User Guide

IM/C355_12

1/4 DIN Advanced Process Controller

C355

ABB

ABB

The Company

We are an established world force in the design and manufacture of instrumentation for industrial process control, flow measurement, gas and liquid analysis and environmental applications.

As a part of ABB, a world leader in process automation technology, we offer customers application expertise, service and support worldwide.

We are committed to teamwork, high quality manufacturing, advanced technology and unrivalled service and support.

The quality, accuracy and performance of the Company's products result from over 100 years experience, combined with a continuous program of innovative design and development to incorporate the latest technology.

The UKAS Calibration Laboratory No. 0255 is just one of the ten flow calibration plants operated by the Company, and is indicative of our dedication to quality and accuracy.

EN ISO 9001:2000

Cert. No. Q5907

EN 29001 (ISO 9001)

Lenno, Italy – Cert. No. 9/90A

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 '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

One or more of the following symbols may appear on the equipment labelling:

	**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

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.

GETTING STARTED

The C350 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 C350 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 fold-out.

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 6.2 of this manual (Electrical Installation) for more information.

Continued...

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

Ⓐ Power-up the instrument. Press the [⮌] and [△] keys simultaneously and hold for 3 seconds to advance directly to Level 6 – Basic Configuration.

Ⓑ Set the appropriate application template, output type and control action. Use the [⮌] key to advance between frames and upper [▲] and [▼] keys to adjust the default values – see Section 5.2 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.

Ⓒ If you are not using 4 to 20mA inputs, then select Level 7 using the upper [▲] and [▼] keys and set up Analog Inputs I/P1 to I/P3 to suit your process – see Section 5.3.

Ⓓ Controller templates only:
Select Level 2 using the upper [▲] and [▼] 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.

Ⓔ Press [🔔] to return to the Operating displays.

Ⓕ Adjust the set point to the required value.

Your C350 is now in operation

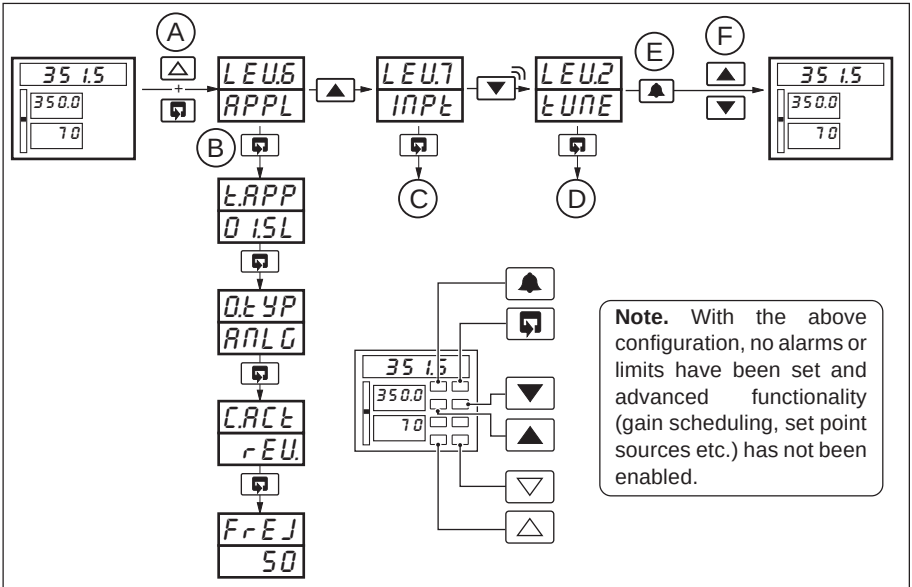


Fig. GS.1 Setting the Parameters

OVERVIEW

This manual is divided into 6 sections which contain all the information needed to install, configure, commission and operate the C350. Each section is identified clearly by a symbol as shown in Fig. 1.

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

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

Operator Mode (Level 1)
- Single Loop Controller
- Motorized Valve Controller
- Auto/Manual & Backup Stations
- Feedforward Controllers
- Cascade Controllers
- Ratio Station/Controller

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

Profile Mode (Levels P, r and t)
- Level P – Profile States
- Level r – Profile Control
- Level t – Profile Program

Installation
- Siting
- Mounting
- Electrical Connections

Fig. 1 Overview of Contents

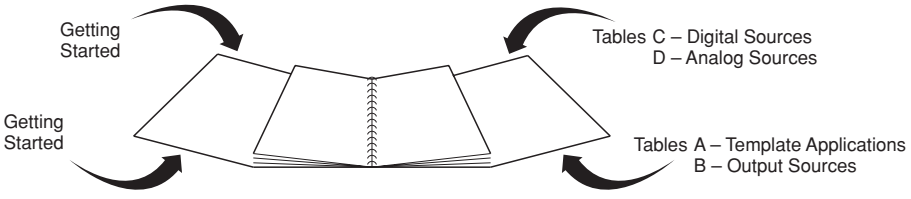
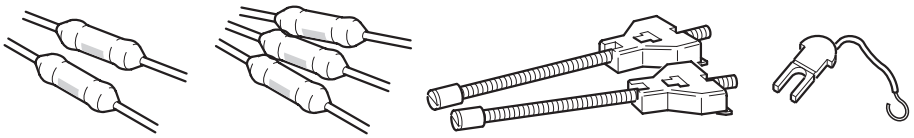


Fig. 2 Foldouts



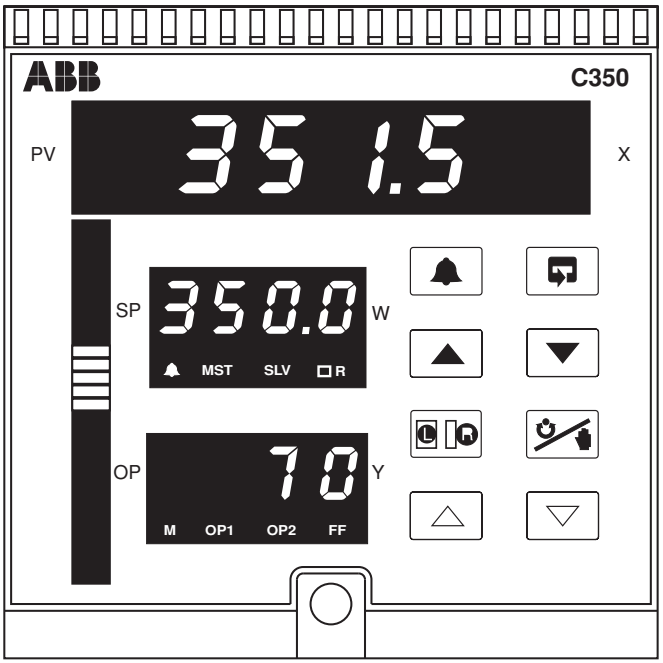
Pull-up Resistors 2 x 100k | **Shunt Resistors 3 x 100** | **Panel Clamps x2** | **CJ Sensor x2**

Fig. 3 Accessories

CONTENTS

1.1 Introduction

The C350 front panel displays, function keys and LED indicators are shown in Fig. 1.1.



Function Keys

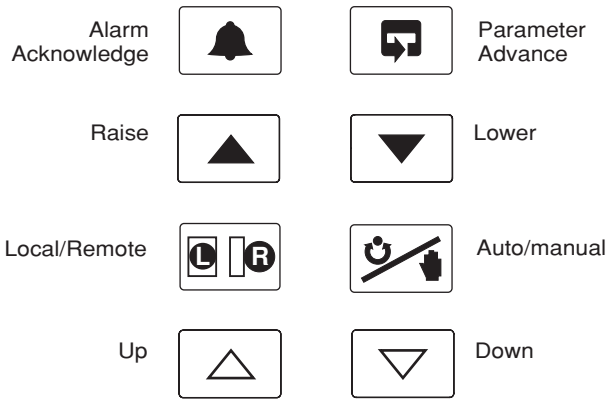
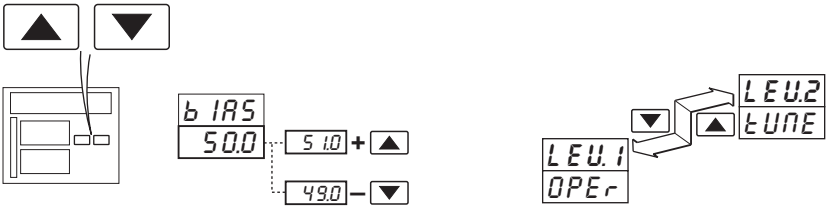


Fig. 1.1 Front Panel Displays and Function Keys

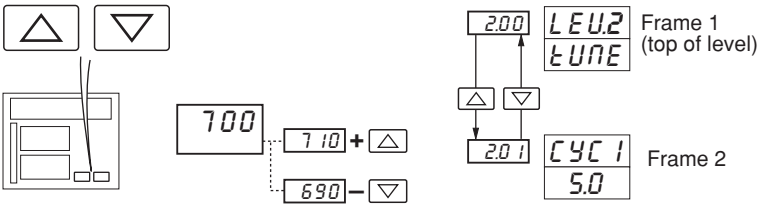
1.2 Use of Function Keys

A – Raise and Lower Keys



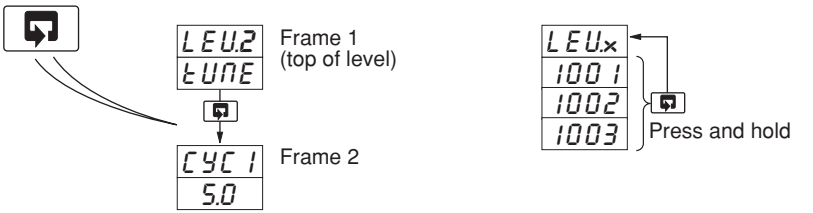
Use to change/set a parameter value… and… …move between levels

B – Up and Down Keys



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

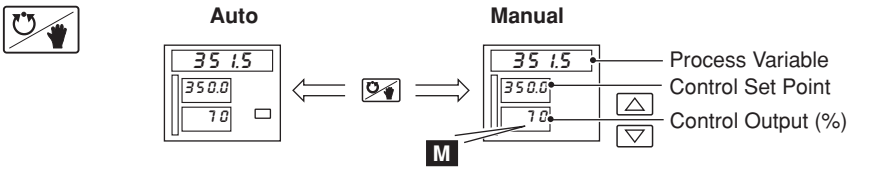
C – Parameter Advance Key



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

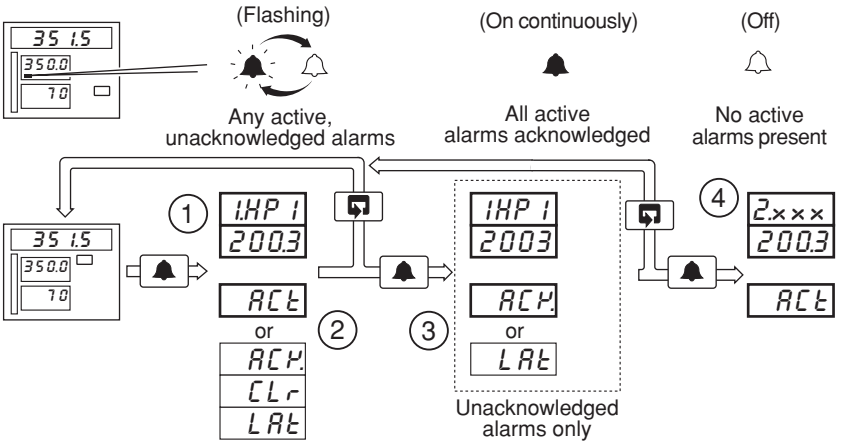


Use to select Auto or Manual control mode

Fig. 1.2a Use of Function Keys

...1.2 Use of Function Keys

E – Alarm Acknowledgement



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

(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	HO	High Output
LPU.	Low Process, PV	LO	Low Output
HLP	High Latch, PV	PF.t	Power Failure Time [✳]
LLP	Low Latch, PV	Hb 1	Math Block 1 High
Hd	High Deviation	Lb 1	Math Block 1 Low
Ld	Low Deviation	Hb2	Math Block 2 High
HP 1	High Process I/P1	Lb2	Math Block 2 Low
LP 1	Low Process I/P1	Hb3	Math Block 3 High
HP2	High Process I/P2	Lb3	Math Block 3 Low
LP2	Low Process I/P2	Hb4	Math Block 4 High
HP3	High Process I/P3	Lb4	Math Block 4 Low
LP3	Low Process I/P3		

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

(2) The lower display shows alarm status:

ACt	Alarm active and unacknowledged
ACK.	Alarm active and acknowledged
CLr	Cleared or Inactive alarm
LAt	Unacknowledged latched alarm

(3) Pressing [🔔] again acknowledges the displayed alarm. Lower display changes to reflect new status.

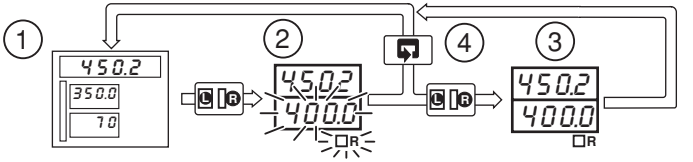
(4) Next active and unacknowledged alarm is displayed. If no alarms are active, the next enabled alarm is displayed.

Fig. 1.2b Use of Function Keys

...1.2 Use of Function Keys

F – Local / Remote Key

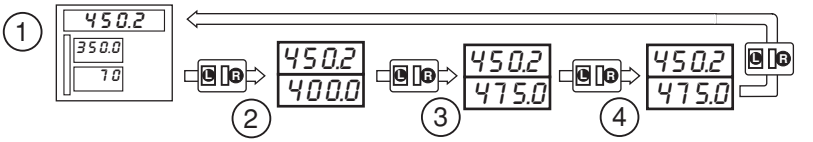
Changing between Local and Remote Set Points



1. Process variable and local set point (ratio) displayed on red and green displays.
2. Remote set point (ratio) value is displayed. The value and R symbol flash to indicate local set point (ratio) still selected.
3. Remote set point (ratio) selected.
4. Remote selection aborted.

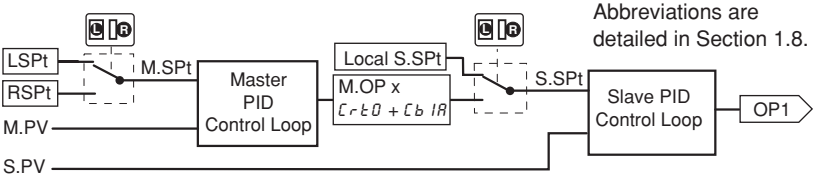
Note. When an Analog Backup template is selected, the L/R key is used to switch between local and remote mode – see Sections 2.4 and 5.2.

Selecting Local Set Points 1 to 4

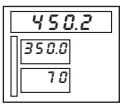


1. Process variable and local set point 1 displayed.
2. Process variable and local set point 2 displayed
3. Process variable and local set point 3 displayed
4. Process variable and local set point 4 displayed

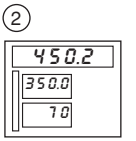
Selecting Master and Slave Set Points – Cascade Mode



Abbreviations are detailed in Section 1.8.



When the MST indicator (see Fig 1.3) is lit, the L/R key can be used to switch between the Master local and remote set points

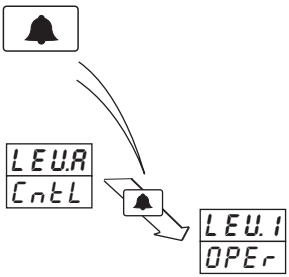


When the SLV indicator (see Fig 1.3) is lit, the L/R key can be used to switch between the local slave set point and the cascade slave set point generated from the master output.

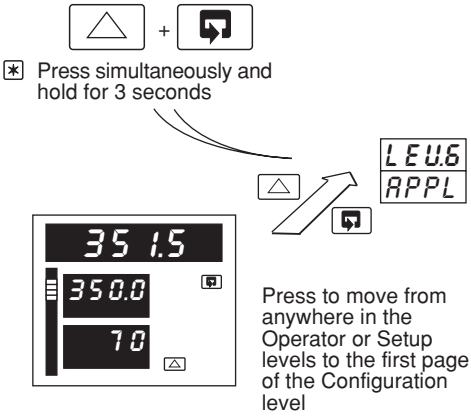
Fig. 1.2c Use of Function Keys

...1.2 Use of Function Keys

G – Short-cut Keys

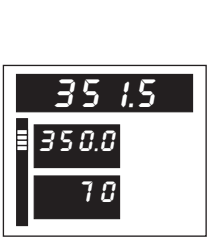


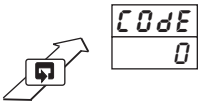
Press to move from anywhere in the Configuration level to the first frame in the Operator level



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

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



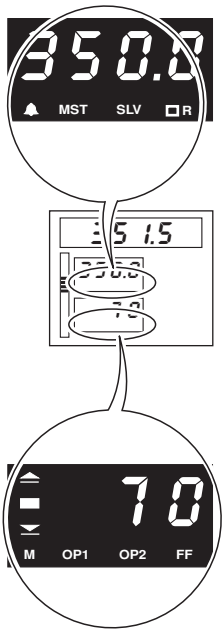


Press to move from the Operator Level to the Security Code Frame and then to other levels:

Tune Level – See Section 2.13.3
Set Up Level – See Fig. 4.1
Configuration Level – See Fig. 5.1

Fig. 1.2d Use of Function Keys

1.3 Secret-til-Lit Indicators



	Flashing	ON	OFF
🔔	One or more alarms active and unacknowledged	All active alarms acknowledged	No alarms active
MST		Master controller parameters displayed	
SLV		Slave controller parameters displayed	
R		Remote or Cascade set point in use	Local set point in use

A – Upper Display

	Flashing	ON	OFF
M	Autotune in progress	Manual control selected	Auto control selected
OP1		Output 1 (heat) value displayed	
OP2		Output 2 (cool) value displayed	
FF		Feedforward disturbance variable displayed	
⏏		Valve opening	
■		Valve stopped	
⧗		Valve closing	

B – Lower Display

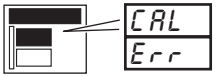
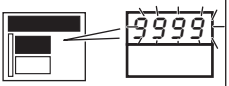
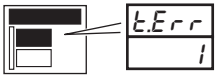
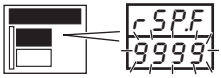
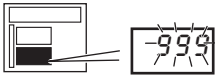
Fig. 1.3 Secret-til-lit Indicators

1.4 Character Set – Fig. 1.4

A	A	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	V
F	F	N	n or n	Y	y
G	G	O	O		
H	H	P	P		

Fig. 1.4 Character Set

1.5 Error Messages

Display	Error/Action	To clear the display:
	**Calibration Error** Turn mains power off and on again (if the error persists contact the Customer Support Organization).	Press the ▲ key
	**Non-volatile Memory Error** x = 1: Processor Board Memory x = 3: Power Supply Board Memory Turn mains power off and on again (if the error persists, check configuration/setup settings).	Press the ▲ key
	**A to D Converter Fault** The analog to digital converter is not communicating correctly.	Contact the Customer Support Organization
	**Input Value Over/Under Range**	Restore valid input
	**Auto-tune Error** Number displayed indicates the type of error – see Table 2.1.	Press the ▲ key
	**Cold Junction Failed** Cold junction sensor is faulty or has not been fitted correctly.	Check connections or replace if faulty.
	**Remote Set Point Failed** Input value is over or under-range. Only appears if the remote set point is displayed or in use.	Restore valid input
	**External Ratio Fail** Input value is over or under-range. Only when templates 14 to 17 are used	Restore valid input
	**Position Feedback Fail** Input value is over- or under-range. Only appears if output type set to '*PFb*' – motorized valve with feeback.	Restore valid input
	**Valve Sticking** Motorized valve not moving at the speed expected. Valve may be sticking.	Check that the correct Regulator Travel Time has been set – see Section 4.5. Check the valve.

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

Abbreviation	Description	Abbreviation	Description
PV	Process Variable	di1	Digital Input 1
LSPt	Local Set Point Value	di2	Digital Input 2
LSP1	Local Set Point 1 Value	di3	Digital Input 3
LSP2	Local Set Point 2 Value	di4	Digital Input 4
LSP3	Local Set Point 3 Value	ao1	Analog Output 1
LSP4	Local Set Point 4 Value	ao2	Analog Output 2
CSPt	Control Set Point Value	do1	Digital Output 1
RSPt	Remote Set Point Value	M.PV	Master Process Variable
PID O/P	Output of the PID Algorithm	M.SPt	Master Control Set Point
OP1	Controller Output 1 (heat)	M.OP	Master PID Output
OP2	Controller Output 2 (cool)	S.SPt	Slave Set Point
I/P1	Analog Input 1	S.PV	Slave Process Variable
I/P2	Analog Input 2	WV	Wild Variable
I/P3	Analog Input 3	DV	Disturbance Variable

Table 1.1 Glossary of Abbreviations

2 OPERATOR LEVEL

2.1 Introduction

The Operator level (Level 1) is the normal day-to-day mode of the C350. 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
- Single loop with feedforward control
- Cascade control
- Cascade with feedforward
- Ratio controller
- Ratio station

Note. Only the frames relevant to the selected template are displayed – see Section 5.

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

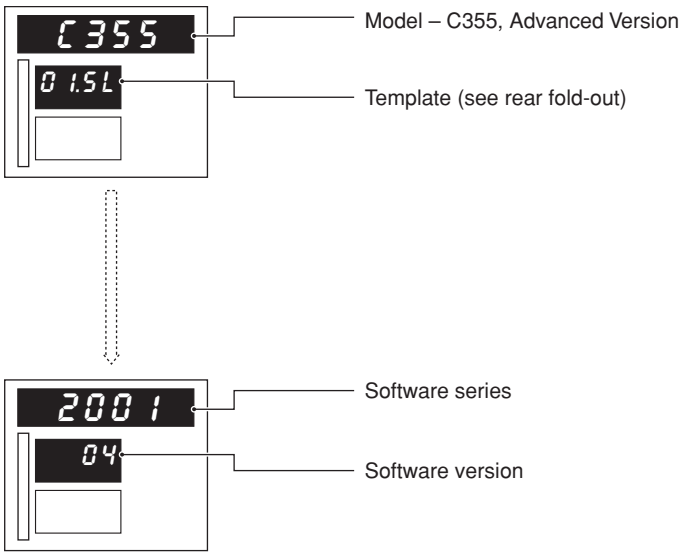


Fig. 2.1 Power-up Displays

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).

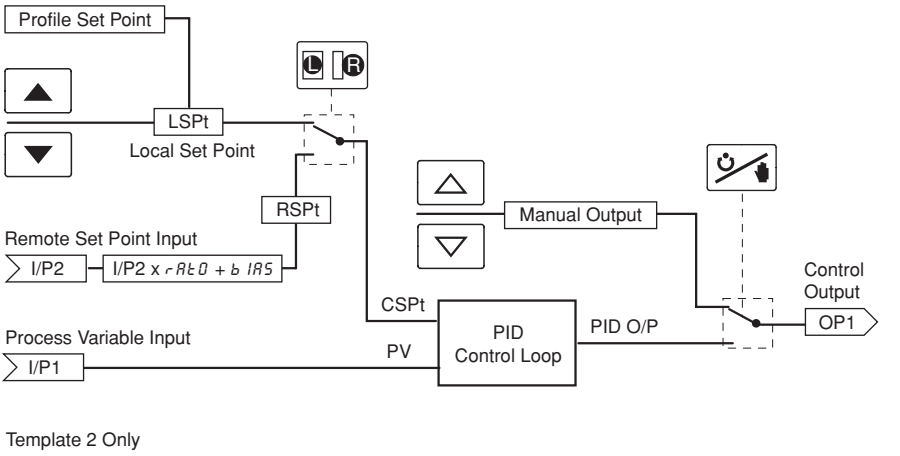
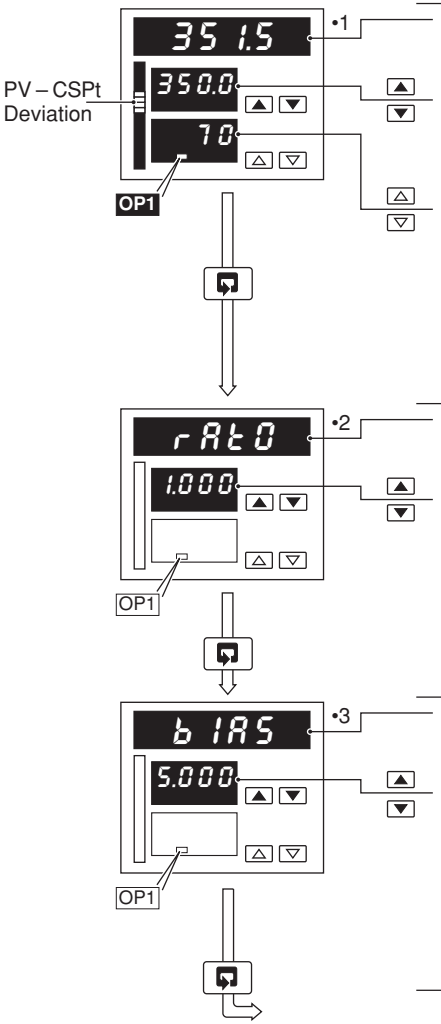


Fig. 2.2 Single Loop Controller

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



Process Variable

Control Set Point
['SPLO' to 'SPHI' – see Section 5.5]
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]

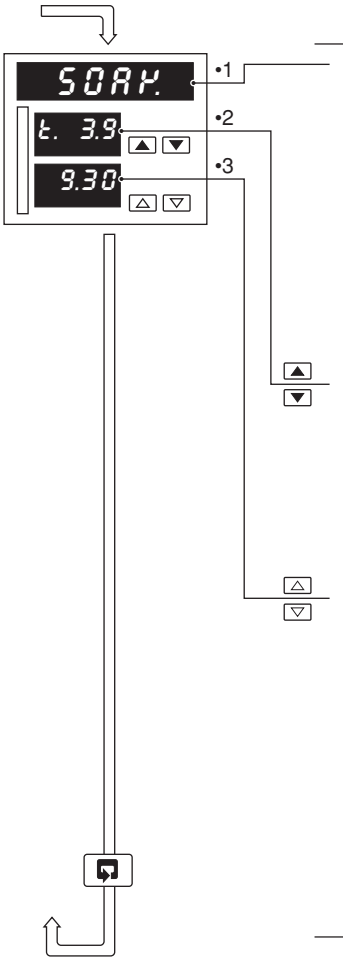
Continued...

•1 With the Ramping Set Point function enabled (see Section 4.3, 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 5.2, Basic Configuration and Section 5.7, Operator Configuration.

•3 Displayed only if template 2 selected and Bias Display is enabled – see Section 5.2, Basic Configuration and Section 5.7, Operator Configuration.

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



Profile Status

SOAK.	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment
[0.0 to 99.9 hours or minutes]
Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment
[1.01 to 9.30]

X.NN
- Current Segment Number
- Current Program Number

When the program is running or held:

Press ▲ to skip forward to the start of the next segment.

Press ▼ to skip backwards to the start of the current segment.

Return to top of page

•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.3 Auto/Manual Station (Templates 3 and 4)

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

The auto/manual station provides a backup for a master controller. In normal operation the C350'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 C350 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 C350 switches back to auto mode.

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

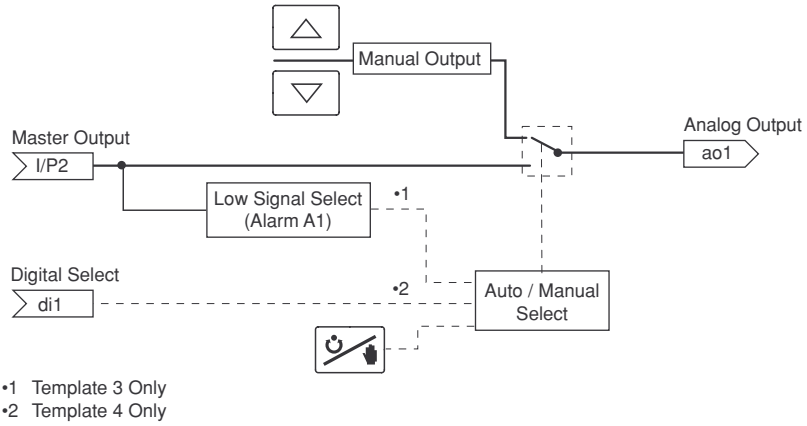
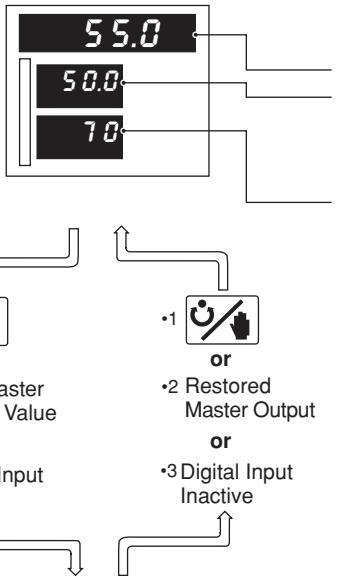


Fig. 2.3 Auto/Manual Station

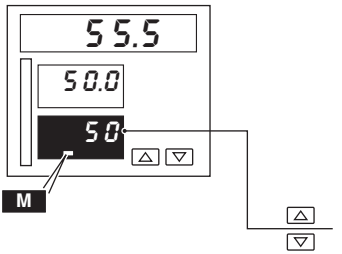
…2.3 Auto/Manual Station (Templates 3 and 4)



Auto Mode

Process Variable
Master Output (I/P2)

Control Output = Master Output
[Master Output, 0 to 100%]



Manual Mode

Control Output (under C350 control)
[0 to 100%]

•1 In template 4 the Auto/Manual switch is overridden by the digital input signal.

•2 Template 3 only – see Section 5.2, Basic Configuration/ Template Application.

•3 Template 4 only – see Section 5.2, 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 C350'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 C350 switches into local control mode and the process is controlled by the PID output of the C350. The C350 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 C350 switches back to remote control mode.

Note. The Alarm A1 Trip value must be set when using template 5.

