of the process.
- A step change of ±10% of the starting output value is applied initially. This is adjusted to give an amplitude of oscillation 3 times the noise level.
- Once the amplitude and period of oscillation are consistent (minimum 2 cycles, maximum 4 cycles) PID parameters are calculated.
- If no errors exist the controller enters auto mode and begins to control the process using the new PID parameters.
- If an error occurs during the auto-tune, the controller reverts to manual mode with the control output set to the default output value. An error message is displayed in the operator level – see Table 2.1.

Note 1. The time taken to complete auto-tune depends upon the system response time.

Note 2. Time Proportioning – the cycle time must be set prior to running an auto-tune. The cycle time is not changed by the auto-tune.
2.8.3 Auto-tune

Accessing the Auto-tune Facility
From any operating frame, press and hold the C key until the ‘CODE’ frame is displayed.

Set the correct auto-tune password.

Auto-tune Enable
Select the type of auto-tune required.

Single Loop Templates
OFF – Off
A – Type A
B – Type B

Auto-tune is started automatically when the key is pressed. Auto-tune can be stopped at any time by pressing the key.

Note. P + I control only – set the derivative term to 'OFF' in the Tuning Level – see Section 3.2.

Return to the Operating Level.

Fig. 2.8 Autotune Types
2.9 Control Efficiency Monitor
The Control Efficiency Monitor can be used either to compare the relative performance with different tuning parameters, or when fine tuning the PID settings, to give optimum control.

When the set point is changed, auto mode is selected or following a power failure, input failure or a large load disturbance, the control monitor performs a series of measurements to indicate the effectiveness of the current control parameters.

General guidelines are shown in Table 2.2.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ideal Setting</th>
<th>Actual Setting</th>
<th>Effect on Response</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate of Approach</td>
<td>Fast</td>
<td>Too slow</td>
<td></td>
<td>• Decrease proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Decrease integral time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Increase derivative time</td>
</tr>
<tr>
<td>Overshoot</td>
<td>Small</td>
<td>Too large</td>
<td></td>
<td>• Increase proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Increase derivative time</td>
</tr>
<tr>
<td>Decay Ratio</td>
<td>Small</td>
<td>Too large</td>
<td></td>
<td>• Increase proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Oscillatory)</td>
<td></td>
<td>• Increase integral time</td>
</tr>
<tr>
<td>Settling Time</td>
<td>Short</td>
<td>Too long</td>
<td></td>
<td>• Increase proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Decrease integral time</td>
</tr>
<tr>
<td>Error Integral</td>
<td>Small</td>
<td>Too large</td>
<td></td>
<td>If large overshoot and oscillatory then:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Increase proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Increase integral time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Increase derivative time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>If slow approach and overdamped then:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Decrease proportional band</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Decrease integral time</td>
</tr>
</tbody>
</table>

Table 2.2 Control Efficiency Monitor Settings
2.9 Control Efficiency Monitor

2.9.1 Manual Tuning

The Control Efficiency Monitor may be used for manually tuning the PID parameters. The following method describes how to tune the controller for 1/4 wave damping:

a) Set the integral and derivative action times to OFF.
b) Set the proportional band (PB) to a low setting.
c) Apply a small set point change.
d) Use the Control Efficiency Monitor to note the decay ratio.
e) If the decay ratio > 0.25, increase the Proportional Band until decay ratio = 0.25
   If the decay ratio < 0.25, decrease the Proportional Band until decay ratio = 0.25
f) Leave the proportional band at the setting which gives 0.25 decay ratio and, using the Control Efficiency Monitor, note the period between peaks.
g) Calculate and set the following parameters:
   Integral action time = Period/1.5
   Derivative action time = Period/6

Note. The manual tuning facility must not be used with boundless motorized valve control, as an Integral Action Time is required for these applications.
2.9.2 Using the Control Efficiency Monitor

Press and hold the ▲ and ▼ keys for 2 seconds.

Note.
If the front panel keys are not operated for 60 seconds whilst any Control Efficiency Monitor frame is being displayed, the instrument reverts to the first operating frame.

Rate of Approach to Set Point
The rate of change of the process variable between 5 and 95% of the step change (Y₂), measured in engineering units per minute.

\[
\text{Rate of approach} = \frac{Y_1}{t_{\text{approach}}}
\]

Overshoot
The maximum error, expressed as a percentage of the set point.

\[
\text{Overshoot} = \frac{X_1}{\text{Set Point}} \times 100
\]

Decay Ratio
The ratio of the amplitude of the first and second overshoots.

\[
\text{Ratio} = \frac{X_2}{X_1}
\]

Period
The time (in seconds) between the first two peaks (t_{\text{period}}).

Settling Time
The time taken (in minutes) for the process variable to settle within ±2% of the set point value (t_{\text{settle}}).

Error Integral
The integral of the error value until the process variable settles to within ±2% of the set point value in 'engineering-unit hours'.

\[
\text{Error integral} = \int_0^{t_{\text{settle}}} |PV - SP| \, dt
\]

Return to the first operating frame.
3.1 Introduction
To access the Set Up mode (Levels 2 to 5) the correct password must be entered in the security code frame.

**Fig. 3.1 Set Up Mode – Overview**

**LEU2**
- Tuning
- Cycle time, output 1 & 2
- On/off hysteresis values
- Proportional bands 1 to 4
- Integral action times 1 to 4
- Derivative action times 1 & 2
- Manual reset value
- Control deadband
- Heat Cool Output 1 & 2 Start

**LEU3**
- Set Points
- Local set point values 1 to 4
- Slave set point value
- Remote set point ratio/bias
- Ramp rate

**LEU4**
- Alarm Trip Points
- Alarm 1 to 8 trip points

**LEU5**
- Motorized Valve Set Up
- With feedback:
  - Feedback ratio/bias
  - Deadband
  - Regulator travel time
- Boundless:
  - Deadband
  - Regulator travel time

**Fig. 3.2 – Scroll Display Overview**

Frame number

2×× – Level 2
3×× – Level 3 etc.
Note. Level 2 is not applicable if an Auto/Manual Station or Indicator template is selected.

Level 2 – Tune

Note. To select this frame from anywhere in this page, press and hold the [ ] key for a few seconds.

Cycle Time Output 1

[1.0 to 300.0 seconds for time proportioning or '0n0f' for on/off control]

Cycle Time Output 2 (Cool)

[1.0 to 300.0 seconds for time proportioning or '0n0f' for on/off control]

Output 1 On/Off Hysteresis Value

[In engineering units]

Output 2 On/Off Hysteresis Value

[0% to (Y1.St – Y2.St)%] – see parameters 2.22 and 2.23

• 1 Displayed only if Relay or Digital output type is selected – see Section 4.2, Basic Configuration/Output Type.
• 2 Displayed only if Heat/Cool output type is selected.
• 3 Only if On/Off control is selected – see parameters 2.01 and 2.02 above.
• 4 Displayed only if Heat/Cool output type is selected and the 'CYC.2' parameter is set to '0n0f'.
...3.2 Level 2 – Tune

**2.05**

**Proportional Band 1**

Enter the value for Proportional Band 1.  
[0.1% to 999.9%]

'\(Pb\) - 1' is the default proportional band

**2.06**

**Proportional Band 2, 3 and 4**

Enter the value for Proportional Band 2, 3 and/or 4.  
[0.1% to 999.9%]

**2.08**

**Integral Action Time 1**

[1 to 7200 seconds or ‘OFF’]

'\(IAt\) - 1' is the default integral action time.

**2.10**

**Integral Action Time 2, 3 and 4**

[1 to 7200 seconds or ‘OFF’]

**2.12**

**Derivative Action Time 1**

[0.1 to 999.9 seconds or ‘OFF’]

Continued on next page.

- 1 Heat/cool outputs use a common proportional band. The default is '\(Pb\) - 1'.
- 2 Displayed only if a tune parameter source is selected – see Section 4.2, Basic Configuration/Template Application and Section 4.6, Control Configuration/ Tune Parameter Source.
- 3 Displayed only if a tune parameter source is selected – see Section 4.6, Control Configuration/ Tune Parameter Source.
...3 SET UP MODE

2.13...2.21

3.2 Level 2 – Tune

2.15

Approach Band 1

[0.1 to 3.0 proportional bands]

This parameter limits when derivative action time 1 is applied. When the process variable is outside the approach band, derivative action is not applied.

2.17

Manual Reset Value 1

The value applied to bring the master control output to the zero error point under normal load conditions (integral action disabled) or the offset applied to the control output (integral action enabled).

Turning on ‘SET’ [5.0]

[0.0 to 100%]

Note. Manual reset is applied whether or not an integral action time is set.

2.21

Control Deadband

When the process variable is in the deadband, changes to the control output due to proportional and integral action are suppressed. When a cascade template is selected, the control deadband is applied to the master output only.

Turning on ‘DEADBAND’ [OFF]

[In engineering units or ‘OFF’]

Continued on next page.

•1 Not displayed if the associated derivative action time is set to OFF.

•2 If manual control is selected and no integral action time is set, the manual reset value is calculated automatically to give bumpless transfer into auto control.
3.2 Level 2 – Tune

Heat/Cool Output 1 Start
This parameter defines the PID output value above which Output 1 (heat) becomes active.

[0.0 to 100.0%]

Heat/Cool Output 2 Start
This parameter defines the PID output value below which Output 2 (cool) becomes active.

[0.0 to \(\leq Y1\text{st \%}\)] – see Heat/Cool Output 1

**•1** Displayed only if a Heat/Cool output type is selected – see Section 4.2, Basic Configuration/ Output Type.
3.3 Level 3 – Set Points

Note. Level 3 is not applicable if Auto/Manual Station or Indicator templates are selected.

Level 3 – Set Points

Note. To select this frame from anywhere in this page, press and hold the key for a few seconds.

Local Set Point Value 1
Set the default local set point value.
[Within set point high and low limits, in engineering units – see Level 9]

Local Set Point Values 2 to 4
[Within set point high and low limits, in engineering units – see Level 9]

Remote Set Point Ratio
The remote set point value is (ratio x remote set point input) + bias.
[0.001 to 9.999]

Remote Set Point Bias
[In engineering units]

Continued...

1. Displayed only if a local set point source is selected – see Section 4.5/ Set Point Configuration/Local/Remote Set Point Source.

2. Displayed only for templates with a remote set point.
3.3 Level 3 - Set Points

3.10 Ramp Rate

[1 to 9999 engineering units per hour, or OFF]

The Ramping Set Point facility can be used to prevent a large disturbance to the control output when the set point value is changed. The rate set applies to both the local and the remote set points.

