MODEL 2704 CONTROLLER

Engineering Handbook

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1. Chapter 1 INTRODUCTION

Thank you for selecting the 2704 High Performance Programmer/Controller. This chapter provides a general overview of your controller to help you to become more familiar with its use, and to ensure that it is the correct type for your process.

1.1. ABOUT THIS MANUAL

This manual is intended for those who wish to configure the controller.
Installation and operation of the controller is described in the Installation and Operation Manual Part No. HA026502 supplied with the controller.

Access to the parameters in the controller is achieved through five levels of security:-

Level 1	Operation only. This level allows, for example, parameters to be changed within safe limits or programmers to be run, held or reset.
Level 2	Supervisory level. This level allows, for example, parameter limits to be pre-set or programs to be edited or created. (Default Passcode = 2)
Level 3	Commissioning level. This level is intended for use when commissioning the instrument. It allows, for example, calibration offsets to be adjusted to match transducer and transmitter characteristics. (Default Passcode = 3)
View Config	It is possible also to read the configuration of the controller at any level but the configuration cannot be changed. (Passcode = 2704)
Config	Configuration of the controller allows you to set up the fundamental characteristics of the controller so that it can be made to match the requirements of the process. (Default Passcode = 4)

1.1.1. The Structure Of This Manual

This chapter provides an overview of the controller including the principle of the key handling and parameter navigation diagram.

Chapter 2 describes the principle of function blocks.

Chapter 3 explains how to wire function blocks using software wiring.

The remaining chapters provide the parameter tables with explanations of their meanings. These chapters follow the order in which the features appear in the pull out navigation at the end of this chapter.

1.2. WHAT IS 2704

The 2704 is a high accuracy, high stability temperature and process controller which is available in a single, dual or three loop format. It has a 120 x 160 pixel electroluminescent used to show all process information. The user interface is menu driven via the display and seven front panel keys.

When the 2704 is configured as a programmer it provides advanced programming facilities such as:

- storage of up to 50 programs.
- up to three variables can be profiled in each program, or one profile can be assigned to run in more than one loop.
- up to sixteen event outputs can be assigned to each program.

Special machine controllers can be created by connecting analogue and digital parameters to the control loops, either directly or by using a selection of mathematical and logical functions.

Figure 1-1: General View of 2704 Controller

Other features include:

- A wide variety of inputs which can be configured, including thermocouples, Pt100 resistance thermometers and high level process inputs.
- Direct connection of zirconia oxygen probes is also supported for use in heat treatment furnaces and ceramic kiln applications.
- Each loop can be defined to be PID, On/Off or motorised valve position and can control using a variety of strategies including single, cascade, override and ratio control.
- PID control outputs can be relay, logic, triac or dc with motorised valve position outputs being relay triac or logic.
- Auto tuning and PID gain scheduling are available to simplify commissioning and optimise the process

Configuration of the controller is explained in this Manual. Configuration is achieved either via the front panel operator interface or by using ‘iTools’ - a configuration package which runs under the Windows 95, or NT operating systems.

1.3. OPERATOR INTERFACE - OVERVIEW

The front panel of the 2704 consists of a 120 x 160 pixel electroluminscent display, and seven operator push-buttons. See Figure 1-2.

- The display is used to show the process conditions.
- The seven operator buttons allow adjustments to be made to the controller.

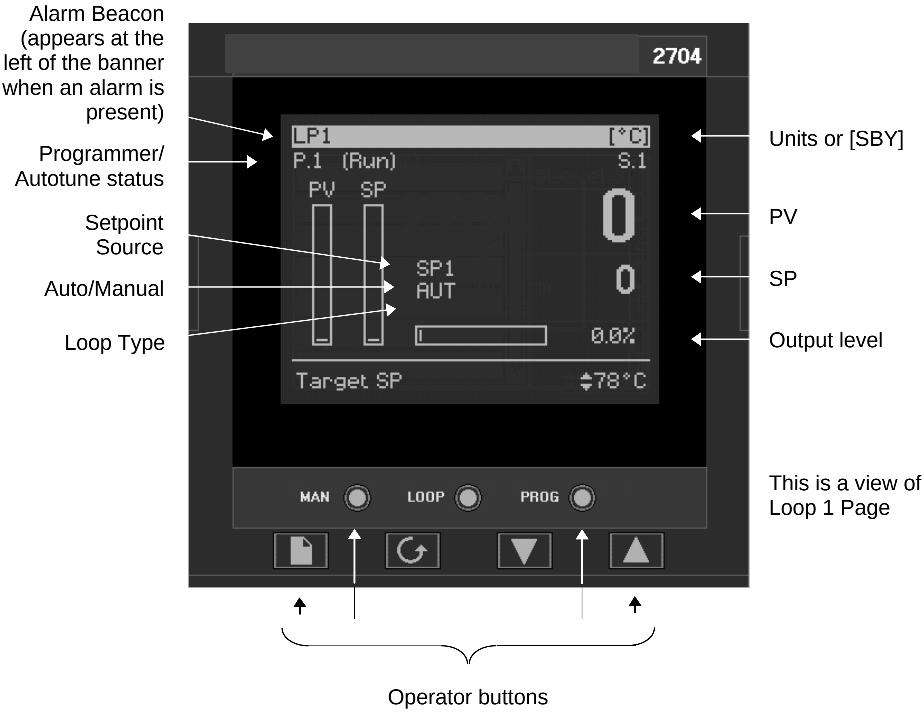
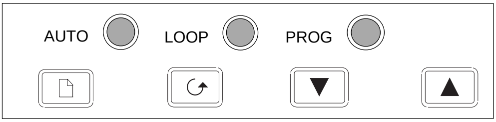
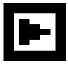
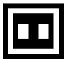
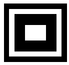
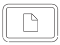
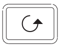


Figure 1-2: Operator Interface

1.3.1. The Operator Buttons



	Auto/Manual button	When pressed, this toggles between automatic and manual mode: • If the controller is in automatic mode 'AUT' is displayed • If the controller is in manual mode, 'MAN' is displayed
	Loop select button	Each press selects each loop in turn or between each loop and the trend chart if each of the above options are configured plus a summary of all loops. *The loop name is shown in the banner at the top of the display*
	Programmer button This button operates the programmer on all loops See also Chapter 6 'Programmer Operation'	• Press once to display a pop up window  The pop up window will remain for approximately 6 seconds and during this period:- • Press PROG again to RUN a program  • Press PROG again to HOLD a program  • Press PROG again to toggle between RUN & HOLD • Press PROG and hold for two seconds to reset 
	Page button	Press to select new pages from the page header 'Menu'. If held down it will continuously scroll the pages.
	Scroll button	Press to select a new parameter from the page heading. If held down it will continuously scroll through the parameters.
	Down button	Press to decrease an analogue value, or to change the state of a digital value
	Up button	Press to increase an analogue value, or to change the state of a digital value

Note:- The AUTO, LOOP, or PROG may have been disabled in configuration level.

Figure 1-3: Operator Buttons

1.3.2. Status Messages

Messages appear on the display to show the current status of the controller. Table 1-1 below describes these messages:-

LP1, LP2, LP3	Indicates which loop is being viewed. *LP1, LP2, LP3* may be user defined names. All user defined names are shown in *italics* throughout this manual
P01 to 50	Indicates which program is in use and its current status. P01: to P50: can be followed by a user defined name.
AUT	The selected loop is in automatic (closed loop) control
MAN	The selected loop is in manual (open loop) control
SP1, SP2, PO, REM	Indicates where the SP is derived, i.e. Setpoint 1, Setpoint 2, Programmer, Remote
CSD	Indicates that the loop is in cascade.
OVR	Indicates that the loop is in override.
RAT	Indicates that the loop is in ratio (Ratio must be enabled from the parameter list at the bottom of the display)
	Indicates a program is activated
	Indicates a program is held at its current levels
	Indicates a program is in reset condition i.e. not running
	When an alarm occurs an alarm symbol flashes in the header banner. When the alarm is acknowledged but is still active the symbol will be permanently lit. When the alarm is acknowledged but is no longer active the symbol will disappear. See Chapter 7 'Alarm Operation' for further details.
[UNITS]	The process units are displayed in the right hand side of the banner
[SBY]	This symbol will flash in the right hand side of the banner in place of 'units' when the controller is in standby mode. In this state all interfaces to the plant are switched to a rest condition. For example, all control outputs = 0. **When this symbol is on the controller is no longer controlling the process.** This symbol will be on when:- • The controller is in configuration mode • Standby mode has been selected through the user interface or via an external digital input • During the first few seconds after start up

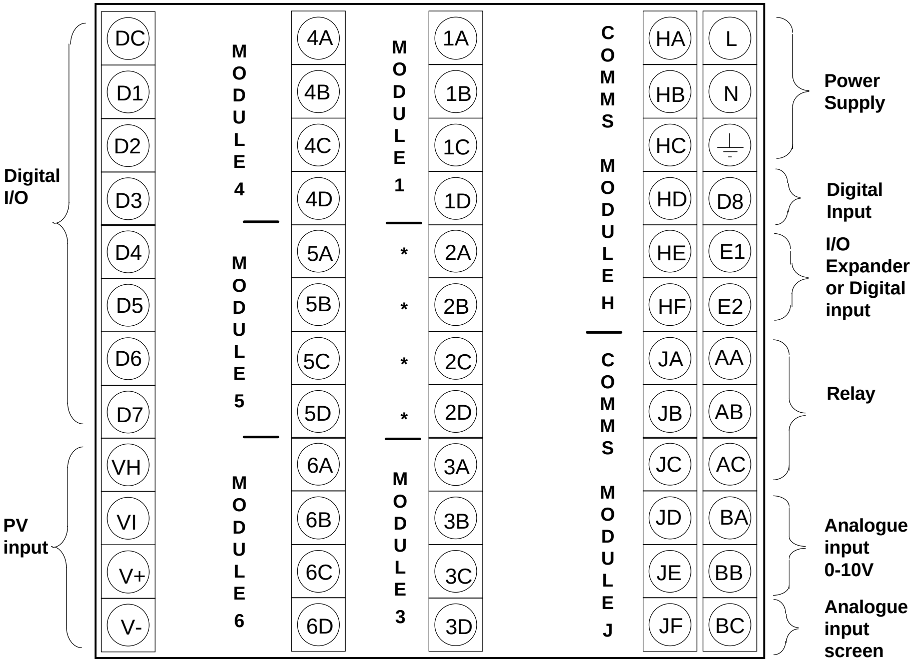
Table 1-1: Status Messages

1.4. INSTALLATION - OVERVIEW

The 2704 controller must be mounted and wired in accordance with the instructions given in Chapter 2 of the Installation and Operation Handbook, Part No. HA026502.

The controller is intended to be mounted through a cut out in the front panel of an electrical control cabinet. It is retained in position using the panel mounting clips supplied.

All wires are connected to terminals at the rear of the instrument. Each block of six terminals is protected by a hinged cover which clicks into closed position.



The functionality of the two outer rows of terminals is common to all instrument variants, as follows:-

PV input	VH, VI, V+, V-
Analogue input	BA, BB
I/O expander	E1, E2
Fixed changeover relay	AA, AB, AC
Digital I/O channels	D1 to D8 and DC
Power supply	L, N, Earth

*** Terminals 2A, 2B, 2C, 2D must not be wired to.**

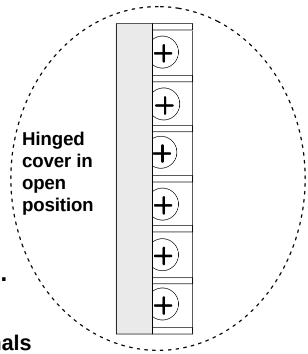


Figure 1-4: Rear Terminals

1.5. I/O MODULES

The 2704 controller has the facility to fit optional plug in modules. The connections for these modules are made to the inner three connector blocks as shown in Figure 1-4
The modules are:

- Communications modules.
- I/O modules

These modules are fitted simply by sliding them into the relevant position as shown in Figure 1-5.

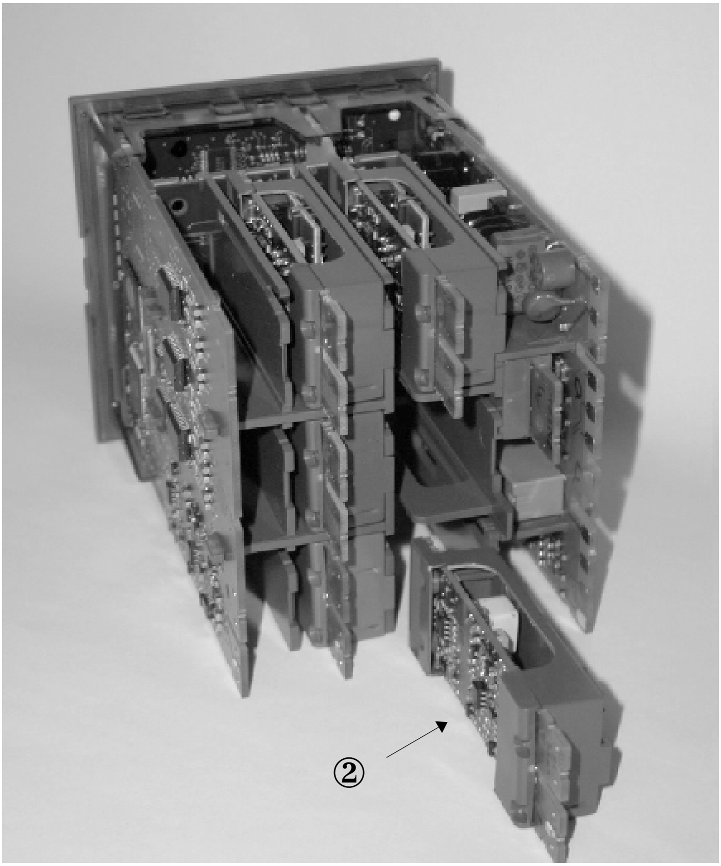


Figure 1-5: View of the Plug-in Modules

1.5.1. To Add or Change Modules

It is recommended that the controller is switched off before it is removed from its sleeve.

1. Remove the controller from its sleeve by pushing both latching ears ① (Figure 1-6) outwards and easing the controller forwards from its sleeve. It should not be necessary to use any tools for this.

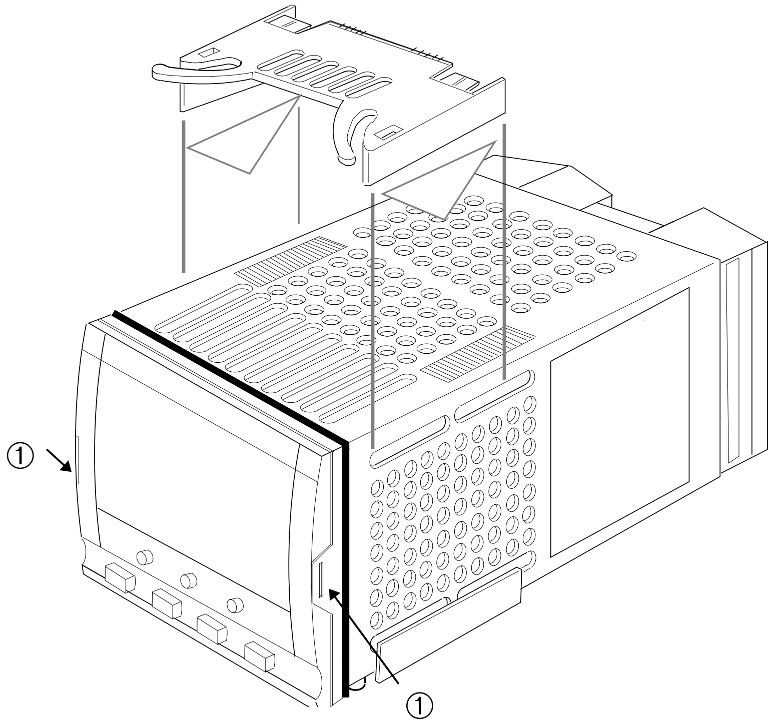


Figure 1-6: View of the Controller in its Sleeve

2. To remove a module it may be gripped by the rear terminals and pulled out from its location.
3. To fit a new module gently insert it into the required location ensuring that the raised section on the plastic cover ② (Figure 1-5) of the module slides into the slot in the retaining housing .
4. Slide the controller back into its sleeve and turn power back on.
5. After a brief initialisation period, the message **!:Module Changed** will appear on the display.
6. Press 🗋 and ⟳ together, as instructed, to acknowledge.
7. If the message **Bad Ident** is displayed this indicates that the wrong type of module has been installed, for example an unisolated logic output module from 2400 series.

1.6. PARAMETERS AND HOW TO ACCESS THEM

Parameters are settings, within the controller, which determine how the controller will operate. They are accessed, using the  and  buttons, and can be changed, to suit the process, using the  and  buttons.
Selected parameters may be protected under different security access levels.

Examples of parameters are:-
Values - such as setpoints, alarm trip levels, high and low limits, etc.,
or
States - such as auto/manual, on/off, etc. These are often referred to as enumerated values.

1.6.1. Pages

The parameters are organised into different pages. A page shows information such as page headers, parameter names and parameter values.

Parameters are grouped in accordance with the function they perform. Each group is given a '**Page Header'** which is a generic description of the parameter group. Examples are 'The Alarm Page', 'The Programmer Page', etc,. A complete list of these is shown in the full navigation diagram, Section 1.12.

Where a function has many parameters associated with it, the Page Header may be further sub divided into **'Sub-Headers'.** The parameters are then found under this category.

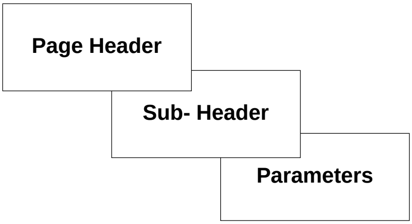


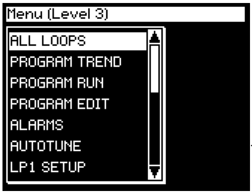
Figure 1-7: Page Types

It is possible to configure different start up pages as the Home page, but the principle of navigation is the same for all pages.

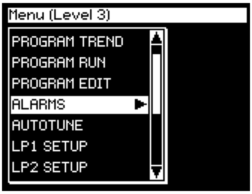
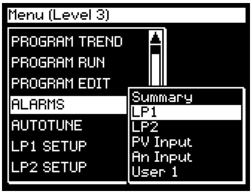
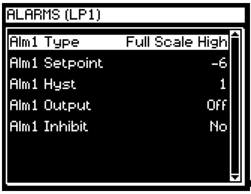
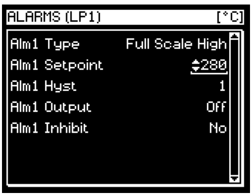
Note:-
A page only appears on the controller if the function has been ordered and is enabled in Configuration mode. For example, if a programmer is not configured the RUN page and the EDIT PROGRAM pages will not be displayed in operation levels.

1.7. NAVIGATION OVERVIEW

1.7.1. To Select a Page Header

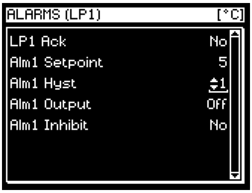
Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu		The vertical bar on the right of the display indicates the position of the page header.
2. Press ▼ to scroll down the list of page headers.		When the vertical bar reaches the centre of the screen the text moves up. This feature allows you to see previous and following page header names.
3. Press ▲ to scroll back up the list of page headers.	 The sequence is repeated following further presses of ▼ button	When the last name in the Page Header list appears at the bottom of the display, the vertical bar and the highlighted text will continue move downwards.

1.7.2. To Navigate to a Parameter from a Page Header.

Do This	This Is The Display You Should See	Additional Notes
1. From any page press [page] as many times as necessary to select the list of **Page Headers** 2. Press [▲] or [▼] to scroll up or down the list of page headers.		The ▸ symbol indicates that the page header is followed by a list of sub-headers.
		Press [page] to return to Page Header
3. Press [scroll] to select the list of **Page Sub-Headers** for the highlighted Page Header. 4. Press [▲] or [▼] to scroll up or down the list of page sub-headers		If a page does not contain a Sub-Header the display goes directly to 5 below
		Press [page] to return to Sub- Header
5. Press [scroll] to select the list of **Parameters** in the highlighted sub-header. 6. Press [▲] or [▼] to scroll up or down the list of parameters.		
		Press [page] to return
7. Press [scroll] to select the parameter which you wish to change 8. Press [▲] or [▼] to change the value		A flashing bar underlines the selected parameter. The parameter can only be altered if the value is preceded by ⬍ If the value is read only it will be replaced by **'- -'** for as long as the raise or lower buttons are pressed

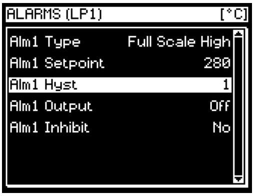
1.7.3. To Change Next Parameter in the List

This sections describes how to select further parameters in the list which you may wish to alter or to view.

Do This	This Is The Display You Should See	Additional Notes
1. From the previous display, press to select the next parameter which you wish to change 2. Press ▲ or ▼ to change the value		The button will allow you to scroll down the list. If this button is held down it will continuously scroll around the list, which will enable you to change a previous parameter.

1.7.4. To Change Any Parameter in the List

As stated above you can keep pressing or hold down the button to continuously scroll around the list of parameters. There are two other alternatives. The first is to return to the highlight bar, described below. The second is 'Backscroll' described in the next section.

Do This	This Is The Display You Should See	Additional Notes
1. From the previous display, press to highlight the parameter value and its name. 2. Press ▲ or ▼ to scroll up or down the list.		

1.8. BACKSCROLL

In some cases it may be more convenient to scroll back up the list, for example, to select a new segment number when setting up a program.
A short cut is provided by holding down and pressing ▲ or ▼.

Each press of ▲ will step back to the previous parameter. Each press of ▼ will step forward to the next parameter.

This function is provided as a short cut and is not necessary to navigate through the parameters.

1.9. PARAMETER VALUES

Parameter values can be displayed in different ways depending upon the parameter type. The different types of parameter, and how their values are changed, are shown below.

1. Numerical Values (eg Full Scale High Alarm Setpoint)

FS Hi Setpoint ⇕ 200 ←

Press ▲ to increase the value
Press ▼ to decrease the value

2. Enumerated Values (eg PV Input Alarm Acknowledge)

PV Alm Ack ⇕ No ←

Press ▲ to show next state
Press ▼ to show previous state

3. Digital Values (e.g. programmer event outputs)

Prog Reset DO ⇕ □□■□ ←

Press ⟳ to step along the values. A cursor under the selected value flashes.

Press ▼ or ▲ to turn the value on or off

4. Parameter Addresses (eg PV Src)

PV Src ⇕ 05108:PVIn.Val ←

Press ▲ or ▼ to change the **Parameter address**. A cursor under the parameter address flashes.

The parameter name for that address (if it exists) is shown to the right of the Modbus address.

↓

Press ⟳ to change from parameter address to parameter mnemonic

↓

PV Src ⇕ 05108:PVIn.Val ←

Press ▲ or ▼ to change the parameter address by scrolling through a list of the most popular mnemonics. A cursor under the parameter mnemonic flashes.

5. Text (eg Program Name - User definable)

Display	Action
Program Name ⬍ Program 1 (cursor under first character)	← Press ▲ or ▼ to change the character
↓ Press ↻ to change to the next character ↓	
Program Name ⬍ Program 1 (cursor under next character)	Press ▲ or ▼ to change the character. Up to 16 characters can be altered.

6. Time (eg Programmer Segment Duration)

Display	Action
Seg Duration ⬍ 0:01:00	← Press ▲ or ▼ to increase or decrease the time setting. This is an accelerating display.

Figure 1-8: Changing Parameter Values for Different Parameter Types

1.9.1. Confirmation Mechanism

Having changed a value, when the ▲ or ▼ key is released, the display will blink after a period of 1.5 seconds, indicating that the new parameter value has been accepted. If any other key is pressed during the 1.5 second period the parameter value is accepted immediately.

There are exceptions for specific parameters. Examples of these are:-

Output Power adjustment when in Manual mode. The value is written continuously as the value is changed.

Alarm Acknowledge. If the Alarm Acknowledge is changed from ‘No’ to ‘Acknowledge’ a confirmation message appears. Press ↻ key to confirm the change. If no key is pressed for 10 seconds the value is restored to its previous value.

1.9.2. Invalid key actions

At any time some state transitions may be invalid, due, for example, to contention with digital inputs or to the current operating state of the instrument.
Examples are:-

1. Digital inputs have priority over the operator buttons.
2. If a parameter value cannot be changed the ⬍ prompt is not shown
3. If the ▲ or ▼ button is pressed for a read only parameter a number of dashes, ----, is displayed.

1.10. PARAMETER TABLES

Subsequent chapters in this manual refer to parameter tables. These tables provide the full list of parameters available in 'Config' level in a particular page. The table below is an example.

Column 1 gives the name of the parameter as it appears on the display.
Column 2 is a description and possible usage of the parameter
Column 3 is the range of values which can be set. . This may be a numerical value, eg -n to +n, or the condition (enumeration) of a parameter, eg the parameter 'Program Status' has enumerations 'Run', 'Hold', 'Reset'.
Column 4 is the default value (if applicable) of the parameter set during manufacture
Column 5 is the access level required to change the parameter value.
L1 means that the value is only shown in Level 1
L2 means that the value is only shown in Level 1 and Level 2
L3 means that the value is always available in the instrument operating mode
Conf means Configuration Level
R/O is Read Only
Access Levels are described in Chapter 4.

Table Number:	**Description of the page**			**Page Header**
1 **Parameter Name**	**2** **Parameter Description**	**3** **Value**	**4** **Default**	**5** **Access Level**
Program Number	The number of the selected program			L3
Segment Number	The currently running segment number			L3
PSP1 Type	Program Setpoint 1 type			L3
PSP1 Working SP	Program Setpoint 1 working setpoint			L3
PSP1 Target	Program Setpoint 1 target setpoint			L3
PSP1 Dwell Time	Program Setpoint 1 dwell time			L3
This is a continuous loop which returns to the list header				

Note:-
A parameter only appears if it is relevant to the configuration of the controller. For example, a programmer configured as Time to Target will not display the Rate parameter.

1.11. PARAMETER AVAILABILITY AND ALTERABILITY

A parameter which appears on a page is described as available. Parameters are not available if they are not appropriate for a particular configuration or instrument status. For example, relative cool gain does not appear in a heat only controller, and integral time does not appear in an On/Off controller.

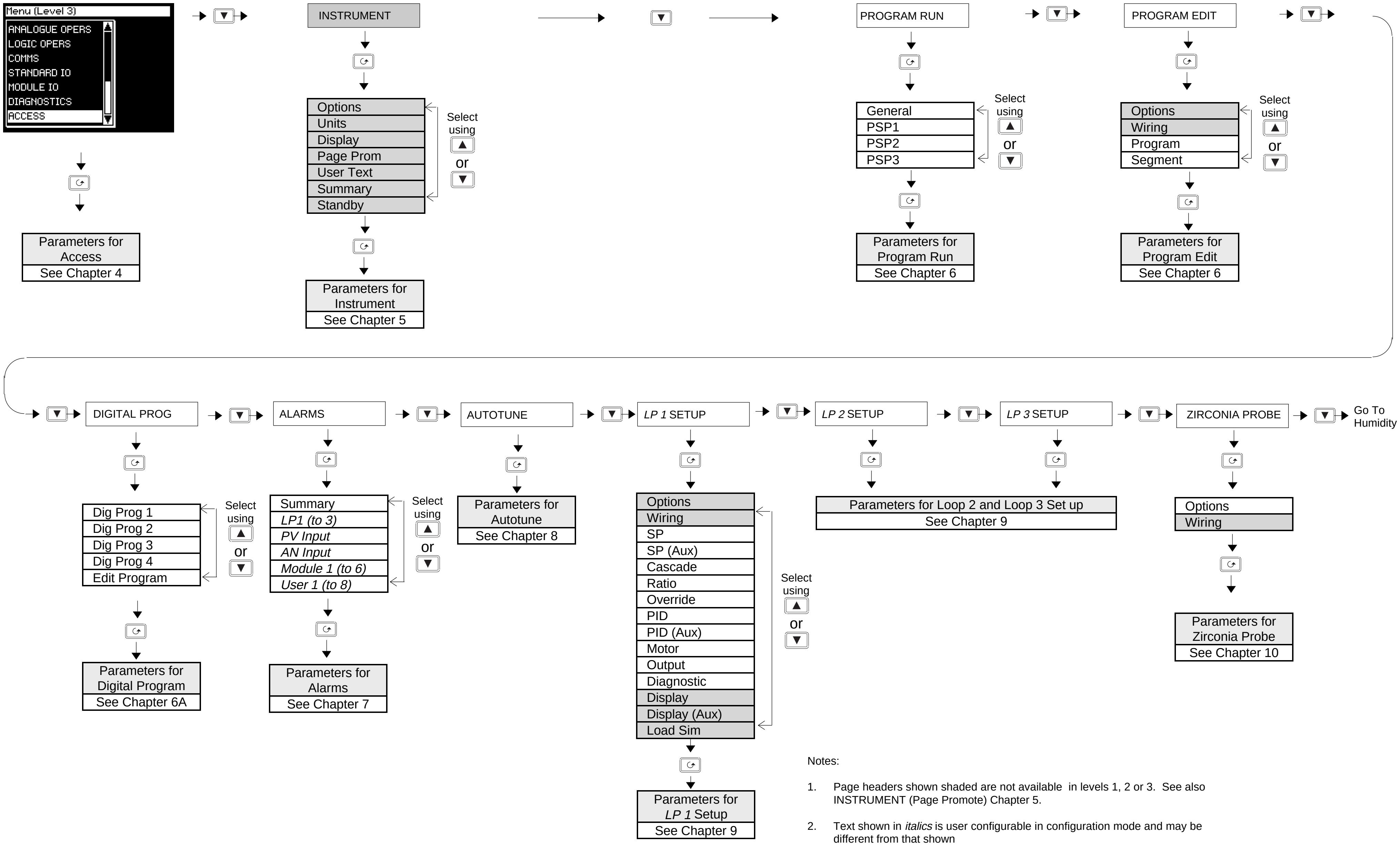
A parameter described as alterable is preceded by the ⬍ symbol which indicates that its value can be changed. A parameter which is not alterable may be viewed (subject to availability), but may be changed by an instrument algorithm.

A parameter is alterable only if the following conditions are satisfied:-

- The parameter is READ/WRITE
- The parameter does not conflict with the status of the instrument. For example, the proportional band will not be alterable if autotune is active
- The instrument keys must be enabled. Keys can be disabled by a logic input, turned off in configuration level or via digital communications. A logic input can be configured to disable front panel keys; this will not remove remote control of the user interface via digital communications.

The Navigation Diagram which follows shows all pages which are available at Config level.

1.12 NAVIGATION DIAGRAM



Notes:

1. Page headers shown shaded are not available in levels 1, 2 or 3. See also INSTRUMENT (Page Promote) Chapter 5.

2. Text shown in *italics* is user configurable in configuration mode and may be different from that shown

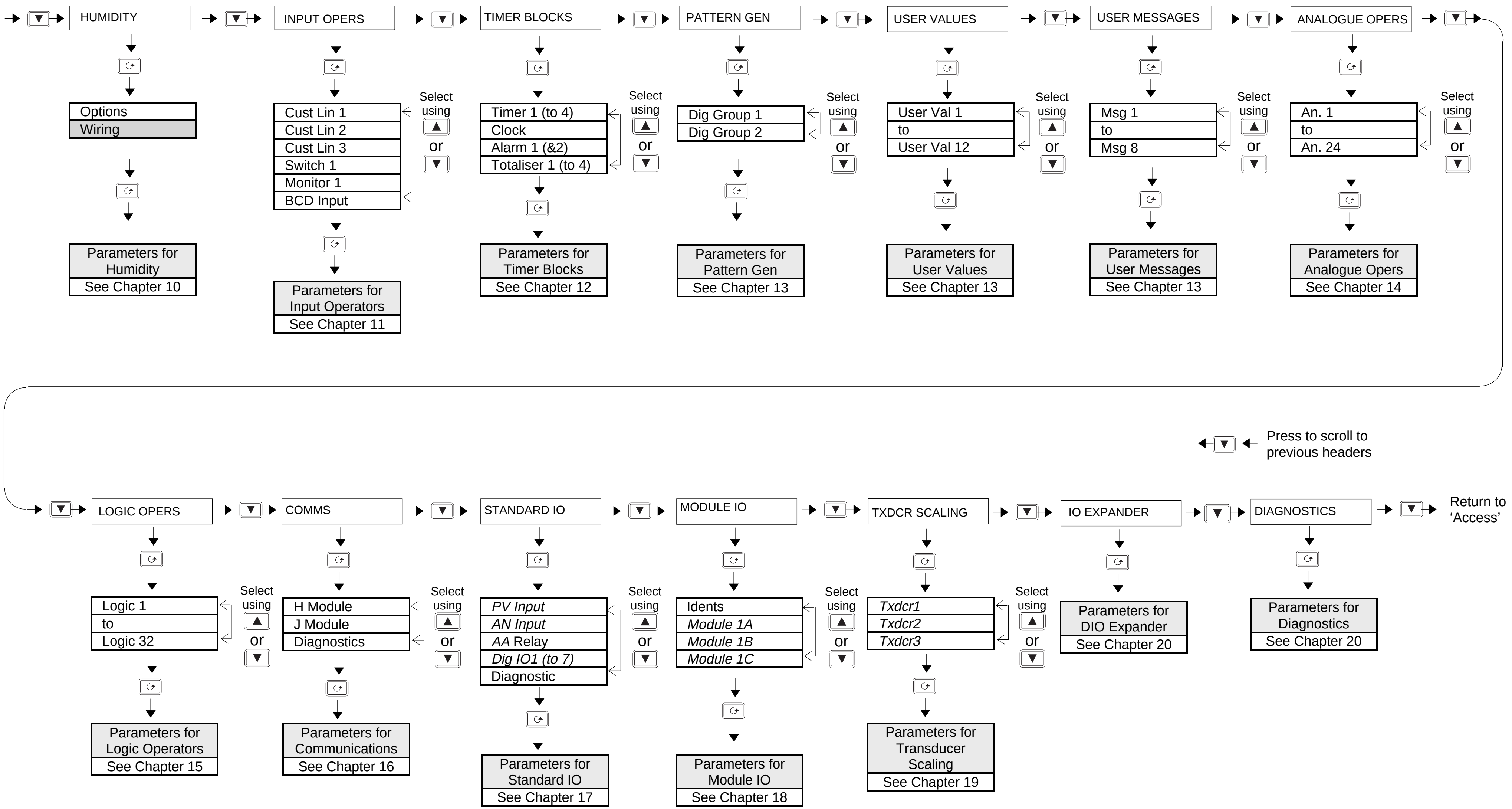


Figure 1-7: Navigation Diagram

2. Chapter 2 Function Blocks

2.1. WHAT IS A FUNCTION BLOCK?

A function block is a software device which performs a control strategy. Examples are PID Controller, Setpoint Programmer, Cascade Controller, Timer, etc. A function block may be represented as a 'box' which takes in data at one side (as 'Inputs'), manipulates the data internally (using parameter 'Settings') and 'outputs' data at the other side to interface with analogue or digital IO and other function blocks. Figure 2-1 shows a representation of a PID function block as used in the 2704 controller.

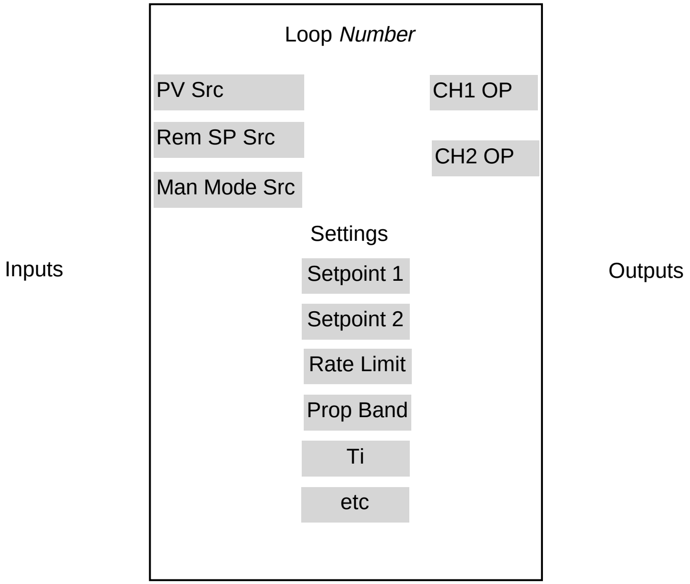


Figure 2-1: A Simple PID Function Block

2.1.1. Inputs

Inputs are provided to the function block from field sensors or from other function blocks within the controller. Each field input is served by an analogue or digital input block which processes the signal (depending upon the type of input) and makes it available to the function block in a useable form.

Each input 'wire' (see Chapter 3) is labelled as 'Src' since it defines the source of the signal by holding its Modbus address.

2.1.2. Outputs

In a similar way the function block makes available signals to other blocks, plant actuators and other devices. Each output interfaces with analogue or digital output drivers which provide signals to the plant such as relay, 4-20mA, 0-10V outputs, etc

2.1.3. Settings

The purpose of a particular function block is defined by its internal parameters. Some of these parameters are available to the user so that they can be adjusted to suit the characteristics of the plant.

Examples of parameters available to the user are shown in Figure 2-1 as ‘Settings’. In this manual these parameters are shown in tables an example of which is shown in Section 1.10.

3. Chapter 3 Soft Wiring

3.1. WHAT IS SOFT WIRING?

Soft Wiring (sometimes known as User Wiring) refers to the connections which are made in software between function blocks. This chapter describes the principles of soft wiring.

In general every function block has at least one input and one output. Input parameters are used to specify where a function block reads its incoming data (the ‘Input Source’). The input source is usually soft wired to the output from a preceeding function block. Output parameters are usually soft wired to the input source of subsequent function blocks.

It is possible to wire from any parameter using its Modbus address. In practice, however, it is unlikely that you will wish to wire from many of the available parameters. A list of commonly wireable parameters has, therefore, been produced and these are displayed in the controller with both their Modbus address and a mnemonic of the parameter name. An example is shown in the Section 3.1.2.1. i.e. 05108:PVIn.Val. The full list if these commonly wired parameters is given in Appendix D.

The function blocks used in this manual are drawn as follows:
1. Input parameters defined by ‘Src’ on the left of the function block diagram
2. Typically wired output parameters on the right hand side
3. Other parameters, which are not normally wired to, are shown as settings

A parameter which is not wired to can be adjusted through the front panel of the controller provided it is not Read Only (R/O) and the correct access level is selected.

All parameters shown in the function block diagrams are also shown in the parameter tables, in the relevant chapters, in the order in which they appear on the instrument display.

Figure 3-1 shows an example of how a PID function block (Loop 1) might be wired to other function blocks to produce a simple single loop controller. The Loop1‘PV Src’ input is soft wired to the output value from the Standard IO PV Input block on terminals V- to VH.
The channel 1 (heat) output from the PID block is soft wired to the input source (‘Wire Src’) of Module 1A, fitted as an output module.

Also in this example, a digital input to the ‘Man Mode Src’, allows the loop to be placed into manual depending upon the state of the digital input. The digital input is DIO1 connected to terminal D1 on the controller.

For further information on the configuration of the Standard IO and the Module IO see Chapters 17 and 18 respectively.

Further examples of function block wiring are given in specific chapters throughout this manual.

3.1.1. An Example of Soft Wiring

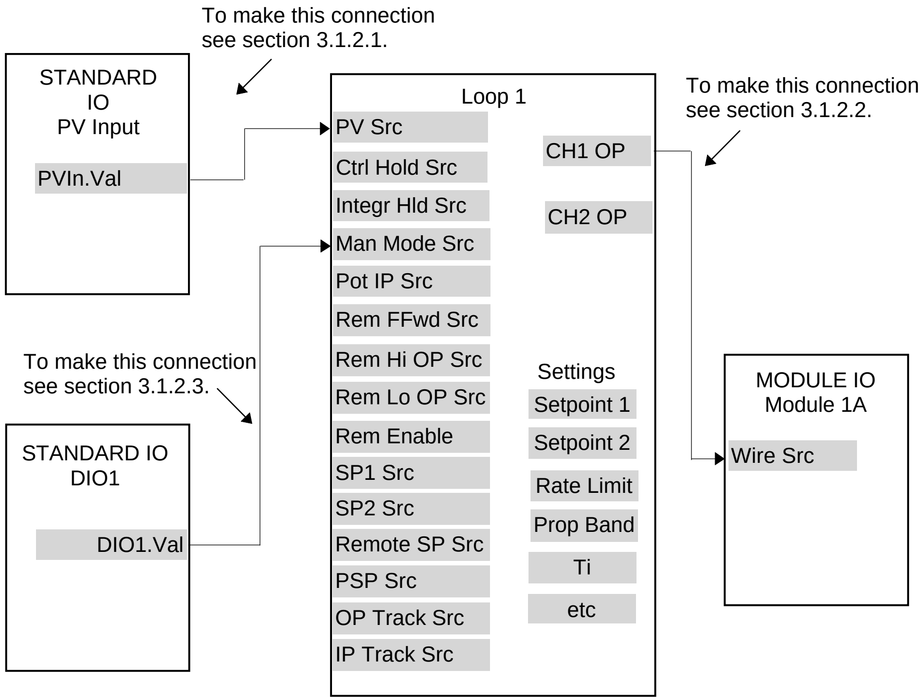


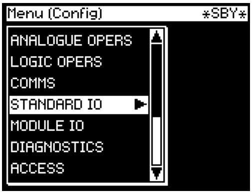
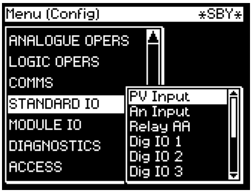
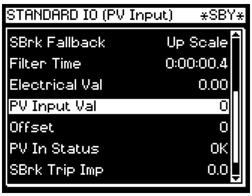
Figure 3-1: A Simple Wiring Example of a PID Function Block

3.1.2. Configuration of the Simple PID Loop

The following description explains how the wiring connections are made to produce the simple PID controller shown in Figure 3-1.

3.1.2.1. To connect the PV input to the Loop

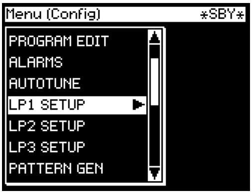
The example is to connect the output from the 'PV Input' to the 'PV Source' of Loop 1. Firstly, enter Configuration mode, as explained in Chapter 4.
Then:-

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'STANDARD IO'**	**Select the wire source** 	
3. Press [scroll key] to display the list of sub-headers 4. Press ▲ or ▼ to select **'PV Input'** (if necessary)		
5. Press [scroll key] to display the parameter list 6. Press ▲ or ▼ to select **'PV Input Val'**		This selects the **'PV Input Val'** parameter which is to be wired from
7. Press AUTO/MAN [button] to copy this parameter. This button becomes a 'copy' button in configuration mode.	PV Input Val Address '05108' Copied Value '0' Copied	This display confirms that the parameter with Modbus address 05108 (ie PV Input.Val) has been copied. This display appears for as long as the A/M button is depressed

Select the wire destination

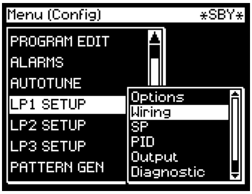
8. Press [□] as many times as necessary to access the page header menu

9. Press [▲] or [▼] to select ‘***LP1* SETUP**’



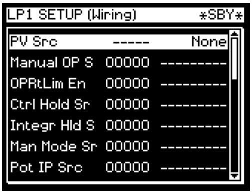
10. Press [↻] to display the list of sub-headers

11. Press [▲] or [▼] to select **‘Wiring’**



12. Press [↻] to display the parameter list

13. Press [▲] or [▼] to select **‘PV Src’** (if necessary)



PV Src of LP1.is the parameter to be wired to.

The flashing last character is the modbus address of the parameter to be wired from.

If the address is known it can be entered directly here.

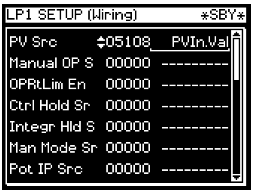
At this point you have three choices:

1. If the modbus address is known, enter it here by pressing the [▲] or [▼] button
2. If the modbus address is not known press [↻]. The display transfers to the name of the parameter. Press [▲] or [▼] to scroll through a list of parameter names. See Appendix D for the list of these parameters.
3. Paste the parameter (already copied) as follows

Paste the wire source

14. Press the Loop Select button, [LP1 LP2 LP3 AUX], to paste the copied parameter ie 05108 to the PV Src of LPI.

This button becomes a ‘paste’ button in configuration mode



The Loop Select button becomes a ‘paste’ button in this mode

Press [↻] to confirm

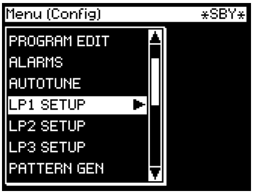
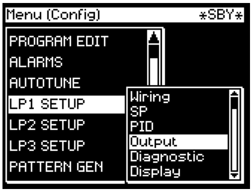
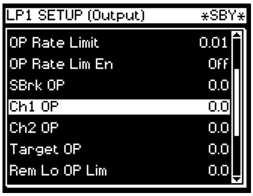
Press [□] to cancel as instructed

The parameter with Modbus address 05108 is pasted to PV Src.

The cursor flashes to indicate that you can change the Modbus address if required, using the [▲] or [▼] button

3.1.2.2. To connect the Loop to the Output Module

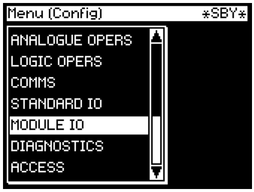
The example is Loop 1 Channel 1 output to Module 1A input.

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page button] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'*LP1* SETUP'**	**Select the wire source** 	
3. Press [scroll button] to display the list of sub-headers 4. Press [▲] or [▼] to select **'Output'**		
5. Press [scroll button] to display the parameter list 6. Press [▲] or [▼] to select **'CH1 OP'**		This selects the parameter to be wired from.
7. Press AUTO/MAN [button] to copy this parameter. This button becomes a 'copy' button in configuration mode.	**Copy the wire source** Ch1 OP Address '00013' Copied Value '0.0' Copied	This display confirms that the parameter with Modbus address 00013 (ie CH1 OP) has been copied. This display appears for as long as the A/M button is depressed

Select the wire destination

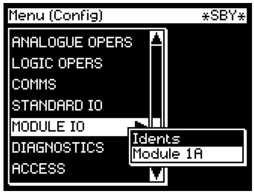
8. Press as many times as necessary to access the page header menu

9. Press or to select **'MODULE IO'**



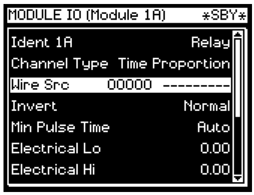
10. Press to display the list of sub-headers

11. Press or to select **'Module 1A'**



12. Press to display the parameter list

13. Press or to scroll to **'Wire Src'**



This is the parameter to be wired to.

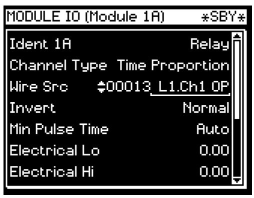
The flashing last character is the modbus address of the parameter to be wired from.

At this point you have three choices:

1. If the modbus address is known, enter it here by pressing the or button
2. If the modbus address is not known press . The display transfers to the name of the parameter. Press or to scroll through a list of parameter names
3. Paste the parameter (already copied) as follows

14. Press the Loop Select button, LP1 LP2 LP3 AUX, to paste the copied parameter ie 00013 to the Wire Src of Module 1A.

This button becomes a 'paste' button in configuration mode



The Loop Select button becomes a 'paste' button in this mode

Press to confirm

Press to cancel as instructed

☺ **Tip:**

You can page back by holding down the button and pressing button.

You can scroll back by holding down the button and pressing button.

3.1.2.3. To connect Digital Input DIO1 to Loop 1 Manual Input

The following description is given as a quick summary of the previous two examples.

1. Select the Wire Source 05402:DIO1.Val
2. Copy
3. Select the Wire Destination LP1 Man Mode Src
4. Paste

The source and destination of parameters is given in the **Parameter Tables** listed in following chapters.

4. Chapter 4 ACCESS LEVELS

Parameters are protected under five different levels of access for which security codes may be necessary. This chapter describes the different levels of access to the operating parameters available in the controller.

4.1. THE DIFFERENT ACCESS LEVELS

Access Level	What you can do	Password Protection
Level 1	This is sometimes referred to as Operator Level since it allows operators to view and adjust parameters within limits set in higher levels. Any page available in levels 2 or 3 may be configured to appear in level 1. This is done from the configuration level using the page promote feature.	No
Level 2	This is sometimes referred to as Supervisor level since all the parameters relevant to a particular configuration are visible. All alterable parameters can be adjusted.	Yes
Level 3	These are parameters which are generally required when commissioning the controller. Any page at this level can also be configured to appear at Level 2.	Yes
Config	This level allows access to configure the fundamental characteristics of the controller and it is this level which is described in this manual.	Yes
View Config	This is a read only level which allows you to view the configuration of the controller. It is not possible to change parameter values in this level. It is not possible to read passcodes in this level.	Yes

4.2. PASSCODES

On switch on the controller defaults to Level 1 which is not protected by a passcode. A limited set of parameters can be changed in this level. The parameter tables in each chapter list those parameters which can be changed.

Level 2, level 3 and Configuration level are protected by passcodes. The default passcodes set in a new controller are:

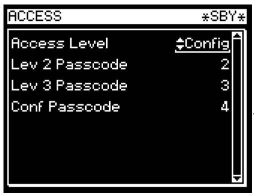
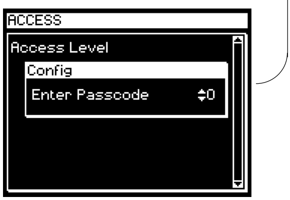
Level 2	Passcode ‘2’
Level 3	Passcode ‘3’
View Config	Passcode ‘2704’
Config	Passcode ‘4’

These passcodes, with the exception of View Config, can be changed in configuration level.

If a passcode of ‘None’ has been entered for any level (apart from View Config which is fixed) it will not be necessary to enter a passcode to enter that level.

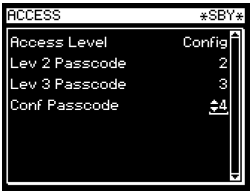
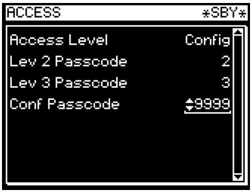
Note:-
In configuration mode the controller enters a standby state in which all outputs are frozen. If the controller is connected to a process, it no longer controls that process when it is in Configuration mode.

4.3. TO ENTER CONFIGURATION LEVEL

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] to return to the page header menu. 2. Press [▲] or [▼] to select '**ACCESS'**		This is the page header which contains the access levels
3. Press [scroll key] to select the access level parameters		
4. Press [▲] or [▼] to select **'Config'** 5. Press [▲] or [▼] to enter the passcode. When the correct passcode is entered the display momentarily changes to ⬍ PASS, then back to the start level to confirm correct entry.	 	The default passcode of a new controller is 4 to enter Config level. If a new passcode has been entered in Config level this will be in the form 0 to 9999. If an incorrect passcode is entered, the display returns to ⬍ 0. Note: In the special case that the passcode has been configured as None, the display will blink momentarily when Config level is selected and Config level will be entered immediately.

To go from a higher level to a lower level does not require entry of a passcode.

4.4. TO ENTER NEW PASSCODES

Do This	This Is The Display You Should See	Additional Notes
1. From the previous display, press to scroll to the level at which you wish to change the passcode		This will change the passcode for the configuration level
2. Press ▲ or ▼ to enter the new passcode, from 0 to 9999		The display will blink to accept the new passcode

4.5. TO EXIT CONFIGURATION LEVEL

To exit configuration level it is only necessary to select the level which you wish to go to. When entering a new level from a higher level it is not necessary to enter the passcode for this level. It is only necessary to enter the passcode when going from a lower level of access to a higher level.

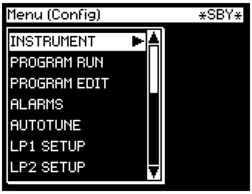
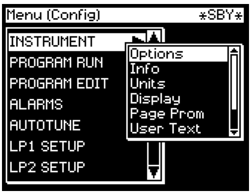
5. Chapter 5 Instrument Configuration

5.1. WHAT IS INSTRUMENT CONFIGURATION?

Instrument configuration allows you to set up:-

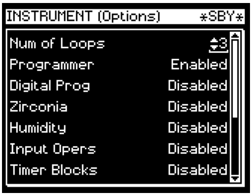
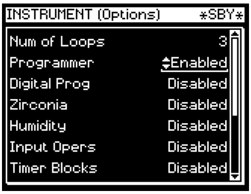
2. The number of loops
3. To enable. PID Loops, Programmer, Zirconia, Humidity, Input Operators, Timer Blocks, Analogue and Logic Operators, Transducer Scaling
4. Displayed Units
5. To format the display
6. The functions of the keys (buttons)
7. Promotion of selected parameters to different levels
8. User text
9. Format of the Summary Page
10. Standby Behaviour

5.1.1. To Select the Instrument Configuration Pages

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'INSTRUMENT**		
3. Press [scroll key] to display the list of sub-headers 4. Press ▲ or ▼ to scroll around the sub-headers		The choice of page headers is:- Options Info Units Display Page Prom User Text Summary Standby

Note:-
It is only possible to configure chargeable options which have been ordered. An example of a chargeable option is the number of loops. For other chargeable options see Order Code, Appendix A.

5.2. TO CONFIGURE CONTROLLER OPTIONS

Do This	This Is The Display You Should See	Additional Notes
1. Select **INSTRUMENT (Options Page)** as in 5.1.1.		
3. Press ⟳ to display the list of parameters 4. Press ▲ or ▼ to scroll around the parameters 5. Press ⟳ to select a parameter. In this example **'Num of Loops'** 6. Press ▲ or ▼ to set the number of loops required		1, 2 or 3 loops can be selected if the option has been supplied
7. Press ⟳ to scroll to further parameters in the list 8. Press ▲ or ▼ to change the value or state of the parameter		In this example the programmer function can be **Enabled** or **Disabled**

Continue to select and change instrument options as described above.

The following table gives the full list of parameters available under INSTRUMENT list header

5.2.1. INSTRUMENT Options Page

Table Number: 5.2.1.	These parameters allow you to enable or disable instrument options which have been ordered		INSTRUMENT (Options Page)	
Parameter Name Press ↻ to select	**Parameter Description**	**Value**	**Default**	**Access Level**
Num of Loops *	To configure the number of loops		1, 2 or 3	Config
Programmer *	To enable or disable the programmer		Disabled Enabled	Config
Digital Prog *	To enable or disable the digital programmer		Disabled Enabled	Config
Zirconia *	To enable or disable a zirconia block		Disabled Enabled	Config
Humidity	To enable or disable the humidity block		Disabled Enabled	Config
Input Opers	To enable or disable the Input Operators		Disabled Enabled	Config
Timer Blocks	To enable or disable the Timer Blocks		Disabled Enabled	Config
Pattern Gen	To enable or disable the pattern generator		Disabled Enabled	Config
An/Logic Opers *	To enable or disable the Analogue and Logic Operators		Disabled Enabled	Config
Txdcr Scaling	To enable or disable transducer scaling		Disabled Enabled	Config
IO Expander	To enable or disable the IO Expander		Disabled Enabled	Config
Clear Memory?	Clears all changes. Do not use unless the instrument is first cloned using iTools		No Yes	Config
Load Sim A Technical Note, Ref TIN123 is available for further information.	To enable or disable load simulation. This allows a simulation of a control loop to be enabled for test and demonstration purposes		Disabled Enabled	Config

* These are options which can only be activated if they have been ordered, see 'Ordering Code' Appendix A.

5.2.2. INSTRUMENT Info Page

Table Number: 5.2.2.	These parameters give you information about the controller		INSTRUMENT (Info Page)	
Parameter Name Press ↻ to select	**Parameter Description**	**Value**	**Default**	**Access Level**
Inst Type	Instrument type	2704	2704	R/O
Inst Serial No	Instrument serial number	Numeric		R/O
Inst Version	Software version	V2.00		R/O
CBC Version	Software version number of the 'cross board'			R/O
Feature Code 1	Codes required to upgrade the controller features			R/O
Feature Code 2				R/O
Inst 2nd Lang	Instrument language for user interface			R/O
Alt Protocol	Alternative comms protocol Profibus			R/O
ROM Size	ROM Size	eg 512K Word		R/O
RAM Size	RAM Size	eg 128K Bytes		R/O

5.2.3. INSTRUMENT Units Page

Table Number: 5.2.3.	These parameters allow you to configure instrument units		INSTRUMENT (Units Page)	
Parameter Name Press ↻ to select	**Parameter Description**	**Value**	**Default**	**Access Level**
Temp Units	Temperature Units		None ^oC, ^oF, ^oK	Conf
Custom Units 1	An index of customised display units available in the controller.	01:Usr1 to 50:Usr50	01:Usr1	Conf
Custom Units 2			01:Usr1	Conf
Custom Units 3			01:Usr1	Conf
Custom Units 4			01:Usr1	Conf
Custom Units 5			01:Usr1	Conf
Custom Units 6			01:Usr1	Conf

5.2.4. INSTRUMENT Display Page

Table Number: 5.2.4.	**These parameters allow you to configure the display**		**INSTRUMENT (Display Page)**	
Parameter Name Press ↻ to select	**Parameter Description**	**Value**	**Default**	**Access Level**
Language	Display language	See note 1		Conf
Startup Text 1	Text which may be used to override the default message	01:Usr01 to 50:Usr50	Default Text	L3
Startup Text 2	Up to 50 text strings are available	01:Usr01 to 50:Usr50	Default Text	L3
Home Page	Defines which page is displayed in the lower readout after initialisation[2].	See Note 2		L3
Home Timeout	To set a timeout for the display to return to the Home page.	None 9:99:99.9	0:10:00	L3
Disable Keys	Yes will disable all front panel buttons when in operation levels	No Yes	No	Conf
Function Key 1	Function key 1 is Auto/Manual or disabled	Auto/Manual Disabled	Auto/Man	Conf
Function Key 2	Function key 2 is Loop Select key or disabled	View Loop Disabled	View Loop	Conf
Function Key 3	Function key 1 is Program Run/Hold or disabled	Run/Hold Disabled	Run/Hold	Conf
Page Key Src	Keys may be wired to an external source such as a digital input for remote panel operation.		See note 1 Modbus address	Conf
Scroll Key Src				Conf
Lower Key Src				Conf
Raise Key Src				Conf
Func Key 1 S				Conf
Func Key 2 S				Conf
Func Key 3 S				Conf
Func1 Pressed [(1)]	State of function key 1	No Yes	No	Conf
Func2 Pressed [(1)]	State of function key 2		No	Conf
Func3 Pressed [(1)]	State of function key 3		No	Conf

Notes:-

1. The 2704 stores the user interface in 2 languages. English is always available plus French, German or Spanish.

2. The first page to be displayed when the instrument is switched on can be chosen from:-

LP1, *LP1* A., *LP2*, *LP2* A., *LP3*, or *LP3* A. (In 2704 *LPx* and *LPx A* have the same effect)
Access Page
Cycle Each Loop
All Loops
LP1 Trend, *LP2* Trend, *LP3* Trend
Program Mimic
Summary
Program Run

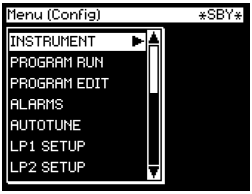
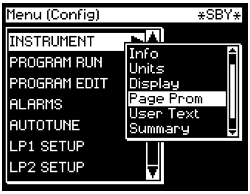
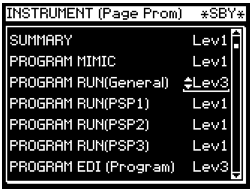
3. These may be wired to function blocks to trigger other events in the system.