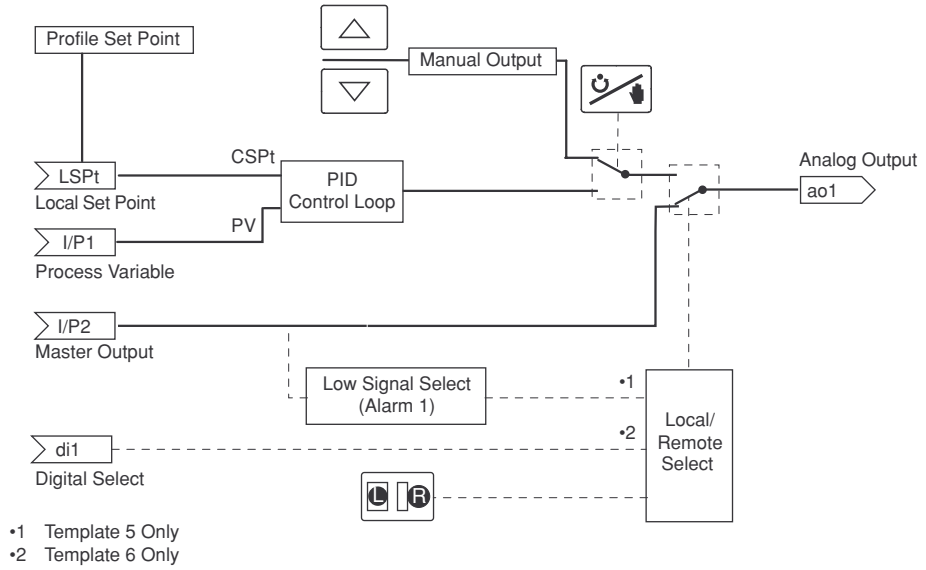
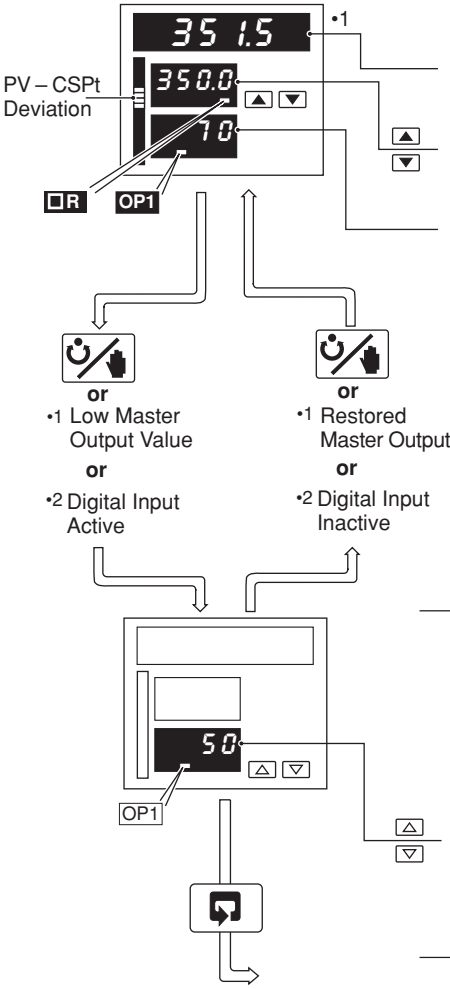


Fig. 2.4 Analog Backup Station

…2.4 Analog Backup (Templates 5 and 6)



Remote Mode

Process Variable

Set Point
['SPLO' to 'SPHI' – see Section 5.5]

Control Output = Master Output
[Master Output, 0 to 100%]

Local Mode

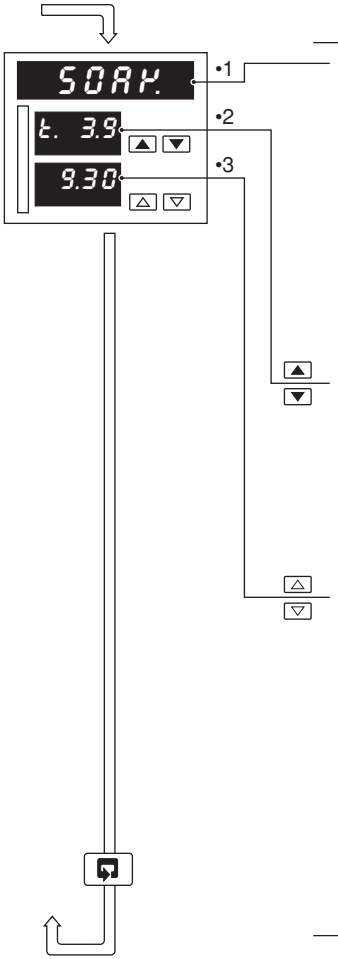
Control Output (under C350 control)
[0 to 100%]
Adjustable in Manual Mode only.

Continued…

•1 Template 5 only – see Section 5.2, Basic Configuration/ Template Application.

•2 Template 6 only – see Section 5.2, Basic Configuration/ Template Application.

...2.4 Analog Backup (Templates 5 and 6)



Profile Status

SOAK	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment

[0.0 to 99.9 hours or minutes]

Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment

[1.01 to 9.30]

X.NN
- Current Segment Number
- Current Program Number

When the program is running or held:

Press ⏶ to skip forward to the start of the next segment.

Press ⏷ to skip backwards to the start of the current segment.

Return to top of page

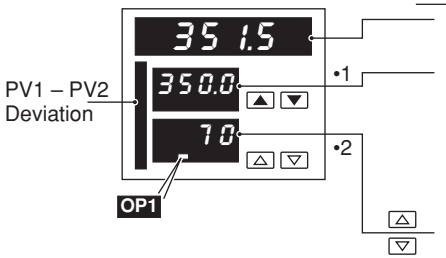
•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

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.



Process Variable PV1

Process Variable PV2

Output Value
[–10 to 110%]

•1 Displayed only if template 8 selected – see Section 5.2, Basic Configuration/ Template Application.

•2 Displayed only if control output type is 'analog' (output is assigned to Analog Output 1).

2.6 Single Loop with Feedforward (Templates 9 and 10)

These templates provide three-term PID control with feedforward. The disturbance variable is weighted by the feedforward gain (FFGn) and the feedforward bias (FFbS) values and added to the controller output value.

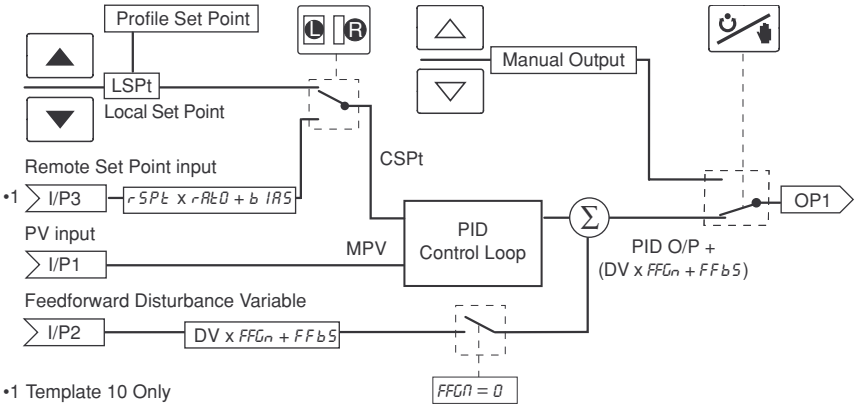
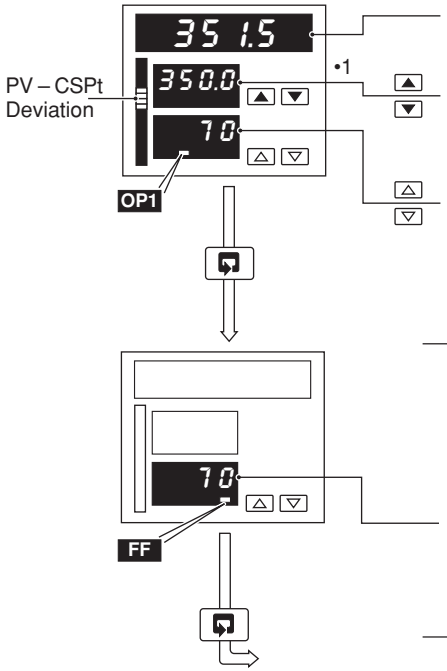


Fig. 2.5 Single Loop Controller with Feedforward



Process Variable

Control Set Point
['SPLO' to 'SPHI' – see Section 5.5]
Adjustable in Local control only.

Control Output
[0 to 100%]
Adjustable in Manual control only.

Feedforward

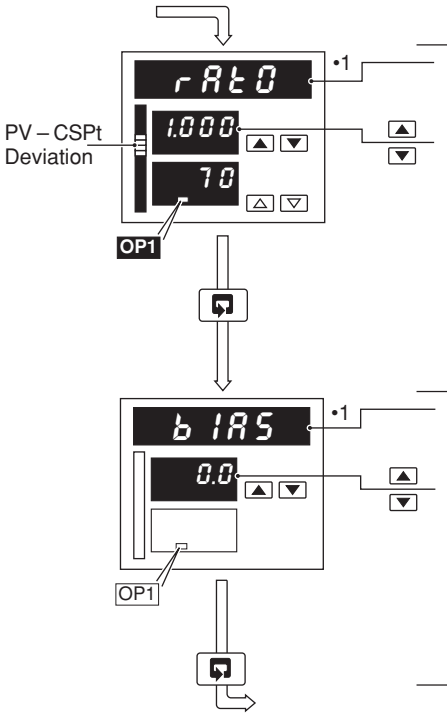
Note. To disable feedforward action (e.g. during system tuning), set the Feedforward Gain parameter to OFF – see Section 4.2, Level 2/ Tune.

[0 to 100%]
Feedforward disturbance variable signal.

Continued…

•1 With the Ramping Set Point function enabled (see Section 4.3, Set Points/ Ramp Rate), the bargraph shows the actual deviation (PV/Ramping Set Point value) The digital display shows the target set point value.

…2.6 Single Loop with Feedforward (Templates 9 and 10)



Remote Set Point Ratio

[0.001 to 9.999]
Remote set point value =
(ratio x remote set point input) + bias

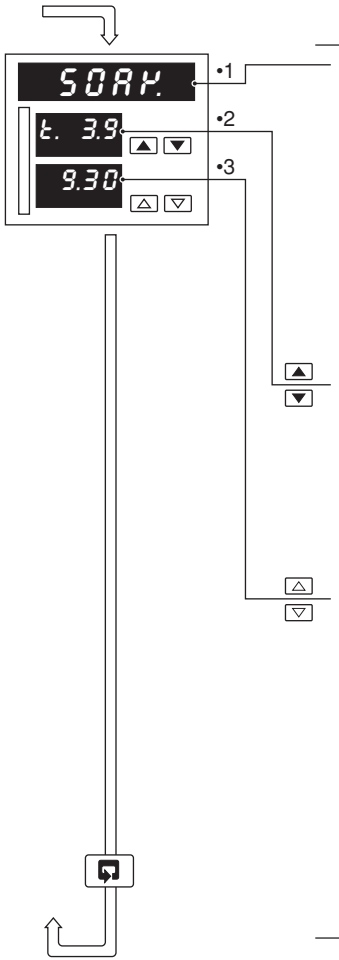
Remote Set Point Bias

[In engineering units]

Continued…

•1 Displayed only if template 10 selected – see Section 5.2, Basic Configuration/ Template Application and Section 5.7, Operator Configuration/ Operator Ratio Display and Operator Bias Display.

...2.6 Single Loop with Feedforward (Templates 9 and 10)



Profile Status

SOAK	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment
[0.0 to 99.9 hours or minutes]
Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment
[1.01 to 9.30]

X.NN
- Current Segment Number
- Current Program Number

When the program is running or held:

Press ⏶ to skip forward to the start of the next segment.

Press ⏷ to skip backwards to the start of the current segment.

Return to **Process Variable** display

•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.7 Cascade Control (Templates 11 and 12)

For cascade control, two internally-linked PID controllers are used, with the first (master) PID controller providing the set point for the second (slave) controller. The master output is weighted using the cascade ratio (*C.rtO*) and bias (*C.bIA*) values to create the slave set point value.

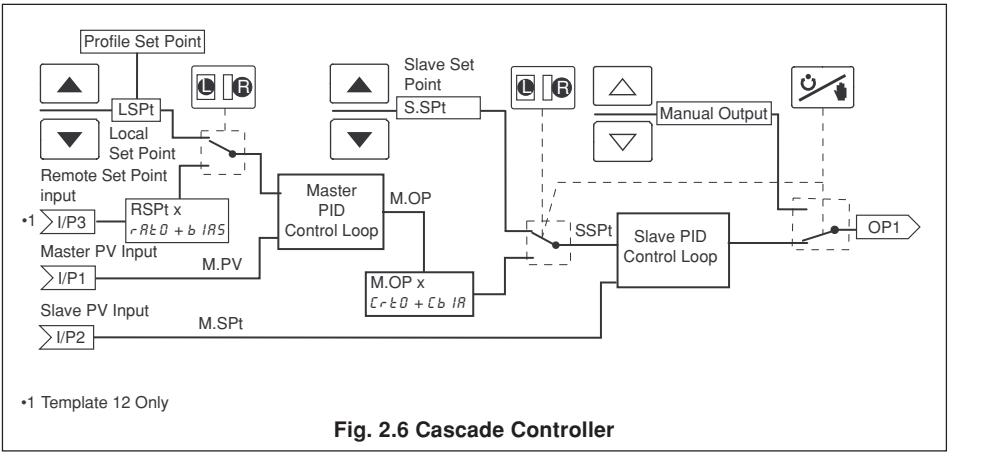
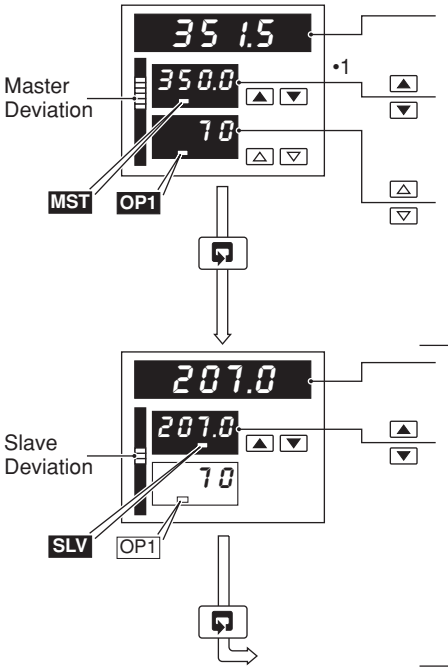


Fig. 2.6 Cascade Controller



Master Process Variable (M.PV)

Master Control Set Point (MSPt)
['SPLO' to 'SPHI' – see Section 5.5]
Adjustable in local control only.

Slave Control Output
[0 to 100%] (–10 to 110% for analog outputs)
Adjustable in manual mode only.

Note. With template 12 the key can be used to change between local/remote set point values.

Slave Process Variable (S.PV)

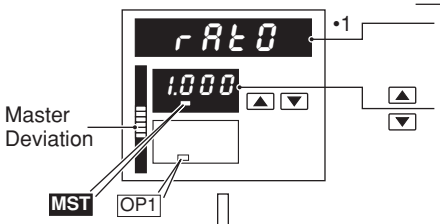
Slave Set Point (S.SPt)
['SPLO' to 'SPHI' – see Section 5.5]
Adjustable in manual or local slave set point modes only.

Note. The key can be used in this frame to change between cascade (R symbol is lit) and local slave set points.

Continued…

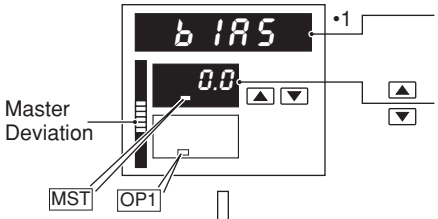
•1 With the Ramping Set Point function enabled (see Section 4.3, Set Points/ Ramp Rate), the bargraph shows the actual deviation (PV/Ramping Set Point value). The digital display shows the target set point value.

...2.7 Cascade Control (Templates 11 and 12)



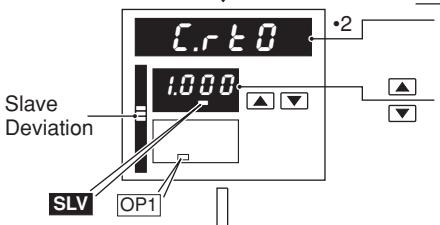
Remote Set Point Ratio

[0.001 to 9.999]
Master remote set point value =
(ratio x remote set point input) + bias



Remote Set Point Bias

[in engineering units]



Cascade Slave Set Point Ratio

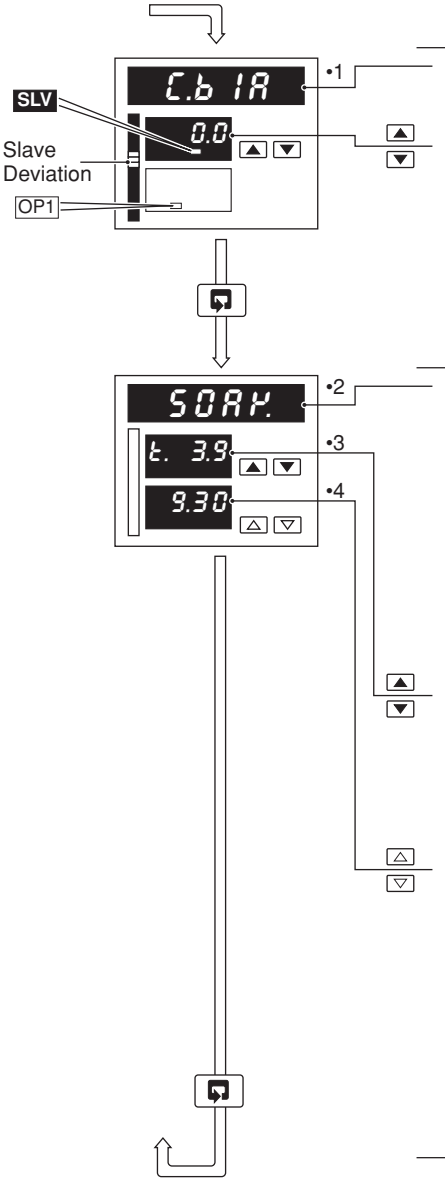
[0.001 to 9.999]
Slave set point (S.SPt) value =
(ratio x master ouput) + bias [in engineering units]

Continued...

•1 Displayed only if template 12 selected and ratio/bias display enabled – see Section 5.2, Basic Configuration and Section 5.7, Operator Configuration.

•2 Displayed only if ratio/bias display enabled – see Section 5.7, Operator Configuration.

…2.7 Cascade Control (Templates 11 and 12)



Cascade Slave Set Point Bias

[In engineering units]

Profile Status

SOAK	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment

[0.0 to 99.9 hours or minutes]

Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment

[1.01 to 9.30]

X.NN

Current Segment Number

Current Program Number

When the program is running or held:

Press ⏶ to skip forward to the start of the next segment.

Press ⏷ to skip backwards to the start of the current segment.

Return to **Master Process Variable (M.PV)** display

•1 Displayed only if ratio/bias display enabled – see Section 5.7, Operator Configuration.

•2 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•3 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•4 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.8 Cascade Control with Feedforward (Template 13)

For cascade control, two internally-linked PID controllers are used, with the first (master) PID controller providing the set point for the second (slave) controller. The feedforward disturbance variable signal is added to the master output (slave set point). The disturbance signal is weighted by the feedforward gain (*FFGn*) and the feedforward bias (*FFbs*) values.

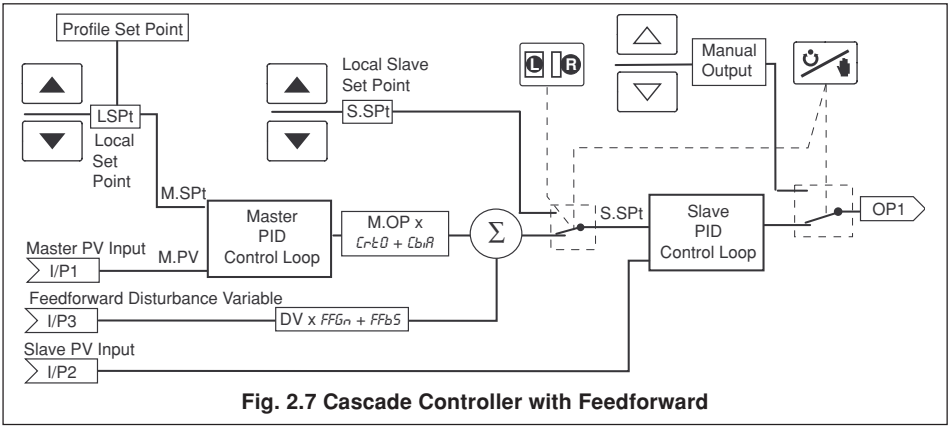
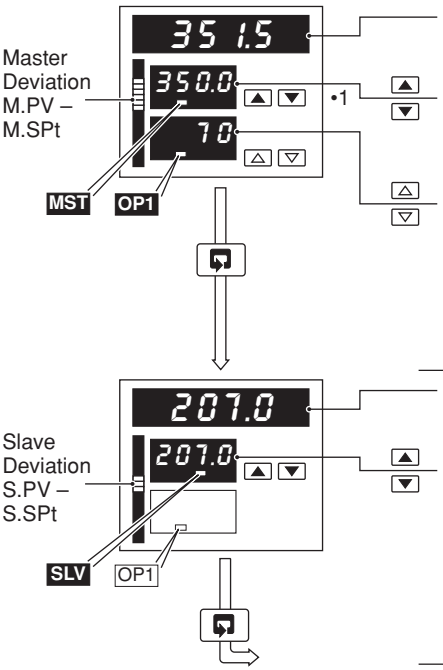


Fig. 2.7 Cascade Controller with Feedforward



Master Process Variable (M.PV)

Master Control Set Point (M.SPt)
['SPLO' to 'SPHI' – see Section 5.5]
Adjustable in Local control only

Slave Control Output
[0 to 100% (–10 to 110% for analog outputs)]
Adjustable in Manual mode only.

Slave Process Variable (S.PV)

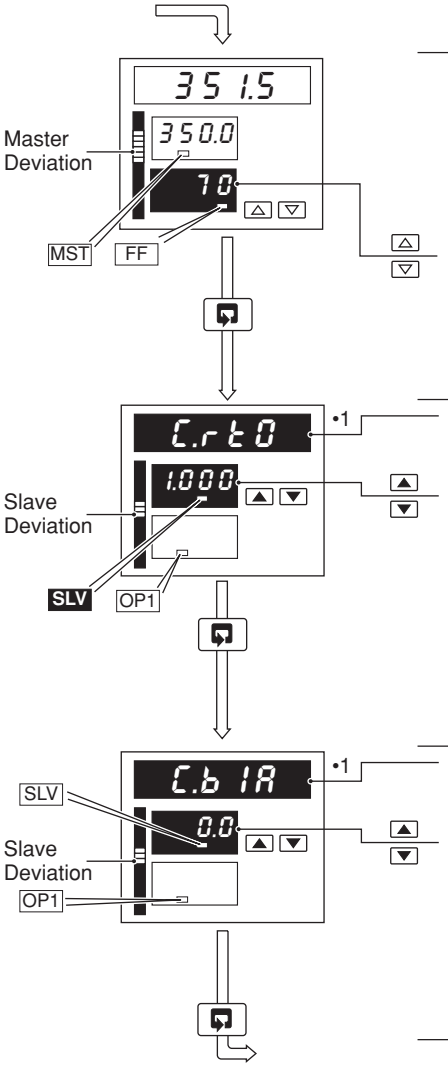
Slave Set Point (S.SPt)
['SPLO' to 'SPHI' – see Section 5.5]
Adjustable in Manual mode only

Note. The key can be used in this frame to change between cascade (R symbol is lit) and local slave set points.

Continued...

•1 With the Ramping Set Point function enabled (see Section 4.3, Set Points/ Ramp Rate), the bargraph shows the actual deviation (PV/Ramping Set Point value). The digital display shows the target set point value.

…2.8 Cascade Control with Feedforward (Template 13)



Feedforward Disturbance Variable

[0 to 100%]
Feedforward disturbance variable input.

•1 **Cascade Slave Set Point Ratio**

[0.001 to 9.999]
Slave set point (CSP2) value =
(ratio x master ouput) + bias [in engineering units]

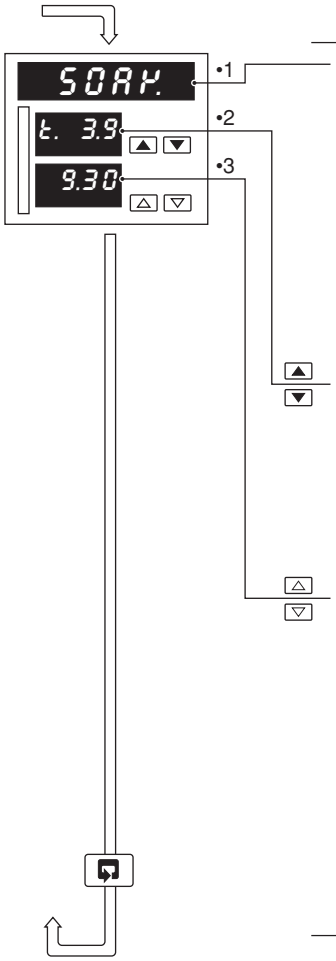
•1 **Cascade Slave Set Point Bias**

[In engineering units]

Continued…

•1 Displayed only if enabled in Level B, Operator Configuration – see Section 5.7.

...2.8 Cascade Control with Feedforward (Template 13)



Profile Status

SOAK.	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment
[0.0 to 99.9 hours or minutes]
Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment
[1.01 to 9.30]

X.NN
- Current Segment Number
- Current Program Number

When the program is running or held:

Press ▲ to skip forward to the start of the next segment.

Press ▼ to skip backwards to the start of the current segment.

Return to **Master Process Variable (M.PV)** display

•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.9 Ratio Controller (Templates 14 and 15)

Ratio control enables a controlled process variable to be maintained automatically in definite proportion to another variable known as the wild variable. The wild variable weighted by ratio (rAtO) and bias (bIAS) values, forms the control set point for the process variable.

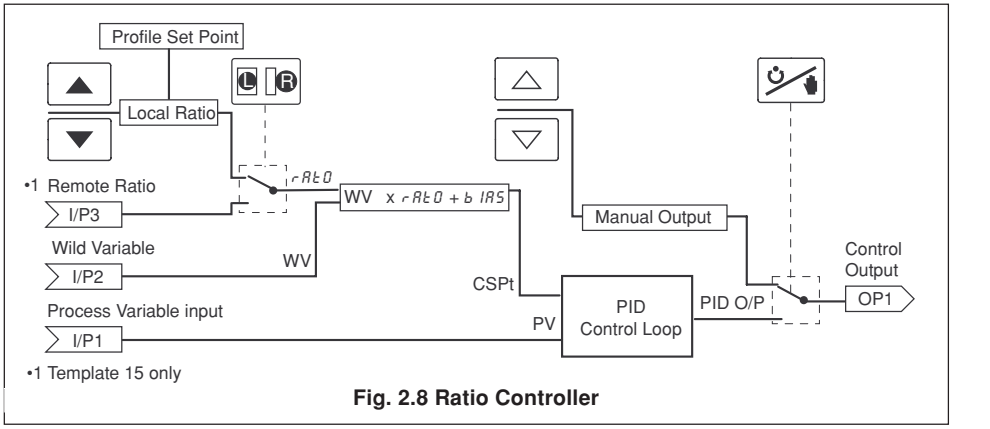
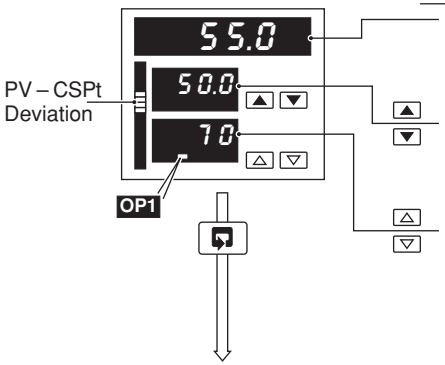


Fig. 2.8 Ratio Controller

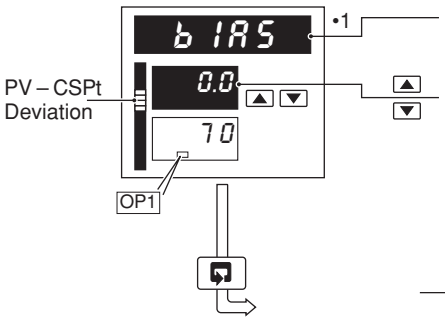


Actual Ratio

$$= \frac{\text{Process Variable (PV)} - \text{Bias}}{\text{Wild Variable (WV)}}$$

Desired Ratio
Adjustable in Local control only.
Control Set Point = (WV x Ratio) + Bias

Control Output
[0 to 100% (–10 to 110% for analog outputs)]
Adjustable in manual mode only.



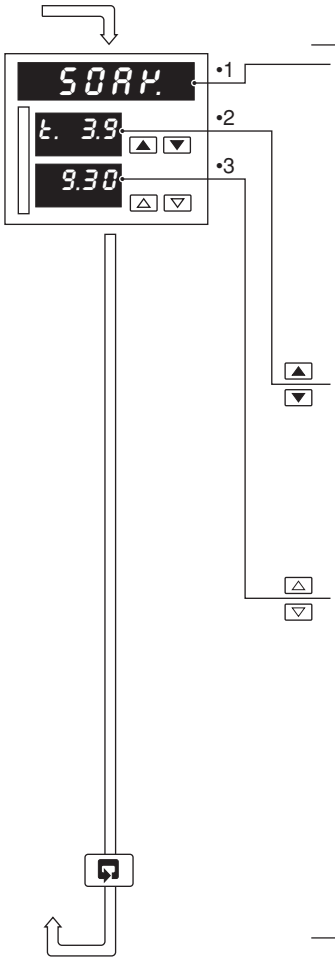
Bias

[in engineering units]

Continued...

•1 Displayed only if enabled in Level B, Operator Configuration – see Section 5.7.

...2.9 Ratio Controller (Templates 14 and 15)



Profile Status

SOAK.	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment
[0.0 to 99.9 hours or minutes]
Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment
[1.01 to 9.30]

X.NN
- Current Segment Number
- Current Program Number

When the program is running or held:

Press ▲ to skip forward to the start of the next segment.

Press ▼ to skip backwards to the start of the current segment.

Return to **Actual Ratio** display

•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.10 Ratio Station (Templates 16 and 17)

The ratio station provides a set point for a subsequent slave controller. The wild variable (WV) is weighted by ratio (rAtO) and bias (bIAS) values and is then retransmitted as an analog output value.

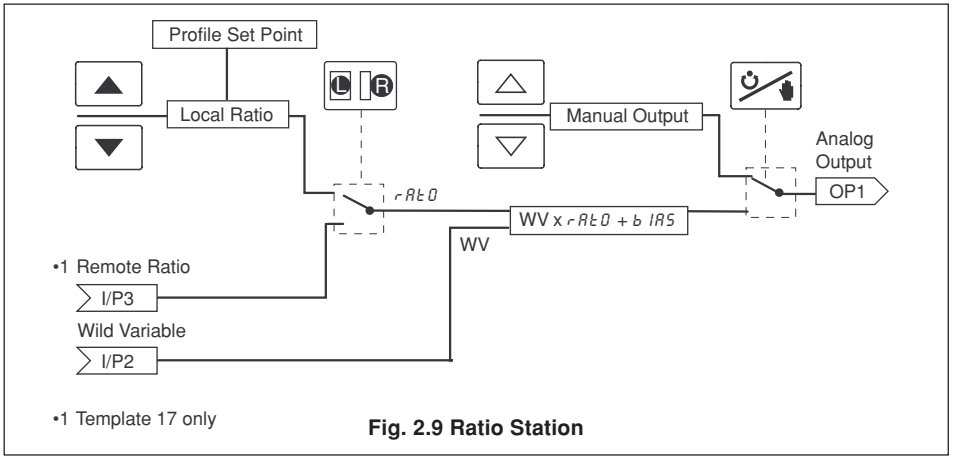
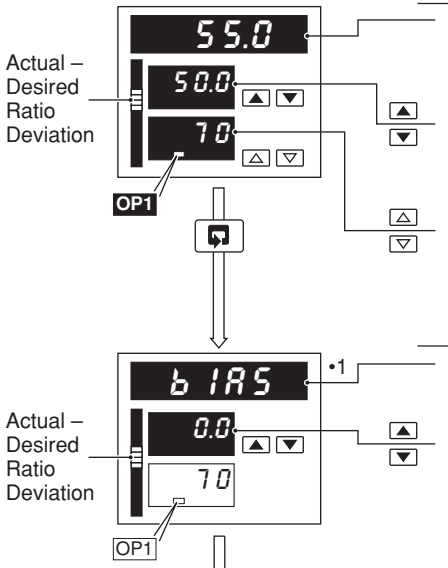


Fig. 2.9 Ratio Station



Actual Ratio

$$= \frac{\text{Process Variable (PV)} - \text{Bias}}{\text{Wild Variable (WV)}}$$

Desired Ratio
Adjustable in local control only.

Ratio Setpoint Output
= (WV x Ratio) + Bias
[–10 to 110%]
Adjustable in manual control only.