* e.g. Ramp Rate = 200 Increments/Hour

Return to top of page.
3.4 Level 4 – Alarm Trip Points

**Note.** Level 4 is not applicable if all alarm types are set to ‘None’ – see Section 4.4, Alarms/Alarm Type.

### Level 4 – Alarm Trip Points

**Note.** To select this frame from anywhere in this page, press and hold the key for a few seconds.

#### Alarm 1 Trip

**Alarm Number and Type**

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NONE</strong></td>
<td>None</td>
<td><strong>LP2</strong></td>
<td>Low Process I/P2</td>
</tr>
<tr>
<td><strong>HPU</strong></td>
<td>High Process, PV</td>
<td><strong>KB</strong></td>
<td>High Output</td>
</tr>
<tr>
<td><strong>LP1</strong></td>
<td>Low Process, PV</td>
<td><strong>LH</strong></td>
<td>Low Output</td>
</tr>
<tr>
<td><strong>HP1</strong></td>
<td>High Latch, PV</td>
<td><strong>Kb1</strong></td>
<td>Math Block 1 High</td>
</tr>
<tr>
<td><strong>LLP</strong></td>
<td>Low Latch, PV</td>
<td><strong>Lb1</strong></td>
<td>Math Block 1 Low</td>
</tr>
<tr>
<td><strong>Hd</strong></td>
<td>High Deviation</td>
<td><strong>Kb2</strong></td>
<td>Math Block 2 High</td>
</tr>
<tr>
<td><strong>Ld</strong></td>
<td>Low Deviation</td>
<td><strong>Lb2</strong></td>
<td>Math Block 2 Low</td>
</tr>
<tr>
<td><strong>HP2</strong></td>
<td>High Process I/P1</td>
<td><strong>Kb3</strong></td>
<td>Math Block 3 High</td>
</tr>
<tr>
<td><strong>LP2</strong></td>
<td>Low Process I/P1</td>
<td><strong>Lb3</strong></td>
<td>Math Block 3 Low</td>
</tr>
<tr>
<td><strong>HP3</strong></td>
<td>High Process I/P2</td>
<td><strong>Kb4</strong></td>
<td>Math Block 4 High</td>
</tr>
<tr>
<td><strong>LP3</strong></td>
<td>Low Process I/P3</td>
<td><strong>Lb4</strong></td>
<td>Math Block 4 Low</td>
</tr>
</tbody>
</table>

**Trip Value**

[In engineering units]

**Note.** When an auto/manual station template or analog backup template is selected, Alarm 1 is set automatically as a low process alarm on Analog Input 2.

#### Alarm 2 to Alarm 8 Trip

**Alarm Number and Type**

See Alarm 1.

**Trip Value**

[In engineering units]

---

1. Not displayed if alarm type set to 'None' – see Section 4.4, Alarms/Alarm Type.
2. Applies to PID output with single or heat/cool outputs.
3.5 Level 5 – Valve Setup

Note. Level 5 is applicable only for a motorized valve output type – see Section 4.2, Basic Configuration/ Output Type.

![Fig. 3.3 Motorized Valve Output with Feedback – Schematic](image)

3.5.1 Valve Setup (Feedback Types)

**Level 5 – Valve Setup**

Note. To select this frame from anywhere in this page, press and hold the [ ] key for a few seconds.

**Motorized Valve Ratio and Bias**

Desired valve position = (Ratio x PID output) + Bias

**Motorized Valve Ratio**

[0.01 to 10.00]

**Motorized Valve Bias**

[-100.0 to 100.0%]

**Motorized Valve Deadband**

[0.0 to 100% of the position feedback span]

Example. If the valve is set to be driven to the 50% open position and the deadband is set to 4%, the motor stops driving when the position feedback is 48%. The deadband is between 48% and 52%.

**Regulator Travel Time**

The time entered is compared with the actual travel time. If the valve is sticking an error message is generated.

[0 to 5000 seconds, 0 = no check]
3.5.2 Valve Setup (Boundless Types) – Fig. 3.4

A ‘boundless’ process controller provides an output that is effectively the time derivative of the required regulator position, i.e. the COMMANDER 350 signals the regulator, not where to go to (position derivative), but in which direction to travel and how far to move, by a series of integral action pulses. Thus, the COMMANDER 350 does not need to know the absolute regulator position and is unaffected when regulator reaches the upper or lower limit, as determined by the regulator’s limit switches (giving rise to the term ‘boundless’).

When a deviation from set point is introduced the regulator is driven, for a length of time equivalent to the proportional step. The regulator is then driven by integral action pulses until the deviation is within the deadband setting.

Calculation for Control Pulses (Boundless Control)

The following calculations are shown for guidance when setting deadband, proportional and integral values. They can be used to check the suitability of boundless control for a particular actuator/application.

Minimum 'ON' time of integral action pulses (for a fixed control deviation).

\[ \text{Minimum time} = \frac{\text{Travel Time} \times \text{Deadband \%}}{\text{\% Proportional Band}} \] (in seconds)

Minimum (approximate) time between integral action pulses (for a fixed control deviation)

\[ \text{Minimum time} = \frac{\text{Integral Action Time} \times \text{Deadband \%}}{2 \times \text{\% Control Deviation}} \] (in seconds)

Duration of the proportional step

\[ \text{Proportional Step} = 2 \times \left( \frac{\% \text{Control Deviation}}{\% \text{Proportional Band}} \right) \times \text{Travel Time in Seconds} \]

% Control Deviation

\[ \% \text{Control Deviation} = \frac{\text{Set Point} - \text{Process Variable}}{\text{Eng Hi} - \text{Eng Lo}} \times 100\% \]

% Deadband

\[ \% \text{Deadband} = \frac{\text{Deadband (eng units)}}{\text{Eng Hi} - \text{Eng Lo}} \times 100\% \]
...3.5.2 Valve Setup – Boundless

Level 5 – Valve Setup

Note. To select this frame from anywhere in this page, press and hold the key for a few seconds.

Boundless Deadband

[In engineering units]

Regulator Travel Time

The time taken for the regulator to travel from the fully open to the fully closed position.

[1 to 5000 seconds]

Return to top of page.
4.1 Introduction
To access the Configuration mode (Levels 6 to E) the correct password must be entered in the security code frame.

Note. When in the configuration mode, the green bargraph led illuminates. All relays and digital outputs are de-energized and all analog outputs revert to the set minimum current output.

---

**Basic Configuration**
- Template application
- Output type
- Control action
- Mains rejection frequency

**Analog Inputs 1 to 3**
- Type
- Electrical range
- Decimal places
- Engineering range
- Broken sensor drive
- Input filter time constant

**Alarms 1 to 8**
- Type
- Trip level
- Hysteresis band

**Set Points**
- Tracking enable
- Set point limits
- Local set point sources 1 to 4
- Local/remote set point selection

**Control Configuration**
- Power fail recovery action
- Output high/low limits
- Slew rate + disable
- Configured outputs 1 to 3
- Manual output selection sources
- Auto mode selection source
- Tune parameter sources 1 to 4

**Operator Configuration**
- Auto/manual key enables
- Local/remote key enables
- Alarm acknowledge key enable
- Operator set point adjust enable
- Operator ratio/bias enable
- Password settings
- Clock settings

**Output Assignment**
- Outputs 1 and 2 type
- Digital output
- Assignment source
- Polarity
- Analog output
- Assignment source
- Electrical range
- Engineering range
- Relay outputs 1 to 4
- Assignment source
- Polarity

**Serial Communications**
- 2-/4-wire connection
- 2400/9600/19200 baud rate
- Parity
- Modbus address

**Calibration**
- Offset/span adjustment
- Motorized valve feedback

---

Fig. 4.1 Configuration Mode – Summary
4.2 Level 6 – Basic Configuration

Template Application
Templates are provided to make the basic configuration for a particular application as simple as possible. The appropriate template should be selected before any other parameters are configured. When a template is selected, the COMMANDER 350 assumes the preset form for that template (see Appendix A). The inputs and software blocks are automatically soft-wired to perform the selected function.

Select the Template required

<table>
<thead>
<tr>
<th>Display</th>
<th>Template Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 1SL</td>
<td>Single loop with local set point only</td>
</tr>
<tr>
<td>02SL</td>
<td>Single loop with remote set point</td>
</tr>
<tr>
<td>03R-</td>
<td>Auto/Manual station with low signal selection</td>
</tr>
<tr>
<td>04R-</td>
<td>Auto/Manual station with digital selection</td>
</tr>
<tr>
<td>05Rb</td>
<td>Analog backup with low signal selection</td>
</tr>
<tr>
<td>06Rb</td>
<td>Analog backup with digital selection</td>
</tr>
<tr>
<td>07 IN</td>
<td>Single indicator/manual loader</td>
</tr>
<tr>
<td>08 IN</td>
<td>Double indicator/manual loader</td>
</tr>
</tbody>
</table>

**Note 1.** When a template is selected, the following default values apply: The ‘Analog Input Type’ of all inputs used by the template defaults to ‘2’, i.e. 4 to 20mA; The engineering ranges of all inputs used default to ‘0.0 to 100.0’. All other inputs are set to ‘OFF’.

**Note 2.** Templates customized using the PC Configurator are identified by the letter ‘U’ in the template code – i.e. template ‘0 1SL’ becomes ‘0 IU’.
Control Output Type
The appropriate relays, digital outputs and analog outputs are assigned to the control output variables. The other hardware outputs are provisionally assigned to alarm and retransmission functions but these may be changed in the output assignment level – see Section 4.8.

Select the Output Type required – see also Fig. 4.2 overleaf and Rear Fold-out/Table B.

<table>
<thead>
<tr>
<th>Display</th>
<th>Output Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>nOnE</td>
<td>None</td>
</tr>
<tr>
<td>A nLG</td>
<td>Analog output (Control output = ao1)</td>
</tr>
<tr>
<td>rLY</td>
<td>Relay output (Control output = RLY1)</td>
</tr>
<tr>
<td>d IG</td>
<td>Digital output (Control output = do1)</td>
</tr>
<tr>
<td>P Fb</td>
<td>Motorized valve with feedback (Open = RLY1, Close = RLY2)</td>
</tr>
<tr>
<td>b nd</td>
<td>Motorized valve without feedback (Open = RLY1, Close = RLY2)</td>
</tr>
<tr>
<td>H C r r</td>
<td>Heat/cool with OP1 = relay, OP2 = relay</td>
</tr>
<tr>
<td>H C r d</td>
<td>Heat/cool with OP1 = relay, OP2 = digital output</td>
</tr>
<tr>
<td>H d r</td>
<td>Heat/cool with OP1 = digital output, OP2 = relay</td>
</tr>
<tr>
<td>H C A r</td>
<td>Heat/cool with OP1 = analog, OP2 = relay</td>
</tr>
<tr>
<td>H C A A</td>
<td>Heat/cool with OP1 = analog, OP2 = analog</td>
</tr>
</tbody>
</table>

- Only output types ‘nOnE’ and ‘A nLG’ are applicable to indicator templates. Only output type ‘A nLG’ is applicable to auto/manual station and analog backup templates.

- Analog Input 3 Type defaults to ‘11’ – Resistance Feedback.
...4.2 Level 6 – Basic Configuration

Output Types:
- ANLG
- rLY
- d IG

A – Single Output

Output Type:
- PFb

B – Motorized Valve Output with Feedback

Output Type:
- bNd

C – Motorized Valve Output without Feedback (Boundless)

Output Types:
- HCrr
- HCrd
- HCdr
- HCAr
- HCRA

D – Heat/cool Output

Fig 4.2 Output Type Schematic Diagrams
...4 CONFIGURATION MODE

...4.2 Level 6 – Basic Configuration

6.03 C.A.C.T

r.EU

6.06 F.r.E.J

50

Control Action

<table>
<thead>
<tr>
<th>Single Loop</th>
<th>Output 1</th>
<th>Output 2 (Cool)</th>
</tr>
</thead>
<tbody>
<tr>
<td>r.EU,</td>
<td>Reverse</td>
<td></td>
</tr>
<tr>
<td>d.r</td>
<td>Direct</td>
<td></td>
</tr>
</tbody>
</table>

Heat/Cool  | Output 1 (Heat) | Output 2 (Cool) |
-------------|-----------------|-----------------|
r - d        | Reverse         | Direct          |

Mains Rejection Frequency

Used to filter mains frequency pick-up on external analog input wiring.

[50 or 60Hz]

Return to top of page.