4. Text in *italics* can be customised

5. A parameter marked as available in Access Level 'L3' means that it will be visible if the page is promoted from configuration level to Level 3.

5.2.5. INSTRUMENT Page Promote Page

Any page shown un-shaded in the Navigation Diagram, Figure 1-7 can be promoted to Level 1, Level 2 or Level 3 as follows:-

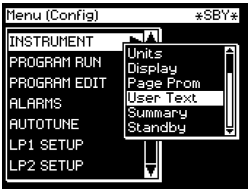
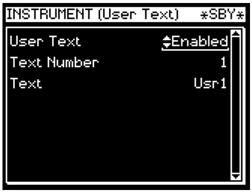
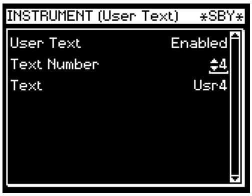
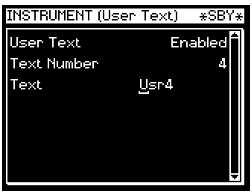
Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'INSTRUMENT'**		
3. Press [scroll key] to show sub-headers 4. Press ▲ or ▼ to select '**Page Prom'**		The choices are:- Options Info Units Display Page Prom User Text Summary Standby
5. Press [scroll key] to show parameters 6. Press ▲ or ▼ to scroll to the name of a page which you wish to promote to levels 1, 2 or 3. 7. Press [scroll key] to select the page 8. Press ▲ or ▼ to choose the level at which you wish the page to be displayed		The choices are **Lev1, Lev2,** or **Lev3.** In this view, the Program Run (General) page will only be displayed at Lev 3. It will not be shown at Lev 1 Note:- Not all parameters in a page will be seen. For example, parameters marked as available in a higher level eg 3 will not be shown in the page if it is promoted to a lower

Repeat the above for every page which you wish to promote to a different level. By default all pages will be at Level 3 except those listed below:-

Parameter Name	Level	Parameter Name	Level
SUMMARY	Lev1	PROGRAM RUN (PSP2)	Lev1
PROGRAM MIMIC	Lev1	PROGRAM RUN (PSP3)	Lev1
PROGRAM RUN (General)	Lev1	PROGRAM EDIT (Segment)	Lev1
PROGRAM RUN (PSP1)	Lev1	ALARMS (All Pages)	Lev1

5.2.6. INSTRUMENT User Text Page

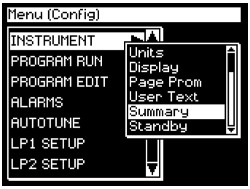
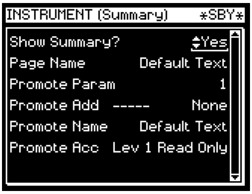
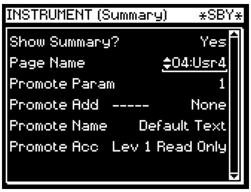
This page allows you to configure up to 50 User Text strings of up to 16 characters. Any string can be used to provide a name for particular parameters. For example Loops can be given names which are more meaningful to the user, such as ‘Zone 1’, ‘Level Controller’, etc. (To use a customised name, go to the relevant page such as LPx SETUP/Display page or MODULE IO/Module x page. Examples are given at the end of this chapter).
To enter User Text:-

Do This	This Is The Display You Should See	Additional Notes
1. From the **‘INSTRUMENT’** page header, press ↻ to display the list of sub-headers 2. Press ▲ or ▼ to select ‘**User Text’**		
3. Press ↻ to show sub-headers 4. Press ↻ to select User Text 5. Press ▲ or ▼ to **‘Enabled’**.		If **‘Disabled’** no further parameters are available
6. Press ↻ to select **‘Text Number’** 7. Press ▲ or ▼ to choose the text number to be configured		Up to 50 Text Numbers are available
8. Press ↻ to select **‘Text’** 9. Press ▲ or ▼ to set the first (under-scored) character of the user text 10. Repeat 8 and 9 above to set every character in the required text		‘Usrx’ is the default text which is replaced by the text of your choice. Up to 16 characters are available

5.2.7. INSTRUMENT Summary Page

These parameters allow you to configure a page consisting of a list of up to 10 parameters which are in common use on a particular installation. The first parameter in the list - 'Show Summary' must be enabled so that the summary list is shown in operating levels.

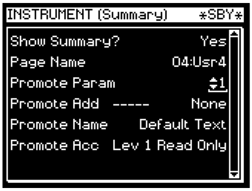
To configure Summary pages:-

Do This	This Is The Display You Should See	Additional Notes
To Show the Summary Page in Operating Levels		
1. From the **'INSTRUMENT'** page header, press ↻ to display the list of sub-headers 2. Press ▲ or ▼ to select '**Summary'**		The level at which the Summary Page is shown is selected by the Page Promote section 5.2.5.
3. Press ↻ to show the list of parameters 4. Press ↻ to select '**Show Summary?'** 5. Press ▲ or ▼ to **'Yes'**.		If Yes is selected the Summary Page, which consists of up to 10 parameters, will be shown in the Operation levels 1, 2 or 3. If 'No' is selected the Summary page will not be shown in operating levels.
To Allocate a Name to the Summary Page		
1. Press ↻ to select '**Page Name'** 2. Press ▲ or ▼ to select the required name from the User Text 'library'		Up to 50 user defined text Names are available. The previous section explains how User Text is set up.

To Select the First Parameter which is to Appear on the Summary Page

1. Press ⟳ to select ‘**Promote Param’**

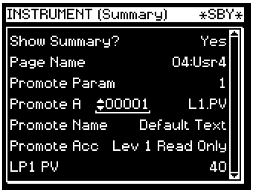
2. Press ▲ or ▼ to select **‘1’** (if necessary)



Up to 10 parameters are available

3. Press ⟳ to select ‘**Promote Ad’**

4. Press ▲ or ▼ to select the required parameter using its Modbus address

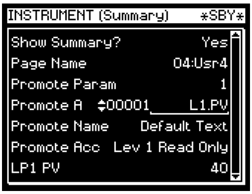


The flashing _ indicates the value to be changed

If the Modbus Address is not known it is possible to select the required parameter from a list of commonly used parameters. This list is shown in Appendix D

5. Press ⟳ again

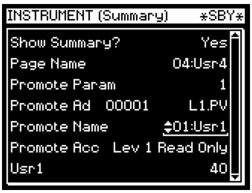
6. Then press ▲ or ▼ to scroll through a list of commonly used parameters



To Select a User Defined Name for the First Parameter in the List

1. Press ⟳ to select ‘**Promote Name’**

2. Press ▲ or ▼ to select the name from the User Text library

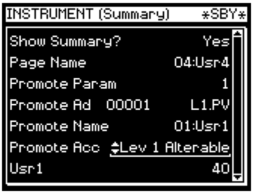


The name of the parameter is chosen from the User Text library set up as described in section 5.2.5.

To Set the Access level for the First Parameter in the List

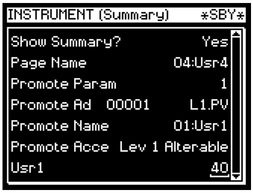
1. Press ↻ to select **Promote Access** '

2. Press ▲ or ▼ to select the Access Level



This sets the level to which the parameter is promoted. The choices are:-
Lev 1 Read Only
Lev 1 Alterable
Lev 2 Read Only
Lev 2 Alterable

3. Press ↻**.** This shows the first parameter which will appear in the operation level selected in 7 above.



The actual value of the parameter is shown in this display together with its allocated units

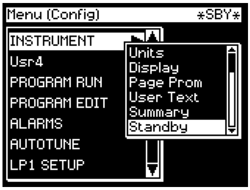
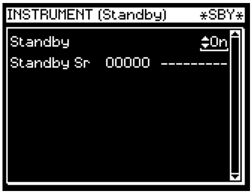
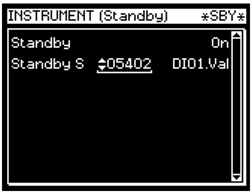
Repeat the above steps for up to 10 parameters which are to be promoted to the Summary page.

5.2.8. INSTRUMENT Standby Page

The standby state of the controller occurs when it is in configuration mode or during the first few seconds after switch on, see also Section 1.3.1.

The INSTRUMENT Standby Page allows you to wire to a parameter such as a digital input which when true will switch the controller to Standby Mode.

5.2.8.1. Example:- To wire Standby to Fixed Digital Input 1.

Do This	This Is The Display You Should See	Additional Notes
1. From the **'INSTRUMENT'** page header, press ↻ to display the list of sub-headers 2. Press ▲ or ▼ to select '**Standby'**		
3. Press ↻ to show the list of parameters 4. Press ↻ to select '**Standby'** 5. Press ▲ or ▼ to **'On'**.		If On is selected the controller will be switched to Standby Mode when the event (DI01) becomes true. If Off is selected the event is ignored.
6. Press ↻ to select '**Standby Src'** 7. Press ▲ or ▼ to. select the Modbus Address of the parameter to be wired to		The Modbus Address of Fixed Digital Input number 01 is 05402

If the Modbus Address is not known it is possible to select the required parameter from a list of commonly used parameters. This list is shown in Appendix D

8. Press ↻ again 9. Then press ▲ or ▼ to scroll through a list of commonly used parameters		If the Modbus Address is not known the parameter can be selected its mnemonic. See Appendix D for a list of these commonly used parameters.

☺ **Tip: See 'Copy and Paste' Section 3.1.1.**

5.3. USER TEXT EXAMPLES

5.3.1. To Re-Name Loop 1 to Zone 1

First enable User Text since its factory default is disabled. A library of User Text can then be created from which the new loop name can be selected.

5.3.1.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set ‘Text Number’ = 1 (or any unused text no.) set ‘Text’ = Zone 1 This defines Text Number 1 to be Zone 1.
2. In LOOP 1 SETUP /Display Page (Table 9.10.1)	set ‘Loop Name’ = 01:Zone 1 This replaces the default name (LP1) with Zone 1

5.3.2. To Re-Name User Alarm 1 and Provide a Message

User alarms can be re-named and also provide a diagnostic message to the user.

5.3.2.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set ‘Text Number’ = 2 (or any unused text no.) set ‘Usr2’ = High Temp This defines Text Number 2 to be High Temp. set ‘Text Number’ = 3 (or any unused text no.) set ‘Usr3’ = Check Chiller
2. In ALARMS/User 1 Page (Table 7.7.6)	set ‘Name’ = 02:High Temp This replaces the default name with High Temp Set ‘Message’ =03:Check Chiller

5.3.3. To Re-Name Module 1 to be called Heat Output

Individual modules can be re-named to simplify plant diagnostics.

5.3.3.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set ‘Text Number’ = 4 (or any unused text no.) set ‘Usr4’ = Heat Output This defines Text Number 4 to be Heat Output.
2. In MODULE IO/Module 1A Page (Section 18.4)	set ‘Module Name’ = 04:Heat Output This replaces the default name with Heat Output

5.3.4. To Rename a Digital Input and show in the Summary Page

This example will display the value of the digital input alongside the text ‘Test 1’ in the Summary Page for Digital Input 1.

5.3.4.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set ‘Text Number’ = 5 (or any unused text no.) set ‘Usr5’ = Test 1
2. In STANDARD IO /Dig IO1 Page (Table 17.5.1.)	set Channel Type = Digital Input This page also allows you to set the input for inverted operation
3. In INSTRUMENT/Summary Page (Table 5.2.7)	set ‘Show Summary? = Yes set ‘Promote Param’ = 5 (or the text no. above) set ‘Promote Addr’ = 05402:DIO1.Val This connects digital input 1 to the first parameter of the Summary display set ‘Promote Name’ = 05:Test 1

In Operation Level, the text in the Summary page will show:-

In place of 0 or 1, you may wish to display On or Off. This can be achieved by using a Logic or Analogue Operator. The implementation using Logic Operator 1 is as follows:

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set ‘Text Number’ = 5 (or any unused text no.) set ‘Usr5’ = Test 1
2. In STANDARD IO /Dig IO1 Page (Table 17.5.1)	set Channel Type = Digital Input This page also allows you to set the input for inverted operation
3. In LOGIC OPERS/Logic 1 Page (Table 15.2.1)	set ‘Operation = OR set ‘Input 1 Src = 05402:DIO1.Val set ‘Input 2 Src = 05402:DIO1.Val This connects digital input 1 to logic operator 1. Note: it is necessary to wire to both inputs of a logic (or analogue operator)
4. In INSTRUMENT/Summary Page (Table 5.2.7)	set ‘Show Summary? = Yes set ‘Promote Param’ = 1 (or the text no. above) set ‘Promote Addr’ = 07176:LgOp1.OP The logic operator is defined simply to provide On/Off annunciation in the display Summary page.

See Appendix D for list of Modbus addresses.

5.3.5. To Assign Custom Units

Most commonly used units can be selected for display on the user interface. In addition to the standard selection up to six custom units can be created. In this example the units of the PV Input will be Gal/m

5.3.5.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set 'Text Number' = 6 (or any unused text no.) set 'Usr6' = Gal/m This defines Text Number 6 to be Gal/m.
2. In INSTRUMENT/Units Page (Table 5.2.3)	set 'Custom 1 Units' = 08:Gal/m This sets Custom Units 1 to Gal/m
3. In STANDARD IO/PV Input Page (Table 17.2.1.)	set 'Units' = Custom 1

5.3.6. To Customise the Power Up Display

In this example the users company name will be used provide the start up message when the controller is switched on. The company name will be CML Controls and is based in Scotland.

5.3.6.1. Implementation

1. In INSTRUMENT/User Text Page (Table 5.2.6)	set User Text = Enabled set 'Text Number' = 7 (or any unused text no.) set 'Usr7' = CML Controls This defines Text Number 7 to be CML Controls set 'Text Number' = 8 (or any unused text no.) set 'Usr8' = Scotland
2. In INSTRUMENT/Display Page (Table 5.2.4)	set 'Startup Text 1' = 07: CML Controls set 'Startup Text 2' = 08: Scotland

6. CHAPTER 6 PROGRAMMER CONFIGURATION............. 2

6. Chapter 6 PROGRAMMER Configuration

This chapter explains Setpoint Programming and how to configure and edit the programmer function block. Editing and running programs is described in the Installation and Operating Handbook, Part No. HA026502

Note: The 2704 controller is an application specific controller and can be configured to the preferences of a particular process, site or even user. This means that the displays shown in this and following chapters may not be identical to those shown in your instrument. Displays shown in *italics* are user definable and may, therefore, vary between instruments.

About this Chapter

This chapter describes:

◊ The meaning of setpoint programs
◊ Setpoint programming terminology
◊ Programmer types
◊ How to configure a programmer
◊ Programmer soft wiring
◊ Examples of how to soft wire programmers

6.1.1. Customisable Parameter Names

Throughout this chapter parameter names shown in *italics* are customisable by the user when in configuration access level. The name of the parameter may vary, therefore, from instrument to instrument.
Typical customisable parameter names are:

Program names
Profile Setpoint names
Segment names

6.2. WHAT IS SETPOINT PROGRAMMING ?

Many applications need to vary the process value over time. Such applications need a controller which varies a setpoint as a function of time. The 2704 controller will program up to three separate profiles. These may be temperature, pressure, light level, humidity, etc., depending on the application, and are referred to as **Profiled Setpoints (PSPs).** A setpoint program containing three profile setpoints is shown in Figure 6-1.

The **Program** is divided into a flexible number of **Segments** - each being a single time duration, - and containing details for each profiled setpoint. The total number of segments available is **100 per program** with a **maximum of 500.**
A controller containing functionality to control profile setpoints against time is referred to as a **Programmer**. The 2704 programmer works on a single timebase for all programs.

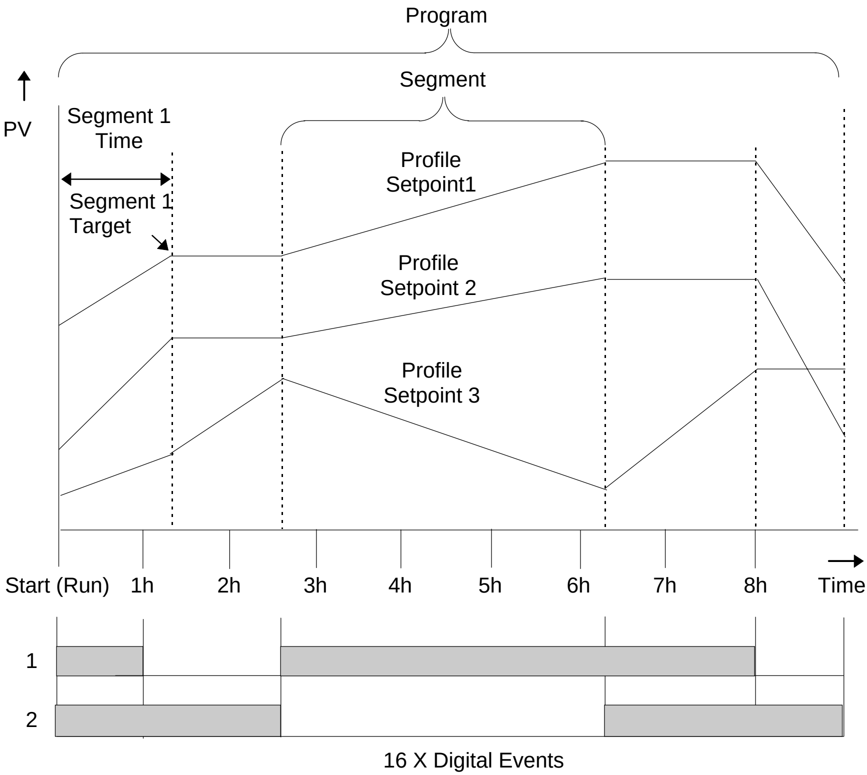


Figure 6-1: A Setpoint Program

The profiled setpoints may be used as either **control loop setpoints** or independent parameters for **retransmission** or use in **derived calculations**.
The 2704 may store up to **20 programs** as standard, with up to 50 if purchased.

6.3. THE 2704 SETPOINT PROGRAMMER DEFINITIONS

6.3.1. Run

In run the programmer varies the setpoint in accordance with the profile set in the active program.

6.3.2. Hold

In hold the programmer is frozen at its current point. In this state you can make temporary changes to program parameters such as a target setpoint, ramp rates and dwells (if programmer configured for ramp rate) or segment duration (if programmer configured as Time to Target). Such changes will only remain effective until the end of the currently running segment, when they will be overwritten by the stored program values.

6.3.3. Reset

In reset the programmer is inactive and the controller behaves as a standard controller, with the setpoint determined by the raise/lower buttons.

6.3.4. Servo

When a program is run the setpoint can start from the initial controller setpoint or from the current process value. Whichever it is the starting point is called the servo point. This can be set in the program.

The usual method is to servo to the process value because this will produce a smooth and bumpless start to the process.

If, however, when using a Ramp Rate programmer, it is essential to guarantee the time period of the first segment it may be better to set the controller to servo to setpoint. (Note: in a Time to Target programmer the segment duration will always be determined by the setting of the Segment Duration parameter.)

6.3.5. Hot Start

Hot start can occur in any segment type, for any PSP but is most useful to ramp segments. When run is initiated it allows the program to automatically advance to the correct point in the profile which corresponds to the operating value of the process. Hot start is enabled in configuration level and specifies which programmed variable to use when deciding the correct segment.

6.3.6. Power Fail Recovery

In the event of power fail to the controller, a strategy may be set in configuration level, which defines how the controller behaves on restoration of the power. These strategies include:

Continue	The program runs from the last setpoint. This may cause full power to be applied to the process for a short period to heat the process back to its value prior to the power failure
Ramp back	This will ramp the process value back to its original value at a controlled rate. This will be the last encountered rate.
Reset	The process is aborted by resetting the program
Hold Program	The programmer will enter the HOLD state. The operator may then change the state to Reset or Run. On exiting from Hold into Run the program will continue, it will not ramp back.
Test Time	This option makes use of the real time clock in the controller to determine how long the power has been off. Two time periods can be set which allows three strategies: 1. If the power is off for less than the first period, the programmer will continue from its last operating point 2. If the power is off for a time between the two time boundaries, the controller will servo to the PV and ramp back to the operating point using the previous ramp rate. 3. If the power is off for longer than the second time boundary, the programmer will reset. Note: The programmer takes about 25 seconds to start running after power is applied to the 2704. This delay should be taken into consideration when setting up the Test Time recovery parameter.

6.3.7. Profile Lock

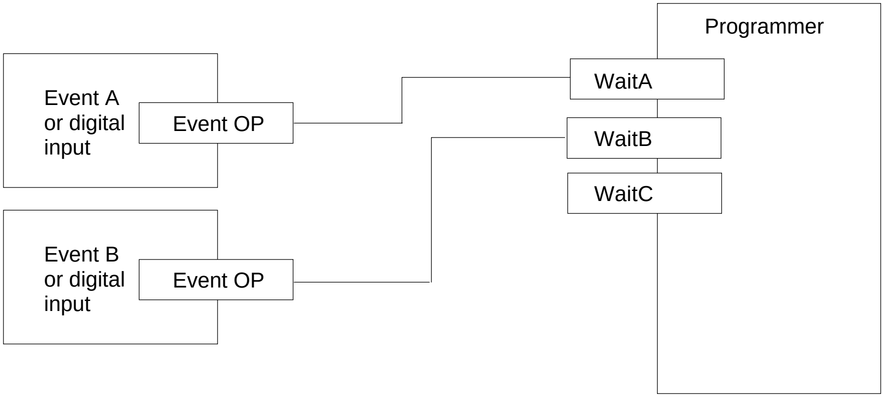
Profile Lock is a configuration parameter which allows programs to be created but which prevents them from being changed in operation levels.
If more than one program was created prior to 'Profile Lock' being selected, then the user can select these programs (using 'Program Number') but cannot create any more.

The options are:-

Fully Locked	No parameter or the profile can be changed in operation levels
Profile Locked	The profile of the program is locked but changes can be made to certain parameters such as Target setpoints, rates, dwells or segment duration.

6.3.8. Wait

Three wait conditions are provided at the end of each segment which may be wired, in configuration level, using a 'Toolkit Block' expression or by a digital input. Each segment may then select No-Wait, Wait on Event A, Wait on Event B or Wait on Event C. When all profile segments are complete, and the configured wait event is active, the program waits until the wait event becomes in-active before progressing to the next segment.



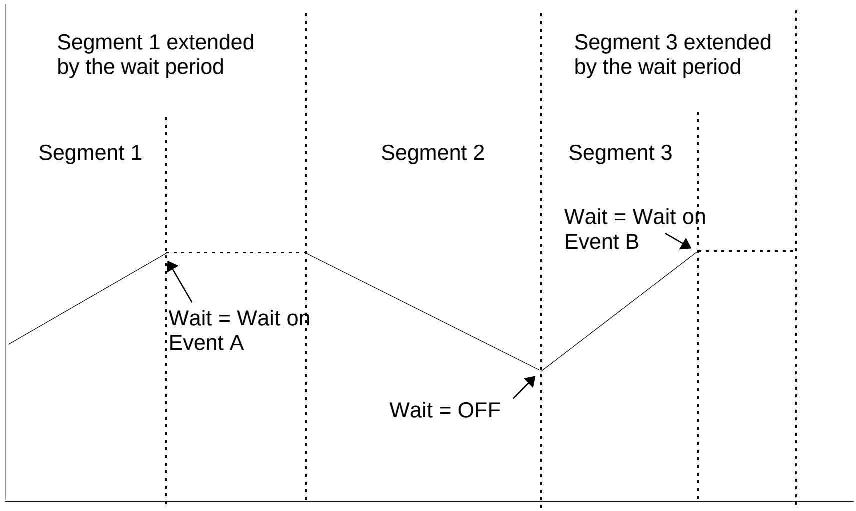


Figure 6-2: Wait Events

6.3.9. Holdback (Guaranteed Soak)

Holdback freezes the program if the process value does not track the setpoint by an amount which can be set by the user. It may operate in any PSP type.
In a **Ramp** it indicates that the process value is lagging the setpoint by more than a pre-set amount and that the program is waiting for the process to catch up.
In a **Dwell** it will freeze the dwell time if the difference between SP and PV exceeds pre-set limits.
In both cases it guarantees the correct soak period for the product.
Holdback may be configured in three modes:

- OFF - holdback does not operate
- Applied to the complete program. Holdback operates the same way in every segment
- To each individual segment. A different holdback type can be applied to each segment

Holdback Type defines how holdback operates. It may apply when:

- The PV is below the SP by a pre-set value (Lo),
- The PV is above the SP by a pre-set value(Hi)
- The PV is below or above the SP by a pre-set value (Band).

In addition two levels of holdback are available per profile setpoint, per program. These are defined as ‘Fine’ and ‘Course’.

Example:
Holdback, operating in each segment, is often used in a temperature control application as detailed below:-

During a ramp up period the holdback type may be set to deviation low. If the Process Value lags the programmed rate of rise, holdback will stop the program until the PV catches up. This prevents the set program from entering the next segment until the PV has attained the correct temperature.

During a dwell period the holdback type may be set to deviation band. This guarantees that the dwell or soak period operates only when the process value is within both high and low deviation limits.

During a ramp down period the holdback type may be set to deviation high. If the process cannot cool at the rate set by the ramp down rate the program will be held until the process catches up.

When a profile is placed into holdback the other profiles are (normally) not held. They continue and rendezvous at the end of the segment.

Each segment may consist of up to three profiles. Two levels of holdback value, course and fine, may be applied for each profile of each segment in the PROGRAM EDIT Program page.

6.3.10. Digital Inputs

Digital inputs are available on the controller which can be configured for the following programmer functions:

Run	Allows the program to be run from an external source such as a pushbutton or other event. The Run input is edge triggered.
Hold	Allows the program to be held from an external source such as a pushbutton or other event. The Hold input is level triggered.
Reset	Allows the program to be reset from an external source such as a pushbutton or other event. The Reset input is level triggered.
Run/Hold	Allows the program to be run or held from a single external input source
Run/Reset	Allows the program to be run or reset from a single external input source
Advance Segment	Selects the next segment from an external input source
Advance Program	Selects the next program from an external input source. When this event occurs, the controller display will change to programmer view. Subsequent changes of this input source will cause the program number to increment.
Holdback disabled	Disables holdback from an external input source

For more information on digital inputs refer to Chapters 17 and 18.

6.3.11. Program User Values

Program User Values provide multiplexor facilities for the user. Each user value provides storage for a number of event values (currently 100). Each user value will normally be wired (in software) to call up another feature.

The following example shows how the programmer user values may be used to call up different sets of pre-configured digital output values for different segments in a programmer. This would make use of the Pattern Generator described in Chapter 13, and assumes that an user value has been wired to a Pattern Generator.

Program Segment 1	Program Segment 2	Program Segment 3	Program Segment x
User Value 1 Value 1	User Value 1 Value 6	User Value 1 Value 11	User Value 1 Value 15
Pattern Generator output 1	Pattern Generator output 6	Pattern Generator output 11	Pattern Generator output 15

In each segment a different pattern of digital outputs is set up from the single value set in the User Value for each segment.

6.4. PROGRAMMER TYPES

The programmer can be configured as **Time to Target** or **Ramp Rate.** A time to target programmer requires fewer settings and is simple to use since all segments are the same. A time to target programmer can, in general contain more segments than a ramp rate.

6.4.1. Time To Target Programmer

Each segment consists of a **single duration parameter** and a set of **target values** for the profiled variables.

1. The **duration** specifies the time that the segment takes to change the profiled variables from their current values to the new targets.
2. A **dwell** type segment is set up by leaving the target setpoint at the previous value.
3. A **Step** type segment is set up by setting the segment time to zero.

6.4.2. Ramp Rate Programmer

Each segment can be specified by the operator as **Ramp Rate, Dwell or Step**.

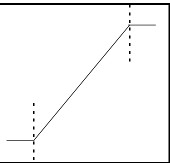
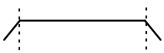
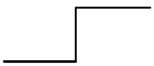
1. Each profiled setpoint must complete its segment before the programmer will move to the next segment. If one ramp reaches its target setpoint ahead of the other variables, it will dwell at that value until the other variables have completed. The program will then move to the next segment.
2. The duration parameter for a segment is read only. In this case the dwell period can be changed when the program is in Hold..
3. The duration is determined by the longest profile setting.

6.5. SEGMENT TYPES

A segment type can be defined as **Profile, Go Back To** or **End.**

6.5.1. Profile

A profile segment may be set as:-

Ramp		**The setpoint ramps linearly**, from its current value to a new value, either at a set rate (called *ramp-rate programming*), or in a set time (called *time-to-target programming*). You must specify the ramp rate or the ramp time, and the target setpoint, when creating or modifying a program.
Dwell		**The setpoint remains constant** for a specified period at the specified target. When creating programs the target is inherited from the previous segment. When editing an existing program it is necessary to re-enter the target value. This allows the dwell target to be matched to a go-back segment.
Step		**The setpoint steps instantaneously** from its current value to a new value at the beginning of a segment.

6.5.2. Go Back To Segment

Go Back allows segments in a program to be repeated by a set number of times. It is the equivalent of inserting 'sub-programs' on some controllers. Figure 6-3 shows an example of a program which is required to repeat the same section a number of times and then continue the program.

A Go Back To segment is used to save the total number of segments required in a program and to simplify setting up. When planning a program it is advisable to ensure that the end and start setpoints of the program are the same otherwise it will step to the different levels. A Go Back To segment is defined when editing a program, see 6.9.4.

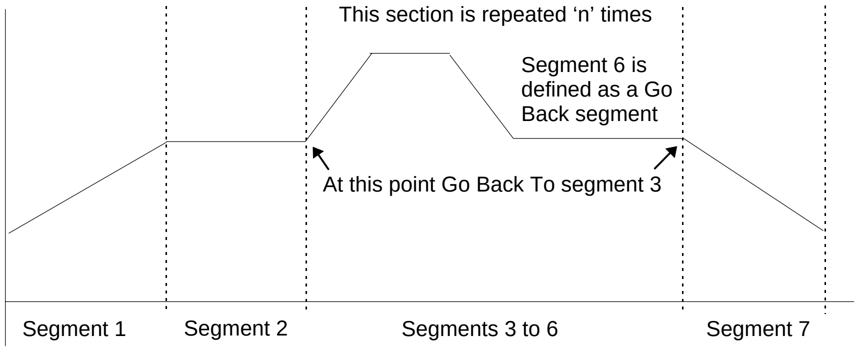


Figure 6-3: An Example of a Program with Repeating Section

Note 1. If a second or more 'Go Back' segments are created, they cannot return to a segment before the previous 'Go Back' segment as shown below.

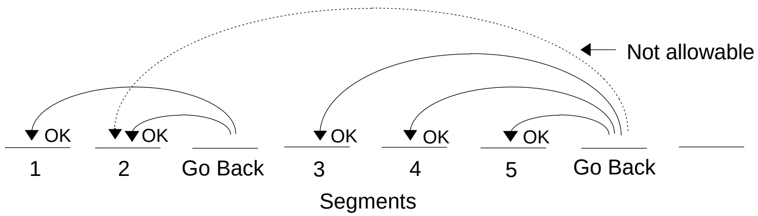


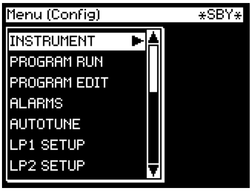
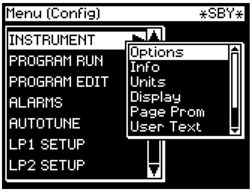
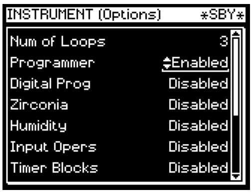
Figure 6-4: Permitted Go Back Segments

6.5.3. End Segment

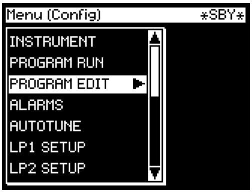
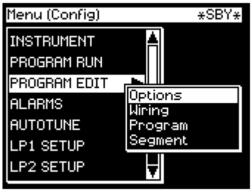
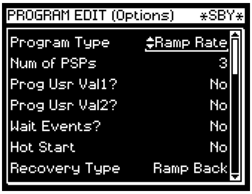
The last segment in a program is normally defined as an End segment

The program either ends, repeats or resets in this segment. You specify which is the case when you create, or modify, the program. When the program ends, the programmer is put into either, a continuous dwell state with all outputs staying unchanged, or the reset state.

6.6. TO ENABLE THE PROGRAMMER FUNCTION BLOCK

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] to access the page header menu. 2. Press [▲] or [▼] to select '**INSTRUMENT'**		
3. Press [scroll key] to display sub-headers 4. Press [▲] or [▼] to select '**Options'** (if necessary)		
5. Press [scroll key] to display parameters 6. Press [▼] to scroll to '**Programmer'** 7. Press [scroll key] to select 'Programmer' 8. Press [▲] or [▼] to **'Enabled'**		This turns the programmer feature on. If the instrument has been supplied as a programmer it will only be necessary to complete this step if the programmer feature has subsequently been disabled

6.7. TO CONFIGURE PROGRAMMER TYPE

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page] to access the page header menu. 2. Press [▲] or [▼] to select ‘**PROGRAM EDIT’**		
3. Press [scroll] to display sub-headers 4. Press [▲] or [▼] to select ‘**Options’** (if necessary)		
5. Press [scroll] to display parameters 6. Press [scroll] again to select **‘Program Type’** 7. Press [▲] or [▼] to **‘Time to Target’** or **‘Ramp Rate’**		The Program Type may be:- Time to Target - Each segment is a single duration. Or Ramp Rate - Segments are Ramp, Dwell or Step. Time to Target is the default **If programs have already been set up using the previous Program Type all segment data will be deleted and will need to be re-entered in Operation level.**
8. Confirm or reject as instructed	 If no button is pressed for 10 seconds the display reverts to previous.	The Program Type requires a few seconds to re-configure during which time **‘INITIALISING’** is displayed. The Program Type is then confirmed

The following table lists further parameters in this page

6.7.1. PROGRAM EDIT Options Page

Table Number: 6.7.1.	These parameters allow you to configure Program Type and Options. Press ↻ to select		PROGRAM EDIT (Options Page)
Parameter Name	**Parameter Description**	**Value**	**Default**
Program Type	See previous section		
Num of PSPs	Number of programmer setpoints	1, 2 or 3	
Prog Usr Val1?	Allows a programmer User Value to be enabled. See also section 6.3.11.	No Yes	No
Prog Usr Val2?		No Yes	No
PID Schedule?	Activates the display of PID set	No Yes	
Wait Events?	Activates the Wait events option	No Yes	
Hot Start	Activates the hot start option	No Yes	
Recovery Type	Defines the power recovery strategy See also Section 6.3.6.	Ramp Back Reset Continue Hold Test Time	Continue
Reset Time	Power recovery reset time (Only if 'Recovery Type' = 'Test Time')	0:00:00 to 23:59:59	
Servo Time	Power recovery servo time (Only if 'Recovery Type' = 'Test Time')	0:00:00 to 23:59:59	
Num of Prg DOs	Defines the number of digital event outputs used	None to 16	
PSP1 Units	Units to be displayed for PSP1	See Appx D.2.	
PSP1 Resol	PSP1 decimal point resolution	XXXXX XXXX.X XXX.XX XX.XXX	
PSP1 Low Lim	PSP1 low limit	Display range	
PSP1 High Lim	PSP1 high limit	Display range	
PSP1 Reset Val	Safe state target setpoint	Prog SP lo lim - Prog SP hi lim	
PSP1 Name	To choose a name for PSP1 from user text	Default Text to 50:User50	Default Text
Profile Lock	Prevents a program from being selected See also 6.3.7.	Unlocked Profile Locked Fully Locked	
The above parameters are repeated for PSP2 and PSP3 if 'Num of PSPs' = 2 or 3			

6.8. PROGRAMMER WIRING

6.8.1. Programmer Function Block

The programmer function block, shown in Figure 6-4, shows an example of soft wiring to other functions.. The connections can be made using the copy and paste method described in Section 3.1.2. with the exception of the Prg.DO1 to Prg.DO16 event outputs. These can be found by searching through the list of parameters or by entering the Modbus address directly. The Modbus addresses for these parameters are 05869 to 05883 inclusive.

The parameters which can be wired are listed in Table 6.7.2. These parameters can be wired to any other parameter by Modbus address or using the shorter list of parameter names.

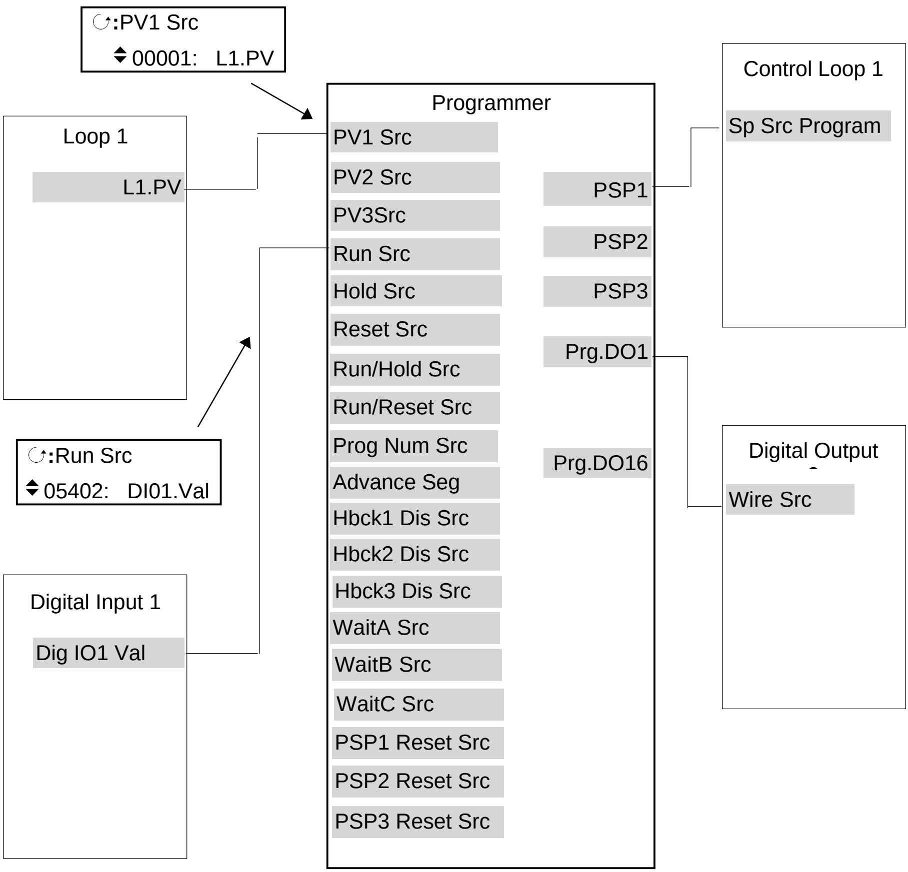


Figure 6-5: Programmer Function Block and Wiring Example

6.8.2. PROGRAM EDIT Wiring Page

This page is accessed using the same procedure as described in section 6.7.

Table Number: 6.8.2.	These parameters allow you to soft wire programmer functions	PROGRAM EDIT (Wiring Page)
Parameter Name Press ↻ to select	**Parameter Description**	**Default Wiring Value** Modbus Address:Parameter Mnemonic
PV1 Src	PV 1 source	00001:LP1 PV
PV2 Src	PV 2 source	01025:LP2 PV
PV3 Src	PV 3 source	02049:LP3 PV
Prog Num Src	Program number source	Note 2
Run Src	Run source	05494:DIO5
Hold Src	Hold Source	05642:DIO6
Reset Src	Reset Source	05690:DIO7
Run/Hold Src	Run/Hold Source	Note 2
Run/Reset S	Run/Reset Source	Note 2
Advanc Prog	Advance Program source	Note 2
Advanc Seg	Advance segment source	12609:DI8
FineHbck1 Sr	Fine holdback 1 source	Note 2
CorseHbck1	Course holdback 1 source	Note 2
Hbck1 Dis Src	Holdback 1 disable source	Note 2
FineHbck2 Sr	Fine holdback 2 source	Note 2
CorseHbck2	Course holdback 2 source	Note 2
Hbck2 Dis Src	Holdback 2 disable source	Note 2
FineHbck3 Sr	Fine holdback 3 source	Note 2
CorseHbck3	Course holdback 3 source	Note 2
Hbck3 Dis Src	Holdback 3 disable source	Note 2
WaitA Src	Wait A source	Note 2
WaitB Src	Wait B source	Note 2
WaitC Src	Wait C source	Note 2
PSP1 Reset Src	PSP1 reset source (1)	00001:LP1 PV
PSP2 Reset Src	PSP2 reset source (1)	01025:LP2 PV
PSP3 Reset Src	PSP3 reset source (1)	02049:LP3 PV

Note 1:-

The PSP Reset Source defines the programmer starting conditions. To servo to setpoint, wire the relevant reset source into the SP. To servo to PV, wire the relevant reset source into the PV.
The value which is wired into the Reset Source is the value which appears at the programmer output.

Note2:-
By default these parameters are not soft wired.

6.9. TO CREATE OR EDIT A PROGRAM

To create or edit a program it is first necessary to define the parameters associated with the overall program. These parameters will be found under the page header **'PROGRAM EDIT (Program)',** see section 6.9.2.

Then set up the parameters which define each individual segment. These parameters will be found in the page **'PROGRAM EDIT (Segments)',** see 6.9.4.

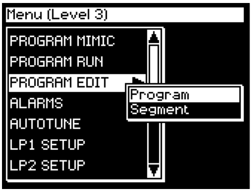
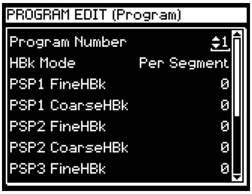
Notes:-

1. A running program cannot be edited, it must be put into **Reset** or **Hold** mode.
2. Changes can be made to any segment of a currently running program as follows:-

- To the currently running segment - use the PROGRAM RUN page. These changes are always temporary and apply to the current run only
- To segments subsequent to the current segment - use the PROGRAM EDIT page. These changes are always permanent and will apply to subsequent runs Changes can be made to the current segment in the PROGRAM EDIT page but do not take effect in the currently running program.

3. Other programs can be created or edited when another program is running.

6.9.1. To Access the Program Edit pages

Do This	This Is The Display You Should See	Additional Notes
1. From any display press to access the page header menu. 2. Press ▲ or ▼ to select '**PROGRAM EDIT**'		
3. Press to show sub-headers 4. Press ▲ or ▼ (if necessary) to select **'Program'**		This page allows the overall programmer parameters to be defined
5. Press to show parameters 6. Press again to select the highlighted parameter		The value of a parameter prefixed by ⬍ can be changed using ▲ or ▼ The full list of parameters is shown in the following table

⇓

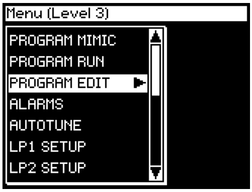
6.9.2. PROGRAM EDIT (Program Page) Parameters

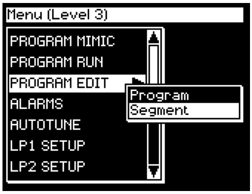
Table Number: 6.9.2	These parameters affect the overall program.		PROGRAM EDIT (Program Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Program Number	Selects the program number to be edited. If 'Profile Lock' ≠ 'Unlocked', only those programs which were created prior to setting the 'Profile Lock' parameter can be selected.	1 to 20 or 1 to 50	1	L1
Hbk Mode	Holdback mode		None	L1

	None = no holdback Per prog = applied over the whole program Per seg = active in every segment	None Per Program Per Segment		
PSP1 HBk Type	Holdback type for *PSP1* (per program) These are deviations between SP and PV Fine and course holdback allows two levels of holdback to be applied to different segments.	Off Fine Lo Fine Hi Fine Band Course Lo Course Hi Course Band	Off	L1 Only displayed if Per Program configured
PSP1 FineHbk	Fine holdback value for *PSP1*	Display Range	0	L3. Only shown if HBk Type ≠ Off
PSP1 CourseHbk	Course holdback value for *PSP1*	Display Range	0	
The above three parameters are repeated for *PSP2* and for *PSP3* if these are configured				
Hot Start PSP	Allows hot start to be applied to each PSP. See also 6.3.5.	None *PSP1* *PSP2* *PSP3*	None	L1
Rate Units	Rate units for a Ramp Rate Programmer	Per Second Per Minute Per Hour		L3. Only displayed if the programmer is Ramp Rate
Program Cycles	The number of times a program repeats.	Cont. to 999	Cont.	L1
End Action	Defines the action in the end segment. Dwell - the program will dwell indefinitely at the conditions set in the end segment. Reset - the program will reset to the start conditions.	Dwell Reset		L1
Program Name	Allows a user defined name to be given to the program number	User string Each character can be set in turn		L1

6.9.3. To Set Up Each Segment of a Program

<table>
<tr><th>Do This</th><th>This Is The Display You Should See</th><th>Additional Notes</th></tr>
<tr><td>1. From any display press 🗋 to access the page header menu.

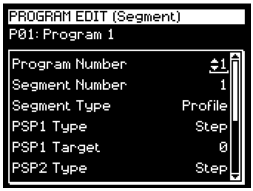
2. Press ▲ or ▼ to select 'PROGRAM EDIT'</td><td>
</td><td></td></tr>
<tr><td>3. Press ⟳ to show sub-headers

4. Press ▲ or ▼ (if necessary) to select 'Segment'</td><td>
</td><td>If the program is new, confirm as instructed on the display

Create Prg: 2?
🗋→Cancel ⟳→OK</td></tr>
<tr><td>5. Press ⟳ to select the segment parameters

6. Press ▲ or ▼ to scroll up or down the list of parameters.

7. Press ⟳ again to choose parameter.

The value or state of a parameter prefixed by ⬍ can be changed using ▲ or ▼</td><td>If the program exists, the segment details are displayed

</td><td>Up to 100 segments are available per program</td></tr>
</table>

Tip ☺ A back and forward scroll is available by holding down ⟳ and pressing ▲ or ▼ respectively

Further parameters may be accessed and adjusted in the same way. These are listed together with an explanation of their function in the following table

.

⇓

6.9.4. PROGRAM EDIT (Segment) Parameters

Table Number: 6.9.4.	**These parameters allow you to set up each segment in the program**			**PROGRAM EDIT (Segment)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Program Number	Selects the program number to be edited	1 to 20 (or 50)		L1
Segment Number	Selects the segment number to be edited	1 to 100		L1
Segment Type	Segment type	Profile End Segment Go Back	Profile	L1
Profile = a normal segment End Segment = the last segment in the program (press ⭯ to confirm) Go Back = repeat part of program. Not shown for segment 1.				
PSP1 Type	Profile setpoint 1 type	Step Dwell Ramp		L1.
Only shown if Program Type = Ramp Rate and program not in End				
PSP1 Target	Profile setpoint 1 target value	SP1 lo limit to SP1 hi limit	0	L2
PSP1 Dwell Tm	Profile setpoint 1 dwell time	d : h : m : s		L1.
Only shown if Program Type =Ramp Rate; Segment Type = Dwell and program not in End				
PSP1 Rate	Profile setpoint 1 rate			L2.
Only shown if Program Type =Ramp Rate; Segment Type = Dwell and program not in End				
PSP1 Hbk Type	Profile setpoint 1 holdback type	Off Fine Lo Fine Hi Fine Band Course Lo Course Hi Course Band	Off	L2.
Only shown if holdback is configured per segment				

The above five parameters are repeated if *PSP2* and *PSP3* are configured

Seg Duration	Duration for Time to Target programmer only	d : h : m : s		L2.
Wait Event	Wait if selected event is true Only shown if wait events configured	No wait Event A Event B Event C	No Wait	L2.
Prog User Val 1	Allows a Programmer User Val to be chosen. See also section 6.3.11. Only shown if Prog User Val 1 is configured	0 to 100	0	L1
Prog User Val 2	Allows a Programmer User Val to be chosen. See also section 6.3.11. Only shown if Prog User Val 2 is configured	0 to 100	0	L1
Prog DO Values	Sets programmer event outputs on or off. The number of DO values is set by 'Num of Prog DOs' PROGRAM EDIT (Options) Not shown if Num of Prog Dos = 'None'			L2.
GoBack to Seg	Allows repeat segments to be set up within a profile. Go back defines the point in the program where the repeat segments are entered. Only shown if segment. type is Go Back	1 to no. of segments See also Section 6.5.2.		L2.
Go Back Cycles	Sets up the number of times the segments are repeated Only shown if segment. type is Go Back	1 to 999	1	L2.
Segment Name	Allows a user defined name to be chosen	Default Text to 50:Usr 50	Default Text	L1

6.9.5. Run Parameter Tables

A program can only be run from Operator levels 1, 2 or 3, as described in the Installation and Operation Handbook, Part No. HA026502. The ‘PROGRAM RUN’ pages provide information on the running program.

Table Number: 6.9.5a	**These parameters are displayed for a running program**			**PROGRAM RUN (General Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Prog DOs	Digital outputs summary (Up to 16)	□□■□ □ = Off ■ = On		L1
Time Remaining	Time remaining to end of program	Not Running or h:mm:ss		L3
Days Remaining	Number of days left for the programmer to run	0 to 255		L3
Fast Run	Allows the program to fast run	No Yes	No	L3. Alterable in reset or complete
Program Status	Displays the status of the program	Reset Run Hold Complete		L1.
Prog Time Elap	Program time elapsed	h: mm: ss		R/O
Prog Cycle Rem	Remaining number of cycles	1 to 999		L1 R/O (only shown if ‘Prog Cycles’ > 1)
Total Segments	Number of segments in the running program	0 to 100		R/O
Segment Number	The currently running segment number	1 to 100		L1 R/O
Segment Type	Running program segment type Profile = normal segment End Segment = End of prog Go Back =repeat part of prog	Profile End Segment Go Back	Profile	L1 R/O Alterable in Hold
Segment Name	A user defined name for the segment		Default Text	L1 R/O

Seg Time Rem	Time remaining in the current segment	d: h: m: s		L1. R/O Alterable if Time To Target prog and in Hold
Wait Status	Wait Status	No Wait Event A Event B Event C	No Wait	R/O
Wait Condition	Wait condition for the running segment	No Wait Event A Event B Event C	No Wait	L1. Alterable in Hold
Prog User Val 1	Active Programmer User Val 1			L1
Prog User Val 2	Active Programmer User Val 2			L1
Goback Rem	Number of repeat cycles remaining	1 to 999		R/O
End Action	The state required in the end segment	Dwell Reset		R/O
Prog Reset DO	These are the digital events in Reset □□■□□□■□■□□□□□■□			R/O Only shown if configured.
Reset UsrVal1	Reset prog user 1 values			L3
Reset UsrVal1	Reset prog user 1 values			L3

Table Number: 6.9.5b	These parameters are associated with Profiled Setpoint number 1			PROGRAM RUN (*PSP1* Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Seg Time Rem	Segment time remaining	h: m: s		
PSP1 Type	Running segment type for profiled setpoint 1	Step Dwell Ramp		R/O - shown in Ramp Rate prog.
PSP1 WSP	Working setpoint for profiled setpoint 1	Display range [1]		L1. Alterable in Hold
PSP1 Target	Running segment target for profiled setpoint 1	Display range [1]		L1. Alterable in Hold
PSP1 Dwell Tm	Time remaining in running segment for profiled SP 1	Display range		L1. Alterable in Hold
PSP1 Rate	Running segment rate for profiled setpoint 1	Display range [1]		L1. Not in Time To Target prog
PSP1 HBk Appl	Holdback applied for profiled setpoint 1	No Yes		R/O - shown if configured

1. Range limited by user defined upper and lower limits

Table 6.9.5b is repeated for *PSP2* parameters and *PSP3* parameters

6.10. PROGRAMMER WIRING EXAMPLES

6.10.1. One Profile, Three Loops

This example explains how to configure a programmer to allow one profile to generate a setpoint for three control loops.

The 2704 program block can generate up to three profiled variables, which can then be internally wired to any parameter source. In most cases the PSPs are used to allow control loop setpoints to follow a pre-determined ramp/dwell sequence, but they can also be used, for example, to retransmit a setpoint to a slave device.

In this example PSP1 is soft wired to the program setpoints of each control loop. Also, the PV of loop1 is wired to the PV1 source, to provide holdback, and the PSP1 reset source, to provide servo start. This configuration is supplied from the factory by defining the hardware code field, in the 2704 order code, for loops/programs to be '321' or '351'.

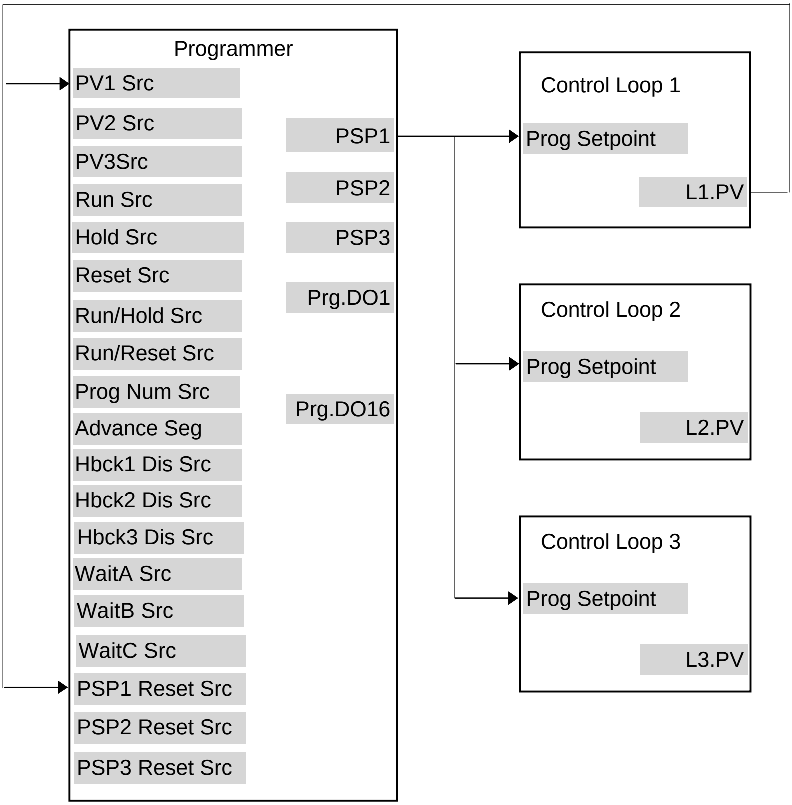


Figure 6-6: Example Programmer Wiring One Profile Three Loops

6.10.1.1.Implementation

1.	In INSTRUMENT/Options Page (Table 5.2.1),	set ’Num of Loops’ = 3 set ‘Programmer = Enabled
2.	In PROGRAM EDIT/Options Page (Table 6.7.1)	set ‘Num of PSPs’ = 1 (Note: other parameters such as number of digital event outputs, SP range and power failure recovery are also set in this page)
3.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set ‘PV1 Src’ = 00001:L1.PV This connection is required so that the programmer can use Loop 1 PV to calculate holdback.
4.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set ‘PSP1 Reset Src’ = 00001:L1.PV This connection is required so that the programmer can use Loop 1 PV to servo start.
5.	In LP1 SETUP/Options Page (Table 9.1.1)	Set ‘Prog Setpoint’ = PSP1 Connects PSP1 to become the program SP for Loop 1
6.	In LP2 SETUP/Options Page (Table 9.1.1)	Set ‘Prog Setpoint’ = PSP1 Connects PSP1 to become the program SP for Loop 2
7.	In LP3 SETUP/Options Page (Table 9.1.1)	Set ‘Prog Setpoint’ = PSP1 Connects PSP1 to become the program SP for Loop 3

See Appendix D for list of Modbus addresses.

☺ Tip:- See ‘Copy and Paste’ description in Chapter 3.

6.10.2. Two Profiles, Two Loops

This example explains how to configure a 2704 programmer to generate two setpoints which are then used to profile the setpoint for two independent control loops.

In this example PSP1 and PSP2 are soft wired to the program setpoints of loop 1 and loop 2 respectively. Also, the PV of loop1 is wired to the PV1 source, to provide holdback, and the PSP1 reset source, to provide servo start. The latter is repeated for Loop 2. This configuration is supplied from the factory by defining the hardware code field, in the 2704 order code, for loops/programs to be ‘222’ or ‘252’.

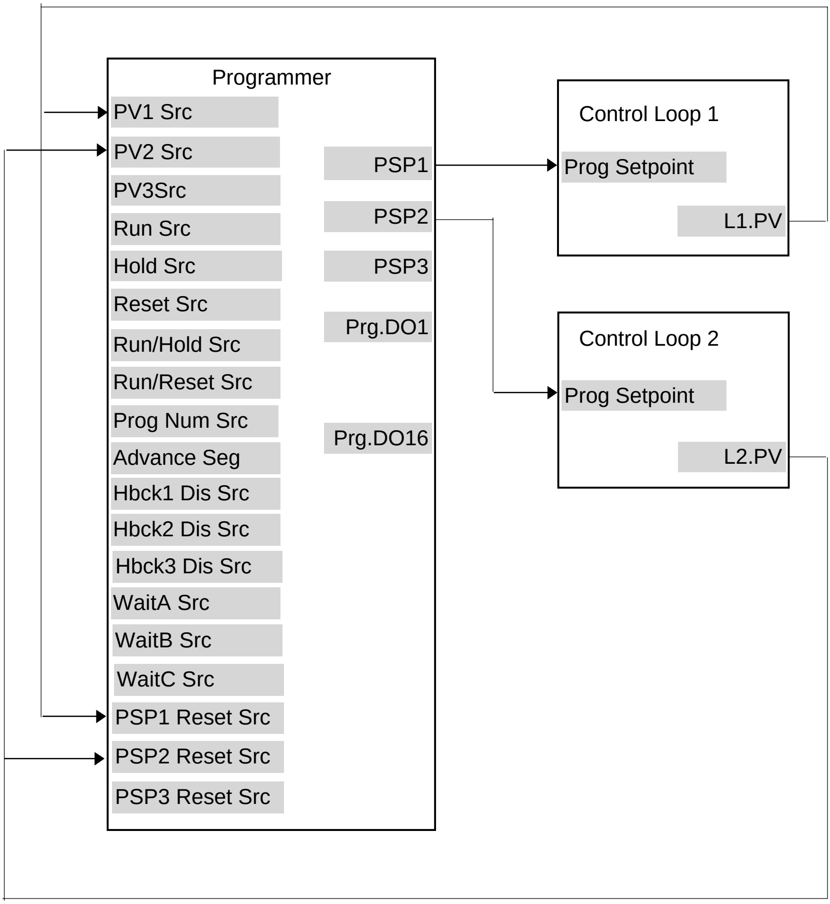


Figure 6-7: Example Programmer Wiring Two Profiles Two Loops

6.10.2.1.Implementation

1.	In INSTRUMENT/Options Page (Table 5.2.1),	set 'Num of Loops' = 2 set 'Programmer = Enabled
2.	In PROGRAM EDIT/Options Page (Table 6.7.1)	set 'Num of PSPs' = 2 (Note: other parameters such as number of digital event outputs, SP range and power failure recovery are also set in this page)
3.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set 'PV1 Src' = 00001:L1.PV This connection is required so that the programmer can use Loop 1 PV to calculate holdback for PSP1.
4.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set 'PV2 Src' = 01025:L2.PV This connection is required so that the programmer can use Loop 2 PV to calculate holdback for PSP2.
5.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set 'PSP1 Reset Src' = 00001:L1.PV This connection is required so that PSP1 can use Loop 1 PV to servo start.
6.	In PROGRAM EDIT/Wiring Page (Table 6.8.2)	Set 'PSP2 Reset Src' = 01025:L2.PV This connection is required so that PSP2 can use Loop 2 PV to servo start.
7.	In LP1 SETUP/Options Page (Table 9.1.1)	Set 'Prog Setpoint' = PSP1 Connects PSP1 to become the program SP for Loop 1
8.	In LP2 SETUP/Options Page (Table 9.1.1)	Set 'Prog Setpoint' = PSP2 Connects PSP2 to become the program SP for Loop 2

See Appendix D for list of Modbus addresses.