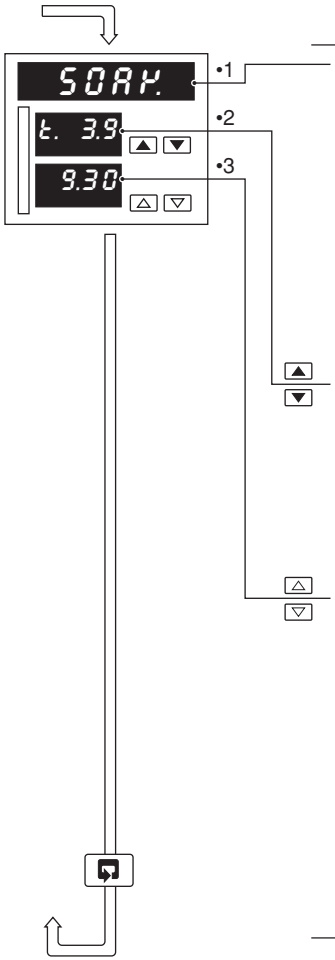
Bias

[In engineering units]

Continued...

•1 Displayed only if enabled in Level B, Operator Configuration – see Section 5.7.

...2.10 Ratio Station (Templates 16 and 17)



Profile Status

SOAK.	–	Soak segment running
rA_P	–	Ramp segment running
StOP	–	Stopped
End	–	End
O.HLd	–	Operator hold
_.HLd	–	Manual hold
H.HLd	–	Holdback hold
r.HLd	–	Retort hold
r.r_P	–	Retort ramp

Time Remaining in Segment

[0.0 to 99.9 hours or minutes]

Allows the total segment time to be increased or decreased by the Time Adjust Value set in the Profile Control Level. If the current segment is a ramp, it will change the ramp rate.

Current Program/Segment

[1.01 to 9.30]

X.NN

Current Segment Number

Current Program Number

When the program is running or held:

Press ▲ to skip forward to the start of the next segment.

Press ▼ to skip backwards to the start of the current segment.

Return to **Actual Ratio** display

•1 **Profile Status** is displayed only if ramp/soak features are enabled – see Section 5.5, Level 9 – Set Point Configuration.

•2 Segment time adjustment can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.18.

•3 Segment skip can be disabled in the Ramp/Soak profile control level – see Section 3.4 frame r.17.

2.11 Heat/Cool Output Types

2.11.1 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 LEDs indicate which output is changing.

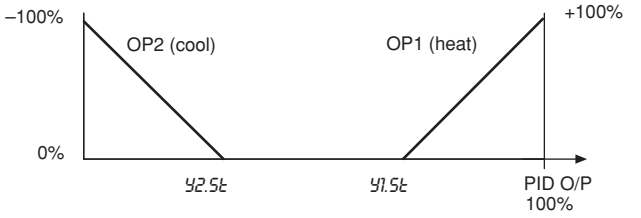
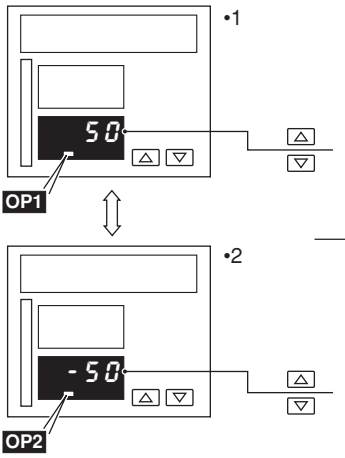


Fig. 2.10 Typical Response – Reverse/Direct or Direct/Reverse Control Action



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.

2.11.2 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 LEDs indicate which output is changing.

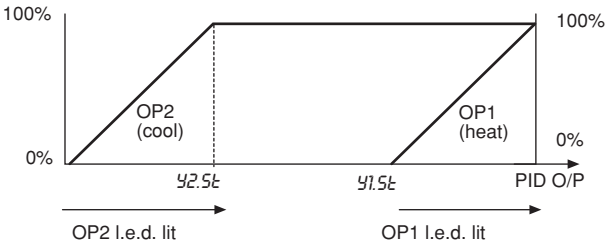
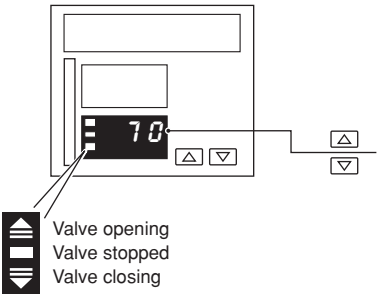


Fig. 2.11 Typical Response – Reverse/Reverse or Direct/Direct Control Action

2.12 Motorized Valve Output Types

2.12.1 Motorized Valve with Feedback

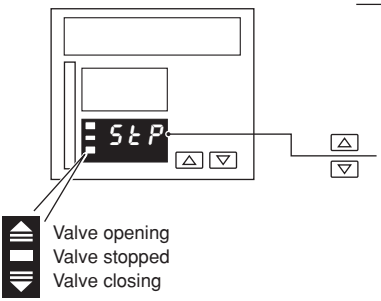


Valve Position Display

[0 to 100% of travel]

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

2.12.2 Motorized Valve without Feedback (Boundless)



Valve State Display

OPn	Valve opening
StP	Valve stopped
CLS	Valve closing

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

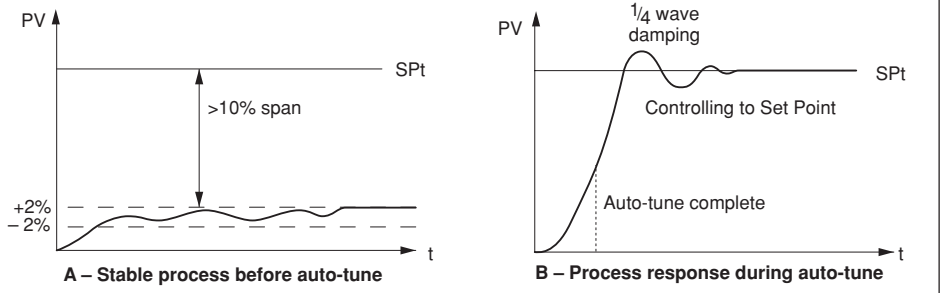
2.13 Auto-tune

Note. Auto-tune is not available:
- For Auto/Manual Station, Indicator or Ratio Station templates.
- When boundless or heat/cool control types are selected.
- While a profile is running.

Information.
- Auto-tune optimizes process control by manipulating the C350 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 C350 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 C350 selects either 'start-up' or 'at set point' tuning automatically, depending upon the level of the process variable relative to the control set point.

2.13.1 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 C350 enters auto mode and begins to control the process using the new PID parameters.
- If an error occurs during the auto-tune, the C350 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.



A – Stable process before auto-tune

B – Process response during auto-tune

Fig 2.12a Typical 'Start-up' Auto-tune Cycles

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

Table 2.1 Auto-tune Error Codes

2.13.2 '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.

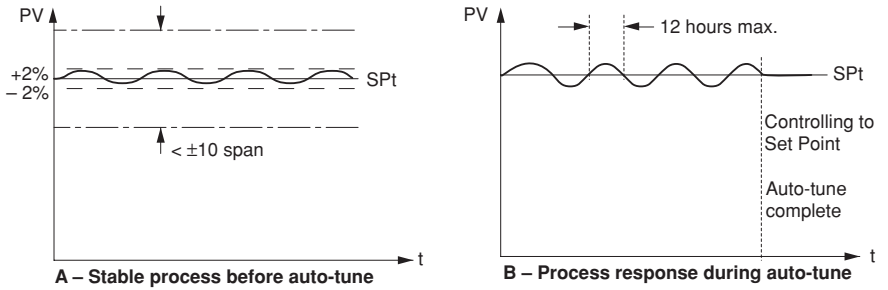


Fig 2.12b Typical 'At Set Point' Auto-tune Cycles

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

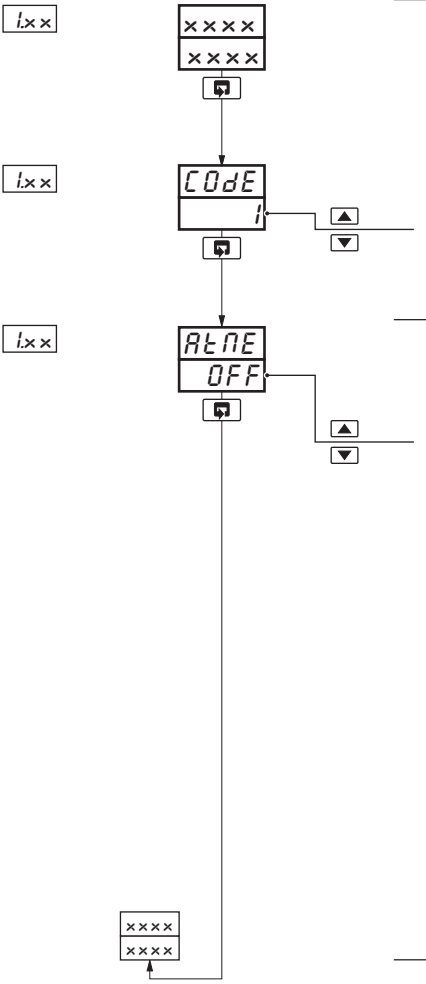
Notes For Special Cases.

Cascade Control – the slave loop must be tuned before the master loop. The slave must be placed into local set point mode (cascade disabled) and the slave set point adjusted to the required value prior to tuning.

Feedforward Control – during an auto-tune with a controller with feedforward the feedforward signal is not applied. The feedforward gain and bias values are not changed by the auto-tune and must be adjusted separately.

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

2.13.3 Auto-tune



Accessing the Auto-tune Facility
From any operating frame, press and hold the ↻ 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		Cascade Templates	
OFF	– Off	SLU.A	– Slave type A
A	– Type A	SLU.b	– Slave type B
b	– Type B	_ St.A	– Master type A
		_ St.b	– Master type B

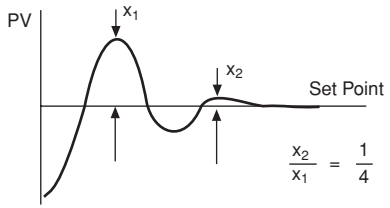
Auto-tune is started automatically when the ↻ key is pressed. Auto-tune can be stopped at any time by pressing the ⏻ key.

Note. **Profile program** – If a profile is running, the auto-tune feature cannot be started. When the ↻ key is pressed, the display reverts to 'OFF'.

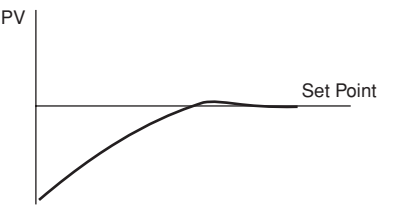
Note. **Slave control loops only** – place the slave into local set point mode and adjust the set point to the required value prior to autotuning.

Note. **P + I control only** – set the derivative term to 'OFF' in the Tuning Level – see Section 4.2.

Return to the Operating Level.



Type A – 1/4 wave damping



Type B – Minimum Overshoot

Fig. 2.13 Autotune Types

2.14 Control Efficiency Monitor

Note. With cascade control, the Control Efficiency Monitor is applicable only to the master controller.

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.

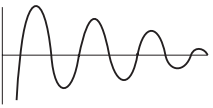
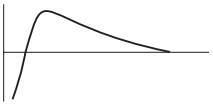
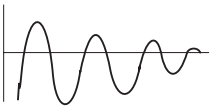
Parameter	Ideal Setting	Actual Setting	Effect on Response	Action
Rate of Approach	Fast	Too slow		• Decrease proportional band • Decrease integral time • Increase derivative time
Overshoot	Small	Too large		• Increase proportional band • Increase derivative time
Decay Ratio	Small	Too large (Oscill-atory)		• Increase proportional band • Increase integral time
Settling Time	Short	Too long		• Increase proportional band • Decrease integral time
Error Integral	Small	Too large	 	If large overshoot and oscillatory then: • Increase proportional band • Increase integral time • Increase derivative time If slow approach and overdamped then: • Decrease proportional band • Decrease integral time

Table 2.2 Control Efficiency Monitor Settings

...2.14 Control Efficiency Monitor

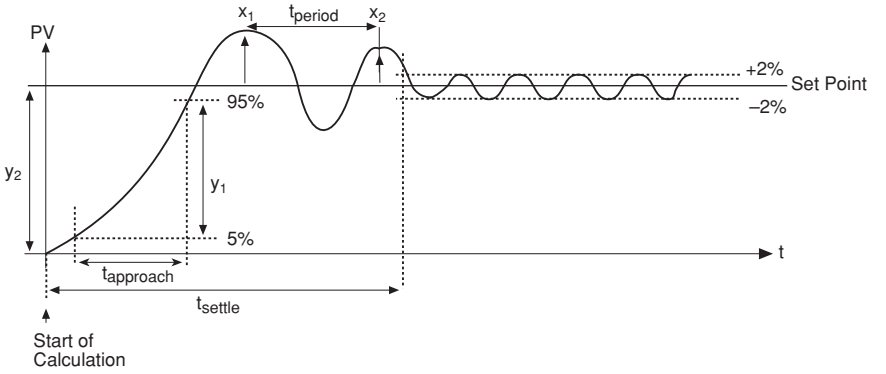


Fig. 2.14 Control Efficiency Monitor Parameters

2.14.1 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.

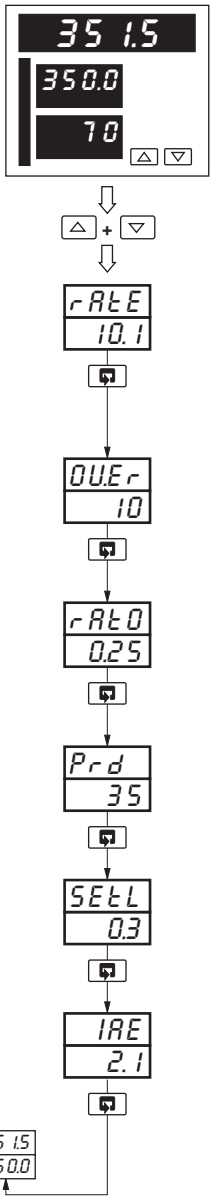
e) If the decay ratio > 0.25, increase the Proportional Band until decay ratio = 0.25
If the decay ratio < 0.25, decrease the Proportional Band until decay ratio = 0.25

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.

2.14.2 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 (Y_2), measured in engineering units per minute.

$$\text{Rate of approach} = \frac{Y_1}{t_{approach}}$$

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_{period}).

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

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

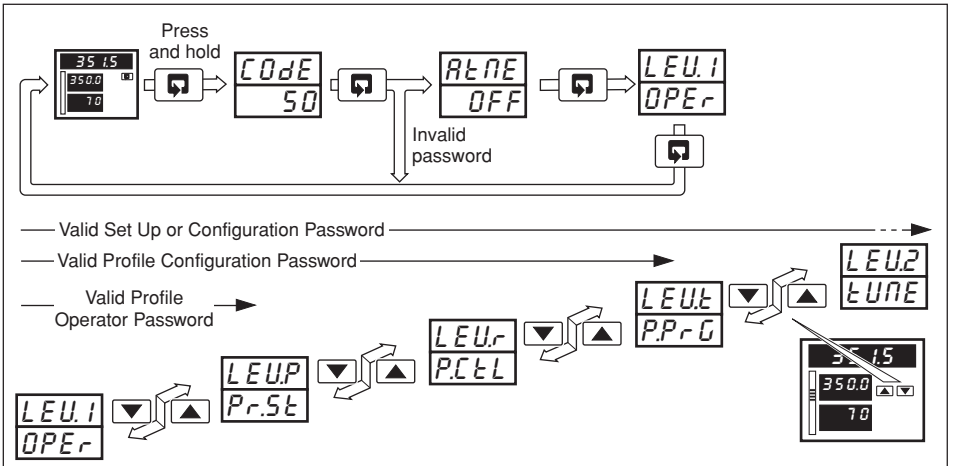
Return to the first operating frame.

3 PROFILES

3.1 Introduction

Note. Profile control is available only with software at issue 4 and later.

To access the Profile operating and configuration modes (Levels *P*, *r* and *t*), the correct password must be entered in the security code frame.



Profile States
Program Select
Run/Hold
Reset Profile
Skip Segment

Profile Control Level
Time Units
Program select source
Run/hold sources
Skip forwards/backwards source
Reset source
End of profile reset source
Soak time increment/decrement source

Profile Program Level
Program Begin/End
Segment Start/End Value
Soak time
Ramp Rate
Guaranteed Ramp/Soak
Time Events
Program Repeats
Program Source

Note. Profile control features are available only if ramp/soak is enabled – see Section 5.5, Level 9 – Set Point Configuration.

Fig. 3.1 Set Up Mode – Overview

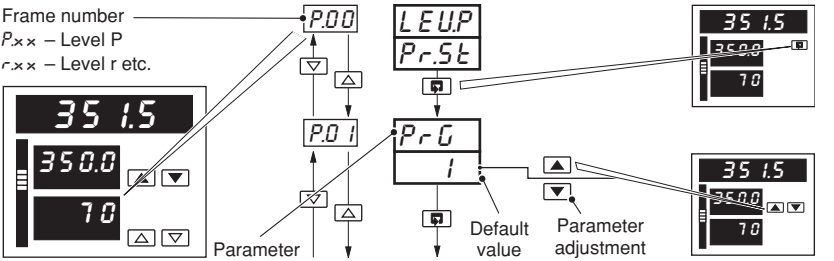


Fig. 3.2 – Scroll Display Overview

3.2 Introduction to Ramp/Soak Profile Control

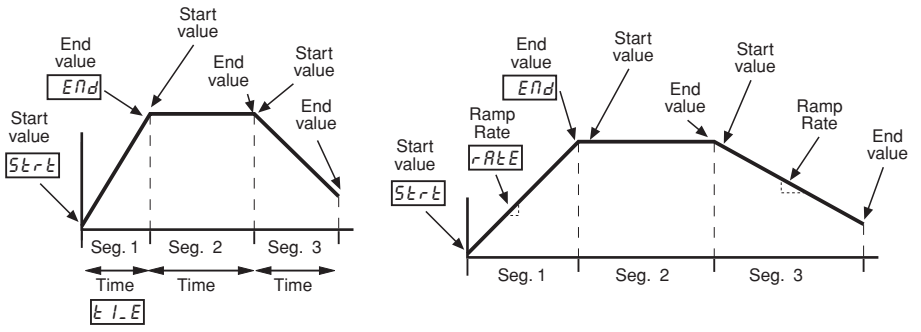
Information.

- **9 programs.**
- **Digital State program selection –** allows digital inputs to select program to be run.
- **30 programmable segments** – can be shared between programs
- **Programmable time units** – can be programmed in hours or minutes.
- **Programmable Ramps** – can be programmed as rates or in time units.
- **Program repeat** – 0 to 99 times or continuously.
- **Program holdback hysteresis** – separate settings for ramping segments and soak segments.
  – can be applied above, below or above and below the set point.
- **6 types of ramp/soak generated events** – segment active event, program active event, end of program event, holdback event, hold active event and time events.
- **6 ramp/soak commands** – can be selected from the front panel or via digital signals to run/hold programs, reset programs, skip forward to next segment, skip backwards to beginning of segment, increase soak time or decrease soak time (refer to Fig. 3.8 for ramp/soak adjust example).
- **4 time event states** – common to each segment.
- **Self-seeking set point function** – avoids unnecessary delays when a program is started – see Fig. 3.5.
- **Retort function** – ensures safe operation under fault conditions – see Fig. 3.6.
- **Power recovery function** – determines ramp/soak profile restart position.
- **End of Profile State** – latched 'ON' until reset.

The Ramp/Soak facility is a set point profile generator which can be used with any type of control process for more complex control. A Profile Program is made up of Ramps (the set point is increased or decreased at a linear rate until it reaches the desired value) and Soaks (the set point is maintained at a fixed value for a set time duration).

3.2.1 Ramp Types – Fig. 3.3

The profile set point can be configured to increment in one of two ways: for a fixed period of time or for a number of engineering units per hour.



A – Time Units **B – Rate of Change**

Fig 3.3 Ramp Types

3.2.2 Guaranteed Ramp/Soak

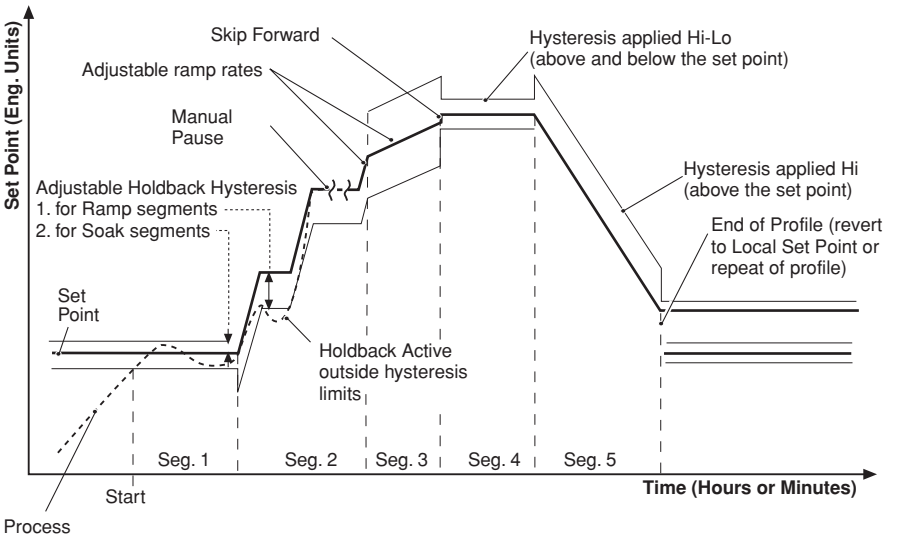
If the process variable deviates from the set point by more than the hysteresis value, the program status is set to 'HOLd' and Guaranteed ramp/soak is applied automatically. Each program has two associated hysteresis values:

- HYS.r – applied to ramping segments, and
- HYS.S – applied to soak segments.

The hysteresis value can be set within the limits '0' to '9999' where a setting of '0' implies that no deviation from the set point value can be tolerated.

Hysteresis can be applied in one of four ways, with individual settings for each segment:

- OFF – hysteresis not applied, ramp/soak not guaranteed.
- HI – hysteresis applied above set point (Holdback ('HOLd') set if PV > [SP + Hysteresis]).
- LO – hysteresis applied below set point ('HOLd' set if PV < [SP – Hysteresis]).
- HI.LO – hysteresis applied above and below set point ('HOLd' set if PV > [SP + Hysteresis] or PV < [SP – Hysteresis]).



Note. Ramp segments can have a different hysteresis to soak segments.

Fig 3.4 Typical 6-segment Ramp/Soak Profile

3.2.3 Power Recovery Function

The Power Recovery function allows pre-selection of the restart position within a ramp/soak profile when power is restored after a failure.

With options A, b or C, if power is restored before the **Power Down Time** expires, the ramp/soak profile continues from the point at which power failed. If power is restored after the **Power Down Time** has expired, the profile resumes from one of the following user-selected points: start of the current program; start of the current segment or from the profile position at the time of failure. In all three cases the controller restarts in **HOLD** mode.

With option d, the profile continues in run mode from the position on the profile that would have been reached had the power failure not occurred.

3.2.4 Self-seeking Set Point – Fig. 3.5

The Self-seeking Set Point function reduces the delay between the end of a program and the beginning of the next program. The process variable value is used as the program start point and the set point steps up to the process variable value. This has the effect of changing the overall segment time and maintains a constant ramp rate.

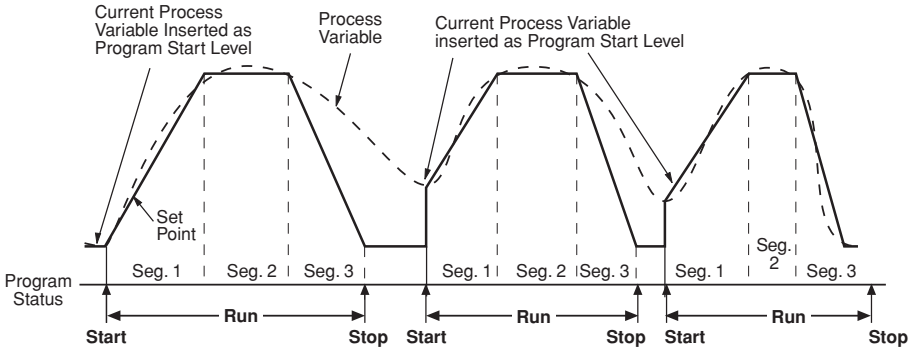


Fig 3.5 Self-seeking Set Point

3.2.5 Retort Function – Fig. 3.6

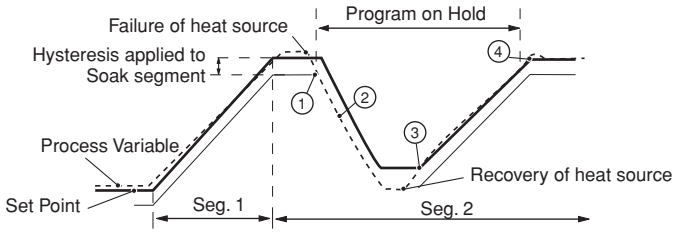
The Retort function ensures safe operation of retort vessels under fault conditions. If the heat source fails during a soak segment, the process variable will inevitably fall. When the process variable falls below the holdback hysteresis value the program is put on *HOLd* (as for normal operation). The set point then follows the process variable as it continues to fall (Retort Hold).

Set Point = Process Variable + Hysteresis value

Upon recovery of the heat source, the process is controlled at the new set point value. When the process variable reaches the set point it is then ramped back to the initial soak value at the rate of the previous ramp (Retort Ramp). When the soak level is reached the program is released from its hold state and the segment is either completed or repeated from the beginning, depending on the retort mode selected.

The retort mode is selected in the **Ramp/Soak Profile Page**.

Note. For the retort function to operate, either *LO* or *HI-LO* hysteresis must be applied to the soak segments.



1. The program is put on HOLD when the process variable falls below the holdback hysteresis
2. The setpoint follows the process variable as it continues to fall. (SP = PV + hysteresis). The set point 'tracks the lowest value of the process variable.
3. When the process variable reaches the set point, the set point is ramped back to the soak level at the rate of the previous ramp.
4. Upon reaching the soak level, 'HOLD' is released and the segment is completed or repeated.

Fig 3.6 Retort Function

3.2.6 Time Events – Fig. 3.7

Each state generates a source ('tEU.1' to 'tEU.4') which can be assigned to relays, digital outputs, logic equations etc. in the same way as any other digital signal.

Time event states are provided in addition to program and segment events states and do not affect their operation. Each segment has an associated 'EU.nt' setting which is used to control the Time-event states.

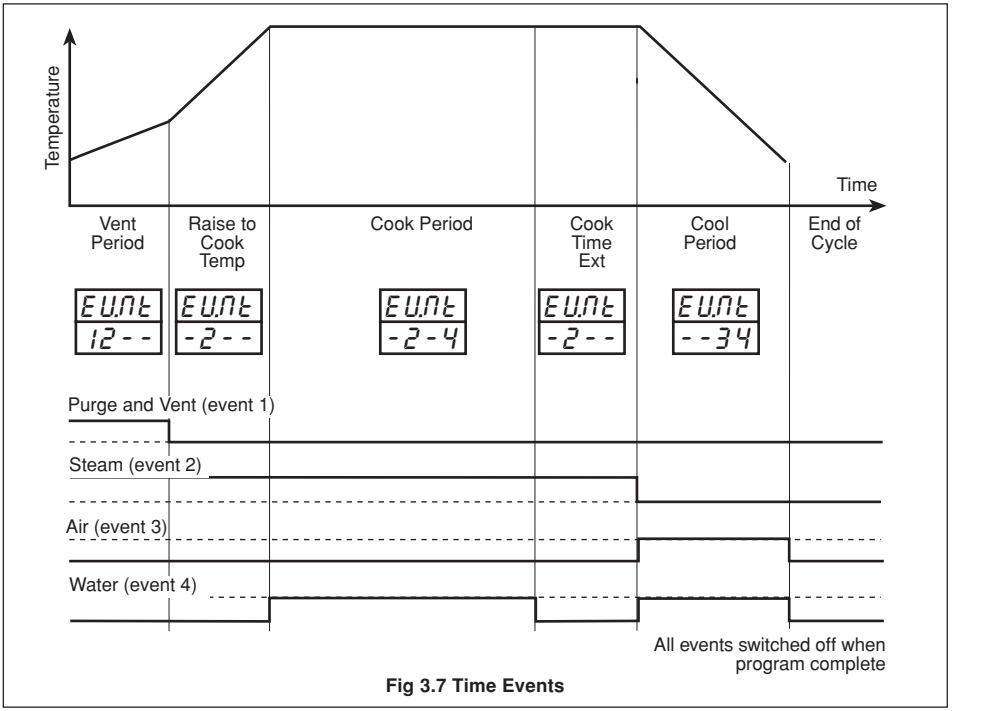


Fig 3.7 Time Events

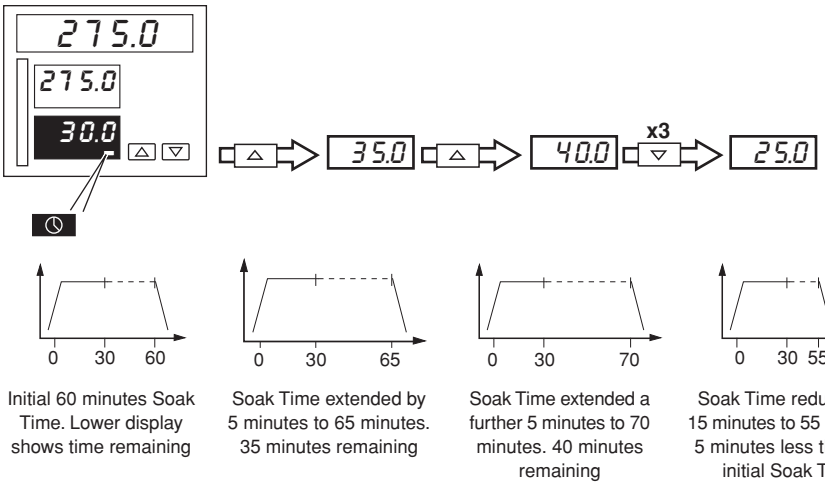
3.2.7 End of Profile State

The end of profile state is a digital source which can be assigned in the same manner as any other digital signal. The state is set automatically when the program is complete and remains set until a reset signal is received. The state can be configured to reset via a digital source or to reset automatically after two seconds – see Section 3.4/ Profile Control/ End of Profile Reset Source.

3.2.8 Current Segment Time Adjustment – Fig. 3.8 & 3.9

The Time Adjust function allows the time of a segment to be extended or reduced by a value preset in the '*t.Rd_J*' frame – see **Ramp/Soak Profile Control Page**. The segment time can be adjusted repeatedly (in preset increments) while the segment is running, either from the controller faceplate or by a digital signal (assigned in the '*In.S*' or '*dEc.S*' frames).

Note. Any changes made to the segment time using this function are not saved in the program memory. At the end of the program, all segment times are reset to their original values.



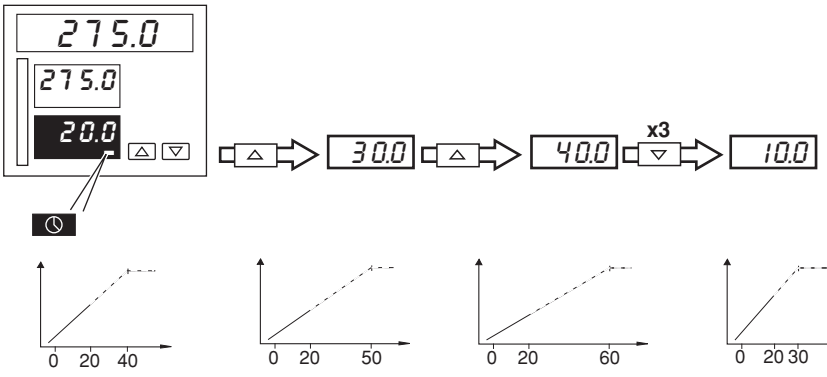
Initial 60 minutes Soak Time. Lower display shows time remaining

Soak Time extended by 5 minutes to 65 minutes. 35 minutes remaining

Soak Time extended a further 5 minutes to 70 minutes. 40 minutes remaining

Soak Time reduced by 15 minutes to 55 minutes, 5 minutes less than the initial Soak Time

Fig. 3.8a Time Adjustment on a Soak Segment



Initial 40 minutes Ramp Time. Lower display shows time remaining

Ramp Time extended by 10 minutes to 50 minutes. 30 minutes remaining.