• 1 Not displayed for auto/manual or indicator templates.

• 2 Not displayed if Heat/Cool output types selected – see parameter 6.02.

• 3 Displayed only if Heat/Cool output types selected – see parameter 6.02.
4.3 Level 7 – Analog Inputs

**4.3.1 Level 7 – Analog Inputs**

*Note 1.* Refer also to Rear Foldout/Table A, Template Applications.

*Note 2.* To select this frame from anywhere in this page, press the [ ] key for a few seconds.

### Analog Input 1 (I/P1) Type & Electrical Range

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>Not Used</td>
<td>P</td>
<td>PT100 RTD</td>
</tr>
<tr>
<td>b</td>
<td>THC Type B</td>
<td>0</td>
<td>0 to 20mA</td>
</tr>
<tr>
<td>E</td>
<td>THC Type E</td>
<td>2</td>
<td>4 to 20mA</td>
</tr>
<tr>
<td>J</td>
<td>THC Type J</td>
<td>3</td>
<td>0 to 5V</td>
</tr>
<tr>
<td>K</td>
<td>THC Type K</td>
<td>4</td>
<td>1 to 5V</td>
</tr>
<tr>
<td>L</td>
<td>THC Type L</td>
<td>5</td>
<td>0 to 50mV</td>
</tr>
<tr>
<td>N</td>
<td>THC Type N</td>
<td>6</td>
<td>4 to 20mV square root linearizer</td>
</tr>
<tr>
<td>r</td>
<td>THC Type R</td>
<td>7</td>
<td>4 to 20mA power 3/2</td>
</tr>
<tr>
<td>S</td>
<td>THC Type S</td>
<td>8</td>
<td>4 to 20mA power 5/2</td>
</tr>
<tr>
<td>t</td>
<td>THC Type T</td>
<td>U</td>
<td>Custom</td>
</tr>
</tbody>
</table>

*1 Displayed only if THC or RTD input types are selected*

### Temperature Units (I/P1)

- **C** – THC/PT100 readings displayed in °C
- **F** – THC/PT100 readings displayed in °F

### Decimal Places (Engineering Range, I/P1)

- **0** – XXXX
- **1** – XXX.X
- **2** – XX.XX
- **3** – X.XXX

Continued...
...4 CONFIGURATION MODE

... 4.3 Level 7 – Analog Inputs

Engineering High (I/P1)

[-999 to 9999]

Note. This parameter defaults to the maximum allowed value when THC or RTD inputs are selected – see Table 4.1.

<table>
<thead>
<tr>
<th>THC/RTD Type</th>
<th>°C</th>
<th>°F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
</tr>
<tr>
<td>Type B</td>
<td>-18</td>
<td>1800</td>
</tr>
<tr>
<td>Type E</td>
<td>-100</td>
<td>900</td>
</tr>
<tr>
<td>Type J</td>
<td>-100</td>
<td>900</td>
</tr>
<tr>
<td>Type K</td>
<td>-100</td>
<td>1300</td>
</tr>
<tr>
<td>Type L</td>
<td>-100</td>
<td>900</td>
</tr>
<tr>
<td>Type N</td>
<td>-200</td>
<td>1300</td>
</tr>
<tr>
<td>Type R &amp; S</td>
<td>-18</td>
<td>1700</td>
</tr>
<tr>
<td>Type T</td>
<td>-250</td>
<td>300</td>
</tr>
<tr>
<td>Pt100</td>
<td>-250</td>
<td>600</td>
</tr>
</tbody>
</table>

Table 4.1 Engineering Limits, THC & RTD Inputs

Engineering Low (I/P1)

[-999 to 9999]

Note. This parameter defaults to the minimum allowed value when THC or RTD inputs are selected – see Table 4.1.

Broken Sensor Drive (I/P1)

NONE – No action. Actual input values remain valid.

UP – Input driven to the maximum upscale value (999)

dn – Input driven to the minimum downscale value (–999)

In the event of a fault being detected on the input, the input is driven in the direction selected.

Input Filter Time Constant (I/P1)

The input values are averaged over the time set.

[0 to 60 seconds]

Continued...
### 4.3 Level 7 – Analog Inputs

**Analog Input Type & Electrical Range (I/P2)**

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>Not Used</td>
<td>t</td>
<td>THC Type 1</td>
</tr>
<tr>
<td>b</td>
<td>THC Type B</td>
<td>i</td>
<td>0 to 20mA</td>
</tr>
<tr>
<td>E</td>
<td>THC Type E</td>
<td>2</td>
<td>4 to 20mA</td>
</tr>
<tr>
<td>J</td>
<td>THC Type J</td>
<td>6</td>
<td>0 to 50mV</td>
</tr>
<tr>
<td>K</td>
<td>THC Type K</td>
<td>7</td>
<td>4 to 20mA square root linearizer</td>
</tr>
<tr>
<td>L</td>
<td>THC Type L</td>
<td>8</td>
<td>4 to 20mA power 3/2</td>
</tr>
<tr>
<td>N</td>
<td>THC Type N</td>
<td>9</td>
<td>4 to 20mA power 5/2</td>
</tr>
<tr>
<td>r</td>
<td>THC Type R</td>
<td>U</td>
<td>Custom</td>
</tr>
<tr>
<td>S</td>
<td>THC Type S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** THC inputs can only be used on I/P2 if I/P1 is also set to THC.

**Temperature Units (I/P2)**

- C – THC readings displayed in °C
- F – THC readings displayed in °F

**Decimal Places (Engineering Range, I/P2)**

- 0 – XXXX
- 1 – XXX.X
- 2 – XX.XX
- 3 – X.XXX

**Engineering High (I/P2)**

[-999 to 9999]

**Note.** This parameter defaults to the maximum allowed value when THC input type is selected – see Table 4.1.

**Engineering Low (I/P2)**

[-999 to 9999]

**Note.** This parameter defaults to the minimum allowed value when THC input is selected – see Table 4.1.

**Broken Sensor Drive (I/P2)**

- NONE – No action. Actual input values remain valid.
- UP – Input driven to the maximum upscale value (999)
- dN – Input driven to the minimum downscale value (~999)

**Filter Time Constant (I/P2)**

The input values are averaged over the time set.

[0 to 60 seconds]

• Frames 7.09 to 7.14 are not displayed if Analog Input Type 2 is set to ‘OFF’.
• Displayed only if THC input type is selected.
• When i/p 2 is assigned to a remote set point input, it is displayed with the same number of decimal places as the associated process variable.
### Analog Input Type & Electrical Range (I/P3)

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>Not Used</td>
<td>1</td>
<td>0 to 20mA</td>
</tr>
<tr>
<td>b</td>
<td>THC Type B</td>
<td>2</td>
<td>4 to 20mA</td>
</tr>
<tr>
<td>E</td>
<td>THC Type E</td>
<td>3</td>
<td>0 to 5V</td>
</tr>
<tr>
<td>J</td>
<td>THC Type J</td>
<td>4</td>
<td>1 to 5V</td>
</tr>
<tr>
<td>k</td>
<td>THC Type K</td>
<td>5</td>
<td>0 to 50mV</td>
</tr>
<tr>
<td>L</td>
<td>THC Type L</td>
<td>6</td>
<td>4 to 20mA square root linearizer</td>
</tr>
<tr>
<td>n</td>
<td>THC Type N</td>
<td>7</td>
<td>4 to 20mA power 3/2</td>
</tr>
<tr>
<td>r</td>
<td>THC Type R</td>
<td>8</td>
<td>4 to 20mA power 5/2</td>
</tr>
<tr>
<td>S</td>
<td>THC Type S</td>
<td>9</td>
<td>Resistance feedback for</td>
</tr>
<tr>
<td>t</td>
<td>THC Type T</td>
<td>10</td>
<td>motorized valve</td>
</tr>
<tr>
<td>P</td>
<td>PT100 RTD</td>
<td>11</td>
<td>Custom</td>
</tr>
</tbody>
</table>

### Temperature Units

- THC readings displayed in °C
- THC readings displayed in °F

### Decimal Places

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>XXXX</td>
</tr>
<tr>
<td>1</td>
<td>XXX.X</td>
</tr>
<tr>
<td>2</td>
<td>XX.XX</td>
</tr>
<tr>
<td>3</td>
<td>X.XXX</td>
</tr>
</tbody>
</table>

### Engineering High

[-999 to 9999]

**Note.** This parameter defaults to the maximum allowed value when THC or RTD inputs are selected – see Table 4.1.

### Engineering Low

[-999 to 9999]

**Note.** This parameter defaults to the minimum allowed value when THC or RTD inputs are selected – see Table 4.1.

### Broken Sensor Drive (I/P3)

- **NONE** – No action. Actual input values remain valid.
- **UP** – Input driven to the maximum upscale value (999)
- **dN** – Input driven to the minimum downscale value (−999)

### Filter Time Constant (I/P3)

The input values are averaged over the time set. [0 to 60 seconds]

---

1. Frames 7.16 to 7.21 are not displayed if Analog Input Type 3 is set to ‘OFF’.
2. Displayed only if THC or RTD input types are selected.
3. When i/p 2 is assigned to a remote set point input, it is displayed with the same number of decimal places as the associated process variable.
4.4 Level 8 – Alarms

**Note.** Any type of alarm can be used to sound an annunciator (klaxon/horn) which is disabled when the alarm is acknowledged. This is achieved by assigning the relay to the acknowledge state of the alarm instead of the actual alarm state.

---

**Process Variable**

On

Off

On

Off

**Trip point**

**Alarm State** ($A_x$)

**Acknowledge State** ($ACK_x$)

Operator acknowledges alarm

---

**Fig 4.3 Using an Alarm to Sound a Horn**

---

**Process Variable**

High Deviation +ve Trip Value

Low Deviation -ve Trip Value

**Alarm On**

**Alarm Off**

**Control Set Point**

**Hysteresis**

**Fig 4.4 High and Low Deviation Alarm Action**
...4 CONFIGURATION MODE

...4.4 Level 8 – Alarms

Fig 4.5 High and Low Process Alarm Action

Fig 4.6 High and Low Latch Alarm Action
8.00...8.03

...4.4 Level 8 – Alarms

Level 8 – Alarms

**Note.** To select this frame from anywhere in this page, press the [Joy pad] key for a few seconds.

### Alarm 1 Type

See Figs 4.3 to 4.6

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L0</td>
<td>None</td>
<td>L0P3</td>
<td>Low Process I/P3</td>
</tr>
<tr>
<td>HPU</td>
<td>High Process, PV</td>
<td>H0</td>
<td>High Output</td>
</tr>
<tr>
<td>HPU</td>
<td>Low Process, PV</td>
<td>L0</td>
<td>Low Output</td>
</tr>
<tr>
<td>HLP</td>
<td>High Latch, PV</td>
<td>Hb1</td>
<td>Math Block 1 High</td>
</tr>
<tr>
<td>LLP</td>
<td>Low Latch, PV</td>
<td>Lb1</td>
<td>Math Block 1 Low</td>
</tr>
<tr>
<td>HlD</td>
<td>High Deviation</td>
<td>Hb2</td>
<td>Math Block 2 High</td>
</tr>
<tr>
<td>LlD</td>
<td>Low Deviation</td>
<td>Lb2</td>
<td>Math Block 2 Low</td>
</tr>
<tr>
<td>HP1</td>
<td>High Process I/P1</td>
<td>Hb3</td>
<td>Math Block 3 High</td>
</tr>
<tr>
<td>LP1</td>
<td>Low Process I/P1</td>
<td>Lb3</td>
<td>Math Block 3 Low</td>
</tr>
<tr>
<td>HP2</td>
<td>High Process I/P2</td>
<td>Hb4</td>
<td>Math Block 4 High</td>
</tr>
<tr>
<td>LP2</td>
<td>Low Process I/P2</td>
<td>Lb4</td>
<td>Math Block 4 Low</td>
</tr>
<tr>
<td>HP3</td>
<td>High Process I/P3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Alarm 1 is set automatically as a Low Process alarm on I/P2 when template 3 or 5 is selected.