☺ **Tip:- See 'Copy and Paste' description in Chapter 3.**

7. CHAPTER 7 ALARM OPERATION

7. Chapter 7 ALARM OPERATION

7.1. DEFINITION OF ALARMS AND EVENTS

Alarms are used to alert an operator when a pre-set level or condition has been exceeded. They are normally used to switch an output - usually a relay - to provide interlocking of the machine or plant or external audio or visual indication of the condition.

Soft Alarms are indication only within the controller and are not attached to an output (relay).

Events - can also be alarms - but are generally defined as conditions which occur as part of the normal operation of the plant. They do not generally require operator intervention. An example might be to open/close a vent during a programmer cycle.
The controller does not display the alarm status on the front panel.

For the purposes of the configuration of this controller, alarms and events can be considered the same.

7.1.1. Customisable Parameter Names

Throughout this chapter parameter names shown in *italics* are customisable by the user. The name of the parameter may vary, therefore, from instrument to instrument.

Typical customisable parameter names are:

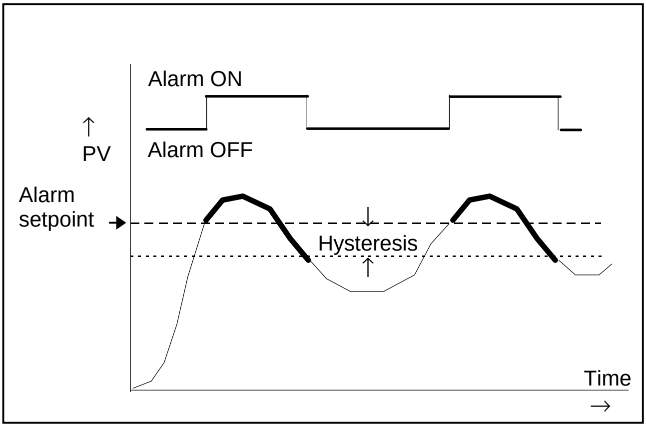
- Alarm names
- Loop names
- Module and Input names
- Custom units
- Promoted parameters

7.2. TYPES OF ALARM USED IN 2704 CONTROLLER

This section describes graphically the operation of different types of alarm used in the 2704 controller. The graphs show measured value plotted against time. The measured value may be any analogue value available in the controller.

7.2.1. Full Scale High

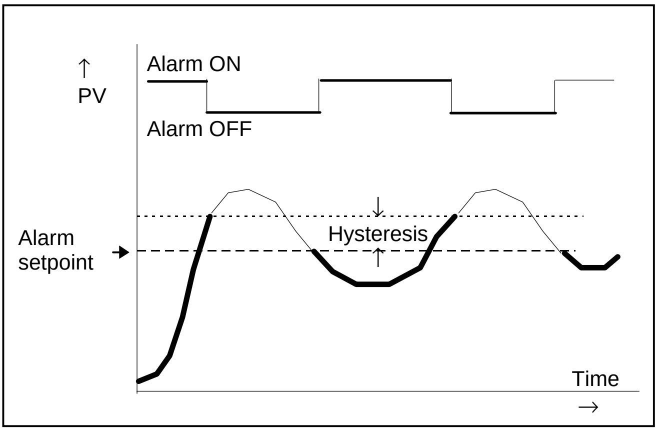
The Process Variable (PV) exceeds a set high level



Hysteresis is the difference between the alarm ON value and the alarm OFF value. It is used to prevent relay chatter.

7.2.2. Full Scale Low

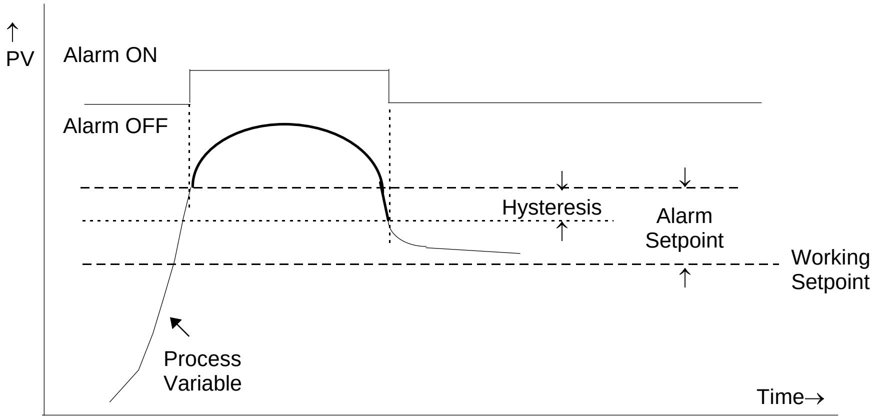
The Process Variable (PV) exceeds a set low level



7.2.3. Deviation High Alarm

The alarm occurs when the difference between the process variable and the setpoint is positive by greater than the alarm setpoint.

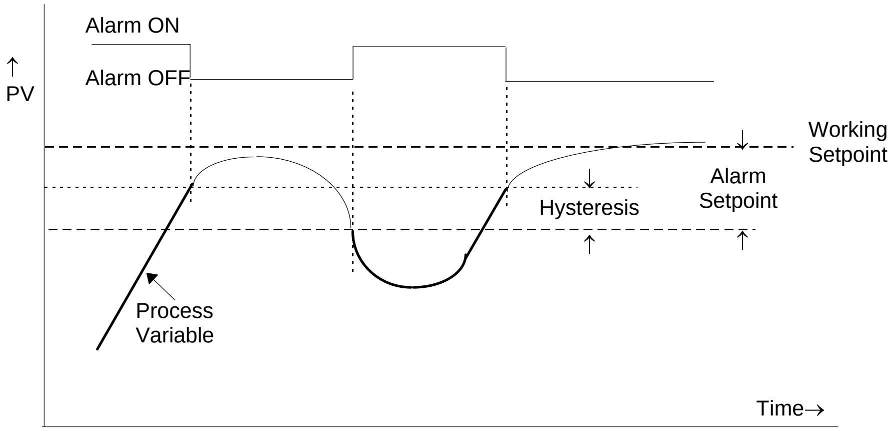
Note: For User Analogue Value the deviation is the difference between the two user wired analogue inputs.



7.2.4. Deviation Low Alarm

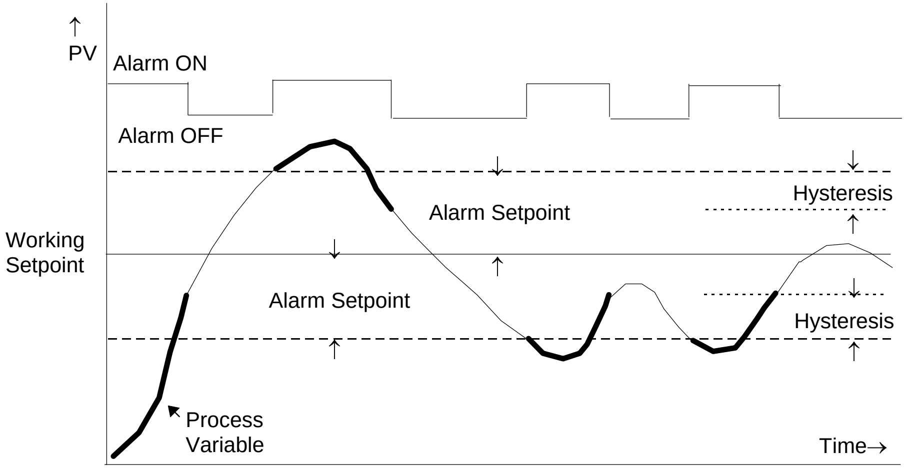
The alarm occurs when the difference between the process variable and the setpoint is negative by greater than the alarm setpoint.

Note: For User Analogue Value the deviation is the difference between the two user wired analogue inputs.



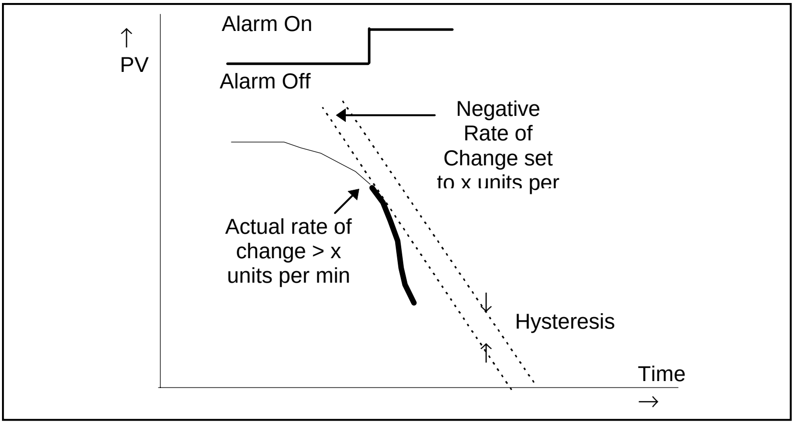
7.2.5. Deviation Band

A deviation band alarm monitors the process variable and the working setpoint and continuously compares the difference against the alarm setpoint. If the difference is either negative by greater than the alarm setpoint, or positive by greater than the alarm setpoint, the alarm state will be active.



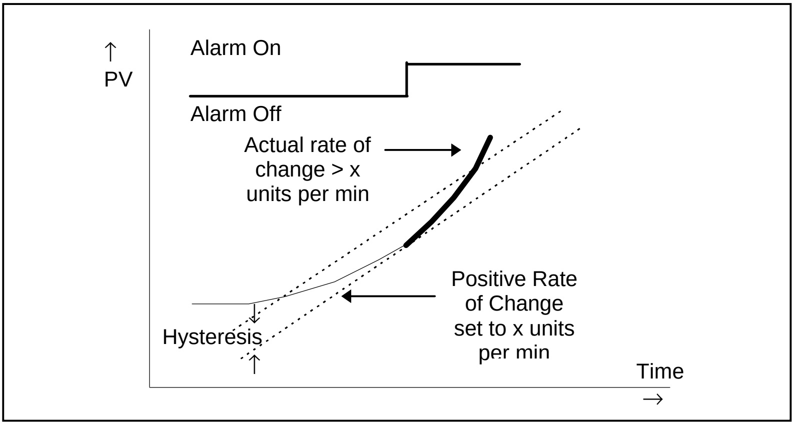
7.2.6. Rate Of Change Alarm (Negative Direction)

The Process Value falls faster than the alarm setting.



7.2.7. Rate Of Change Alarm (Positive Direction)

The Process Value rises faster than the alarm setting.



Notes:

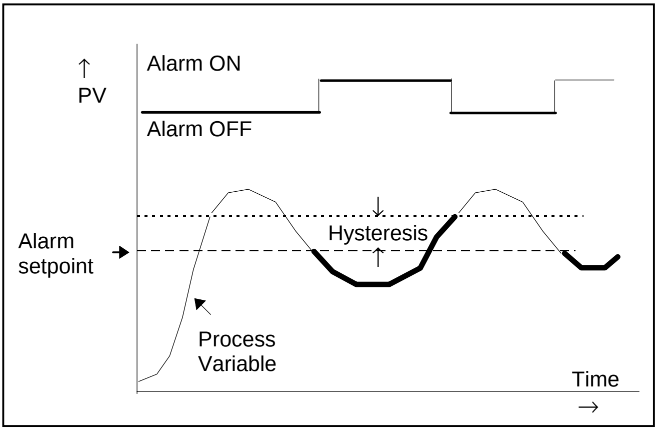
1. Separate alarms are required for positive and negative rates of change
2. An alarm is indicated during the period that the actual rate of change is greater than the set rate of change.
3. There may be a small delay before the instrument displays an alarm condition since the instrument requires several samples. This delay increases if the set value and actual value are close together
4. A hysteresis value of, say, 1 unit per second will prevent the alarm from ‘chattering’ if the rate of change varies by this amount

7.3. BLOCKING ALARMS

A Blocking Alarm only occurs **after** it has been through a start up phase. It is typically used to prevent alarms from being indicated until the process has settled to its normal working conditions.

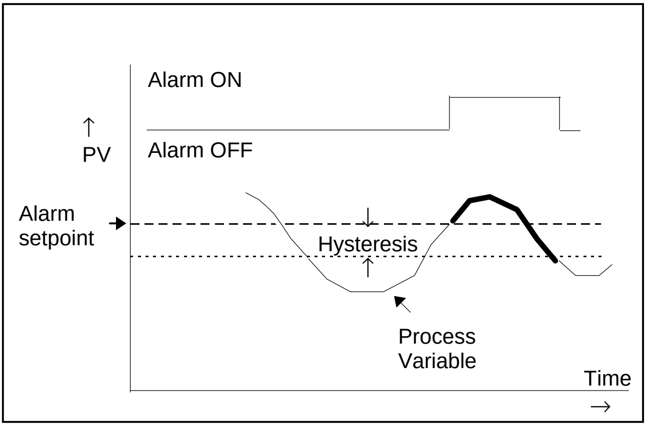
7.3.1. Full Scale Low With Blocking

The alarm only occurs **after** the start up phase when low alarm has first entered a safe state. The next time a low alarm occurs will cause the alarm to become active.



7.3.2. Full Scale High Alarm With Blocking

The alarm only occurs **after** the start up phase when high alarm has first entered a safe state. The next time a high alarm occurs will cause the alarm to become active.

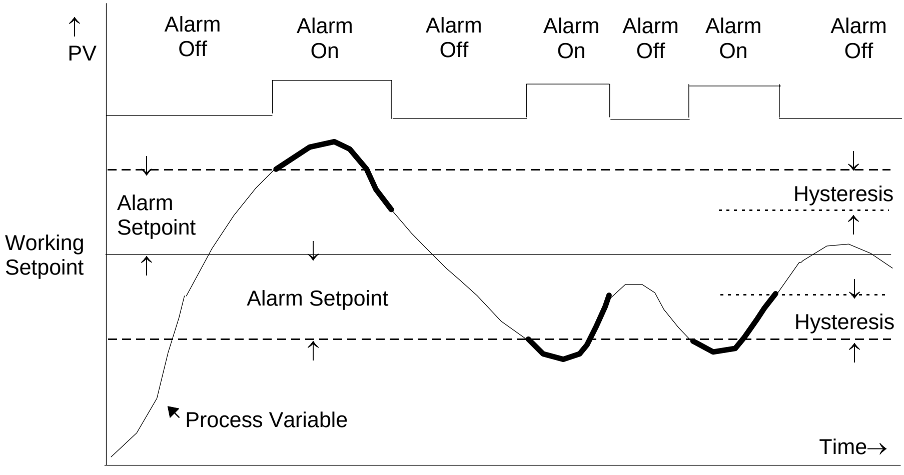


i.e. If the controller is powered up with PV > 'Hi Alarm SP' no alarm is indicated. The PV must reduce below the 'High Alarm SP' and increase again to > 'Hi Alarm SP'. The alarm condition will then be indicated.

If the controller is powered up with PV < 'Hi Alarm SP' an alarm is indicated as soon as PV > 'Hi Alarm SP'

7.3.3. Deviation Band With Blocking

The alarm only occurs **after** the start up phase when low deviation alarm has first entered a safe state. The next time an alarm occurs, whether high band or low band will cause the alarm to become active.



7.4. LATCHING ALARMS

The alarm is indicated until it is acknowledged by the user. Acknowledgement of an alarm can be through the controller front buttons, from an external source using a digital input to the controller or through digital communications.

There are two ways that the alarm can be acknowledged:

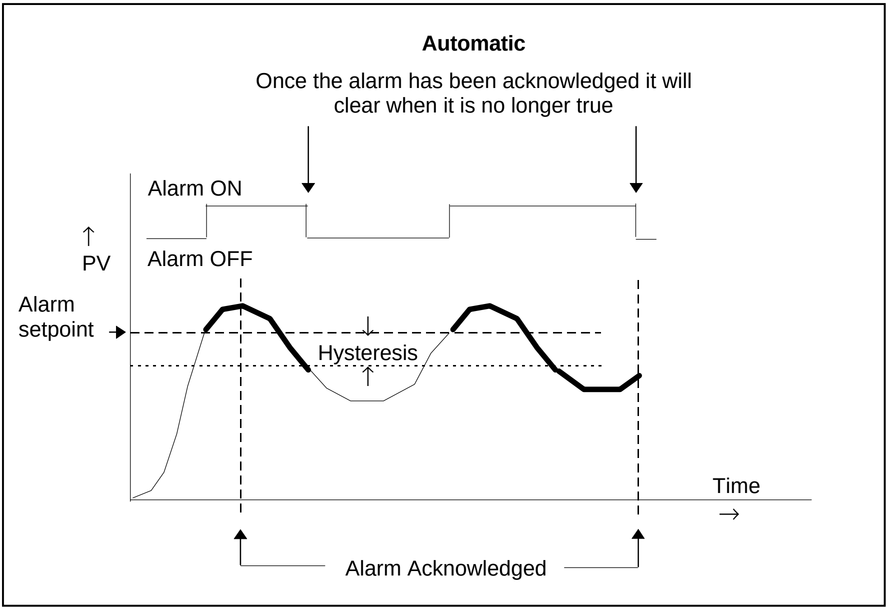
1. **Automatic.** The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can occur **BEFORE** the alarm condition is removed.

2. **Manual.** The alarm continues to be active until both the alarm condition is removed AND the alarm is acknowledged. The acknowledgement can only occur **AFTER** the alarm condition is removed.

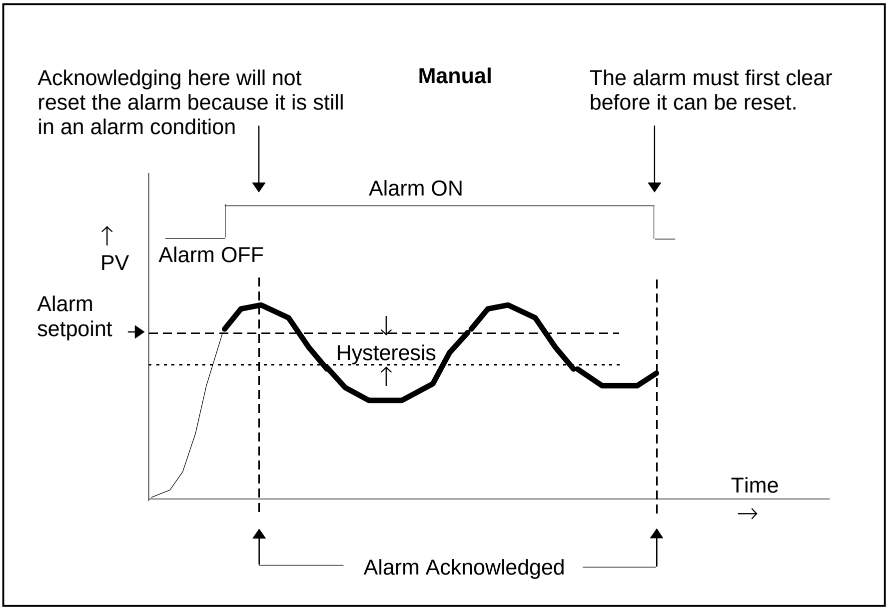
These are shown below for a Full Scale High Alarm

7.4.1. Latched Alarm (Full Scale High) - Automatic

The alarm is displayed until it is acknowledged



7.4.2. Latched Alarm (Full Scale High) - Manual



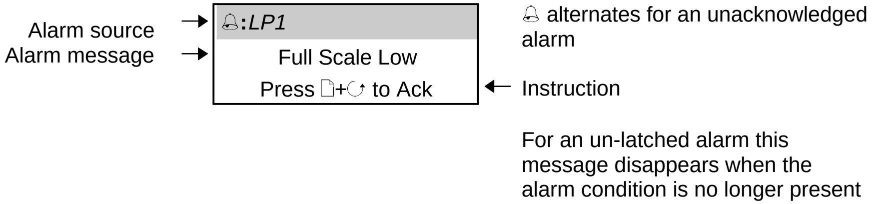
7.4.3. Grouped Alarms

Alarms can be associated with different aspects of the process. They are grouped in accordance with the functions they perform as follows:

Loop Alarms	Alarms associated with each control loop. Examples are: High, Low, Deviation and Rate of Change. Two alarms are available for each loop. On a new controller these are the only alarms which are configured - those listed below must be enabled in configuration level.
PV Input Alarms	Alarms which operate on the PV input. Examples are: High and Low. Two alarms are available with this input.
Analogue Input Alarms	Alarms which operate on the analogue input. Examples are: High and Low. Two alarms are available with this input.
Module Alarms	Alarms which operate on each plug in module. These can be input or output alarms depending upon the function of the module fitted. These alarms are associated with modules 1, 3, 4, 5, & 6, since module 2 is reserved as a an extra memory module
User Alarms	Eight undedicated alarms which can be wired to any variable.

7.5. HOW ALARMS ARE INDICATED

Alarms are indicated when the controller is in normal operating level. When an alarm occurs a message will appear on the display which will indicate the source and the type of alarm. The format of this alarm message is:



When the alarm has been acknowledged the message shown in the banner of the pop up window above will now be shown in the Loop Display page.
The 🔔 symbol will be shown steady in the top banner of any page if any alarm is still present.

If a relay has been connected to the output of the alarm, it will operate to allow an external beacon or audible device to be activated. In general, the relay will be de-activated when the alarm is acknowledged, subject to the latching configuration.

7.5.1. Alarm Delay Time

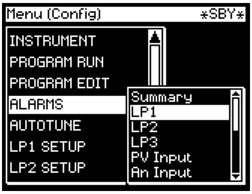
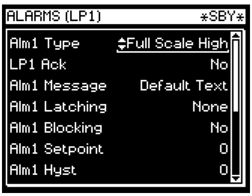
A delay time can be set for each alarm between the occurrence of the alarm and the indication of the alarm in the controller. This is useful to prevent spurious alarms from being indicated in some noisy or rapidly changing processes.
Delay time can only be set in Configuration level.

If delay time has been configured for the alarm the user may be aware that the occurrence of an alarm may not necessarily correspond with the display of the alarm

7.6. TO CONFIGURE AN ALARM

The example below is shows how to configure a Loop 1 Alarm. Each loop has two alarms, shown on the display as Alm1 and Alm2.

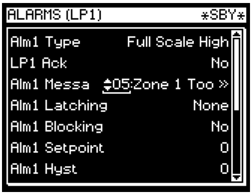
The procedure described below is the same for all alarms.

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'ALARMS'**		
3. Press [scroll key] to display sub-headers 4. Press [▲] or [▼] to select **'*LP1*'**		The first sub-header is Summary. Further sub-headers allow other alarms to be configured Text shown in *italics* is user definable and will appear if:- 1. User Text is enabled in INSTRUMENT page, see section 5.2.6. 2. The text has been assigned to this parameter
5. Press [scroll key] to display *LP1* alarm parameters 6. Press [scroll key] again to select **'Alm1 Type'** 7. Press [▲] or [▼] to configure the alarm type	**To Configure Alarm Type** 	The choices are:- Off Full Scale Low Full Scale High Deviation Band Deviation High Deviation Low Rate of Change

To Configure Alarm Message

1. Press to scroll to **'Alm1 Message'**

2. Press or to select the message



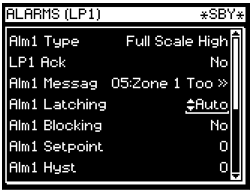
The message which appears when an alarm occurs can be customised from the list of User Text messages.

This example chooses User Text number **'05'** previously set to **'Zone 1 Too Hot'.** See also section 5.2.6.

To Configure Alarm Latching

1. Press to scroll to **'Alm1 Latching'**

2. Press or to select choose the latching type



The choices are:-

None

Auto

Manual

Event See also 7.1

See section 7.4 for a description of alarm latching

To Configure Alarm Blocking, Alarm Setpoint, Alarm Hysteresis, Alarm Delay, Alarm Inhibit

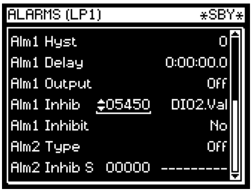
1. Press to scroll to the parameter

2. Press or to select choose the condition or value

To Configure Alarm Inhibit Source

1. Press to display **'Alm1 Inhibit Sr'**

2. Press or to select the Modbus address of the source parameter which you wish to wire to.



The alarm can be inhibited while an event is true.

Here it is shown soft wired to Digital Input 02.

For a list of commonly used wireable parameters see Appendix D.

The next parameter is Alm1 Inhibit. If this is set to:-
No → the event is ignored
Yes → the alarm waits for the event to become true.

7.7. ALARM TABLES

The following alarm pages are available:-

Summary	A summary of all alarms. This table is also available in Level 3 but can be promoted to Level 1, see section 5.2.5.	
Alarms Loop 1	See section 7.6 above	
Alarms Loop 2	These are the same as loop 1	Alarms for These pages are configured As in section 7.6
Alarms Loop 3	These are the same as loop 1	
PV Input	High and Low Alarms are available for the fixed PV Input.	
Analogue Input	High and Low Alarms are available for the fixed Analogue Input.	
Module 1, 3, 4, 5 & 6	High and Low Alarms are available each module.	
User 1 to 8	These are alarms which are user defined	

7.7.1. ALARMS (Summary Page)

Table Number: 7.7.1.	**These parameters indicate alarm status** Alarm parameters in this table only appear if the function is enabled. The last three parameters always appear.			**ALARMS (Summary Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
LP1 Ack1	Loop 1 alarm 1 acknowledge	No Yes		L1
LP1 Ack2	Loop 1 alarm 2 acknowledge	No Yes		L1
LP2 Ack1	Loop 2 alarm 1 acknowledge	No Yes		L1
LP2 Ack2	Loop 2 alarm 2 acknowledge	No Yes		L1
LP3 Ack1	Loop 3 alarm 1 acknowledge	No Yes		L1
LP3 Ack2	Loop 3 alarm 2 acknowledge	No Yes		L1
PV Alm AckH	PV Input high alarm acknowledge	No Yes		L1
PV Alm AckL	PV Input low alarm acknowledge	No Yes		L1
An Alm AckH	Analogue Input high alarm acknowledge	No Yes		L1
An Alm AckL	Analogue Input low alarm acknowledge	No Yes		L1
Module 1A 1 AckH	Module 1 high alarm acknowledge	No Yes		L1
Module 1A 1 AckL	Module 1 low alarm acknowledge	No Yes		L1
The above two alarms are repeated for Module 3, 4, 5 and 6 if the modules are fitted				
User 1 Ack	User defined alarm 1 acknowledge	No Yes		L1
The above alarm is repeated for up to eight user alarms if they have been configured				
New Alarm	Set to true on a new alarm	No Yes		R/O
Ack All Alms?	Acknowledges all alarms (Global acknowledge)	No Yes		L3
Ack All Src	Global Acknowledge Source	Modbus Address		Conf

7.7.2. ALARMS *LP1 (2* or *3)* Page Parameters

Table Number: 7.7.2.	**These parameters configure the Loop alarms.** Alarm 1 parameters only appear if the 'Alm 1 Type' ≠ 'None' Alarm 2 parameters only appear if the 'Alm 2 Type' ≠ 'None'			**ALARMS *LP1 (2* or *3)***
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Alm1 Type	Alarm 1 Type	Off Full Scale Low Full Scale High Deviation Band Deviation High Deviation Low Rate of Change	As order code	Conf
LP1 Ack	Group alarm acknowledge for loop 1. Acknowledges both loop alarms.	No Yes	No	L1
Alm1 Message	Alarm 1 message. Use △ or ▽ to choose from the User Text messages set up in section 5.2.6.	Default Text or User defined Text 01 to 50	Default Text	Conf
Alm1 Latching	Alarm 1 latching. Use △ or ▽ to choose latching type	None Auto Manual Event	None	Conf
Alm1 Blocking	Alarm 1 blocking. Use △ or ▽ to enable/disable	No Yes	No	Conf
Alm1 Setpoint	Alarm 1 Setpoint	Controller range	0.0	L1
Alm1 Hyst	Alarm 1 hysteresis	Controller range		L3
Alm1 Delay	Alarm 1 delay	0:00:00.0	0.0	Conf
Alm1 Output	Alarm 1 output	Off On	Off	R/O
Alm1 Inhibit Src	Alarm 1 inhibit source	Modbus address	None	Conf
Alm1 Inhibit	Alarm 1 inhibit	No Yes	No	L3
Alm2 Type	Alarm 2 Type	As Alm1 Type		Conf
Alm2 Inhibit Src	Alarm 2 inhibit source	Modbus address	None	Conf
Alm2 parameters are the same as Alm1 parameters if 'Alm2 Type' ≠ 'None'				

7.7.3. ALARMS (PV Input Page) Parameters

Table Number: 7.7.3.	**These parameters set up the alarms associated with the PV input signal.** They are only displayed if enabled using the parameter FS Hi Alarm or FS Lo Alarm			ALARMS (PV Input)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
FS Hi Alarm	Full scale high alarm enable/disable	Disabled Enabled	Disabled	Conf
PV Alm Ack	Group acknowledge. Acknowledges both Hi and Lo alarms	No Acknowledge		L1
FS Hi Message	Full scale high message. Use △ or ▽ to choose from the User Text messages set up in section 5.2.6.	Default Text or User defined Text 01 to 50	Default Text	Conf
FS Hi Blocking	Full scale high blocking. Use △ or ▽ to enable/disable	No Yes		Conf
FS Hi Latching	Full scale high latching. Use △ or ▽ to choose latching type	None Auto Manual Event		Conf
FS Hi Setpoint	Full Scale High Alarm (1) Setpoint	Controller range		L1
FS Hi Hyst	Full Scale High alarm (1) hysteresis	Controller range		L3
FS Hi Delay	Full Scale High alarm (1) delay	0:00:00.0		Conf
FS Hi Output	Full Scale High alarm (1) output	Off On	Off	R/O
FS Lo Alarm	Full scale Low alarm enable/disable	Disabled Enabled	Disabled	Conf
FS Lo parameters are the same as FS Hi parameters if ‘FS Lo Alarm’ = ‘Enabled’				
Inhibit Src	Alarm inhibit source	Modbus Address		Conf
Inhibit	Alarm inhibit value	No Yes	No	L3

7.7.4. ALARMS (An Input Page) Parameters

The parameters for the Analogue Input Alarms are identical to the PV Input Alarms

7.7.5. ALARMS (Module 1,3, 4, 5 & 6 Page) Parameters

The parameters for the Module Alarms are identical to the PV Input Alarms. Module alarm pages only appear if suitable modules are fitted.

7.7.6. ALARMS (User 1 to 8 Page) Parameters

Table Number: 7.7.6.	**These parameters set up user defined alarms.**	**ALARMS (User 1) (to User 8)**		
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Type	Alarm Type	Off Full Scale Low Full Scale High Deviation Band Deviation High Deviation Low Rate of Change	As order code	Conf
User 1 Ack	Group alarm acknowledge for user alarm 1	No Acknowledge	No	L1
Src A	Alarm source A	Modbus address	None	Conf
Src B	Alarm source B	Modbus address	None	Conf
Name	User defined alarm name. Use △ or ▽ to choose from the User Text messages set up in section 5.2.6.	Default Text or User defined Text 01 to 50	Default Text	Conf
Message	User defined message. Use △ or ▽ to choose from the User Text messages set up in section 5.2.6.	Default Text or User defined Text 01 to 50	Default Text	Conf
Latching	Indicates if the alarm has been configured as latching	None Auto Manual		R/O at L3

		Event		
Blocking	Indicates if the alarm has been configured as blocking	No Yes		R/O at L3
Setpoint	Alarm Setpoint	Controller range		L1
Hyst	Alarm hysteresis	Controller range		L3
Delay	Alarm delay	0:00:00.0		Conf
Output	Alarm output	Off On	Off	R/O at L1
Val A	Used if the user alarm is deviation. Normally internally wired to the PV	Disp min to disp max		R/O at L3 if wired to PV source
Val B	Used if the user alarm is deviation. Normally internally wired to the SP	Disp min to disp max		R/O at L3 if wired to PV source
Inhibit Src	Alarm inhibit source	Modbus address		Conf
Inhibit	Alarm inhibit	No Yes	No	L3

The above table is repeated for:

User alarm 2
User alarm 3
User alarm 4
User alarm 5
User alarm 6
User alarm 7
User alarm 8

7.8. ALARM WIRING EXAMPLES

7.8.1. Control Loop With High and Low Alarms

In this example two alarms are added to the loop wiring example shown in Section 3.1. Alarm 1 is configured as a high alarm and operates the fixed relay 'AA'. This relay is inhibited until a digital input, 'DIO1' becomes true. Alarm 2 is configured as a low alarm and operates a relay module in slot 3.

- - - - - - - = Connections made in example shown in Section 3.1

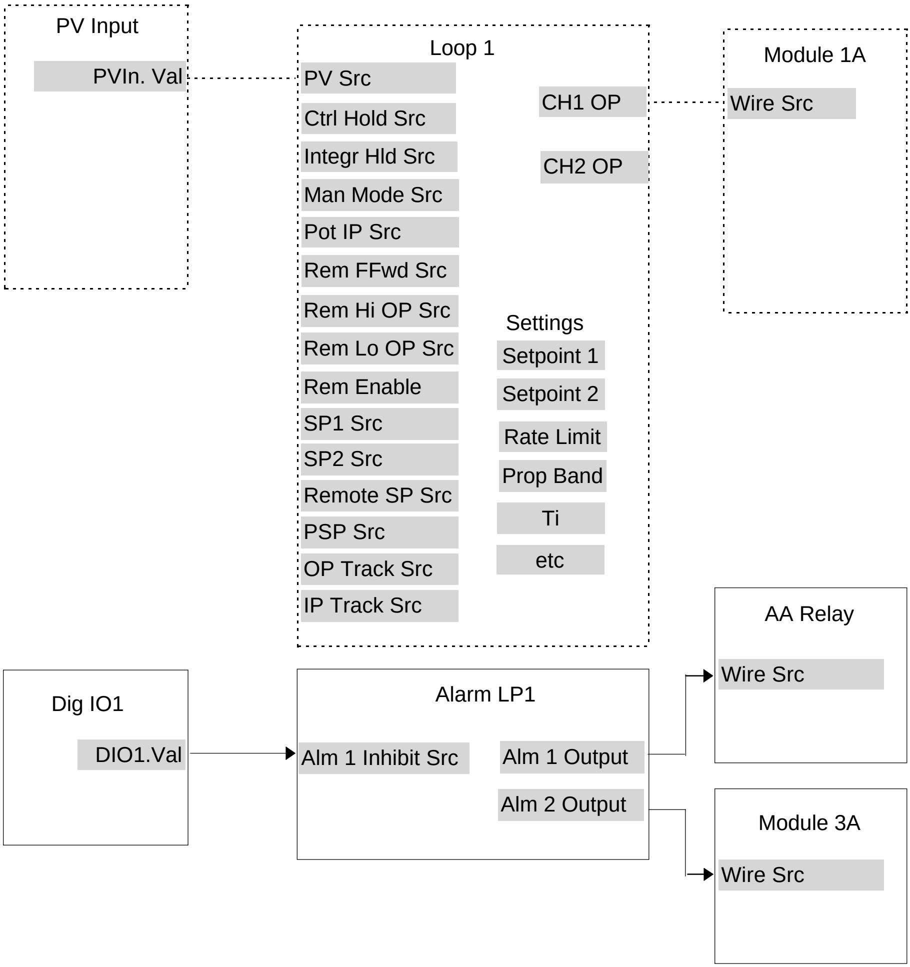


Figure 7-1: Loop Alarm Wiring

7.8.1.1. Implementation

1. In ALARMS/LP1 Page (Table 7.7.2)	set 'Alm1 Type' = Full Scale High
2. In ALARMS/LP1 Page (Table 7.7.2)	set 'Alm2 Type' = Full Scale Low (Note: other parameters such as alarm message, alarm latching, alarm blocking are also set in this page)
3. In ALARMS/LP1 Page (Table 7.7.2)	Set 'Alm1 Inhibit Src' = 05402:DO1.Val This connects the alarm 1 inhibit to fixed digital input 1
4. In STANDARD IO/AA Relay Page (Table 17.4.1)	Set 'Wire Src' = 11592:L1Alm1.OP This connects Alarm 1 output to operate the AA relay
5. In MODULE IO/Module 3A Page (Table 18.4.2)	Set 'Wire Src' = 11602:L1Alm2.OP This connects Alarm 2 output to operate the relay fitted in module position 3.

See Appendix D for list of Modbus addresses.

☺ **Tip:- See 'Copy and Paste' description in Chapter 3.**

7.8.2. Loop Alarm Inhibited if Programmer not in Run

In this example the alarm is gated as in the previous example. To determine if the programmer is in Run mode an Analogue Operator (An Oper 1) is used.

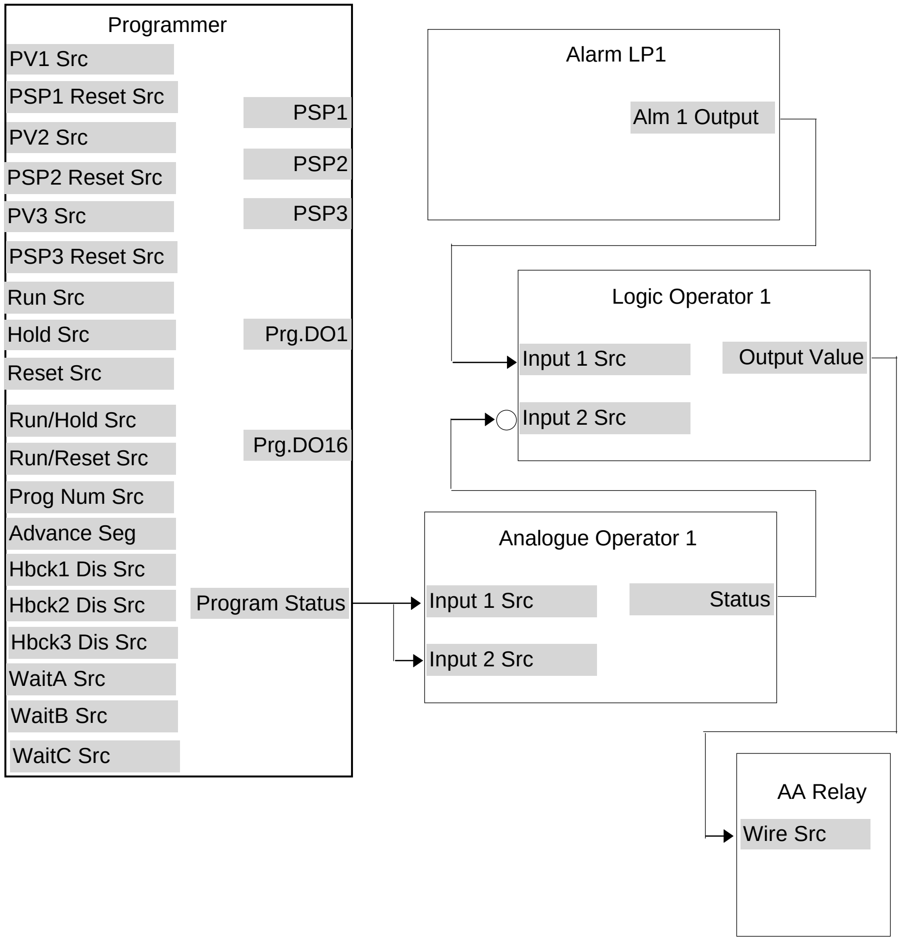


Figure 7-2: Loop Alarm Inhibited if Programmer not in Run

7.8.2.1. Implementation

1. In LOGIC OPERS/Logic 1 Page (Table 15.2.1)	set ’Operation’ = AND set ‘Invert’ = Invert Input 1 Invert input 1 is necessary because the previous operation results in 0 for a true state Set ‘Input 1 Src’ = 06239:--------- This is the Status of the Logic Operator Set ‘Input 2 Src’ = 11592: L1Alm1.OP This sets the logic operator such that both inputs must be true before the output status is true
2. In ANALOGUE OPERS/Analogue 1 Page (Table 14.2.1)	set ‘Operation’ = Select Max set ‘Input 1 Src = 05844:--------- This is the Programmer Status set ‘Input 2 Src’ = 05844 It is necessary to connect both inputs of an analogue operator set ‘Input 1 Scalar’ = 1 set ‘Input 1 Scalar’ = 2 set ‘Low Limit’ = +1 set ‘High Limit’ = +1 (Note: when Programmer Status = Run the result of the calculation is 0)
3. In STANDARD IO/AA Relay Page (Table 17.4.1)	Set ‘Wire Src’ = 07176:LgOp1.OP This connects Logic Operator 1 output to operate the AA relay

8. Chapter 8 Tuning

This chapter describes how to tune your controller to match the characteristics of the process under control.
There are five topics:

- WHAT IS TUNING?
- AUTOMATIC TUNING
- MANUAL TUNING
- GAIN SCHEDULING
- TUNING OF CASCADE LOOPS

This chapter should be read in conjunction with Chapter 9, Loop Set Up.

8.1. WHAT IS TUNING

In tuning, you match the characteristics of the controller to those of the process being controlled in order to obtain good control. Good control means:

- Stable, 'straight-line' control of the PV at setpoint without fluctuation
- No overshoot, or undershoot, of the PV setpoint
- Quick response to deviations from the setpoint caused by external disturbances, thereby rapidly restoring the PV to the setpoint value.

Tuning involves calculating and setting the value of the parameters listed in Table 8-1. These parameters appear in the *Loop* Setup (PID) list, see Chapter 9.

Parameter	Meaning or Function
Proportional band	The bandwidth, in display units or %, over which the output power is proportioned between minimum and maximum.
Integral time	Determines the time taken by the controller to remove steady-state error signals.
Derivative time	Determines how strongly the controller will react to the rate-of-change of the measured value.
High Cutback	The number of display units, above setpoint, at which the controller will increase the output power, in order to prevent undershoot on cool down.
Low cutback	The number of display units, below setpoint, at which the controller will cutback the output power, in order to prevent overshoot on heat up.
Cool gain	Only present if cooling has been configured and a module is fitted. Sets the cooling proportional band, which equals the proportional band value divided by the cool gain value.

Table 8-1: Tuning Parameters

8.2. AUTOMATIC TUNING

The 2704 controller uses a one-shot tuner which automatically sets up the initial values of the parameters listed in Table 8-1 on the previous page.

8.2.1. One-shot Tuning

The ‘one-shot’ tuner works by switching the output on and off to induce an oscillation in the measured value. From the amplitude and period of the oscillation, it calculates the tuning parameter values.

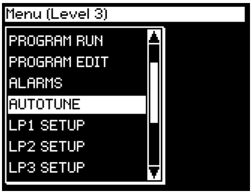
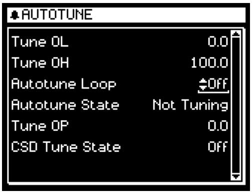
If the process cannot tolerate full heating or cooling being applied during tuning, then the levels can be restricted by setting the autotune high power limit (‘Tune OH’) and autotune low power limit (‘Tune OL’) in the AUTOTUNE parameters page (Table 8.3.2.). However, the measured value *must* oscillate to some degree for the tuner to be able to calculate values.

A One-shot Tune can be performed at any time, but normally it is performed only once during the initial commissioning of the process. However, if the process under control subsequently becomes unstable (because its characteristics have changed), you can re-tune again for the new conditions.

It is best to start tuning with the process at ambient conditions and with the SP close to the normal operating level. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

8.3. TO AUTOTUNE CONTOL LOOP *LP1*

In most cases it will only be necessary to carry out the Autotune procedure when commissioning your controller.

Do This	This Is The Display You Should See	Additional Notes
Set the setpoint to the value at which you will normally operate the process .		
1. From any display press as many times as necessary to access the page header menu 2. Press or to select **'AUTOTUNE'**		Autotune page is at Level 3 by default, but can be promoted to L1 or L2. See 5.2.5.
3. Press to display sub-headers 4. Press or to select **'Autotune Loop'** 5. Press to select the parameter. 6. Press or to choose the loop to tune		The choices are:- *LP1* *LP1A* *LP1* Cascade These are repeated for Loops 2 and 3 Note: Text shown in *italics* is user definable in configuration mode and may be different from that shown

1. The controller induces an oscillation in the PV by first turning the output (power) on, and then off. The power is limited by **'Tune OL'** and **'Tune OH'**. These two parameters are defaulted to 0 and should be set to values which do not overload the process. The first cycle is not complete until the measured value has reached the required setpoint.

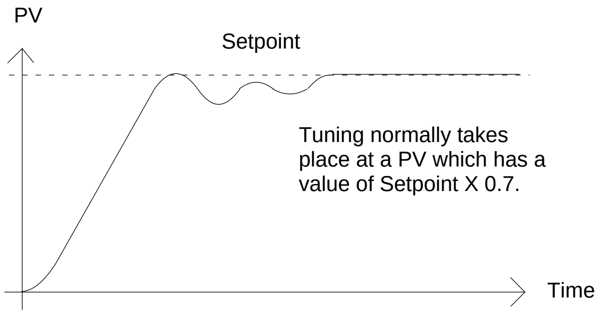
2. After two cycles of oscillation the tuning is completed and the tuner switches itself off.

3. When the controller is autotuning the status of autotune is shown periodically on the relevant loop summary

4. The controller then calculates the tuning parameters listed in Table 8-1 and resumes normal control action.

If you want 'Proportional only', 'PD', or 'PI' control, you should set the Integral time parameter or derivative time parameter to OFF before commencing the tuning cycle. These parameters are found in the *Loop* Setup (PID) pages, see Chapter 9. The tuner will leave them off and will not calculate a value for them.

Typical automatic tuning cycle



Calculation of the cutback values

Low cutback and *High cutback* are values that restrict the amount of overshoot, or undershoot, that occurs during large step changes in PV (for example, under start-up conditions).

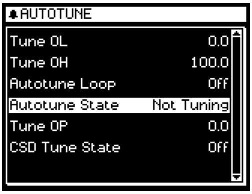
If either low cutback, or high cutback, is set to ‘Auto’ the values are fixed at three times the proportional band, and are not changed during automatic tuning.

8.3.1. AutotuneParameters

Table Number: 8.3.1.	These parameters allow you to autotune the loop			AUTOTUNE
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Tune OL	Auto tune low power limit. Set to a 'safe' value for the process	-100 to 100%	0	L1
Tune OH	Auto tune high power limit Set to a 'safe' value for the process	-100 to 100%	0	L1
Autotune Loop	Selects the loop number to tune	*LP1* *LP!A* *LP1* (CSD) *LP2* *LP2A* *LP2* (CSD) *LP3* *LP3A* *LP3* (CSD)		L1
Autotune State	Shows the current state of autotune	Not Tuning Measuring Noise Tuning A at SP Tuning to SP Finding Minimum Finding Maximum Storing Time End Calculating PID ABORTED	Not Tuning	L1 R/O
Tune OP	Tune output	-100 to 100		L1
CSD Tune State	Cascade tuning state	Off Initialising Tuning Slave Waiting Waiting Again Tuning Master	Off	L1

8.3.2. To View the State of Autotune

As autotune progresses, its state is displayed on the loop overview screen and also in the autoune parameter list as follows.

Do This	This Is The Display You Should See	Additional Notes
1. From the previous display Press to display **'Autotune State**		This parameter displays the state of Autotuning. The choices are: Not Tuning Measuring Noise Tuning A at SP Tuning to SP Finding Minimum Finding Maximum Storing Time Calculating PID End ABORTED In the relevant loop summary, a message below the banner is periodically flashed with the loop being tuned. A second message flashes the state of tuning from the text above.

8.4. MANUAL TUNING

If for any reason automatic tuning gives unsatisfactory results, you can tune the controller manually. There are a number of standard methods for manual tuning. The one described here is the Ziegler-Nichols method.

With the process at its normal running conditions:

1. Set the Integral Time and the Derivative Time to OFF.

2. Set High Cutback and Low Cutback to 'Auto'.

3. Ignore the fact that the PV may not settle precisely at the setpoint.

4. If the PV is stable, reduce the proportional band so that the PV just starts to oscillate. If PV is already oscillating, increase the proportional band until it just stops oscillating. Allow enough time between each adjustment for the loop to stabilise. Make a note of the proportional band value 'B' and the period of oscillation 'T'.

5. Set the proportional band, integral time and derivative time parameter values according to the calculations given in Table 8-2.

Type of control	Proportional band (P)	Integral time (I)	Derivative time (D)
Proportional only	2xB	OFF	OFF
P + I control	2.2xB	0.8xT	OFF
P + I + D control	1.7xB	0.5xT	0.12xT

Table 8-2: Tuning Values

Note:-
The parameters listed in the above table will be found under the heading **Loop Setup**. This heading is also described in the following chapter.

8.4.1. Setting the cutback values

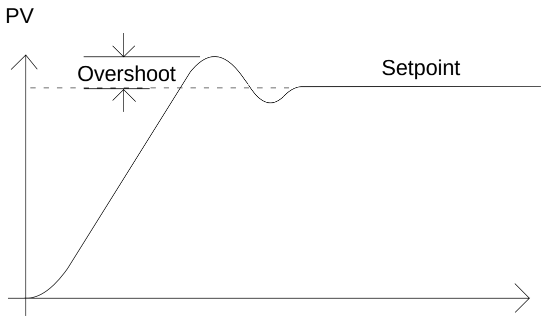
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in PV, then manually set the cutback parameters.

Proceed as follows:

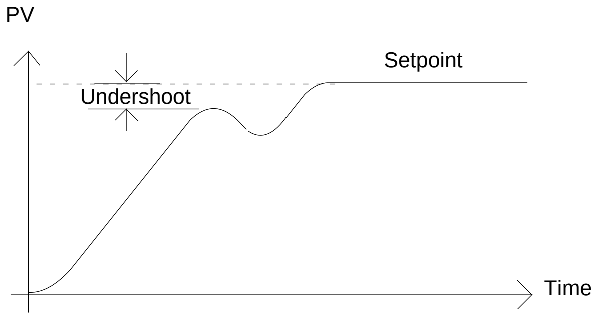
1. Set the low and high cutback values to three proportional bandwidths (that is to say, Lcb = Hcb = 3 x P).
2. Note the level of overshoot, or undershoot, that occurs for large PV changes (see the diagrams below).

In example (a) increase Low Cutback by the overshoot value. In example (b) reduce Low Cutback by the undershoot value.

Example (a)



Example (b)



Where the PV approaches setpoint from above, you can set High Cutback in a similar manner.

8.4.2. Integral action and manual reset

In a full three-term controller (that is, a PID controller), the integral term automatically removes steady state errors from the setpoint. If the controller is set up to work in two-term mode (that is, PD mode), the integral term will be set to 'OFF'. Under these conditions the measured value may not settle precisely at setpoint. When the integral term is set to 'OFF' the parameter *manual reset* appears in the *Loop* Setup (PID) page. This parameter represents the value of the power output that will be delivered when the error is zero. You must set this value manually in order to remove the steady state error.

8.4.3. Valve Position Control

See section 9.7 'Control of Valve Positioning Motors', for an explanation of the additional parameters required for motorised valves and how to set the values of these parameters.

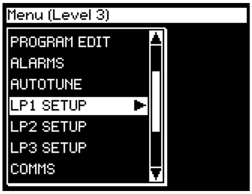
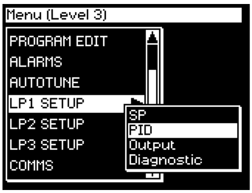
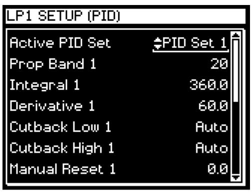
8.5. GAIN SCHEDULING

Gain scheduling is the automatic transfer of control between one set of PID values and another. In the case of the 2704 controller, this is done at a presettable value of SP, PV Error, OP or a remote source. This is determined in configuration level. Gain scheduling is used for the more difficult to control processes which exhibit large changes in their response time or sensitivity at, for example, high and low PVs, or when heating or cooling.

The 2704 controller has three sets of PID values. You can select the active set from either a digital input, or from a parameter in the *Loop* Setup (PID) page, see Chapter 9, or you can transfer automatically in gain scheduling mode. The transfer is bumpless and will not disturb the process being controlled .

8.5.1. To Use Gain Scheduling

If gain scheduling has been enabled in configuration level:-

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'LP1 SETUP'**		Alternatives are *LP 2* and *LP 3*. These only appear in the list if the loops are configured *LPx* SETUP page is at Level 3 by default but may have been promoted to L1 or L2.
3. Press to display sub-headers 4. Press ▲ or ▼ to select **'PID'**		
5. Press to show the parameter list. 6. Press again to select **'Active PID Set'**. 7. Press ▲ or ▼ to select the PID set to use for gain scheduling		The choices are PID Sets 1 to 3. To change the active PID set, press to select, then press ▲ or ▼ to change.

You must now set up the three sets of PID values. The values can be manually set, or automatically tuned as described earlier in this chapter. When tuning automatically you must tune three times, once below the switching point '1/2 Boundary' once between 1/2 Boundary' and '2/3 Boundary' ' and finally above '2/3 Boundary'.

8.6. CASCADE TUNING

Cascade control is explained in section 9-3, but is shown in Figure 8.1 applied to the control of a furnace load.

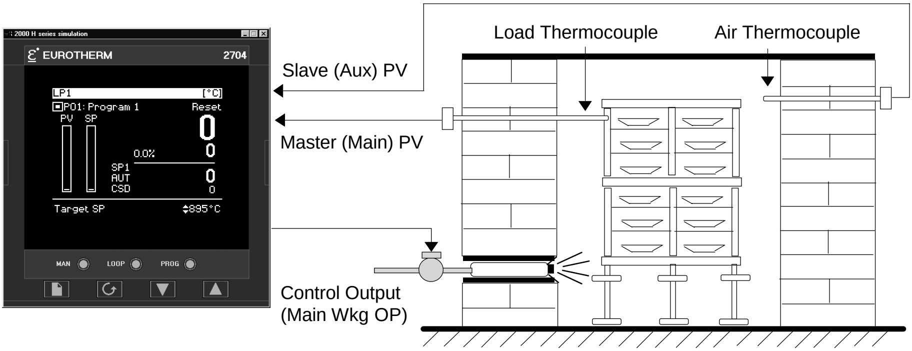


Figure 8-1: Cascade Control of a Furnace Load

When tuning a cascade loop it is necessary that both master and slave loops are tuned.

Because the slave loop is used by the master loop it must be tuned first.

The cascade autotuner tunes to the local setpoint of the auxiliary loop. This value should be set to the value at which the process is typically operated. For example, for a furnace typically used around 1000°C, set 'Local SP' (Aux) to 1000°C. The autotune will take place at a level below this to ensure that the process operating conditions are not exceeded.

Similarly, since autotune applies the full range of the output signal to the process it may in some cases be desirable to limit this range to protect the process.

Cascade autotune tunes the slave loop first followed by the master.

8.6.1. To Autotune a Cascade Loop

1. On the loop overview page, set '**Local SP'** and the **'Target SP'** to the same value at which the process typically operates. Alternatively, this value can also be set in the *LPx* SETUP (SP(Aux)) page.
2. From the AUTOTUNE page header, set '**Tune OL'** and '**Tune OH'** (if necessary) to the required limits for the process. These are normally 0% and 100%.
3. From the AUTOTUNE page header, choose the parameter '**Autotune Loop'** and select '***LPx* (CSD)'**.

The sequence of events which the cascade autotuner now makes is shown in Figure 8.2. This plot is taken from the simulation of a cascade loop set up within the 2704 controller. The plot shows the principle of operation and may not be identical to a specific application.

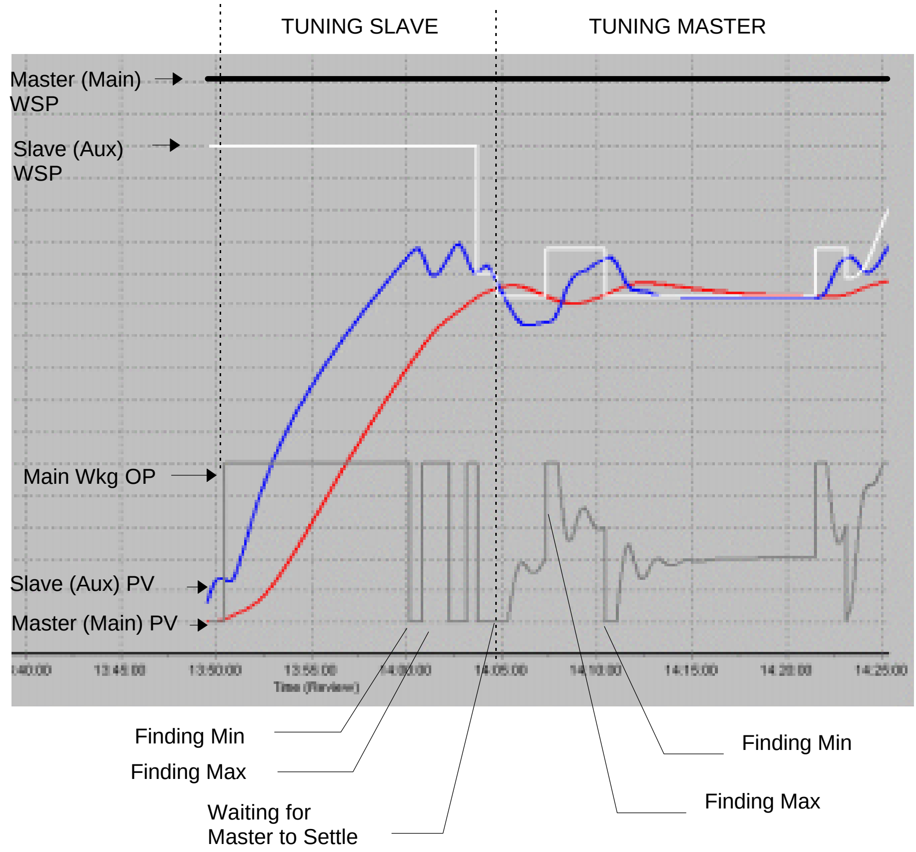


Figure 8-2: Simulation of Cascade Autotune

1. The algorithm disables the cascade loop and begins to tune the slave or auxiliary loop first using the slave (Aux) ‘Local SP’.
2. As for single loop autotune described in section 8.2.1., the output is turned on and off so that the controller can determine the response of the process. During this phase the messages ‘Autotune LPx’, ‘Measuring Noise’, ‘Finding Min’ and ’Finding Max’ will alternate on the loop overview display and in the AUTOTUNE page under the parameter ‘Autotune State’.
3. A settling period, waits for the slave loop to stabilise. The maximum settling time is equal to six times the integral time of the slave loop.
4. The algorithm then calculates suitable values for ‘TuneOL’ and ‘Tune OH’ which is sufficient to make the master loop oscillate.