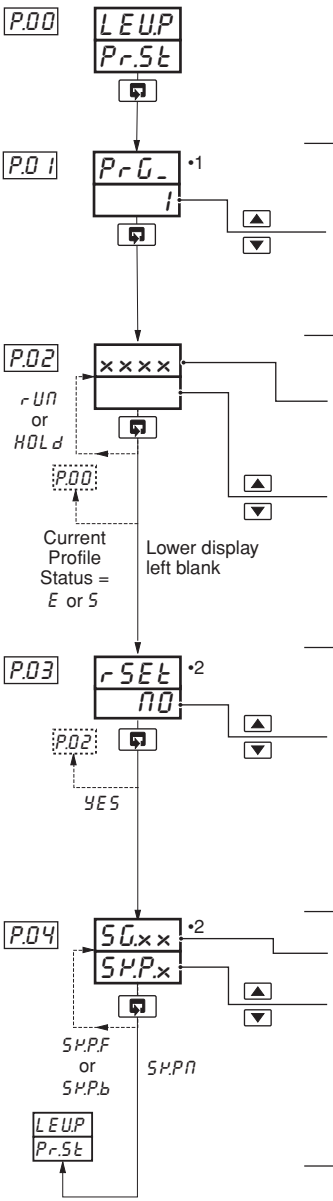
Ramp Time extended a further 10 minutes to 60 minutes. 40 minutes remaining

Ramp Time reduced by 30 minutes to 30 minutes, 10 minutes less than the initial Ramp Time. 10 minutes remaining.

Fig. 3.8b Time Adjustment on a Ramp Segment

3.3 Profile States

P.00...P.04



Level P – Profile States

Program Select
Select the program to be run.

Note. This frame is displayed only if no other program is running.

[1 to 9]

Run/Hold Action

[×××× = current profile status: rUN – running, StOP – stopped, End – end, O.HLd – operator hold, _HLd – manual hold, H.HLd – holdback hold]

rUN – Starts the selected program.
HOLd – Activates the Operator Hold.

Note. If a digital input assigned to the run/hold function has been used to run a program, the user is prevented from activating the operator hold.

Profile Reset
Select YES to restart the profile at the beginning of the program.

YES – restart the profile
nO – do not restart the profile

Note. To end a program, select HOLd at the Profile Status frame (see above) and then select YES at this frame. The local set point value takes the value of the first level of the selected program and the profile status reverts to 'StOP'.

Skip Segment
The current segment number (or nn) is shown in the upper display.

SH.P.F + ▲ **Skip Forward** – abandon current segment and start the next segment.
SH.P.n **Do Not Skip** – maintain control using current segment.
SH.P.b + ▼ **Skip Back** – return to beginning of current segment.

Return to top of Page

•1 Displayed only if the current profile status is Stopped.

•2 Not displayed if the current profile state is Stopped or End.

3.4 Ramp/Soak Profile Control

r.00...r.05

r.00 LEU.r / P.CtL

Level r – Profile Control

r.01 t.Unt / _ IN5

Program Time Units
Select the time units required

hr5 – Hours
_ IN5 – Minutes

The time base selected applies to all segments.

r.02 rA_P / rAtE

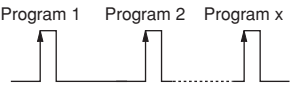
Select Ramp Type
Select the ramp type required

t I_E – Ramp time
rAtE – Ramp rate

The ramp type selected applies to all segments.

r.03 P.SEL / OFF •1

Next Program Select Source



See Rear Fold-out/Table C – Digital Sources

Only programs which have been set up in the profile program level, level t, can be selected.

r.04 r.h.Sr / OFF •1

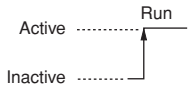
Program Run/Hold Source
The run/hold source is level triggered i.e. the active logic state must be maintained to select the alternative function.

See Rear Fold-out/Table C – Digital Sources

Note. If a program is run using **Program Run/Hold Source**, 'Operator Hold' is disabled until the **Program Run/Hold Source** has been de-activated. The **Program Hold Source** and front panel switches have no effect.

r.05 rUn.S / OFF •1

Program Run Source
The run source is leading edge triggered i.e. the active logic state can be removed after the function is selected.



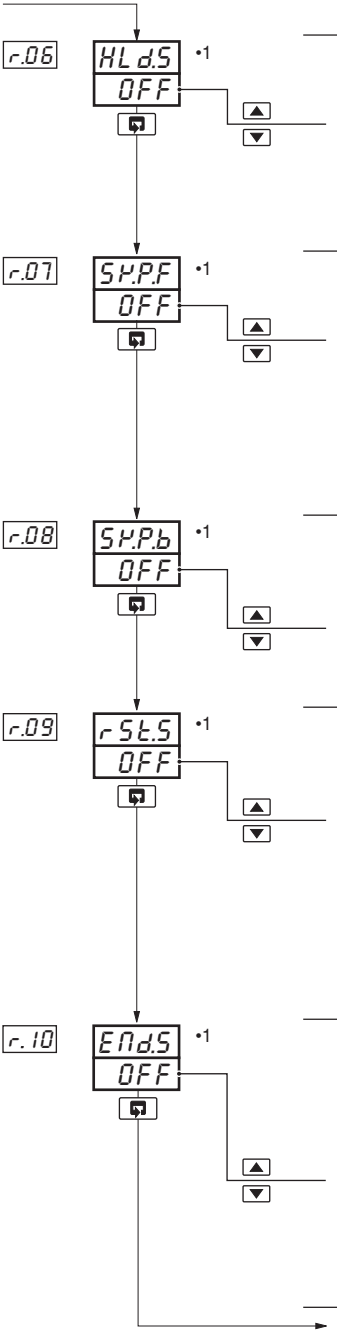
See Rear Fold-out/Table C, Digital Sources

Continued…

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.

…3.4 Ramp/Soak Profile Control

r.06…r.10



Program Hold Source
The hold source is leading edge triggered.

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

Hold mode
Running

The program is restarted using the **Program Run Source** or the front panel keys.

Segment Skip Forward Source
Select the source required to skip to the next segment.

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

Skip Forward

Note. If the segment running is the last segment of the program, the program is stopped. The skip source is leading edge triggered.

Segment Skip Backward Source
Select the source required to skip back to the beginning of the ramp/soak segment running. The skip source is leading edge triggered.

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

Skip Backward

Program Reset Source
Select the source required to reset a running program. The reset source is leading edge triggered.

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

Reset Program

Note. If the program is running normally and is reset, the program returns to the beginning of the first segment and continues to run. If the program is on hold and is reset, the program returns to the beginning of the first segment and stops. No action is taken if a program has already finished.

End of Profile Event Reset Source
The end of profile event state is set automatically when the program is complete. A digital source can be activated to cause the end of profile event state to be reset.
Select the source required to reset the end of profile event state.

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

Reset End of Profile Event State

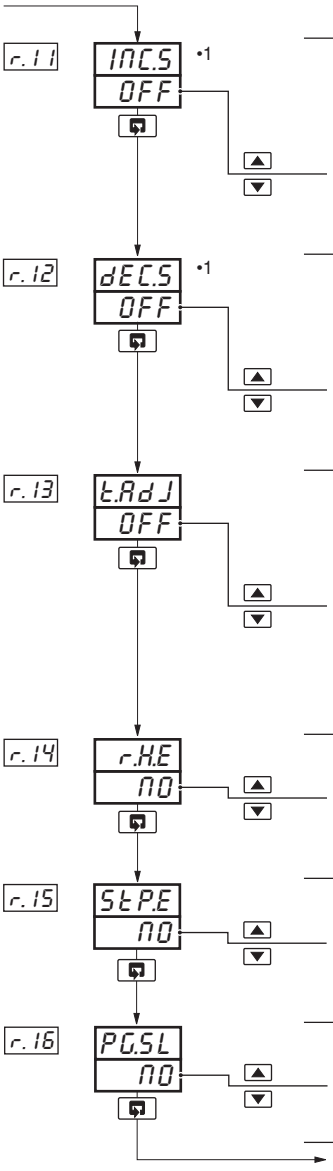
Note. If 'nonE' is selected, the end of profile event state is reset automatically after 2 seconds.

Continued…

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.

...3.4 Ramp/Soak Profile Control

r.11 ...r.16



Segment Time Increment Source (Current Segment)
The time of the current segment can be increased (by an amount set in the Segment Time Adjust frame) each time the source is activated. (ie. the source is leading edge triggered).

Increment Segment Time

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

Segment Time Decrement Source (Current Segment)
The time of the current segment can be decreased (by an amount set in the Segment Time Adjust frame) each time the source is activated. (ie. the source is leading edge triggered).

Decrement Segment Time

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

Segment Time Adjust Value (Current Segment)
The value set is added to or subtracted from the remaining time of a running segment via a digital signal or from front panel keys, when in the **Time Remaining in Current Segment** frame of the **Operating Page**.

[0.1 to 100.0 or 'OFF']

The time units are set in the **Time Units** frame. If OFF is selected, this function is disabled.

Front Panel Run/Hold Enable

YES – ⏯ Enabled
no – ⏯ Disabled

Front Panel Stop Key Enable

YES – ■ Enabled
no – ■ Disabled

Front Panel Program Select Enable

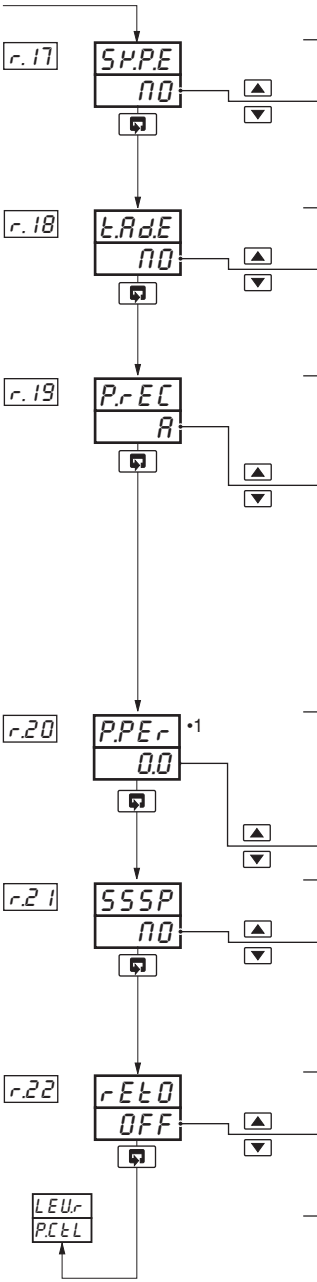
YES – Operator level program select enabled
no – Operator level program select disabled

Continued...

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.

...3.4 Ramp/Soak Profile Control

r.17...r.22



Front Panel Segment Skip Enable

FdbK. – Operator level segment skip forwards & backwards enabled
bK. – Operator level segment skip backwards enabled
Fd – Operator level segment skip forwards enabled
NO – Operator level segment skip disabled

Front Panel Segment Time Adjustment Enable

UPdN – Operator level time increment and decrement enabled
dN – Operator level time decrement enabled
UP – Operator level time increment enabled
NO – Operator level time adjust disabled

Power-down Recovery Option
Select the profile restart position when power is restored after a failure and the **Power Down Time Period** (see below) has expired. See Section 3.2.3.

A – Start of the current program, profile set to operator hold mode
b – start of the current segment, profile set to operator hold mode
C – profile position unchanged, profile set to operator hold mode
d – calculated position in profile had the power not failed

Note. Option d does not work with segments of more than 24 hours duration or if the power down time is greater than 24 hours. When power is restored, the profile is set to operator hold mode and the profile position is unchanged.

Power-down Time Period (Power-down recovery options A, b & C)
Set the time period during which, if power is restored, the profile continues from the point at which power failed. If the **Power-down Time** is exceeded the **Power-down Recovery Option**, selected above, is invoked.

[0.0 to 99.9 minutes]

Self-Seeking Set Point

YES – Enable self-seeking set point
NO – Disable self-seeking set point

When enabled, the controller uses the current process variable value as the starting point of the first profile segment – see Section 3.2.4.

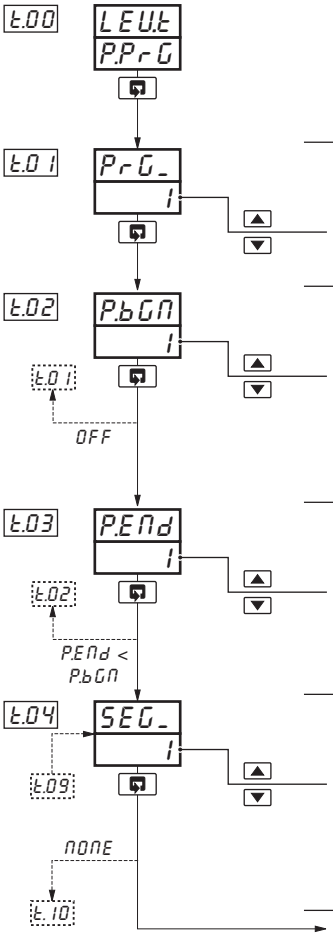
Retort Function
See Section 3.2.5
OFF – Disable retort function
A – Complete soak segment
b – Repeat soak segment

Return to the top of the **Profile Control Page**.

•1 Not displayed if power down recovery option d is selected.

3.5 Ramp/Soak Profile Program

t.00...t.04



Level t – Profile Program.

Select Program
Select the program to be configured

[1 to 9]

Program Begin
Select the program start segment

[1 to 30 or 'OFF']
Setting this parameter to OFF prevents the program being selected.

Note. Program 1 cannot be switched off.

Program End
Select the program end segment

[1 to 30]

Note. If the program end segment is less than the program start segment, the display reverts to the Program Begin frame.

Select Segment
Select the segment to be programmed

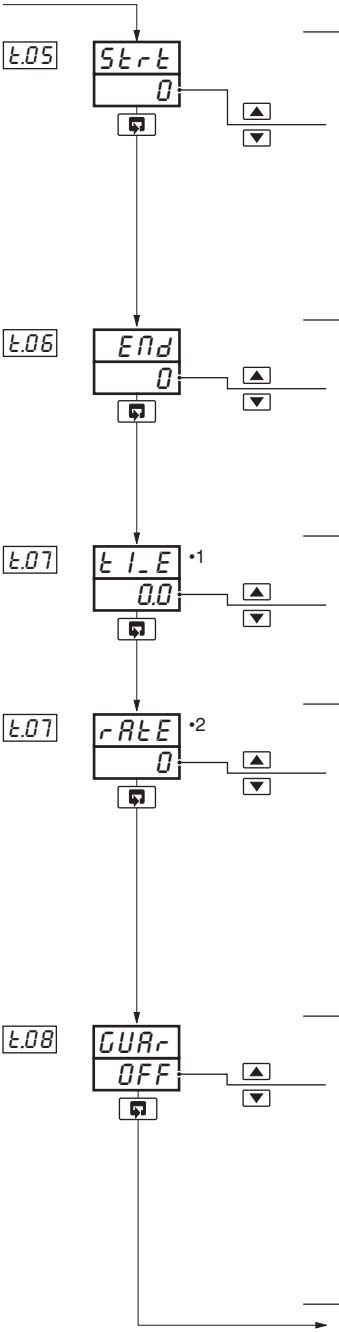
[Valid segments of selected program or 'nonE']

When all segments have been programmed, select nonE to advance to **Repeat Program** frame.

Continued…

...3.5 Ramp/Soak Profile Program

t.05...t.08



Segment Start Value
The segment start value can only be set if it is the first segment of a program.

[–999 to 9999 in engineering units]

Note. A **Ramp** has different start and end set point values. A **Soak** has the same start and end set point values. Adjacent segments of different **Ramp** or **Soak** programs MUST have the same start and end values, unless an intermediate 'spacer' segment is used.
The start value of a segment can only be adjusted if the segment is the first of the selected program.

Segment End Value

[–999 to 9999 in engineering units]

If segment start/end values are the same or the ramp type is set to '*t I_E*', advance to the **Segment Time** frame. If segment start/end values are different and the ramp type is set to '*rAtE*', advance to the **Ramp Rate** frame.

Segment Time

[0 to 999.9]

The time units (hours or minutes) are configured in **Ramp/Soak Time Units** frame, **Profile Control Page**.

Ramp Rate

[0.001 to 9999 engineering units per time period]

The time period (hours or minutes) is set in the **Ramp/Soak Time Units** frame, **Profile Control Page**.

Example – If a ramp of 10°F at 2° every minute is required, the ramp rate value entered is 2.0 (in the minutes time base).

Note. If the **Program Time Units** parameter is set to minutes, the engineering units value is displayed to an extra decimal place.

Guaranteed Ramp/Soak Hysteresis

HILO – hysteresis applied above and below set point ('*HALd*' set if PV > [SP + Hysteresis] or PV < [SP + Hysteresis])
LO – hysteresis applied below set point ('*HALd*' set if PV < [SP – Hysteresis])
HI – hysteresis applied above set point ('*HALd*' set if PV > [SP + Hysteresis])
OFF – hysteresis not applied, ramp/soak not guaranteed.

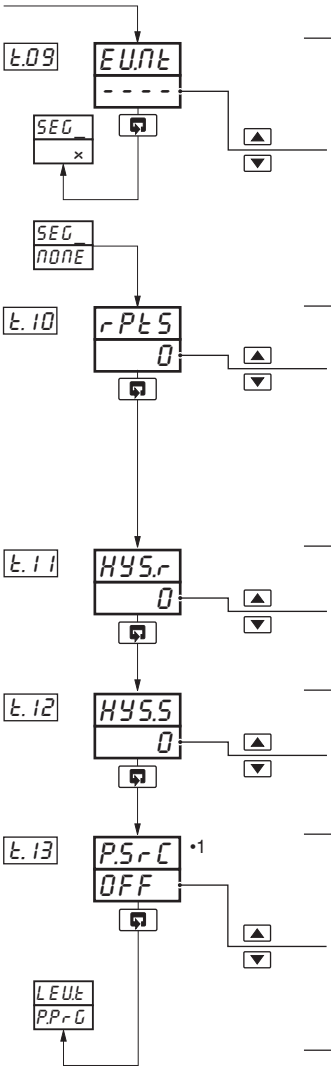
Continued...

•1 Displayed only if segment start and end values are the same, or the Ramp Type is set to '*t I_E*'.

•2 Displayed only if segment start and end values are different and the Ramp Type is set to '*rAtE*'.

...3.5 Ramp/Soak Profile Program

t.09...t.13



Time Events
Up to four time-events can be assigned to the segment currently being programmed – see Fig. 3.7on page 29.

Press the ▲ key to turn event 1 ON.
Press the ▼ key to turn event 1 OFF.
Press the ↵ key to advance to the next event.

Example. '12-4' indicates time events 1, 2, and 4 are active during this segment and time event 3 is inactive

Repeat Program Profile

[0 to 99 or ' InFn']

Note. If 1 is selected, the program runs twice; if 99 is selected, the program runs 100 times in total.

If ' InFn' (infinity) is selected, the program is repeated until stopped by the operator.

Guaranteed Ramp Hysteresis

[0.001 and 9999 in engineering units or '0' if no deviation from the profile is allowed]

Guaranteed Soak Hysteresis

[0.001 and 9999 in engineering units or '0' if no deviation from the profile is allowed]

Program Source
The program source is leading edge triggered i.e. the active logic state can be removed after the function is selected.

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

Select Program

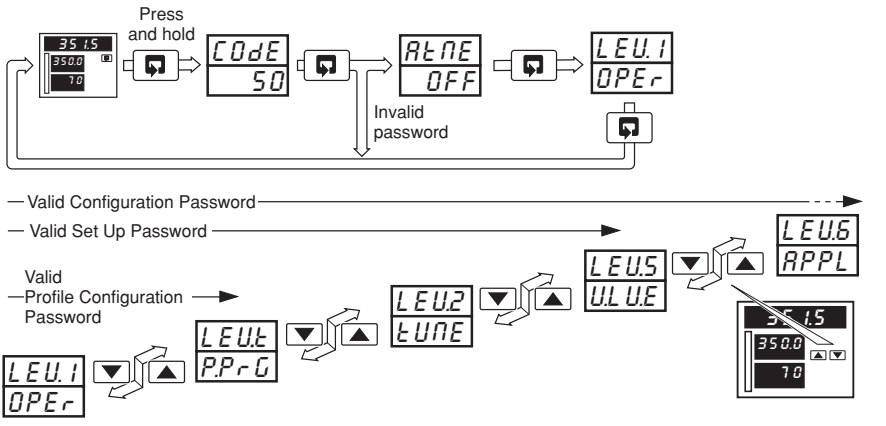
Return to **Select Program** frame.

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.

4 SET UP MODE

4.1 Introduction

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



LEU.2 **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
Feedforward gain and bias
Control deadband
Heat Cool Output 1 & 2 Start

LEU.3 **Set Points**
Local set point values 1 to 4
Slave set point value
Remote set point ratio/bias
Cascade set point ratio/bias
Ramp rate

LEU.4 **Alarm Trip Points**
Alarm 1 to 8 trip points

LEU.5 **Motorized Valve Set Up**
With feedback:
Feedback ratio/bias
Deadband
Regulator travel time
Boundless:
Deadband
Regulator travel time

Fig. 4.1 Set Up Mode – Overview

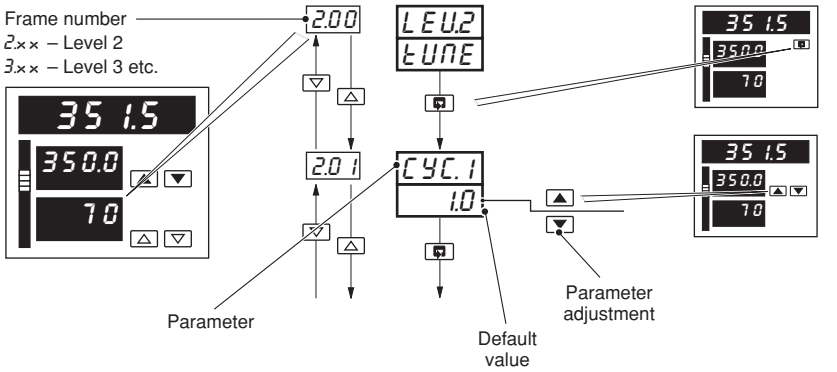


Fig. 4.2 – Scroll Display Overview

4.2 Level 2 – Tune

2.00...2.04

Note. Level 2 is not applicable if an Auto/Manual Station, Indicator or Ratio Station template is selected.

2.00 LEU.2 / tUNE

Level 2 – Tune

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

2.01 CYC.1 1.0 •1

Cycle Time Output 1

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

Note. On/off Control is not available on output 1 with heat/cool control or with cascade templates.

2.02 CYC.2 1.0 •1 •2

Cycle Time Output 2 (Cool)

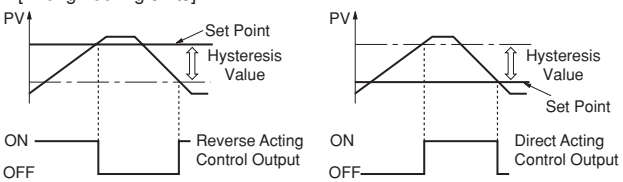
[1.0 to 300.0 seconds for time proportioning or 'OnOF' for on/off control]

Note. On/off Control is not available on output 2 with cascade templates.

2.03 HYS 1 0 •3

Output 1 On/Off Hysteresis Value

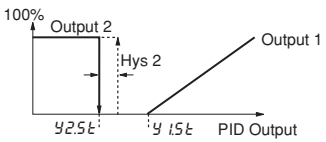
[In engineering units]



2.04 HYS2 0 •4

Output 2 On/Off Hysteresis Value

[0% to (Y 1.5t – Y2.5t)%] – see parameters 2.22 and 2.23



Continued on next page

•1 Displayed only if Relay or Digital output type is selected – see Section 5.2, Basic Configuration/ Output Type.

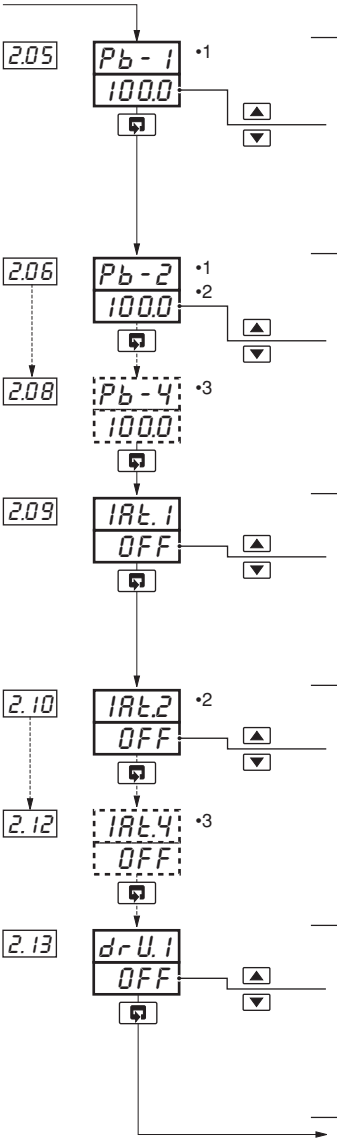
•2 Displayed only if Heat/Cool output type is selected.

•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 select and the 'CYC.2' parameter is set to 'OnOF'.

…4.2 Level 2 – Tune

2.05…2.13



Proportional Band 1

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

'Pb-1' is the default proportional band and is the proportional band for the master controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

Proportional Band 2, 3 and 4

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

'Pb-2' is the proportional band for the slave controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

Integral Action Time 1

[1 to 7200 seconds or 'OFF']

'IAt.1' is the default integral action time and is the integral action time for the master controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

Integral Action Time 2, 3 and 4

[1 to 7200 seconds or 'OFF']

'IAt.2' is the integral action time for the slave controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

Derivative Action Time 1

[0.1 to 999.9 seconds or 'OFF']

'drU.1' is the derivative action time for the master controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

Continued on next page.

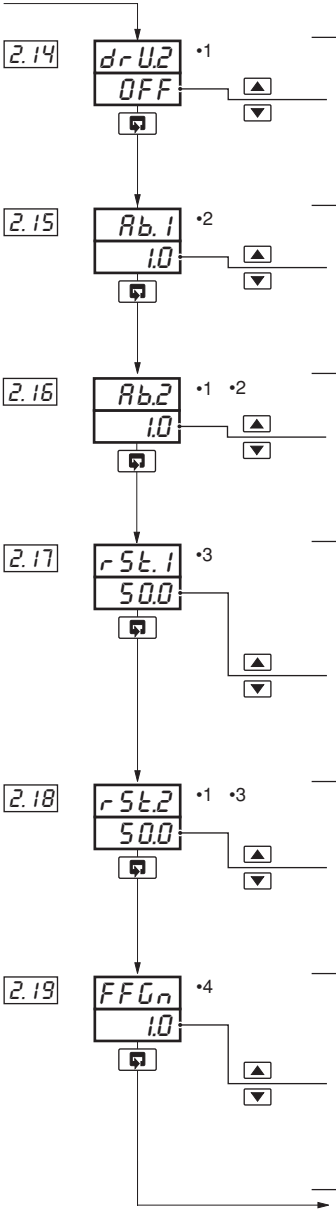
•1 Heat/cool outputs use a common proportional band. The default is 'Pb-1'.

•2 Displayed only if a cascade template or a tune parameter source is selected – see Section 5.2, Basic Configuration/ Template Application and Section 5.6, Control Configuration/ Tune Parameter Source.

•3 Displayed only if a tune parameter source is selected – see Section 5.6, Control Configuration/ Tune Parameter Source.

...4.2 Level 2 – Tune

2.14...2.19



Derivative Action Time 2

[0.1 to 999.9 seconds or 'OFF']

The derivative action time for the slave controller if a cascade template is selected – see Section 5.2, Control Configuration/ Template Application.

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.

Approach Band 2

[0.1 to 3.0 proportional bands]

This parameter limits when derivative action time 2 is applied to the slave control loop.

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).

[0.0 to 100%]

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

Manual Reset Value 2
As **Manual Reset Value 1**, but applied to the slave output.

[0.0 to 100%]

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

Feedforward Gain
The feedforward value applied to the control output is:
(disturbance variable x feedforward gain) + bias

[0.1 to 999.9 or 'OFF']

Note. The feedforward value is normally added to the PID output. Using the PC Configurator, the value can also be multiplied by the PID output.

Continued on next page.

•1 Displayed only if a cascade template is selected – see Section 5.2, Basic Configuration/ Template Application.

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

•3 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.

•4 Displayed only if a feedforward template is selected – see Section 5.2, Basic Configuration/ Template Application.

...4.2 Level 2 – Tune

2.20 FFbS •1 0.0

Feedforward Bias

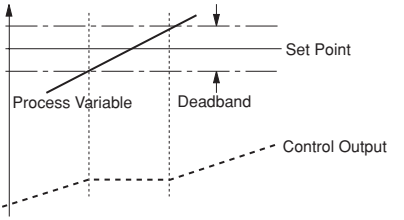
[–100.0% to 100.0%]

2.21 Cbnd OFF

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.

[In engineering units or 'OFF']

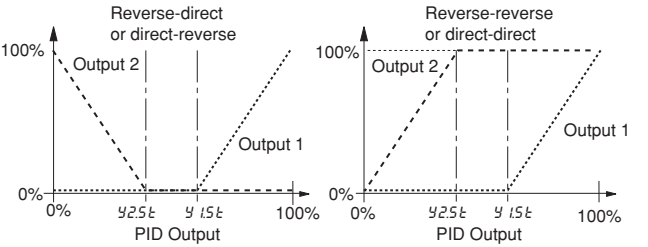


2.22 Y1.St •2 50.0

Heat/Cool Output 1 Start

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

[0.0 to 100.0%]



2.23 Y2.St •2 50.0

Heat/Cool Output 2 Start

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

[0.0 to ≤ Y1.St %] – see Heat/Cool Output 1

LEV.2 TUNE

Return to top of page

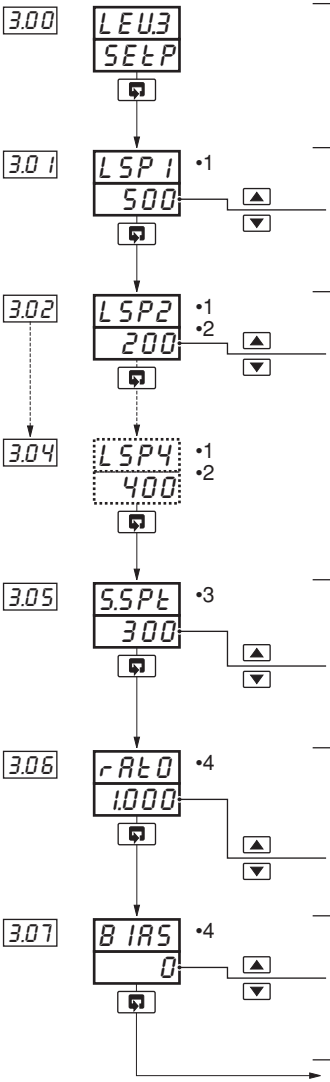
•1 Displayed only if a feedforward template is selected – see Section 5.2, Basic Configuration/ Template Application.

•2 Displayed only if a Heat/Cool output type is selected – see Section 5.2, Basic Configuration/ Output Type.

4.3 Level 3 – Set Points

3.00...3.07

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]

Cascade Slave Set Point Value
Set the slave set point value.

[Within slave set point high and low limits, in engineering units]
Only adjustable in Manual mode.

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 Not displayed for ratio controller or ratio station templates.

•2 Displayed only if a local set point source is selected – see Section 5.5, Set Point Configuration/ Local/Remote Set Point Source.