### Alarm 1 Trip

#### Alarm Number

#### Trip Value

[In engineering units]

### Alarm 1 Hysteresis

Set the hysteresis value (in engineering units) for Alarm 1.

The alarm is activated at the trip level but is only deactivated when the process variable has moved into the safe region by an amount equal to the hysteresis value – see Figs. 4.4 to 4.6.

[In engineering units]

**Note.** Time hysteresis is set using the PC Configurator.

Continued…

• 1 Applies to the PID output with single or heat/cool output types selected – see Section 3.4.
Alarm Type 2 (Alarms 2 to 8)

[see Alarm 1 Type]

Alarm 2 to Alarm 8 Trip

Alarm Number and Type
[see Alarm 1 Trip]

Trip Value
[In engineering units]

Alarm 2 to Alarm 8 Hysteresis
Set the hysteresis value (in engineering units) – see Alarm 1 Hysteresis.

[In engineering units]

Global Alarm Acknowledge Source

Note. This frame is applicable only to issue 4 and later software.

All active and unacknowledged alarms can be acknowledged by a single digital input.
Set the source required to acknowledge all alarms

See Rear Fold-out/ Table C – Digital Sources.

Acknowledged •1

Return to top of page.

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.
4.5 Level 9 – Set Point Configuration

Note. Level 9 is not applicable when an Indicator template (templates 7 and 8) or an Auto/Manual station template (templates 3 and 4) is selected.

Level 9 – Set Point Configuration

Note. To select this frame from anywhere in this page, press and hold the [ ] key for a few seconds.

Set Point Tracking Enable

<table>
<thead>
<tr>
<th>Display</th>
<th>Local Set Point Tracking</th>
<th>Remote Set Point Tracking</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>LOC</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>rEM</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>L-r</td>
<td>ON</td>
<td>ON</td>
</tr>
</tbody>
</table>

Local Set Point Tracking – the local set point tracks the process variable when manual mode is selected.

Remote Set Point Tracking – local set point tracks the remote set point when in remote set point mode. If the controller is put into manual mode the set point reverts from remote to local.

Set Point Limits
The set point limits define the maximum and minimum values to which the local and/or remote set points can be adjusted. The set point limits do not apply when in Manual mode with local set point tracking enabled. If the set point is outside its limits when Automatic mode is selected, the set point value can only be adjusted towards its limits. Once within the limits they apply as normal.

Control Set Point (CSPT) High Limit
[-999 to 9999 in engineering units]

Control Set Point (CSPT) Low Limit
[-999 to 9999 in engineering units]

Note. Operator level adjustment of the set point can be disabled – see Section 4.7, Operator Configuration/ Set Point Adjustment Enable.

Continued...

• Only available if a remote set point template is selected.
...4 CONFIGURATION MODE

...4.5 Level 9 – Set Point Configuration

Remote Set Point Fault Action
The action required when a fault occurs with the remote set point.

- **NONE** – No action
- **LOC** – Select local set point mode
- **dFLt** – Select local set point mode and set to the default value

Local Set Point Default Value
Set the value required for the local set point under remote set point fault conditions.

[In engineering units]

Local Set Point Source 1
The source required to select local set point 1 (LSP1) as the current local set point.

See Rear Fold-out/Table C – Digital Sources.

Local Set Point Source 2
The source required to select local set point 2 (LSP2) as the current local set point.

See Rear Fold-out/Table C – Digital Sources.

Local Set Point Source 3
The source required to select local set point 3 (LSP3) as the current local set point.

See Rear Fold-out/Table C – Digital Sources.

Local Set Point Source 4
The source required to select local set point 4 (LSP4) as the current local set point.

See Rear Fold-out/Table C – Digital Sources.

Continued...

---

*1 Displayed only if a remote set point template is selected.

*2 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.
...4.5 Level 9 – Set Point Configuration

9.12

Local/Remote Set Point Selection Source
The source required to lock into remote set point mode.

When the source is active the key does not operate.

See Rear Fold-out/ Table C – Digital Sources.

9.13

Local Set Point Selection Source
The source required to select local set point mode.

See Rear Fold-out/ Table C – Digital Sources.

9.14

Remote Set Point Selection Source
The source required to select remote set point mode.

See Rear Fold-out/ Table C – Digital Sources.

Return to top of page.

• Digital inputs are active when a volt-free contact is closed or a low TTL signal is applied
4.6 Level A – Control Configuration

Note. Level A is not displayed if an indicator template is selected.

---

**Power Fail Recovery Mode**
Select the default power failure mode required following a power interruption or failure.

<table>
<thead>
<tr>
<th>Display</th>
<th>Setting</th>
<th>Display</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Last mode</td>
<td>5</td>
<td>Auto mode, integral term reset</td>
</tr>
<tr>
<td>1</td>
<td>Manual mode, using last output</td>
<td>6</td>
<td>Auto mode, using last integral term</td>
</tr>
<tr>
<td>2</td>
<td>Manual mode with 0.0% output</td>
<td>7</td>
<td>Power outage ≤ Recovery time: Auto mode, Power outage &gt; Recovery time: Manual mode, last output</td>
</tr>
<tr>
<td>3</td>
<td>Manual mode with 100.0% output</td>
<td>8</td>
<td>Power outage ≤ Recovery time: Auto mode, Power outage &gt; Recovery time: Manual mode, configured output</td>
</tr>
<tr>
<td>4</td>
<td>Manual mode with configured output</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recovery Time**
If power is restored within the recovery time, the controller continues in the last mode when power fail recovery modes 7 or 8 are selected.

[0 to 9999 seconds]

---

*1 Not displayed if power fail modes 0 to 6 are selected.
4 CONFIGURATION MODE...

...4.6 Level A – Control Configuration

**Process Variable Fail Action**
Determines controller output when the process variable input fails.

- **NONE** – No action
- **HOLd** – Put into Manual mode
- **dFLt** – Put into Manual mode and select default output

**Default Output**
This output is used in conjunction with Power Recovery mode 8 and Process Variable Fail action.

- [0 to 100%] (-100% to +100% for heat/cool)

**Output High Limit – Single Output Control**
Limits the high level of the control output in automatic mode. If the control output is above this limit when automatic mode is selected, the current output value becomes the high limit until the value falls below the limit set.

- [0.0 to 100.0%]

**Output Low Limit – Single Output Control**
Limits the low level of the control output in automatic mode. If the control output is below this limit when automatic mode is selected, the current output value becomes the low limit until the value rises above the limit set.

- [0.0 to 100.0%]

**Output 1 (Heat) High Limit – Heat/Cool Control**
Limits the high level of control output 1 in automatic mode. If the control output is above this limit when automatic mode is selected, the current output value becomes the high limit until the value falls below the limit set.

- [0.0 to 100.0%]

**Output 2 (Cool) High Limit – Heat/Cool Control**
Limits the high level of control output 2 in automatic mode, when ‘reverse-direct’ or ‘direct-reverse’ control action selected in the Basic Configuration level. If the control output is above this limit when automatic mode is selected, the current output value becomes the high limit until the value falls below the limit set.

- [0.0 to -100.0%]

---

- **1** Displayed only if a single output type is selected.
- **2** Displayed only if a heat/cool output type is selected.

---

55
### 4.6 Level A – Control Configuration

**Output 2 (Cool) Low Limit – Heat/Cool Control**
Limits the low level of control output 2 in automatic mode, when ‘reverse-reverse’ or ‘direct-direct’ control action is selected in the Basic Configuration level. If the control output is below this limit when automatic mode is selected, the current output value becomes the low limit until the value rises above the limit set.

[0 to 100%]

**Output Slew Rate**
The maximum rate of change of the control output (or both control outputs for heat/cool).

[0.01 to 99.99% change per second or ‘OFF’]

**Note.** The default slew rate setting is applied to both increasing and decreasing output values. The slew rate setting can be applied to either increasing values only or decreasing values only using the PC Configurator.

**Slew Rate Disable Source**
The digital source required to disable slew rate control of the output.

See Rear Fold-out/ Table C – Digital Sources.

**Manual 1 Mode Selection Source**
The digital source required to select manual mode and Configured Output 1.

See Rear Fold-out/ Table C – Digital Sources.

---

1. Displayed only if reverse-reverse or direct-direct control actions are selected.
2. Digital inputs are active when a volt free contact is closed or a low TTL signal is applied.
...4.6  Level A – Control Configuration

**Configured Output 1**
The control output value required when manual is selected by manual mode source 1.

[0 to 100% or LAST (non-heat/cool)]
[-100 to 100% (heat/cool only)]

**Manual Mode Selection Source 2**
The digital source required to select manual mode and Configured Output 2.

See Rear Fold-out/ Table C – Digital Sources.

**Configured Output 2**
The control output value required when manual is selected by manual mode source 2.

[0 to 100% or LAST (non-heat/cool)]
[-100 to 100% (heat/cool only)]

**Auto/Manual Selection Source**
Used with auto/manual station.
The source required to lock into manual mode with Configured Output 3. Switching from manual to auto is not possible via the front panel.

See Rear Fold-out/ Table C – Digital Sources.

**Note.** If template 3 is selected, the source is assigned to alarm 1. If template 4 is selected, the source is assigned to digital input 1.

**Configured Output 3**
The control output value required when manual mode is selected by the auto/manual selection source.

[0 to 100% or LAST (non-heat/cool)]
[-100 to 100% (heat/cool only)]

•1  Digital inputs are active when a volt free contact is closed or a low TTL signal is applied
### Auto Mode Selection Source
Select the digital source used to activate auto mode.

- **Auto**
- **Manual**

See Rear Fold-out/ Table C – Digital Sources.

#### Tune Parameter Source 1 (Gain Scheduling)
Determine the digital source used to select the proportional 1 and integral 1 terms as the tuning parameters.

- Select $Pb-1$ and $IAt.1$

See Rear Fold-out/ Table C – Digital Sources.

#### Tune Parameter Source 2 (Gain Scheduling)
Determine the digital source used to select the proportional 2 and integral 2 terms as the tuning parameters.

- Select $Pb-2$ and $IAt.2$

See Rear Fold-out/ Table C – Digital Sources.

#### Tune Parameter Source 3 (Gain Scheduling)
Determine the digital source used to select the proportional 3 and integral 3 terms as the tuning parameters.

- Select $Pb-3$ and $IAt.3$

See Rear Fold-out/ Table C – Digital Sources.

#### Tune Parameter Source 4 (Gain Scheduling)
Determine the digital source used to select the proportional 4 and integral 4 terms as the tuning parameters.

- Select $Pb-4$ and $IAt.4$

See Rear Fold-out/ Table C – Digital Sources.

Return to top of page.

• Digital inputs are active when a volt free contact is closed or a low TTL signal is applied.