TuneOL is calculated using the formula:-

$$\left[\frac{\text{Slave(local)SP}}{\text{RangeHi} - \text{RangeLo}} - 0.5 * \text{PB\%}\right] - \text{WorkingOutputValue}$$

and TuneOH using the formula:-

$$\left[\frac{\text{Slave(local)SP}}{\text{RangeHi} - \text{RangeLo}} + 0.5 * \text{PB\%}\right] + \text{WorkingOutputValue}$$

For example, if
Slave (local) SP = 200
RangeHi = 500
RangeLo = 0
PB of slave = 6%
Working OP = 40
Then ‘TuneOH’ = 43.4 and ‘TuneOL’ =36.6

8. Cascade is enabled and tuning begins to tune the master loop
9. When tuned the controller returns automatically to closed loop cascade control.

Note:- The ‘SP’, ‘TuneOL’ and ‘TuneOH’ can be manually adjusted during the first few minutes of autotuning, if necessary.

8.6.2. Manual Tuning

It is possible to tune each loop separately if desired. This allows you, for example, to vary the wait periods or to enter values more suited to your particular process.
The loops are tuned automatically by the tuner but with manual intervention as described below:-

1. On the loop overview page, set '**Local SP'** and the **'Target SP'** to the same value at which the process typically operates. Alternatively, this value can also be set in the *LPx* SETUP (SP(Aux)) page.
2. From the AUTOTUNE page header, set '**Tune OL'** and '**Tune OH'** (if necessary) to the required limits for the process. These are normally 0% and 100%.
3. Make a note of the **'Range Min'** and **'Range Max'** parameters of the slave loop set in configuration level before commencing tuning
4. Disable cascade. This can be done from the loop overview page - **'Disable CSD'** = **'Yes'**
5. From the AUTOTUNE page set **'Autotune Loop'** to ***LPxA*** - the auxiliary or slave loop (*x* may be 1, 2 or3)
6. The slave will tune as described in section 8.6.1.
7. Wait for the slave loop to stabilise, ie the Slave (Aux) PV equals the Slave (Aux) SP.
8. Calculate values for **'TuneOL'** and **'Tune OH'** using the same formula given in section 8.6.1. and using the 'Range Min' and 'Range Max' parameters previously noted. It is also possible to set the deviation to one*PB% if preferred - in most cases it only needs an output deviation which is sufficient to make the master loop oscillate.
9. Set the Master (Main) SP to the same as the Master (Main) PV or a value close to this.
10. Enable cascade
11. From the AUTOTUNE page set **'Autotune Loop'** to ***LPx*** - the main or master loop (*x* may be 1, 2 or3)
12. When tuned the controller returns automatically to closed loop cascade control.

9. Chapter 9 Loop Set Up

9.1. WHAT IS LOOP SET UP

The 2704 controller can have up to three control loops, and each control loop will have an auxiliary loop if cascade, ratio and override control has been configured. The Loop Setup pages allow you to set up the parameters associated with the operation of each of these loops. The Loop Setup pages are divided into a number of sub-headers - briefly described below:-

***LP1* SETUP** ▸	SP Page	These parameters are associated with the setpoint of a particular loop
	(SP(Aux)Page	These parameters are associated with the setpoint of the auxiliary loop.
	Cascade Page	These parameters only appear if the control loop is configured for cascade control.
	Ratio Page	These parameters only appear if the control loop is configured for ratio control.
	Override Page	These parameters only appear if the control loop is configured for override control.
	PID Page	These parameters allow you to set up the three term or PID values for the selected loop. See also Chapter 8
	PID (Aux) Page	These parameters allow you to set up the three term or PID values for the selected auxiliary loop. See also Chapter 8
	Motor Page	These parameters allow you to set up the values for a valve positioning output when the selected loop is configured for motorised valve control. See also Chapter 8
	Output Page	These parameters allow you to set up the values for the output when the selected loop is configured for analogue or digital control outputs.
	Diagnostic Page	These parameters are for diagnostic purposes on the selected loop.
	(Diag Aux) Page	These parameters are for diagnostic purposes on the selected auxiliary loop.

Each header listed above is repeated for each control loop configured.

Notes:
1. Text shown in *italics* is user definable in configuration mode and may be different from that shown
2. Since this chapter may be read in conjunction with the previous chapter - 'Tuning' - the manual setting of PID parameters is described first.

9.1.1. LOOP SET UP (Options page)

Table Number: 9.1.1.	**These parameters configure loop options (x) See notes for further parameter descriptions**		***LP1* SETUP Options Page**	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Loop Type	To configure loop type	Single Cascade Override Ratio	As order code	Conf
Control Type (1)	Control type	See note 1	As order code	Conf
Control Action (2)	Control action	Reverse Direct	Reverse	Conf
Aux Ctl Action (2)	Control action of the auxiliary loop	Reverse Direct	Reverse	Conf
Cool Type (3)	Cooling action	Linear Oil Water Fan		Conf
Prog Setpoint (4)	Loop 1 PSP select	PSP1 PSP2 PSP3 None		Conf
Deriv Type (5)	Derivative type	PV Error	PV	Conf
FF Type (6)	Feedforward type	None Remote FeedFwd SP Feedforward PV Feedforward		Conf
Force Man Mode (7)	Forced manual output mode.	Off Track		Conf

		Step		
Rate Lim Units [8]	Rate limit units	Per Second Per Minute Per Hour	Per minute	Conf
Bumpless PD	Initialises the manual reset on Auto/Manual transfer	Yes No	Yes	Conf
Ti/Td Units	Integral and Derivative time units	sec min	sec	Conf
OnOff SBk Type	Sensor break action. Only appears if On Off control is configured	-100 0 100		Conf
Prop Bnd Units	Proportional band units	Eng Units		R/O
Enable Pwr Fbk	Power feedback enable	Off On		Conf
Rem SP Config	Remote setpoint configuration	SP Only LSP Trim RSP Trim	SP Only	Conf
SBrk Type	Sensor break type	Output Hold		Conf
Manual Track [9]	Manual track	Off Track		Conf
Remote Track [10]	Remote tracking	Off Track		Conf
Program Track [11]	Programmer track	Off Track		Conf
Start SRL Mode [12]	Defines Setpoint Rate Limit action on power up.	None No Change Hold Clear Hold	None	Conf
Start Rem Mode [13]	Defines Local/Remote action on power up.	No Change Local Remote	No Change	Conf
Start WSP Mode [14]	Defines the Working SP action on power up.	None PV Target SP		Conf

Notes

1. Control Types

PID-Ch1 Only	Channel 1 PID only. Use for single channel control only
OnOff-Ch1 Only	Channel 1 On/Off. Use for On/Off control.
VP-Ch1 Only	Channel 1 Motorised valve position output - boundless mode.
VPB-Ch1 Only	Channel 1 Motorised valve position output - bounded mode.
PID-Ch1 PID-Ch2	Both output channels PID. Use for heat/cool type applications
PID-Ch1 OnOff-Ch2	Channel 1 PID control, channel 2 On/Off. Use for single channel PID control plus On/Off Control
OnOff-Ch1&2	Both output channels On/Off. Use for On/Off control

2. Control Action

Direct The output will increase positively if the PV > SP.
Reverse The output will increase positively if PV < SP.

3. Cool Type

Linear The control output follows linearly the PID output signal, i.e. 0% PID demand = 0 power output, 100% PID demand = 100% power output.
Oil, Water, Fan The control output is characterised to compensate for the non-linear effect of the cooling medium - oil, water and blown air. Typically used in extrusion processes.

4. Prog Setpoint

When the programmer is running, this parameter determines from which setpoint profile the loop obtains its setpoint. If None is selected this parameter can be soft wired.

5. Deriv Type

Derivative on PV defines that derivative action responds to changes to PV only
Derivative on Error defines that derivative action responds to changes to differences between SP and PV.

6. FF Type

Feedforward control is used typically to overcome time delays or to compensate for the effect of external influences such as control signals from other loops in the process. This is added directly to the output of the PID algorithm, before output limiting and dual output conversions are performed. Trim Limit applied to the PID calculated output is possible when Feedforward is enabled.

7. Force Manual Mode

Force Manual Mode allows you to select how the loop behaves on auto/ manual transfer.

Off	Transfer between auto/manual/auto takes place bumplessly
Track	Transfer from auto to manual, the output reverts to the previous manual value. Transfer from manual to auto takes place bumplessly
Step	Transfer from auto to manual, the output goes to a pre-set value. Transfer from manual to auto takes place bumplessly

8. Rate Limit Units

Rate limit can be applied to the SP, such that the change in PV takes place at a controlled rate. It is used where a full programmer is not justified and is typically used to protect the process from sudden changes in the PV.

9. Manual Track

When the controller is switched into Manual mode the working setpoint tracks the value of the PV so that on return to Auto mode is bumpless.

10. Remote Track

When the controller is switched into Remote SP mode the local setpoint tracks the value of the remote SP so that the return to Local SP is bumpless.

11. Program Track

When the controller is running a program the local setpoint tracks the value of the program setpoint. If the controller is switched to Local SP the transfer takes place bumplessly.

12. Start SRL Mode

Defines Setpoint Rate Limit action on power up.
None = No Change. Setpoint Rate Limit starts up in the same mode as power off
Hold = Setpoint Rate Limit is in hold mode on power up
Clear Hold = Setpoint Rate Limit is active on power up

13. Start Rem Mode

Defines Local/Remote action on power up.
No Change = The controller powers up in the same mode as power off
Local = The controller starts up in Local setpoint mode
Remote = The controller starts up in Remote setpoint mode

14. Start WSP Mode

Defines the Working SP action on power up.
None = No Change. The controller powers up in the same mode as power off
PV = The controller servos to PV on power up
Target SP = The controller servos to the target setpoint on power up

9.1.2. LOOP SET UP (Wiring page)

9.1.2.1. Controller Configured For Single Loop

Table Number: 9.1.2.1.	These parameters allow you to soft wire between function blocks.		*LP1* SETUP Wiring Page	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
PV Src	Process variable source	Modbus address	05108: PVIn.Val	Conf
Manual OP Sr	Target OP power source	Modbus address		Conf
OPRtLim En S	OP rate limit enable source	Modbus address		Conf
Ctrl Hold Src	Freeze control flag source	Modbus address		Conf
Integr Hld Src	Integral hold flag source	Modbus address		Conf
Man Mode Src	Auto/manual select source	Modbus address		Conf
Pot IP Src	Pot position source	Modbus address		Conf
Rem FFwd Src	Remote feedforward source	Modbus address		Conf
Rem Hi OP Src	Remote high power limit source	Modbus address		Conf
Rem Lo OP Src	Remote low power limit src	Modbus address		Conf
The above two parameters do not appear if Control Type (Table 9.1.1.) = On/Off				
Rem SP Ena Src	Remote setpoint enable source	Modbus address		Conf
Remote SP Src	Remote setpoint source	Modbus address		Conf
SP Select Src	Internal setpoint select src	Modbus address		Conf
SP1 Src	Setpoint 1 source	Modbus address		Conf
SP2 Src	Setpoint 2 source	Modbus address		Conf
Rt Lim Dis Src	SP rate limit disable src	Modbus address		Conf
Rt Lim Hld Src	SP rate limit hold source	Modbus address		Conf
Prog SP Src	LP1 PSP wire source	Modbus address		Conf
PID Set Src	PID Set Source	Modbus address		Conf
Power FF Src	Power feedforward source	Modbus address		Conf
Track Enab S (1)	OP track enable source	Modbus address		Conf
Track Src	Track output source	Modbus address		Conf
Ext FBack Src	External feedback source	Modbus address		Conf

9.1.2.2. Controller Configured For Cascade

Table Number: 9.1.2.2.	**These parameters allow you to soft wire between function blocks.**			***LP1* SETUP Wiring Page**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
PV Src	Process variable source	Modbus address	05108: PVIn.Val	Conf
Aux PV Src	Auxiliary PV source	Modbus address		Conf
Manual OP Sr	Target OP power source	Modbus address		Conf
OPRtLim En S	OP rate limit enable source	Modbus address		Conf
Aux LSP Src	Auxiliary local SP source	Modbus address		Conf
Casc Disable S	Cascade disable source	Modbus address		Conf
Casc FFwd Src	Casc. feedforward source	Modbus address		Conf
The above parameter does not appear if FF Type (Table 9.1.1.) = None				
Casc TrmLim S	Casc. FF trim limit source	Modbus address		Conf
Ctrl Hold Src	Freeze control flag source	Modbus address		Conf
AuxCtrlHold Src	Aux. freeze control flag src	Modbus address		Conf
Integr Hld Src	Integral hold flag source	Modbus address		Conf
Aux I Hold Src	Aux. Integral hold flag src	Modbus address		Conf
Man Mode Src	Auto/manual select source	Modbus address		Conf
Pot IP Src	Pot position source	Modbus address		Conf
Rem FFwd Src	Remote feedforward src	Modbus address		Conf
Rem Hi OP Src	Remote hi power limit src	Modbus address		Conf
Rem Lo OP Sr	Remote lo power limit src	Modbus address		Conf
The above two parameters do not appear if Control Type (Table 9.1.1.) = On/Off				
Rem SP Ena S	Remote SP enable source	Modbus address		Conf
Remote SP Sr	Remote setpoint source	Modbus address		Conf
SP Select Sr	Internal SP select source	Modbus address		Conf
SP1 Src	Setpoint 1 source	Modbus address		Conf
SP2 Src	Setpoint 2 source	Modbus address		Conf
Rt Lim Dis Src	SP rate limit disable source	Modbus address		Conf
Rt Lim Hld Src	SP rate limit hold source	Modbus address		Conf
Prog SP Src	LP1 PSP wire source	Modbus address		Conf
PID Set Src	PID Set Source	Modbus address		Conf
Aux PID Set S	Auxiliary PID Set Source	Modbus address		Conf

Power FF Src	Power feedforward source	Modbus address		Conf
Track Enab S	OP track enable source	Modbus address		Conf
Track Src	Track output source	Modbus address		Conf
Aux Trk En S	Aux. OP track enable src	Modbus address		Conf
Aux Trk Src	Aux. track output source	Modbus address		Conf
Ext FBack Src	External feedback source	Modbus address		Conf
AuxExtFBck Src	Auxiliary external feedback source	Modbus address		Conf

9.1.2.3. Controller Configured For Ratio

Table Number: 9.1.2.3.	These parameters allow you to soft wire between function blocks.			*LP1* SETUP Wiring Page
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
PV Src	Process variable source	Modbus address	05108: PVIn.Val	Conf
Manual OP Sr	Target OP power source	Modbus address		Conf
OPRtLim En S	OP rate limit enable src	Modbus address		Conf
Lead PV Src	Lead PV source	Modbus address		Conf
Ratio SP Src	Ratio setpoint source	Modbus address		Conf
Ratio Trim Src	Ratio trim source	Modbus address		Conf
Ratio Enab Src	Ratio enable source	Modbus address		Conf
Ctrl Hold Src	Freeze control flag source	Modbus address		Conf
Integr Hld Src	Integral hold flag source	Modbus address		Conf
Man Mode Src	Auto/manual select source	Modbus address		Conf
Pot IP Src	Pot position source	Modbus address		Conf
Rem FFwd Sr	Remote feedforward src	Modbus address		Conf
Rem Hi OP Src	Remote high power limit source	Modbus address		Conf
Rem Lo OP Src	Remote low power limit src	Modbus address		Conf
The above two parameters do not appear if Control Type (Table 9.1.1.) = On/Off				
Rem SP Ena S	Remote SP enable source	Modbus address		Conf
Remote SP Sr	Remote setpoint source	Modbus address		Conf
SP Select Sr	Internal SP select source	Modbus address		Conf
SP1 Src	Setpoint 1 source	Modbus address		Conf
SP2 Src	Setpoint 2 source	Modbus address		Conf
Rt Lim Dis Src	SP rate limit disable src	Modbus address		Conf
Rt Lim Hld Src	SP rate limit hold source	Modbus address		Conf
Prog SP Src	LP1 PSP wire source	Modbus address		Conf
PID Set Src	PID Set Source	Modbus address		Conf
Power FF Src	Power feedforward source	Modbus address		Conf
Track Enab S	OP track enable source	Modbus address		Conf
Track Src	Track output source	Modbus address		Conf
Ext FBack Src	External feedback source	Modbus address		Conf

9.1.2.4. Controller Configured For Override

Table Number: 9.1.2.4.	These parameters allow you to soft wire between function blocks.			*LP1* SETUP Wiring Page
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
PV Src	Process variable source	Modbus address	05108: PVIn.Val	Conf
Aux PV Src	Auxiliary PV source	Modbus address		Conf
Manual OP Sr	Target OP power source	Modbus address		Conf
OPRtLim En S	OP rate limit enable src	Modbus address		Conf
Aux LSP Src	Auxiliary local SP source	Modbus address		Conf
Ctrl Hold Src	Freeze control flag source	Modbus address		Conf
AuxCtrlHold Sr	Aux freeze control flag src	Modbus address		Conf
Integr Hld Sr	Integral hold flag source	Modbus address		Conf
Aux I Hold Sr	Aux. Integral hold flag src	Modbus address		Conf
Man Mode Sr	Manual mode source	Modbus address		Conf
Active Lp Sr	Active loop source	Modbus address		Conf
OVR Disab Sr	Override disable source	Modbus address		Conf
OVR Trim Src	Override trim source	Modbus address		Conf
Pot IP Src	Pot position source	Modbus address		Conf
Rem FFwd Sr	Remote feedforward src	Modbus address		Conf
Rem Hi OP Src	Remote hi power limit src	Modbus address		Conf
Rem Lo OP Sr	Remote lo power limit src	Modbus address		Conf
The above two parameters do not appear if Control Type (Table 9.1.1.) = On/Off				
Rem SP Ena S	Remote SP enable source	Modbus address		Conf
Remote SP Sr	Remote setpoint source	Modbus address		Conf
SP Select Sr	Internal SP select source	Modbus address		Conf
SP1 Src	Setpoint 1 source	Modbus address		Conf
SP2 Src	Setpoint 2 source	Modbus address		Conf
Rt Lim Dis Src	SP rate limit disable src	Modbus address		Conf
Rt Lim Hld Src	SP rate limit hold source	Modbus address		Conf
Prog SP Src	LP1 PSP wire source	Modbus address		Conf
PID Set Src	PID Set Source	Modbus address		Conf
Aux PID Set S	Auxiliary PID Set Source	Modbus address		Conf
Power FF Src	Power feedforward source	Modbus address		Conf
Track Enab S	OP track enable source	Modbus address		Conf

Track Src	Track input source	Modbus address		Conf
Ext FBack Src	External feedback source	Modbus address		Conf
AuxExtFBck Src	Auxiliary external feedback source	Modbus address		Conf

9.2. SETPOINT DEFINITION

The controller setpoint is the **Working Setpoint** which may be sourced from a number of alternatives. This is the value ultimately used to control the process variable in a loop.
LSP derives from a parameter called the local setpoint which is the value which the operator can alter. This local SP may be derived one of two setpoints, **Setpoint 1** or **Setpoint 2**. Either of these setpoints may be selected by a parameter in the controller or soft wired to a digital input.
In remote mode, the working setpoint is modified by the **Remote SP + Local Trim**, when 'Enable Rem SP' is set to 'Yes'. When 'Remote Track' (*LP1* SETUP (Options Page)) is set to 'Track' the transition to the 'Active Local SP' (SP1 or SP2) takes place bumplessly and the Active Local SP tracks the value of the Remote SP.
In a controller/programmer the Working SP is derived from the output of the programmer function block. In this case the setpoint varies in accordance with fixed rates of change stored within a program.

9.2.1. Setpoint Function Block

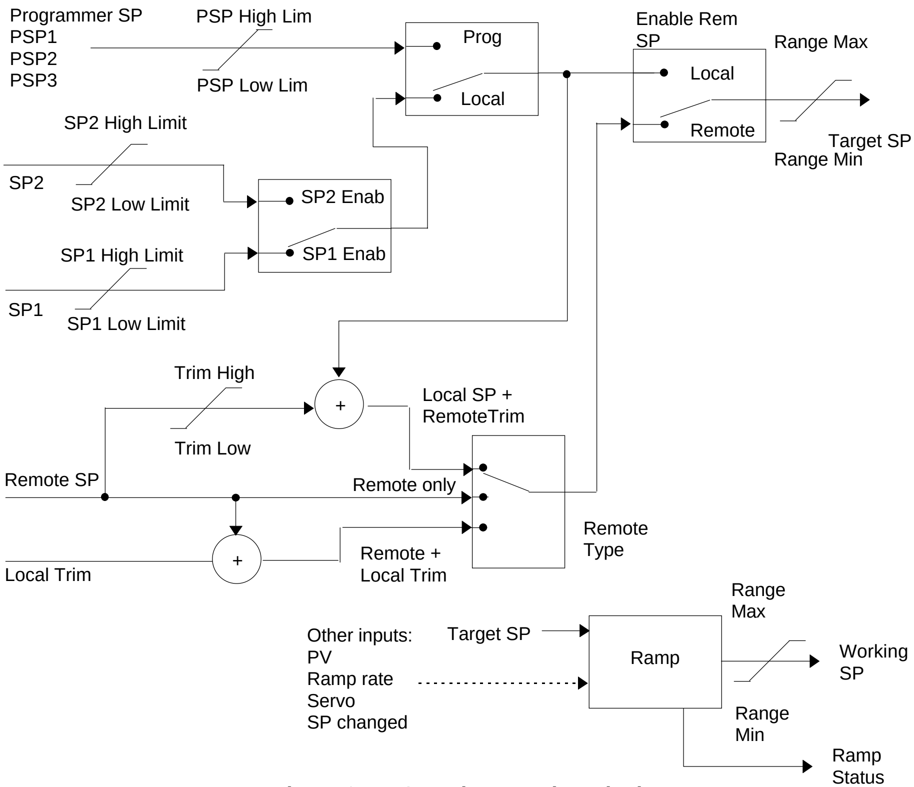


Figure 9-1: Setpoint Function Block

9.2.2. Setpoint Parameters

Table Number: 9.2.2.	**This list allows you to configure SP parameters** Other parameters are available in operation levels			***LP1* SETUP (SP Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Range Min	PV low limit	Min to max	-200 *	Conf
Range Max	PV high limit	disp. limit	1372 *	Conf
SP Select	Internal setpoint select	Setpoint 1 Setpoint 2		L1
SP1 Low Limit	Setpoint 1 low limit		-200 *	L3
SP1 High Limit	Setpoint 1 high limit		1372 *	L3
Setpoint 1	Setpoint 1 value	Range		L1
SP2 Low Limit	Setpoint 2 low limit	units	-200 *	L3
SP2 High Limit	Setpoint 2 high limit		1372 *	L3
Setpoint 2	Setpoint 2 value			L1
Disable Rt Lim	Setpoint Rate limit disable	No Yes		L3
Rt Lim Hold	SP rate limit hold	No Yes	No	L3
Rate Limit Val	Rate of change of setpoint	Off to range		L3
Trim Lo Lim	Local setpoint trim low limit	Range units		L3
Trim Hi Lim	Local setpoint trim high limit	Range		L3
Local SP Trim	Applies a trim value to the remote setpoint	units		L1
Enable Rem SP	Remote setpoint enable	No Yes		L1
Remote SP	Remote setpoint value	Range units		L1
HBk Type	SP rate limit holdback type	Off Low High Band		L3
HBk Value	SP rate limit holdback value	Display range		R/O
HBk Status	SP rate limit holdback status	Off Holdback		L3
* If temp units = ^oC				

9.2.3. *LP1* SETUP (SP Aux) Page

Table Number: 9.2.3	**This list allows you to configure auxiliary loop setpoint limits.** It only appears if cascade or override control is configured, see section 9.1.1. Other parameters are available in operation levels.	***LP1* SETUP (SP Aux) Page**

Parameter Name	Parameter Description	Value	Default	Access Level
Range Min	Auxiliary PV low limit	Min to max display limit	-200 *	Conf
Range Max	Auxiliary PV high limit		1372 *	Conf
SP Low Limit	Auxiliary setpoint 1 low limit	Range units	-200 *	L3
SP High Limit	Auxiliary setpoint 1 high limit		1372 *	L3
OVR SP Trim	Override loop setpoint trim			L3. Only appears when Override control is configured
Local SP	The setpoint which the controller reverts to when not in cascade, ratio or override			L1
Working SP	The current value of the setpoint in use			L1
* If temp units = ^oC				

This table does not appear if the Loop Type is Ratio.

9.3. CASCADE CONTROL

9.3.1. Overview

Cascade control is classified as an advanced control technique used, for example, to enable processes with long time constants to be controlled with the fastest possible response to process disturbances, including setpoint changes, whilst still minimising the potential for overshoot. It is a combination of two PID controllers, where the output signal from one (the master) forms the setpoint for the other (the slave). For cascade control to be effective the slave loop should be more responsive than the master.

9.3.2. Simple Cascade

The main process is controlled using the master PID loop, the output of which is used to determine the setpoint of the slave. The implementation of cascade control in the 2704 is available as a standard option. ie it is not necessary to order a dual loop controller to perform cascade control.

9.3.3. Cascade with Feedforward

An available option with cascade control is feedforward. It allows either the master PV, master SP or user defined variable (Remote Feedforward) to be fed forward so that it directly influences the slave setpoint. The master PID output contribution of the slave setpoint is limited by the Cascade Trim Limit, set in engineering units, when Feedforward is selected. The Cascade Trim Limit is applied to the PID output of the master loop for PV and SP Feedforward. For Remote Feedforward, the Cascade Trim Limit is applied to the Remote Input source. These alternatives are shown in Figures 9-2 and 9-3 respectively.

A typical application for SP feedforward could be in a heat treatment furnace, where it can be used to extend the life of heating elements by limiting their maximum operating temperature. An application using PV feedforward could be in autoclaves or reactor vessels where it is sometimes required to protect the product from excessive temperature gradients (also referred to as Delta T Control).
Remote feedforward is a user defined, wireable parameter (Rem FFwd Src). It may be used if there is a requirement for some additional parameter, for example an analogue input, to trim the master PID output value before the slave setpoint is applied. An application may be a liquid temperature control system using cascade control of heater temperature where variations in control rate can be directly fed forward into the slave loop, modifying heater temperature and giving rapid compensation

9.3.4. Auto/Manual Operation

Auto/Manual operates on both master and slave loops.
When the controller is placed in manual the slave working setpoint will track the value of the slave process value continually, therefore ensuring bumpless transfer.
When cascade is deactivated the master loop will monitor the setpoint of the slave loop and provide a smooth transition of output power when the loop moves back to cascade mode.

9.3.5. Cascade Controller Block Diagram

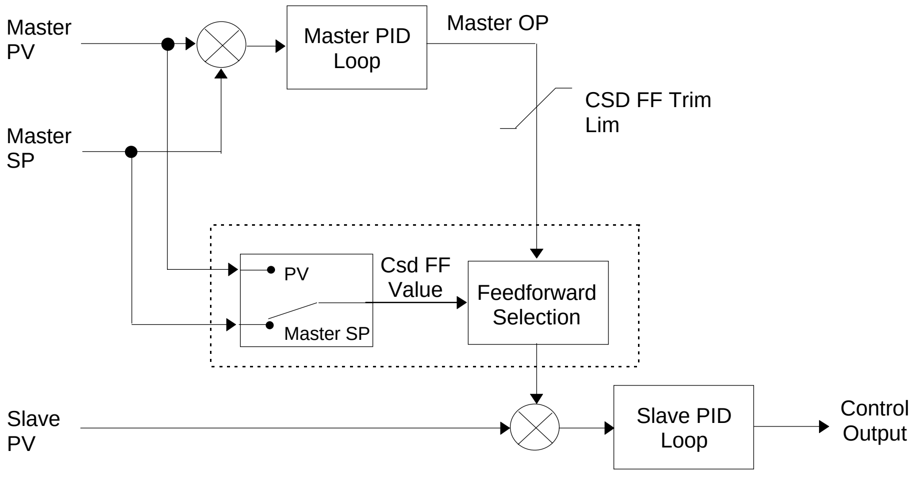


Figure 9-2: Cascade Controller with PV or SP Feedforward Block Diagram

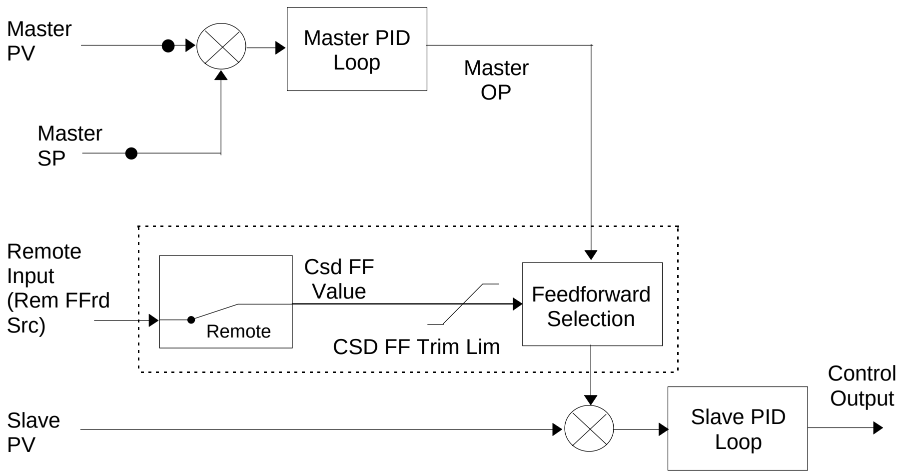


Figure 9-3: Cascade Controller with Remote Input Feedforward Block Diagram

9.3.6. Cascade Parameters

Table Number: 9.3.6.	**This list allows you to set up parameters specific to cascade controllers.** It only appears if cascade is configured, see section 9.1.1.			***LP1* SETUP (Cascade Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Disable CSD	Cascade disable status. (It is sometimes useful to disable cascade when starting a process. This also returns the controller to single loop control using the local SP.)	Off On		L1.
CSD FF Value	Cascade feedforward value i.e. The value being fed forward	Range of signal being fed forward		L3
CSD FF Trim Lim	Cascade feedforward trim limit i.e. The amount the master output can be trimmed up and down.	Range of slave loop		L3
Work FF Value	Working feedforward value			R/O
The above three parameters only appear if ‘FF Type’ ≠ ‘None’				
Master OP	Cascade master PID output power	Range of slave loop		R/O

9.3.7. Cascade Function Block

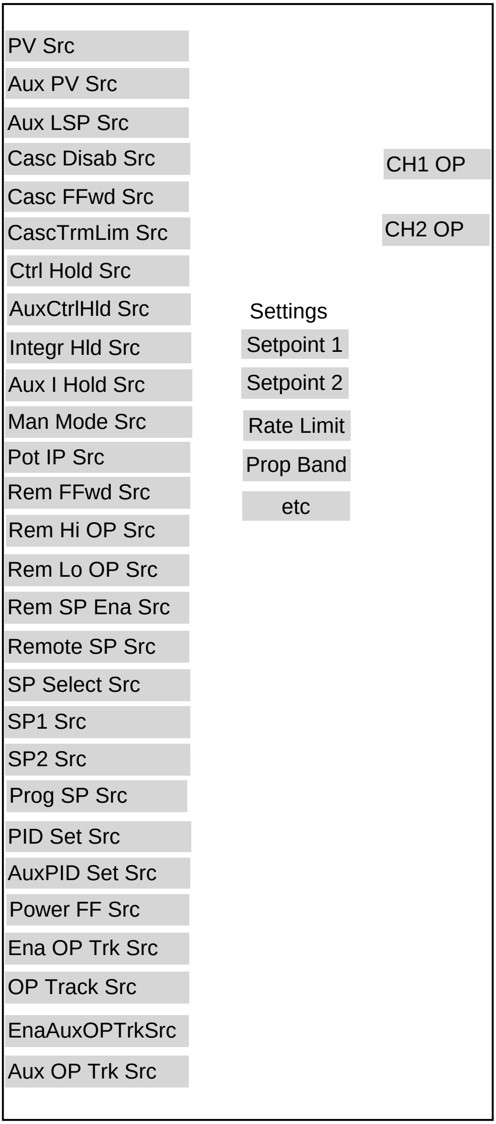


Figure 9-4: Cascade Function Block

Examples of wiring the cascade function block are given in Section 9.13.

9.4. RATIO CONTROL

9.4.1. Overview

Ratio Control is a technique used to control a process variable at a setpoint which is calculated as a proportion of a second (lead) input. The ratio setpoint determines the proportion of the lead value that is to be used as the actual control setpoint. The ratio setpoint can be applied as either a multiplier or as a divisor to the second input.
A typical application is in gas fired furnaces where in order to achieve efficient combustion, the gas and air flow supplied to the burners needs to be maintained at a constant ratio.

9.4.2. Basic Ratio Control

The 2704 contains a ratio control function block which can be used in any control loop. Figure 9.4 shows a block diagram of a simple ratio controller. The lead PV is multiplied or divided by the ratio setpoint to calculate the desired control setpoint. Prior to the setpoint calculation, the ratio setpoint can be offset by the ratio trim value and must obey the overall ratio setpoint operating limits. Another useful feature of the is the automatic calculation of the actual measured ratio which is then available to be displayed on the controller front panel.

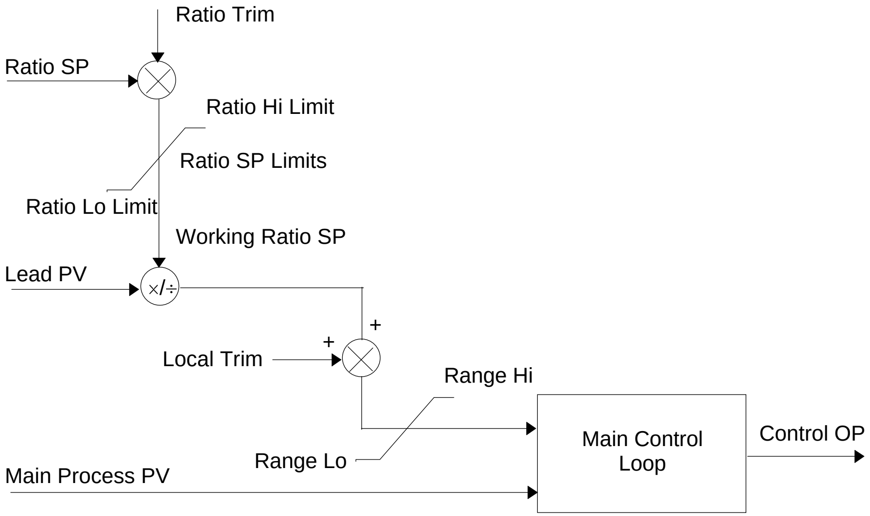


Figure 9-5: Simple Ratio Control Block Diagram

The measured ratio is calculated from the Lead PV and the Process PV. It is also possible to enable 'Ratio Track'. If 'Enable Ratio' is set to 'Off' and Ratio Track is set to 'On', then the Ratio SP will track the measured ratio. This feature allows the user to set the Ratio SP according to the condition of the process.

9.4.3. Ratio Parameters

Table Number: 9.4.3.	This list allows you to set up parameters specific to ratio controllers. It only appears if ratio is configured, see section 9.1.1.	*LP1* SETUP (Ratio Page)

Parameter Name	Parameter Description	Value	Default	Access Level
Ratio Resol	Ratio display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
Ratio Type	Ratio type	Divide Multiply		Conf
Lead PV	The value of the lead process variable			L1
Measured Ratio	Measured Ratio			R/O
Work Ratio SP	Ratio working setpoint			R/O
Ratio Lo Lim	Ratio setpoint low limit			L3
Ratio Hi Lim	Ratio setpoint high limit			L3
Ratio SP	Ratio setpoint			L1
Ratio Trim	Ratio trim value			L1
Enable Ratio	Ratio enable	Off On		L1
Ratio Track	Ratio track mode	Off On		Conf

9.4.4. Ratio Function Block

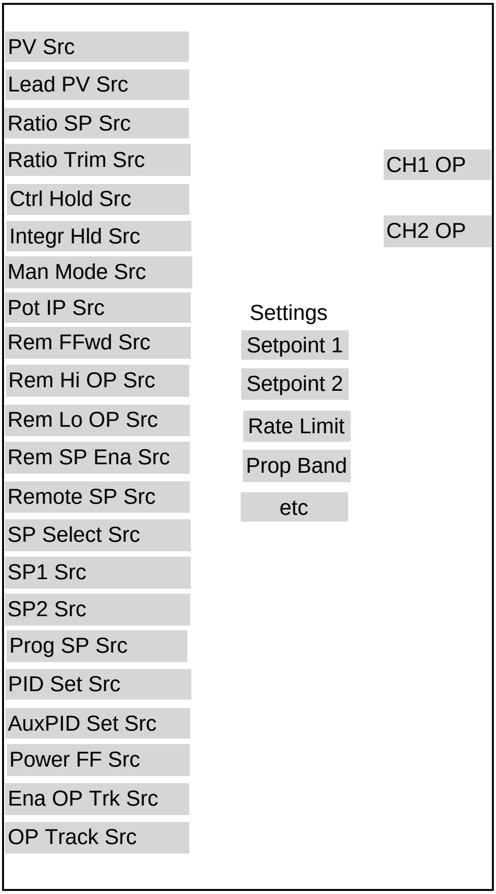


Figure 9-6: Ratio Function Block

9.5. OVERIDE CONTROL

9.5.1. Overview

Override Control allows a secondary control loop to override the main control output in order to prevent an undesirable operating condition. The override function can be configured to operate in either minimum, maximum or select mode.

A typical example can be implemented in a heat treatment furnace with one thermocouple attached to the workpiece, and another situated close to the heating elements. Control of the furnace during the heating up period is regulated by the override (heating element) temperature controller which provides a safeguard against overheating. Control of the furnace will switch over to the workpiece temperature controller at some point when the temperature is near to its target setpoint. The exact point of switchover is determined automatically by the controller, and will be dependent on the selected PID terms.

9.5.2. Simple Override

Override control is available with analogue, time proportioning and ON/OFF control outputs. It is not available with valve position outputs. Figure 9.7 shows a simple override control loop. The main and override controller outputs are fed to a low signal selector. The override controller setpoint is set to a value somewhere above the normal operating setpoint, but below any safety interlocks.

There is only one Auto Manual switch for both loops. In manual mode the control outputs of both loops track the actual output, ensuring bumpless transfer when auto is selected. The transfer between main and override PID control is also bumpless.

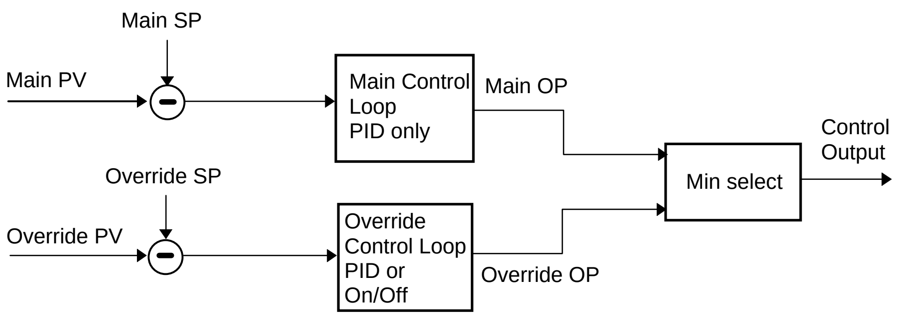


Figure 9-7: Simple Override Control (Select Minimum)

9.5.3. Override Parameters

Table Number: 9.5.3.	This list allows you to set up parameters specific to override controllers It only appears if override is configured, see section 9.1.1.	*LP1* SETUP (Override Page)

Parameter Name	Parameter Description	Value	Default	Access Level
Override Type	Override type See Note 1	Minimum Maximum Select		Conf
OVR Target SP	Override target setpoint	Display range		
Disable OVR	Disable override control. See Note 2.	No Yes		L1
Active Loop	Displays the loop which is controlling at any time			L1
OVR SP Trim	Override loop setpoint trim	Range limit		L1
Main OP	Override main output	-100 to 100		R/O
Override OP	Override output	-100 to 100		R/O

Note 1:-
Minimum selects the lowest output power from the two loops to be the control output.
Maximum selects the highest output power from the two loops to be the control output.
Select allows either the main output or the override output to be used as the control output depending on the state of a digital input or via digital communications.

Note 2:-
The main control loop is active when Override control is disabled.

9.5.4. Override Function Block

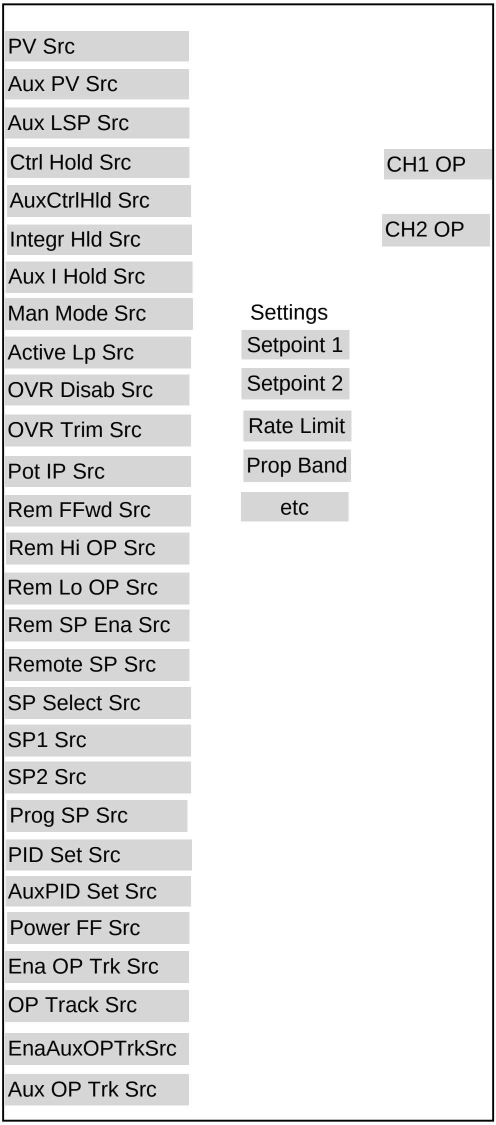


Figure 9-8: Override Function Block

9.6. PID CONTROL

PID control, also referred to as 'Three Term Control', is a technique used to achieve stable straight line control at the required setpoint. The three terms are:

P Proportional band
I Integral time
D Derivative time

The output from the controller is the sum of the contributions from these three terms. The combined output is a function of the magnitude and duration of the error signal, and the rate of change of the process value. It is possible to set P, PI, PD or PID control.

9.6.1. Proportional Term

The proportional term delivers an output which is proportional to the size of the error signal. An example of this is shown in Figure 9.9, for a temperature control loop, where the proportional band is $10^{O}C$ and an error of $3^{O}C$ will produce an output of 30%.

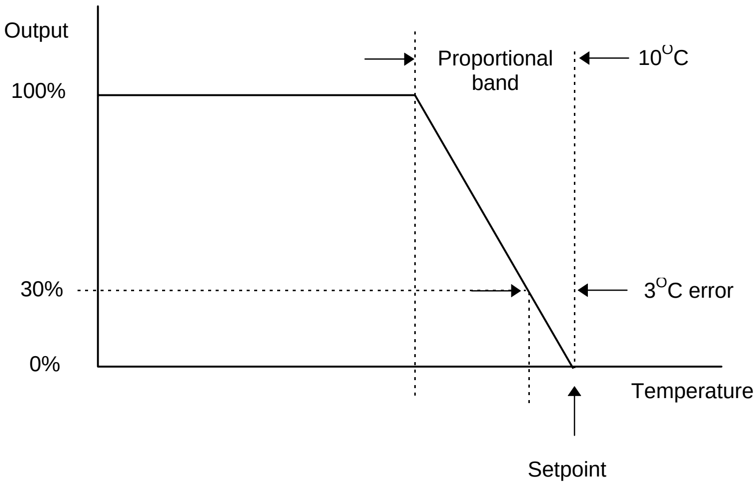


Figure 9-9: Proportional Action

Proportional only controllers will, in general, provide stable straight line control, but with an offset corresponding to the point at which the output power equals the heat loss from the system.

9.6.2. Integral Term

The integral term removes steady state control offset by ramping the output up or down in proportion to the amplitude and duration of the error signal. The ramp rate (reset rate) is the integral time constant, and must be longer than the time constant of the process to avoid oscillations.

9.6.3. Derivative Term

The derivative term is proportional to the rate of change of the temperature or process value. It is used to prevent overshoot and undershoot of the setpoint by introducing an anticipatory action. The derivative term has another beneficial effect. If the process value falls rapidly, due, for example, an oven door being opened during operation, and a wide proportional band is set the response of a PI controller can be quite slow. The derivative term modifies the proportional band according to this rate of change having the effect of narrowing the proportional band. Derivative action, therefore, improves the recovery time of a process automatically when the process value changes rapidly.

Derivative can be calculated on change of PV or change of Error. For applications such as furnace control, it is common practice to select Derivative on PV to prevent thermal shock caused by a sudden change of output following a change in setpoint.

9.6.4. High and Low Cutback

While the PID parameters are optimised for steady state control at or near the setpoint, high and low cutback parameters are used to reduce overshoot and undershoot for large step changes in the process. They respectively set the number of degrees above and below setpoint at which the controller will start to increase or cutback the output power.

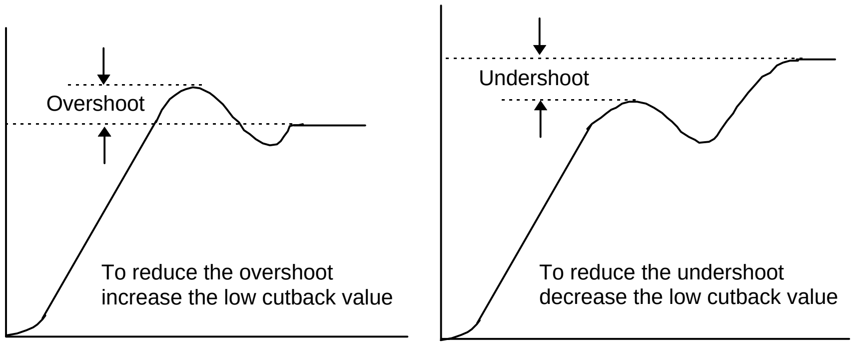


Figure 9-10: High and Low Cutback

9.6.5. PID Block Diagram

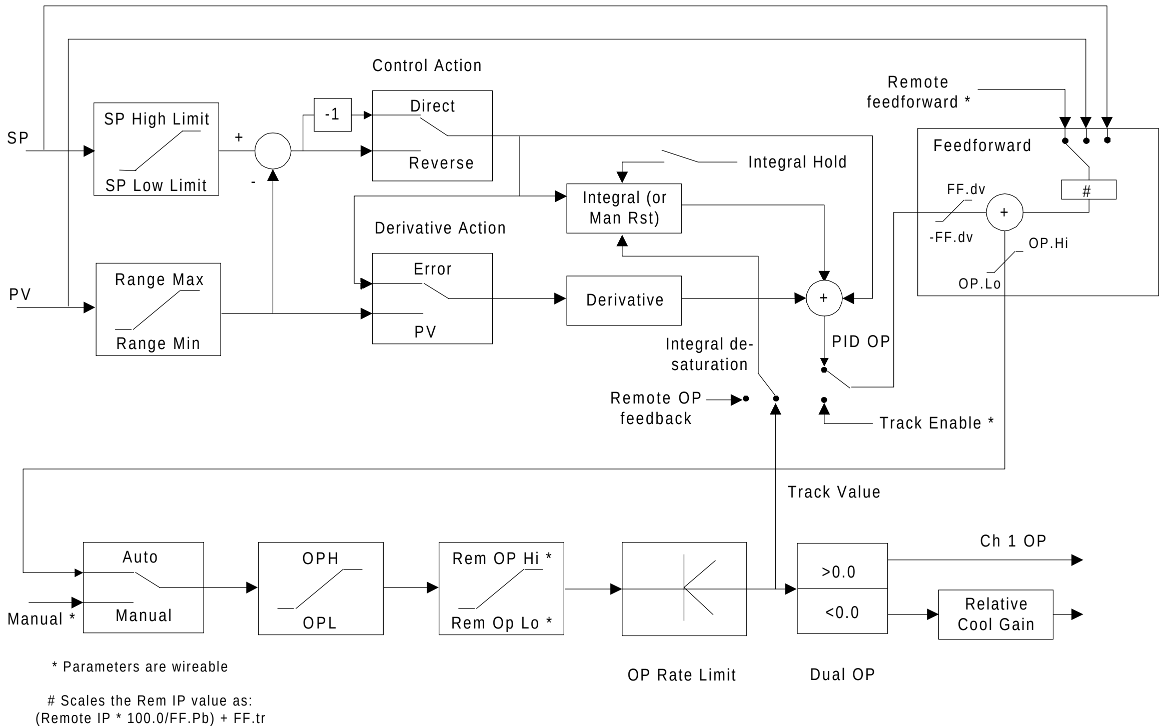


Figure 9-11: PID Block Diagram

9.6.6. Track

The track function shown in the PID block diagram, allows an external source of output to stop integral wind up in some applications such as cascade control. The integral will calculate a PID output to match the external value when manual to auto bumpless transfer is activated.

9.6.7. Gain scheduling

Gain scheduling is commonly used to minimise the effect of non-linearity in a process, by automatically transferring control between one set of PID values and another. In the case of the 2704 controller, this is done on a presettable strategy defined by 'Schedule Type'. The choices are:-

PV The transfer between one set and the next depends on the value of the PV
SP The transfer between one set and the next depends on the value of the SP
Error The transfer between one set and the next depends on the value of the error
OP The transfer between one set and the next depends on the value of the OP demand
Set The transfer between one set and the next is selected by a digital input or via digital communications.

The 2704 controller has three sets of PID values. The maximum number of sets must be configured using the 'Num of Sets' parameter. You can select the active set from:

1. A digital input
2. A parameter in the *Loop* Setup(PID) page
3. Or you can transfer automatically in gain scheduling mode.

Gain scheduling is uni-directional acting on the magnitude of the scheduling variables. The transfer is bumpless and will not disturb the process being controlled.

9.6.8. Analogue Value

The Analogue Value is a customisable parameter available in the PID (and PID Aux) pages which provides the user with additional flexibility when designing a control strategy. This parameter is called **Analogue Value (An Value 1 to 3)**. It is available for each PID set if Gain Scheduling has been configured and for each loop configured . It can be 'soft wired' in configuration mode to perform a specific function relevant to the particular process being controlled. Examples include: Output Power Limit, SP Feedforward Trim, etc,.

9.6.9. PID Parameters

Table Number: 9.6.7.	These parameters allow you to configure PID sets			*LP1* SETUP (PID Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Schedule Type	Scheduling type	Off Set SP PV Error OP	Off	Conf
Num of Sets	Number of PID sets to use	1 to 3	1	Conf
Active PID Set	The PID set in current use	Set 1 to 3		R/O
Active An Val	Displays the current analogue value being used			R/O L3
Prop Band 1	Proportional Band Set 1	1 to 9999.9 eng units	20	L1
Integral 1	Integral Time Set 1	Off to 999.9	360	L1
Derivative 1	Derivative Time Set 1	secs or mins	60	L1
Cutback Low 1	Cutback Low Set 1	Auto to		L1
Cutback High 1	Cutback High Set 1	display range		L1
Manual Reset 1	Manual Reset Set 1 (only applies to a PD controller)	Off, -99.9 to +100		L1
Cool Gain 1	Relative cool gain set 1	0.1 to 10	1	L1
	Only present if ch 1 and ch 2 are configured in the same loop			
An Value 1	Analogue value (set 1)			L3
The above eight parameters are repeated for set 2 and again for set 3 if the number of PID sets has been configured to 2 or 3 respectively.				
Remote FFwd	Remote feedforward			L3
1/2 Boundary	Sets the level at which PID set 1 changes to PID set 2	Range units		L3
2/3 Boundary	Sets the level at which PID set 2 changes to PID set 3	Range units		L3
Loop Brk Time	Loop break time	Off On		L3
AutoDroop Comp	Manual reset when Integral turned off	Manual Calc		L3
Control Hold	Control hold flag. Freezes the control output	No Yes		L3
Integral Hold	Integral hold flag	No Yes		L3

9.6.10. PID (Aux) Parameters

Table Number: 9.6.10.	These parameters allow you to set up the PID sets.(Override & Cascade only)		*LP1* SETUP PID(Aux) Page	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Schedule Type	Scheduling type	Off Set SP PV Error OP	Off	Conf
Num of Sets	Number of PID sets to use	1 to 3	1	Conf
Active PID Set	The PID set currently being used	PID Set 1 to 3		L1
Active An Val	Active analogue value			R/O L3
Prop Band 1	Proportional Band Set 1	1 to 9999.9 eng units	20	L1
Integral 1	Integral Time Set 1	Off to	360	L1
Derivative 1	Derivative Time Set 1	999.9 secs or mins	60	L1
Cutback Low 1	Cutback Low Set 1	Auto to display limit		L1
Cutback High 1	Cutback High Set 1	Auto to display limit		L1
Manual Reset 1	Manual Reset Set 1 (only applies to a PD controller)	Off, -99.9 to +100		L1
Cool Gain 1	Relative cool gain set 1	0.1 to 10	1	L1
	Only present if ch 1 and ch 2 are configured in the same loop			
An Value 1	Analogue value (set 1)			L3
The above seven parameters are repeated for set 2 and again for set 3 if the number of PID sets has been configured to 2 or 3 respectively.				
1/2 Boundary	Sets the level at which PID set 1 changes to PID set 2	Range units		L3
2/3 Boundary	Sets the level at which PID set 2 changes to PID set 3	Range units		L3
Control Hold	Aux. Control hold flag. Freezes the control output	No Yes		L3
Integral Hold	Aux. Integral hold flag	No Yes		L3

This table does not appear if the Loop Type is Ratio.

These tables are repeated for *Loop 2* and *Loop 3* if these have been configured

9.7. MOTORISED VALVE CONTROL

The 2704 controller can be used for motorised valve control as an alternative to the standard PID control algorithm. This algorithm is designed specifically for positioning motorised valves. It operates in boundless or bounded mode as configured by the 'Control Type' parameter in Table 9.1.1. Boundless VP control does not require a position feedback potentiometer for control purposes. Bounded VP control requires a feedback potentiometer as part of the control algorithm. Note, however that a potentiometer may be used with boundless mode but it is used solely for indication of the valve position and is not used as part of the control algorithm. The control is performed by delivering a 'raise' pulse, a 'lower' pulse or no pulse at all in response to the control demand signal via raise and lower relay or triac outputs.

9.7.1. Motor Parameters

Table Number: 9.7.1.	**This list allows you to set up the motor interface parameters for a valve positioning output.** This page only appears if a motor valve positioning output is configured. See Section 9.1.1. (Control Type)			***LP1* SETUP (Motor Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Travel Time	This parameter is set to match the time taken for the motor to travel from fully closed to fully open	0:00:00.1	0:01:00:0	L3
Inertia	This parameter is set to match the inertia (if any) of the motor	Off to 0:00:00.1	0:00:20:0	L3
Backlash	This parameter compensates for any backlash which may exist in the linkages	Off to 0:00:00.1	0:00:20:0	L3
Min Pulse Time	Sets the minimum on time of the signal which drives the motor	Auto to 0:00:00.1	Auto = 0:00:00:2	L3
VP Pot Lo Lim (1)	Adjusts the valve position low limit in bounded mode set by the potentiometer	0 to 100%	0%	L3
VP Pot Hi Lim (1)	Adjusts the valve position high limit in bounded mode set by the potentiometer	0 to 100%	100%	L3
VP SBrk OP	Sets the action of the valve in boundless mode Only appears in boundless mode, i.e. 'Control Type' =	VP Pos Lo to VP Pos Hi		L3

	VP-Ch1 Only			
VP SBrk Action	Sets the action of the valve if the potentiometer becomes disconnected in bounded mode	Rest Up Down		L3
Valve Position	Indicates the position of the valve	0 to 100%		R/O
Enable Pot Cal [1]	Pot input calibration enable	Off On	Off	L3

Note 1

These three parameters are only displayed if the potentiometer is soft wired, i.e. 'Pot IP Src' is wired to a parameter.

9.8. OUTPUT PARAMETERS

Typically the output(s) of the PID function block are wired to:

- The standard relay or logic outputs, configured for on/off or time proportioning pulses
- Relay, triac or logic output module, configured for on/off or time proportioning pulses
- Analogue output module, configured for Volts or mA

9.8.1. Table of Output Parameters

Table Number: 9.8.1	This list allows you to set up the parameters which control the output to the plant			*LP1* SETUP (Output Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Loop Mode	Allows the controller to be switched into manual	Auto Manual		
OP Low Limit	Sets a low limit on an analogue output signal	-100% to 100%		L3
OP High Limit	Sets a high limit on an analogue output signal	-100% to 100%	100	L3
OP Rate Limit	Sets the rate at which the output value changes	Off to 99.99 %/sec		L3
OP Rate Lim En	Output rate limit enable	Off On	Off	L3
Forced OP	Sets the output value when the controller is in manual - alternative to bumpless transfer	-100% to 100%		L3
SBrk OP	Sets the level of the output in sensor break	-100% to 100%		L3
CH1 OP	Reads the current value of channel 1 output	-100% to 100%		R/O
Ch1 Hysteresis	Only shown if the output relay 1 is configured as on/off. It sets the difference between relay on and relay off.	Off to 9999.9		L3
Ch1 Min Pulse	Output minimum on time (on/off control)			L3
The above three parameters are repeated for channel 2				
Deadband	Deadband between ch1 and ch2. Only applies if both ch1 and ch2 are configured	Off to 100.0		L3
Target OP	Target output power	-100 to		L1

		100%		
Rem Lo OP Lim	Remote low power limit	-100% to 100%		L3
Rem Hi OP Lim	Remote high power limit	-100% to 100%		L3
Power FF Val	Current value of power feedforward			L3
Ena OP Track	Output track enable	No Yes		L3
OP Track Value	Track input			L3
Ena Aux OP Trk	Auxiliary Output track enable	No Yes		L3
Aux OP Track	Auxiliary Track input	Display range		L3

9.9. DIAGNOSTICS

Diagnostic parameters are available at all levels, are read only and provide information on the current operating conditions of the controller.