•3 Displayed only if a cascade template is selected.

•4 Displayed only for templates with a remote set point.

…4.3 Level 3 – Set Points

3.08…3.10

3.08 C.rtO •1 1.000

Cascade Set Point Ratio
In automatic mode, the slave set point value is:
(ratio x master output) + bias.

[0.001 to 9.999]

3.09 C.bIA •1 0

Cascade Set Point Bias

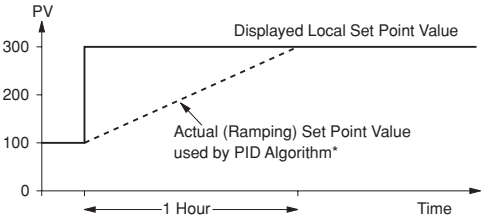
[In engineering units]

3.10 r.rtE OFF

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

LEU3 SEt.P

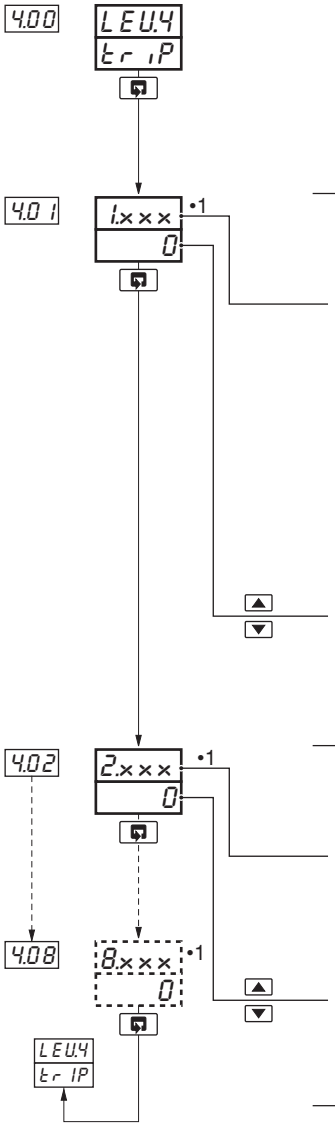
Return to top of page.

•1 Displayed only if a Cascade template is selected – see Section 5.2, Basic Configuration/ Template Application.

4.4 Level 4 – Alarm Trip Points

4.00...4.08

Note. Level 4 is not applicable if all alarm types are set to 'NONE' – see Section 5.4, 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

Display	Description	Display	Description	
NONE	None	LP3	Low Process I/P3	
HPV.	High Process, PV	HO	High Output	•2
LPV.	Low Process, PV	LO	Low Output	•2
HLP	High Latch, PV	Hb1	Math Block 1 High	
LLP	Low Latch, PV	Lb1	Math Block 1 Low	
Hd	High Deviation	Hb2	Math Block 2 High	
Ld	Low Deviation	Lb2	Math Block 2 Low	
HP1	High Process I/P1	Hb3	Math Block 3 High	
LP1	Low Process I/P1	Lb3	Math Block 3 Low	
HP2	High Process I/P2	Hb4	Math Block 4 High	
LP2	Low Process I/P2	Lb4	Math Block 4 Low	
HP3	High Process I/P3			

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]

Return to top of page.

•1 Not displayed if alarm type set to 'NONE' – see Section 5.4, Alarms/ Alarm Type.

•2 Applies to PID output with single or heat/cool outputs.

4.5 Level 5 – Valve Setup

5.00...5.04

Note. Level 5 is applicable only for a motorized valve output type – see Section 5.2, Basic Configuration/ Output Type.

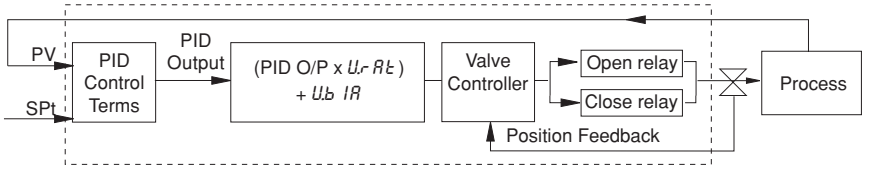


Fig. 4.3 Motorized Valve Output with Feedback – Schematic

4.5.1 Valve Setup (Feedback Types)

5.00 LEU.S / U.L U.E

Level 5 – Valve Setup

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

5.01 U.rAt 0

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

Motorized Valve Ratio
[0.01 to 10.00]

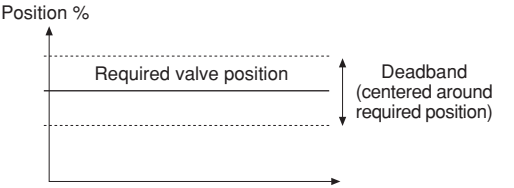
5.02 U.b IA 0

Motorized Valve Bias
[–100.0 to 100.0%]

5.03 d.bnd 10

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%.

5.04 r.trU. 30

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]

LEU.S / U.L U.E

Return to top of page.

4.5.2 Valve Setup (Boundless Types) – Fig. 4.4

A 'boundless' process controller provides an output that is effectively the time derivative of the required regulator position, i.e. the C350 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 C350 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.

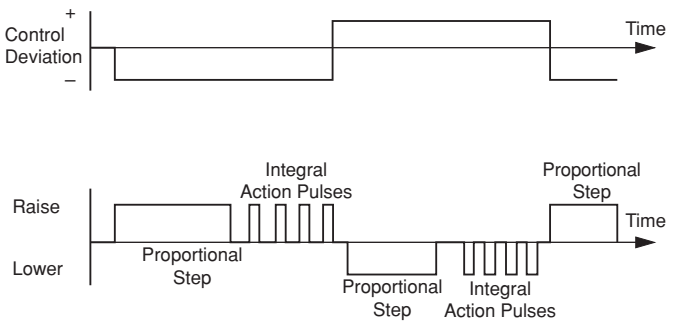


Fig. 4.4 Boundless Control Action

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).

$$= \frac{\text{Travel Time x Deadband \%}}{\text{\% Proportional Band}} \text{ (in seconds)}$$

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

$$= \frac{\text{Integral Action Time x Deadband \%}}{\text{2 x \% Control Deviation}} \text{ (in seconds)}$$

Duration of the proportional step

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

% Control Deviation

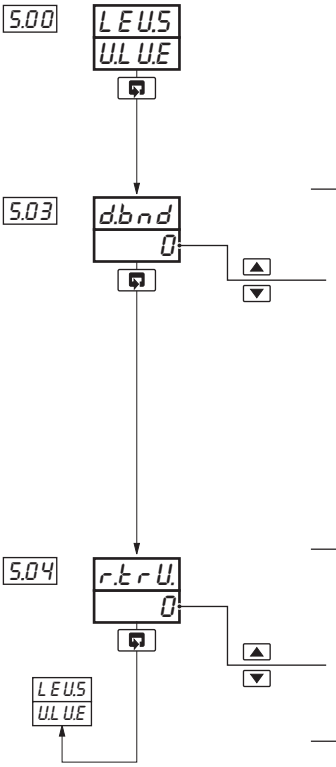
$$= \frac{\text{Set Point – Process Variable}}{\text{Eng Hi – Eng Lo}} \times 100\%$$

% Deadband

$$= \frac{\text{Deadband (eng units)}}{\text{Eng Hi – Eng Lo}} \times 100\%$$

…4.5.2 Valve Setup – Boundless

5.00…5.04

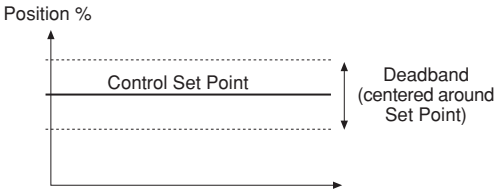


Level 5 – Valve Setup

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.

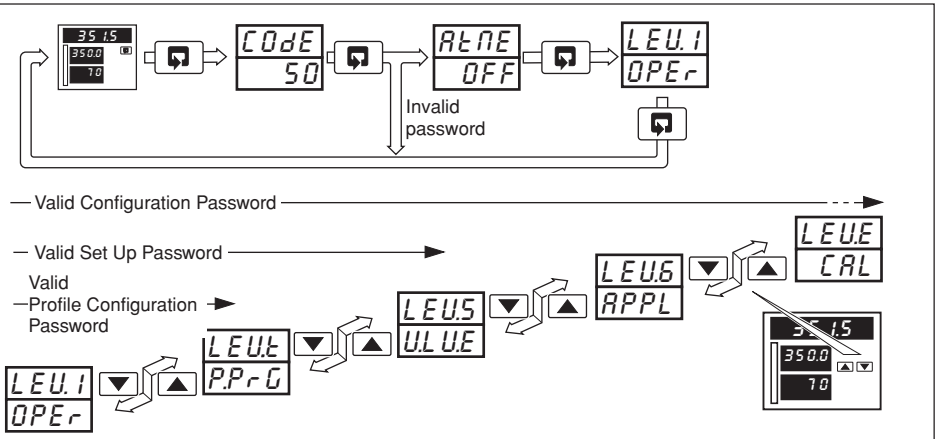
[1 to 5000 seconds]

Return to top of page.

5 CONFIGURATION MODE

5.1 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.

LEU.6 APPL

Basic Configuration
Template application
Output type
Control action
Mains rejection frequency

LEU.7 INPt

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

LEU.8 AL_S

Alarms 1 to 8
Type
Trip level
Hysteresis band
Global Acknowledgement

LEU.9 SEt.P

Set Points
Tracking enable
Set point limits
Local set point sources 1 to 4
Ramp/Soak enable

LEU.A CNtL

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

LEU.b OPEr

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

LEU.C ASSN

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

LEU.d SErL

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

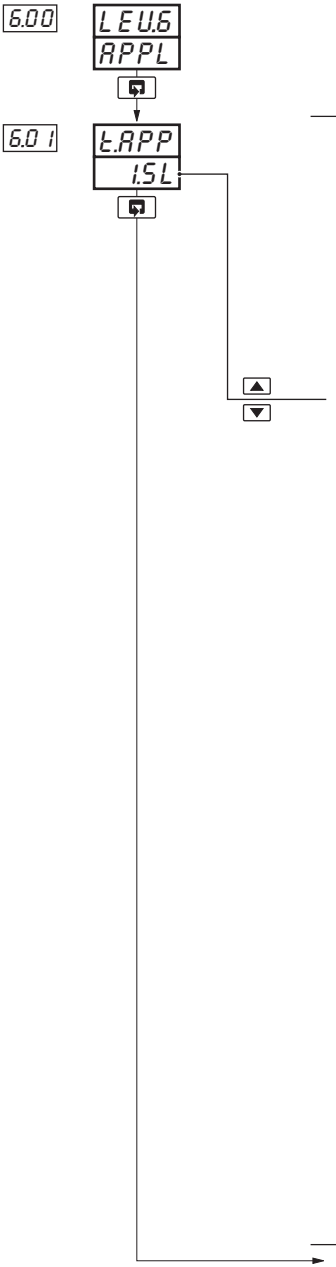
LEU.E CAL

Calibration
Offset/span adjustment
Motorized valve feedback

Fig. 5.1 Configuration Mode – Summary

5.2 Level 6 – Basic Configuration

6.00...6.01



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 C350 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

Display	Template Description
0 1.5L	Single loop with local set point only
02.5L	Single loop with remote set point
03.A_	Auto/Manual station with low signal selection
04.A_	Auto/Manual station with digital selection
05.Ab	Analog backup with low signal selection
06.Ab	Analog backup with digital selection
07. 1n	Single indicator/manual loader
08. 1n	Double indicator/manual loader
09.FF	Single loop with feedforward with local set point only
10.FF	Single loop with feedforward with remote set point
1 1.CC	Cascade with local set point only
12.CC	Cascade with remote set point
13.CF	Cascade with feedforward with local set point only
14.rC	Ratio controller
15.rC	Ratio controller with external ratio
16.rS	Ratio station
17.rS	Ratio station with external ratio

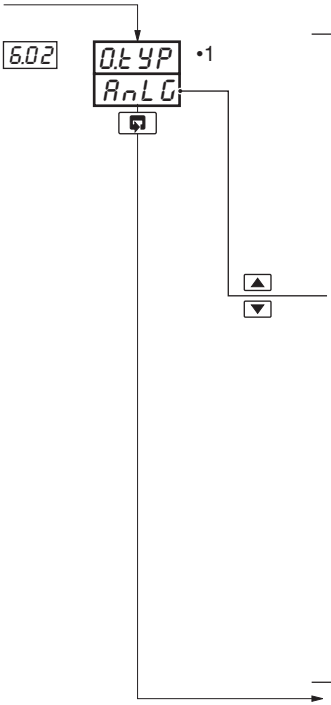
Note 1. When a template is selected, the following default values apply: The 'Analog Input Type' of all inputs used by the template defaults to '2', i.e. 4 to 20mA; The engineering ranges of all inputs used default to '0.0 to 100.0'. All other inputs are set to 'OFF'.

Note 2. Templates customized using the PC Configurator are identified by the letter 'U' in the template code – i.e. template '0 1.5L' becomes '0 1.U'.

Continued…

...5.2 Level 6 – Basic Configuration

6.02



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 5.8.

Select the Output Type required – see also Fig. 5.2 overleaf and Rear Fold-out/ Table B.

Display	Output Type
nONE	None
AnLG	Analog output (Control output = ao1)
rLY	Relay output (Control output = RLY1)
d IG	Digital output (Control output = do1)
PFb	Motorized valve with feedback (Open = RLY1, Close = RLY2) •2
bNd	Motorized valve without feedback (Open = RLY1, Close = RLY2) •3
HC.rr	Heat/cool with OP1 = relay, OP2 = relay
HC.rd	Heat/cool with OP1 = relay, OP2 = digital output
HC.dr	Heat/cool with OP1 = digital output, OP2 = relay
HC.Ar	Heat/cool with OP1 = analog, OP2 = relay
HC.AA	Heat/cool with OP1 = analog, OP2 = analog

Continued…

•1 Only output types '*nONE*' and '*AnLG*' are applicable to indicator templates. Only output type '*AnLG*' is applicable to auto/manual station, analog backup and ratio station templates.

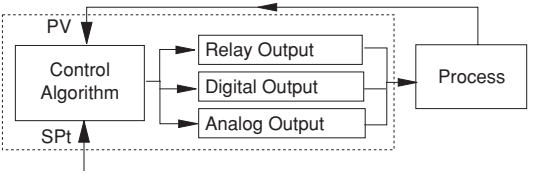
•2 Analog Input 3 Type defaults to '11' – Resistance Feedback. This output type is not available with templates 10, 12, 13 and 15.

•3 Output type '*bNd*' (Motorized valve without feedback) is not available with templates 9, 10 and 13.

…5.2 Level 6 – Basic Configuration

Output Types:

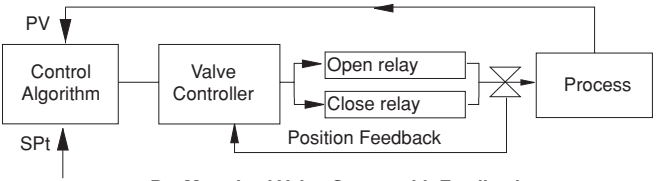
AnLG
rLY
dIG



A – Single Output

Output Type:

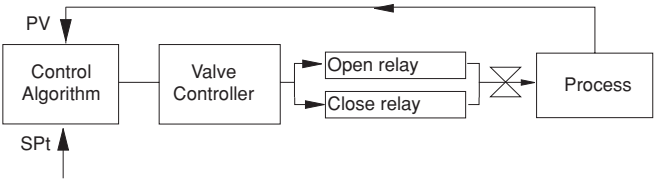
PFb



B – Motorized Valve Output with Feedback

Output Type:

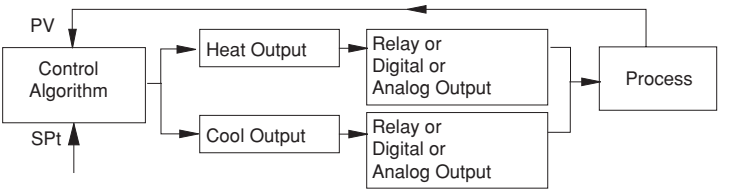
bNd



C – Motorized Valve Output without Feedback (Boundless)

Output Types:

HC.rr
HC.rd
HC.dr
HC.Ar
HC.AA

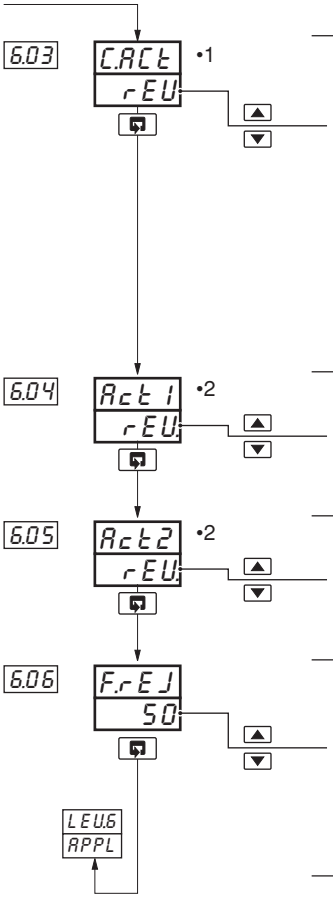


D – Heat/cool Output

Fig 5.2 Output Type Schematic Diagrams

...5.2 Level 6 – Basic Configuration

6.03...6.06



Control Action

	Single Loop	Output 1	
•3	rEU.	Reverse	
•3	dir	Direct	
	Heat/Cool	**Output 1 (Heat)**	**Output 2 (Cool)**
•4	r-d	Reverse	Direct
•4	r-r	Reverse	Reverse
•4	d-r	Direct	Reverse
•4	d-d	Direct	Direct

Control Action (Master Loop)

rEU. – Reverse
dIr – Direct

Control Action (Slave Loop)

[Options as frame 6.03 above]

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, indicator, ratio station or cascade templates.

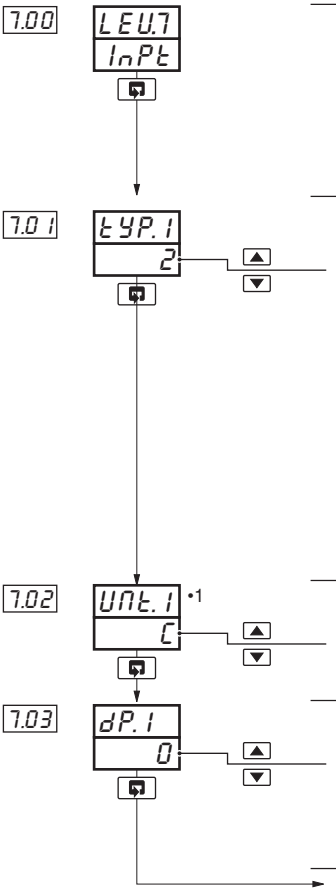
•2 Displayed only if a Cascade template is selected.

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

•4 Displayed only if Heat/Cool output types selected – see parameter 6.02.

5.3 Level 7 – Analog Inputs

7.00...7.03



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

Display	Description	Display	Description
OFF	Not Used	P	PT100 RTD
b	THC Type B	1	0 to 20mA
E	THC Type E	2	4 to 20mA
J	THC Type J	3	0 to 5V
K	THC Type K	4	1 to 5V
L	THC Type L	6	0 to 50mV
n	THC Type N	7	4 to 20mA square root linearizer
r	THC Type R	8	4 to 20mA power 3/2
S	THC Type S	9	4 to 20mA power 5/2
t	THC Type T	U	Custom

Temperature Units (I/P1)

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

Decimal Places (Engineering Range, I/P1)

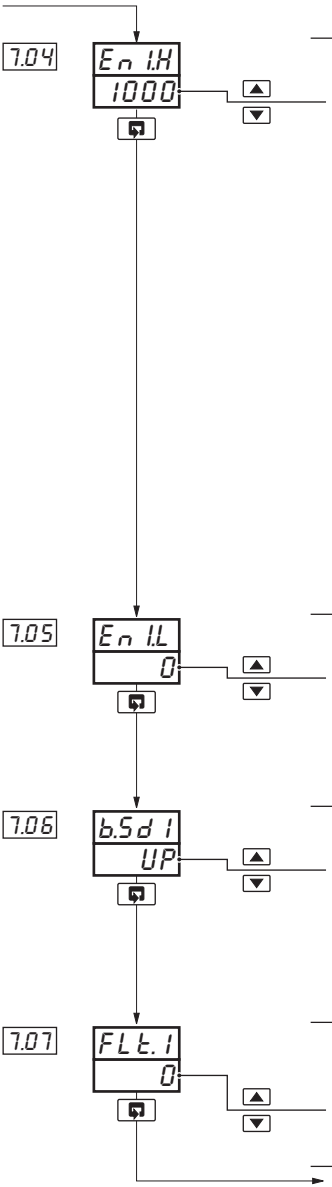
0 – XXXX
1 – XXX.X
2 – XX.XX
3 – X.XXX

Continued…

•1 Displayed only if THC or RTD input types are selected.

...5.3 Level 7 – Analog Inputs

7.04...7.07



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 5.1.

THC/RTD Type	°C			°F		
	Min.	Max.	Min. Span	Min.	Max.	Min. Span
Type B	–18	1800	710	0	3272	1278
Type E	–100	900	45	–148	1652	81
Type J	–100	900	50	–148	1652	90
Type K	–100	1300	65	–148	2372	117
Type L	–100	900	50	–148	1652	90
Type N	–200	1300	90	–328	2372	162
Type R & S	–18	1700	320	0	3092	576
Type T	–250	300	60	–418	572	108
Pt100	–250	600	25	–328	1112	45

Table 5.1 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 5.1.

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.

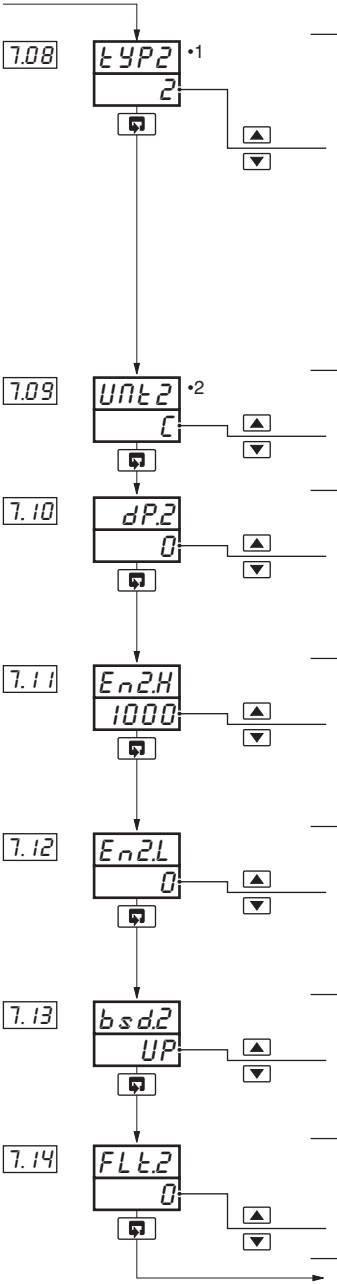
Input Filter Time Constant (I/P1)
The input values are averaged over the time set.

[0 to 60 seconds]

Continued...

…5.3 Level 7 – Analog Inputs

7.08…7.14



Analog Input Type & Electrical Range (I/P2)

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

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

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 5.1.

Engineering Low (I/P2)

[–999 to 9999]

Note. This parameter defaults to the minimum allowed value when THC input is selected – see Table 5.1.

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]

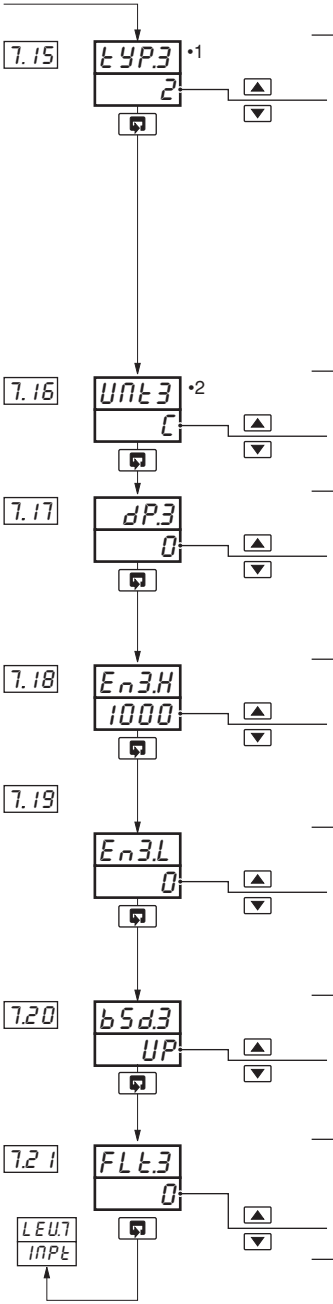
Continued…

•1 Frames 7.09 to 7.14 are not displayed if Analog Input Type 2 is set to 'OFF'.

•2 Displayed only if THC input type is selected.

...5.3 Level 7 – Analog Inputs

7.15 ... 7.21



Analog Input Type & Electrical Range (I/P3)

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

Temperature Units

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

Decimal Places

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

Engineering High

[–999 to 9999]

Note. This parameter defaults to the maximum allowed value when THC or RTD inputs are selected – see Table 5.1.

Engineering Low

[–999 to 9999]

Note. This parameter defaults to the minimum allowed value when THC or RTD inputs are selected – see Table 5.1.

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]

Return to top of page.

•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.

5.4 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.

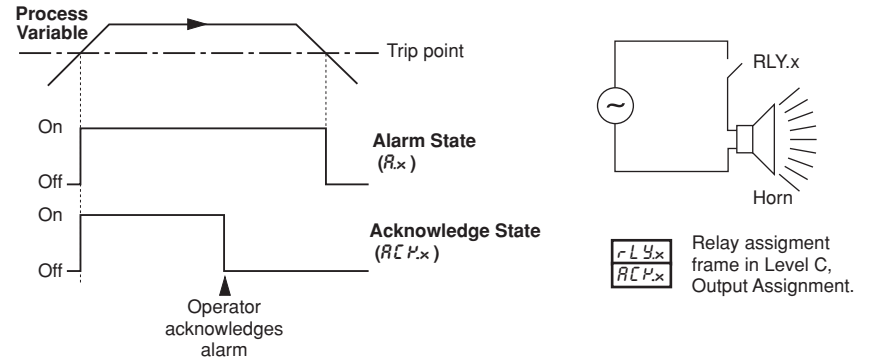


Fig 5.3 Using an Alarm to Sound a Horn

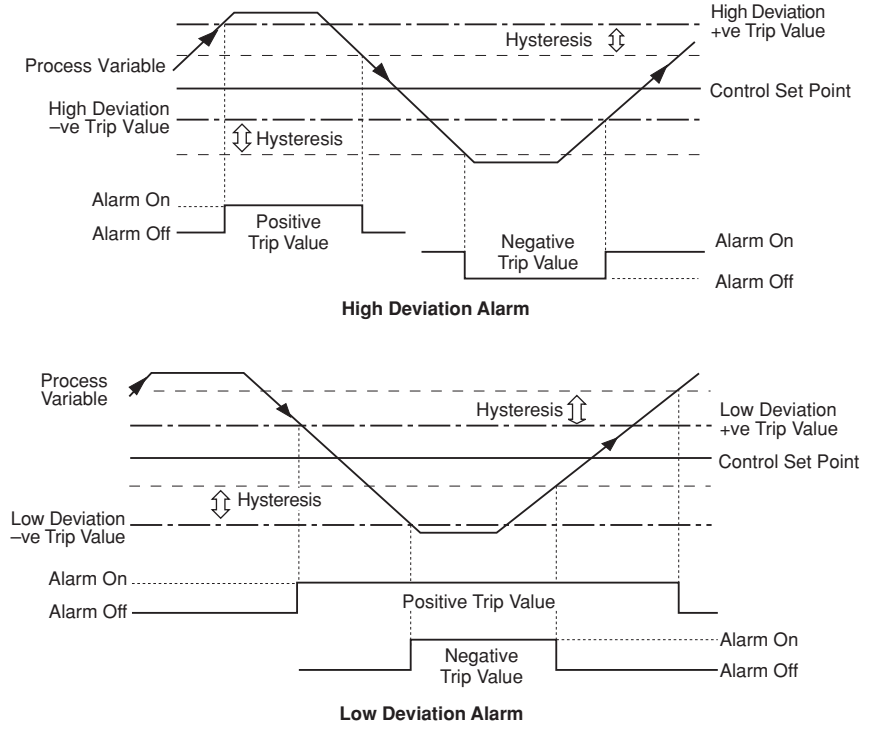


Fig 5.4 High and Low Deviation Alarm Action

...5.4 Level 8 – Alarms

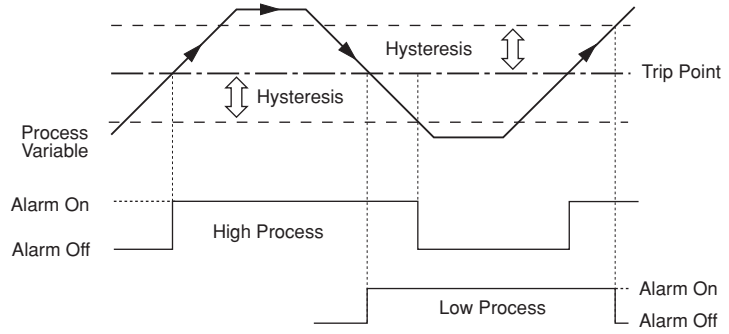
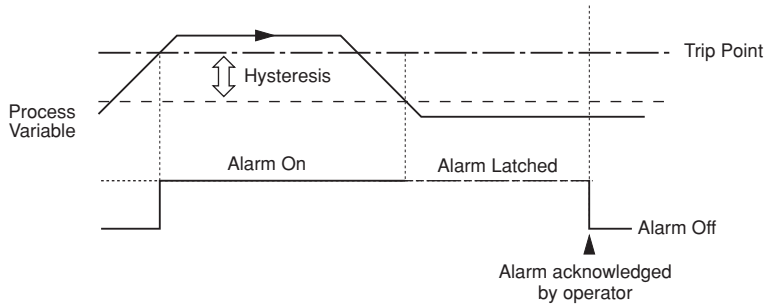
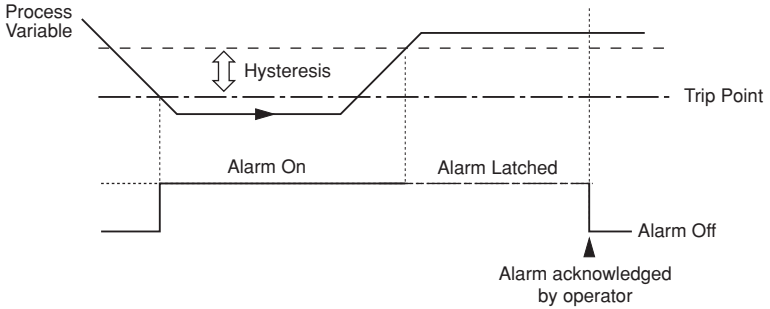


Fig 5.5 High and Low Process Alarm Action



High Latch Alarm Action

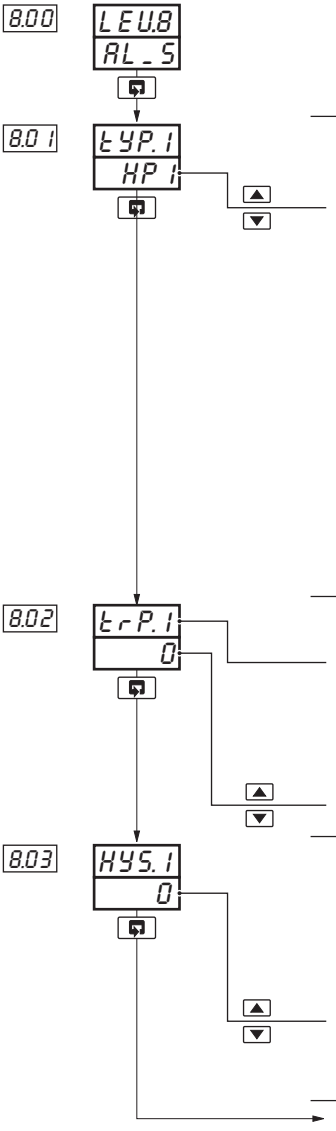


Low Latch Alarm Action

Fig 5.6 High and Low Latch Alarm Action

…5.4 Level 8 – Alarms

8.00...8.03



Level 8 – Alarms

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

Alarm 1 Type
See Figs 5.3 to 5.6

Display	Description	Display	Description	
nONE	None	LP3	Low Process I/P3	
HPU.	High Process, PV	HO	High Output	•1
LPU.	Low Process, PV	LO	Low Output	•1
HLP	High Latch, PV	Hb1	Math Block 1 High	
LLP	Low Latch, PV	Lb1	Math Block 1 Low	
Hd	High Deviation	Hb2	Math Block 2 High	
Ld	Low Deviation	Lb2	Math Block 2 Low	
HP1	High Process I/P1	Hb3	Math Block 3 High	
LP1	Low Process I/P1	Lb3	Math Block 3 Low	
HP2	High Process I/P2	Hb4	Math Block 4 High	
LP2	Low Process I/P2	Lb4	Math Block 4 Low	
HP3	High Process I/P3			

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 deactivated only when the process variable has moved into the safe region by an amount equal to the hysteresis value – see Figs. 5.4 to 5.6.