• $Pb-x$ and $IAt.x$ values are set in Level 2 – see Section 3.2, Tune/Proportional Band $x$ and Integral Action Time $x$. This function is not applicable to Auto/Manual Station or Indicator templates.
4.7 Level B – Operator Configuration

**Level B – Operator Configuration**

**Front Panel Auto/Manual Key Enable**
- **YES** – Enabled
- **NO** – Disabled

**Front Panel Local/Remote Key Enable**
- **YES** – Enabled
- **NO** – Disabled

**Front Panel Alarm Acknowledge Key Enable**
- **YES** – Enabled
- **NO** – Disabled

**Operator Level Set Point Adjustment Enable**
- **YES** – Enabled
- **NO** – Disabled

**Operator Ratio Display**
- **YES** – Ratio setting for Remote set point displayed in operator level.
- **NO** – Ratio setting for Remote set point not displayed in operator level.

**Operator Bias Display**
- **YES** – Bias setting for Remote set point displayed in operator level.
- **NO** – Bias setting for Remote set point not displayed in operator level.

---

1. Not displayed if the Indicator template is in use.
2. Displayed only if a template with remote set point is selected.
4.7 Level B – Operator Configuration

Auto-tune Password
Enables access to the auto-tune facility in the operator level.
[0 to 9999 (default 0)]

Set Up Password
Enables access to the set up levels (levels 2, 3, 4 and 5) and the autotune facility.
[0 to 9999 (default 0)]

Configuration Password
Enables access to the configuration levels, set up levels and the autotune facility.
[0 to 9999 (default 0)]

Day Setting
Use to set the weekday of the on-board clock.
[1 to 7, 1 = Sunday, 7 = Saturday]

Hour Setting
Use to set the hour of the on-board clock.
[0 to 23]

Minute Setting
Use to set the minute of the on-board clock.
[0 to 59]

Current Time
Actual on-board clock time.
[Hours : Mins]

Bargraph Increment
Deviation represented by each bargraph element.
[1 to 10% of engineering range]

• 1 Not displayed on Indicator or Auto/manual station templates.
4.8 Level C – Output Assignment Configuration

**Note.** The Output Assignment default settings are preconfigured to each template – see Table B, Output Sources on the rear fold-out.

---

**Analog/Digital Output 1 (ao1/do1) Type**

Select the output type for Output 1.

- **ANLG** – Analog
- **DIG** – Digital

Press ▲ to advance to Analog Output 1 Assignment Source.

or

Press ▼ to advance to Digital Output 1 Assignment Source.

---

**Level C – Output Assignment**

**Note.** To select this frame from anywhere in this page, press and hold the [ ] key for a few seconds.

---

**1** If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/Control Output Type.
4.8.1 Digital Output 1

**Digital Output 1 (do1) Assignment Source**
Select the source required to activate Digital Output 1.

See Rear Fold-out/ Table C – Digital Sources.

**Digital Output 1 (do1) Polarity**
The output can be set to energize for either an active or inactive digital signal.

- **POS** – Output energized when source is active.
- **NEG** – Output energized when source is inactive.

**Notes:**

1. If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/Control Output Type.
2. Not applicable if digital output 1 is assigned to a control output.
4.8.2 Analog Output 1

Analog Output 1 (ao1) Assignment Source
Select the source required to activate Analog Output 1. See Rear Fold-out/ Table D – Analog Sources.

Analog Output 1 (ao1) Electrical High
The maximum current output required for the analog output. [0.0 to 22.0mA]

Analog Output 1 (ao1) Electrical Low
The minimum current output required for the analog output. [0.0 to 22.0mA]

Retransmission 1 Engineering High
The engineering range value at which maximum output is required. [In engineering units]

Retransmission 1 Engineering Low
The engineering range value at which minimum output is required. [In engineering units]

• If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/ Control Output Type.

• Not applicable if analog output 1 is assigned to a control output.
4.8.3 Analog Output 2

**Analog Output 2 (ao2) Assignment Source**
Select the source required to activate Analog Output 2.
See Rear Fold-out/ Table D – Analog Sources.

**Analog Output 2 (ao2) Electrical High**
The maximum current output required for the retransmission range.
[0.0 to 20.0mA]

**Analog Output 2 (ao2) Electrical Low**
The minimum current output required for the retransmission range.
[0.0 to 20.0mA]

**Retransmission 2 Engineering High**
The engineering range value at which maximum output is required.
[In engineering units]

**Retransmission 2 Engineering Low**
The engineering range value at which minimum output is required.
[In engineering units]

---

*1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/ Control Output Type.

*2 Not applicable if analog output 2 is assigned to a control output.
4.8.4 Relay Outputs 1 to 4

**Relay 1 Assignment Source**
Select the source required to activate relay output 1.
See Rear Fold-out/ Table C – Digital Sources.

**Relay 1 Polarity**
The relay can be set to energize for either an active or inactive digital signal.

- **POS** – Relay energized when source is active.
- **NEG** – Relay energized when source is inactive.

**Relay 2 Assignment Source**
Select the source required to activate relay output 2.
See Rear Fold-out/ Table C – Digital Sources.

**Relay 2 Polarity**
The relay can be set to energize for either an active or inactive digital signal.

- **POS** – Relay energized when source is active.
- **NEG** – Relay energized when source is inactive.

**Relay 3 Assignment Source**
Select the source required to activate relay output 3.
See Rear Fold-out/ Table C – Digital Sources.

**Relay 3 Polarity**
The relay can be set to energize for either an active or inactive digital signal.

- **POS** – Relay energized when source is active.
- **NEG** – Relay energized when source is inactive.

- **1** If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/ Control Output Type.
- **2** Not displayed if relay is assigned to a control output signal.
- **3** Not applicable if relay is assigned to a control output.
- **4** Displayed only if optional relay output is fitted.

Continued…
### 4.8.4 Relay Outputs 1 to 4

**C23...C24**

#### Relay 4 Assignment Source
Select the source required to activate relay output 4.

See Rear Fold-out/ Table C – Digital Sources.

#### Relay 4 Polarity
The relay can be set to energize for either an active or inactive digital signal.

- **POS** – Relay energized when source is active.
- **NEG** – Relay energized when source is inactive.

Return to top of page.

---

1. If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 4.2, Basic Configuration/ Control Output Type.

2. Not displayed if relay is assigned to a control output signal.

3. Not applicable if relay is assigned to a control output.

4. Displayed only if relay output is fitted.
4.9 Level D – Serial Communications Configuration  

Note. Level D is only applicable if the serial communications option is fitted.

Level D – Serial Communications Configuration

Note. To select this frame from anywhere in this page, press and hold the key for a few seconds.

Serial Configuration

0 – Off
1 – 2-wire connection, 2400 baud rate
2 – 4-wire connection, 2400 baud rate
3 – 2-wire connection, 9600 baud rate
4 – 4-wire connection, 9600 baud rate
5 – 2-wire connection, 19200 baud rate
6 – 4-wire connection, 19200 baud rate

Parity

NONE – None
Odd – Odd
EVEN – Even

ModbusTM Address

Each slave on a Modbus link must be assigned a unique address – see IM/C350–MOD.

[1 to 99]

Return to top of page.
4.10 Level E – Calibration

Note. This page enables fine tuning of the inputs to eliminate system errors.

**Level E – Calibration**

*Note.* To select this frame from anywhere in this page, press the [ ] key for a few seconds.

**Analog Input 1 Offset Calibration**

- **Analog Input 1 Value in Engineering Units**
- **Offset [in engineering Units]**

If the [ ] and [ ] keys are not operated for three seconds the display reverts to the offset value only.

**Analog Input 1 Span Calibration**

- **Analog Input 1 Value in Engineering Units**
- **Span Adjustment [0.750 to 1.250]**

If the [ ] and [ ] keys are not operated for three seconds the display reverts to the span value only.

**Analog Input 2 Offset Calibration**

- **Analog Input 2 Value in Engineering Units**
- **Offset [in engineering Units]**

If the [ ] and [ ] keys are not operated for three seconds the display reverts to the offset value only.

**Analog Input 2 Span Calibration**

- **Analog Input 2 Value in Engineering Units**
- **Span Adjustment [0.750 to 1.250]**

If the [ ] and [ ] keys are not operated for three seconds the display reverts to the offset value only.

Continued...
4 CONFIGURATION MODE...

...4.10 Level E – Calibration

**E.05**

Analog Input 3 Offset Calibration

- Analog Input 3 Value in Engineering Units
- Offset [In engineering Units]

If the ▲ and ▼ keys are not operated for three seconds the display reverts to the offset value only.

**E.06**

Analog Input 3 Span Calibration

- Analog Input 3 Value in Engineering Units
- Span Adjustment [0.750 to 1.250]

If the ▲ and ▼ keys are not operated for three seconds the display reverts to the offset value only.

**E.07**

Position Feedback Calibration

Select the calibration required.

- NO – No Calibration
- AUTO – Auto Calibration
- MAN – Manual Calibration

**E.08**

Regulator Travel Time

[0 to 5000 seconds]

Ensure that the value entered is compatible with the regulator motor, as this is used to determine the length of travel of the feedback mechanism.

**E.09**

Motorized Valve Feedback – Fully-closed Position

- NO – No action
- YES – Fully closes the valve automatically and sets the electrical input to low range value.

**E.10**

Motorized Valve Feedback – Fully-open Position

- NO – No action
- YES – Fully opens the valve automatically and sets the electrical input to high range value.

Note. Input value flashes when calibration is in progress.

Continued in Cold Junction Reference Value frame.

- Displayed only if Motorized Valve with feedback output type is selected – see Section 4.2, Basic Configuration.
Position Feedback Electrical Range Low
Set the minimum electrical input value.
[0.0 to 999.9]
For resistance input types, no decimal places are displayed. For all other input types, 1 decimal place is displayed.

Position Feedback Electrical Range High
Set the maximum electrical input value.
[0.0 to 999.9]
Continued in Cold Junction Reference Value frame.

Cold Junction Reference Value
This value should only be changed if a new CJ sensor is supplied with a CJ reference value different to 2700.
The resistance (in Ohms) of the CJ sensor at 25°C.

Cold Junction Beta Value
This value should only be changed if a new CJ sensor is supplied with a CJ Beta value different to 3977.
The beta value of the CJ sensor.

Cold Junction Reading – I/P1 and I/P2
The temperature measured by the cold junction sensor is displayed in °C.

Cold Junction Reading – I/P3
The temperature measured by the cold junction sensor is displayed in °C.

Return to top of Calibration Level.

•1 Displayed only if Motorized Valve with feedback output type is selected – see Section 4.2, Basic Configuration.
•2 Displayed only if corresponding input type is set to ‘THC’.
EC Directive 89/336/EEC
In order to meet the requirements of EC Directive 89/336/EEC for EMC regulations, this product must not be used in a non-industrial environment.

Cleaning
Clean only the front panel, using warm water and a mild detergent.

End of Life Disposal
- The instrument contains a small lithium battery which should be removed and disposed of responsibly in accordance with local environmental regulations.
- The remainder of the instrument does not contain any substance that will cause undue harm to the environment and may therefore be considered as normal waste and disposed of accordingly.

5.1 Mechanical Installation

5.1.1 Siting – Figs. 5.1 and 5.2

A – Close to Sensor

B – At Eye-level Location

C – Avoid Vibration

D – Use Screened Cables

Warning. Select a location away from strong electrical and magnetic fields. If these cannot be avoided, particularly in applications where 'walkie talkies' are used, connect using screened cables within grounded metal conduit.
5.1.2 Mounting – Figs. 5.3 to 5.5

The instrument is designed for panel mounting (Fig. 5.4). Overall dimensions are shown in Fig. 5.3.

Note. For NEMA4X protection, a minimum panel thickness of 2.5mm is recommended.