9.9.1. Diagnostic Page

Table Number: 9.9.1.	**This list allows you to interrogate operating conditions of the loop**			***LP 1* SETUP (Diagnostic Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
LP1 PV	Process Variable	Display range		L1
*LP1*A PV	Auxiliary Process Variable			L1
Working SP	The value of the working setpoint			L1
Working OP	The value of the working output	-100 to 100		L1
Error	Value of main loop error (PV - SP)	Display range		L1
Aux Error	Value of the auxiliary loop error (PV - SP)	-9999 to 9999		R/O
P OP	Proportional component of the output	-999 to 9999		R/O
Aux P OP	Proportional component of the auxiliary loop output	-999 to 9999		R/O
I OP	Integral component of the output	-999 to 9999		R/O
Aux I OP	Integral component of the auxiliary loop output	-999 to 9999		R/O
D OP	Derivative component of the output	-999 to 9999		R/O
Aux D OP	Derivative component of the auxiliary loop output	-999 to 9999		R/O
FF OP	Feedforward component of output	-9999 to 9999		R/O
SRL Complete	Setpoint rate limit complete			R/O
VP Velocity	VP output velocity	-100 to 100		R/O
Loop Brk Stat	Loop break status flag	No Yes		R/O
Ext FBack	External Feedback			R/O
Aux Ext FBack	Auxiliary External Feedback			R/O

9.10. DISPLAY

The Summary Page, displayed in Operation levels, (see Chapter 5, Installation and Operation Handbook Part No HA026502) consists of up to 10 parameters which are in common use on a particular process. These parameters are 'promoted' to this display using the following table.

9.10.1. Display Page

Table Number: 9.10.1.	**This list configures the Loop Summary display.**			***LP 1* SETUP (Display Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Loop Name	Loop name chosen from User Text, see Section 5.2.6.	Default Text or 01 to 50 User Text	Default Text	Conf
Graph Low	Sets the lower limit on the trend plot	Display Range		L3
Graph High	Sets the upper limit on the trend plot	Display Range		L3
Param Promote	Selects the parameter which is to be promoted to the Summary Page.	1 to 10		Conf
Param Address	The modbus address of the parameter selected by 'Param Promote'. See Appendix D.1.	Modbus address		Conf
Param Name	A name can be selected from User Text (see 5.2.6.) and replaces the number of the 'Param Promote' parameter.	Default Text or 01 to 50 User Text		Conf
Param Access	Sets the read/write access level of the 'Param Promote' parameter.	Lev 1 Read Only Lev 1 Alterable Lev 2 Read Only Lev 2 Alterable		Conf
Parameters which have been promoted using 'Param Promote' are listed at the end of this table as a preview of those which will appear in the Summary page in operation levels.				

9.11. LOOP 2 SET UP

All pages listed in sections 9.1.1 to 9.10.1 are repeated for Loop 2.

9.12. LOOP 3 SET UP

All pages listed in sections 9.1.1 to 9.10.1 are repeated for Loop 3.

9.13. CONTROL LOOP WIRING EXAMPLES

9.13.1. Cascade Wiring

This example shows how to configure Loop 1 to be a simple cascade controller. The master PV is connected to the Main PV input and the slave PV is connected to a PV Input module fitted in Slot 3. The control output is a 4-20mA signal which uses a DC control module fitted in Slot 1.

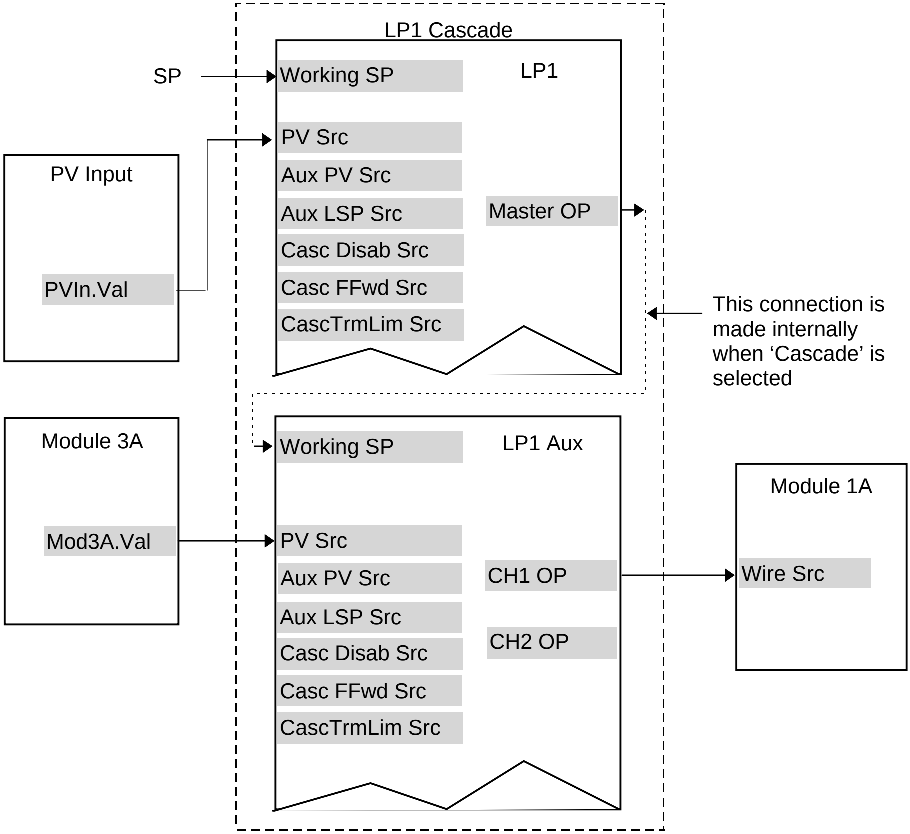


Figure 9-11: Wiring for Simple Cascade Control Loop

9.13.1.1.Implementation

1. In LP1 SETUP / Options Page (Table 9.1.1),	set ‘Loop Type’ = Cascade
2. In LP1 SETUP / Wiring Page (Table 9.1.2.2)	set ‘PV Src’ = 05108: PVIn.Val (Appendix D) *This connects the PV input to the master PV of the cascade loop*
3. In LP1 SETUP / Wiring Page (Table 9.1.2.2)	set ‘Aux PV Src’ = 04468: Mod3A.Val (Appendix D) *This connects the PV input from Module 3 to the slave PV of the cascade loop*
4. In MODULE IO / Module 1 A Page (Table 18.4.1)	set ‘Wire Src = 00013: L1.Ch1.OP (Appendix D) *This connects channel 1(heat) control to the DC output module*

See Appendix D for list of Modbus addresses.

☺ Tip:- See ‘Copy and Paste’ description in Chapter 3.

9.13.2. Cascade Control with SP Feedforward

SP Feedforward allows the master SP to be fed forward so that it directly influences the slave SP. By setting the feedforward trim parameter, it can be used to limit the amount by which the slave SP may differ from the master SP. The trim value is set in the slave in engineering units.

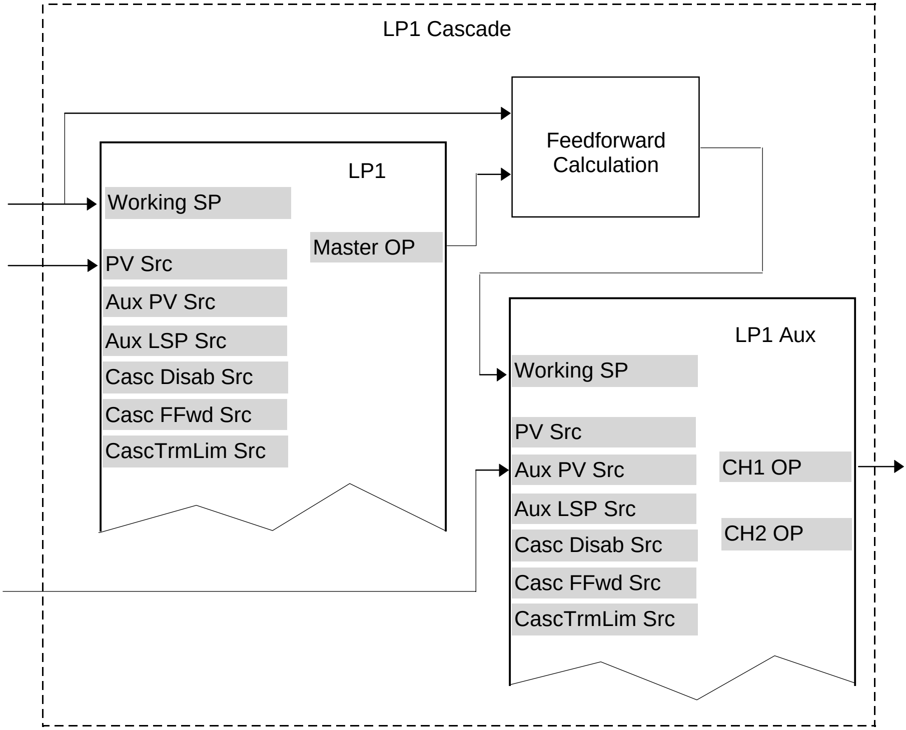


Figure 9-12: Cascade Control with SP Feedforward

9.13.2.1.Implementation

1. In LP1 SETUP / Options Page (Table 9.1.1),	set 'Loop Type' = Cascade
2. In LP1 SETUP / Options Page (Table 9.1.1)	set 'FF Type' = SP Feedforward *Cascade trim limits are found in LP1 SETUP/Cascade Page. To limit slave setpoint to ± 50 from master SP, set CSD FF TrimLim to 50.*
3. In LP1 SETUP / Wiring Page (Table 9.1.2.2)	set ' PV Src' = 05108: PVIn.Val (Appendix D) *This connects the main PV input to the master PV of the cascade loop*
4. In LP1 SETUP / Wiring Page (Table 9.1.2.2)	set 'Aux PV Src = 04468: Mod3A.Val (Appendix D) *This connects the PV input from Module 3 to the slave PV of the cascade loop.*
5. In MODULE IO / Module 1 A Page (Table 18.4.1)	set 'Wire Src = 00013: L1.Ch1.OP (Appendix D) *This connects channel 1(heat) control to the DC output module.*

See Appendix D for list of Modbus addresses.

☺ Tip:- See 'Copy and Paste' description in Chapter 3.

9.13.3. Ratio Wiring

This example shows how to configure Loop 1 to be a simple ratio controller. The main PV is connected to the PV Input (rear terminals V+ & V-) and the lead PV is connected to the Analogue Input (rear terminals BA & BB). The control output is a valve position signal which uses a dual triac control module fitted in Slot 1.

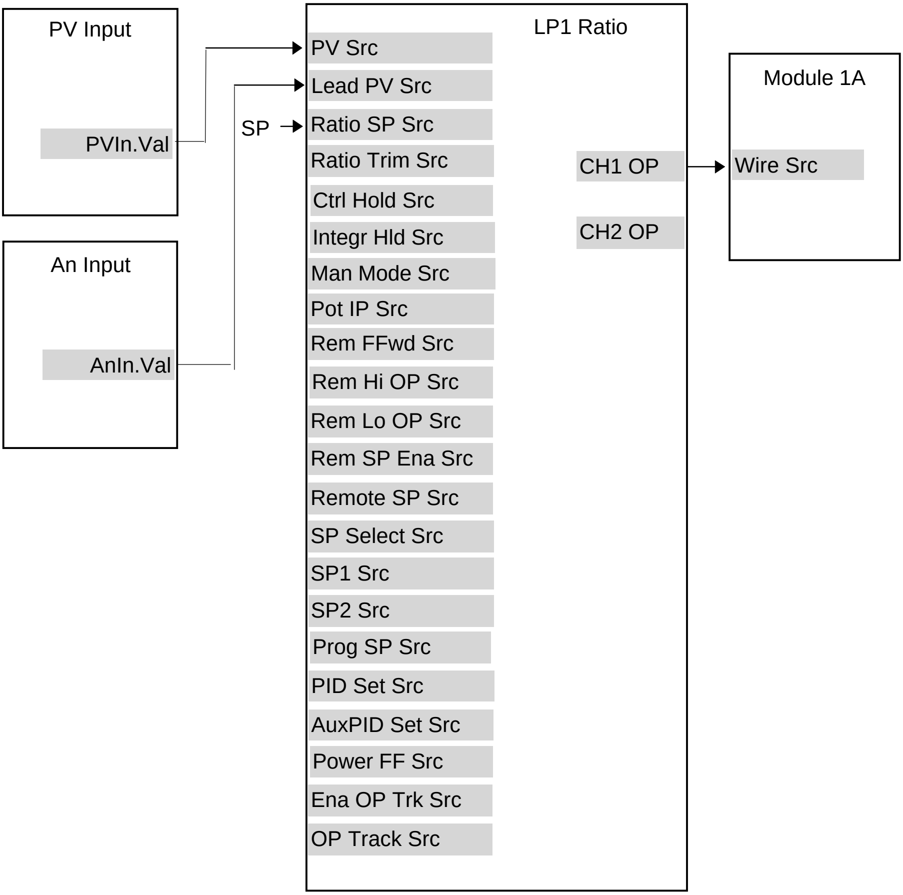


Figure 9-13: Wiring for Simple Ratio Control Loop

9.13.3.1.Implementation

1. In LP1 SETUP / Options Page (Table 9.1.1),	set ‘Loop Type’ = Ratio
2. In LP1 SETUP / Ratio Page (Table 9.4.3),	set ‘Enable Ratio’ = On Set other parameters as required
3. In LP1 SETUP / Wiring Page (Table 9.1.2.3)	set ‘PV Src’ = 05108: PVIn.Val (Appendix D) *This connects the PV input to the main PV of the ratio loop*
4. In LP1 SETUP / Wiring Page (Table 9.1.2.3)	set ‘Lead PV Src’ = 05268: AnIn.Val (Appendix D) *This connects the lead PV input of the ratio loop from Analogue Input*
5. In MODULE IO / Module 1 A Page (Table 18.4.1)	set ‘Wire Src = 00013: L1.Ch1.OP (Appendix D) *This connects channel 1(heat) control to the Dual Triac output module*

See Appendix D for list of Modbus addresses.

☺ Tip:- See ‘Copy and Paste’ description in Chapter 3.

9.13.4. Override Wiring

This example shows how to configure Loop 1 to be a simple override furnace temperature controller. The main PV is connected to the PV Input (rear terminals V+ & V-) and the override PV is connected to a PV Input module fitted in slot 3 (rear terminals 3C & 3D). The control output is an analogue control module fitted in Slot 1.

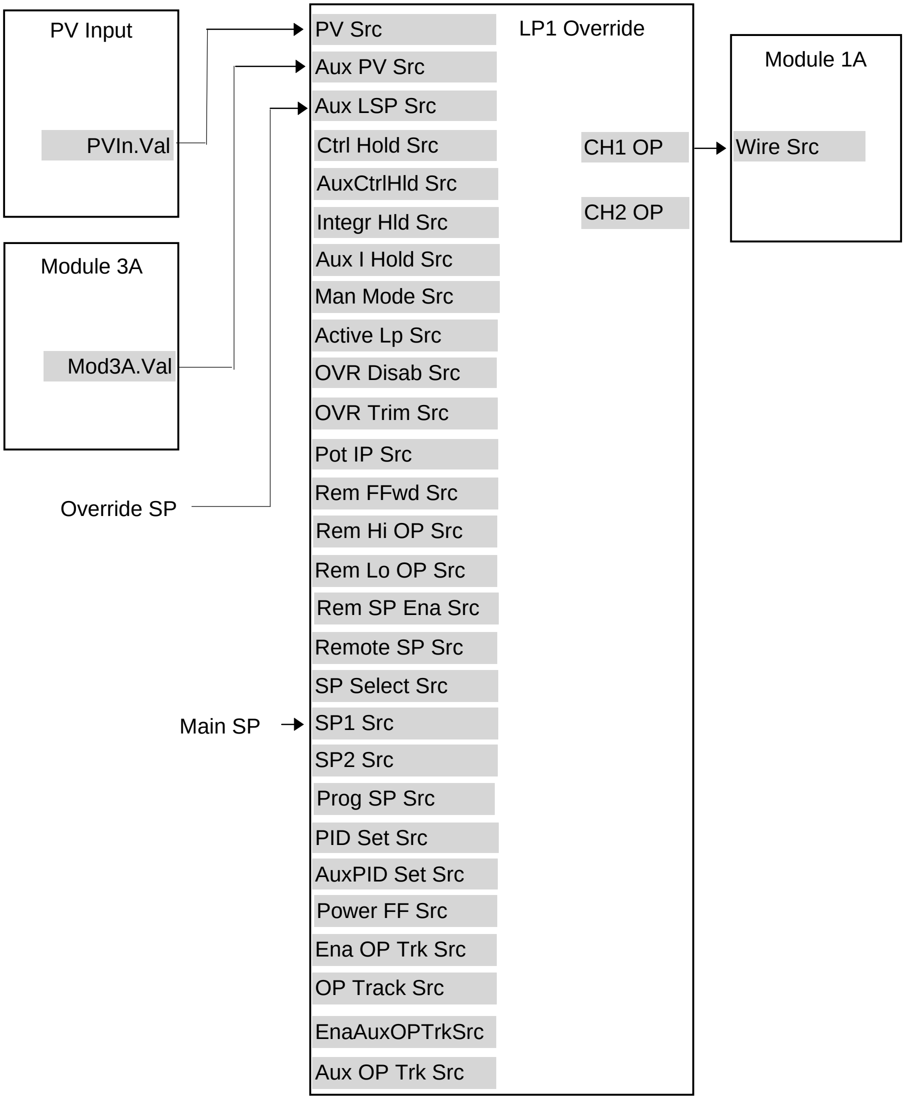


Figure 9-14: Wiring for Simple Override Control Loop

9.13.4.1.Implementation

1. In LP1 SETUP / Options Page (Table 9.1.1),	set 'Loop Type' = Override *This action also connects the main SP and override SP to SP1 and SP2 respectively.*
2. In LP1 SETUP / Override Page (Table 9.5.3),	set 'Override Type' = Minimum Set other parameters as required
3. In LP1 SETUP / Wiring Page (Table 9.1.2.4)	set 'PV Src' = 05108: PVIn.Val (Appendix D) *This connects the PV input to the main PV of the override loop*
4. In LP1 SETUP / Wiring Page (Table 9.1.2.4)	set 'Aux PV Src' = 04468: Mod3A.Val (Appendix D) *This connects the override PV input of the override loop from Analogue Input*
5. In MODULE IO / Module 1 A Page (Table 18.4.1)	set 'Wire Src = 00013: L1.Ch1.OP (Appendix D) *This connects channel 1(heat) control to the Analogue output module*

See Appendix D for list of Modbus addresses.

☺ Tip:- See 'Copy and Paste' description in Chapter 3.

10. CHAPTER 10 CONTROLLER APPLICATIONS............... 2

10. Chapter 10 Controller Applications

The 2704 controller contains control blocks specifically designed to suit a number of different applications.
Examples are:-
Carbon Potential, Oxygen or Dew Point control using Zirconia probes
Humidity control using wet and dry platinum resistance thermometers

About this chapter

This chapter gives general descriptions (which are not intended to be of a particular installation) of the use of the 2704 controller in the above applications.

◊ Brief description and terminology applications using zirconia probes

◊ An example wiring diagram for carbon potential control

◊ Viewing and adjusting the parameters for a carbon potential controller

◊ An example of soft wiring for a carbon potential control loop

◊ Brief description of humidity control

◊ An example wiring diagram for humidity control

◊ Viewing and adjusting the parameters for a humidity controller

◊ An example of soft wiring for a humidity control loop

10.1. ZIRCONIA - CARBON POTENTIAL CONTROL

A dual loop 2704 controller is required to control temperature of the process on one loop and carbon potential on the other. The controller is often a programmer which generates temperature and carbon potential profiles synchronised to a common timebase. In this section it is assumed that a programmer is used.

10.1.1. Temperature Control

The sensor input of the temperature loop may come from the zirconia probe but it is common for a separate thermocouple to be used. The controller provides a heating output which may be connected to gas burners or thyristors to control electrical heating elements. In some applications a cooling output may also be connected to a circulation fan or exhaust damper.

10.1.2. Carbon Potential Control

The zirconia probe generates a millivolt signal based on the ratio of oxygen concentrations on the reference side of the probe (outside the furnace) to the amount of oxygen in the furnace. The controller uses the temperature and carbon potential signals to calculate the actual percentage of carbon in the furnace. This second loop generally has two outputs. One output is connected to a valve which controls the amount of an enrichment gas is supplied to the furnace. The second output controls the level of dilution air.

10.1.3. Sooting Alarm

In addition to other alarms which may be detected by the controller (see also Chapter 7 ‘Alarm Operation’), the 2704 can trigger an alarm when the atmospheric conditions are such that carbon will be deposited as soot on all surfaces inside the furnace.

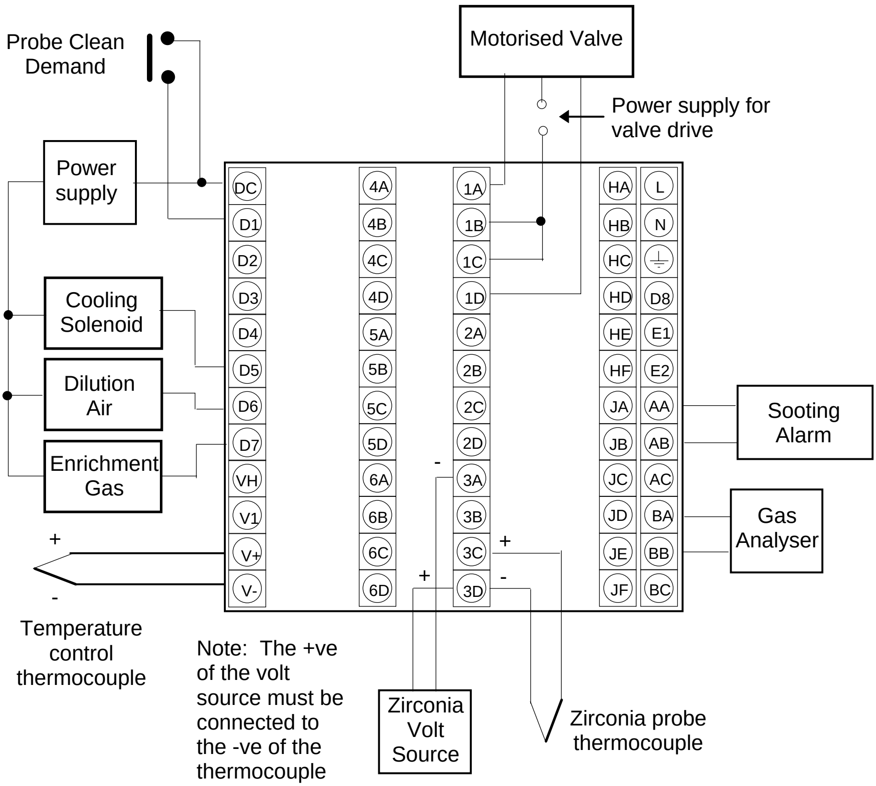
10.1.4. Automatic Probe Cleaning

The 2704 has a probe clean and recovery strategy that can be programmed to occur between batches or manually requested. A short blast of compressed air is used to remove any soot and other particles that may have accumulated on the probe. Once the cleaning has been completed the time taken for the probe to recover is measured. If the recovery time is too long this indicates that the probe is ageing and replacement or refurbishment is due. During the cleaning and recovery cycle, the %C reading is frozen thereby ensuring continuous furnace operation.

10.1.5. Enriching Gas Correction

A gas analyser may be used to determine the CO concentration of the enriching gas. If a 4-20mA output is available from the analyser, it can be fed into the 2704 to automatically adjust the calculated % carbon reading. Alternatively, this value can be entered manually.

10.1.6. Example Of Carbon Potential Controller Connections

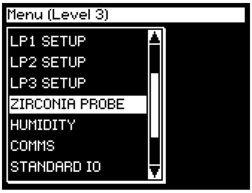
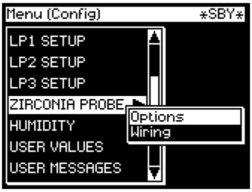
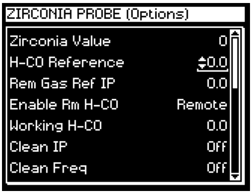


The above diagram is a generalised connection diagram, for further information refer to the Installation chapter 2 in the Installation and Operation Handbook, Part No. HA026502, and to the instructions supplied by the probe manufacturer.
In the above example the following modules are fitted. This will change from installation to installation:

Module 1	Dual triac or relay to drive motorised valve
Module 3	Dual PV Input Module
Standard Digital I/O	Used as logic input for manual probe clean and outputs for solenoid valve drives
Standard PV Input	For the temperature control thermocouple input
Standard Analogue Input	For gas analyser
Standard Relay Output	For sooting alarm

Figure 10-1: An Example of 2704 Wiring for Carbon Potential Control

10.2. TO VIEW AND ADJUST ZIRCONIA PARAMETERS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press or to select **'ZIRCONIA PROBE'**		This page is only available if 'Zirconia' is Enabled in the INSTRUMENT (Options) page
3. Press to display sub-headers		Options: Configure and adjust zirconia parameters. Wiring: Soft wires zirconia parameters
4. Press or to scroll to the required sub-header 5. Press to select the parameter list for the required sub-header		

The full list of parameters available under these list headers is shown in the following tables

10.2.1. Zirconia Parameters

Table Number: 10.2.1.	This table allows you to view or adjust zirconia probe parameters		ZIRCONIA PROBE (Options Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Zirconia Value	Zirconia control process value The O2 or dew point value derived from temperature and remote gas ref inputs	Range units		R/O
Probe Type	Zirconia probe equation	See note 1 for types supported		Conf
Units	Zirconia display units	See Appendix D.2.		Conf
Resolution	Zirconia display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
Oxygen Exp	Oxygen units Only available for 'Probe Type' = 'Log Oxygen'	0 to 19		Conf
The following 10 parameters are not relevant to 'Probe Type' = 'Oxygen'				
H-CO Reference	Gas reference	0.0 to 999.0	20.0	L3
Rem Gas Ref IP	Remote gas reference	0.0 to 999.0		L3
Enable Rem H-CO	Remote gas enable. This can be an internal value from the user interface or remote from an external source.	Internal Remote	Internal	L3
Working H-CO	Working gas reference or process factor	0.0 to 999.0		L3 R/O
Process Factor	Process Factor is used in some zirconia probes to provide compensation for the varying abilities of different alloys to absorb carbon. Applies to MMI probes only	0.0 to 999.0		L3
Clean Mode	Clean probe input	Off On	Off	L3
Clean Freq	Zirconia probe cleaning interval	Off to 99:54:00.0	4:00:00: 0	L3

Clean Duration	Sets the cleaning time	0:00:06.0 to 1:39:54.0	0:10:00:0	L3
Max Recvy Time	Maximum recovery time after purging	0:00:06.0 to 1:39:54.0	0:10:00:0	L3
Min Recvy Time	Minimum recovery time after purging	0:00:06.0 to 1:39:54.0	0:10:00:0	L3
Min Cal Temp	Minimum calculation temp.	-999.0		L3
Probe Offset	Zirconia mV offset	to	0.0	L3
Temp Offset	Sets the temperature offset for the probe	2000.0	0.0	L3
The following 4 parameters are not relevant to 'Probe Type' = 'Oxygen'				
Next Clean	Time to next cleaning. (counts down to 0:00:00.0)	0:00:00.1		R/O
Clean State	The burn off state of the zirconia probe	Inactive Cleaning Recovering		R/O
Clean Output	Clean valve output	Off On	Off	L3
Probe Status	Probe requires cleaning	Good Bad		L1
Probe SBrk	Probe sensor break	No Yes		R/O
The following parameter is not relevant to 'Probe Type' = 'Oxygen'				
Sooting Alarm	Probe sooting alarm output	Good Bad		R/O
Probe IP	Zirconia probe mV input	-0.100 to 2.000		R/O
Temp IP	Zirconia probe temp input val	Temp range		R/O
PV Invalid	PV Invalid	No Yes		L3
This is a boolean which is true when the temperature is below that set by 'Min Cal Temp'. It may have been wired in configuration mode, for example, to disable the gas valve				
The following parameter is not relevant to 'Probe Type' = 'Oxygen'				
PV Frozen	PV Frozen	No Yes		L3
This is a boolean which freezes the PV during a purging cycle. It may have been wired in configuration mode, for example, to disable control output during purging				

Note 1 Probe types supported: Probe mV, Bosch Carbon, MMI Carbon, MMI Dewpoint, AACC, Drayton, Accucarb, SSI, MacDhui, Oxygen, Log Oxygen, Bosch Oxygen, Dewpoint.

10.2.2. Wiring Page

Table Number: 10.2.2.	These parameters configure zirconia probe block wiring.			ZIRCONIA PROBE (Wiring Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
mV Src	Zirconia probe mV input source	Modbus address		Conf
Temp Src	Zirconia probe temperature input source	Modbus address		Conf
Clean Src	Zirconia clean probe input source Not available for Oxygen Probe Types	Modbus address		Conf
Rem Gas Src	Remote gas reference/Process factor source Not available for Oxygen Probe Types	Modbus address		Conf.

10.3. ZIRCONIA WIRING EXAMPLE

10.3.1. The Zirconia Function Block

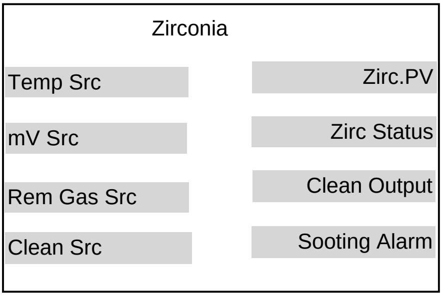


Figure 10-2: Zirconia Function Block

10.3.1.1.Main Features

Calculation of PV: The Process Variable can be carbon potential, Dewpoint or Oxygen concentration. The PV is derived from the probe temperature input, the probe mV input and remote gas reference input values. Various probe makes are supported.

Endothermic Gas Correction: This enables the user to set the percentage of carbon monoxide (%CO) present in the Endothermic Gas. This value can be measured via a gas analyser and fed into the controller as an analogue value.

Probe Clean: As these sensors are used in furnace environments they require regular cleaning. Cleaning (Burn Off) is performed by forcing compressed air through the probe. Cleaning can be initiated either manually or automatically using a timed period. During cleaning the PV output is frozen.

Health Alarm (Zirconia Probe Status): After cleaning an alarm output is generated if the PV does not return to 95% of its value within a specified time. This indicates that the probe is deteriorating and should be replaced.

Sooting Alarm: An output is generated which indicates that the furnace is about to soot.

10.3.2. Configuration of a Carbon Potential Control Loop

This example assumes that the probe temperature (Type K) input is connected to module 3 and the milli-volt input to module 6. Loop 1 normally controls temperature, so the carbon loop will be Loop 2. Carbon control and alarm outputs are relays and configured as On/Off.

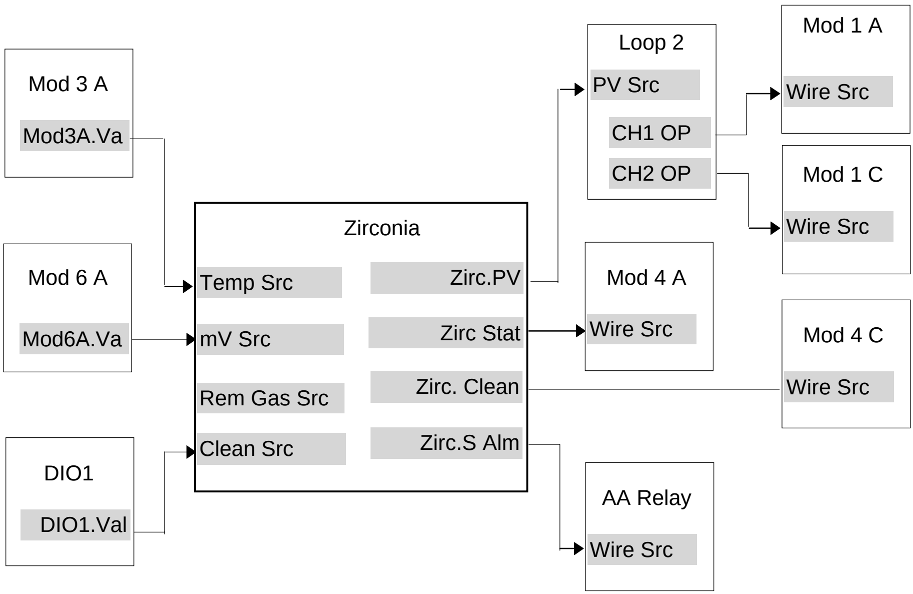


Figure 10-3: Zirconia Wiring for Carbon Potential

10.3.2.1.Implementation

1. In INSTRUMENT/Options Page (Table 5.2.1),	set ’Num of Loops’ = 2 set ‘Zirconia’ = Enabled
2. In MODULE IO/Module 3A Page (Table 18.4.9)	set ’Channel Type’ = Thermocouple set ‘Linearisation’ = K-Type set ‘Units’ = $^oC/^oF/^oK$ set ‘Resolution’ = XXXXX set ‘SBrk Impedance’ = Low set ‘SBrk Fallback’ = Up Scale set ‘CJC Type’ = Internal This configures Module 3 to measure temperature.
3. In MODULE IO/Module 6A Page (Table 18.4.9)	set ’Channel Type’ = HZVolts set ‘Linearisation’ = Linear set ‘Units’ = mV set ‘Resolution’ = XXXXX set ‘SBrk Impedance’ = Off set ‘SBrk Fallback’ = Up Scale set ‘Electrical Lo’ = 0.00 set ‘Electrical Hi’ = 2.00 set ‘Eng Val Lo’ = 0.00 set ‘Eng Val Hi’ = 2000 This configures Module 6 to measure probe mV.
4. In STANDARD IO/Dig IO1 Page (Table 17.5.1)	set ‘Channel Type’ = Digital Input This configures DIO1 to be a digital input.
5. In ZIRCONIA PROBE/Options Page (Table 10.2.1)	set ’Probe Type’ = *Type of probe in use* set ‘Units’ = %CP set ‘Resolution’ = XXX.XX set ‘H-CO Reference’ = *Required Value* *This value defines the % carbon monoxide (%CO) in the gas used for carburising* This configures the zirconia probe
6. In ZIRCONIA PROBE/Wiring Page (Table 10.2.2)	set ’Clean Src’ = 05402:DI01.Val set ‘mV Src’ = 04948:Mod6A set ‘Temp Src’ = 04468:Mod3A This connects inputs to the Zirconia block

7. In LP2 SETUP/Options Page (Table 9.1.1)	set 'Loop Type' = Single set 'Control Type' = OnOff→Ch1&2
8. In LP2 SETUP/Wiring Page (Table 9.1.2)	set 'PV Src' = 11059:Zirc.PV This connects the PV to Loop 2 PV
9. In MODULE IO/Module 1A Page (Table 18.4.2)	set 'Channel Type' = On/Off set 'Wire Src' = 01037:L2.Ch1OP This connects LP2 Ch1 output to module 1
10. In MODULE IO/Module 1C Page (Table 18.4.2)	set 'Channel Type' = On/Off set 'Wire Src' = 01038:L2.Ch2OP This connects LP2 Ch2 output to module 1
11. In MODULE IO/Module 4A Page (Table 18.4.2)	set 'Channel Type' = On/Off set 'Wire Src' =11066:Zirc.Stat This connects the health (probe status) to module 4A
12. In MODULE IO/Module 4C Page (Table 18.4.2)	set 'Channel Type' = On/Off set 'Wire Src' = 11067: Zirc.Clean This connects the clean outputs to module 4C
13. In STANDARD IO/AA Relay Page (Table 17.4.1)	set 'Channel Type' = On/Off set 'Wire Src' = 11068: Zirc.SAlm This connects the sooting alarm to the fixed relay output

See Appendix D for list of Modbus addresses.

☺ **Tip:- See 'Copy and Paste' description in Chapter 3.**

10.4. HUMIDITY CONTROL

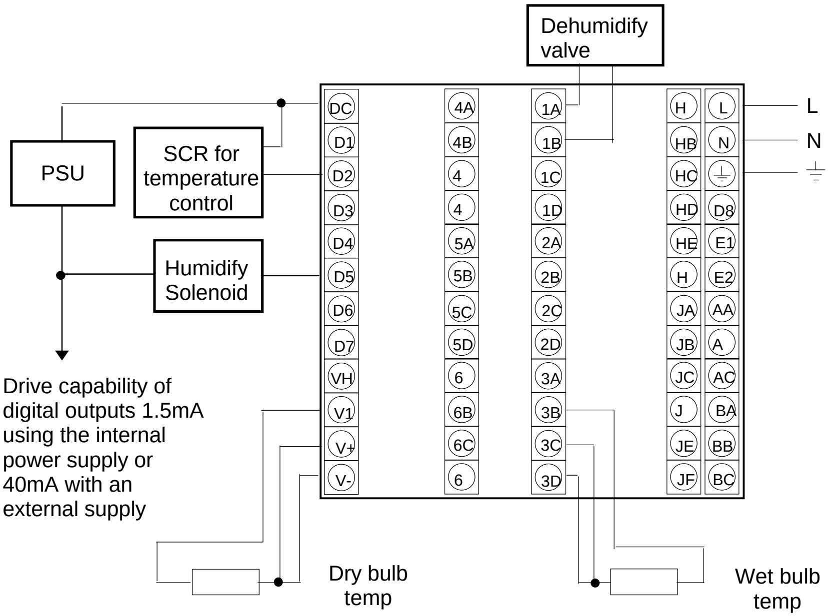
10.4.1. Overview

Humidity (and altitude) control is a standard feature of the 2704 controller. In these applications the controller may be configured to generate a setpoint profile (see Chapter 6 'Programmer Operation').

Also the controller may be configured to measure humidity using either the traditional Wet/Dry bulb method (figure 10.4) or it may be interfaced to a solid state sensor.

The controller output may be configured to turn a refrigeration compressor on and off, operate a bypass valve, and possibly operate two stages of heating and/or cooling

10.4.2. Example Of Humidity Controller Connections



In the above example the following modules are fitted. This will change from installation to installation:

Module 1	Analogue or relay to drive dehumidify valve
Module 3	PV input module for wet bulb temperature RTD
Standard Digital I/O	Used as logic outputs for humidify solenoid valve and temperature control SCR
Standard PV Input	For the dry bulb RTD used for the temperature control and humidity calculation

Figure 10-4: Example of Humidity Controller Connections

10.4.3. Temperature Control Of An Environmental Chamber

The temperature of an environmental chamber is controlled as a single loop with two control outputs. The heating output time proportions electric heaters, usually via a solid state relay. The cooling output operates a refrigerant valve which introduces cooling into the chamber. The controller automatically calculates when heating or cooling is required.

10.4.4. Humidity Control Of An Environmental Chamber

Humidity in a chamber is controlled by adding or removing water vapour. Like the temperature control loop two control outputs are required, i.e. Humidify and Dehumidify. To humidify the chamber water vapour may be added by a boiler, an evaporating pan or by direct injection of atomised water.

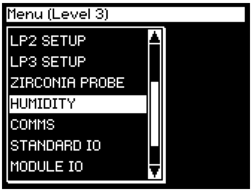
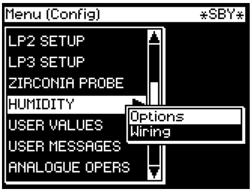
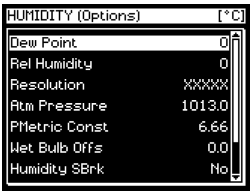
If a boiler is being used adding steam increases the humidity level. The humidify output from the controller regulates the amount of steam from the boiler that is allowed into the chamber.

An evaporating pan is a pan of water warmed by a heater. The humidify output from the controller humidity regulates the temperature of the water.

An atomisation system uses compressed air to spray water vapour directly into the chamber. The humidify output of the controller turns on or off a solenoid valve.

Dehumidification may be accomplished by using the same compressor used for cooling the chamber. The dehumidify output from the controller may control a separate control valve connected to a set of heat exchanger coils.

10.5. TO VIEW AND ADJUST HUMIDITY PARAMETERS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page button] as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'HUMIDITY'**		This page is only available if 'Humidity' is Enabled in the INSTRUMENT (Options) page
3. Press [scroll button] to display sub-headers		Options — Configure and adjust zirconia parameters. Wiring — Soft wires zirconia parameters
4. Press ▲ or ▼ to scroll to the required sub-header 5. Press [scroll button] to select the parameter list for the required sub-header		

The full list of parameters available under these list headers is shown in the following tables

⇓

10.5.1. Humidity Options Parameters

Table Number: 10.5.1.	These parameters allow you to view or adjust the parameters for humidity control			HUMIDITY
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Dew Point	Wet/Dry temperature measurement of dew point	-999.9 to 999.9		L1 R/O
Rel Humidity	Relative Humidity	0.0 to 100.0		L1 R/O
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX		L3
Atm Pressure	Atmospheric Pressure	0.0 to 2000.0	1013 mbar	L3
PMetric Const	Psychometric Constant	0.0 to 10.0	6.66	L3
Wet Bulb Offs	Wet bulb temperature correction	-100.0 to 100.0	0.0	L3
Humidity SBrk	Sensor break action for humidity control	No Yes		L1
Dry Bulb Temp	Dry Bulb Temperature	Range units		L1 R/O
Wet Bulb Temp	Wet Bulb Temperature	Range units		L1 R/O

10.5.2. Wiring Page

Table Number: 10.5.2.	These parameters configure humidity block wiring.			HUMIDITY (Wiring Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Dry Bulb Src	Dry bulb temperature source	Modbus address.		Conf
Wet Bulb Src	Wet bulb temperature source			Conf
Atm Press Src	Atmospheric pressure source			Conf
PMtric Cst Src	Psychometric Constant source		6.66	Conf

10.6. HUMIDITY WIRING EXAMPLE

10.6.1. The Humidity Function Block

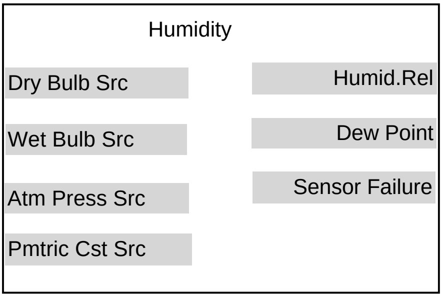


Figure 10-5: Humidity Function Block

10.6.1.1. Main Features

Calculation of PV: The Process Variable can be Relative Humidity or Dewpoint. The PV is derived from the wet and dry bulb inputs and atmospheric pressure.

Pressure Compensation: This value can be measured via a transmitter and fed into the controller as an analogue value. Alternatively, it can be set as a fixed parameter.

10.6.2. Configuration of a Humidity Control Loop

This example assumes that the dry temperature (Pt100) input is connected to the main PV and the wet input (Pt100) to module 3. Loop 1 normally controls temperature, so the humidity loop will be Loop 2. Humidity control outputs are relays and configured as time proportioning.

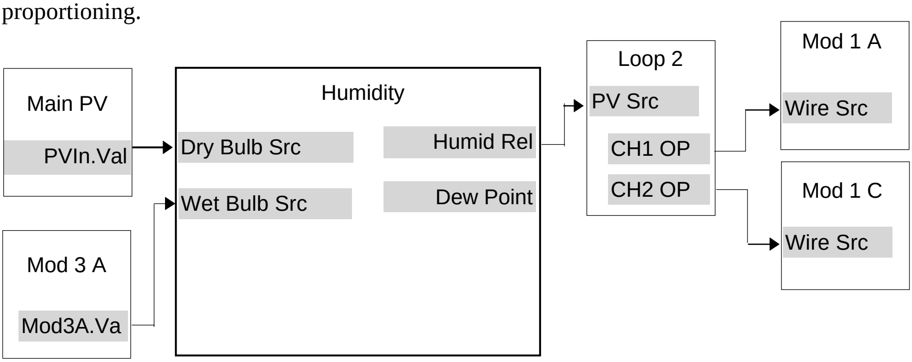


Figure 10-6: Humidity Control Loop

10.6.2.1.Implementation

1. In INSTRUMENT/Options Page (Table 5.2.1),	set 'Num of Loops' = 2 set 'Humidity' = Enabled
2. In STANDARD IO/PV Input Page (Table 17.2.1)	set 'Channel Type' = RTD set 'Linearisation' = PT100 set 'Units' = °C/°F/°K set 'Resolution' = XXXX.X set 'SBrk Impedance' = Low set 'SBrk Fallback' = Up Scale This configures the PV Input to measure dry temperature
3. In MODULE IO/Module 3A Page (Table 18.4.9)	set 'Channel Type' = RTD set 'Linearisation' = PT100 set 'Units' = °C/°F/°K set 'Resolution' = XXXX.X set 'SBrk Impedance' = Off set 'SBrk Fallback' = Up Scale This configures Module 3 to measure wet temperature
4. In HUMIDITY/Options Page (Table 10.5.1)	set 'Atm Pressure' = 1013.0 (for sea level)
5. In HUMIDITY/Wiring Page (Table 10.5.2)	set 'Dry Bulb Src = 05108:PVIn.Val set 'Wet Bulb Src = 04468:Mod3A.Val This connects the sensors to the humidity block
6. In LP2 SETUP/Options Page (Table 9.1.1)	set 'Control Type' = PID→Ch1 PID→Ch2
7. In LP2 SETUP/Wiring Page (Table 9.1.2)	set 'PV Src' = 11105:Humid.Rel Note: For Dewpoint select 11106 This connects the %RH output to Loop 2 PV
8. In LP2 SETUP/Output Page (Table 9.8.1)	set 'OP Low Limit' = -100.0 set 'OP High Limit' = 100.0
9. In MODULE IO/Module 1A Page (Table 18.4.2)	set 'Channel Type' = Time Proportion set 'Wire Src' = 01037:L2.Ch1OP This connects LP2Ch1 output to Module 1A
10. In MODULE IO/Module 1C Page (Table 18.4.2)	set 'Channel Type' = Time Proportion set 'Wire Src' = 01038:L2.Ch2OP This connects L21Ch2 output to Module 1C

See Appendix D for list of Modbus addresses.

☺ Tip:- See 'Copy and Paste' description in Chapter 3.

11. Chapter 11 Input Operators

11.1. WHAT ARE INPUT OPERATORS

The 2704 controller can have three control loops. Each loop can be independently configured to the process to be controlled. This has been described in Chapters 9 and 10 for PID, Cascade, Ratio, Override, Humidity Control, etc. It is also possible to apply custom linearisation to the inputs of each loop. This is a 16 point straight line linearisation and the parameters can be made available at Levels 1, 2 and 3 so that scaling can be carried out during commissioning. There are three Custom linearisation pages.

Also included in this section are parameters which allow you to switch inputs between different thermocouple types or between a thermocouple and pyrometer when the process is a high temperature furnace.

The page headers are:

INPUT OPERERS ▶	Cust Lin 1 Page	These parameters set up the custom linearisation for input 1
	Cust Lin 2 Page	These parameters set up the custom linearisation for input 2
	Cust Lin 3 Page	These parameters set up the custom linearisation for input 3
	Switch 1 Page	These parameters provide switch over between thermocouple types or pyrometer
	Monitor 1 Page	Logs maximum and minimum, counts time above threshold
	BCD Input	Monitors the Digital Inputs when configured for BCD switch

The Input Operators page is only available if Input Operators has been enabled in configuration level.

Note:
In addition to linearising the controller inputs channels, it is equally valid to customise other sources such as Output Channels. This allows you, for example, to compensate for non linear control valve characteristics.

11.2. CUSTOM LINEARISATION

The linearisation uses a 16 point straight line fit.
Figure 11.1 shows an example of a curve to be linearised and is used to illustrate the terminology used for the parameters found in the **INPUT OPERS (Cust Lin*1* Page)**.

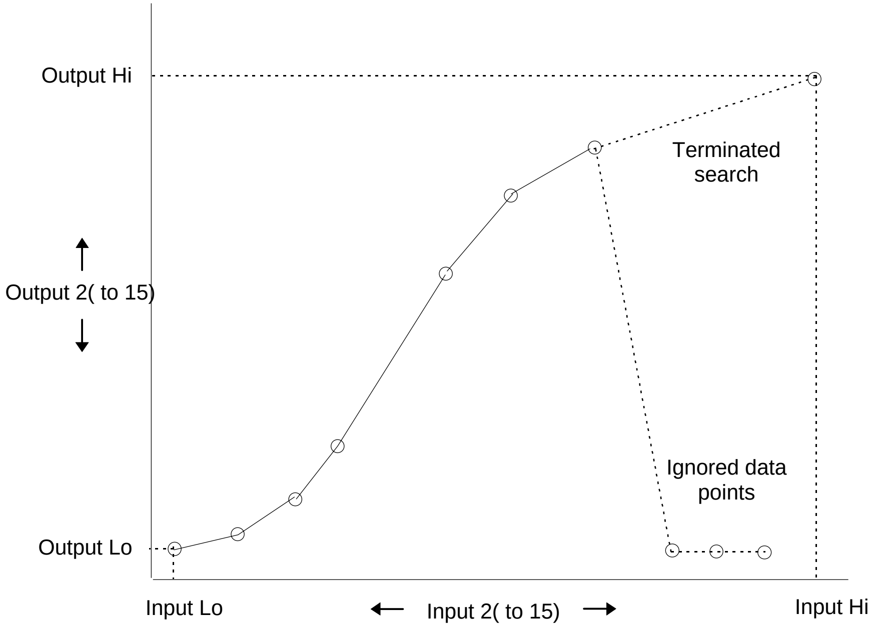


Figure 11-1: Linearisation Example

Notes:

1. The linearisation block works on rising inputs/rising outputs or rising inputs/falling outputs. It is not suitable for outputs which rise and fall on the same curve.
2. Input Lo/Output Lo and Input Hi/Output Hi are entered first to define the low and high points of the curve. It is not necessary to define all 15 intermediate points if the accuracy is not required. Points not defined will be ignored and a straight line fit will apply between the last point defined and the Input Hi/Output Hi point.

11.2.1. Compensation for Sensor Non-Linearities

The custom linearisation feature can also be used to compensate for errors in the sensor or measurement system. The intermediate points are, therefore, available in Level 1 so that known discontinuities in the curve can be calibrated out. Figure 11.2 shows an example of the type of discontinuity which can occur in the linearisation of a temperature sensor.

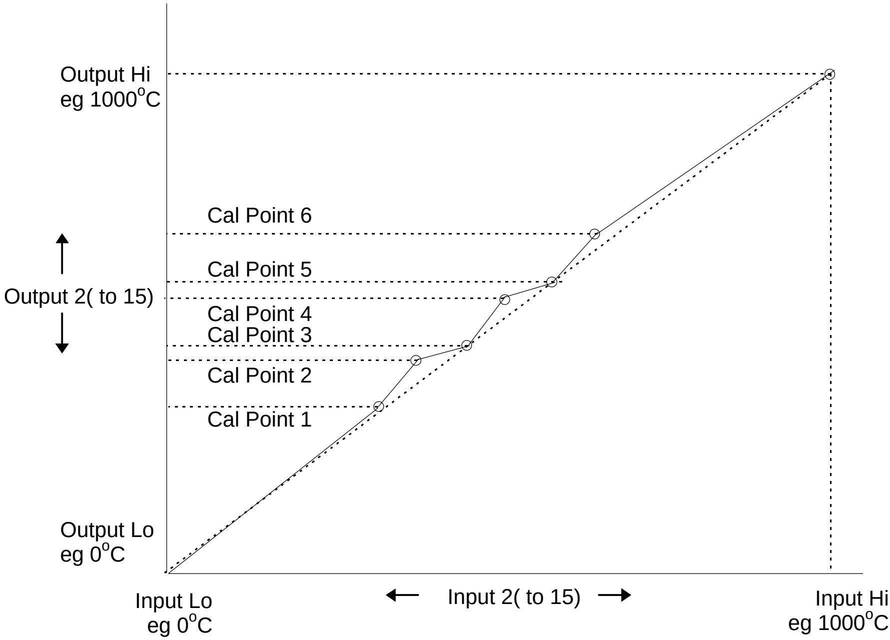
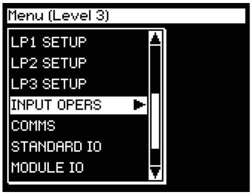
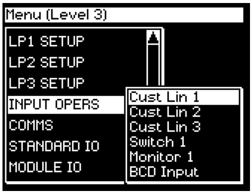
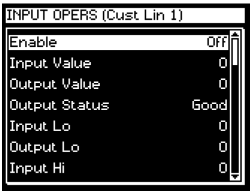


Figure 11-2: Compensation for Sensor Discontinuities

The calibration of the sensor uses the same procedure as described above. Adjust the output (displayed) value against the corresponding input value to compensate for any errors in the standard linearisation of the sensor.

11.3. TO VIEW AND ADJUST INPUT OPERATOR PARAMETERS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'INPUT OPERS'**		This page is only available if 'Input Opers' is Enabled in the INSTRUMENT (Options) page
3. Press [scroll key] to show Sub-headers		Cust Lin 1, Cust Lin 2, Cust Lin 3: Custom linearisation of inputs 1, 2 and 3 Switch 1: T/C to pyrometer switch over Monitor 1: Logs max., min. and time above threshold BCD Input: For use with external BCD switch
4. Press [▲] or [▼] to scroll to the required sub-header 5. Press [scroll key] to select the parameter list for the required sub-header		

The full list of parameters available under these list headers is shown in the following tables

11.3.1. Input Operator Custom Linearisation Parameters

Table Number: 11.3.1.	This page allows you to set up a customised linearisation curve			INPUT OPERS (Cust Lin *1*)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Enable	To enable custom linearisation	Off On	Off	L3
Input Src	Custom linearisation input source	Modbus address		Conf
Output Units	Custom linearisation output units	See Appendix D.2.		Conf
Output Resol	Custom linearisation output resolution	XXXXX XXXX.X XXX.XX XX.XXX		
Input Value	The current value of the input	Range		R/O
Output Value	The current value of the output	Range		R/O
Output Status	The conditions are OK The conditions are bad or out of range	Good Bad		R/O
Input Lo	Adjust to the low input value	Range		L3
Output Lo	Adjust to correspond to the low input value	Range		L3
Input Hi	Adjust to the high input value	Range		L3
Output Hi	Adjust to correspond to the high input value	Range		L3
Input 2	Adjust to the first break point	Range		L1
Output 2	Adjust to correspond to input 2	Range		L1
The above two parameters are repeated for all intermediate break points, ie 3 to 14				
Input 15	Adjust to the last break point	Range		L1
Output 15	Adjust to correspond to input 15	Range		L1

The above table is repeated for:

- **INPUT OPERS (Cust Lin 2 Page)**
- **INPUT OPERS (Cust Lin 3 Page)**

11.4. THERMOCOUPLE/PYROMETER SWITCHING

This facility is commonly used in wide range temperature applications where it is necessary to control accurately over the range. A thermocouple may be used to control at lower temperatures and a pyrometer then controls at very high temperatures. Alternatively two thermocouples of different types may be used.

Figure 11-3 shows a process heating over time with boundaries which define the switching points between the two devices. The higher boundary (2 to 3) is normally set towards the top end of the thermocouple range and the lower boundary (1 to 2) set towards the lower end of the pyrometer (or second thermocouple) range. The controller calculates a smooth transition between the two devices.

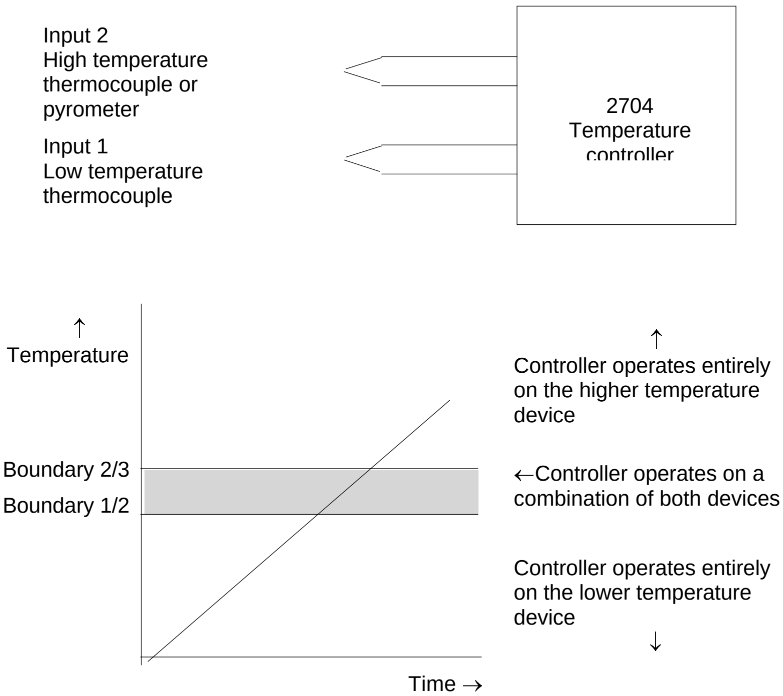


Figure 11-3: Thermocouple to Pyrometer Switching

11.4.1. Input Operators Switch Over Parameters

Table Number: 11.4.1.	This page allows you to set up and inspect Switch Over parameters		INPUT OPERS (Switch 1 Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Enable	To enable switch over	Off On	Off	Conf
Input 1 Src	Input 1 source	Modbus address		Conf
Input 2 Src	Input 2 source			Conf
Input Lo	Display low limit	Display range		Conf
Input Hi	Display High limit	Display range		Conf
Switch Lo	PV = Input 1 below this value Can be adjusted up to the limit set by ‘Input Lo’ in configuration level or the limit set by ‘Switch Hi’	Display Range		L3
Switch Hi	PV = Input 2 above this value Can be adjusted up to the limit set by ‘Input Hi’ in configuration level or the limit set by ‘Switch Lo’	Display Range		L3
Output Value	The current working value	Display Range		R/O
Output Status	The conditions are OK or out of range	Good Bad		R/O
Input 1 Value	The current working value Can be adjusted between the limits set by ‘Input Lo’ and ‘Input Hi’ in configuration level	Display Range		R/O
Input 1 Status	The conditions are correct or out of range	Good Bad		R/O
Input 2 Value	The current working value Can be adjusted between the limits set by ‘Input Lo’ and ‘Input Hi’ in configuration level	Display Range		R/O
Input 2 Status	The conditions are correct or out of range	Good Bad		R/O

11.5. TO SET UP INPUT OPERATORS (MONITOR)

The Monitor block:

1. Logs the Maximum and Minimum excursions of the PV. These values are reset when:-
    a) An external logic input, configured as reset, is enabled
    b) The reset parameter, see Table 11.5.1, is changed to Yes
2. Counts the time above a threshold
3. Provides a time alarm

11.5.1. Input Operator Monitor Parameters

Table Number: 11.5.1.	This page allows you to set up Monitor parameters.			INPUT OPERS (Monitor 1 Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Enable	Monitor enable	Disabled Enabled	Off	Conf
Input Src	Input source	Modbus addr		Conf
Reset Src	Reset source	Modbus addr		Conf
Input	Input value	Range		L1
Reset	Reset	No = to run Yes = to reset	No	L3
Maximum	The maximum value recorded by the controller between resets, see 1. above	Range		R/O
Minimum	The minimum value recorded by the controller between resets, see 1. above	Range		R/O
Trigger	PV threshold for timer log	Range		L3
Day	Days above threshold	0 to 32767		R/O
Time	Time above threshold	0:00:00.0		R/O
Day Alarm	This sets the alarm threshold for the number of days that the alarm is active	0 to 32767		L3
Time Alarm	This sets the alarm threshold for the time that the alarm is active	0:00:00.0		L3
Alarm Output	Displays an alarm when the number of days and time has been exceeded	Off On		R/O

11.6. BCD INPUT

An available option with the 2704 is the Binary Coded Decimal (BCD) function block. This feature is normally used to select a program number by using panel mounted BCD decade switches. A configuration example for this block is given in Section 11.7.2.