[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 5.2.

...5.4 Level 8 – Alarms

8.04...8.25

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.

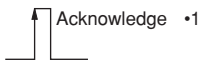
[In engineering units]

Global Alarm Acknowledge Source

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

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.



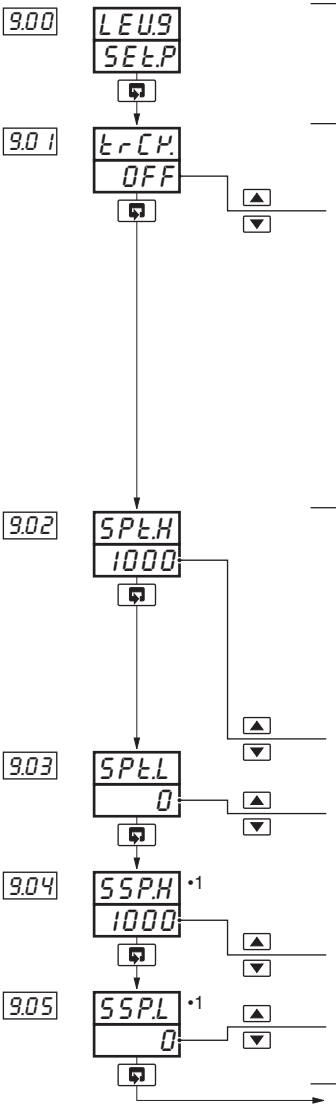
Return to top of page.

•1 A digital input becomes active when a volt-free contact is closed or a low TTL signal is applied.

5.5 Level 9 – Set Point Configuration

9.00...9.05

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

Display	Local Set Point Tracking	Remote Set Point Tracking	
OFF	OFF	OFF	
LOC	ON	OFF	•2
rE_	OFF	ON	•3
L-r	ON	ON	•3

Local Set Point Tracking – the local set point tracks the process variable when manual mode is selected. Applies to master and slave set points with cascade templates.
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. Also applies to the local and remote ratio when the ratio controller template is selected.

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) or Master Set Point (M.SPT) High Limit
[–999 to 9999 in engineering units]

Control Set Point (CSPT) or Master Set Point (M.SPT) Low Limit
[–999 to 9999 in engineering units]

Note. Operator level adjustment of the set point can be disabled – see Section 5.7, Operator Configuration/ Set Point Adjustment Enable.

High Limit for Slave Set Point
[In engineering units]

Low Limit for Slave Set Point
[In engineering units]

Continued…

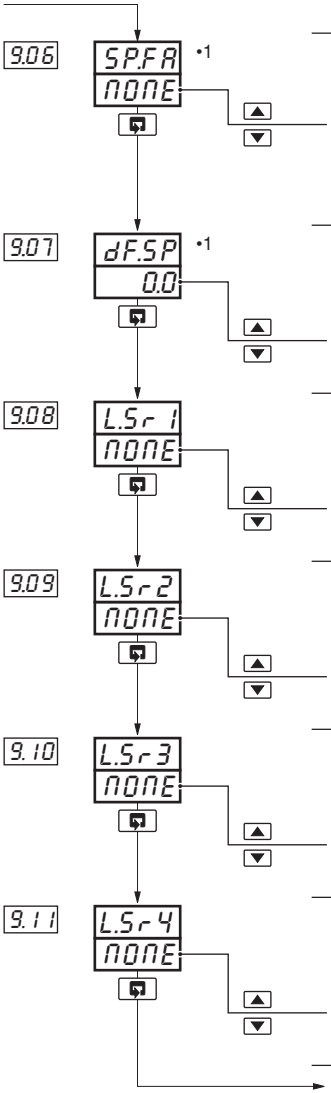
•1 Displayed only if a Cascade template is selected.

•2 Not available with ratio controller and ratio station templates.

•3 Available only if a remote set point template is selected.

...5.5 Level 9 – Set Point Configuration

9.06...9.11



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.

•2

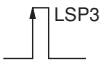
Local Set Point Source 2
The source required to select local set point 2 (LSP2) as the current local set point.

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

•2

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

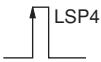
See Rear Fold-out/ Table C – Digital Sources.



•2

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.



•2

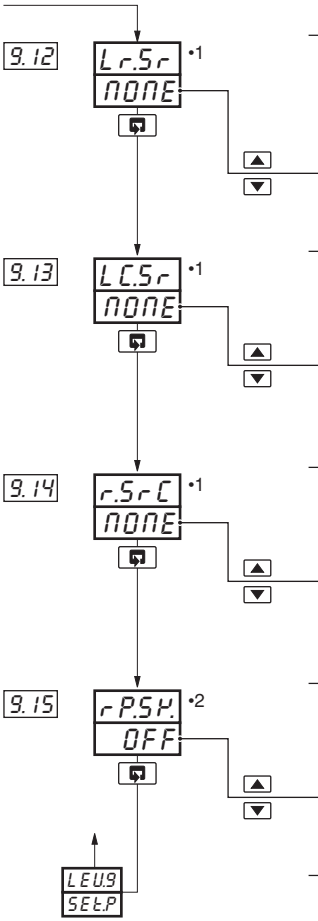
Continued...

•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.

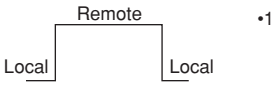
…5.5 Level 9 – Set Point Configuration

9.1 2…9.1 5



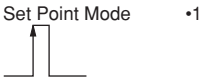
Local/Remote Set Point (or Ratio) Selection Source
The source required to lock into remote set point mode or remote ratio mode when the ratio controller template is selected.
When the source is active the key does not operate.

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



Local Set Point (or Ratio) Selection Source
The source required to select local set point mode or remote ratio mode when the ratio controller template is selected.

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



Remote Set Point (or Ratio) Selection Source
The source required to select remote set point mode or remote ratio mode when the ratio controller template is selected.

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

Ramp/Soak Enable

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

OFF – Ramp/Soak features disabled
On – Ramp/Soak features enabled

Return to top of page.

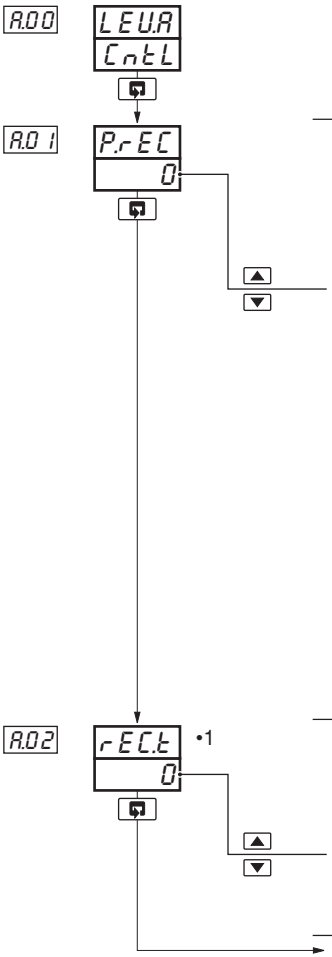
•1 Digital inputs are active when a volt-free contact is closed or a low TTL signal is applied.

•2 Ramp/Soak is available only on controllers with the following application templates:
0 1.5L , 02.5L , 05.AB , 06.Ab , 09.FF , 10.FF , 11.CC , 12.CC , 12.CF , 14.rC , 15.rC , 16.rS & 17.rS .

5.6 Level A – Control Configuration

A.00...A.02

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



Level A – Control Configuration

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

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

Display	Setting	Display	Setting
0	Last mode	5	Auto mode, integral term reset
1	Manual mode, using last output	6	Auto mode, using last integral term
2	Manual mode with 0.0% output	7	Power outage ≤ Recovery time: Auto mode. Power outage > Recovery time: Manual mode, last output
3	Manual mode with 100.0% output	8	Power outage ≤ Recovery time: Auto mode. Power outage > Recovery time: Manual mode, configured output
4	Manual mode with configured output		

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]

Continued…

•1 Not displayed if power fail modes 0 to 6 are selected.

…5.6 Level A – Control Configuration

A.03...A.08

A.03 — PU.FA / NONE

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

A.04 — dF.OP / 0

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)

A.05 — OP.H 1 / 100 •1

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%]

A.06 — OP.L 0 / 0 •1

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%]

A.07 — OP 1H / 100.0 •2

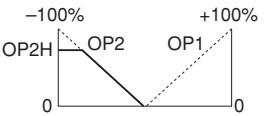
Output 1 (Heat) High Limit – Heat/Cool Control
Limits the high level of control output 1 in automatic mode. If the control output is above this limit when automatic mode is selected, the current output value becomes the high limit until the value falls below the limit set.

[0.0 to 100.0%]

A.08 — OP2H / 100 •2

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%]



Continued…

•1 Displayed only if a single output type is selected.

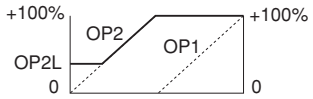
•2 Displayed only if a heat/cool output type is selected.

...5.6 Level A – Control Configuration

A.09 OP2L 0 •1

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.

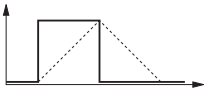
[0 to 100%]



A.10 OP.Sr OFF

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']

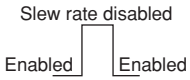


Note. The default slew rate setting is applied to both increasing and decreasing output values. The slew rate setting can be applied to either increasing values only or decreasing values only using the PC Configurator.

A.11 SrdS OFF

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

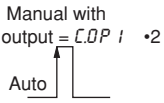
See Rear Fold-out/ Table C – Digital Sources.



A.12 _Sr1 OFF

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.



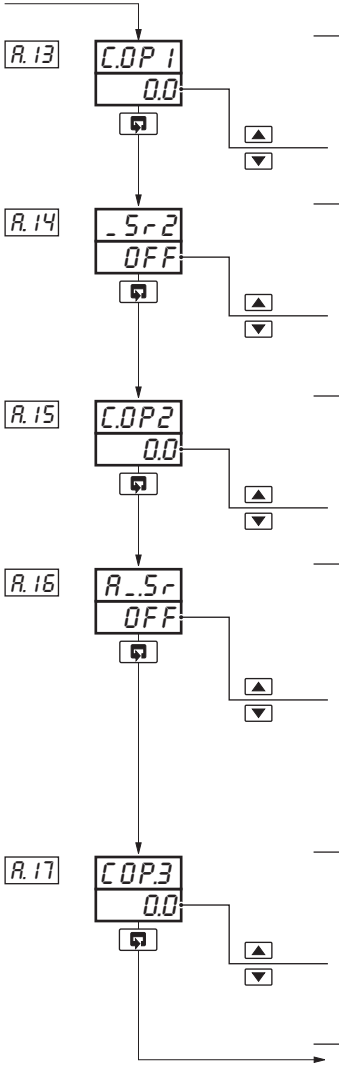
Continued...

•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.

…5.6 Level A – Control Configuration

A.I 3...A.I 7



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.

Manual with output = C.OP2 •1

Auto

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.

Manual with output = C.OP3 •1

Auto Auto

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.

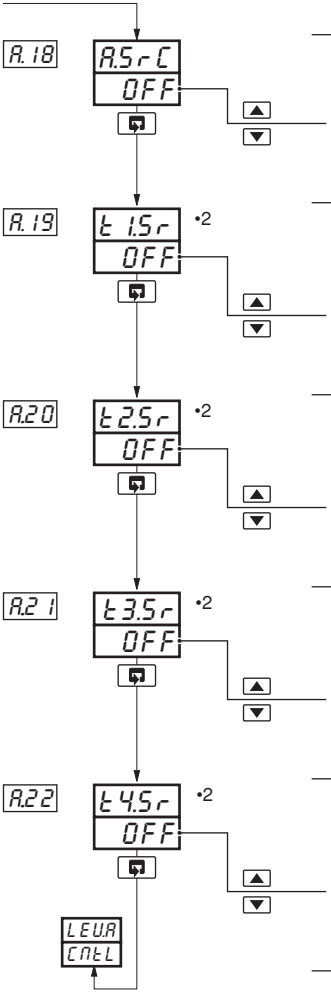
[0 to 100% or 'LASt' (non-heat/cool)]
[–100 to 100% (heat/cool only)]

Continued…

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

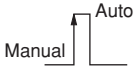
...5.6 Level A – Control Configuration

A.18...A.22



Auto Mode Selection Source
Select the digital source used to activate auto mode.

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



•1

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

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

Select Pb - 1 and IAt.1 •1

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

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

Select Pb - 2 and IAt.2 •1

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

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

Select Pb - 3 and IAt.3 •1

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

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

Select Pb - 4 and IAt 4 •1

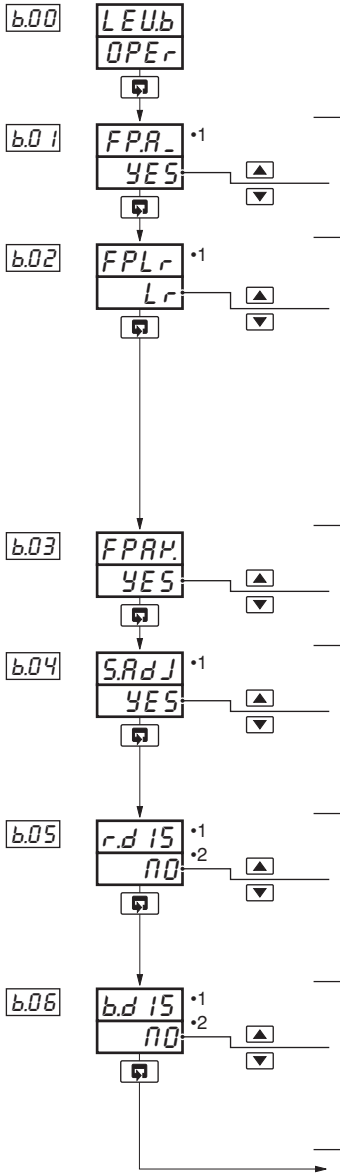
Return to top of page.

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

•2 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 available with Cascade control and it is not applicable to Auto/Manual Station, Indicator or Ratio Station templates.

5.7 Level B – Operator Configuration

b.00...b.06



Level B – Operator Configuration

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

Front Panel Auto/Manual Key Enable

YES – Enabled
NO – Disabled

Front Panel Local/Remote Key Enable

Display	Local/Remote Key Action	
NO	Local/Remote key disable.	
Lr	Switches between local and remote set point modes.	
2L	Selects local set point 1 or 2.	
3L	Selects local set point 1, 2 or 3.	
4L	Selects local set point 1, 2, 3 or 4.	
Lr.Lc		•3
2L.Lc	As above, but with switching between local and cascade	•3
3L.Lc	when slave parameters are displayed	•3
4L.Lc		•3

Front Panel Alarm Acknowledge Key Enable

YES – Enabled
NO – Disabled

Operator Level Set Point Adjustment Enable

YES – Enabled
NO – Disabled

Note. Applies to master and slave set points in cascade mode.

Operator Ratio Display

YES – Ratio setting for Remote and Cascade set point displayed in operator level.
NO – Ratio setting for Remote and Cascade set point not displayed in operator level.

Operator Bias Display

YES – Bias setting for Remote and Cascade set point displayed in operator level.
NO – Bias setting for Remote and Cascade set point not displayed in operator level.

Continued…

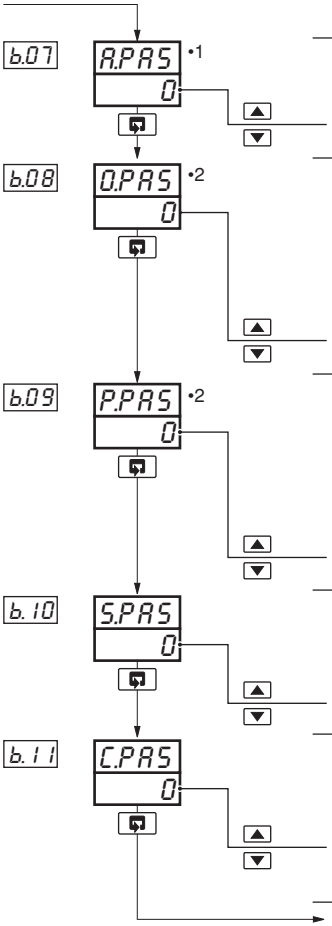
•1 Not displayed if the Indicator template in use.

•2 Displayed only if a template with remote set point or cascade control is selected.

•3 Cascade templates only.

...5.7 Level B – Operator Configuration

b.07...b.11



Auto-tune Password
Enables access to the auto-tune facility in the operator level.

[0 to 9999 (default 0)]

Profile Operator Password

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

Enables access to the profile states level (level P) and the autotune facility.

[0 to 9999 (default 0)]

Profile Configuration Password

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

Enables access to the profile states, profile control and profile program levels (levels P, r and t) and the autotune facility.

[0 to 9999 (default 0)]

Set Up Password
Enables access to the set up levels (levels 2, 3, 4 and 5) and the auto-tune 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)]

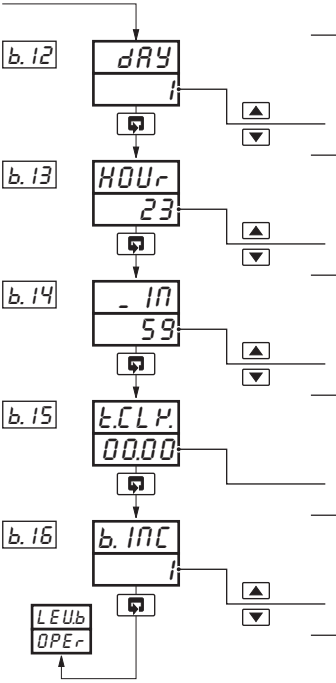
Continued...

•1 Not displayed on Indicator or Auto/manual station templates.

•2 Displayed only if Ramp/Soak enabled – see Section 5.5, Set Point Configuration/ Ramp/Soak Enable.

…5.7 Level B – Operator Configuration

b.12…b.16



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.

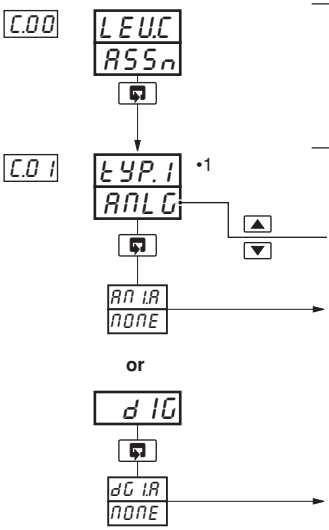
[1 to 10% of engineering range]

Return to top of page.

5.8 Level C – Output Assignment Configuration

C.00, C01

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



Level C – Output Assignment

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

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**.

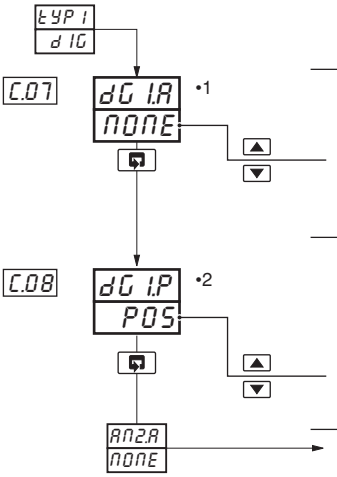
Press ⟳ to advance to **Digital Output 1 Assignment Source**.

Continued…

•1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 5.2, Basic Configuration/Control Output Type.

5.8.1 Digital Output 1

C07, C08



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.

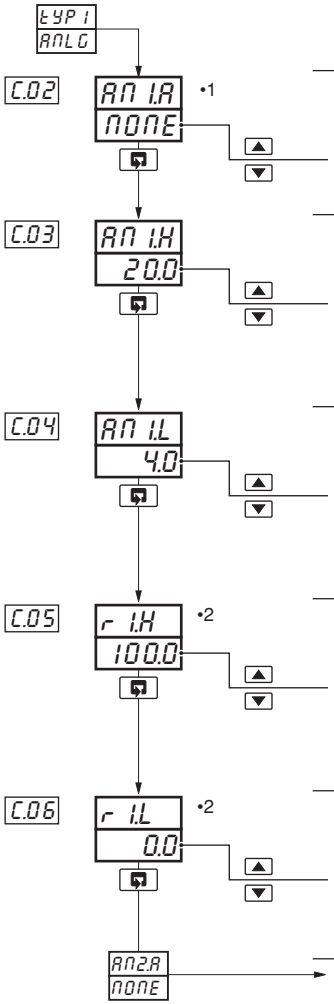
Continued…

•1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 5.2, Basic Configuration/Control Output Type.

•2 Not applicable if digital output 1 is assigned to a control output.

5.8.2 Analog Output 1

C02...C06



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]

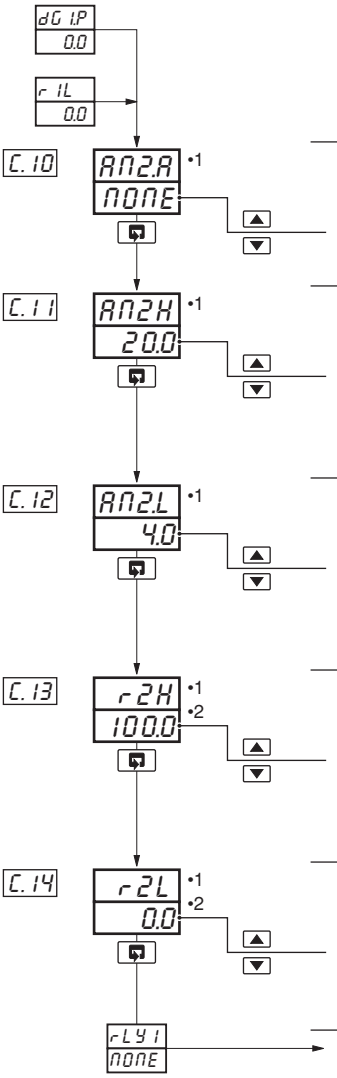
Continued…

•1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 5.2, Basic Configuration/ Control Output Type.

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

5.8.3 Analog Output 2

C10…C14



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]

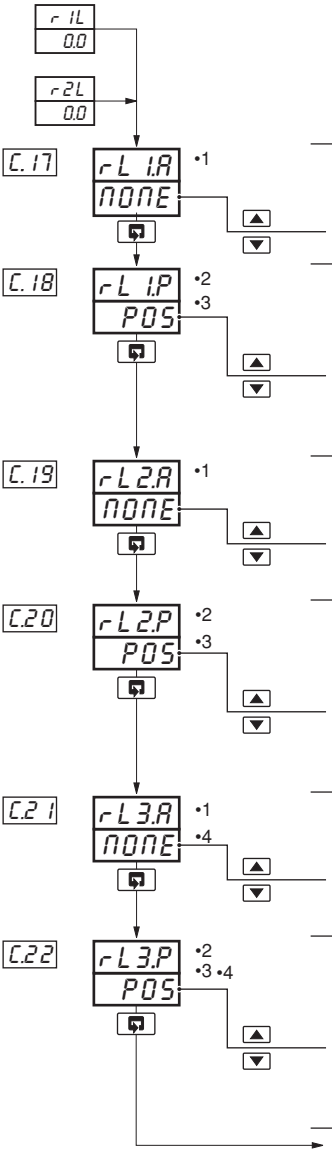
Continued…

•1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 5.2, Basic Configuration/ Control Output Type.

•2 Not applicable if analog output 2 is assigned to a control output.

5.8.4 Relay Outputs 1 to 4

C17...C22



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.

Continued…

•1 If the output is assigned to a control output by the control type, the setting displayed cannot be changed – see Section 5.2, Basic Configuration/ Control Output Type.

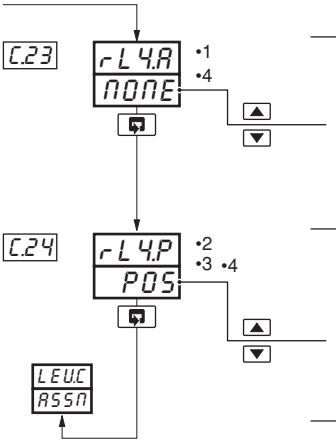
•2 Not displayed if relay is assigned to a control output signal.

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

•4 Displayed only if optional relay ouput is fitted.

…5.8.4 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 5.2, Basic Configuration/ Control Output Type.

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

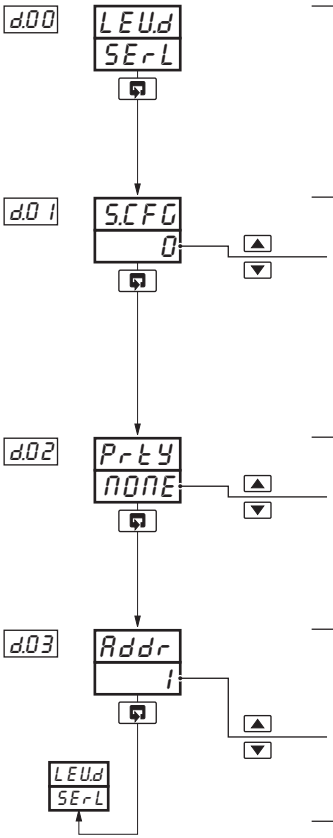
•3 Not applicable if relay is assigned to a control output.

•4 Displayed only if relay ouput is fitted.

5.9 Level D – Serial Communications Configuration

d.00...d.03

Note. Level D is applicable only 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
EUEN – Even

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

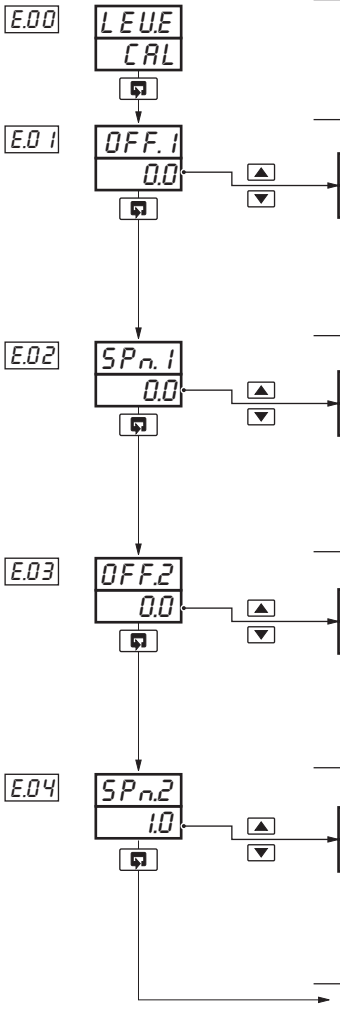
[1 to 99]

Return to top of page.

5.10 Level E – Calibration

E.00...E.04

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

100.3 — Analog Input 1 Value in Engineering Units

0.0 — 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

100.3 — Analog Input 1 Value in Engineering Units

0.0 — 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

100.3 — Analog Input 2 Value in Engineering Units

0.0 — 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

100.3 — Analog Input 2 Value in Engineering Units

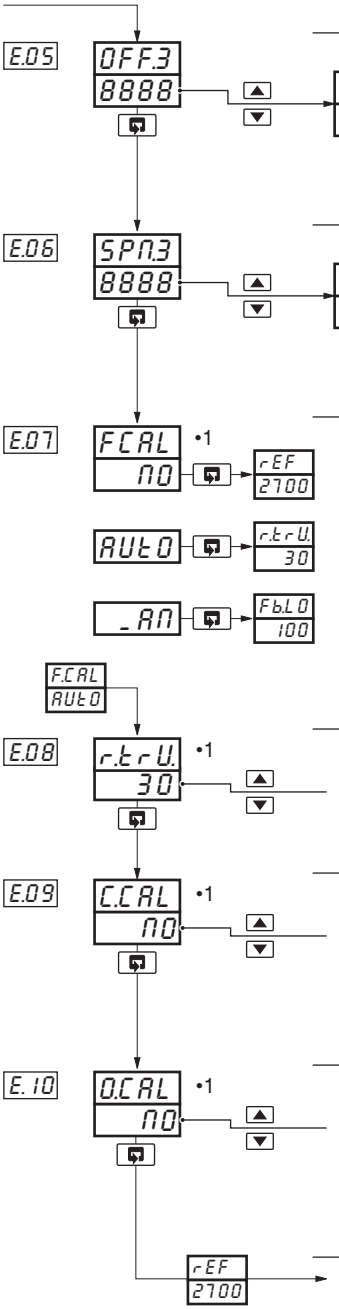
0.0 — Span Adjustment [0.750 to 1.250]

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

Continued…

...5.10 Level E – Calibration

E.05...E.10



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.

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.

Position Feedback Calibration

Select the calibration required.

no – No Calibration
AUtO – Auto Calibration
_An – Manual Calibration

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.

Motorized Valve Feedback – Fully-closed Position

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

Note. Input value flashes when calibration is in progress.

Motorized Valve Feedback – Fully-open Position

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

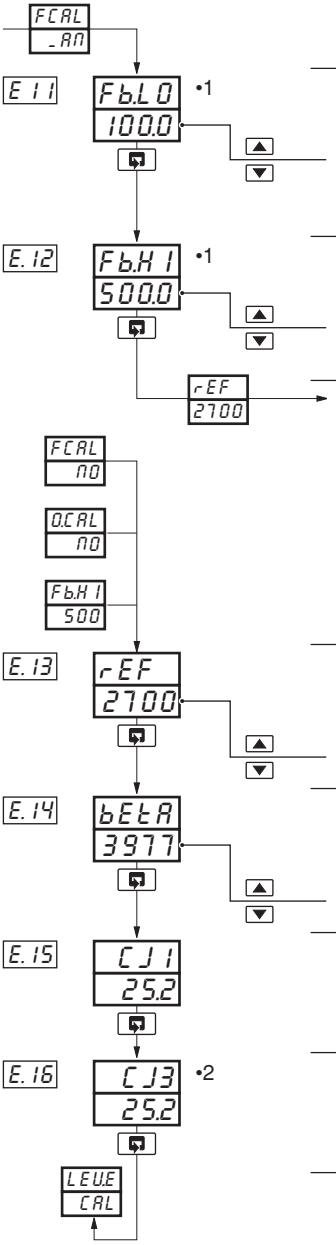
Note. Input value flashes when calibration is in progress.

Continued in **Cold Junction Reference Value** frame.

•1 Displayed only if Motorized Valve with feedback output type is selected – see Section 5.2, Basic Configuration.

…5.10 Level E – Calibration

E.11 …E.16



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 be changed only 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 be changed only 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 5.2, Basic Configuration.