Fig. 5.3 Overall Dimensions
5.1.2 Mounting – Figs. 5.3 to 5.5

1. Cut a hole in the panel (see Fig. 5.3 for dimensions). Instruments may be close stacked to DIN 43835.

2. Insert the instrument into the panel cut-out.

3. Fit the panel clamps, ensuring that the lugs are located correctly in their slots.

4. Secure the panel clamp using the retaining screws. The rubber friction sleeve prevents over-tightening.

Fig. 5.4 Mounting
5.1.2 Mounting – Figs. 5.3 to 5.5

1. Release the jacking screw cover

2. Turn the jacking screw anticlockwise to pull the instrument from the case

**Note.** Refitting is the reversal of removal.

Fig. 5.5 Inserting/Removing the Instrument from the Case
5.2 Electrical Installation
Refer to the Template Applications table and Output Sources table on the rear fold-out to determine the input and output connections to be made.

⚠️ Warnings.

• The instrument is not fitted with a switch therefore a disconnecting device such as a switch or circuit breaker conforming to local safety standards must be fitted to the final installation. It must be fitted in close proximity to the instrument within easy reach of the operator and must be marked clearly as the disconnection device for the instrument.

• Remove all power from supply, relay and any powered control circuits and high common mode voltages before accessing or making any connections.

• Use cable appropriate for the load currents. The terminals accept cables up to 14AWG (2.5mm²).

• The instrument conforms to Mains Power Input Insulation Category II. All other inputs and outputs conform to Category II.

• All connections to secondary circuits must have basic insulation.

• After installation, there must be no access to live parts e.g. terminals.

• Terminals for external circuits are for use only with equipment with no accessible live parts.

• If the instrument is used in a manner not specified by the Company, the protection provided by the equipment may be impaired.

• All equipment connected to the instrument’s terminals must comply with local safety standards (CEI/IEC 61010-1:2001-2).

Notes.

• Always route signal leads and power cables separately, preferably in earthed (grounded) metal conduit.

• It is strongly recommended that screened cable is used for signal inputs and relay connections. Connect the screen to the earth (ground stud) – see Fig. 5.4.

• The battery is a 3V non-replaceable lithium cell.
5.2.1 Electrical Connections – Figs 5.6 to 5.8

**Output/Power Supply Terminals**
- Terminal blocks viewed from rear of case

**Option Board Terminals**

**Input Terminals**

*Warning.* The AC power supply ground cable must be connected to a Ground Stud.

**Fig. 5.6 Electrical Connections – General**
5.2.1 Electrical Connections – Figs 5.6 to 5.8

* Using internal transmitter power supply
** Use 100Ω shunt resistor provided with instrument
*** For correct broken sensor operation with voltage inputs, fit a 100KΩ pull-up resistor
# Fit the CJ sensor supplied if I/P1 or I/P2 are THC inputs
## I/P2 can only be used with THC inputs if I/P1 is also used as a THC input
### Fit the CJ sensor supplied if I/P3 is a THC input

Fig. 5.7 Electrical Connections – Analog Inputs

---

Fig. 5.8 Electrical Connections – Digital Inputs
5.3 Relays

Note. Refer to the Rear Fold-out/Table B for default relay assignments.

Relay contacts are rated at:
- 115/230 V AC at 5 A (non-inductive)
- 250 V DC 25 W max.

A suitable fuse must be fitted.

5.3.1 Setting the Relay Links – Fig. 5.9
Set the links on the option board (if fitted).

Note. The default setting for the relay links is ‘Normally Open’ (N/O).

5.4 Digital Output
15 V DC min. at 20 mA
Min. load 750 Ω

5.5 Control or Retransmission
Analog Output
Max. load 15 V (750 Ω at 20 mA).
Isolated from analog input, dielectric strength 500 V for 1 minute.
5.6 Motorized Valve Connections – Fig. 5.10

Note. Relays used to drive the motorized valve must be set for 'Normally Open' operation – see Section 5.3.1.

![Motorized Valve Connections Diagram](image)

5.7 Input Connections

Make connections to each input – see Fig 5.7.

Refer to Table A on the rear fold-out for the default input assignment settings.

5.7.1 Thermocouple (THC) Inputs

Note. Use the correct compensating cable between the THC and the terminals – see Table 5.1.

Automatic Cold Junction Compensation (ACJC) is incorporated by use of CJ sensors wired across the input terminals of I/P1 and I/P3 – see Fig. 5.11.

Alternatively, the CJ sensor can be mounted remotely at the point where the thermocouple cable terminates into copper cable, e.g. where cables enter an instrument panel – see Fig. 5.12.

It is possible to use an external fixed cold (reference) junction, if the instrument is programmed for use with millivolt inputs and the appropriate thermocouple linearizer is selected. This is only possible via the PC Configurator.

![CJ Sensor Connections Diagram](image)

![Remote-mounted CJ Sensor Diagram](image)
5.7.2 3-lead Resistance Thermometer (RTD) Inputs
The three leads must have equal resistance, not exceeding 50Ω each.

5.7.3 2-lead Resistance Thermometer (RTD) Inputs
If long leads are necessary it is preferable to use a 3-lead RTD. If the RTD is to be used in a hazardous area, a 3-lead RTD connected via a suitable Zener barrier, must be used.

5.8 Output Connections
Make connections as shown in Fig 5.6.
Refer to Table B on the rear fold-out for the default output assignment settings.

5.9 Power Supply Connections

<table>
<thead>
<tr>
<th>Type of Thermo-couple</th>
<th>Compensating Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BS1843</td>
</tr>
<tr>
<td>Ni-Cr/Ni-Al (K)</td>
<td>Brown</td>
</tr>
<tr>
<td>Nicriss/Nisil (N)</td>
<td>Orange</td>
</tr>
<tr>
<td>Pt/Pt-Rh (R and S)</td>
<td>White</td>
</tr>
<tr>
<td>Pt-Rh/Pt-Rh (B)</td>
<td>—</td>
</tr>
<tr>
<td>Fe/Con (J)</td>
<td>Yellow</td>
</tr>
<tr>
<td>Fe/Con (L) (DIN 43710)</td>
<td>—</td>
</tr>
</tbody>
</table>

* Case Blue for intrinsically safe circuits

Table 5.1 Thermocouple Compensating Cable
**Single Loop Control** provides basic feedback control using three term PID or On/off control. The controller output is calculated from the difference between the process variable and the control set point. The control set point can be a fixed value entered by the user or from a remote source.

- Set Point
- Remote Set Point Input
- Local Set Point
- Process Variable Input
- PID Control Loop
- Manual Output
- OP1

• Template 2 Only
A2  Auto/Manual Station and Analog Backup Station

A2.1  Series and Parallel Operation

Note. See Sections A2.2 and A2.3 for detailed templates.

Fig. A1 Series and Parallel Operation
The **Auto/manual Station** provides a backup for a Master controller. In normal operation the COMMANDER 350’s current output follows the master controller’s output value. A fault in the master system can be identified either by detecting a low signal on the master output (template 3) or via a digital signal (template 4). When a fault is detected the COMMANDER 350 selects manual mode with its output either set to the last valid master output value or to a configured output value – see Section 4.6/ Control Configuration/ Configured Output 1. When the master signal is restored or the digital input returns to its normal state the COMMANDER 350 switches back to auto mode (i.e. COMMANDER 350 output = master output).

The auto/manual station can be used in series or in parallel with the master output signal – see Fig. A1. Parallel operation is achieved by using relay 1 in the COMMANDER 350 to energize an external relay (with suitable changeover contacts for switching low level signals) which selects the output to be routed to the actuator.

1. Template 3 only. Alarm A1 trip value can be set to give the desired low signal detection
2. Template 4 only
The Analog Backup provides a backup for a master controller. In normal operation (remote control mode selected) the COMMANDER 350’s current output follows the master controller’s output value. A fault in the master system can be identified either by detecting a low signal on the master output (template 5) or via a digital signal (template 6). When a fault is detected the COMMANDER 350 switches into local control mode and the process is controlled by the PID output of the COMMANDER 350. The COMMANDER 350 PID algorithm continually tracks the master output value to ensure bumpless transfer from remote to local mode operation. When the master signal is restored or the digital input returns to its normal state the COMMANDER 350 switches back to remote control mode (i.e., COMMANDER 350 output = master output).

The analog backup station can be used in series or in parallel with the master output signal. (See Fig. A1). Parallel operation is achieved by using relay 1 in the COMMANDER 350 to energize an external relay (with suitable changeover contacts for switching low level signals) which selects the output to be routed to the actuator.

1. Template 5 only. Alarm A1 trip value can be set to give the desired low signal detection
2. Template 6 only.
The Indicator/manual Loader Station is used to display one or two process variables on the digital and bargraph displays. If the control output is assigned to an analog output, the lower display indicates its value which can be adjusted by the user. This output can be used to manually control a process or to provide a set point value for another controller.

- • 1 Template 8 Only
- • 2 Not applicable if Control Output Type is set to ‘None’ – see Section 4.2/Basic Configuration.
B1 Introduction
Using the COMMANDER Configurator the COMMANDER 350 can be programmed without using any of the front panel keys.

In addition to the standard settings, the Configurator also gives access to more advanced features not accessible via the front panel keys. These are summarized below.

For information on using individual features, refer to the on-line help facility.

Note. The instrument must be in Configuration Mode (Level 6 or above) and Modbus serial communications must be disabled when uploading or downloading from the PC Configurator.

B2 Analog Input Customization
- Custom mA, mV, Voltage and Resistance ranges
- Standard Linearizers can be assigned to electrical inputs (eg. allowing transmitter inputs to have thermocouple or resistance linearizers to be applied)
- Programmable fault detection levels (default = 10%)

B3 Four Programmable Math Blocks
One of seven types can be assigned to each math block:

<table>
<thead>
<tr>
<th>Standard Arithmetic</th>
<th>Up to 4 operands and 3 operators can be combined in each block, with the operands being calculated sequentially.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operators:</td>
<td>add, subtract, divide, multiply, high select, low select, median select</td>
</tr>
<tr>
<td>Operands:</td>
<td>any analog or digital signals (digital signals have the value ‘1’ or ‘0’)</td>
</tr>
<tr>
<td>Average</td>
<td>The average value of an analog signal over a selectable time period, reset by digital signal</td>
</tr>
<tr>
<td>Maximum detection</td>
<td>The maximum value of an analog signal, reset by digital signal</td>
</tr>
<tr>
<td>Minimum detection</td>
<td>The minimum value of an analog signal, reset by digital signal</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>Calculated from wet and dry bulb temperature sensors</td>
</tr>
<tr>
<td>Square root</td>
<td>The square root value of any analog signal</td>
</tr>
<tr>
<td>Input multiplexer</td>
<td>Selection of one or two analog variables using a digital signal</td>
</tr>
</tbody>
</table>

B4 Six Logic Equations

<table>
<thead>
<tr>
<th>Elements</th>
<th>Up to 15 per equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operators</td>
<td>Up to 7 per equation: OR, AND, NOR, NAND, NOT, EXOR</td>
</tr>
<tr>
<td>Operands</td>
<td>Up to 8 per equation: any digital signal. The NOT operator can be used to invert digital signals.</td>
</tr>
</tbody>
</table>

B5 Process Alarm Customization
- Time Hysteresis, 0 to 9999 seconds
- Alarm Disable Source

B6 Two Real Time Alarms
- Programmable ON days, hours, minutes and duration (00:00 to 23:59)
- Wildcard (*) to allow operation every x minutes past the hour
B7 Two Delay Timers
- Programmable delay and duration (0 to 9999 seconds)

B8 Two Custom Linearizers
- 15 breakpoints per linearizer
- The source can be any analog signal

B9 Template Customization
Each template can be customized by changing the sources for various functions in the COMMANDER 350. This allows maths blocks and custom linearizers to be added into the standard template format.