11.6.1. Main Features

Calculation of BCD Value: The function calculates a BCD value dependant upon the state of the inputs. Unconnected inputs are detected as off. This value is available as a wireable parameter.

Calculation of BCD Value: The function calculates a decimal value dependant upon the state of the inputs. Unconnected inputs are detected as off. This value is available as a wireable parameter.

Digit 1 Output: The function calculates the first decade BCD value dependant on the state of inputs 1 to 4. Unconnected inputs are detected as off. This value is available as a wireable parameter.

Digit 2 Output: The function calculates the second decade BCD value dependant on the state of inputs 5 to 8. Unconnected inputs are detected as off. This value is available as a wireable parameter.

2nd Decade	1st Decade	BCD	Decimal	2nd Digit	1st Digit
0011	1001	39	57	3	9
0010	0110	26	38	2	6

11.6.2. BCD Parameters

Table Number: 11.6.2.	This page allows you to configure the BCD input values			INPUT OPERS (BCD Input Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Enable	BCD enable	Off On	Off	Conf
Input1 Src-L	Input 1 source (LSB)	Modbus address		Conf
Input2 Src	Input 2 source	Modbus address		Conf
Input3 Src	Input 3 source	Modbus address		Conf
Input4 Src	Input 4 source	Modbus address		Conf
Input5 Src	Input 5 source	Modbus address		Conf
Input6 Src	Input 6 source	Modbus address		Conf
Input7 Src	Input 7 source	Modbus address		Conf
Input8 Src-M	Input 8 source (MSB)	Modbus address		Conf
BCD Value	Reads the value (in BCD) of the switch as it appears on the digital inputs	0-99		R/O
Decimal Value	Reads the value(in decimal) of the switch as it appears on the digital inputs	0-255		R/O
Digit 1(units)	Units value of the first switch	0-9		R/O
Digit 2(Tens)	Tens value of the second switch	0-9		R/O

11.7. INPUT OPERATORS WIRING EXAMPLES

11.7.1. Switch Over Loop With Custom Linearised Input

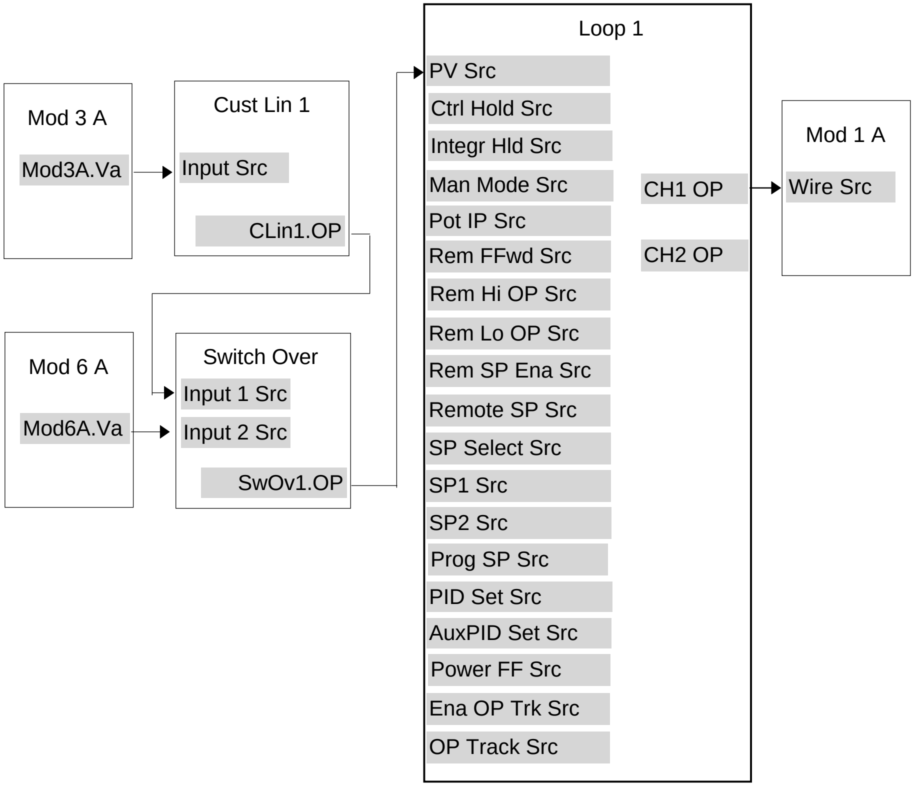


Figure 11-4: Example Wiring, Switch Over Loop with Custom Linearised Input

11.7.1.1.Implementation

1. In INPUT OPERS/Custom Lin 1 (Table 11.3.1),	set 'Input Src' = 04468:Mod3A.Val (Appendix D) This connects the input of the custom linearisation block to the output of Module 3A fitted as a PV input module.
2. In INPUT OPERS/Switch 1 Page (Table 11.4.1)	set 'Input 1 Src' = 03365:CLin1.OP (Appendix D) This connects input 1 of the switch over block to the output of custom linearisation block 1.
3. In INPUT OPERS/Switch 1 Page (Table 11.4.1)	set 'Input 2 Src' = 04948:Mod6A.Val (Appendix D) This connects input 2 of the switch over block to the output of module 6A fitted as an analogue input module.
4. In LOOP SETUP/Wiring Page (Table 9.1.2.1)	Set 'PV Src' = 03477:SwOv1.OP (Appendix D) This connects the PV input of Loop 1 to the output of the switch over block.
5. In MODULE IO/Module 1A Page (Table 18.4.1 if analogue output)	Set 'Wire Src' = 00004:L1.Wkg OP (Appendix D) This connects the input of module 1A to channel 1 output of loop 1. This module may be fitted as an analogue, relay, triac or logic output.

See Appendix D for list of Modbus addresses.

☺ **Tip:- See 'Copy and Paste' description in Chapter 3.**

11.7.2. Configuring the BCD Input to Select a Program

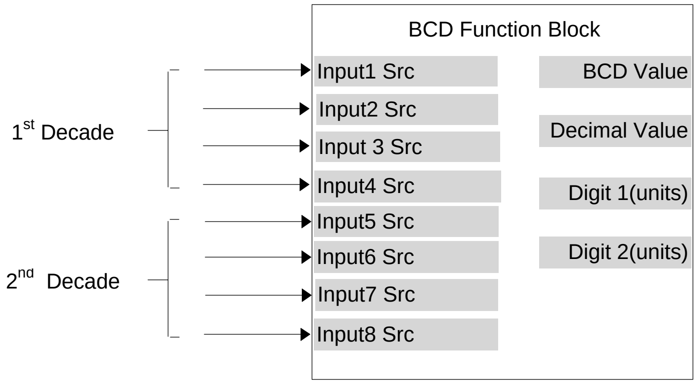


Figure 11-5: BCD Function Block

This example assumes that the digital inputs are connected to the standard IO.

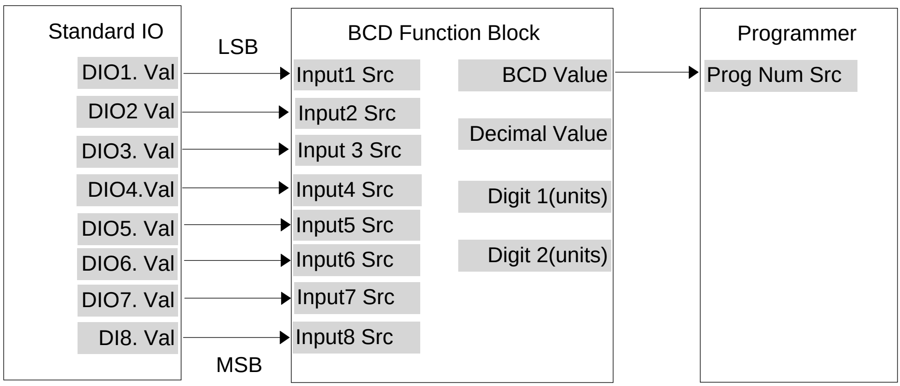


Figure 11-6: Wiring of Digital Inputs to the BCD Function Block

11.7.2.1.Implementation

1.	In PROGRAM EDIT/Options Page (Table 6.6.1.)	set 'BCD Prg Num' = Yes
2.	In STANDARD IO/DI01 Page (Table 17.5.1.)	set 'Channel Type' = Digital Input
3.	In STANDARD IO/DI02 Page	set 'Channel Type' = Digital Input
4.	In STANDARD IO/DI03 Page	set 'Channel Type' = Digital Input
5.	In STANDARD IO/DI04 Page	set 'Channel Type' = Digital Input
6.	In STANDARD IO/DI05 Page	set 'Channel Type' = Digital Input
7.	In STANDARD IO/DI06 Page	set 'Channel Type' = Digital Input
8.	In STANDARD IO/DI07 Page	set 'Channel Type' = Digital Input
9.	In INPUT OPERS/BCD Input Page (Table 11.6.2.)	set 'Enable' = On
10.	In INPUT OPERS/BCD Input Page	Set 'Input1 Src' = 05402:DIO1.Val
11.	In INPUT OPERS/BCD Input Page	Set 'Input2 Src' = 05450:DIO2.Val
12.	In INPUT OPERS/BCD Input Page	Set 'Input3 Src' = 05498:DIO3.Val
13.	In INPUT OPERS/BCD Input Page	Set 'Input4 Src' = 05546:DIO4.Val
14.	In INPUT OPERS/BCD Input Page	Set 'Input5 Src' = 05594:DIO5.Val
15.	In INPUT OPERS/BCD Input Page	Set 'Input6 Src' = 05642:DIO6.Val
16.	In INPUT OPERS/BCD Input Page	Set 'Input7 Src' = 05690:DIO7.Val
17.	In INPUT OPERS/BCD Input Page	Set 'Input8 Src' = 11313:DIO8.Val
18.	In PROGRAM EDIT/Wiring Page (Table 6.7.2.)	Set 'Prog Num Src' = 10450 *This connects the output of the BCD block to the program number.*

11.7.3. Holdback Duration Timer

This procedure describes how to configure a 2704 controller, using the Monitor Block, to accumulate the total time that a program has been in holdback within a segment. A holdback timer can be used to inform the user his application is taking longer to heat up than normal, possibly indicating a problem with the heat source or unusually high losses.

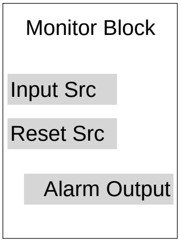


Figure 11-7: Monitor Function Block

The Monitor Block functions are as follows:

1. Logs the maximum and minimum excursions of its input value. These values are reset when:
    a) the controller power is cycled
    b) the block is reset
2. Counts the time above a threshold
3. Provides a time alarm

This example assumes that the controller has already been set up as a single loop programmer, and that program digital output 1 is used to enable the timer during certain segments. This used to reset the monitor at the end of the segment. The maximum expected holdback time is set to 30 minutes. When this time is exceeded the AA relay is switched on.

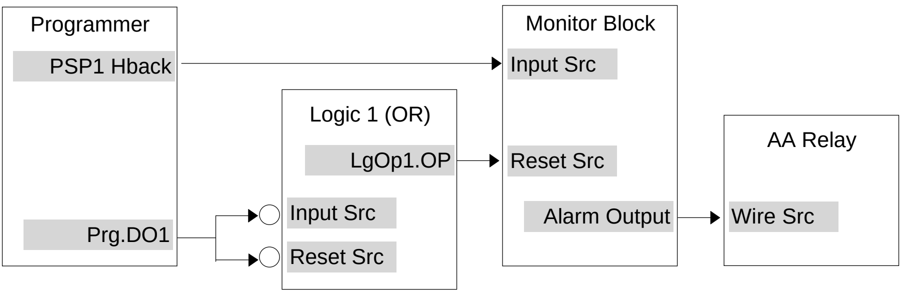


Figure 11-8: Example Wiring, Holdback Duration Timer

11.7.3.1. Implementation

1. In LOGIC OPERATORS/Logic 1 Page (Table 15.2.1.)	set ’Operation’ = OR set ’Input 1 Src’ = 05869:Prg.DO1 set ’Input 2 Src’ = 05869:Prg.DO1 set ’Invert’ = Invert Both This inverts the sense of Program DO1
2. In INPUT OPERS/Monitor 1 Page (Table 11.5.1.)	Set ‘Enable’ = Enabled Set ‘Input Src’ = 05804: This connects PSP1 Holdback Status Set ‘Reset Src’ = 07176:LgOp1.OP This connects Logic 1 Output to the Monitor Reset Set ‘Trigger’ = 1.0 Set ‘Day Alarm’ = 0 Set ‘Time Alarm’ = 0:30:00:0
3. In STANDARD IO/AA Relay Page (Table 17.4.1.)	Set ‘Channel Type’ = On/Off Set ‘Wire Src’ = 03500: This assigns AA Relay to Monitor OP

12. CHAPTER 12 TIMER, CLOCK, TOTALISER, OPERATION2

12. Chapter 12 Timer, Clock, Totaliser, Operation

12.1. WHAT ARE TIMER BLOCKS?

Timer Blocks allow the controller to use time/date information as part of the control process. They can be triggered by an event and used to initiate an action. For example, a programmer can be set to RUN at a particular day and time or an action delayed as a result of a digital input signal. The Timer Blocks page is only available if Timer Blocks has been enabled in configuration level. The Timer Blocks fitted in the 2704 controller are:

Four timer blocks	Timer blocks can have four modes of operation which are explained in Section 12.2. The timer type is set in Configuration level. The timer is activated by an event. The event is also defined in Configuration mode or it may be triggered by a parameter in the list. Timing continues for a set time period. The output can be 'wired' in configuration mode to operate a further event.
Clock	This is a real time clock which can be used to operate other time based functions.
Two alarm (clock) blocks	Alarms can be switched on or off at a particular day or time and provide a digital output. The alarm output can be wired in configuration mode to operate an event.
Four totaliser blocks	Totaliser blocks can also be 'wired', in Configuration level, to any parameter. They are used to provide a running total of a parameter and give an output when a pre-set total is reached. An example might be to totalise the flow through a pipe. The output can also be 'wired' in Configuration level to operate an event such as a relay.

Timer Blocks are grouped under page headers as follows:

TIMER BLOCKS ▶	Timer 1 Page	Parameters to set the time period and read elapsed time for timer 1
	Timer 2 Page	Parameters to set the time period and read elapsed time for timer 2
	Timer 3 Page	Parameters to set the time period and read elapsed time for timer 3
	Timer 4 Page	Parameters to set the time period and read elapsed time for timer 4
	Clock Page	To set time and day
	Alarm 1 Page	Parameters to set a time and day alarm and read the alarm output condition for alarm 1
	Alarm 2 Page	Parameters to set a time and day alarm and read the alarm output condition for alarm 2
	Totaliser1 Page	Parameters to read the totalised value, set and monitor an alarm on totalised value.
	Totaliser2 Page	Parameters to read the totalised value, set and monitor an alarm on totalised value.
	Totaliser3 Page	Parameters to read the totalised value, set and monitor an alarm on totalised value.
	Totaliser4 Page	Parameters to read the totalised value, set and monitor an alarm on totalised value.

12.2. TIMER TYPES

Each timer block can be configured to operate in four different modes. These modes are explained below

12.2.1. On Pulse Timer Mode

This timer is used to generate a fixed length pulse from an edge trigger.

- The output is set to On when the input changes from Off to On.
- The output remains On until the time has elapsed
- If the 'Trigger' input parameter recurs while the Output is On, the Elapsed Time will reset to zero and the Output will remain On
- The triggered variable will follow the state of the output

Figure 12.1 illustrates the behaviour of the timer under different input conditions.

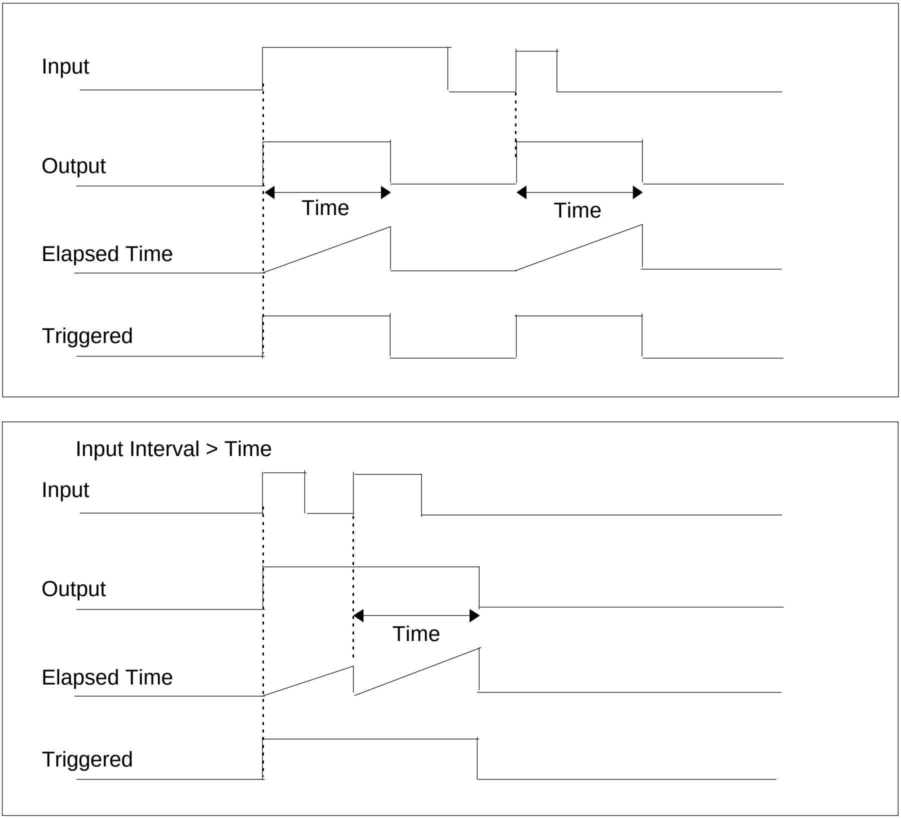


Figure 12-1: On Pulse Timer Under Different Input Conditions

12.2.2. Off Delay Timer Mode

This timer provides a delay between the trigger event and the Timer output. If a short pulse triggers the Timer, then a pulse of one sample time (110mS) will be generated after the delay time.

- The Output is set to Off when the Input changes from Off to On.
- The Output remains Off until the Time has elapsed.
- If the Input returns to Off before the time has elapsed, the Timer will continue until the Elapsed Time equals the Time. It will then generate a pulse of one Sample Time duration.
- Once the Time has elapsed, the Output will be set to On.
- The Output will remain On until the Input is cleared to Off.
- The Triggered variable will be set to On by the Input changing from Off to On. It will remain On until both the Time has elapsed and the Output has reset to Off.

Figure 12.2 illustrates the behaviour of the timer under different input conditions.

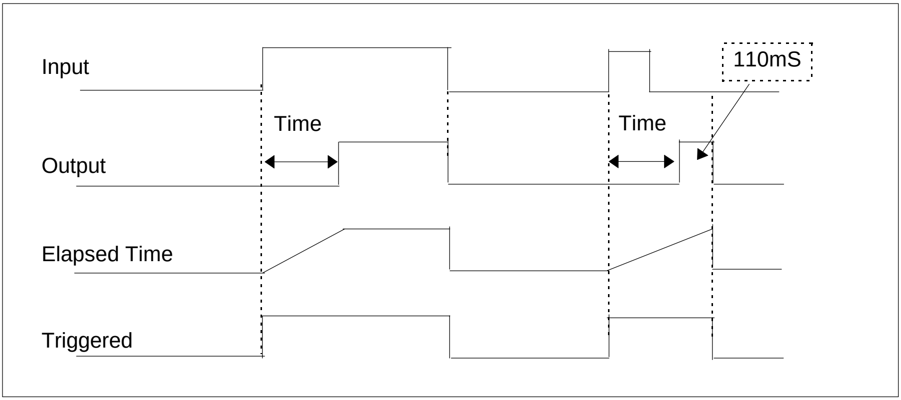


Figure 12-2: Off Delay Timer Under Different Input Conditions

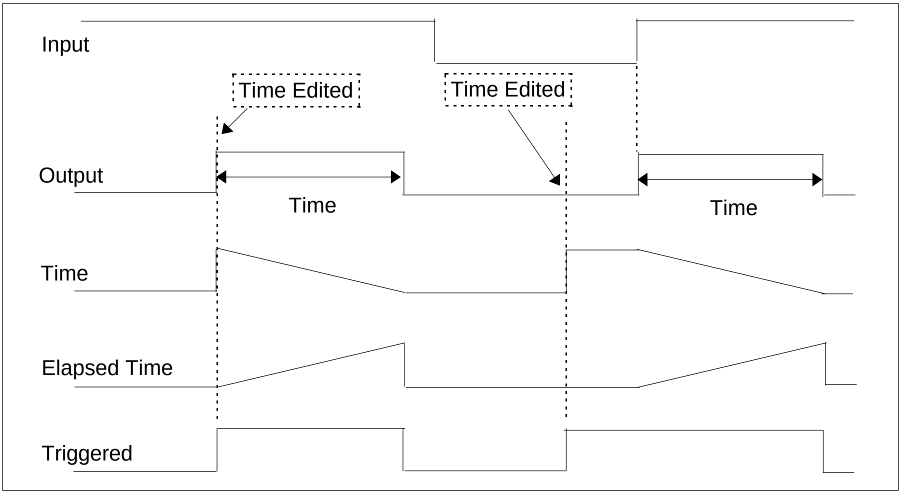
12.2.3. One Shot Timer Mode

This timer behaves like a simple oven timer.

- When the Time is edited to a non-zero value the Output is set to On
- The Time value is decremented until it reaches zero. The Output is then cleared to Off
- The Time value can be edited at any point to increase or decrease the duration of the On time
- Once set to zero, the Time is not reset to a previous value, it must be edited by the operator to start the next On-Time
- The Input is used to gate the Output. If the Input is set, the time will count down to zero. If the Input is cleared to Off, then the Time will hold and the Output will switch Off until the Input is next set.

  Note: since the Input is a digital wire, it is possible for the operator to NOT wire it, and set the Input value to On which permanently enables the timer.
- The Triggered variable will be set to On as soon as the Time is edited. It will reset when the Output is cleared to Off.

Figure 12.3 illustrates the behaviour of the timer under different input conditions.



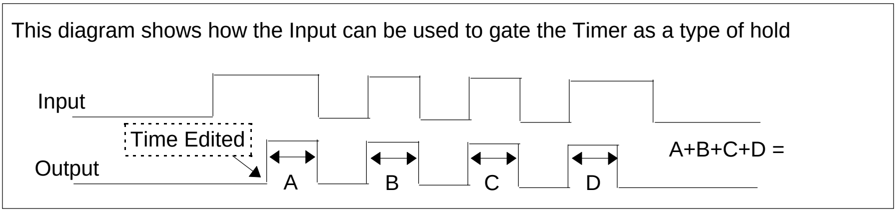


Figure 12-3: One Shot Timer

12.2.4. Minimum On Timer Mode

This timer has been targeted at guaranteeing that the output remains On for a duration after the input signal has been removed. It may be used, for example, to ensure that a compressor is not cycled excessively.

- The output will be set to On when the Input changes from Off to On.
- When the Input changes from On to Off, the elapsed time will start incrementing towards the set Time.
- The Output will remain On until the elapsed time has reached the set Time. The Output will then switch Off.
- If the Input signal returns to On while the Output is On, the elapsed time will reset to 0, ready to begin incrementing when the Input switches Off.
- The Triggered variable will be set while the elapsed time is >0. It will indicate that the timer is counting.

Figure 12.4 illustrates the behaviour of the timer under different input conditions.

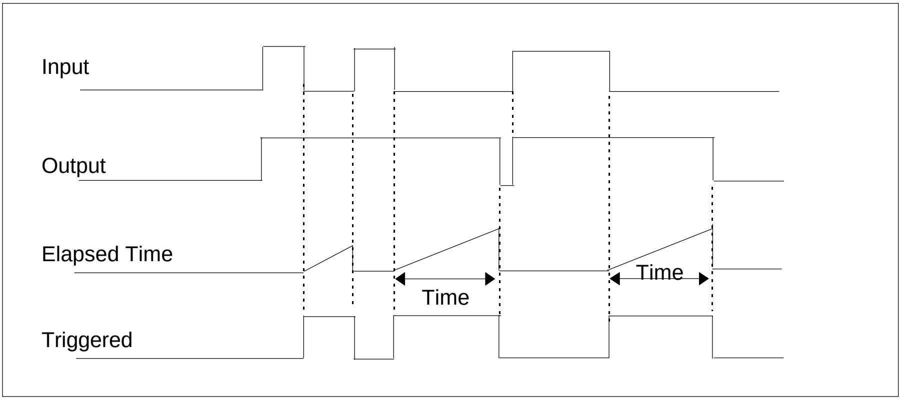
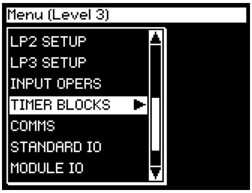
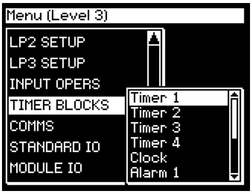
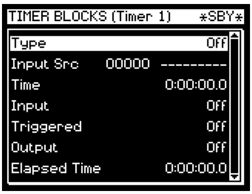


Figure 12-4: Minimum On Timer Under Different Input Conditions

12.3. TO VIEW AND ADJUST TIMER PARAMETERS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press or to select **'TIMER BLOCKS'**		This page is only available if 'Timer Blocks is Enabled in the INSTRUMENT (Options) page
3. Press to show Sub-headers		Timer 1, Timer 2, Timer 3, Timer 4 — To configure timer types and parameters Clock — To set time and day Alarm 1, Alarm 2 — To wire and set alarm outputs Totaliser 1, Totaliser 2, Totaliser 3, Totaliser 4 — To wire and set totaliser 1, 2, 3 & 4 parameters
4. Press or to scroll to the required sub-header 5. Press to select the parameter list for the required sub-header		

The full list of parameters available under these list headers is shown in the following tables

⇓

12.3.1. Timer Parameters

Table Number: 12.3.1.	This page allows you to configure timer type and set up Timer Parameters			TIMER BLOCKS (Timer 1 to 4 Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Type	Timer type	Off On Pulse Timer Off Delay Timer One Shot Timer Min-On Timer	Off	Conf
Input Src	Timer input wire source	Modbus address		Conf
Time	Timer Time	0:00:00.0		L1
Input	Trigger/Gate input. Turn On to start timing	Off On	Off	L1
Triggered	Timer triggered (timing)	Off On		R/O
Output	Timer output. Occurs when the timer has timed out	Off On	Off	L1
Elapsed Time	Timer elapsed time	0:00:00.0		R/O

The above table is repeated for Timers 2 to 4.

12.4. THE CLOCK

A real time clock is provided for use with various timer functions in the controller.

12.4.1. Clock Parameters

Table Number: 12.4.1.	This page allows you to configure the clock		TIMER BLOCKS (Clock Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Mode	Real time clock mode	Run Stop Set		Conf
Time	Real time clock time	HH:MM:SS		L1 R/O when Mode =Set
Day	Real time clock day	Never Monday Tuesday Wednesday Thursday Friday Saturday Sunday Mon-Fri Mon-Sat Sat-Sun Every Day		L1 R/O when Mode =Set

12.5. TIME BASED ALARMS

There are two alarms available which allow an output to be turned **on** or **off** at a set time and day.

12.5.1. Timer Alarm Parameters

Table Number: 12.5.1.	This page allows you to set up Timer Alarm Parameters		TIMER BLOCKS (Alarm 1 or 2 Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Enable Src	Enable input wire source	Modbus address	None	Conf
Enable	RTC Alarm 1 Enable Enables the timer alarm	Off On	Off	L3
On-Day	Sets the day to turn the alarm on	Never Monday Tuesday Wednesday Thursday Friday Saturday Sunday Mon-Fri, Mon-Sat Sat-Sun Every Day	Never	L3
On-Time	Sets the time of day to turn the alarm on	0:00:00 to 23:59:59	0:00:00	L3
Off-Day	Sets the day to turn the alarm off	Never Monday Tuesday Wednesday Thursday Friday Saturday Sunday Mon-Fri, Mon-Sat Sat-Sun Every Day	Never	L3
Off-Time	Sets the time of day to turn the alarm off	0:00:00 to 23:59:59	0:00:00	L3
Output	Alarm 1 output.	Off On	Off	L1

12.6. TOTALISERS

There are four totaliser function blocks which are used to measure the total quantity of a measurement integrated over time. A totaliser can, by soft wiring, be connected to any measured value. The outputs from the totaliser are its integrated value, and an alarm state. The user may set a setpoint which causes the alarm to activate once the integration exceeds the setpoint.

The totaliser has the following attributes:-

1. Run/Hold/Reset
   In Run the totaliser will integrate its input and continuously test against an alarm setpoint.
   In Hold the totaliser will stop integrating its input but will continue to test for alarm conditions.
   In Reset the totaliser will be zeroed, and alarms will be reset.
2. Alarm Setpoint
   If the setpoint is a positive number, the alarm will activate when the total is greater than the setpoint.
   If the setpoint is a negative number, the alarm will activate when the total is lower (more negative) than the setpoint.
   If the totaliser alarm setpoint is set to 0.0, the alarm will be off. It will not detect values above or below.
   The alarm output is a single state output. It may be cleared by resetting the totaliser, or by changing the alarm setpoint.
3. The total is limited to a maximum of 99999 and a minimum of -19999.

12.6.1. Totaliser Parameters

Table Number: 12.6.1.	**This page allows you to set up Totaliser Parameters**			**TIMER BLOCKS (Totaliser1 (to 4) Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Input Src	Totaliser monitored parameter source	Modbus address		Conf
Reset Src	Totaliser reset source	Modbus address		Conf
Run Src	Totaliser run source	Modbus address		Conf
Hold Src	Totaliser hold source	Modbus address		Conf
Units	Totaliser units	See Appendix D2		Conf
Resolution	Totaliser resolution	XXXXX	XXXXX	Conf

		XXXX.X XXX.XX XX.XXX X.XXXX		
Reset	Resets the totaliser	No Yes	No	L1
Run	Runs the totaliser	Run Reset	Reset	L1
Hold	Holds the totaliser at its current value Note: The Run & Hold parameters are designed to be wired to (for example) digital inputs. Run must be ‘on’ and Hold must be ‘off’ for the totaliser to operate.	Hold Continue	Hold	L1
Total	This shows the totalised value			L1
Alarm Setpoint	Sets the totalised value at which an alarm will occur			L3
Alarm Output	This is a read only value which indicates the alarm output On or Off. The totalised value can be a positive number or a negative number. If the number is positive the alarm occurs when Total > + Alarm Setpoint If the number is negative the alarm occurs when Total > - Alarm Setpoint	Off On	Off	L1
Input Val	Totaliser monitored value	-9999 to 99999		L1

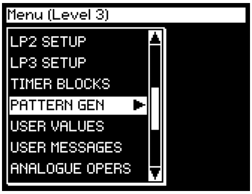
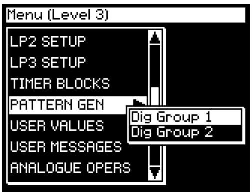
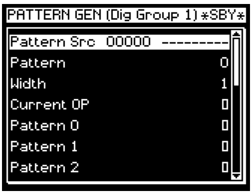
13. Chapter 13 Pattern Generator, User Values and User Messages

13.1. WHAT IS THE PATTERN GENERATOR?

The pattern generator allows groups of digital values to be selected from a single input number. This number may be provided from the programmer, from BCD inputs or from a user defined source. An example of its application would be to allow fixed output patterns to be applied to different segments in a programmer

The pattern generator consists of 16 patterns, and each pattern consists of up to 16 digital outputs. The pattern can be selected from the user interface as follows although it is much more likely to have been wired to another source such as a programmer user values .

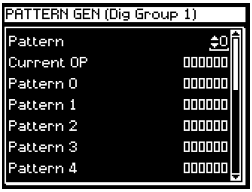
13.1.1. To Configure and Set Up The Pattern Generator

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press or to select **'PATTERN GENERATOR'**		This page is only available if Enabled as described in section 5.2.
3. Press to show Sub-headers 4. Press or to select **'Dig Group 1 (or 2)'**		
5. Press to show parameters 6. Press again to select **'Pattern Src'**		If you wish to wire this parameter, press or to select the Modbus address of the parameter you wish to wire to

7. Press to show the parameter list

8. Press again to select **‘Pattern’**

9. Press ▲ or ▼ to change the pattern



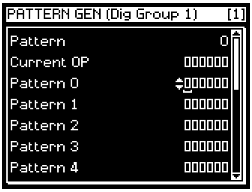
This is the number of the pattern to set up.

---

10. Press to select the first pattern - **‘Pattern 0’**

11. Press ▲ or ▼ to change to change the first digit in the pattern to On or Off

Current selected output



□ = Off

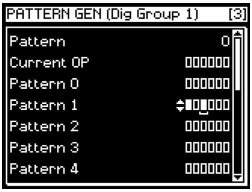
■ = On

In this example the number of digits in each pattern row has been configured to six.

---

12. Press to select the next digit in the pattern

13. Repeat the above three steps to set all digits in Pattern 0



---

14. Repeat steps 10 to 13 to set up all 16 patterns in Dig Group 1.

Note:-

The parameter ‘Current OP’ shows the current state of the pattern generator as it is being run.

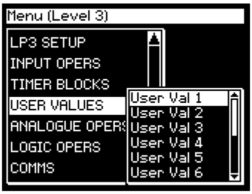
13.2. WHAT ARE USER VALUES?

User Values are normally used as constants in an analogue or digital operation.
The 2704 controller contains up to 12 user values which are in a single list under the page header **'User Values'**. The User Values page is only available if Analogue and Logic Operators have been enabled as described in section 5.2.

13.2.1. To Access User Values

<table>
<tr><th>Do This</th><th>This Is The Display You Should See</th><th>Additional Notes</th></tr>
<tr><td>1. From any display press [page key] as many times as necessary to access the page header menu

2. Press ▲ or ▼ to select 'USER VALUES'</td><td>
</td><td></td></tr>
<tr><td>3. Press [scroll key] to show Sub-headers

4. Press ▲ or ▼ to select 'User Val 1 (to 12)'</td><td>
</td><td></td></tr>
</table>

The list of User Value parameters available under this list header is shown in the following table

⇓

13.2.2. User Values Parameter Table

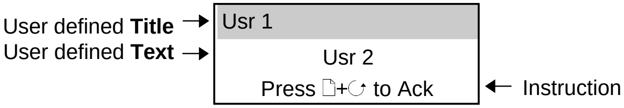
Table Number: 13.2.2.	This page allows you to configure User Values		USER VALUES (User Val 1 Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Units	User value units	See Appendix D.2.		Conf
Resolution	User values resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
Low Limit	User values low limit	Display min to display max		Conf
High Limit	User values high limit	Display min to display max		Conf
User 1 Value	User 1 value	User val lo lim to user val hi lim		L1

The above table is repeated for User Values 2 to 12.

Note: It is often required to generate a User Value = 1, and to wire this from a source. A User Value can be used for this but this takes up one or more of the User Values available. An alternative is to use the parameter 'Const.1' which is a User Value = 1. This parameter is listed in Appendix D.

13.3. WHAT ARE USER MESSAGES?

A User Message takes the form of a pop window which will be displayed in operation level as a result of a particular action occurring. The format of this window is shown below:-

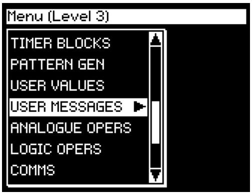
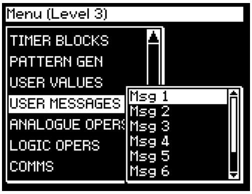
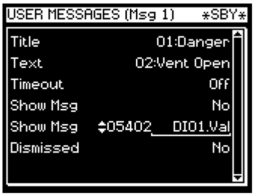


This is a similar format to that which occurs, for example, when an alarm occurs. This message, however, can be displayed when a particular event - defined by the user - occurs. For example, a User Message can be displayed if it has been wired to a digital input to alert an operator to a particular event.

User messages can only se set up in configuration level. They can, however, be inspected in Level 1.

Up to eight User Messages can be configured. Message 1 has a higher priority than Message 2 and so on.

13.3.1. To Configure User Messages

Do This	This Is The Display You Should See	Additional Notes
1. From any display press 🗋 as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'USER MESSAGES'**		
3. Press ⟳ to show Sub-headers 4. Press ▲ or ▼ to select **'Msg 1 (to 8)'**		
5. Press ⟳ to show the parameter list 6. Press ⟳ again to select **'Title'** 7. Press ▲ or ▼ to choose a user defined text set up as described in section 5.2.6. 8. Press ⟳ to select **'Text'** 9. Press ▲ or ▼ to choose a user defined text set up as described in section 5.2.6. 10. Press ⟳ to select **'Show Msg (Src)'** 11. Press ▲ or ▼ to choose the Modbus address of the parameter which will trigger the message when the controller is in operation mode		In operation mode a pop up window, as shown below, will be displayed when digital input 1 is true. Danger Vent Open Press 🗋+⟳ to Ack If 'Timeout' is set to a value of:- 5 sec 10 sec 1 min 5 min or 10 min the user message will disappear after this period and will only re-appear when the digital input becomes true once more. The parameters **'Show Msg'** and **'Dismissed'** are intended for use over digital communications.

14. Chapter 14 Analogue Operators

14.1. WHAT ARE ANALOGUE OPERATORS?

Analogue Operators allow the controller to perform mathematical operations on two input values. These values can be sourced from any available parameter including Analogue Values, User Values and Digital Values. Each input value can be scaled using a multiplying factor or scalar as shown in Figure 14.1.

The parameters to use, the type of calculation to be performed and the acceptable limits of the calculation are determined in Configuration level. In access level 3 you can change values of each of the scalars. In Access levels 2 & 3, provided the Analogue Operators page has been promoted, the input values and the result of the calculation can be read.

The Analogue Operators page is only available if Analogue and Logic Operators have been enabled in configuration level as described in section 5.2.

Up to 24 separate operations can be performed and a separate page header is provided for each one.

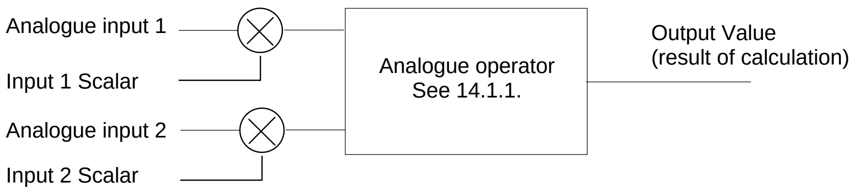
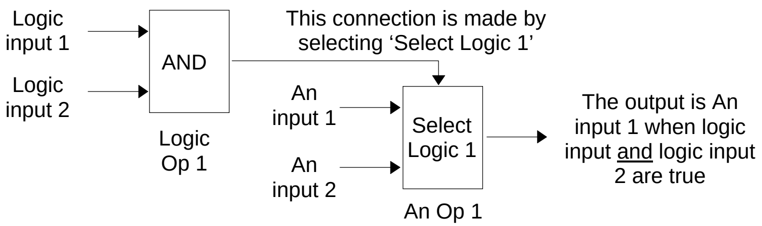


Figure 14-1: Analogue Operators

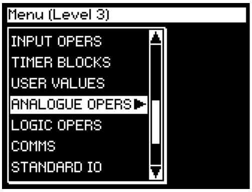
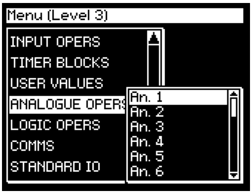
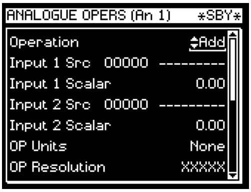
14.1.1. Analogue Operations

The following operations can be performed:

Off	The selected analogue operator is turned off
Add	The output result is the addition of Input 1 and Input 2
Subtract	The output result is the difference Input 1 and Input 2 where Input 1 > Input 2
Multiply	The output result is the multiplication of Input 1 and Input 2
Divide	The output result is Input 1 divided by Input 2
Absolute Difference	The output result is the absolute difference between Input 1 and 2
Select Max	The output result is the maximum of Input 1 and Input 2
Select Min	The output result is the minimum of Input 1 and Input 2
Hot Swap	Input 1 appears at the output provided input 1 is 'good'. If input 1 is 'bad' then input 2 value will appear at the output. An example of a bad input occurs during a sensor break condition.
Sample and Hold	Normally input 1 will be an analogue value and input B will be digital. The output tracks input 1 when input 2 = 1 (Sample). The output will remain at the current value when input 2 = 0 (Hold). Input 2 can be an analogue value and must change from 0 to 100% to provide a sample and hold at the output.
Power	The output is the value at input 1 raised to the power of the value at input 2. I.e. input $1^{\text{input 2}}$
Square Root	The output result is the square root of Input 1. Input 2 has no effect.
Log	The output is the logarithm (base 10) of Input 1. Input 2 has no effect
Ln	The output is the logarithm (base n) of Input 1. Input 2 has no effect
Exp	The output result is the exponential of Input 1. Input 2 has no effect
10x	The output result is 10 raised to the power of Input 1 value. I.e. $10^{\text{input 1}}$. Input 2 has no effect
Select Logic 1 up to Select Logic 32	Logic Operator 1 to 32 is used to control which Analogue Input is switched to the output of the Analogue Operator. If the output from the logic operator is true input 1 is switched through to the output. If false input 2 is switched through to the output. See example below:-



14.2. TO CONFIGURE ANALOGUE OPERATORS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press or to select **'ANALOGUE OPERS'**		
3. Press to show Sub-headers 4. Press or to select **'An 1 (to 24)'**		
5. Press to show the parameter list 6. Press or to scroll to the required parameter 7. Press to select the parameter 8. Press or to change the value or state		The first parameter is **'Operation'**. The choices are: Off, Add, Subtract, Multiply, Divide, Absolute Difference, Select Max, Select Min, Hot Swap, Sample Hold, Square Root, Log, Ln, Exp, 10x, Select Logic 1 to Select Logic 32.

Remaining parameters in the Analogue Operators list are accessed and adjusted in the same way.

The list of parameters available is shown in the following table ⇓

14.2.1. Analogue Operator Parameters

Table Number: 14.2.1.	This page allows you to configure Analogue Operators 1 to 24			ANALOGUE OPERS (Analogue 1 Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Operation	The operation to be performed	See 14.1.1	Off	L1
Input 1 Src	Input 1 source	Modbus address		Conf
Input 1 Scalar	Input 1 scalar	-99.99 to 999.99		L3
Input 2 Src	Input 2 source	Modbus address		Conf
Input 2 Scalar	Input 2 scalar	-99.99 to 999.99		L3
OP Units	Output units	See Appendix D.2.		Conf
OP Resolution	Output resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
Low Limit	Output low limit	Display min to display max		Conf
High Limit	Output high limit	Display min to display max		Conf
Default Enable	Enable fall back	Clip (Bad) Fallback (Bad) Clip (Good) Fallback (Good)		Conf
Default OP	Fall back value	Display min to display max		Conf
Input 1 Value	Input 1 Value	Display min to display max		L1
Input 2 Value	Input 2 Value	Display min to display max		L1
Output Value	output Value	Display min to display max		L1
Status	Status	Good Bad		L1

The above table is repeated for Analogue Operators 2 to 24.

15. Chapter 15 Logic Operators

Logic Operators allow the controller to perform logical calculations on two input values. These values can be sourced from any available parameter including Analogue Values, User Values and Digital Values.

The parameters to use, the type of calculation to be performed, input value inversion and ‘fallback’ value are determined in Configuration level. In levels 1 to 3 you can view the values of each input and read the result of the calculation.

The Logic Operators page is only available if Analogue and Logic Operators have been enabled as described in section 5.2.

Up to 32 separate calculations can be performed and a separate page header is provided for each one.

15.1.1. Logic Operations

The following calculations can be performed:

Off	The selected logic operator is turned off
AND	The output result is ON when both Input 1 and Input 2 are ON
OR	The output result is ON when either Input 1 or Input 2 is ON
XOR	Exclusive OR. The output result is true when one and only one input is ON. If both inputs are ON the output is OFF.
Latch	The output is ON when input 1 turns ON. The output remains ON when input 1 turns OFF. The output is reset to OFF by turning input 2 ON.
Equal	The output result is ON when Input 1 = Input 2
Greater	The output result is ON when Input 1 > Input 2
Less than	The output result is ON when Input 1 < Input 2
Greater or Equal	The output result is ON when Input 1 $\geq$ Input 2
Less or Equal	The output result is ON when Input 1 $\leq$ Input 2

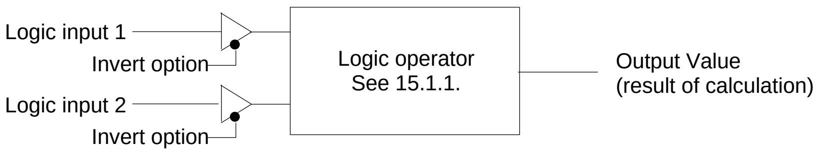
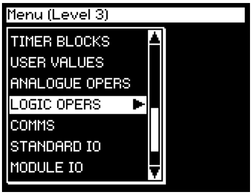
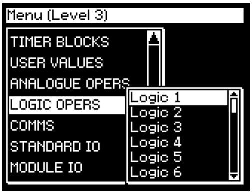
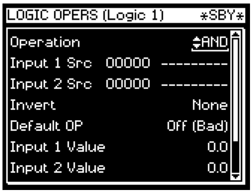


Figure 15-1: Logic Operators

15.2. TO CONFIGURE LOGIC OPERATORS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press as many times as necessary to access the page header menu 2. Press ▲ or ▼ to select **'LOGIC OPERS'**	 	
3. Press to show Sub-headers 4. Press ▲ or ▼ to select **'Logic 1 (to 32)'**	 	
5. Press to show the parameter list 6. Press ▲ or ▼ to scroll to the required parameter 7. Press to select the parameter 8. Press ▲ or ▼ to change the value or state	 	The first parameter is **'Operation'**. The choices are: Off, AND, OR, XOR, Latch, Equal, Not Equal, Greater, Less Than, Great or Equal, Less or Equal.

Remaining parameters in the Analogue Operators list are accessed and adjusted in the same way.

The list of parameters available is shown in the following table ⇓

15.2.1. Logic Operator Parameters

Table Number: 15.2.1.	This page allows you to configure Logic Operators 1 to 31		LOGIC OPERS (Logic 1 Page)	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Operation	The logical operation to be performed	See Section 15.1.1.	Off	L1
Input 1 Src	Input 1 source	Modbus address		Conf
Input 2 Src	Input 2 source	Modbus address		Conf
Invert	Invert inputs	None Invert Input 1 Invert Input 2 Invert Both		Conf
Default OP	Fall back value (Does not appear if 'Operation' = Off)	0 or 1		Conf
Input 1 Value	Input 1 Value	Off On		L3
Input 2 Value	Input 2 Value	Off On		L3
Output Value	Output Value	Off On		L3
Status	Status	Good Bad		L3

The above table is repeated for Logic Operators 2 to 31.

16. Chapter 16 Digital Communications

16.1. WHAT IS DIGITAL COMMUNICATIONS?

Digital Communications (or 'comms' for short) allows the controller to communicate with a PC or a networked computer system. A choice of comms protocol is available and can be selected in configuration level. These are MODBUS (or JBUS), EIBisynch, and Profibus.

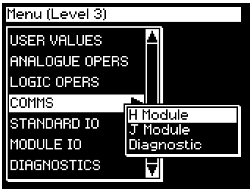
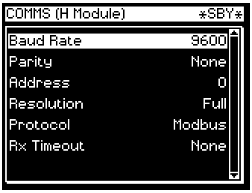
Comms modules can be fitted which use RS232, RS485 or RS422 Transmission Standards. A full description of these standards is given in the 2000 series Communications Handbook, part number HA026230.

Comms modules can be fitted into either or both of two positions referred to as the H slot and the J slot which correspond to the rear terminal connections. This is shown in the Installation and Operation Handbook, Part No. HA026502, section 2.4. Both slot positions may be used at the same time. An example is, to allow a multi-drop connection between a number of controllers and a computer running, say, a SCADA package on one comms position, and a separate PC used for configuration purposes on the second comms position. In this example an RS485 module may be fitted for the multi-drop/SCADA requirement and RS232 in the second position for the single PC/configuration requirement.

Note: When the controller is placed into Configuration Level it is taken 'off line' and placed into a standby state. In this state it no longer monitors or controls the plant.

16.2. TO CONFIGURE COMMUNICATIONS PARAMETERS

The operation of the H and J Modules is the same.

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'COMMS'**		
3. Press [scroll key] to show Sub-headers 4. Press [▲] or [▼] to select **'H Module'**		Digital communications modules may be fitted in either one or both positions.
5. Press [scroll key] to show the parameter list 6. Press [▲] or [▼] to scroll to the required parameter 7. Press [scroll key] to select the parameter 8. Press [▲] or [▼] to change the value or state		The first parameter is **'Baud Rate'**. The choices are: 4800, 9600, 19200

Remaining parameters in the Analogue Operators list are accessed and adjusted in the same way.

The list of parameters available is shown in the following table

⇓

16.2.1. H Module parameters

Table Number: 16.2.1.	This page allows you to configure Digital Communications fitted in slot H.			COMMS (H Module Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Baud Rate	Baud rate	9600, 19200, 4800	9600	Conf
Parity	Parity	None Even Odd	None	Conf
Address	Mainboard controller address	1 to 255	1	L1
Resolution	Comms resolution	Full Integer	Full	L3
Protocol	Comms protocol	Modbus EI Bisynch or Profibus (1)		L3
Rx Timeout	H Comms timeout value	None to 1:00:00		Conf

Note 1
Profibus replaces EIBisynch if this option has been ordered. For Profibus instruments only 'Address', 'Protocol' and 'Rx Timeout' parameters are displayed.

The above table is repeated for a Digital Communications module fitted into the J slot position.

16.3. DIGITAL COMMUNICATIONS DIAGNOSTICS

Digital communications diagnostics is available under the Comms page menu. Two parameters are displayed. The H Rx and J Rx messages increments each time a valid message is received via the H Comms Module or J Comms module respectively. The Timed Out messages indicate a comms time out.

They are displayed as follows:

Table Number: 16.3.	**This page allows you to monitor the number of times that a particular comms module has received a message**			**COMMS (Diagnostic Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
H Rx Messages	Valid H comms messages received			L1 R/O
H Rx Timed Out	H Comms timeout			L1 R/O
J Rx Messages	Valid J comms messages received			L1 R/O
J Rx Timed Out	J Comms timeout			L1 R/O
Profibus Stat (1)	Profibus status Only shown if the Profibus option has been ordered	Running Initialising Ready Hardware Fail Bad GSD		L1 R/O

Note 1
If Profibus is selected from the previous page, it will be necessary, either to power cycle the controller, or to switch to operation level before this parameter is displayed.

17. Chapter 17 Standard IO

17.1. WHAT IS STANDARD IO?

Standard IO allows you to configure the fixed Input/Output connections as listed in the table below. Parameters such as Input Types, Linearisation Curves, Resolution, Digital I/O Types, etc., can be configured in these pages.

STANDARD IO ▶	(*PV Input* Page)	Allows access to parameters which set up the fixed Process Variable Input connected to terminals VH, VI, V+ and V-. This is, generally, the PV input for a single loop controller.
	(*An Input* Page)	Allows access to parameters which set up the fixed Analogue Input connected to terminals BA, BB and BC. This is the high level input from a remote source.
	(*AA Relay* Page)	Allows access to parameters which set up the fixed Relay output connected to terminals AA, AB and AC. This relay may be used as an alarm relay. a time proportioning control output or valve raise or lower..
	(*Dig IO1* Page) to (*Dig IO7* Page)	Allows access to parameters which set up the fixed digital IO connected to terminals D1 to D7 and DC.
	(Diagnostic Page)	Allows access to parameters which set up the fixed digital Input connected to terminal D8 and DC.

Note:-
Names shown in *italics* can be customised.

Table 17-1: Standard I/O

17.2. PV INPUT

Allows access to parameters which set up the fixed Process Variable Input connected to terminals VH, VI, V+ and V-. This is the PV input for a single loop controller.

17.2.1. Standard IO *PV Input* Parameters

Table Number: 17.2.1.	This page allows you to configure the PV Input Parameters			STANDARD IO (*PV Input* Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Channel Type	Input/Output type	RTD, Thermocouple Pyrometer 40mV, 80mV, mA, Volts, HZVolts, Ohms		Conf
Linearisation	Input linearisation	See note 1		Conf
Units	Engineering units	See Appendix D.2.		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
CJC Type	CJC type Only shown if ‘Channel Type’ = ‘Thermocouple’	Internal 0^oC 45^oC 50^oC None	Internal	Conf
SBrk Impedance	Sensor break enable for certain high output impedance sensors	Off Low High	Off	Conf
SBrk fallback	Sensor break fallback	Off Down scale Up Scale		Conf
The following four parameters do not appear for ‘Channel Type’ = ‘Thermocouple’ or ‘RTD’				
Electrical Lo	Electrical low input level	Input range		L3.
Electrical Hi	Electrical high input level	Input range		L3
Eng Value Lo	Low display reading	Display		L3

Eng Value Hi	High display reading	range		L3
Filter Time	PV input filter time.	⬍ Off to 0:10:00.0		L3
Emissivity	Emissivity. Only appears if the PV input is configured as a pyrometer	Off to 1.00		L3
Electrical Val	The current electrical value of the PV input	Input range		R/O
PV Input Val	The current value of the PV input in engineering units.	Display range		R/O
Offset	Transducer scaling offset.	Display range		L3 R/O
CJC Temp	CJC Temperature. Only appears if the PV input is configured for thermocouple	Display Range		R/O
PV In Status	PV input status	See note 2		L3 R/O
SBrk Trip Imp	Sensor break value	Display range		L3 R/O
PV Input Name	User defined name for PV input. Select from User Text Page Section 5.2.6.	User text	Default Text	Conf
Cal State	Calibration state	See Ch 22		Conf
Rear Term Temp	Temperature at the rear terminals	Auto See note 3		Conf

Notes

1. **Input Linearisation**

   J Type, K Type, L Type, R Type, B Type, N Type, T Type, S Type, Platinel II, C Type, PT 100, Linear, Square Root, Custom 1, Custom 2, Custom 3.

2. **PV Input Status**

   OK, Initialising, Ch A Sbreak, Ch C Sbreak, Ch A Out range, Ch C Out range, Ch A IP Sat, Ch C IP Sat, Ch A Not Calib, Ch C Not Calib

3. **Rear Terminal Temperature**

   Auto means that the controller automatically measures the temperature at the rear terminals for use with cold junction compensation. The temperature of the rear terminals can be measured externally, if required, and this measured value can then be entered manually when calibrating CJC.

17.3. ANALOGUE INPUT

Allows access to parameters which set up the fixed Analogue Input connected to terminals BA, BB and BC. This is the high level input from a remote source.

17.3.1. Standard IO *Analogue Input* Parameters

Table Number: 17.3.1.	**This page allows you to configure the Analogue Input Parameters**			**STANDARD IO (*An Input* Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Channel Type	Input/Output type	Volts mA		Conf
Linearisation	Input linearisation	See note 1		Conf
SBrk fallback	Sensor break fallback	Off Down scale Up Scale		Conf
SBrk Impedance	Sensor break enable for certain high output impedance sensors	Off Low High	Off	Conf
Units	Engineering units	See Appendix D.2.		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
Electrical Lo	Electrical low input level	Input range		L3.
Electrical Hi	Electrical high input level	Input range		L3
Eng Value Lo	Low display reading	Display range		L3
Eng Value Hi	High display reading	Display range		L3
Filter Time	PV input filter time.	Off to 0:10:00.0		L3
Electrical Val	The current electrical value of the PV input	Input range		R/O
An Input Val	The current value of the An input in engineering units. *An Input* can be a user defined name.	Display range		R/O

Offset	Transducer scaling offset.			
An In Status	Status of the analogue input	OK Diagnostic messages are displayed to show the state of the Input if not OK.		R/O
SBrk Trip Imp	Sensor break value			R/O
An Input Name	User defined name for the analogue input. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Calibration state	See Chapter 22		Conf

Notes

1. **Input Linearisation**
   J Type, K Type, L Type, R Type, B Type, N Type, T Type, S Type, Platinel II, C Type, PT 100, Linear, Square Root, Custom 1, Custom 2, Custom 3.

17.4. THE FIXED RELAY OUTPUT PARAMETERS

These parameters configure the fixed relay output connected to terminals AA, AB and AC. This relay may be used as an alarm, time proportioning or On/Off control output.

17.4.1. Standard IO *AA Relay* Parameters

Table Number: 17.4.1	**This page allows you to configure the Fixed Relay Parameters**			**STANDARD IO (*AA Relay*)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Channel Type	Function of the relay	On/Off Time Proportion Valve Lower Valve Raise	As order code	Conf
Wire Src	AA relay source	Modbus address		Conf
Invert	Relay energised Relay de-energised	Normal Inverted		Conf
The following five parameters only appear if 'Channel Type' = 'Time Proportion'				
Min Pulse Time	Minimum relay on or off time	Auto = 0.05s or 0.1 to 999.9	20sec	L3
Electrical Lo	Electrical low input level	Input range		L3
Electrical Hi	Electrical high input level	Input range		L3
Eng Value Lo	Low display reading	Display range		L3
Eng Value Hi	High display reading			L3
AA Relay Value (1) *AA Relay* can be a user defined name.	Status of the relay output	-100 to 100 -ve values not used		(editable if not wired)
	If configured as On/Off 0 = Relay Off; Any other value (+ or -) = Relay On			R/O L3
	If configured for control 0 = Relay off; 100 = on; 1 to 99 = time proportioning			R/O L3
Electrical Val	The current (analogue) value of the output			R/O L3
Channel Name	A name which replaces *AA Relay* from User Text			Conf

Note 1: If the relay is wired to a source such as a loop output (Ch1 or Ch2) the 'value' will read in a positive direction only, i.e. it does not signify heating or cooling but just the position of the relay.

17.5. STANDARD IO DIG I/OPARAMETERS

This page allows access to parameters which set up the fixed digital IO connected to terminals D1 to D7 and DC.