•2 Displayed only if corresponding input is a Thermocouple input.

EC Directive 89/336/EEC

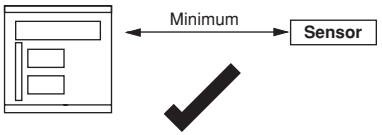
In order to meet the requirements of the EC Directive 89/336/EEC for EMC regulations, this product must not be used in a non-industrial environment.

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

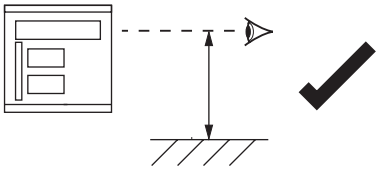
End of Life Disposal
This instrument does not contain any substance that will cause undue harm to the environment. However, the unit contains a small lithium battery. This should be removed and disposed of responsibly in accordance with local environmental regulations. The remainder of the unit can be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

6.1 Mechanical Installation

6.1.1 Siting – Figs. 6.1 and 6.2



A – Close to Sensor



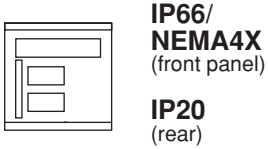
B – At Eye-level Location

C – Avoid Vibration

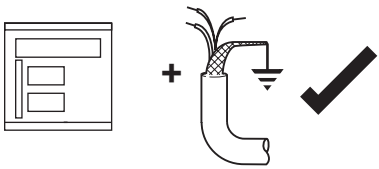
Fig. 6.1 General Requirements

A – Within Temperature Limits

B – Within Humidity Limits



C – Within Protection Rating Limits



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.

D – Use Screened Cables

Fig. 6.2 Environmental Requirements

6.1.2 Mounting – Figs. 6.3 to 6.5

The instrument is designed for panel mounting (Fig. 6.4). Overall dimensions are shown in Fig. 6.3.

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

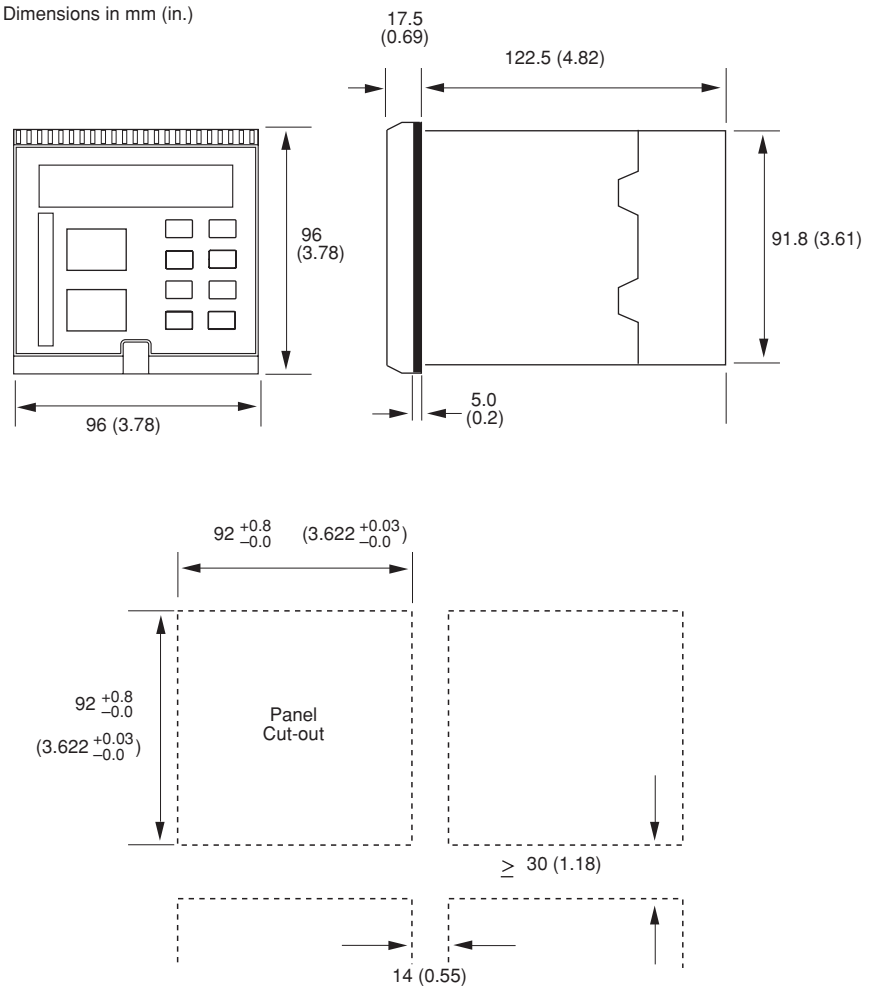


Fig. 6.3 Overall Dimensions

...6.1.2 Mounting – Figs. 6.3 to 6.5

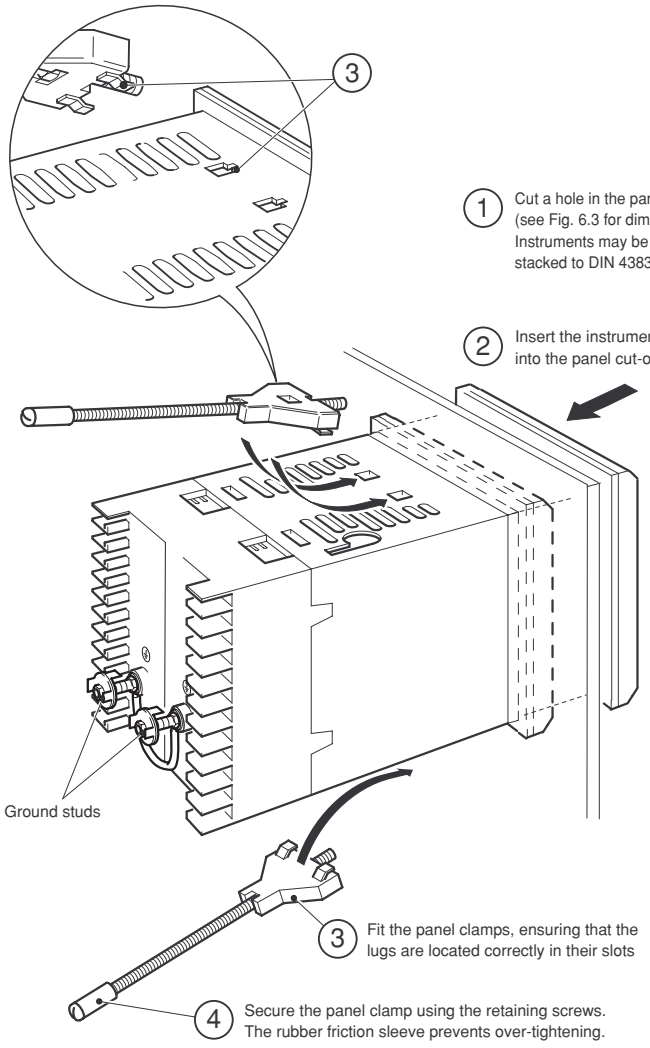
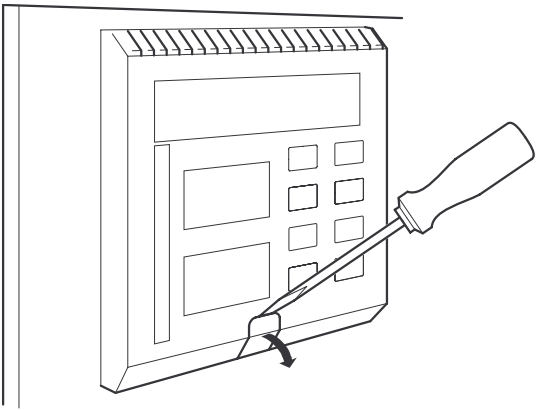
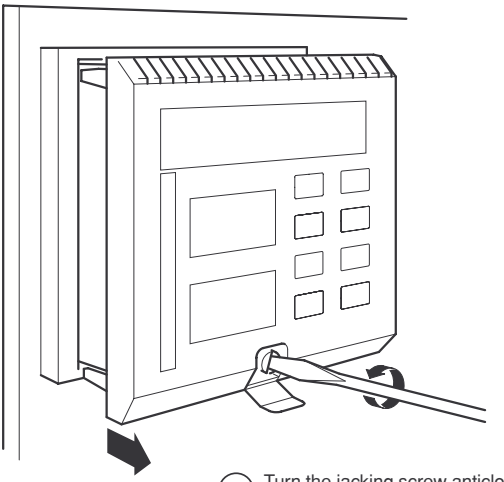


Fig. 6.4 Mounting

…6.1.2 Mounting – Figs. 6.3 to 6.5



(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. 6.5 Inserting/Removing the Instrument from the Case

6.2 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 (2.5mm^2).
- 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. 6.4.
- The battery is a 3V non-replaceable lithium cell.

This equipment is protected through double insulation (Class II).

6.2.1 Electrical Connections – Figs 6.6 to 6.8

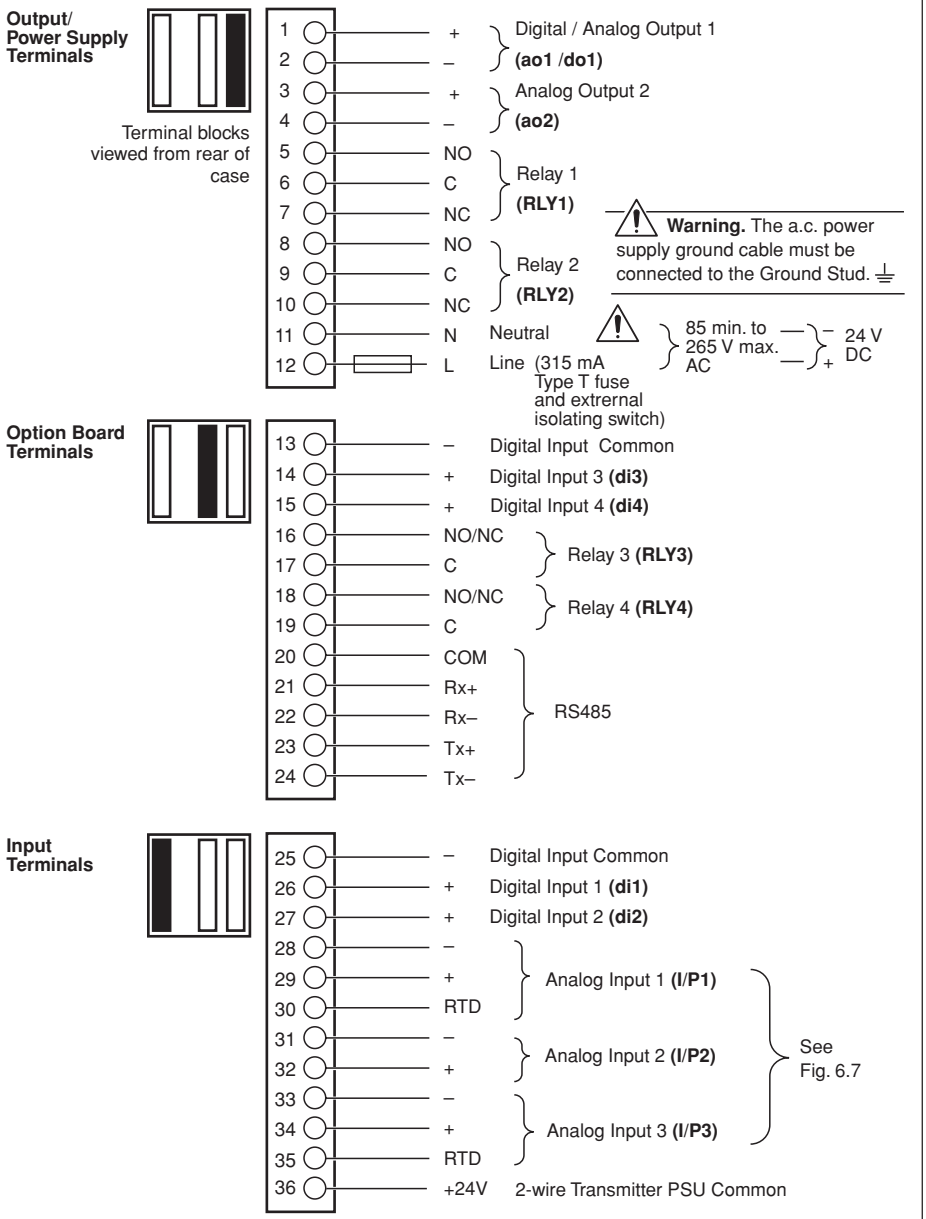
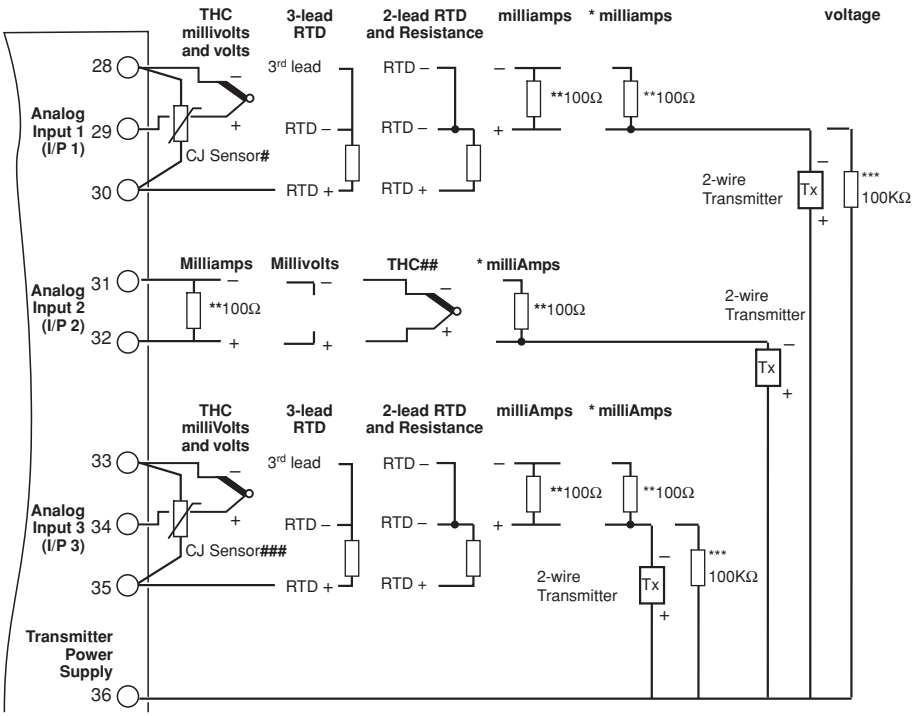


Fig. 6.6 Electrical Connections – General

...6.2.1 Electrical Connections – Figs 6.6 to 6.8



* 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. 6.7 Electrical Connections – Analog Inputs

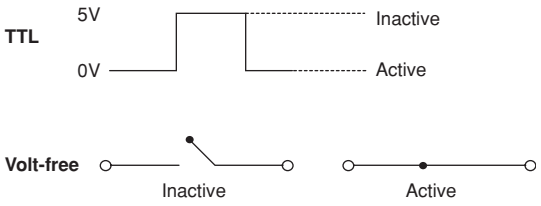


Fig. 6.8 Electrical Connections – Digital Inputs

Note. The battery is a 3 Volt non-replaceable lithium cell.

6.3 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.

6.3.1 Setting the Relay Links – Fig. 6.9

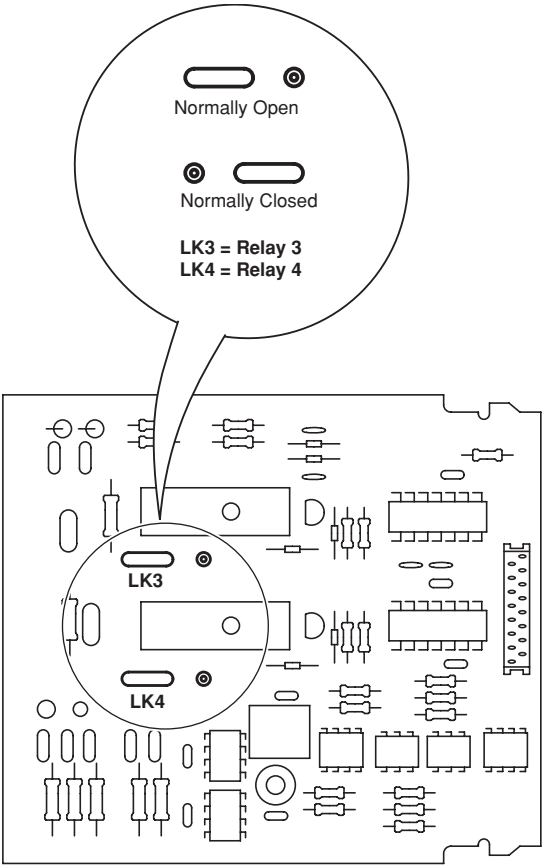
Set the links on the option board (if fitted).

6.4 Digital Output

15 V DC min. at 20 mA
Min. load 750 Ω

6.5 Control or Retransmission Analog Output

Max. load 15 V (750 Ω at 20 mA).
Isolated from analog input, dielectric strength 500V for 1 minute.

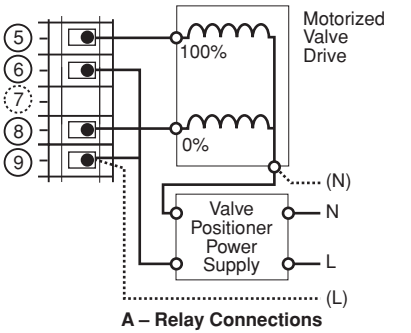


Note. The default setting for the relay links is 'Normally Open' (N/O).

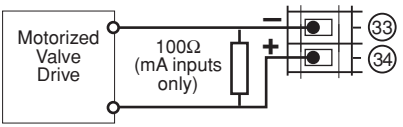
Fig. 6.9 Relay Links

6.6 Motorized Valve Connections – Fig. 6.10

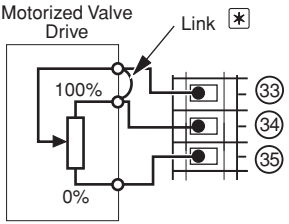
Note. Relays used to drive the motorized valve must be set for 'Normally Open' operation – see Section 6.3.1.



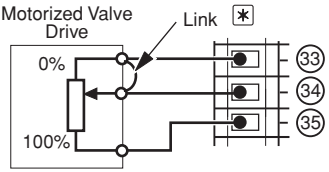
A – Relay Connections



B – Feedback Connections (V, mA or mV Input Types)



C – Feedback Slidewire Connection



D – Alternative Feedback Slidewire Connection

Note. The wire link must be connected at the motorized valve end, NOT to the instrument terminals.

Fig. 6.10 Motorized Valve Connections

6.7 Input Connections

Make connections to each input – see Fig 6.7.

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

6.7.1 Thermocouple (THC) Inputs

Note. Use the correct compensating cable between the THC and the terminals – see Table 6.1.

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. 6.11.

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. 6.12.

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 possible only via the PC Configurator.

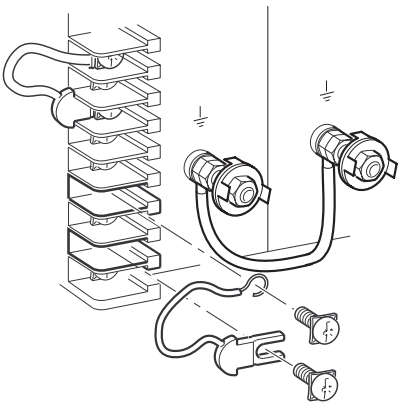


Fig. 6.11 CJ Sensor – Connections

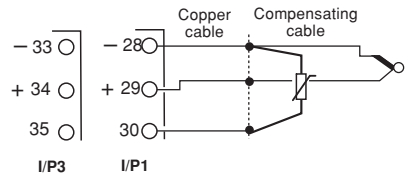


Fig. 6.12 Remote-mounted CJ Sensor – Connections

6.7.2 3-lead Resistance Thermometer (RTD) Inputs

The three leads must have equal resistance, not exceeding 30Ω each.

6.7.3 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.

6.8 Output Connections

Make connections as shown in Fig 6.6.

Refer to Table B on the rear fold-out for the default output assignment settings.

6.9 Power Supply Connections

Warning.

- A 315 mA Type T fuse must be fitted in the live (+ve) supply line.
- The ground line must be connected to the ground studs on the terminal block – see Fig. 6.6.
- Do not disturb the link between the two ground studs.
- The type of power supply required (AC or DC) is stated at the time of order and can be identified from the instrument code number:
  C35X/XX0X/STD = 100 to 240 V AC
  C35X/XX1X/STD = 24 V DC

Type of Thermo-couple	Compensating Cable											
	BS1843			ANSI MC 96.1			DIN 43714			BS4937 Part No.30		
	+	–	Case	+	–	Case	+	–	Case	+	–	Case
Ni-Cr/Ni-Al (K)	Brown	Blue	Red	Yellow	Red	Yellow	Red	Green	Green	Green	White	Green *
Nicrisil/Nisil (N)	Orange	Blue	Orange	Orange	Red	Orange	—			Pink	White	Pink *
Pt/Pt-Rh (R and S)	White	Blue	Green	Black	Red	Green	Red	White	White	Orange	White	Orange *
Pt-Rh/Pt-Rh (B)	—			—			—			Grey	White	Grey *
Cu/Cu-Ni (T)	White	Blue	Blue	Blue	Red	Blue	Red	Brown	Brown	Brown	White	Brown *
Fe/Con (J)	Yellow	Blue	Black	White	Red	Black	Red	Blue	Blue	Black	White	Black *
* Case Blue for intrinsically safe circuits												
Fe/Con (L) (DIN 43710)	—			—			DIN 43710			—		
							Blue/ red	Blue	Blue			

Table 6.1 Thermocouple Compensating Cable

SPECIFICATION

Summary

17 application templates: Single loop, Cascade, Feedforward, Ratio, Auto/Manual

Two Autotune options

Control Efficiency Monitor (CEM)

30 segments, 9 profiles

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, Cascade*, Feedforward, Ratio

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

30 segments, 9 profiles

Configured Outputs

Three preset output values, selectable via digital signals

Autotune

On demand for 1/4 wave or minimal overshoot

Process Alarms

Number	8
Types	High/low process, High/low output, High/low deviation
Hysteresis	Level and time**
Alarm enable/disable	Enable/disable of alarms via digital signal

Real Time Alarms**

Number	2
Programmable	On time/day and duration

* Motorized valve without feedback output is not available with the Cascade template.

** 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 (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	100 Ω
mV, V	10 MΩ

Broken Sensor Protection

Programmable for upscale or downscale drive

Sample Interval

125 ms (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	>120 dB at 50/60 Hz with 300 Ω imbalance resistance
Series mode rejection	>60 dB at 50/60 Hz

Transmitter Power Supply

Voltage	24 V DC nominal
Drive	Up to 60 mA, (3 loops)

EMC

Emissions and Immunity

Meets requirements of IEC 61326 for an Industrial Environment

Design & manufacturing standards

CSA/UL General Safety

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

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 20 mA (programmable), max. 750 Ω
	accuracy 0.25 %
Digital voltage	17 V @ 20 mA

Relay Outputs

Number	2 standard,
Type	SPCO, rated 5 A at 115/230 V AC

Digital Inputs

Number	2 standard,
Type	Volt-free
Minimum pulse	200 ms

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 5 A at 115/230 V AC

Digital Inputs

Number	2
Type	Volt-free
Minimum pulse	200 ms

Serial Communications

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

Physical

Size

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

Weight

680 g (1.5 lb)

Electrical

Voltage

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

24 V DC

Power consumption

15 VA max.

Power interruption protection

Up to 60 ms

Safety

General safety EN 61010-1

Isolation

All inputs/outputs to earth: 500 V DC

Analog/Digital output 1 to rest of the circuitry:

500 V DC for 1 minute

Analog/Digital output 2 to rest of the circuitry:

500 V DC for 1 minute

Serial communications to rest of the circuitry:

500 V DC for 1 minute

Environmental

Operating Limits

0° to 55 °C (32 ° to 130 °F)

5 to 95 %RH (non-condensing)

Temperature stability

<0.02 %/°C or 2 µV/°C (<0.011 %/°F or 1.11 µV/°F)

Long term drift <0.02 % of reading or 20 µV annually

Front face

NEMA4X (IP66)

Standard Analog Input Ranges

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

* For B, R and S thermocouples, accuracy is not guaranteed below value stated

Min. span below zero Type T 70 °C (126 °F)
Type N 105 °C (189° F)

THC standards DIN 43710
IEC 584

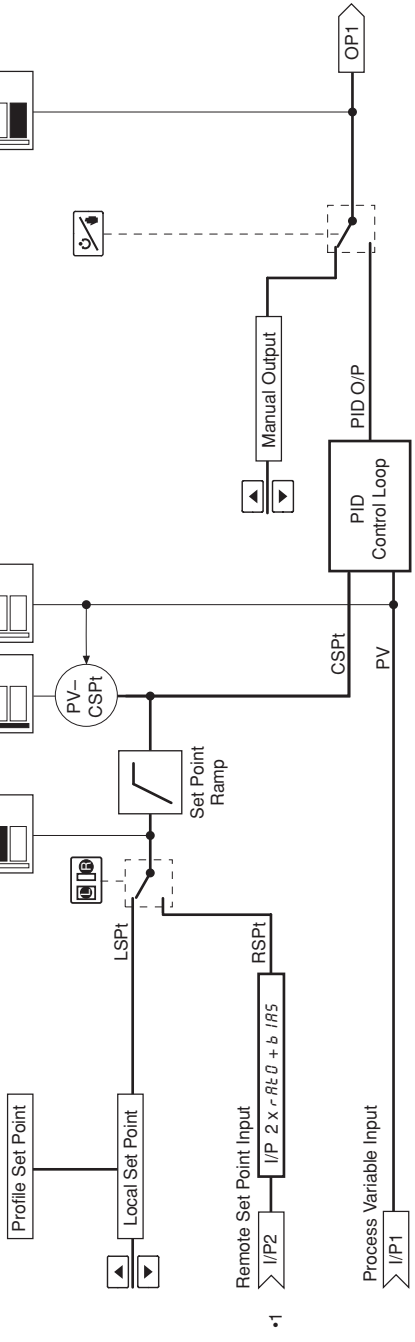
RTD	Maximum Range °C	Maximum Range °F	Accuracy (% of reading)**
Pt100	–200 to 600	–325 to 1100	0.1 % or ±0.5 °C (0.9 °F)

** RTD, 3-wire platinum, 100 Ω per DIN 43760 standard (IEC 751), with range of 0 to 400 Ω

Linear Inputs	Range	Accuracy (% of reading)
Millivolts	0 to 500 mV	0.1 % or ±10 µA
Milliamps	0 to 50 mA	0.2 % or ±2 µA
Volts	0 to 5 V	0.2 % or ±2 mV
Resistance	0 to 5000 Ω	0.2 % or ±0.08 Ω

A1 Single Loop Controller (Templates 1 and 2)

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, a value from a remote source or a value derived by the profile control algorithm.



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.

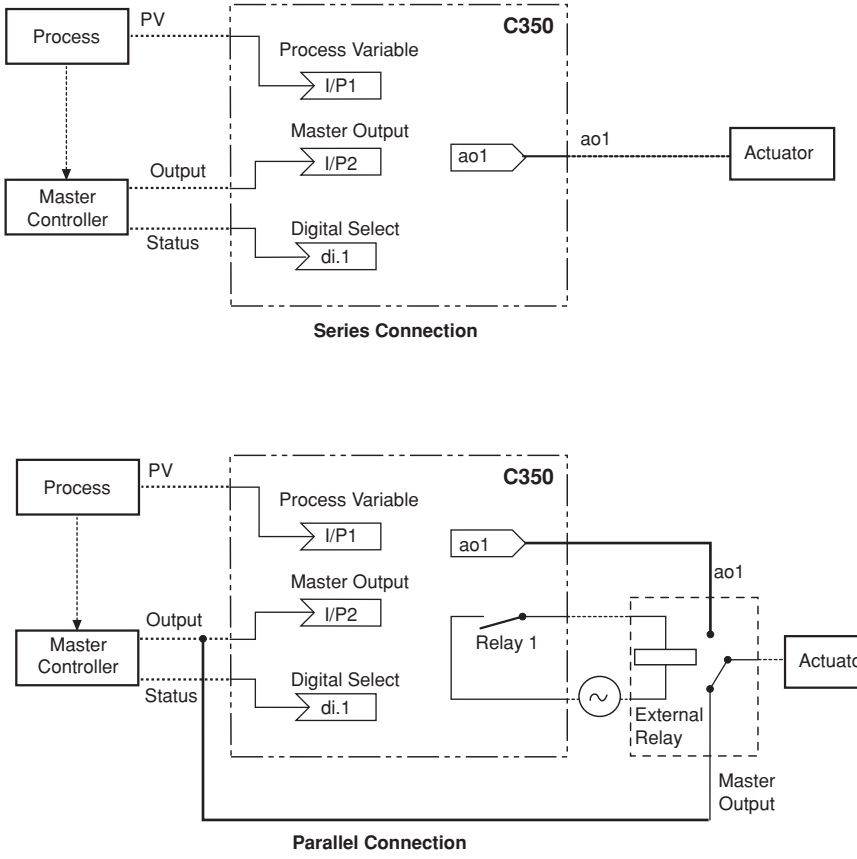
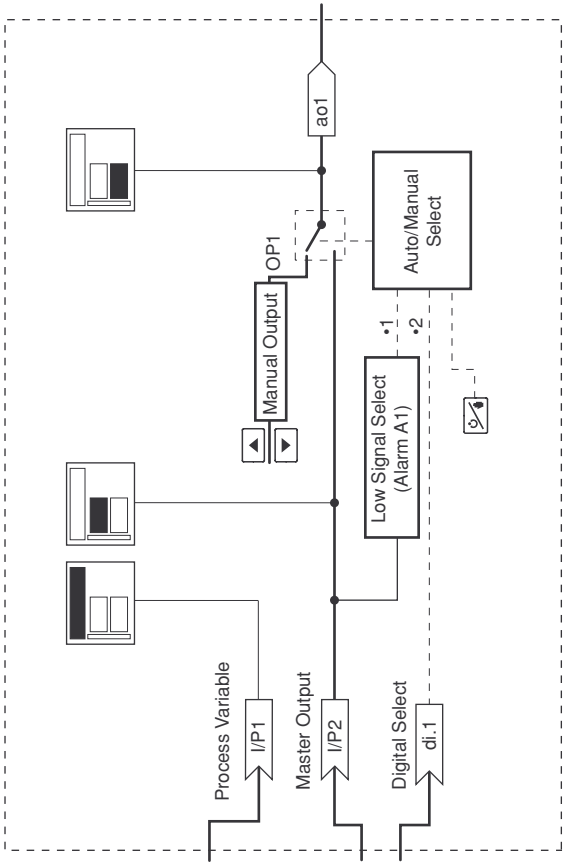


Fig. A1 Series and Parallel Operation

...A2.2 Auto/Manual Station (Templates 3 and 4)

The **Auto/manual Station** provides a backup for a Master controller. In normal operation the C350'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 C350 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 C350 switches back to auto mode (i.e. C350 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 C350 to energize an external relay (with suitable changeover contacts for switching low level signals) which selects the output to be routed to the actuator.