The following sources can be programmed:
- process variable inputs
- set point inputs
- position feedback input
- input to ratio/bias block
- ratio inputs
- bias inputs

B10 Connecting the COMMANDER PC Configurator

Note. The COMMANDER 350 must be in Configuration Mode (levels 6 to E) and Modbus serial communications must be disconnected when using the PC Configurator.

Fig. B1 Connecting the COMMANDER PC Configurator
### Specification

**Summary**
- 8 application templates: Single loop, Auto/Manual, Analog backup, Indicator
- Two Autotune options
- Control Efficiency Monitor (CEM)
- PC configuration
- IP66/NEMA4X front face

**Operation**

**Display**
- 1 x 4-digit, 14 mm (Red) LED – process variable
- 1 x 4-digit 8 mm (Green) LED – set point
- 1 x 3-digit, 8 mm (Yellow) LED – output
- 1 x 21-segment deviation bargraph

**Configuration**
- Basic configuration via front panel keys or PC
- Advanced feature configuration by PC

**Security**
- Password-protected menus

---

**Standard Functions**

**Control Strategies**
- Single-loop, Auto/manual Station, Analog Backup, Indicator/Manual Loader

**Output Types**
- Current proportioning, Time proportioning, On/off, Motorized valve (with and without feedback), Heat/cool.

**Control Parameters**
- Four sets of PI settings, selectable via digital signals

**Set Points**
- Local, remote and four local fixed set points, selectable via digital signals

**Configured Outputs**
- Three preset output values, selectable via digital signals

**Autotune**
- On demand for ¼ wave or minimal overshoot

**Process Alarms**

<table>
<thead>
<tr>
<th>Number</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types</td>
<td>High/low process, High/low output, High/low deviation</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>Level and time *</td>
</tr>
<tr>
<td>Alarm enable/disable</td>
<td>Enable/disable of alarms via digital signal</td>
</tr>
</tbody>
</table>

**Real Time Alarms ***

<table>
<thead>
<tr>
<th>Number</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programmable</td>
<td>On time/day and duration</td>
</tr>
</tbody>
</table>

* Accessed via PC Configurator
Analog Inputs

Universal Process Inputs

Number
2 standard

Type
Universally configurable to provide:
- Thermocouple (THC)
- Resistance thermometer (RTD)
- mV
- Volts
- mA
- Resistance

Non-universal Process Input

Number
1 standard

Types
- mV only (THC only if I/P1 is also THC)
- mA

Analog Inputs – Common

Linearizer Functions
THC types B, E, J, K, L, N, R, S, T, PT100, √, 3/2, 5/2

Input Impedance
- mA: 100Ω
- mV, V: 10MΩ

Broken Sensor Protection
Programmable for upscale or downscale drive

Sample Interval
125ms (1 input)

Digital filter
Programmable

Cold Junction Compensation
Automatic CJC incorporated as standard
Stability 0.05°C/°C (0.05°F/°F) change in ambient temperature

Input Protection
- Common mode rejection: >120dB at 50/60Hz with 300Ω imbalance resistance
- Series mode rejection: > 60dB at 50/60Hz

Transmitter Power Supply
- Voltage: 24V DC nominal
- Drive: Up to 60mA, (3 loops)

Standard Analog Input Ranges

<table>
<thead>
<tr>
<th>Thermocouple</th>
<th>Maximum Range °C</th>
<th>Maximum Range °F</th>
<th>Accuracy (% of reading)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>−18 to 1800</td>
<td>0 to 3270</td>
<td>0.1% or ±1°C (1.8°F) [above 200°C (392°F)] *</td>
</tr>
<tr>
<td>E</td>
<td>−100 to 900</td>
<td>−140 to 1650</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
</tr>
<tr>
<td>J</td>
<td>−100 to 900</td>
<td>0 to 3270</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
</tr>
<tr>
<td>K</td>
<td>−100 to 1300</td>
<td>−140 to 2350</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
</tr>
<tr>
<td>L</td>
<td>−100 to 900</td>
<td>−140 to 1650</td>
<td>0.1% or ±1.5°C (2.7°F)</td>
</tr>
<tr>
<td>N</td>
<td>−200 to 1300</td>
<td>−325 to 2350</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
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<tr>
<td>R</td>
<td>−18 to 1700</td>
<td>0 to 3000</td>
<td>0.1% or ±0.5°C (0.9°F) [above 300°C (540°F)] *</td>
</tr>
<tr>
<td>S</td>
<td>−18 to 1700</td>
<td>0 to 3000</td>
<td>0.1% or ±0.5°C (0.9°F) [above 200°C (392°F)] *</td>
</tr>
<tr>
<td>T</td>
<td>−250 to 300</td>
<td>−400 to 550</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
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</tbody>
</table>

* Performance accuracy is not guaranteed below 300°C (572°F) for B, R and S thermocouples

<table>
<thead>
<tr>
<th>RTD</th>
<th>Maximum Range °C</th>
<th>Maximum Range °F</th>
<th>Accuracy (% of reading)</th>
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</thead>
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<tr>
<td>PT100</td>
<td>−200 to 600</td>
<td>−325 to 1100</td>
<td>0.1% or ±0.5°C (0.9°F)</td>
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</table>

** RTD, 3-wire platinum, 100Ω per DIN43760 standard (IEC751), with range of 0 to 4000Ωs

Linear Inputs

<table>
<thead>
<tr>
<th>Range</th>
<th>Accuracy (% of reading)</th>
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</thead>
<tbody>
<tr>
<td>Millivolts</td>
<td>0 to 500 mV</td>
</tr>
<tr>
<td>Milliamps</td>
<td>0 to 50 mA</td>
</tr>
<tr>
<td>Volts</td>
<td>0 to 5V</td>
</tr>
<tr>
<td>Resistance</td>
<td>0 to 5000Ω</td>
</tr>
</tbody>
</table>
### Outputs

**Control/Retransmission Outputs**
- **Number**: 2 standard
- **Type**: 1 x programmable as analog or logic (digital) output
  - 1 x analog only
- **Isolation**: Galvanically isolated from the rest of the circuitry
- **Analog range**: 0 and 20mA (programmable), max. 750Ω
  - Accuracy: 0.25%
- **Digital voltage**: 17V @ 20mA

**Relay Outputs**
- **Number**: 2 standard
- **Type**: SPST, rated 5A at 115/230V AC

### Digital Inputs
- **Number**: 2 standard
- **Type**: Volt-free
- **Minimum pulse**: 200ms

### Advanced Features

**Maths Blocks** *
- **Number**: 4
- **Operators**: +, –, x, ÷, Average, Maximum, Minimum, High select, Low select, √, Median select, Relative Humidity
- Input multiplexer (digitally selected)

**Delay Timers** *
- **Number**: 2
- Programmable: Delay and Duration in seconds

**Logic Equations** *
- **Number**: 6
- **Elements**: 15 per equation
- **Operators**: OR, AND, NOR, NAND, NOT, EXOR

**Custom Linearizers** *
- **Number**: 2
- **Breakpoints**: 15 per linearizer

* Accessed via PC Configurator

### Options

**Relay Outputs**
- **Number**: 2
- **Type**: SPST, rated 5A at 115/230V AC

**Digital Inputs**
- **Number**: 2
- **Type**: Volt-free
- **Minimum pulse**: 200ms

**Serial Communications**
- **Connections**: RS485, 2- or 4-wire
- **Protocol**: Modbus RTU
- **Isolation**: Galvanically isolated from the rest of the circuitry

### EMC

**Emissions**
- Meets requirements of EN50081-2

**Immunity**
- Meets requirements of EN50082-2

**Design & manufacturing standards**
- CSA/UL General Safety (cCSAus mark)
  - satisfies the requirements of –
  - CAN/CSA C22.2 No. 1010.1-1-92 Standard
  - CAN/CSA C22.2 No. 1010.1-B97
  - UL Standard 3121-1
- FM General Safety Pending
Physical

Size
96 x 96 x 122.5mm (3.78 in. x 3.78 in. x 4.82 in.)

Weight
680g (1.5lb)

Electrical

Voltage
85 min. to 265 V max. AC 50/60Hz
24V DC

Power consumption
15VA max.

Power interruption protection
Up to 60ms

Safety
General safety EN 61010-1

Isolation
All inputs/outputs to earth: 500V DC
Analog/digital output 1 to rest of the circuitry: 500V DC for 1 minute
Analog output 2 to rest of the circuitry: 500V DC for 1 minute
Serial communications to rest of the circuitry: 500V DC for 1 minute

Environmental

Operating Limits
0°C to 55°C (32°F to 130°F)
5 to 95%RH (non-condensing)

Temperature stability
<0.02%/°C or 2µV/°C (<0.011%/°F or 1.11µV/°F)
Long term drift <0.02% of reading or 20µV annually

Front face
NEMA4X (IP66)
# Set Up Frames

<table>
<thead>
<tr>
<th>Frame Title</th>
<th>Mnemonic</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>xxx</td>
<td>4.01</td>
</tr>
<tr>
<td>Alarm 1 Trip</td>
<td>1.xxx</td>
<td>4.01</td>
</tr>
<tr>
<td>Alarm 2 Trip</td>
<td>2.xxx</td>
<td>4.02</td>
</tr>
<tr>
<td>Alarm 3 Trip</td>
<td>3.xxx</td>
<td>4.03</td>
</tr>
<tr>
<td>Alarm 4 Trip</td>
<td>4.xxx</td>
<td>4.04</td>
</tr>
<tr>
<td>Alarm 5 Trip</td>
<td>5.xxx</td>
<td>4.05</td>
</tr>
<tr>
<td>Alarm 6 Trip</td>
<td>6.xxx</td>
<td>4.06</td>
</tr>
<tr>
<td>Alarm 7 Trip</td>
<td>7.xxx</td>
<td>4.07</td>
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<tr>
<td>Alarm 8 Trip</td>
<td>8.xxx</td>
<td>4.08</td>
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<tr>
<td>Approach Band 1</td>
<td>Rb</td>
<td>1.15</td>
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<tr>
<td>C</td>
<td>dbnbnd</td>
<td>2.21</td>
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<tr>
<td>Control Zone Deadband</td>
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<tr>
<td>Cycle Time 1</td>
<td>CYC1</td>
<td>2.01</td>
</tr>
<tr>
<td>Cycle Time 2</td>
<td>CYC2</td>
<td>2.02</td>
</tr>
<tr>
<td>D</td>
<td>ddbnd</td>
<td>5.03</td>
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<td>Deadband (Feedback only)</td>
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<td>Derivative Action Time 1</td>
<td>drU1</td>
<td>2.13</td>
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<tr>
<td>H</td>
<td>yis</td>
<td>2.22</td>
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<tr>
<td>Heat/Cool Output 1 Start</td>
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<td></td>
</tr>
<tr>
<td>Heat/Cool Output 2 Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>irL1</td>
<td>2.09</td>
</tr>
<tr>
<td>Integral Action Time 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral Action Time 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integral Action Time 3</td>
<td></td>
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<tr>
<td>Integral Action Time 4</td>
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<tr>
<td>L</td>
<td>lsp1</td>
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<tr>
<td>Local Set Point 1</td>
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<tr>
<td>Local Set Point 2</td>
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<td>Local Set Point 3</td>
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<td>Local Set Point 4</td>
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<tr>
<td>M</td>
<td>rsL1</td>
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<td>Manual Reset</td>
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<tr>
<td>Motorised Valve Bias</td>
<td>ub1r</td>
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</tr>
<tr>
<td>Motorised Valve Ratio</td>
<td>urAl</td>
<td>5.01</td>
</tr>
<tr>
<td>O</td>
<td>hys1</td>
<td>2.03</td>
</tr>
<tr>
<td>Output 1 On/off Hysteresis Value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output 2 On/off Hysteresis Value</td>
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</table>