The standard digital IO1 to 7 can either be input or output and is set up in configuration level. The choices are:-

1. Digital Input — IO configured as a digital input
2. On/Off — IO configured as a digital output
3. Time Proportion — IO configured as a control output
4. Valve Lower — IO configured to raise the output of a motor valve controller
5. Valve Raise — IO configured to lower the output of a motor valve controller

The parameters which appear in the Dig IO pages depend upon the function of the digital IO configured. These are shown in Table 17.5.1.

When the logic outputs are configured as time proportioning outputs, they can be scaled using the procedure described in the Installation and Operation Handbook, Part No. HA026502.

17.5.1. Standard *Digital IO* Parameters

Table Number: 17.5.1.	**This page allows you to configure the Digital I/O Parameters**			**STANDARD IO (*Dig IO1 to 7* Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Channel Type	Input/Output type	Digital Input On/Off Time Proportion Valve Lower Valve Raise		Conf
Wire Src	Source of the signal to operate a digital output. This parameter does not appear for digital input	Modbus address		Conf
Invert	Normal/inverted I/O	Normal Inverted		Conf

The following five parameters only appear if 'Channel Type' = 'Time Proportioning'				
Min Pulse Time	Minimum logic on or off time.	Auto = 0.05s or 0.1 to 999.9s	20sec	L3
Electrical Lo	Electrical low input level	Input range		L3
Electrical Hi	Electrical high input level	Input range		L3
Eng Value Lo	Low display reading	Display		L3
Eng Value Hi	High display reading	range		L3
Dig IO1 Val (1)	If Channel Type = Digital Input this reads the state of the input	0 = Off 1 = On		R/O L3
	If configured as an output this reads the desired output value	or -100 to 100		
Electrical Value (1)	If Channel Type = Digital Input this value does not appear			R/O L3
	If configured as an output this reads the actual electrical value.	0 or 1		
Channel Name	A name which replaces *Dig IOx* from User Text			Conf

Note 1:
Only settings between 0 & 100 are valid for Dig IO-Val. The corresponding Electrical value is shown in the following table:-

Channel Type	Dig IO- Val	Electrical Value
On/Off	0 to 100	0.0 to 100.0
Time Proportion	0 to 100	0.0 (off) to 1.0 (on). Time proportions between 0.0/1.0 for other positive settings of Dig IO- Val
Valve Raise/Lower	0 to 100	0.0

17.6. STANDARD IO DIAGNOSTIC PARAMETERS

This page allows you to configure a name for the digital input and to inspect its status or that of the IO Expander if fitted. The parameters are shown in Table 17.6.1.

17.6.1. Standard IO Diagnostic Parameters Table

Table Number: 17.6.1.	**This page allows you to inspect Digital Input 8 or IO Expander status**			**STANDARD IO (Diagnostic Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Dig In8 Val	Status of digital input 8	Off On		R/O
Dig In E1 Val	Status of IO expander input	Off On		R/O
Bad Channels	A bad input or output will be displayed as ■ and will occur if the I/O is either a short or open circuit	□□□□□□□ to ■■■■■■■		R/O
Dig In 8 Name	A name which replaces *Dig In8* from User Text			Conf

18. Chapter 18 Module IO

18.1. WHAT IS MODULE IO?

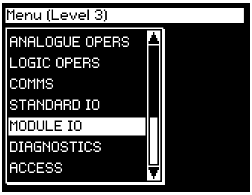
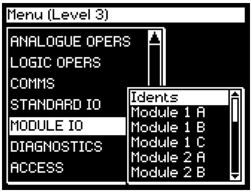
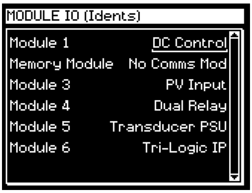
Additional analogue and digital IO is provided by the plug in IO modules. These modules can be fitted in any of five slots (see Section 2.4.2, Installation and Operation Handbook, Part No. HA026502). The type and position of any modules fitted in the controller is shown in the order code printed on the label on the side of the controller. This can be checked against the order code in Appendix A of this manual.
Modules are available as single channel, two channel or three channel IO as listed below

Module	Order Code	Idents Displayed As	Number of Channels
Change over relay 2 pin relay Dual relay	R4 R2 RR	Form C Relay Form A Relay Dual Relay	1 1 2
Triac Dual triac	T2 TT	Triac Dual Triac	1 2
DC control	D4	DC Control	1
DC retransmission	D6	DC Retrans	1
PV input	PV	PV Input	1
Triple logic input Triple contact input	TL TK	Tri-Logic IP Tri-Contact IP	3 3
Triple logic output	TP	Tri-Logic OP	3
24V transmitter supply	MS	Transmitter PSU	1
5VdcTransducer power supply	G3	Transducer PSU	1
10VdcTransducer power supply	G5	Transducer PSU	1
Potentiometer input	VU	Pot Input	1
Analogue input module (2604/2704 dc Input)	AM	DC Input	1
Dual PV input (Dual Probe Input)	DP	Dual PV In	2

Table 18-1: I/O Modules

Parameters for the above modules, such as input/output limits, filter times and scaling of the IO, can be adjusted in the Module IO pages. The procedures are very similar to those covered in Chapter 17 ‘STANDARD IO’.

18.2. TO ACCESS MODULE IO PARAMETERS

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'MODULE IO'**		
3. Press [scroll key] to show Sub-headers		Idents: Summary of modules fitted Module XA: X = Module number Module XB Module XC: A, B, C = Single, Two, Three, channels resp. Above repeated for every module fitted
4. Press [▲] or [▼] to scroll to the required sub-header 5. Press [scroll key] to select the parameter list for the required sub-header		This view shows the 'Ident' page which is read only. If a module is fitted in any module position, it's type, as listed in Table 18-1, is displayed. 'No Module' is displayed if the slot is empty.

The full list of parameters available under these list headers is shown in the following tables

⇓

18.3. MODULE IDENTIFICATION

The first page which appears under the heading Module IO shows the type of module fitted in each slot position.

18.3.1. Idents Page

Table Number: 18.3.1.	This page allows you to read the type of module fitted.			MODULE IO (Idents Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Module 1	Actual module fitted	See note 1		L1 R/O
Memory Module	Memory module position	No Module		L1 R/O
Module 2	Actual module fitted	See note 1		L1 R/O
Module 3	Actual module fitted	See note 1		L1 R/O
Module 4	Actual module fitted	See note 1		L1 R/O
Module 5	Actual module fitted	See note 1		L1 R/O
Module 6	Actual module fitted	See note 1		L1 R/O

Note 1:-

Module Types
No Module, Bad Ident, Form C Relay, Form A Relay, Triac, Dual Relay, Dual Triac, DC Control, DC Retrans, PV Input, Tri-Logic IP, Tri-Contact IP, Tri-Logic OP, Transmitter PSU, Transducer PSU, DC Input, Dual PV Input. See also Table 18.1.

18.4. MODULE IO PARAMETERS

Each module has a unique set of parameters which depend on the function of the module fitted. The following tables list the parameters for each type of module available.

18.4.1. DC Control and DC Retransmission

Table Number: 18.4.1.	**This page allows you to configure a DC Output module.**			**MODULE IO (Module *1*(A))**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	DC Output		R/O
Channel Type	I/O type	Volts mA		Conf
Wire Src	Source to which the channel is wired	Modbus address		Conf
Electrical Lo	Electrical low input level	O/P range		L3.
Electrical Hi	Electrical high input level	O/P range		See
Eng Value Lo	Low display reading	Disp. range		output
Eng Value Hi	High display reading	Disp. range		scaling
Electrical Val	The current electrical value of the output in operation mode	0 to 10.00		R/O L3
Module 1A Val (can be a user defined name).	The current output value in operation mode.	±100.0% -ve values are not used		R/O L3
Cal Trim	Analogue output calibration trim. Only available in calibration mode. See 22.6.1.			Conf
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Calibration status	See Chapter 22		R/O
This module has a single output. Its parameters are displayed under 'channel' (A).				

18.4.2. Relay Output

Table Number: 18.4.2.	This page allows you to configure a Relay Output module. Types included:- Form C Relay; Form A Relay; Dual Relay.	MODULE IO (Module *1*(A) Page)

Parameter Name	Parameter Description	Value	Default	Access Level
Ident	Module identification	Relay		R/O
Channel Type	Channel/Module Type	On/Off Time Proportion Valve Lower Valve Raise		Conf
Wire Src	Wire source	Modbus address		Conf
Invert	Relay energised Relay de-energised	Normal Inverted		Conf
The following five parameters only appear if Channel Type is set to Time Proportion.				
Min Pulse Time	Minimum relay on or off time	Auto = 0.05s Manual = 0.1 to 999.9	5 sec	L3 Only
Electrical Lo	Electrical low input level	O/P range		shown
Electrical Hi	Electrical high input level	O/P range		for time
Eng Value Lo	Low display reading	Disp. range		prop.
Eng Value Hi	High display reading	Disp. range		O/Ps
Electrical Val	The current electrical value of the output in operation mode	0.00 or 1.00 (time prop)		R/O L3
Module 1A Val *Module 1A* can be user defined text.	The current output value in operation mode.	±100.0% -ve values are not used		R/O L3
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
The changeover relay and 2 pin relay are single output modules. The parameters above are displayed under 'channel' (A) only. Dual Relay has two outputs. The parameters above are displayed under Channel (A) and Channel C.				

18.4.3. Triac Output

Table Number: 18.4.3.	This page allows you to configure a Triac Output module. Types included:- Triac; Dual Triac			MODULE IO (Module *1*(A) Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	Triac		R/O
Channel Type	Channel/Module Type	On/Off Time Proportion Valve Lower Valve Raise		Conf
Wire Src	Wire source	Modbus address		Conf
Invert	Invert triac operation	Normal Inverted		Conf
The following five parameters only appear if Channel Type is set to Time Proportion.				
Min Pulse Time	Minimum triac on or off time	Auto = 0.05s or 0.1 to 999.9	5 sec	L3 Only
Electrical Lo	Electrical low input level	O/P range		shown
Electrical Hi	Electrical high input level	O/P range		for time
Eng Value Lo	Low display reading	Disp. range		prop.
Eng Value Hi	High display reading	Disp. range		O/Ps
Electrical Val	The current electrical value of the output in operation mode	0.00 or 1.00 (time prop)		R/O L3
Module 1A Val *Module 1A* can be user defined text.	The current output value in operation mode.	±100.0% -ve values are not used		R/O L3
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
The triac output is a single output module. The parameters above are displayed under 'channel' (A) only. Channel (B) and channel (C) show 'No IO Channel'. The dual triac has two outputs. The parameters above are displayed under Channel (A) and Channel (C).				

18.4.4. Triple Logic Output

Table Number: 18.4.4.	This page allows you to configure a Logic Output module.			MODULE IO (Module *1*(A) Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	Logic Output		R/O
Channel Type	Channel/Module Type	On/Off Time Proportion Valve Lower Valve Raise		Conf
Wire Src	Wire source	Modbus address		Conf
Invert	Invert triac operation	Normal Inverted		Conf
The following five parameters only appear if Channel Type is set to Time Proportion.				
Min Pulse Time	Minimum on or off time	Auto = 0.05s or 0.1 to 999.9	Auto	L3 Only
Electrical Lo	Electrical low input level	O/P range		shown
Electrical Hi	Electrical high input level	O/P range		for time
Eng Value Lo	Low display reading	Disp. range		prop.
Eng Value Hi	High display reading	Disp. range		O/Ps
Electrical Val	The current electrical value of the output in operation mode	0.00 or 1.00 (time prop)		R/O L3
Module 1A Val *Module 1A* can be user defined text.	The current output value in operation mode.	±100.0% -ve values are not used		R/O L3
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
This module has three outputs. Each output is found under Module *1*(A), (B) and (C).				

18.4.5. Triple Logic and Triple Contact Input

Table Number: 18.4.5.	**This page allows you to set the parameters for a Triple Logic Input module.**			**MODULE IO (Module *1*(A) Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	Logic Input		R/O
Channel Type	Channel/Module Type	Digital Input	Digital Input	Conf
Invert	Invert input operation	Normal Invert		Conf
Module 1A Val *Module 1A* can be user defined text.	The current input value.	0 = Off 1 = On		R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
This module has three inputs. Each input is found under Module *1*(A), (B) and (C).				

18.4.6. Transmitter Power Supply

Table Number: 18.4.6.	**This page allows you to set the parameters for a Transmitter Power Supply module.**			**MODULE IO (Module *1*(A) Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	Transmitter PSU		R/O
Channel Type	Input/Output type	Transmitter PSU	Transmitter PSU	Conf
Module 1A Val *Module 1A* can be user defined text.	The current value in engineering units.			R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
This module has a single output providing 24Vdc at 20mA. Its parameters are displayed under ‘channel’ (A).				

18.4.7. Transducer Power Supply

Table Number: 18.4.7.	**This page allows you to set the parameters for a Transducer Power Supply module.**			**MODULE IO (Module *x*(A) Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	Transducer PSU		R/O
Voltage	Voltage select	5 Volts 10 Volts		
Shunt	Selects calibration resistor fitted internally within the controller or externally (eg in the transducer)	External Internal		
Wire Src	Wire source	Modbus address		
Electrical Value	The current output electrical value in operation mode	0.00 to 10		
Module 1A Val	The current value in engineering units. *Module 1A* can be a user defined name.			R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
This module has a single output. Its parameters are displayed under ‘channel’ (A).				

18.4.8. Potentiometer Input

Table Number: 18.4.8.	This page allows you to set the parameters for a Potentiometer Input module.			MODULE IO (Module *x*(A) Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Pot Input			R/O
Units	Engineering units.	See Appendix D2		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX		Conf
SBrk Fallback	Sensor break fallback	Off Downscale Upscale		Conf
Eng Val Lo	Engineering value low	Display		L3
Eng Val Hi	Engineering value high	range		L3
Filter Time	Input filter time	Off to 0:10:00.0		L1
Module 1A Val	The current value in engineering units. *Module 1A* can be a user defined name.			R/O
Module Status	Module status	OK Initialising Ch A Sbreak Ch A OutRange Ch A IP Sat Ch A Not Calib		R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Allows the potentiometer to be calibrated. See section 18.4. Installation and Operation Handbook HA026502	Idle Pot Low Pos Pot High Pos Restore Fact	Idle	L3
This module has a single input. Its parameters are displayed under 'channel' (A).				

18.4.9. PV Input

Table Number: 18.4.9.	This page allows you to set the parameters for a PV Input module. This module can only be fitted in slots 3 or 6.			MODULE IO (Module *3*(A) Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	PV Input		R/O
Channel Type	Input/Output type	RTD Thermocouple Pyrometer 40mV 80mV mA Volts HZVolts		Conf
Linearisation	Input linearisation	See note 1		Conf
Units	Engineering units	See Appendix D.2.		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
SBrk Impedance	Sensor break enable for high output impedance sensors	Off Low High	Off	Conf
SBrk fallback	Sensor break fallback	Off Down scale Up Scale		Conf
CJC Type	CJC type Only shown if Channel Type = thermocouple	Internal 0^oC 45^oC 50^oC None	Internal	Conf
The following four parameters are only shown for 'Channel Type' = mV, V, mA, and High Z Volts				
Electrical Lo [units]	Electrical low input level	Input range		L3. Only
Electrical Hi [units]	Electrical high input level	Input range		shown
Eng Val Lo	Low display reading	Display range		for mV,
Eng Val Hi	High display reading	Display range		V, mA

Filter Time	Input filter time	Off to 0:10:00.0		L1
Emissivity	Emissivity Ch Type = pyrometer only	Off to1.00		
Electrical Val [units]	The current electrical value of the input	Input range		R/O L3
Module 3A Val *Module 3A* can be user defined text.	The current value in engineering units.			R/O
CJC Temp	Temperature read at the rear terminals ^{O}C Ch Type = thermocouple only			R/O
Offset	To apply a simple offset over the whole input range	Display range		L3
Module Status	Module status See Appendix D3	OK or message		R/O
SBrk Trip Imp	Sensor break value			R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Calibration state Not shown for Pyrometer or mA inputs	See Chapter 22.		Conf
Rear Term Temp	Allows a user measured offset to be entered for CJC calibration Ch Type = thermocouple only	Auto to 50.00^{o}C		
This module has a single input. Its parameters are displayed under ‘channel’ (A).				

Notes

1. **Input Linearisation**
   J Type, K Type, L Type, R Type, B Type, N Type, T Type, S Type, Platinel II, C Type, PT 100, Linear, Square Root, Custom 1, Custom 2, Custom 3.

18.4.10. DC Input

Table Number: 18.4.10.	This page allows you to set the parameters for a DC Input module. This module can only be fitted in slots 1, 3, 4 or 6.			MODULE IO (Module *x*(A) Page)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Ident	Module identification	DC Input		R/O
Channel Type	Input/Output type	RTD Thermocouple Pyrometer mV mA Volts HZVolts		Conf
Linearisation	Input linearisation	See note 1		Conf
Units	Engineering units	See Appendix D.2.		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX		Conf
SBrk Impedance	Sensor break enable for high output impedance sensors	Off Low High	Off	Conf
SBrk fallback	Sensor break fallback	Off Down scale Up Scale		Conf
CJC Type	CJC type Only shown if Channel Type = thermocouple	Internal 0°C 45°C 50°C None	Internal	Conf
The following four parameters are only shown for 'Channel Type' = mV, V, mA, and HZVolts				
Electrical Lo	Electrical low input level	Input range		L3.
Electrical Hi	Electrical high input level	units as configured		See **'To Scale**
Eng Value Lo	Low display reading	Display		**the PV**
Eng Value Hi	High display reading	range		**Input'**
Filter Time	Input filter time	Off to 0:10:00.0		L3

Emissivity	Emissivity Pyrometer input only	Off to 1.00		L3
Electrical Val	The current electrical value of the input	Input range units as configured		R/O
Module 3A (or 6A) Val	The current value in engineering units. *Module 3A* can be a user defined name.			R/O
Offset	Transducer scale offset	Display range	0	L3
CJC Temp	Temperature read at the rear terminals ^{o}C Thermocouple inputs only			R/O
Module Status	Module status	OK Initialising Ch A Sbreak Ch A OutRange Ch A IP Sat Ch A Not Calib		R/O
SBrk Trip Imp	Current sensor break value Read as a % of the SBrk Impedance configured			R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Allows input to be calibrated. Not shown for Pyrometer or mA inputs	See Chapter 22	Idle	Conf
Rear Term Temp	Allows a user measured offset to be entered for CJC calibration Ch Type = thermocouple only	Auto to 50.00^{o}C		
This module has a single input. Its parameters are displayed under 'channel' (A).				

Notes

1. **Input Linearisation**
   J Type, K Type, L Type, R Type, B Type, N Type, T Type, S Type, Platinel II, C Type, PT 100, Linear, Square Root, Custom 1, Custom 2, Custom 3.

18.4.11. Dual PV Input

The dual PV input module accepts two inputs - one from a high level source (channel A) and one from a low level source (channel C). The two inputs are not isolated from each other and have an update rate of 5Hz. A typical application for the module is for a zirconia probe input. The module can also be configured for a single input when the update rate becomes 10Hz.

Table Number: 18.4.11a.	**This page allows you to set the parameters for Channel A of a Dual PV Input module. This module can only be fitted in slots 3 or 6.**			**MODULE IO (Module *3*(A) Page)**
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
This module has two inputs. Parameters are displayed under 'channel' (A) and 'channel' (C) Channel A is the high level input, channel C is the low level input. This table shows Module 3 (or 6)A parameters				
Ident	Channel identification	High Level Inp		R/O
Channel Type	Input/Output type	HZ Volts Volts	DC Input	Conf
Linearisation	Input linearisation	See note 1		Conf
Units	Engineering units	See Appendix D2		Conf
Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX		Conf
SBrk Impedance	Sensor break impedance for high impedance output sensors	Off Low High	Off	Conf
SBrk Fallback	Sensor break fallback	Off Downscale Upscale		Conf
Electrical Lo	Electrical low input level	Input range units as configured		L3. See 'To Scale the PV Input'
Electrical Hi	Electrical high input level			
Eng Val Lo	Low display reading	Display range		
Eng Val Hi	High display reading	Display range		
Filter Time	Input filter time	Off to 0:10:00.0		L3
Electrical Val	The current electrical value of the input	Input range units as configured		R/O

Module 3A Val	The current value in engineering units. *Module 3 (or 6)A* can be a user defined name.			R/O
Offset	Transducer scale offset	Range limits		
Module Status	Module status	OK Initialising Ch A Sbreak Ch A OutRange Ch A IP Sat Ch A Not Calib		R/O
SBrk Trip Imp	Current sensor break value Read as a % of the SBrk Impedance configured			R/O
Channel Name	User defined name for the channel. Select from User Text Page Section 5.2.6.		Default Text	Conf
Cal State	Allows input calibration Only shown when 'En Dual Mode' = 'No' (Table 18.4.11c)	See Chapter 22	Idle	Conf

Notes

1. **Input Linearisation**
   J Type, K Type, L Type, R Type, B Type, N Type, T Type, S Type, Platinel II, C Type, PT 100, Linear, Square Root, Custom 1, Custom 2, Custom 3.

Table Number: **18.4.11c.**	**This page allows you to set the parameters for Channel C of a Dual PV Input module.** **This module can only be fitted in slots 3 or 6.**		**MODULE IO (Module *3*(C) Page)**	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
This module has two inputs. Parameters are displayed under 'channel' (A) and 'channel' (C) Channel A is the high level input, channel C is the low level input. This table shows Module 3 (or 6)C parameters				
Ident	Channel identification	Low Level Inp		R/O
Channel Type	Input/Output type	DC Input	DC Input	Conf
En Dual Mode	Enable dual mode See note 2	Yes No		
Linearisation	Input linearisation	See note 1		Conf
Units	Engineering units	See Appendix D2		Conf

Resolution	Display resolution	XXXXX XXXX.X XXX.XX XX.XXX X.XXXX		Conf
SBrk Impedance	Sensor break impedance for high impedance output sensors	Off Low High	Off	Conf
SBrk Fallback	Sensor break fallback	Off Downscale Upscale		Conf
CJC Type	CJC type Only shown if Channel Type = Thermocouple	Internal $0^{o}C$ $45^{o}C$ $50^{o}C$ None	Internal	Conf
Filter Time	Input filter time	Off to 0:10:00.0		L3
Emissivity	Emissivity Only shown if Channel Type = Pyrometer	Off to 1.00		L3
Electrical Val	The current electrical value of the input	Input range units as configured		R/O
Module 3A Val	The current value in engineering units. *Module 3 (or 6)A* can be a user defined name.			R/O
Offset	Transducer scale offset	Range limits		
CJC Temp	Temperature read at the rear terminals ^{o}C Thermocouple inputs only			R/O
SBrk Trip Imp	Current sensor break value Read as a % of the SBrk Impedance configured			R/O
Channel Name	Channel name		Default Text	R/O

Note 2:-
The parameters in the above two tables are displayed when **'En Dual Mode' = 'Yes'**
If **'En Dual Mode' = 'No'**, then the module can be used as a single input with an update rate of 10Hz. Also, to calibrate the module it is necessary to switch into this mode. The module then operates the same as the single PV Input module using Channel A parameters. Channel C parameters are then not applicable.

18.5. MODULE IO WIRING EXAMPLES

18.5.1. To Configure Module 1 Channel A to Run a Program

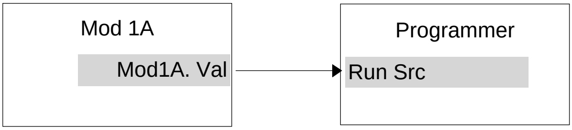


Figure 18-1: External Run/Hold Switch

This example assumes a Triple Logic module fitted in module slot 1. No configuration of the Module 1A function block is required but the output of the block must be wired to the Run Source in the Programmer block.

18.5.1.1. Implementation

1. In PROGRAM EDIT/Wiring Page (Table 6.8.2.)
   set 'Run Src' = 04148:Mod1A.Val
   This connects the output of module 1A to the Run Source wire in the Programmer block.

18.5.2. To Operate a Relay from a Digital Input

This example assumes that a Relay Module is fitted in module slot 2, and it is required to operate when Digital Input 1 is true.

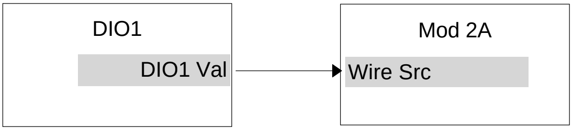


Figure 18-2: To Operate a Relay from a Digital Input

18.5.2.1. Implementation

1. In STANDARD IO/Dig IO1 Page (Table 17.5.1.)
   set 'Channel Type' = Digital Input
   This configures DIO1 to be digital input
2. In MODULE IO/Module 2 A Page (Table 18.4.2.)
   set 'Channel Type' = On/Off
   set 'Wire Src' = 05402:DIO1.Val
   This configures Module 2A to On/Off relay and connects DIO1 to operate this relay.

19. Chapter 19 Transducer Scaling

19.1. WHAT IS TRANSDUCER SCALING?

Transducer scaling is a software function block which provides a method of offsetting the calibration of the controller input when compared to a known input source. Transducer scaling is often performed as a routine operation on a machine to take out system errors. In the case of a load cell, for example, it may be necessary to zero the scale when a load is removed.

Transducer scaling can be applied to any input or derived input, i.e. the PV Input, Analogue Input or Modules 1, 3, 4, 5, or 6. In practice, however, it is unlikely that transducer scaling would be required on every input and so the 2704 controller includes three transducer calibration function blocks. These can be wired in configuration level to any three of the above inputs.

Four types of calibration are explained in this chapter:-

1. Shunt Calibration
2. Load Cell Calibration
3. Comparison Calibration
4. Auto-tare

19.2. SHUNT CALIBRATION

Shunt calibration is so called since it refers to switching a calibration resistor across one arm of the four wire measurement bridge in a strain gauge transducer. It also requires the use of a Transducer Power Supply.

The strain gauge transducer is calibrated as follows:

1. Remove any load from the transducer to establish a zero reference.
2. Enter 'Scale Low' and 'Scale High' values which are normally set at 0% and 80% of the span of the transducer.
3. Start the procedure using the low point calibration parameter 'Start Pnt1 Cal', or a digital input wired to this parameter.

The controller will automatically perform the following sequence:

1. Disconnect the shunt resistor
2. Calculate the low point calibration value by continuously averaging two lots of 50 measurements of the input until stable readings are obtained
3. Connect the shunt resistor
4. Calculate the high point calibration value by averaging two lots of 50 measurements of the input

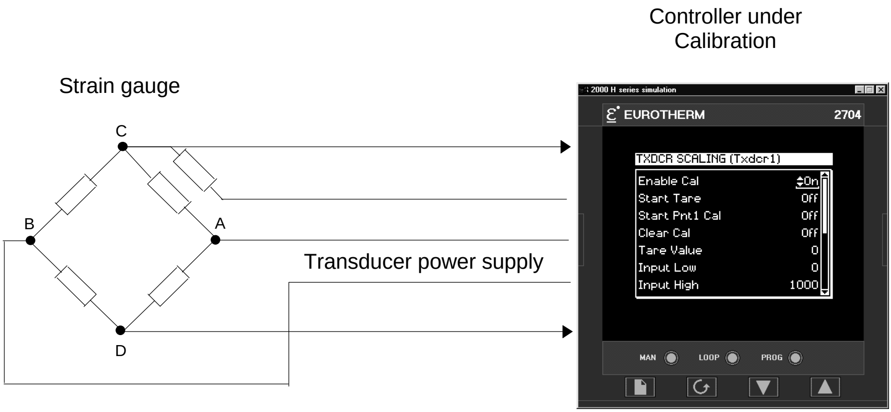


Figure 19-1: Strain Gauge Calibration

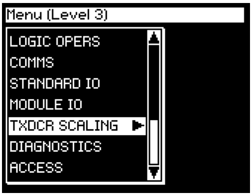
19.2.1. To Calibrate a Strain Gauge Bridge Transducer

The controller must have been configured for Cal Type = Shunt, and the transducer connected as shown in the Installation and Wiring handbook, Part No. HA026502, Figure 2-13 using the 'Transducer Power Supply'. Then:-

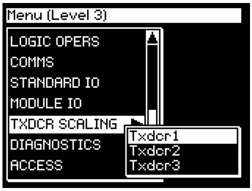
Do This	This Is The Display You Should See	Additional Notes

It is first necessary to enable calibration as follows:-

1. From any display press [page key] as many times as necessary to access the page header menu
2. Press [▲] or [▼] to select **'TXDCR SCALING'**



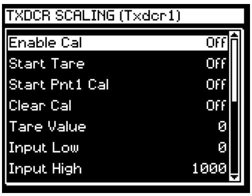
3. Press [scroll key] to show Sub-headers
4. Press [▲] or [▼] to select **'Txdcr 1' (or 2 or 3)**



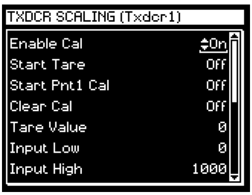
The choices are :
Txdcr 1
Txdcr 2
Txdcr 3

This text can be user defined

5. Press [scroll key] to show the parameter list



6. Press [scroll key] again to select **Enable Cal**
7. Press [▲] or [▼] to **On**



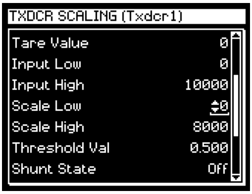
This parameter remains 'On' once it has been set. It requires to be switched 'Off' manually.

It may be wired to an external digital input source such as a key switch

Set the strain gauge bridge to its 'zeroed' condition

8. Press as many times as necessary to scroll to **Scale Low**

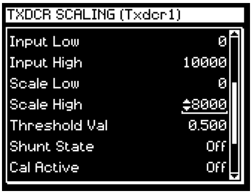
9. Press or to enter the low end calibration value



This will normally be zero

10. Press to scroll to **Scale High**

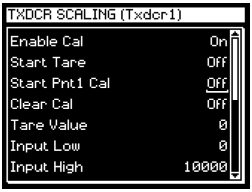
11. Press or to enter the high end calibration value



In this example a value of 8000 is chosen which may represent 80% of the 0 -10,000psi range of a pressure transducer.

12. Press to scroll to **Start Pnt 1 Cal**

13. Press or to enter **On**



This parameter can be configured to be initiated from a digital input and wired, for example, to an external switch.

An example of this wiring is given at the end of this chapter

☺ Tip: To backscroll hold down and press

The controller automatically performs the procedure described in Section 19-2. During this time the **Cal Active** parameter will change to **On.** When this parameter value changes back to **Off** the calibration is complete.

The **Shunt State** parameter will also change during the procedure to show when it is being connected (On = connected, Off = disconnected).

Note:-
It is possible to start the calibration procedure before the system has settled at a stable value. The controller continuously takes blocks of 50 samples. When the average value between two consecutive blocks is within the **'Threshold Value'** the controller will then calibrate. The Threshold Value defaults to 0.5 but can be adjusted in configuration level. If the readings are not stable within this period the controller will abort the calibration.

19.3. LOAD CELL CALIBRATION

A load cell with V, mV or mA output may be connected to the PV Input, Analogue Input or Modules 1, 3, 4, 5, 6 supplied as analogue inputs. The wiring connections are shown in Sections 2.3.3, 2.3.4, and 2.4.2 respectively.

The load cell is calibrated as follows:

1. Remove any load and start the procedure using the low point calibration parameter 'Start Pnt1 Cal', or a digital input wired to this parameter. The controller will calculate the low calibration point
2. Place a reference weight on the load cell and turn on the high point calibration parameter 'Start Pnt2 Cal', or a digital input wired to this parameter. The controller will then calculate the high calibration point.

Note:-
If 'Start Pnt1 Cal' = 'On', 'Start Pnt2 Cal' cannot be turned to 'On'.
If 'Start Pnt2 Cal' = 'On', 'Start Pnt1 Cal' cannot be turned to 'On'.
Either must complete before the other can be set to 'On'.

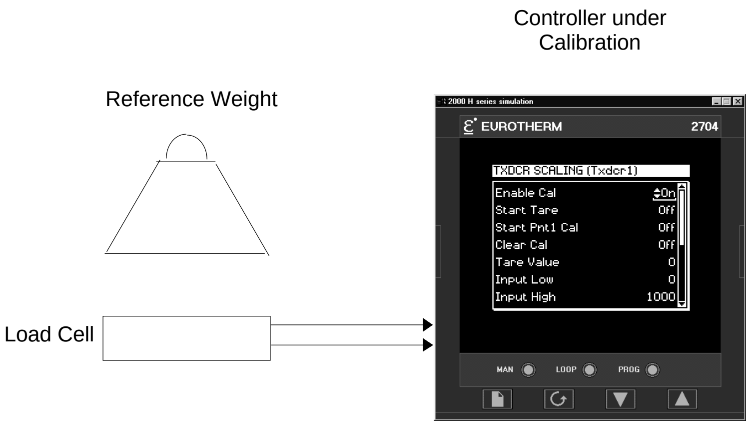
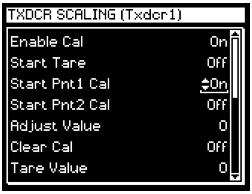
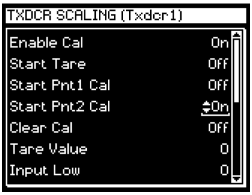


Figure 19-2: Load Cell Calibration

19.3.1. To Calibrate a Load Cell

The controller must have been configured for Cal Type = Load Cell, and the transducer connected as shown in the Installation and Operation Handbook, Part No, HA026502, Chapter 2. Then:-

Do This	This Is The Display You Should See	Additional Notes
Enable calibration as described in steps 1-7 of section 19.2.1.		
Then set the load cell to its 'zeroed' condition		
1. Press as many times as necessary to scroll to '**Start Pnt1 Cal'** 2. Press ▲ or ▼ to '**On'**		This parameter can be configured so that it is activated from a digital input and wired, for example, to an external switch. An example of this wiring is given at the end of this chapter During the time taken for the controller to calculate the low point calibration value, the **Cal Active** parameter will be **On**.
When the Calibration low procedure is complete, place the reference load on the load cell		
3. Press to scroll to **Start Pnt2 Cal** 4. Press ▲ or ▼ to **On**		It can be configured to be initiated from a digital input and wired, for example, to an external switch. An example of this wiring is given at the end of this chapter

Note:-
'Scale High' is the high calibration point and 'Scale Low' is the low calibration point. These should be set to the range over which calibration is required. 'Threshold Value' applies as in the previous section.

19.4. COMPARISON CALIBRATION

Comparison calibration is most appropriate when calibrating the controller against a second reference instrument.

In this case the process calibration points are not entered ahead of performing the calibration. The input may be set to any value and, when the system is stable, a reading is taken from the reference measurement device and entered into the controller. The controller stores both this new target value and the actual reading taken from its input.
The process is repeated at a different value, with the controller storing both the new target value and the reading taken from its input.

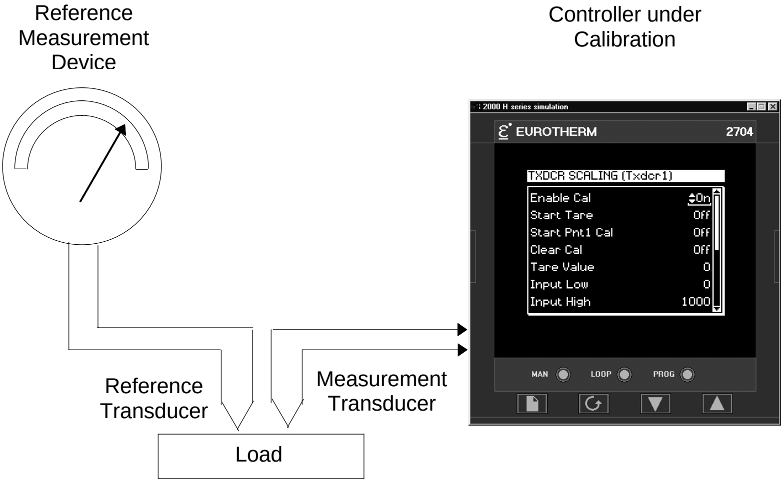
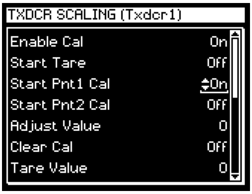
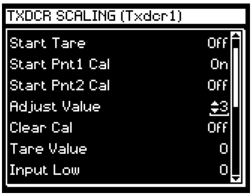


Figure 19-3: Comparison Calibration

19.4.1. To Calibrate a Controller Against a Second Reference

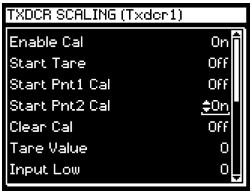
The controller must have been configured for Cal Type = Comparison, and the transducer connected as shown in the Installation and Operation Handbook, Part No, HA026502, Chapter 2. Then:-

Do This	This Is The Display You Should See	Additional Notes
Enable calibration as described in steps 1-7 of section 19.2.1.		
Then allow the process to settle at the low calibration point		
8. Press [scroll key] as many times as necessary to scroll to **‘Start Pnt1 Cal’** 9. Press [up key] or [down key] to **‘On’**		This parameter can be configured to be activated from a digital input and wired, for example, to an external switch. An example of this wiring is given at the end of this chapter
10. Press [scroll key] as many times as necessary to scroll to **‘Adjust Value’** 11. Press [up key] or [down key] to enter the value indicated on the reference instrument 12. Press [scroll key] to confirm or [page key] to cancel as instructed		The confirm message does not appear unless ‘Adjust Value’ is changed. If the displayed value is acceptable change it momentarily then back to the value to step to the next stage. On confirm the current input value is stored as ‘Input Low’ and the value entered by the user is stored in the ‘Scale Low’ parameter.

Allow the Process to settle at the high calibration point

13. Press to **'Start Pnt2 Cal'**

14. Press or to **'On'**



This parameter can be initiated from a digital input and wired, for example, to an external switch.

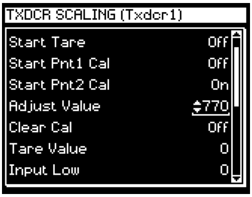
An example of this wiring is given at the end of this chapter

---

15. Press as many times as necessary to scroll to **'Adjust Value'**

16. Press or to enter the value indicated on the reference instrument

17. Press to confirm or to cancel as instructed



The confirm message does not appear unless 'Adjust Value' is changed.

If the displayed value is acceptable change it momentarily then back to the value to step to the next stage.

On confirm the current input value is stored as 'Input High' and the value entered by the user is stored in the 'Scale High' parameter.

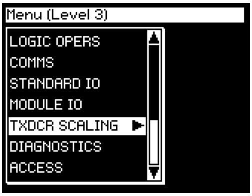
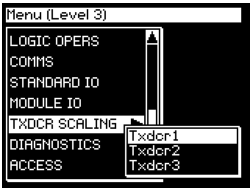
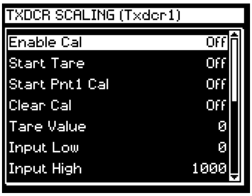
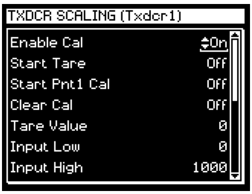
It is possible to perform either low or high points in isolation, or to calibrate both points consecutively as described above.

19.5. AUTO-TARE CALIBRATION

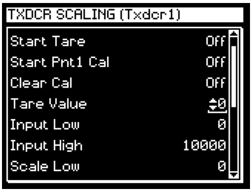
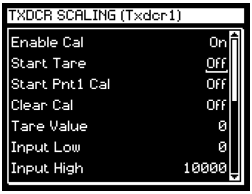
The auto-tare function is used, for example, when it is required to weigh the contents of a container but not the container itself.
The procedure is to place the empty container on the weigh bridge and ‘zero’ the controller. Since it is likely that following containers may have different tare weights the auto-tare feature is always available in the controller at access level 1.

19.5.1. To Use the Auto-Tare Feature

Firstly, access the transducer scaling parameters as follows:-

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **‘TXDCR SCALING’**		
3. Press [scroll key] to show Sub-headers 4. Press [▲] or [▼] to select **‘Txdcr 1’ (or 2 or 3)**		The choices are : *Txdcr 1* *Txdcr 2* *Txdcr 3* This can be user defined text
5. Press [scroll key] to show the parameter list		
6. Press [scroll key] again to select **Enable Cal** 7. Press [▲] or [▼] to **On** (if necessary)		This parameter remains ‘On’ once it has been set. It requires to be switched ‘Off’ manually. It may be wired to an external digital input source such as a key switch.

The auto-tare calibration is then as follows:-

Do This	This Is The Display You Should See	Additional Notes
1. Set the equipment at the normal tare point, eg place the empty container on the weigh bridge		
1. Press ⟳ to **'Tare Value'** 2. Press ▲ or ▼ to enter the required value		This will normally be zero. When once set it will only be necessary to access this parameter again if a new tare value is required.
3. Press ⟳ as many times as necessary to scroll to **'Start Tare'** 4. Press ▲ or ▼ to **'On'**		This parameter can be initiated from a digital input and wired, for example, to an external switch. An example of this wiring is given at the end of this chapter.

The effect of auto-tare is to introduce a DC bias to the measurement, as shown in Figure 19-4 below.

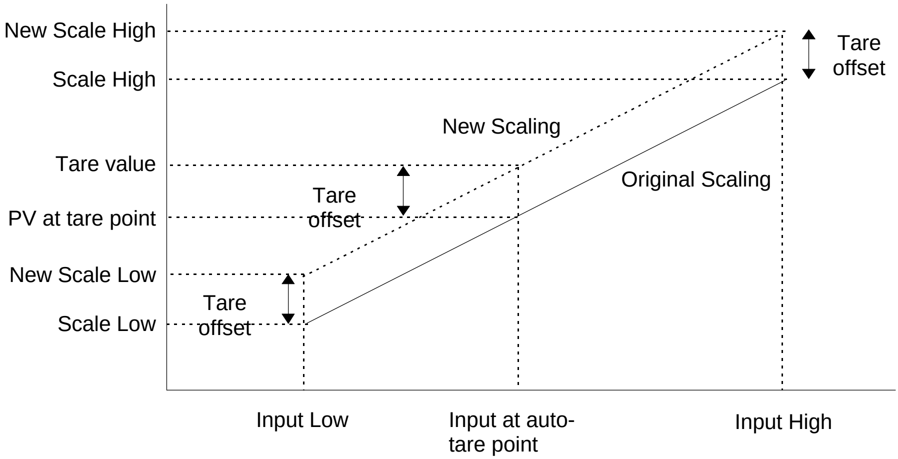


Figure 19-4: Effect of Auto-Tare

Note:- A Tare calibration will change the values of 'Scale High' and 'Scale Low'.

19.6. TRANSDUCER SCALING PARAMETERS

The parameters listed in the table below allow you to soft wire to sources within the controller to provide, for example, operation of calibration procedure via external switches.

19.6.1. Transducer Scaling Parameter Table

Table Number: 19.6.1.	This page shows the Transducer Scaling parameters.			TXDCR SCALING (*Txdcr* 1)
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Cal Type	Type of calibration	Off Shunt Load Cell Comparison	Off	Conf
Input Src	Pre-scaled value source	Modbus Address	None	Conf
Enable Cal Src	Enable calibration source			Conf
Clear Cal Src	Clear calibration source			Conf
Start Pnt 1 Src	Start calibration point 1 source			Conf
Start Pnt 2 Src	Start calibration point 2 source			Conf
Start Tare S	Start auto tare calibration source			Conf
Range Min	Minimum scale value			Conf
Range Max	Maximum scale value			Conf
Txdcr Name	Transducer name	From User Text	Default Text	Conf
Enable Cal (1)	Enable calibration	Off On	Off	L3
Start Tare (2)	Start auto-tare calibration	Off On	Off	L1
Start Pnt1 Cal (3)	Start the calibration at point 1, normally the low point	Off On	Off	L1
Start Pnt2 Cal (4)	Start the calibration at point 2, normally the low point	Off On	Off	L1
Clear Cal (5)	Clear previous calibration values	Off On	Off	L3
Tare Value	Sets the value that the controller will read after an auto-tare calibration	Display range		L3

Input Low	Sets the scaling input low point			L3
Input High	Sets the scaling input high point			L3
Scale Low	Sets the scaling output low point			L3
Scale High	Sets the scaling output high point			L3
Threshold Val (6)	The allowed difference between two consecutive averages during calibration	0 - 99.999 mins		L3
Shunt State (7)	Indicates that the shunt resistor is connected or not	Off On		L3 R/O
Cal Active	Indicates calibration in progress	Off On		L3 R/O
Input Value	Pre-scaled input value	-100 to 100	0	L1
Scaled Value	Output from the scaling block. Used for diagnostic purposes only			R/O
Adjust Value	Sets the value read by the reference source in comparison calibration only			L1
OP Status	Output status based on input status and scaled PV	Good Bad		R/O

19.6.2. Parameter Notes

1. Enable Cal — This may be wired to a digital input for an external switch. If not wired, then the value may be changed.

   When enabled the transducer parameters may be altered as described in the previous sections. When the parameter has been turned On it will remain on until turned off manually even if the controller is powered cycled.
2. Start Tare — This may be wired to a digital input for an external switch. If not wired, then the value may be changed.
3. Start Pnt1 Cal — This may be wired to a digital input for an external switch. If not wired, then the value may be changed.

   It starts the calibration procedure for:
   1. Shunt Calibration
   2. The low point for Load Cell Calibration
   3. The low point for Comparison Calibration
4. Start Pnt2 Cal — This may be wired to a digital input for an external switch. If not wired, then the value may be changed.

   It starts the calibration procedure for:
   1. The high point for Load Cell Calibration
   2. The high point for Comparison Calibration
5. Clear Cal — This may be wired to a digital input for an external switch. If not wired, then the value may be changed.

   When enabled the input will reset to default values. A new calibration will overwrite the previous calibration values if Clear Cal is not enabled between calibrations.
6. Threshold Val — The input needs to settle within a range which has been set in configuration level. The threshold value sets the required settling time for shunt, load cell and auto-tare calibration.
7. Shunt — This parameter is an output from the function block which can be wired to a transducer scale module to close the shunt circuit and introduce the calibration resistor. It may be used in copy and paste wiring.

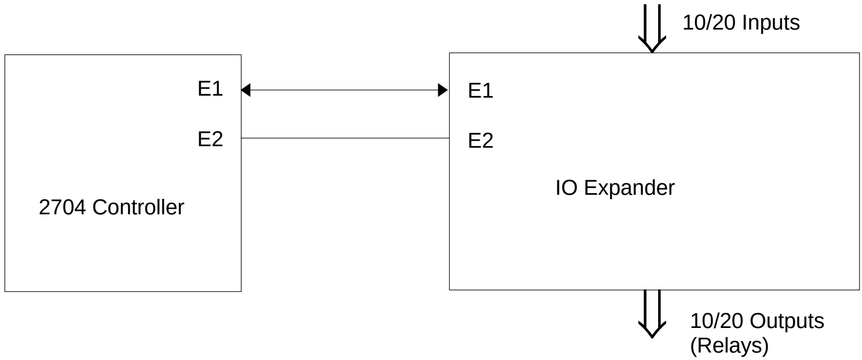
20. Chapter 20 IO Expander

20.1. WHAT IS IO EXPANDER?

The IO Expander is an external unit which can be used in conjunction with the 2704 controller to allow the number of digital IO points to be increased. There are two versions:-

1. 10 Inputs and 10 Outputs
2. 20 Inputs and 20 Outputs

Each input is fully isolated and voltage or current driven. Each output is also fully isolated consisting of four changeover contacts and six normally open contacts in the 10 IO version and four changeover and sixteen normally open contacts in the 20 IO version.
Data transfer is performed serially via a two wire interface as shown in Figure 20-1.



E1 and E2 are the terminal numbers on both Controller and IO Expander. It is recommended that a cable length of 10 metres is not exceeded, however, no shielding or twisted pair cable is required.

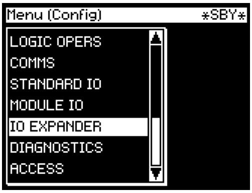
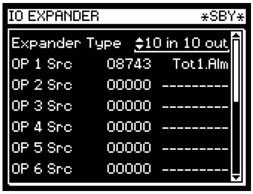
Figure 20-1: IO Expander Data Transfer

Wiring connections and further details of the IO Expander are given in the IO Expander Handbook, Part No. HA026893.

When this unit is connected to the controller it is necessary to set up parameters to determine its operation. These parameters can be set up in Operation Level 3 and are repeated here for information.

The IO Expander is enabled in INSTRUMENT/Options Page, see Chapter 5.

20.2. TO CONFIGURE IO EXPANDER

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary to access the page header menu 2. Press [▲] or [▼] to select **'IO EXPANDER**		
5. Press [scroll key] to show the parameter list 6. Press [▲] or [▼] to scroll to the required parameter 7. Press [scroll key] to select the parameter 8. Press [▲] or [▼] to change the value or state		In this view the IO Expander type has been configured as **10 In and 10 Out'** and parameter **'OP 1 Src'** has been connected to the **'Totaliser 1 Alarm Output'**. The IO Expander output 1 will operate when Totaliser 1 alarm output is exceeded.

Remaining parameters in the Analogue Operators list are accessed and adjusted in the same way.

The list of parameters available is shown in the following table ⇓

20.2.1. IO Expander parameters

Table Number: 20.2.1	This page allows you to configure the IO Expander.			IO EXPANDER
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Expander Type	Expander type	None 10 in 10 out 20 in 20 out	None	Conf
OP 1 Src	Output 1 source Source of the signal to operate relay 1 in the IO Expander.	Modbus address		Conf
The above parameter is repeated for all 20 outputs available in the IO Expander				
Status	IO Expander status	Good Bad		L3 R/O
In Stat 1-10	Status of the first 10 digital inputs □□□□□□□□□□ to ■■■■■■■■■■	□ = Off ■ = On		L3 R/O
In Stat 11-20	Status of the second 10 digital inputs □□□□□□□□□□ to ■■■■■■■■■■	□ = Off ■ = On		L3 R/O
OP Stat 21-30	Status of the first 10 digital outputs. Press ⟳ to select outputs in turn. The flashing underlined output can be changed using ▲▼ buttons. ▲▼□□□□□□□□□□ to ▲▼■■■■■■■■■■	□ = Off ■ = On		L3
OP Inv 1-10	To change the sense of the first 10 outputs.	□ = direct ■ = Inverted		L3
Out Stat 31-40	Status of the second 10 digital outputs. Press ⟳ to select outputs in turn. The flashing underlined output can be changed using ▲▼ buttons. ▲▼□□□□□□□□□□ to ▲▼■■■■■■■■■■	□ = Off ■ = On		L3
OP Inv 31-40	To change the sense of the second 10 outputs.	□ = direct ■ = Inverted		L3

21. Chapter 21 Diagnostics

21.1. WHAT IS DIAGNOSTICS?

Diagnostics are displayed in Access Level 3 and Configuration level, and provide information on the internal state of the controller. The parameters are intended for use in advanced fault finding situations. Up to eight error messages can be listed and each error message displays a message showing the state of the controller. The error messages are shown in Note 1.

The diagnostic parameters are listed below:-

21.1.1. Diagnostics parameters

Table Number: 21.1.1	This page allows you to inspect diagnostic information		DIAGNOSTICS	
Parameter Name	**Parameter Description**	**Value**	**Default**	**Access Level**
Error Count	Number of errors recorded			R/O
Error 1	Historical errors where 1 is the most recent	See Note 1		R/O
Error 2				R/O
Error 3				R/O
Error 4				R/O
Error 5				R/O
Error 6				R/O
Error 7				R/O
Error 8				R/O
Clear Err Log?	Error log reset	No Yes	No	Conf
CPU % Free	A measure of the loading on the CPU			R/O
Con Task Ticks	A measure of the activity of the algorithm			R/O
UI Task 1 Ticks				R/O
UI Task 2 Ticks				R/O
Power FF	Power feedback. Measures the supply voltage to the controller			R/O
Power Failures	A count of the number of power failures			R/O

Note 1.
Possible error messages:-

OK
Bad Ident
Bad Fact Cal
Module Changed
DFC1 Error, DFC2 Error, DFC3 Error
Module N/A
CBC Comms Error
Cal Store Error
CBC Cal Error
Bad PV Input
Bad Mod3 Input, Bad Mod4 Input, Bad Mod6 Input,
Bad An Input
Bad NVOL Check
Bad X Board
Bad Res Ident
Bad SPI SemRel
Bad CW EETrans
Bad Prog Data
Bad Prog Csum
SegPool Over
SPI Locked
SPI Queue Full
HighP Lockout
Pro Mem Full
Invalid Seg
Program Full
Invalid Prog
Bad Logic 1 to Bad Logic 7
CPU Add Err
Calc CRC Err
Bad Cal Restore
Bad Cust Lin
Bad Instruct
Bad Slot Instr
DMA Addr Err
Reserved Int
Undefined Int
SPC Init Err

22. Chapter 22 Calibration

The 2704 controller is calibrated in three ways. These are:-

1. **Factory Calibration.** The controller is calibrated to very high accuracy during manufacture and the calibration values are permanently stored within the controller. Factory calibration is not available to the user, but it is always possible to revert to the factory values if required.
2. **Transducer Scaling.** This is described in Chapter 19. Transducer scaling allows offsets to be entered to compensate for errors or differences in the process measurement system.
3. **User Calibration.** This allows the instrument to be calibrated against a certified field calibration source. This chapter describes User Calibration.

22.1. USER CALIBRATION

The following inputs can be calibrated:

1. **PV Input.** This is the fixed PV input on terminals VH, V1, V+, V-. The PV Input can be configured for Thermocouple, Platinum Resistance Thermometer (RTD), Pyrometer, mV, Volt, High Impedance Input Volts or mA inputs. Each input type can be separately calibrated except mA and pyrometer which is included in the mV range.
2. **Analogue Input.** This is the fixed input on terminals BA, BB, BC, and is intended for volt or current sources.
3. **Analogue I/O Modules.** These are inputs which can be connected to terminals A, B, C, D of the module I/O. Any input type listed above can be connected to these modules.

See also the ‘Installation’ chapter in Installation and Operation handbook, Part No. HA026502 for details on terminal connections.

22.2. PRECAUTIONS

Before starting any calibration procedure the following precautions should be taken:-

1. When connecting a calibration source to any terminal, at least 1 hour should elapse before calibration.
2. If power is ever brought up with the V1 terminal unconnected (for as little as 1 sec) then calibration should not take place for at least 1 hour.

A pre-wired jig built using a spare instrument sleeve may help to speed up the calibration procedure especially if a number of instruments are to be calibrated. This can be built using a spare instrument sleeve available by quoting Part No. SUB26/SLE.
It is very important that power is turned on only after the controller has been inserted in the sleeve of the pre-wired circuit.
Allow at least 10 mins for the controller to warm up after switch on.

Failure to observe these precautions will result in the controller not being calibrated to its full capability.

22.3. PV INPUT

22.3.1. To Calibrate mV Range

Calibration of the PV Input is carried out using a milli-volt or volt source. Pyrometer and mA calibration is included in this procedure. To calibrate thermocouples it is first necessary to calibrate the 40mV and 80mV ranges followed by CJC described in section 22.3.2.

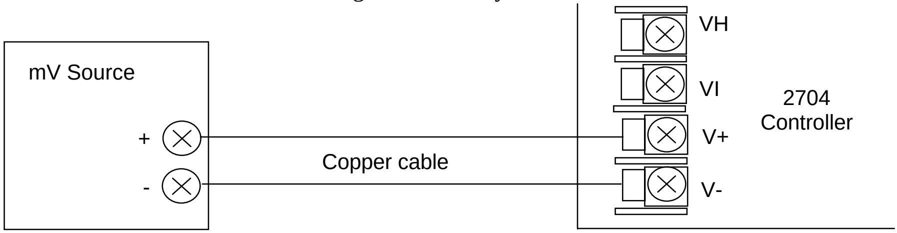
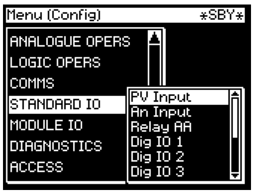
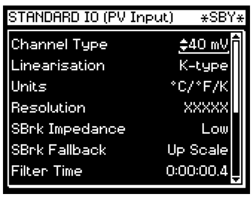


Figure 22-1: Connections for mV Range

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary until the 'STANDARD IO' page header is displayed. 2. Press [scroll key] to select sub-headers and **'PV Input'**		To choose PV Input
3. Press [scroll key] to select the parameter list 4. Press [scroll key] again to select **'Channel Type'** 5. Press [▲] or [▼] to choose the 40mV or 80mV range		To choose mV input range
6. Press [scroll key] until the parameter **'Cal State'** is displayed		

Calibrate at 0mV

7. Set mV source to 0mV		
8. Press ▲ to choose **'Low - 0mV'**	Cal State ⇕ Low - 0mv Cal State ⇕ Confirm	Calibration at 0mV commences (**Go**) and progresses to 'passed' state.
9. Press ▲ to choose **'Go'**	Cal State ⇕ Low - 0mv Cal State ⇕ Doing Fine Cal Cal State ⇕ Passed	If the message ⇕ **Failed** appears this usually indicates that the input is not connected. At any point in this process press ▲ to select **Abort.**
10. Press ▲ to choose '**Accept'**	Cal State ⇕ Accept Cal State ⇕ Idle	To accept the 0mV calibration values. Alternatively press ▲ to 'Abort'

Calibrate at 50mV

11. Set mV source to 50mV		
12. Press ▲ to choose **'High - 50mV'**	Cal State ⇕ Low - 50mv Cal State ⇕ Confirm	Apply 50mV and press ▲ to confirm
13. Repeat step 10 to '**Accept'**		

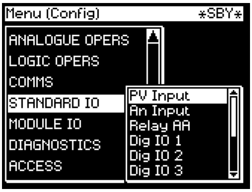
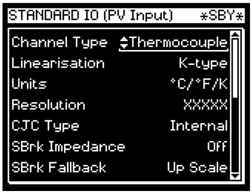
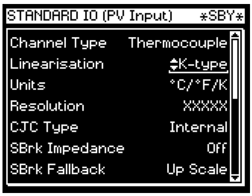
At this point the calibration values are used by the controller. They will, however, be lost when the power to the controller is turned off. Complete the following step to store the values to the User Calibration area.

14. Press ▲ or ▼ to choose '**Save to User'**	Cal State ⇕ Save to User Cal State ⇕ Idle	The 0mV and 50 mV calibration values are stored and used by the controller. To return to factory calibration press ▲ to '**Restore Factory'**, then choose **'Save to User'**

22.3.2. Thermocouple Calibration

Thermocouples are calibrated, firstly, by following the previous procedure for the 40mV and 80mV ranges, (both ranges should be calibrated to cover all types of thermocouple) then calibrating CJC.