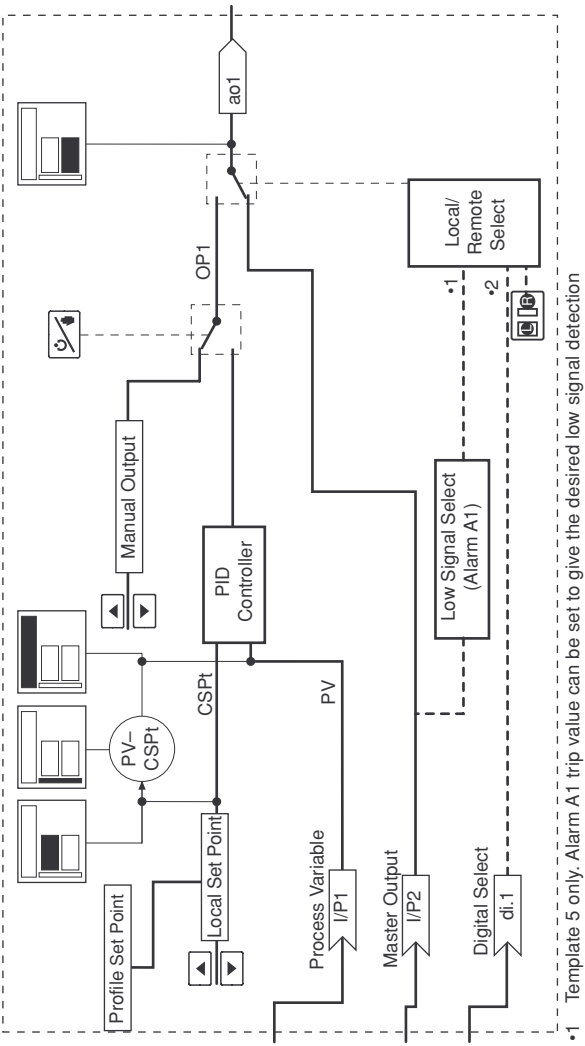


•1 Template 3 only. Alarm A1 trip value can be set to give the desired low signal detection
•2 Template 4 only

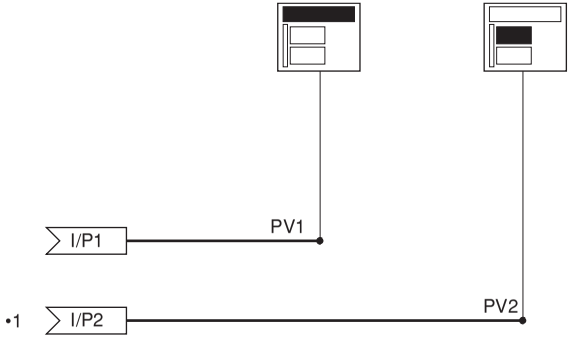
A2.3 Analog Backup (Templates 5 and 6)

The **Analog Backup** provides a backup for a master controller. In normal operation (remote control mode selected) the C350'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 C350 switches into local control mode and the process is controlled by the PID output of the C350. The C350 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 C350 switches back to remote control mode (i.e. C350 output = master output).

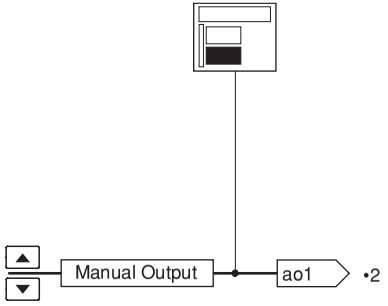
The analog backup station can be used in series or in parallel with the master output signal. (See Fig. A1). Parallel operation is achieved by using relay 1 in the C350 to energize an external relay (with suitable changeover contacts for switching low level signals) which selects the output to be routed to the actuator.



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.



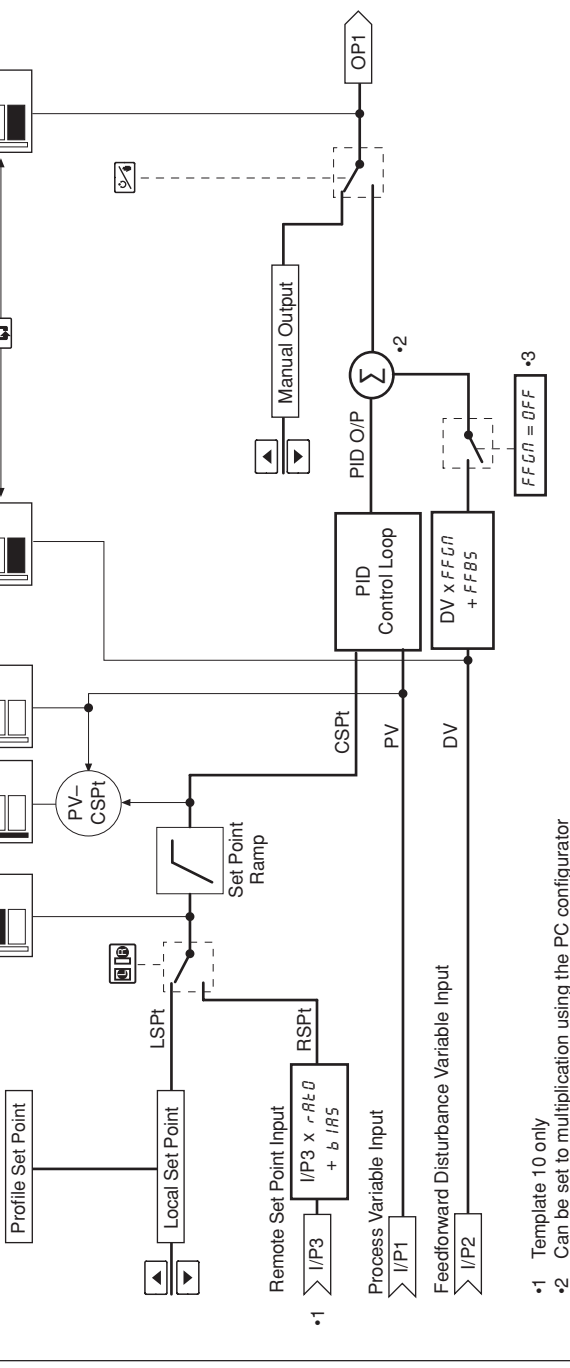
•1 Template 8 Only



•2 Not applicable if Control Output Type is set to 'None' – see Section 4.2/Basic Configuration.

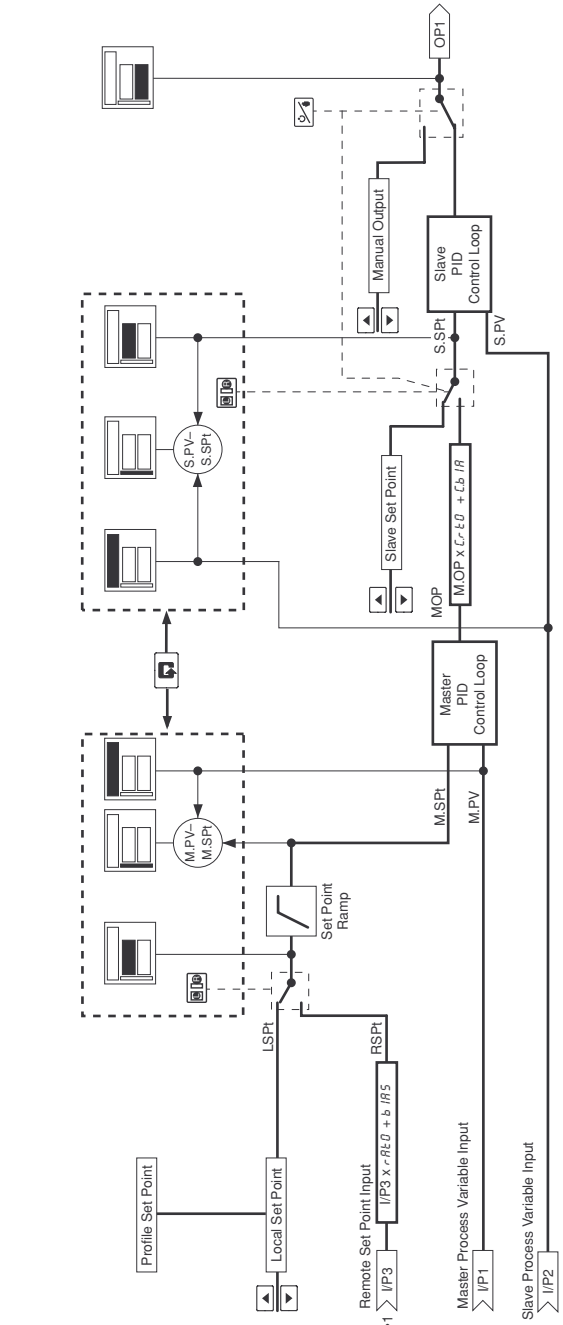
A4 Single Loop Controller with Feedforward (Templates 9 and 10)

Single Loop Controller with Feedforward. A disturbance variable is weighted by the feedforward gain (*FFGn*) and the feedforward bias (*FFbs*) values and then added to the controller output value. Multiplication of the feedforward signal with the control output (instead of addition) can be selected using the configurator. When in Manual mode, the PID output tracks the difference between the control output value and the feedforward signal, to ensure bumpless transfer back to auto mode.



A5 Cascade Controllers (Templates 11 and 12)

Cascade Controller. Two PID controllers are used with the first (master) controller providing the set point for the second (slave) controller. The two controllers are linked internally. The master output can be weighted using the cascade ratio (*Cr.to*) and bias (*Cb.id*) values to create the slave set point value. When the auto/manual mode is changed (from the front panel or by a digital signal) both the master and slave controllers change mode. In manual the slave set point can be adjusted by the user and the value is tracked by the master controller to ensure bumpless transfer back into auto. The slave can also be taken out of cascade mode by selecting local mode using the front panel key (when slave values are displayed).



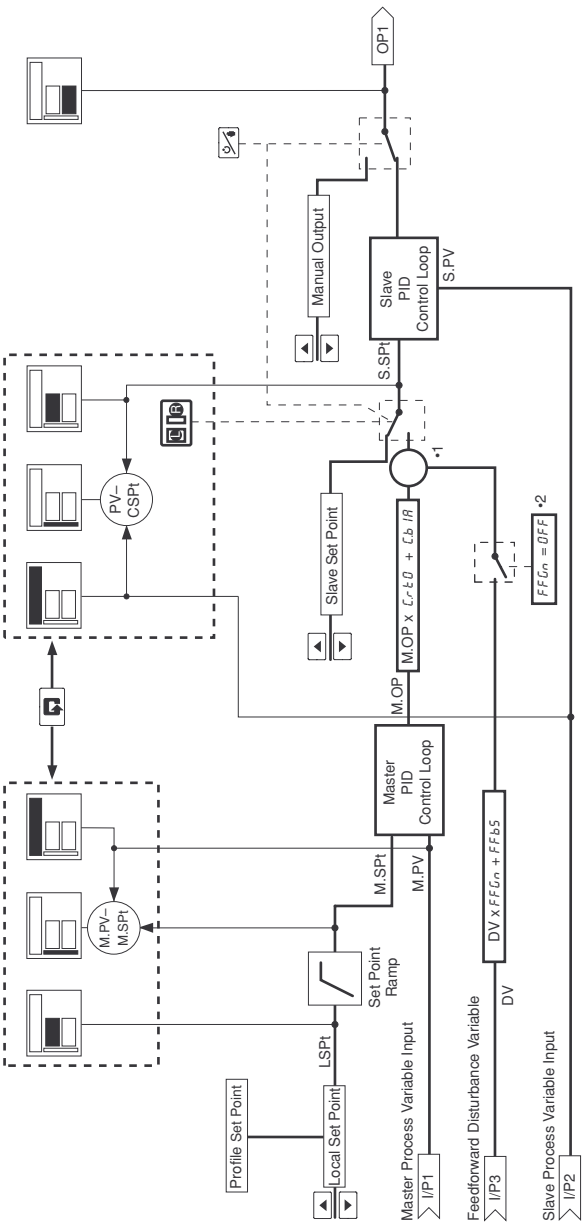
Note. It is not possible to have Motorized Valve without feedback on a Cascade template (templates 11 & 12)

•1 Template 12 only

A6 Cascade Controller with Feedforward (Template 13)

Note. This template cannot be used for heat/cool or boundless control

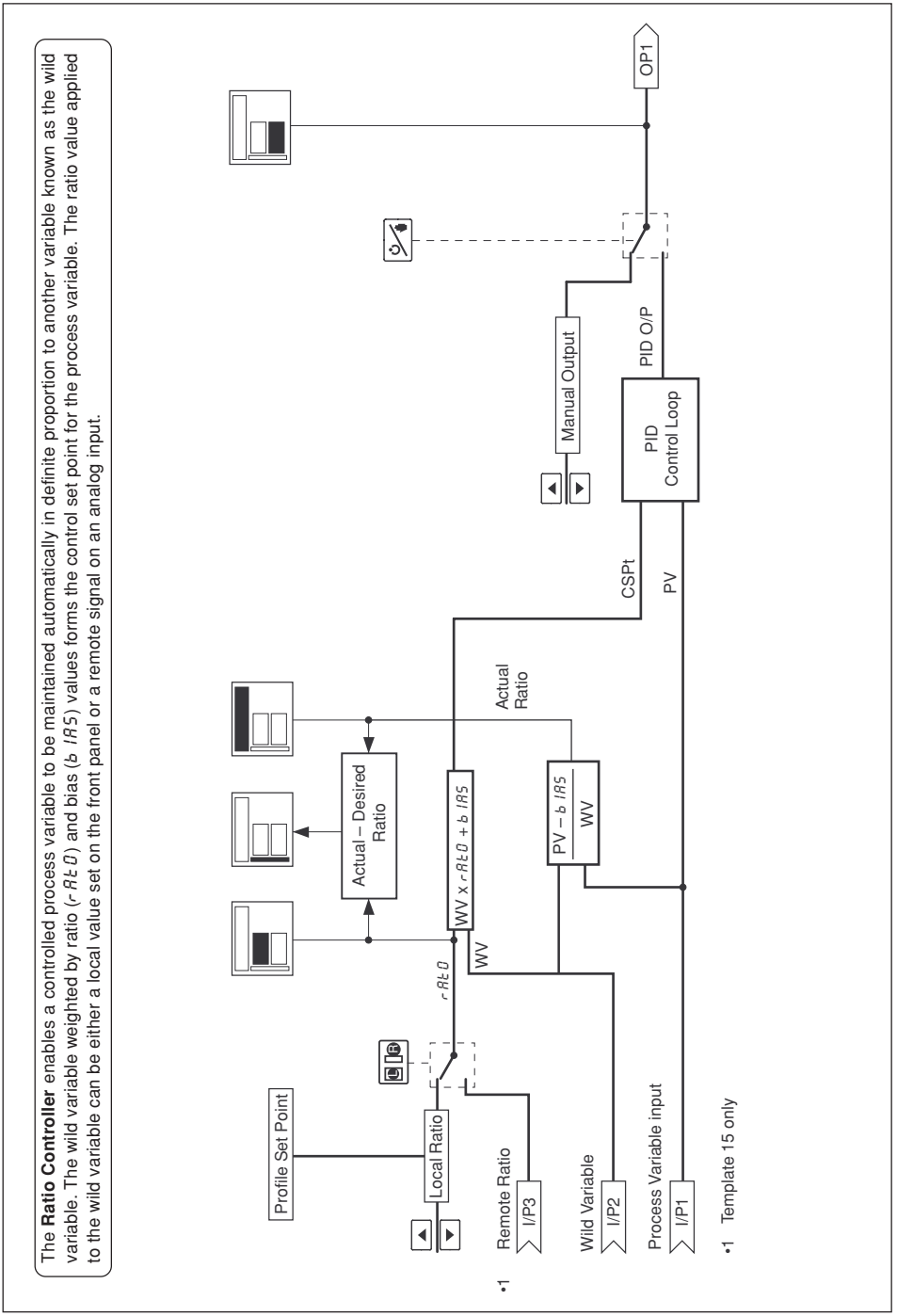
Cascade with Feedforward Control. Two PID controllers are implemented within the C350 with the first (master) controller providing the set point for the second (slave) controller. The two controllers are linked internally. To the master output (slave set point) a feedforward signal is added. This signal is a disturbance variable which is weighted by the feedforward gain (*FFGn*) and the feedforward bias (*FFbS*) values. When the auto/manual mode is changed (from the front panel or by a digital signal) both the master and slave controllers change mode. In manual the slave set point can be adjusted by the user and the value is tracked by the master controller (taking account of the feedforward signal) to ensure bumpless transfer back into auto. The slave can also be taken out of cascade mode using the front panel A/M switch (when the slave values are displayed).



•1 The feedforward signal can be multiplied by the control output (instead of added) using the PC configurator
•2 Feedforward operation is disabled by setting *FFGn* to *OFF*

A7 Ratio Controller (Templates 14 and 15)

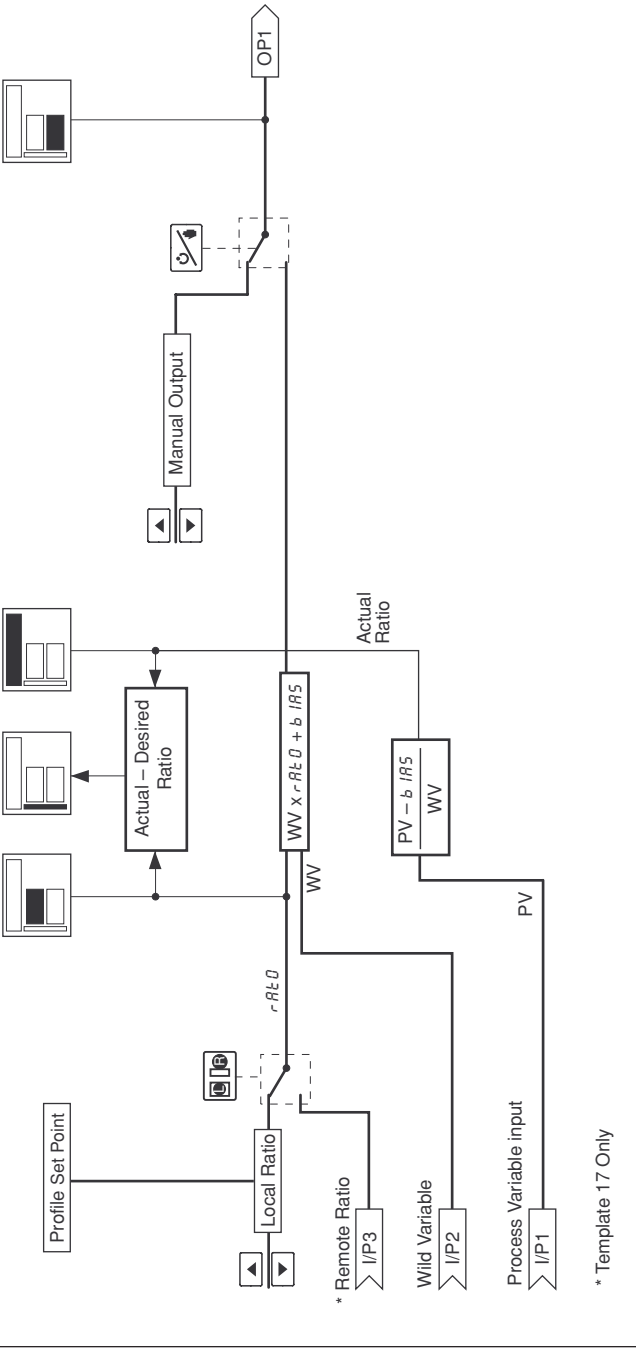
The **Ratio Controller** enables a controlled process variable to be maintained automatically in definite proportion to another variable known as the wild variable. The wild variable weighted by ratio (*rAtO*) and bias (*bIAS*) values forms the control set point for the process variable. The ratio value applied to the wild variable can be either a local value set on the front panel or a remote signal on an analog input.



A8 Ratio Station (Templates 16 and 17)

The **Ratio Station** provides a set point for a subsequent slave controller. The wild variable is weighted by ratio (*rAtO*) and bias (*bIAS*) values and is then retransmitted as an analog output value. The ratio value applied to the wild variable can be either a local value set on the front panel or a remote signal on an analog input.

The actual ratio of the process variable to the wild variable is also displayed.



APPENDIX B – PC CONFIGURATION EDITOR

B1 Introduction

Using the PC Configurator the C350 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:

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

B4 Six Logic Equations

Elements	Up to 15 per equation
Operators	Up to 7 per equation: OR, AND, NOR, NAND, NOT, EXOR
Operands	Up to 8 per equation: any digital signal. The NOT operator can be used to invert digital signals.

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

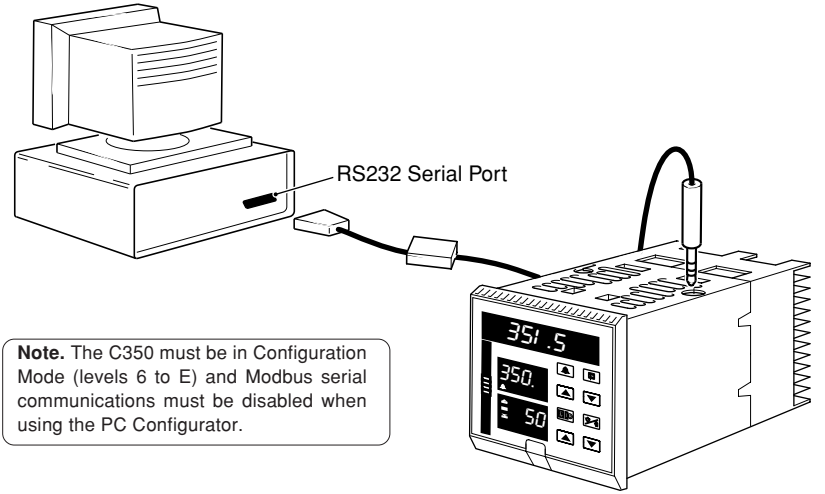
B9 Template Customization

Each template can be customized by changing the sources for various functions in the C350. This allows math 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
- disturbance variable inputs
- input to feedforward block
- feedforward term: add to or multiply with PID O/P

B10 Connecting the PC Configurator



Note. The C350 must be in Configuration Mode (levels 6 to E) and Modbus serial communications must be disabled when using the PC Configurator.

Fig. B1 Connecting the PC Configurator

FRAMES INDEX

Profile Frames

Set Up Frames

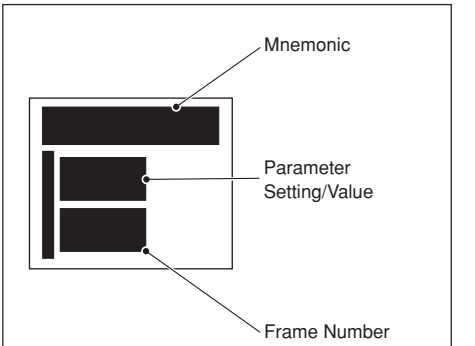


Fig. I.1 Parameter Identification

Configuration Frames

...Configuration Frames

Frame Title	Mnemonic	Number
L		
Level Heading	LEU.1	7.00
Local Set Point Source	LC.Sr	9.13
Local/Remote Enable	FPLr	b.02
Local/Remote Set Point Source	Lr.Sr	9.12
M		
Mains Rejection	F.rEJ	6.06
Man/Auto Selection Source	A_.Sr	A.16
Manual 1 Selection Source	_.Sr 1	A.12
Manual 2 Selection Source	_.Sr2	A.14
Minute Setting (Clock)	_ 1M	b.14
MV Calibration selection	FCAL	E.07
MV Feedback – closed	C.CAL	E.09
MV Feedback – open	O.CAL	E.10
Modbus Address	Addr	d.03
Modbus Parity	PrtY	d.02
O		
O/P Low Limit	OP.LO	A.06
O/P High Limit	OP.H 1	A.05
OP 1 High Limit	OP 1H	A.07
OP 2 High Limit	OP2H	A.08
OP 2 Low Limit	OP2L	A.09
Operator Configuration	LEU.b, OPEr	b.00
Output Assignment	LEU.C, ASSn	C.00
Output Slew Rate	OP.Sr	A.10
Output Slew Rate Disable	SrdS	A.11
Output Type	O.tYP	6.02
P		
Power Fail Recovery Mode	P.rEC	A.01
Power Fail Recovery Time	rEC.t	A.02
Process Variable Fail Action	PU.FA	A.03
PV Fail Default Output	dF.OP	A.04
Profile Operator Password	O.PAS	b.08
Profile Configurator Password	P.PAS	b.09
R		
Ramp/Soak enable	rP.SE.	9.15
Ratio Display Enable	r.d IS	b.05
Regulator Travel Time	r.trU.	E.08
Relay 1 Polarity	rL 1P	C.18
Relay 1 Source	rL 1A	C.17
Relay 2 Polarity	rL2P	C.20
Relay 2 Source	rL2A	C.19
Relay 3 Polarity	rL3P	C.22
Relay 3 Source	rL3A	C.21
Relay 4 Polarity	rL4P	C.24
Relay 4 Source	rL4A	C.23
Remote Set Point Source	r.SrC	9.14
RSPT Fault Action	SP.FA	9.06

Frame Title	Mnemonic	Number
S		
Serial Communications	LEU.d	d.00
Serial Configuration	S.CFG	d.01
Set Point Configuration	LEU.9, SEt.P	9.00
Set Point 1 Source	L.Sr.1	9.08
Set Point 2 Source	L.Sr.2	9.09
Set Point 3 Source	L.Sr.3	9.10
Set Point 4 Source	L.Sr.4	9.11
Set Point Default Value	dF.SP	9.07
Set Point High Limit	SPt.H	9.02
Set Point Low Limit	SPt.L	9.03
Set Point Tracking	trCH.	9.01
Set up Password	S.PAS	b.10
Slave Set Point High Limit	SSP.H	9.04
Slave Set Point Low Limit	SSPL	9.05
Set Point Adjust Disable	S.AdJ	b.04
T		
Template Applications	t.APP	6.01
Time Display	t.CLH.	b.15
Tune Select Source 1	t 1Sr	A.19
Tune Select Source 2	t2Sr	A.20
Tune Select Source 3	t3Sr	A.21
Tune Select Source 4	t4Sr	A.22

INDEX

REFERENCE TABLES

Table A – Template Applications

Config. Display	Template Title	Analog Input 1 (I/P1)	Analog Input 2 (I/P2)	Analog Input 3 (I/P3)
1. SL	Single loop	Process Variable		Feedback †
2. SL	Single loop + Remote set point	Process Variable	Remote Set Point	Feedback †
3. A_	Auto/Manual station (low signal select)	Process Variable	Master Output	–
4. A_	Auto/Manual station (digital select)	Process Variable	Master Output	–
5. Ab	Analog backup (low signal select)	Process Variable	Master Output	–
6. Ab	Analog backup (digital select)	Process Variable	Master Output	–
7. In	Single indicator/manual loader	Process Variable	–	–
8. In	Double indicator/manual loader	Process Variable 1	Process Variable 2	–
9. FF	Single loop + Feedforward	Process Variable	Disturbance Variable	Feedback †
10. FF	Single loop + Feedforward + Remote set point	Process Variable	Disturbance Variable	Remote Set Point
11. CC	Cascade	Master PV	Slave PV	Feedback †
12. CC	Cascade + Remote set point	Master PV	Slave PV	Remote Set Point
13. CF	Cascade with Feedforward	Master PV	Slave PV	Disturbance Variable
14. rC	Ratio controller	Process Variable	Wild Variable	Feedback †
15. rC	Ratio controller with remote ratio	Process Variable	Wild Variable	Remote ratio
16. rS	Ratio station	Process Variable	Wild Variable	–
17. rS	Ratio station with external ratio	Process Variable	Wild Variable	Remote ratio

† Motorized Valve output types only

Table B – Output Sources

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

Setting	Output Type	Relays				Analog Outputs		Digital Output
		Rly 1	Rly 2	Rly 3	Rly 4	ao1	ao2	do1
NONE	None	–	–	–	–	–	–	–
ANLG	Analog Output	Alm1#	Alm 2	Alm 3	Alm 4	**OP1**	PV	–
rLY	Relay Output	**OP1**	Alm 1#	Alm 2	Alm 3	PV	CSPT	–
d IG	Digital Output	Alm 1	Alm 2	Alm 3	Alm 4	OP1	PV	**OP1**
PFb	Motorized valve with FB	**OPEN**	**CLOSE**	Alm 1	Alm 2	PV	CSPT	–
bnd	Motorized valve without FB	**OPEN**	**CLOSE**	Alm 1	Alm 2	PV	CSPT	–
HC.rr	Heat/Cool	**OP1** (Heat)	**OP2** (Cool)	Alm 1	Alm 2	PV	CSPT	–
HC.rd	Heat/Cool	**OP1**	Alm 1	Alm 2	Alm 3	–	PV	**OP2**
HC.dr	Heat/Cool	**OP2**	Alm 1	Alm 2	Alm 3	–	PV	**OP1**
HC.Ar	Heat/Cool	**OP2**	Alm 1	Alm 2	Alm 3	**OP1**	PV	–
HC.AA	Heat/Cool	Alm 1	Alm 2	Alm 3	Alm 4	**OP1**	**OP2**	–

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

Alm = Alarm
Rly = Relay
ao1 = Analog Output1
ao2 = Analog Output2

do1 = Digital Output 1
OP1, 2 = Output 1, 2
PV = Process Variable RTX
CSPT = Set Point RTX

Table C – Digital Sources

Source Type	Display	Description
Control Outputs	OP 1	Control output 1 (heat)
	OP 2	Control output 2 (cool)
	OPEN	Motorized valve Open Relay
	CLSE	Motorized valve Close Relay
Process Alarms	A 1	Alarm 1 active
	:	:
	A8	Alarm 8 active
Alarm Acknowledge	ACK.1	Alarm 1 acknowledge
	:	:
	ACK8	Alarm 8 acknowledge
Digital inputs	DG1	Digital input 1 active
	:	:
	DG4	Digital input 4 active
Control Modes	_AM	Manual mode selected
	AUt	Auto mode selected
	LOC	Local set point/ Local control selected
	rE_	Remote set point/ Remote control selected
Failure States	F.IN.1	Input 1 failed
	F.IN.2	Input 2 failed
	F.IN.3	Input 3 failed
	LbK1	Loop break - analog output 1
	dOG	Watchdog active
	PF	Power fail

Source Type	Display	Description
Logic Equations*	LG 1	Logic equation 1 true
	:	:
	LG 6	Logic equation 6 true
Timers	rt1	Real time alarm 1
	rt2	Real time alarm 2
	dt1	Delay timer 1
	dt2	Delay timer 2
Modbus Signals	_b.1	Modbus Signal 1
	:	:
	_b.2	Modbus Signal 2
Other	ON	Always enabled
Profile States	t.EU.1	Time Event 1 Active
	:	:
	t.EU.4	Time Event 4 Active
	P.End	End of Profile Event
	PrG.1	Program 1 Event
	:	:
	PrG.9	Program 9 Event
	SG. 1	Segment 1 Event
	:	:
	SG.30	Segment 30 Event
	rUN	Program Running
	H.HLd	'Holdback' Program Hold
	O.HLd	Operator Program Hold
	ON	Digital Output On

* The default factory setting 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 states

LG5 – The OR of the second four alarm states

LG6 – The OR of the input fail states

Table D – Analog Sources

Display	Description
OP 1	Control output 1 (heat)
OP2	Control output 2 (cool)
PU.	Process variable 1
PU.2	Process variable 2
_PU.	Master process variable
S.PU.	Slave process variable
I/P 1	Analog input 1
I/P2	Analog input 2
I/P3	Analog input 3
CSPt	Control setpoint
rSPt	Remote setpoint
LSP 1	Local setpoint 1
LSP2	Local setpoint 2
LSP3	Local setpoint 3
LSP4	Local setpoint 4

Display	Description
SSPt	Slave setpoint
dEU.1	PID (master loop) deviation (PV – setpoint)
dEU.2	PID (slave loop) deviation (PV – setpoint)
AU.P	Actual valve position
bLM.1	Math block 1 output
bLM.2	Math block 2 output
bLM.3	Math block 3 output
bLM.4	Math block 4 output
CUS.1	Custom linearizer 1 output
CUS.2	Custom linearizer 2 output
PID.1	PID block (master loop) output
PID.2	PID block (slave loop) output
rb.	Remote set point ratio/bias
Crb.	Cascade ratio/bias output
FF	Feedforward block output

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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.
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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.

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