## Mnemonic Number

<table>
<thead>
<tr>
<th>Frame Title</th>
<th>Mnemonic</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>P</td>
<td>Pb-1</td>
<td>2.05</td>
</tr>
<tr>
<td>Proportional Band 1</td>
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<td></td>
</tr>
<tr>
<td>Proportional Band 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportional Band 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proportional Band 4</td>
<td></td>
<td></td>
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<tr>
<td>R</td>
<td>rrkE</td>
<td>3.10</td>
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<tr>
<td>Ramp Rate</td>
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<td>Regulator Travel Time</td>
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<td>Remote Set Point Bias</td>
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<td>Remote Set Point Ratio</td>
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<tr>
<td>S</td>
<td>leu3</td>
<td>3.00</td>
</tr>
<tr>
<td>Set Points</td>
<td></td>
<td></td>
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<tr>
<td>T</td>
<td>leu2</td>
<td>2.00</td>
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<tr>
<td>Tune</td>
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<td></td>
</tr>
<tr>
<td>V</td>
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<tr>
<td>Valve Set Up</td>
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</table>

![Fig. 1.1 Parameter Identification](image)
### Configuration Frames

<table>
<thead>
<tr>
<th>Frame Title</th>
<th>Mnemonic</th>
<th>Number</th>
<th>Frame Title</th>
<th>Mnemonic</th>
<th>Number</th>
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</thead>
<tbody>
<tr>
<td>A</td>
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<td></td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm 1 Hysteresis</td>
<td>HY5.1</td>
<td>0.03</td>
<td>Basic Configuration</td>
<td>LEU6.</td>
<td>0.00</td>
</tr>
<tr>
<td>Alarm 1 Trip</td>
<td>trP.1</td>
<td>0.02</td>
<td>Bias Display Enable</td>
<td>b.d</td>
<td>0.15</td>
</tr>
<tr>
<td>Alarm 1 Type</td>
<td>tYP.1</td>
<td>0.01</td>
<td>Bargraph Increment</td>
<td>b INC</td>
<td>0.16</td>
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<td>Alarm 2 Hysteresis</td>
<td>HY5.2</td>
<td>0.05</td>
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<td>Alarm 2 Trip</td>
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<td>Alarm 2 Type</td>
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<tr>
<td>Alarm 3 Hysteresis</td>
<td>HY5.3</td>
<td>0.09</td>
<td>Calibration</td>
<td>LEU,</td>
<td>0.00</td>
</tr>
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<td>Alarm 3 Trip</td>
<td>trP.3</td>
<td>0.08</td>
<td>CJ Beta Value</td>
<td>E b</td>
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<td>Alarm 3 Type</td>
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<td>0.07</td>
<td>CJ Reading - I/P1 &amp; I/P2</td>
<td>E</td>
<td>0.15</td>
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<td>Alarm 4 Hysteresis</td>
<td>HY5.4</td>
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<td>CJ Reading - I/P3</td>
<td>E</td>
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<td>CJ Reference Value</td>
<td>r EF</td>
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<td>Alarm 6 Hysteresis</td>
<td>HY5.5</td>
<td>0.15</td>
<td>Configuration Password</td>
<td>CP R</td>
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<td>Alarm 6 Trip</td>
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<td>0.14</td>
<td>Configured Output 1</td>
<td>C O P.1</td>
<td>0.13</td>
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<td>Alarm 5 Type</td>
<td>tYP.5</td>
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<td>Configured Output 2</td>
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<td>Alarm 7 Hysteresis</td>
<td>HY5.6</td>
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<td>Configured Output 3</td>
<td>C O P.3</td>
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<td>Alarm 7 Trip</td>
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<td>0.17</td>
<td>Control Configuration</td>
<td>LE U R</td>
<td>0.00</td>
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<td>Alarm 8 Hysteresis</td>
<td>HY5.7</td>
<td>0.21</td>
<td>Current Time</td>
<td>E CL P.</td>
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<td>Alarm 8 Trip</td>
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<td>Alarm Acknowledge Enable</td>
<td>F P R Y.</td>
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<td>D</td>
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<td>Alarm Configuration</td>
<td>LEU8,</td>
<td>0.00</td>
<td>Day Setting</td>
<td>d R Y</td>
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<td></td>
<td>RL - 5.</td>
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<td>Digital Output 1 Polarity</td>
<td>d G 1 P</td>
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<td>Digital Output 1 Source</td>
<td>d G 1 R</td>
<td>0.07</td>
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<tr>
<td></td>
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<td>E</td>
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<td>F</td>
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<td>Feedback Range High</td>
<td>F b H I</td>
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<td>Feedback Range Low</td>
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<td>G</td>
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<td>Global Alarm Acknowledge</td>
<td>G R C P.</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Hour Setting</td>
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• ammonia, nitrate, phosphate, silica, sodium, chloride, phosphide, dissolved oxygen and hydrinate analyzers.
• Zirconia oxygen analyzers, katharometers, hydrogen purity and purge-gas monitors, thermal conductivity.

Table A – Template Applications

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<td>Feedback †</td>
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<td>SL</td>
<td>Single loop + Remote set point</td>
<td>Process Variable</td>
<td>Remote Set Point</td>
<td>Feedback †</td>
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† Motorized Valve output types only

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Note. Settings shown in bold are fixed and cannot be adjusted. Other settings are changed in Level C/ Output Assignment.

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</table>

# Relay 1 is assigned to energize when in manual mode and templates 3, 4, 5 or 6 are selected

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company’s published specification. Periodic checks must be made on the equipment’s condition. In the event of failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.
### Table C – Digital Sources

<table>
<thead>
<tr>
<th>Source</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Outputs</td>
<td>DP1</td>
<td>Control output 1 (heat)</td>
</tr>
<tr>
<td></td>
<td>DP2</td>
<td>Control output 2 (cool)</td>
</tr>
<tr>
<td></td>
<td>DP1E</td>
<td>Motorized valve Open Relay</td>
</tr>
<tr>
<td></td>
<td>CLSE</td>
<td>Motorized valve Close Relay</td>
</tr>
<tr>
<td>Process Alarms</td>
<td>R1</td>
<td>Alarm 1 active</td>
</tr>
<tr>
<td></td>
<td>R2</td>
<td>Alarm 2 active</td>
</tr>
<tr>
<td></td>
<td>R8</td>
<td>Alarm 8 active</td>
</tr>
<tr>
<td>Alarm Acknowledgement</td>
<td>RCP1</td>
<td>Alarm 1 acknowledge</td>
</tr>
<tr>
<td></td>
<td>RCP2</td>
<td>Alarm 2 acknowledge</td>
</tr>
<tr>
<td></td>
<td>RCP8</td>
<td>Alarm 8 acknowledge</td>
</tr>
<tr>
<td>Digital Inputs</td>
<td>DLI</td>
<td>Digital input 1 active</td>
</tr>
<tr>
<td></td>
<td>DL2</td>
<td>Digital input 2 active</td>
</tr>
<tr>
<td></td>
<td>DL3</td>
<td>Digital input 3 active</td>
</tr>
<tr>
<td></td>
<td>DL4</td>
<td>Digital input 4 active</td>
</tr>
<tr>
<td>Control Modes</td>
<td>RTH</td>
<td>Manual mode selected</td>
</tr>
<tr>
<td></td>
<td>RUL</td>
<td>Auto mode selected</td>
</tr>
<tr>
<td></td>
<td>LOC</td>
<td>Local set point/Local control selected</td>
</tr>
<tr>
<td></td>
<td>rE</td>
<td>Remote set point/Remote control selected</td>
</tr>
</tbody>
</table>

### Table D – Analog Sources

<table>
<thead>
<tr>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP1</td>
<td>Control output 1 (heat)</td>
</tr>
<tr>
<td>DP2</td>
<td>Control output 2 (cool)</td>
</tr>
<tr>
<td>P1</td>
<td>Process variable 1</td>
</tr>
<tr>
<td>P2</td>
<td>Process variable 2</td>
</tr>
<tr>
<td>I/P1</td>
<td>Analog input 1</td>
</tr>
<tr>
<td>I/P2</td>
<td>Analog input 2</td>
</tr>
<tr>
<td>I/P3</td>
<td>Analog input 3</td>
</tr>
<tr>
<td>CSP1</td>
<td>Control setpoint</td>
</tr>
<tr>
<td>rSPb</td>
<td>Remote setpoint</td>
</tr>
<tr>
<td>CSP1</td>
<td>Local setpoint 1</td>
</tr>
<tr>
<td>CSP2</td>
<td>Local setpoint 2</td>
</tr>
<tr>
<td>CSP3</td>
<td>Local setpoint 3</td>
</tr>
<tr>
<td>CSP4</td>
<td>Local setpoint 4</td>
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<table>
<thead>
<tr>
<th>Source</th>
<th>Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure States</td>
<td>F1</td>
<td>Input 1 failed</td>
</tr>
<tr>
<td></td>
<td>F2</td>
<td>Input 2 failed</td>
</tr>
<tr>
<td></td>
<td>F3</td>
<td>Input 3 failed</td>
</tr>
<tr>
<td></td>
<td>LB1</td>
<td>Loop break - analog output 1</td>
</tr>
<tr>
<td></td>
<td>dOG</td>
<td>Watchdog active</td>
</tr>
<tr>
<td></td>
<td>PF</td>
<td>Power fail</td>
</tr>
<tr>
<td>Logic equations*</td>
<td>LG1</td>
<td>Logic equation 1 true</td>
</tr>
<tr>
<td></td>
<td>LG2</td>
<td>Logic equation 2 true</td>
</tr>
<tr>
<td></td>
<td>LG6</td>
<td>Logic equation 6 true</td>
</tr>
<tr>
<td>Timers</td>
<td>r1</td>
<td>Real time alarm 1</td>
</tr>
<tr>
<td></td>
<td>r2</td>
<td>Real time alarm 2</td>
</tr>
<tr>
<td></td>
<td>d1</td>
<td>Delay timer 1</td>
</tr>
<tr>
<td></td>
<td>d2</td>
<td>Delay timer 2</td>
</tr>
<tr>
<td>Modbus Signals</td>
<td>_b1</td>
<td>Modbus Signal 1</td>
</tr>
<tr>
<td></td>
<td>_b2</td>
<td>Modbus Signal 2</td>
</tr>
<tr>
<td></td>
<td>_b3</td>
<td>Modbus Signal 3</td>
</tr>
<tr>
<td></td>
<td>_b4</td>
<td>Modbus Signal 4</td>
</tr>
<tr>
<td>Other</td>
<td>O1</td>
<td>Always enabled</td>
</tr>
</tbody>
</table>

*The default factory settings for each logic equation is:
- LG1 – The OR of all alarm states; LG2 – The AND of all alarm states
- LG3 – The OR of the alarm acknowledge states
- LG4 – The OR of the first four alarm state; LG5 – The OR of the second four alarm states
- LG6 – The OR of the input fail states

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