This can be carried out using an external CJC reference source such as an ice bath or using a thermocouple mV source. Replace the copper cable shown in Figure 22-1 with the appropriate thermocouple compensating cable. Set the mV source to internal compensation for the thermocouple in use and set the output for 0mV. Then:-

Do This	This Is The Display You Should See	Additional Notes
1. Access the PV Input sub-header from **STANDARD IO** menu as described in the previous section		To choose PV Input
2. Press to show the parameter list. 3. Press again to select **'Channel type'** 4. Press ▲ or ▼ to choose **'Thermocouple'**		To choose input type.
5. Press to select '**Linearisation'** 6. Press ▲ or ▼ to choose the linearisation curve for the thermocouple in use		To choose thermocouple linearisation curve Ensure that **'Rear Term Temp'** is set to **'Auto'**. If not it will be necessary to accurately measure the temperature at the rear terminals and set this value accordingly
7. Press until the parameter '**Cal State'** is displayed		
8. Press ▲ or ▼ to choose '**CJC'**		Press ▲ to confirm. Then **Accept** and **Save to User** as described in previously in steps 9 and 14.

22.3.3. Voltage Calibration

The procedure is identical to mV calibration with the exception that the low calibration point is 0V and the high point is 8V.

Note:- The voltage input terminals are VH and V- as detailed in the Installation and Operation Handbook, Part No. HA026502.

22.3.4. High Z Voltage Calibration

The procedure is identical to mV calibration with the exception that the low calibration point is 0V and the high point is 1V.

Note:- The voltage input terminals are VH and V- as detailed in the Installation and Operation Handbook, Part No. HA026502.

22.3.5. RTD Calibration

The 40mV and 80mV input ranges should be calibrated before calibration of the RTD input. Calibration of the PV Input for RTD requires a Decade Box between 100.00 and 400.00Ω.

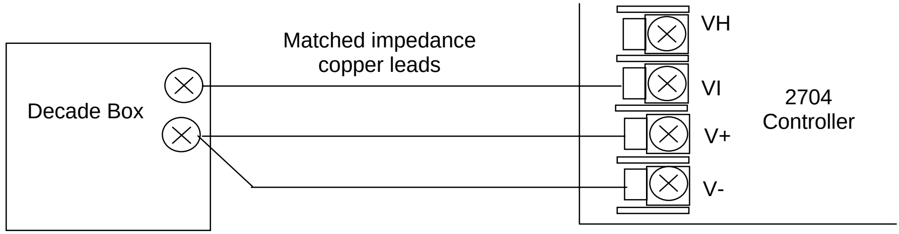
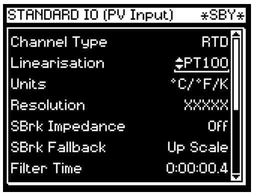
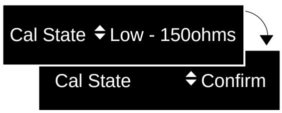
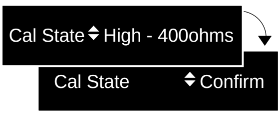


Figure 22-2: Connections for RTD

Do This	This Is The Display You Should See	Additional Notes
1. For a controller calibrated for RTD type PT100, the view on the display should be as shown.		
2. Press  until the parameter '**Cal State'** is displayed		
3. Set the decade box for 150.00Ω 4. Repeat procedure 22.3.1. paragraphs 7 to 10	**Calibrate at 150 ohms**. 	
5. Set the decade box for 400.00Ω 6. Repeat procedure 22.3.1. paragraphs 11 to 14	**Calibrate at 400 ohms**. 	

22.4. ANALOGUE INPUT

Calibration of the Analogue input is carried out using an 8 volt (±2mV) source.

There are three conditions to be calibrated - **Offset, Common Mode Rejection** and **Gain.**

The use of a pre-wired jig is recommended assuming that all three conditions are to be calibrated. The connections for this are shown in Figure 22-3.

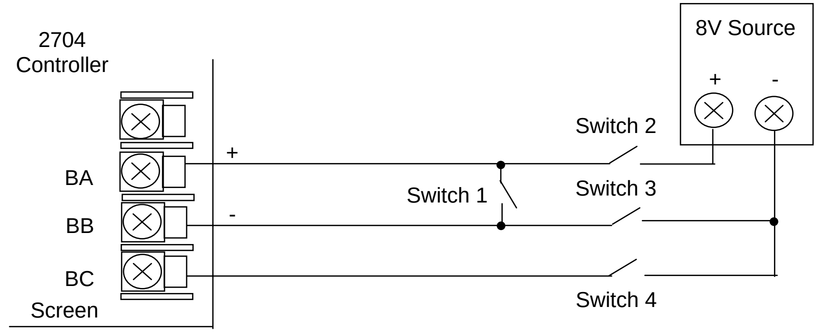
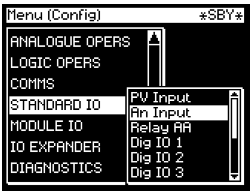
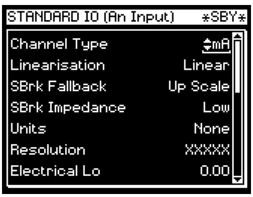


Figure 22-3: Analogue Input Calibration Connections

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary until the '**STANDARD IO'** page header is displayed. 2. Press [cycle key] to select sub-headers and **'An Input'**		
3. Press [cycle key] to select the parameter list 4. Press [cycle key] again to select **'Channel Type'** 5. Press [▲] or [▼] to choose the mA or Volts range		The Channel Type may be mA or Volts. The calibration procedure is the same.
6. Press [cycle key] until the parameter '**Cal State'** is displayed	Cal State ⇕ Idle	

To calibrate Offset

Connect + and - terminals together by closing switch 1. Open switches 2, 3 and 4 to allow the short circuited inputs to float.

7. Press ▲ or ▼ to choose '**Offset**'	Cal State ⬍ Offset	The procedure is now the same as paragraphs 9, 10 and 14 for mV calibration.

To calibrate Common Mode Rejection Ratio

Close switches 2 and 4, while switch 1 remains closed and switch 3 remains open, so that 8V is applied to both + and - input terminals with respect to the Screen terminal.

8. Press ▲ or ▼ to choose '**CMRR Enhance**'	Cal State ⬍ CMRR Enhance	The procedure is now the same as paragraphs 9, 10 and 14 for mV calibration.

To calibrate Gain

Open switches 1 and 4 and close switches 2 and 3 so that 8V is connected to both + and - input terminals while the screen is floating.

9. Press ▲ or ▼ to choose '**Gain**'	Cal State ⬍ Gain	The procedure is now the same as paragraphs 9, 10 and 14 for mV calibration.

22.5. TO RESTORE FACTORY CALIBRATION VALUES

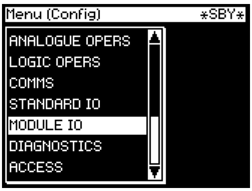
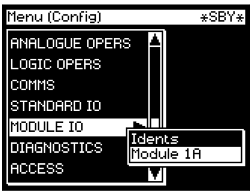
Do This	This Is The Display You Should See	Additional Notes
1. Press ⟳ until the parameter '**Cal State**' is displayed	Cal State ⬍ Idle	
2. Press ▲ or ▼ to choose '**Restore Factory**'	Cal State ⬍ Restore Factory	The factory calibration values are restored for the input selected, i.e. if the Analogue Input is selected the PV Input and Module input values are not affected.

22.6. MODULE I/O

22.6.1. DC Output Module

The DC output module is calibrated in the factory at 10% and 90% of output level.
This is 1 and 9V for 0 to 10Vdc output and 2mA and 18mA for a 0 to 20mA output.
The factory calibration can be modified by the user by adjusting the '**Cal Trim'** parameter, i.e. Actual Output = Factory Cal (Low & High) Value + User Cal (Low & High) Trim Value.
The user trim value can be accepted and saved as for input calibration data.

Figure 22-4: DC Module Connections Volts or Current Output

Do This	This Is The Display You Should See	Additional Notes
1. From any display press [page key] as many times as necessary until the **MODULE IO** page header is displayed		
2. Press [scroll key] to show sub-headers 3. Press [▲] or [▼] to choose the module in which the DC Output module is fitted		
4. Press [scroll key] until the parameter '**Cal State'** is displayed		Other choices are: Cal Low Cal High Restore Factory Save (only appears after cal procedure complete.

Calibrate at 10% Output

5. Press ▲ to choose **'Cal Low'**	Cal State ⬍ Cal Low Cal State ⬍ Confirm	Other choices are: Go Abort
6. Press ▲ to choose **'Go'**	Cal State ⬍ Go Cal State ⬍ Now Trim O/P	
7. Press ⟳ to scroll to **'Cal Trim'** 8. Press ▲ or ▼ to achieve the required output value read by the multimeter. 1.00 Vdc or 2.00mA	Cal Trim ⬍ 0	The adjustment is between -9999 and +9999. These numbers do not have units and are used for indication only.
9. Press ⟳ and ▲ together to return to **'Cal State'** 10. Press ▲ to choose **'Accept'**	Cal State ⬍ Accept Cal State ⬍ Idle	You can also scroll forward using the ⟳ button only. This, however, means that you will need to scroll through all parameters in the list.
	Calibrate at 90% Output	
11. Press ▲ to choose **'Cal High'**	Cal State ⬍ Cal High Cal State ⬍ Confirm	Other choices are: Go Abort

12. Repeat steps 4 to 8 to calibrate at 90% output. 9.00Vdc or 18mA

At this point the calibration values are used by the controller. They will, however, be lost when the power to the controller is turned off. From **Cal State/Idle:**

13. Press ▲ or ▼ to choose **Save**	Cal State ⬍ Save Cal State ⬍ Idle	The 10% and 90% calibration values are stored and used by the controller. To return to factory calibration press ▲ to **'Restore Factory'** the choose **'Save'**

22.6.2. PV Input Module

PV Input modules can be fitted in positions 3 and 6. These modules can provide inputs for thermocouple, 3-wire RTD, mV, Volts or mA. The wiring connections for these inputs are shown below.

The calibration procedure is identical to that described in Section 21-3, but the **Cal State** parameter will be found under the page header **MODULE IO/Module 3 A Page** or **Module 6 A Page.**

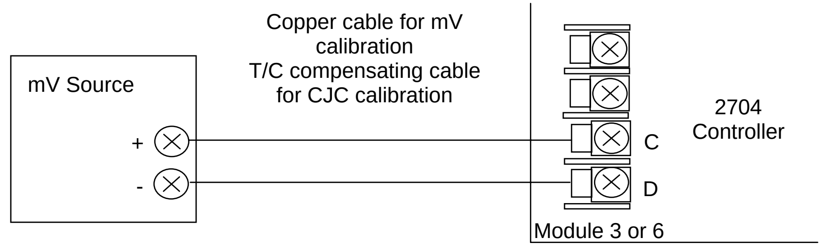


Figure 22-5: Volt, mV and Thermocouple Connections to Modules 3 & 6

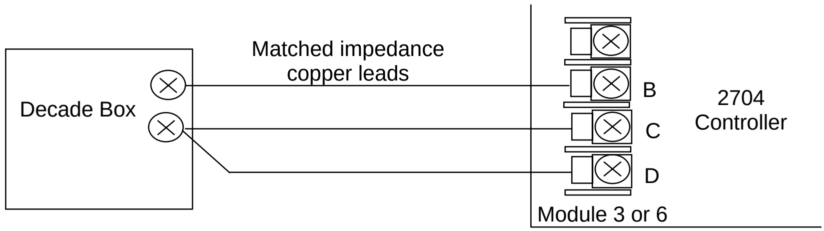


Figure 22-6: 3-Wire RTD Connections to Modules 3 & 6

22.6.3. Dual PV Input Module

The procedure is the same as the PV Input module above, but the parameter **'En Dual Mode'** in the Channel C parameter list must be set to **'No'. 'Cal State'** is accessed from Channel A when enable dual mode is set to No.

22.6.4. DC Input Module

The procedure is the same as the PV Input module above except that only the 1mV range is available.

A. Appendix A Order Code

A. HARDWARE CODE

The 2704 controller has a modular hardware construction, which accepts up to six plug-in modules and two communications modules. Eight digital IO and a relay form part of the fixed hardware build.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

1	Controller Type
2704	Standard
2704f	Profibus

2	Supply Voltage
VH	85-264Vac
VL	20-29Vac/dc

3	Loops/Programs
First Digit	
1_ _	One Loop
2_ _	Two Loop
3_ _	Three Loop
Second Digit	
_XX	No Programs
_2_	20 Programs (1)
_5_	50 Programs
Third Digit	
_ XX	No Programs
_ _1	1 Profile
_ _2	2 Profile
_ _3	3 Profile

4 Application	
XX	Standard
ZC	Zirconia

5 - 9	I/O Slots 1 3 4 5 6
XX	None Fitted
R4	Change Over Relay
R2	2 Pin Relay
RR	Dual Relay
T2	Triac
TT	Dual Triac
D4	DC Control
D6	DC Retransmission
PV	PV Input(slots 3 & 6 only)
TL	Triple Logic Input
TK	Triple Contact Input
TP	Triple Logic Output
MS	24Vdc Transmitter PSU
VU	Potentiometer Input
G3	5Vdc transducer PSU
G5	10Vdc transducer PSU
AM	Analogue Input module (not slot 5)
DP	Dual DC input (4) (slots 3 & 6 only)

Hardware notes:

2. *Programmer includes 8 digital operations*
3. *Toolkit 1 includes 16 analogue, 16 digital, event groups & 4 user values*
4. *Toolkit 2 includes Toolkit 1 plus extra 8 analogue, 16 digital operations and 8 user values*
5. *Dual analogue input suitable for carbon probes*

10	Memory Module
XX	Not Fitted

11 - 12	Comms H J
First Slot only	
PB	Profibus
Both Slots	
XX	None Fitted
A2	EIA-232
Y2	2 wire EIA-485
F2	4 wire EIA-485

13 Manual	
ENG	English
FRA	French
GER	German
NED	Dutch
SPA	Spain
SWE	Sweden
ITA	Italian

14	Toolkit Functions
XX	Standard
U1	16 An & 16 Dig
U2	24 An & 32 Dig

15	Config Tools
XX	None
IT	iTools

Hardware Code Example

2704/VH/323/XX/RR/PV/D4/TP/PV/XX/A2/XX/ENG/U1/IT

Three loop controller with capability to store 20 three profile programs. Supply voltage 85 - 264 Vac. Modules: 2 x PV input, 1 x Dual relay, 1 x DC control, 1 x Triple logic output, EIA-232 Comms. 16 analogue and 32 digital operations and iTools supplied with controller.

B. QUICK START CODE

The controller supplied in accordance with the hardware code on the previous page requires to be configured. Configuration is carried out using iTools. Alternatively, for simple applications the controller may be supplied pre-configured using the following code:-

1	2	3	4	5	6	7	8	9	10	11	12

1 - 3	Loop function
XXXX	None
S___	Standard PID
C___	Cascade
R___	Ratio
O___	Override (7)
_PID	PID control
_ONF	On/Off control
_PIF	PID/OnOff control
_VP1	VP w/o feedback
_VP2	VP with feedback

4 - 6	Process inputs (Input type)
X	None
J	J Thermocouple
K	K Thermocouple
T	T Thermocouple
L	L Thermocouple
N	N Thermocouple
R	R Thermocouple
S	S Thermocouple
B	B Thermocouple
P	P Thermocouple
C	C Thermocouple
Z	RTD/PT100
A	4-20mA linear
Y	0-20mA linear
V	0-10Vdc linear
W	0-5Vdc linear
G	1-5Vdc linear
Custom (Replace C)	
Q	Custom curve
D	D Thermocouple
E	E Thermocouple
1	Ni/Ni18%Mo
2	Pt20%Rh/Pt40%Rh
3	W/W26%Re(Eng)
4	W/W26%Re(Hos)
5	W5%Re/W26%Re(Eng)
6	W5%Re/W26%Re(Hos)
7	Pt10%Rh/Pt40%Rh
8	Exergen K80 IR Pyro

7	Analogue input
XXX	None
P2_	PV Loop 2
P3_	PV Loop 3
S1_	SP Loop 1
S2_	SP Loop 2
S3_	SP Loop 3
A1_	Aux PV Loop 1
A2_	Aux PV Loop 2
A3_	Aux PV Loop 3
L1_	Ratio lead PV Loop 1
L2_	Ratio lead PV Loop 2
L3_	Ratio lead PV Loop 3
Input range	
Select third digit from table 1	

Table 1	
A	4-20mA linear
Y	0-20mA linear
V	0-10Vdc linear
W	0-5Vdc linear
G	1-5Vdc linear

8 - 12	Slot function
Loop number	
XXX	Unconfigured
1__	Loop No 1
2__	Loop No 2
3__	Loop No 3
Single relay or triac	
_HX	Heat
_CX	Cool
Dual relay or triac	
_HC	PID Heat & Cool
_VH	VP Heat
_AA	FSH & FSH
_AB	FSH & FSL
_AC	DH & DL
_AD	FSH & DH
_AE	FSL & DL
HHX	Heat O/P Ips 1 & 2
P12	Prog events 1 & 2
P34	Prog events 3 & 4
P56	Prog events 5 & 6
P78	Prog events 7 & 8
Triple logic output	
_HX	Ch1 Heat
_CX	Ch1 Cool
_HC	Ch1 Heat, Ch2 Cool
HHX	Heat O/P Ips 1 & 2
HHH	Heat O/P Ips 1,2 & 3
DC outputs	
_H_	PID Heat
_C_	PID Cool
_T_	PV Retransmission
_S_	SP Retransmission
For output range select third digit from table 1	
Precision PV input	
_PV	PV input Module
_PA	Aux PV Input (8)
_PL	Ratio lead input
Analogue Input *	
_R_	Setpoint
Aux & lead PV inputs *	
_L_	Ratio lead input
_B_	Aux PV input
* For input range select third digit from table 1	
Potentiometer input	
_VF	VP Feedback
_RS	Remote SP

Notes

1. Loop 1 PV defaults to main input on microboard. Loop 2 and 3 PV inputs must be fitted in I/O slots 3 or 6 or be assigned to the analogue input.
2. This alarm configuration refers to loop alarms only. One selection per loop is allowed. Additional alarms are available for the user to configure.
3. Thermocouple and RTD inputs assume sensor min and max values with no decimal point.
4. Linear inputs are ranged 0-100%, no decimal point.
5. Temperature inputs will be C unless ordered by USA where F will be supplied.
6. Remote setpoints assume loop min & max ranges.
7. VP1 or VP2 not available with override function.
8. For cascade and override inputs only.

Quick start code example:

SVP1/SPID/SPID/K/Z/A/S1A/1VH/2PV/2HV/3HC/3PV

This code configures the hardware specified on page A2 to be:

Loop1: Valve position control, Type K input, Ch1 VP output in slot 1, 4-20mA remote setpoint input.
Loop 2: PID control, RTD input in slot 3, 0-10Vdc Ch1 output in slot 4.
Loop 3: PID control, 4-20mA input in slot 6, Logic Ch1/Ch2 output in slot 5.

B. Appendix B Safety and EMC Information

This controller is manufactured in the UK by Eurotherm Controls Ltd.

Please read this section carefully before installing the controller

This controller is intended for industrial temperature and process control applications when it will meet the requirements of the European Directives on Safety and EMC. Use in other applications, or failure to observe the installation instructions of this handbook may impair the safety or EMC protection provided by the controller. It is the responsibility of the installer to ensure the safety and EMC of any particular installation.

B.1. SAFETY

This controller complies with the European Low Voltage Directive 73/23/EEC, amended by 93/68/EEC, by the application of the safety standard EN 61010.

B.1.1. Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 89/336/EEC, amended by 93/68/EEC, by the application of a Technical Construction File. This instrument satisfies the general requirements for heavy/light industrial and residential/commercial environments as described by EN 50081-1 and EN 50082-2. For more information on product compliance refer to the Technical Construction File.

B.2. SERVICE AND REPAIR

This controller has no user serviceable parts. Contact your supplier for repair.

Caution: **Charged capacitors**

Before removing an instrument from its sleeve, disconnect the supply and wait at least two minutes to allow capacitors to discharge. Failure to observe this precaution will expose capacitors that may be charged with hazardous voltages. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the sleeve.

B.2.1. Electrostatic discharge precautions

When the controller is removed from its sleeve, some of the exposed electronic components are vulnerable to damage by electrostatic discharge from someone handling the controller. To avoid this, before handling the unplugged controller discharge yourself to ground.

B.2.2. Cleaning

Do not use water or water based products to clean labels or they will become illegible. Isopropyl alcohol may be used to clean labels. A mild soap solution may be used to clean other exterior surfaces of the product.

B.3. INSTALLATION SAFETY REQUIREMENTS

B.3.1. Safety Symbols

Various symbols are used on the instrument, they have the following meaning:

⚠	Caution, (refer to the accompanying documents)	⏚	Functional earth (ground) terminal

The functional earth connection is not required for safety purposes but to ground RFI filters.

B.3.2. Personnel

Installation must only be carried out by qualified personnel.

B.3.3. Enclosure of live parts

To prevent hands or metal tools touching parts that may be electrically live, the controller must be installed in an enclosure.

B.3.4. Isolation

The fixed digital I/O and analogue input are not isolated. The PV Input and all plug in modules are fully isolated. This is shown in Figure B-1.

The Analogue Input is a self biased differential input suitable for either grounded or floating transducers of low output impedance generating signal in the range of +/-10V or +/-20mA (with a burden resistor of 100 Ohms across + and - terminals).
This input is neither isolated from the instrument ground (which can be earthed via fixed I/O ports) nor isolated from the instrument earth terminal, therefore, under no circumstances should mains potentials be applied to any of its inputs.
In order for the Input to operate safely the common voltage at the inputs measured with respect to instrument ground should not exceed +/-120Vdc or ac_{rms}. For actively enhanced common mode rejection (i.e. operation within the spec.) this voltage should be limited to +/-40Vdc.
Floating transducers will automatically be biased to +2.5V with respect to instrument ground upon connection.

> Note: All the other I/Os are fully isolated from the instrument ground and each other.

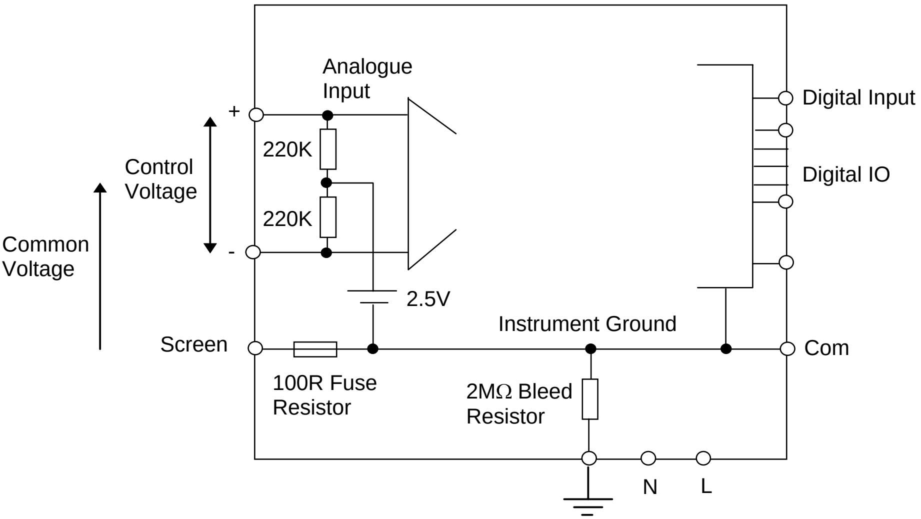


Figure B-1: Analogue Input and Fixed Digital I/O Equivalent Circuit

B.3.5. Wiring

It is important to connect the controller in accordance with the wiring data given in this handbook. Take particular care not to connect AC supplies to the low voltage sensor input or other low level inputs and outputs. Only use copper conductors for connections (except thermocouple inputs) and ensure that the wiring of installations comply with all local wiring regulations. For example in the in the UK use the latest version of the IEE wiring regulations, (BS7671). In the USA use NEC Class 1 wiring methods.

B.3.6. Power Isolation

The installation must include a power isolating switch or circuit breaker. This device should be in close proximity to the controller, within easy reach of the operator and marked as the disconnecting device for the instrument.

B.3.7. Earth leakage current

Due to RFI Filtering there is an earth leakage current of less than 0.5mA. This may affect the design of an installation of multiple controllers protected by Residual Current Device, (RCD) or Ground Fault Detector, (GFD) type circuit breakers.

B.3.8. Overcurrent protection

To protect the internal PCB tracking within the controller against excess currents, the AC power supply to the controller and power outputs must be wired through the fuse or circuit breaker specified in the technical specification.

B.3.9. Voltage rating

The maximum continuous voltage applied between any of the following terminals must not exceed 264Vac:

- line or neutral to any other connection;
- relay or triac output to logic, dc or sensor connections;
- any connection to ground.

The controller should not be wired to a three phase supply with an unearthed star connection. Under fault conditions such a supply could rise above 264Vac with respect to ground and the product would not be safe.

Voltage transients across the power supply connections, and between the power supply and ground, must not exceed 2.5kV. Where occasional voltage transients over 2.5kV are expected or measured, the power installation to both the instrument supply and load circuits should include a transient limiting device.

These units will typically include gas discharge tubes and metal oxide varistors that limit and control voltage transients on the supply line due to lightning strikes or inductive load switching. Devices are available in a range of energy ratings and should be selected to suit conditions at the installation.

B.3.10. Conductive pollution

Electrically conductive pollution must be excluded from the cabinet in which the controller is mounted. For example, carbon dust is a form of electrically conductive pollution. To secure a suitable atmosphere in conditions of conductive pollution, fit an air filter to the air intake of the cabinet. Where condensation is likely, for example at low temperatures, include a thermostatically controlled heater in the cabinet.

B.3.11. Over-temperature protection

When designing any control system it is essential to consider what will happen if any part of the system should fail. In temperature control applications the primary danger is that the heating will remain constantly on. Apart from spoiling the product, this could damage any process machinery being controlled, or even cause a fire.

Reasons why the heating might remain constantly on include:

- the temperature sensor becoming detached from the process;
- thermocouple wiring becoming short circuit;
- the controller failing with its heating output constantly on;
- an external valve or contactor sticking in the heating condition;
- the controller setpoint set too high.

Where damage or injury is possible, we recommend fitting a separate over-temperature protection unit, with an independent temperature sensor, which will isolate the heating circuit.

Please note that the alarm relays within the controller will not give protection under all failure conditions.

B.3.12. Grounding of the temperature sensor shield

In some installations it is common practice to replace the temperature sensor while the controller is still powered up. Under these conditions, as additional protection against electric shock, we recommend that the shield of the temperature sensor is grounded. Do not rely on grounding through the framework of the machine.

B.4. INSTALLATION REQUIREMENTS FOR EMC

To ensure compliance with the European EMC directive certain installation precautions are necessary as follows:

- For general guidance refer to EMC Installation Guide, HA025464.
- When using relay or triac outputs it may be necessary to fit a filter suitable for suppressing the emissions. The filter requirements will depend on the type of load. For typical applications we recommend Schaffner FN321 or FN612.

B.4.1. Routing of wires

To minimise the pick-up of electrical noise, the wiring for low voltage dc and particularly the sensor input should be routed away from high-current power cables. Where it is impractical to do this, use shielded cables with the shield grounded at both ends.

C. Appendix C Technical Specification

All figures quoted at 0 to 50°C unless otherwise stated.

C.1. ALL ANALOGUE, DUAL AND PV INPUTS

Sample rate	9Hz (110msec.)
Input filtering	OFF to 999.9 seconds of filter time constant (f.t.c.). Default setting is 0.4 seconds unless stated otherwise
User calibration	Both the user calibration and a transducer scaling can be applied.
Sensor break	a.c. sensor break on each input (i.e. fast responding and no dc errors with high impedance sources).
Thermocouple types	Most linearisations including K,J,T,R,B,S,N,L,PII,C,D,E with linearisation error < ±0.2°C
General	Resolution (noise free) is quoted as a typical figure with f.t.c. set to the default value = 0.4 second. Resolution generally improves by a factor of two with every quadrupling of f.t.c. Calibration is quoted as offset error + percentage error of absolute reading at ambient temperature of 25°C Drift is quoted as extra offset and absolute reading errors per degree of ambient change from 25°C.

C.2. PRECISION PV INPUT / MODULE

Allocation (isolated)	One standard and up to two additional PV input modules can be fitted in I/O slots 3 and 6
mV input	Two ranges: ±40mV & ±80mV, used for thermocouple, linear mV source or 0 - 20mA with 2.49Ω Calibration: ±(1.5µV + 0.05% of reading), Resolution: 0.5µV for 40mV range & 1µV for 80mV range Drift: <±(0.05µV + 0.003% of absolute reading) per °C Input impedance: >100MΩ, Leakage: < 1nA
0 - 2V input	-1.4V to +2V, used for zirconia Calibration: ±(0.5mV + 0.05% of reading) Resolution: 60µV Drift: < ±(0.05mV + 0.003% of reading) per °C Input impedance: >100MΩ, Leakage: < 1nA
0 - 10V input	-3V to +10V, used for voltage input Calibration: ±(0.5mV + 0.1% of reading) Resolution: 180µV Drift: <±(0.1mV + 0.01% of reading) per °C Input impedance: 0.66MΩ
Pt100 input	0 to 400ohms (-200°C to +850°C), 3 matched wires - up to 22Ω in each lead without errors. Calibration: ±(0.1°C + 0.04% of reading in °C) Resolution: 0.02°C Drift: < ±(0.006°C + 0.002% of absolute reading in °C) per °C Bulb current: 0.2mA.
Thermocouple	Internal compensation: CJC rejection ratio >40:1 typical. CJ Temperature calibration error at 25°C: <± 0.5°C 0°C, 45°C and 50°C external compensation available.
Zirconia probes	Most probes supported. Continuous monitoring of probe impedance (100Ω to 100KΩ)

C.3. DUAL (PROBE) INPUT MODULE

General	The same specification as for the Precision PV Input module applies with the exception of the following: Module offers two sensor/transmitter inputs, which share the same negative input terminal. One low level (mV, 0-20mA, thermocouple, Pt100) and one high level (0-2Vdc, 0-10Vdc) can be connected
Isolation	The two inputs are isolated from the rest of the instrument but not from each other
Sample rate (each input)	4.5Hz (220msec)
Input filtering	Default setting is 0.8 seconds

C.4. ANALOGUE INPUT

No of inputs	One fixed (Not isolated) Can be used with either floating or ground referenced transducers of low impedance.
Input range	-10V to +10V linear or 0 -20 mA with burden resistor of 100Ω. Calibration: ±(1.5mV + 0.1% of reading) Resolution: 0.9mV Drift: < ±(0.1mV + 0.006% of reading) per °C Input Impedance: 0.46MΩ (floating input), 0.23MΩ (ground referenced input)
Isolation	Not isolated from standard digital I/O . Differential type input with common mode range of ± 42Vdc (the average voltage of the two inputs with respect to 'Screen' or 'Common' terminals should be within ±42Vdc. CMRR : >110dB at 50/60Hz, >80dB at DC
Functions	Process variable, remote setpoint, power limit, feedforward, etc.

C.5. ANALOGUE INPUT MODULE

Allocation	Up to 4 analogue input modules can be fitted in I/O slots 1,3,4 & 6
mV input	100mV range - used for thermocouple, linear mV source, or 0-20mA with 2.49Ω external burden resistor. Calibration: ± 10µV + 0.2% of reading Resolution: 6µV Drift: < ± 0.2µV + 0.004% of reading per °C Input impedance: >10MΩ, Leakage: <10nA
0 - 2Vdc input	-0.2V to +2.0V range - used for zirconia. Calibration: ± 2mV + 0.2% of reading Resolution: 30µV Drift: < ± 0.1mV + 0.004% of reading per °C Input impedance: >10MΩ, Leakage: <20nA
0 - 10Vdc input	-3V to +10.0V range - used for voltage input. Calibration: ± 2mV + 0.2% of reading Resolution: 200µV Drift: < ± 0.1mV + 0.02% of reading per °C Input impedance: >69KΩ
Pt100 input	0 to 400ohms (-200°C to +850°C), 3 matched wires - up to 22Ω in each lead without errors. Calibration: ±(0.4°C + 0.15% of reading in °C) Resolution: 0.08°C Drift: < ±(0.015°C + 0.005% of reading in °C) per °C Bulb current: 0.3mA.
Thermocouple	Internal compensation: CJC rejection ratio >25:1 typical. CJ Temperature calibration error at 25°C: <± 2°C 0°C, 45°C and 50°C external compensation available.

C.6. STANDARD DIGITAL I/O

Allocation not isolated	1 digital input standard and 7 I/O which can be configured as inputs or outputs plus 1 changeover relay
Digital inputs	Voltage level : input active < 2Vdc, inactive >4Vdc Contact closure : input active <100ohms, inactive >28kohms
Digital outputs	Open collector, 24Vdc at 40mA drive capability, requires external supply
Changeover relay	Contact rating 2A at 264Vac resistive
Functions	Refer to Chapter 17
Operations	1,000,000 operations with addition of external snubber

C.7. DIGITAL INPUT MODULES

Module type	Triple contact input, Triple logic input
Allocation	Can be fitted into slots 1, 3, 4, 5 or 6
Contact closure	Active <100ohms, inactive >28kohms
Logic inputs	Current sinking : active 10.8Vdc to 30Vdc at 2.5mA inactive -3 to 5Vdc at <-0.4mA
Functions	Refer to Chapter 18

C.8. DIGITAL OUTPUT MODULES

Module types	Single relay, dual relay, single triac, dual triac, triple logic module (isolated)
Allocation	Can be fitted into slot 1, 3, 4, 5 or 6 (max. 3 triac modules per instrument)
Relay rating	2A, 264Vac resistive
Logic drive	12Vdc at 8mA
Triac rating	0.75A, 264Vac resistive
Functions	Refer to Chapter 18

C.9. ANALOGUE OUTPUT MODULES

Module types	1 channel DC control, 1 channel DC retransmission (5 max.)
Allocation (isolated)	Can be fitted into slot 1, 3, 4, 5 or 6
Range	0-20mA, 0-10Vdc
Resolution	1 part in 10,000 (2,000-noise free) 0.5% accurate for retransmission 1 part in 10,000 2.5% accurate for control
Functions	Refer to Chapter 18

C.10. TRANSMITTER PSU

Allocation	Can be fitted into slots 1, 3 ,4 ,5 or 6 (isolated)
Transmitter	24Vdc at 20mA

C.11. TRANSDUCER PSU

Bridge voltage	Software selectable 5 or 10Vdc
Bridge resistance	300Ω to 15KΩ
Internal shunt resistor	30.1KΩ at 0.25%, used for calibration of 350Ω bridge

C.12. POTENTIOMETER INPUT

Potentiometer resistance	330Ω to 15KΩ, excitation of 0.5 volts

C.13. DIGITAL COMMUNICATIONS

Allocation	2 modules fitted in slots H & J (isolated)
Modbus	RS232, 2 wire or 4 wire RS485, max baud 19.2KB in H module & 9.6KB in J module
Profibus-DP	High speed, RS485, 1.5Mbaud

C.14. ALARMS

No of Alarms	Input alarms (2), loop alarms (2) User alarms (8)
Alarm types	Full scale, deviation, rate of change, sensor break plus application specific
Modes	Latching or non-latching, blocking, time delay
Parameters	Refer to Chapter 7

C.15. USER MESSAGES

No of messages	Maximum 50, triggered by operator or alarm or used for custom parameter names
Format	Up to 16 characters

C.16. CONTROL FUNCTIONS

No of loops	One, two or three
Modes	On/off, PID, motorised valve with or without feedback
Options	Cascade, ratio, override or feed forward
Cooling algorithms	Linear, water, oil or fan
PID sets	3 per loop (Cascade loop includes master and slave parameters)
Manual mode	Bumpless transfer or forced manual output, manual tracking available
Setpoint rate limit	Display units per second, minute or hour

C.17. SETPOINT PROGRAMMER

No of programs	A maximum of 50 programs assignable over 500 segments for a time to target programmer and 400 segments for a ramp rate programmer. A program can consist of up to 3 variables. Programs can be given user defined 16 character names
Event outputs	Up to 16, can be assigned individually to segments or called as part of an event group

C.18. ADVANCED FUNCTIONS

Application blocks	32 digital operations 24 Analogue calculations
Timers	4, On Pulse, Off delay, one shot and min-On
Totalisers	4, trigger level & reset input
Real time clock	Day of week and time
Pattern generators	16 x 16, 2 off

C.19. GENERAL SPECIFICATION

Display range	5 digits including up to 3 decimal places
Supply	85-264Vac, 20Watts (max)
Operating ambient	0 - 50°C and 5 to 95% RH non condensing
Storage temp	-10 to +70°C
Panel sealing	IP54
Dimensions	96H x 96W x 150D (mm)
EMC standards	EN50081-1 & EN50082-2 generic standards - suitable for domestic, commercial and light industrial as well as heavy industrial environments
Safety standards	Meets EN61010 installation category II, pollution degree 2
Atmospheres	Not suitable for use above 2000m or in explosive or corrosive atmospheres

C.20. GRAPHICAL REPRESENTATION OF ERRORS

This section shows graphically the effects of adding all contributions of different errors for each input type and range. The errors are a combination of:
Calibration accuracy, Drift with ambient temperature, Linearity error, Leakage

C.20.1. mV Input

Two ranges:

working range	±40mV		
full linear range	±60mV		
noise (resolution)	1uV - OFF,	0.5uV - 0.4sec,	0.25uV - 1.6sec
working range	±80mV		
full linear range	±105mV		
noise (resolution)	2uV - OFF,	1uV - 0.4sec,	0.5uV - 1.6sec

Calibration accuracy @ 25°C

< ± (1.5uV + 0.05% of |reading|)

Drift with ambient temperature

< ±(0.05uV + 0.003% of |reading|) per °C

Linearity error

< ±0.002% of span (i.e. <1uV, <2uV)

Leakage

< ±1nA (typically ±200pA)

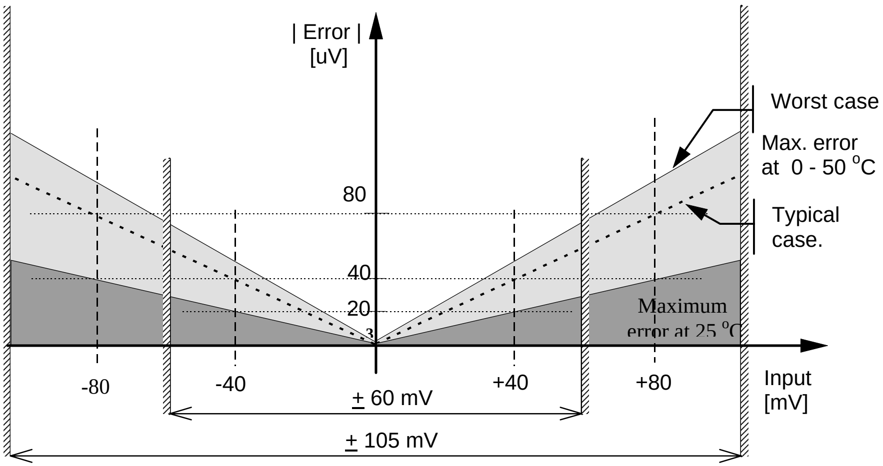


Figure C-1: Error Graph - mV Input

C.20.2. Mid range high impedance Input

0 - 2V Input type

Range:

working range	-1.4V to +2V	
full linear range	-1.8V to +2.4V	
noise (resolution)	100uV - OFF,	50uV - 0.4sec, 35uV - 1.6sec

Calibration accuracy @ 25°C

< ± (0.5mV + 0.05% of |reading|)

Drift with ambient temperature

< ±(0.05mV + 0.003% of |reading|) per °C

Linearity error

< ± 0.01% of span (i.e. ± 200uV)

Input Impedance & Leakage

>100MΩ < 1nA

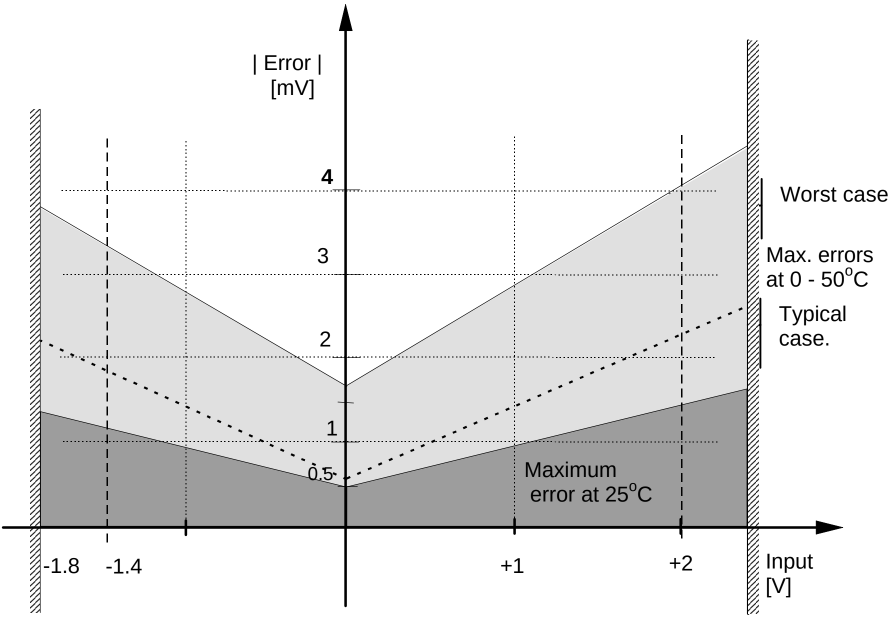


Figure C-2: Error Graph - 0 - 2V Input

C.20.3. High Level Input

0 - 10V Input type

Range:

working range -3V to +10V

full linear range - 5V to +14V

noise (resolution) 300uV - OFF, 150uV - 0.4sec, 100uV - 1.6sec

Calibration accuracy @ 25^{o}C

< $\pm$ (0.5mV + 0.1% of |reading|)

Drift with ambient temperature

< $\pm$(0.01mV + 0.006% of |reading|) per ^{o}C

Linearity error

< $\pm$0.02% of span (i.e. $\pm$ 2mV)

Input Impedance

0.66 MΩ

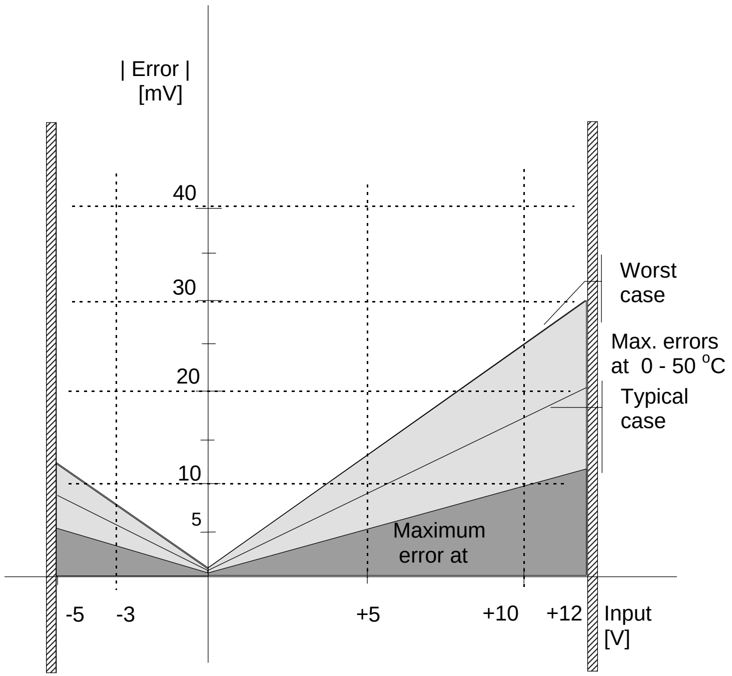


Figure C-3: Error Graph - 0 - 10V Input

C.20.4. RTD (Pt-100) Input type

Resistance measurement specification in Ohms:

Range

0 to 400 Ω with up to 22 Ω in each connecting lead

Noise (resolution)

80 mΩ - 0.4sec, 40mΩ - 1.6sec

Calibration accuracy limits @ 25°C

< $\pm$ (35mΩ @110Ω + 0.03% of |reading - 110Ω|)

Drift with ambient temperature

$\pm$ (0.002% of |reading|) per $^{\circ}$C

Linearity error

< $\pm$15 mΩ

Pt-100 measurement specification in $^{\circ}$C:

Range

-200 $^{\circ}$C to +850 $^{\circ}$C

Noise (resolution)

0.02 $^{\circ}$C - 0.4sec, 0.01 $^{\circ}$C - 1.6sec

Calibration accuracy limit @ 25°C

< $\pm$ (0.1 $^{\circ}$C + 0.03% of |reading in $^{\circ}$C|)

Drift with ambient temperature

< $\pm$(0.0055 $^{\circ}$C + 0.002% of |reading in $^{\circ}$C|) per $^{\circ}$C of ambient change

Linearity + Linearisation error

< $\pm$ 55 $^{\circ}$mC (i.e. 50 $^{\circ}$mC + 5 $^{\circ}$mC)

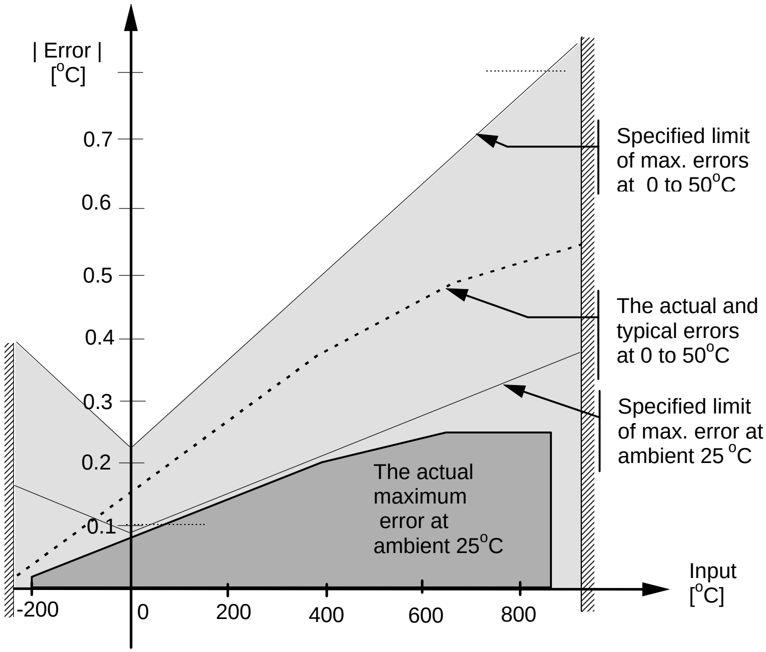


Figure C-4: Error Graph - RTD Input

C.20.5. Thermocouple Input type

Internal CJT sensing spec
Calibration error @ 25 °C (including temp. difference between top and bottom screws)
< ± 0.5 °C

Total CJT error
< ± (0.5 °C + 0.012 °C per 1 °C of ambient change)
(i.e. CJC Rejection for measured temperatures above 0 °C is > 80 : 1)

Noise (resolution)
0.01 °C

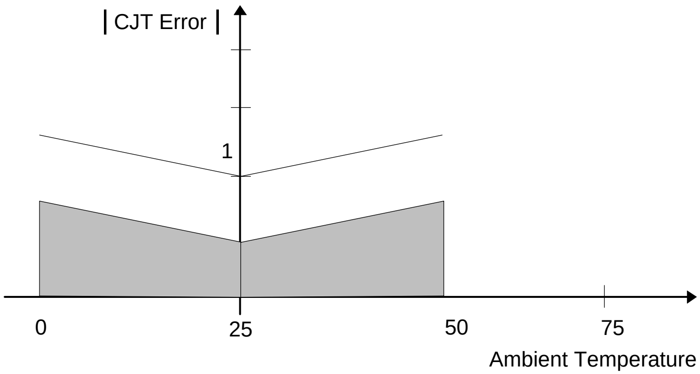


Figure C-5: Overall CJT Error at Different Ambient Temperatures

D. Appendix D Parameter Units and Addresses

D.1. COMMONLY USED PARAMETERS

Although any parameter can be chosen for Soft Wiring, Parameter Promotion or Customised Display purposes, the controller contains those which are most commonly used together with their Modbus Addresses. These parameters are shown below:

Parameter Name	Parameter Description	Refer To Section:-	Modbus Address
None	None		00000
L1.PV	Loop1 PV	Chapter 9	00001
L1.Wkg OP	Loop1 working output	LP1 SETUP	00004
L1.Wkg SP	Loop1 working setpoint	Diagnostic Page	00005
L1.Ch1 OP	Loop1 channel 1 output	Output Page	00013
L1.Ch2 OP	Loop1 channel 2 output	Output Page	00014
L2.PV	Loop2 PV	Chapter 9	01025
L2.Wkg OP	Loop2 working output	LP2 SETUP	01028
L2.Wkg SP	Loop2 working setpoint	Diagnostic Page	01029
L2.Ch1 OP	Loop2 channel 1 output	Output Page	01037
L2.Ch2 OP	Loop2 channel 2 output	Output Page	01038
L3.PV	Loop3 PV	Chapter 9	02049
L3Wkg OP	Loop3 working output	LP3 SETUP	02052
L3Wkg SP	Loop3 working setpoint	Diagnostic Page	02053
L3Ch1 OP	Loop3 channel 1 output	Output Page	02061
L3Ch2 OP	Loop3 channel 2 output	Output Page	02062
CLin1.OP	Custom linearisation 1	Chapter 11 INPUT OPERS Cust Lin 1	03365
CLin2.OP	Custom linearisation 2	Cust Lin 2	03413
CLin3.OP	Custom linearisation 3	Cust Lin 3	03461
SwOv1.OP	Switchover output value	Switch 1 Page	03477
Mod1A.Val	Module 1A output value	Chapter 18 MODULE IO Module 1A page	04148
Mod1B.Val	Module 1B output value	Module 1B page	04196
Mod1C.Val	Module 1C output value	Module 1C page	04244
Mod3A.Val	Module 3A output value	Module 3A page	04468
Mod3B.Val	Module 3B output value	Module 3B page	04516
Mod3C.Val	Module 3C output value	Module 3C page	04564
Mod4A.Val	Module 4A output value	Module 4A page	04628
Mod4B.Val	Module 4B output value	Module 4B page	04676
Mod4C.Val	Module 4C output value	Module 4C page	04724
Mod5A.Val	Module 5A output value	Module 5A page	04788

Mod5B.Val	Module 5B output value	Module 5B page	04836
Mod5C.Val	Module 5C output value	Module 5C page	04884
Mod6A.Val	Module 6A output value	Module 6A page	04948
Mod6B.Val,	Module 6B output value	Module 6B page	04996
Mod6C.Val	Module 6C output value	Module 6C page	05044
PVIn.Val	PV input value	Chapter 17 STANDARD IO PV Input page	05108
AnIn.Val	Analogue input value	An Input Page	05268
DIO1.Val	Digital input/output value 1	Dig IO1 Page	05402
DIO2.Val	Digital input/output value 2	Dig IO2 Page	05450
DIO3.Val	Digital input/output value 3	Dig IO3 Page	05498
DIO4.Val	Digital input/output value 4	Dig IO4 Page	05546
DIO5.Val	Digital input/output value 5	Dig IO5 Page	05594
DIO6.Val	Digital input/output value 6	Dig IO6 Page	05642
DIO7.Val	Digital input/output value 7	Dig IO7 Page	05690
Prg.PSP1	Programmer working SP1	Chapter 6 RUN PSP1 Page	05800
Prg.PSP2	Programmer working SP2	PSP2 Page	05801
Prg.PSP3	Programmer working SP3	PSP3 Page	05802
Prg.Uval1	Programmer user value 1	PROGRAM EDIT Segment Page	05808
Prg.Uval2	Programmer user value 2	PROGRAM EDIT Segment Page	05809
Prg.DO1	Programmer digital OP1	Chapter 6 RUN General Page	05869
Prg.DO2	Programmer digital OP2		05870
Prg.DO3	Programmer digital OP3		05871
Prg.DO4	Programmer digital OP4		05872
Prg.DO5	Programmer digital OP5		05873
Prg.DO6	Programmer digital OP6		05874
Prg.DO7	Programmer digital OP7		05875
Prg.DO8	Programmer digital OP8		05876
AnOp1.OP	Analogue operator OP1	Chapter 14 ANALOGUE OPERS Analogue 1 Page	06158
AnOp2.OP	Analogue operator OP2	Analogue 2 Page	06178
AnOp3.OP	Analogue operator OP3	Analogue 3 Page	06198
AnOp4.OP	Analogue operator OP4	Analogue 4 Page	06218
AnOp5.OP	Analogue operator OP5	Analogue 5 Page	06238
AnOp6.OP	Analogue operator OP6	Analogue 6 Page	06258
AnOp7.OP	Analogue operator OP7	Analogue 7 Page	06278

AnOp8.OP	Analogue operator OP8	Analogue 8 Page	06298
AnOp9.OP	Analogue operator OP9	Analogue 9 Page	06318
AnOp10.OP	Analogue operator OP10	Analogue 10 Page	06338
AnOp11.OP	Analogue operator OP11	Analogue 11 Page	06358
AnOp12.OP	Analogue operator OP12	Analogue 12 Page	06378
AnOp13.OP	Analogue operator OP13	Analogue 13 Page	06398
AnOp14.OP	Analogue operator OP14	Analogue 14 Page	06418
AnOp15.OP	Analogue operator OP15	Analogue 15 Page	06438
AnOp16.OP	Analogue operator OP16	Analogue 16 Page	06458
LgOp1.OP	Logic operator output 1	Chapter 15 LOGIC OPERS Logic 1 Page	07176
LgOp2.OP	Logic operator output 2	Logic 2 Page	07192
LgOp3.OP	Logic operator output 3	Logic 3 Page	07208
LgOp4.OP	Logic operator output 4	Logic 4 Page	07224
LgOp5.OP	Logic operator output 5	Logic 5 Page	07240
LgOp6.OP	Logic operator output 6	Logic 6 Page	07256
LgOp7.OP	Logic operator output 7	Logic 7 Page	07272
LgOp8.OP	Logic operator output 8	Logic 8 Page	07288
LgOp9.OP	Logic operator output 9	Logic 9 Page	07304
LgOp10.OP	Logic operator output 10	Logic 10 Page	07320
LgOp11.OP	Logic operator output 11	Logic 11 Page	07336
LgOp12.OP	Logic operator output 12	Logic 12 Page	07352
LgOp13 OP	Logic operator output 13	Logic 13 Page	07368
LgOp14.OP	Logic operator output 14	Logic 14 Page	07384
LgOp15.OP	Logic operator output 15	Logic 15 Page	07400
LgOp16.OP	Logic operator output 16	Logic 16 Page	07416
Clk.Alm1	Timer alarm 1	Chapter 12 TIMER BLOCKS Alarm 1 Page	08711
Clk.Alm2	Timer alarm 2	Alarm 2 Page	08716
Tot1.Alm	Totaliser 1 alarm output	Chapter 12 TIMER BLOCKS Totaliser 1 Page	08743
Tot2.Alm	Totaliser 2 alarm output	Totaliser 2 Page	08757
Tot3.Alm	Totaliser 3 alarm output	Totaliser 3 Page	08775
Tot4.Alm	Totaliser 4 alarm output	Totaliser 4 Page	08791
Tmr1.OP	Timer 1 output	Chapter 12 TIMER BLOCKS Timer 1 Page	08963
Tmr2.OP	Timer 2 output	Timer 2 Page	08975
Tmr3.OP	Timer 3 output	Timer 3 Page	08987

Tmr4.OP	Timer 4 output	Timer 4 Page	08999
UVal1.Val	User 1 value	Chapter 13 USER VALUES User Val 1 Page	09220
UVal2.Val	User 2 value	User Val 2 Page	09225
UVal3.Val	User 3 value	User Val 3 Page	09230
UVal4.Val	User 4 value	User Val 4 Page	09235
Sum.LP2&3	Summary of loop 2 and loop3		10246
Sum.PrName	Summary of programmer name	Chapter 6 PROGRAM RUN General Page	10247
Sum.D1-16	Summary of digital outputs 1 to 16	Chapter 6 PROGRAM RUN General Page	10248
Sum.TiRem	Summary of program time remaining	Chapter 6 PROGRAM RUN General Page	10249
Const.1	Constant value = 1 May be used in place of a User Value		10464
Zirc.PV	Zirconia Value	Chapter 10	11059
Zirc.Stat,	Probe Status	ZIRCONIA	11066
Zirc.Clea	Clean State	Options Page	11067
Zirc.SAlm	Sooting Alarm	PROBE	11068
Humid.%RH	Relative Humidity	Chapter 10 HUMIDITY Options Page	11105
Humid.DwP	Dewpoint	Chapter 10 HUMIDITY Options Page	11106
DI8.Val	Status of digital input 8	Chapter 17 STANDARD IO Diagnostic Page	11313
DI-E1.Val	Status of IO expander inputs		11314
L1Alm1.OP	Loop1 alarm 1 output	Chapter 7 ALARMS LP1 Page	11592
L1Alm2.OP	Loop1 alarm 2 output	LP1 Page	11602
L2Alm1.OP	Loop2 alarm 1 output	LP2 Page	11640
L2Alm2.OP	Loop2 alarm 2 output	LP2 Page	11650
L3Alm1.OP	Loop3 alarm 1 output	LP3 Page	11688
L3Alm2.OP	Loop3 alarm 2 output	LP3 Page	11698
U1Alm.OP	User 1 alarm output	User 1 Page	11737

U2Alm.OP	User 2 alarm output	User 2 Page	11753
U3Alm.OP	User 3 alarm output	User 3 Page	11769
U4Alm.OP	User 4 alarm output	User 4 Page	11785
U5Alm.OP	User 5 alarm output	User 5 Page	11801
U6Alm.OP	User 6 alarm output	User 6 Page	11817
U7Alm.OP	User 7 alarm output	User 7 Page	11833
U8Alm.OP	User 8 alarm output	User 8 Page	11849
NewAlarm	New alarm	Summary Page	12162
IOEx.IP1	IO expander input 1		12187
IOEx.IP2	IO expander input 2		12188
IOEx.IP3	IO expander input 3		12189
IOEx.IP4	IO expander input 4		12190
IOEx.IP5	IO expander input 5		12191
IOEx.IP6	IO expander input 6		12192
IOEx.IP7	IO expander input 7		12193
IOEx.IP8	IO expander input 8		12194
IOEx.IP9	IO expander input 9		12195
IOEx.IP10	IO expander input 10		12196

D.2. PARAMETER UNITS

PSP Units are:-
None
$^oC/^oF/^oK$,
V, mV, A, mA,
PH, mmHg, psi, bar, mbar, %RH, %, mmWG, inWG, inWW, Ohms, PSIG, %O2, PPM, %CO2, %CP, %/sec,
$^OC\backslash^oF\backslash^oK$(rel),
Custom 1, Custom 2, Custom 3, Custom 4, Custom 5, Custom 6,
sec, min, hrs,

D.3. MODULE STATUS MESSAGES

OK	Module good
Initialising	Module initialising
Ch A SBreak	Channel A sensor input break
Ch C SBreak	Channel C sensor input break
Ch A Out Range	Channel A out of range
Ch C Out Range	Channel C out of range
Ch A IP Sat	Channel A input saturation
Ch C IP Sat	Channel C input saturation
Ch A Not Calib	Channel A not calibrated
Ch C Not Calib	Channel C not calibrated