IM-P323-35
CH Issue 4

SX80 and SX90 Controllers

Installation and Maintenance Instructions

SX80

SX90

Summary of specific features included in SX series

- Soft Start algorithm. This takes the form of an output limit applied for a fixed duration after start up. Duration and threshold level may be set by the user. This is achieved by the internal timer as detailed in sections 5.4 and 13.
- When moving between setpoints (as forced by logic inputs, etc) a limited rate of change can be applied. Two parameters, one defining the rising rate of change (SP.RRT) and one defining falling rate of change (SP.FRT), are available in SX series. These parameters are found in the level 2 operator list section 5.3 and also in the Setpoint list section 10.1.
- Holdback is available in SX90 only to stop the ramp when the PV deviates from SP more than a set threshold value. The holdback parameter (HOLD.B) is found in the Setpoint list section 10.1.
- There are three local setpoints in SX80 and SX90 and the ability to take a remote setpoint in SX90 only. See also level 2 parameter section 5.3 and sections 9.1.11, and 10.
- A forced output may be activated when the controller is switched into Manual mode. The forced output is defined by parameters (F.MOD & F.OP) in the Control list section 11.11.
- In SX90 only and when the controller is configured for bounded valve position control a remote analogue input may be configured to read valve position. This is defined by a parameter (VPB.IN) in the Control list section 11.11.
- EIA422 digital communications is only available in SX90. See section 15.

Issue History of this Manual

Issue 1 applies to firmware versions V1.02.

Issue 2 updates Part Number and Reference Number.

Issue 3 corrects humidity rating in section 1.4.

Issue 4 changes supply frequency from 50/60Hz to 48 to 62Hz.

Issue 5 Correct description of enumerations for parameter IM section 15.6. Correct Fahrenheit ranges in section 8.1.1. Change to definition of LOC.T. in section 10.1.

Issue 6 applies to firmware version V1.04. This version allows the instruments to be used in cascade applications shown in sections 2.21.3 and 2.21.4. Further parameters have been added to the Setpoint list section 10. These are Loc.t Local Setpoint with Remote as a trim and rEm.t; Remote Setpoint with Local as a trim; RATIO and BIAS.

Issue 7 adds Digital Inputs A & B and updates the Safety and EMC section.

Issue 8 applies to firmware version 1.05 and above and adds Split output feature and Output alarms.

1. Installation and Basic Operation

1.1 What Instrument Do I Have?

The SX series provide precise control of temperature or pressure in industrial processes and is available in two standard DIN sizes:-

- 1/16 DIN Model Number SX80
- 1/8 DIN Model Number SX90

A universal input accepts various thermocouples, RTDs or process inputs. Up to three (SX80) or six (SX90) outputs can be configured for control, alarm or re-transmission purposes. Digital communications is included in SX90 only.

On start up the controller may be configured using a 'Quick Start' code. It is possible, however, to add further features by configuring the controller in deeper levels of access. This is described in this manual.

1.2 Unpacking Your Controller

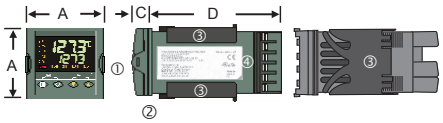
The controller is supplied with:-

- Sleeve (with the controller fitted in the sleeve)
- Two panel retaining clips and IP65 sealing gasket mounted on the sleeve
- Component packet containing two snubbers for use with relay outputs (see section 2.18.1) and a 2.49Ω resistor for current input (see section 2.5.3)
- Installation sheet Part Number 3231351.

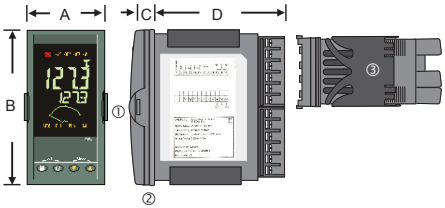
1.3 Dimensions

General views of the controllers are shown below together with overall dimensions.

SX80



SX90



①	Latching ears
②	IP65 Sealing Gasket
③	Panel retaining clips
④	Sleeve

A	48mm (1.89inch)	C	11mm (0.44 inch)
B	96mm (3.78 inch)	D	90mm (3.54 inch)

1.4 Step 1: Installation

This instrument is intended for permanent installation, for indoor use only, and enclosed in an electrical panel

Select a location which is subject to minimum vibrations the ambient temperature is within 0 and 55°C (32 - 131°F) and humidity 5 to 85% RH non condensing.

The instrument can be mounted on a panel up to 15mm thick.

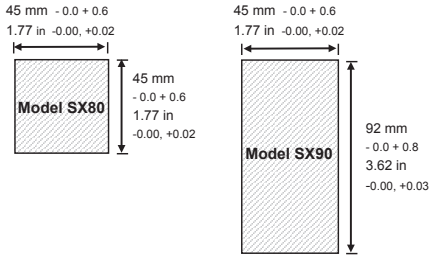
To ensure IP65 and NEMA 4 front protection, mount on a non-textured surface.

Please read the safety information in section 3 before proceeding. The EMC Booklet is available for further installation information.

1.4.1 Panel Mounting the Controller

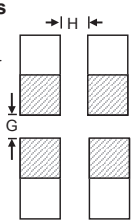
1. Prepare a cut-out in the mounting panel to the size shown. If a number of controllers are to be mounted in the same panel observe the minimum spacing shown.
2. Fit the IP65 sealing gasket behind the front bezel of the controller
3. Insert the controller through the cut-out
4. Spring the panel retaining clips into place. Secure the controller in position by holding it level and pushing both retaining clips forward.
5. Peel off the protective cover from the display.

1.4.2 Panel Cut Out Sizes



1.4.3 Recommended minimum spacing of controllers

Applies to all models.



(Not to scale)

G	38mm (1.5in)
H	10mm (0.4in)

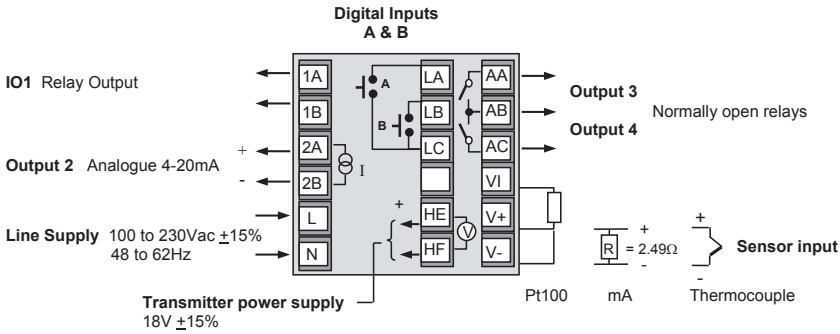
1.4.4 To Remove the Controller from its Sleeve

The controller can be unplugged from its sleeve by easing the latching ears outwards and pulling it forward out of the sleeve. When plugging it back into its sleeve, ensure that the latching ears click back into place to maintain the IP65 sealing.

2. Step 2: Wiring

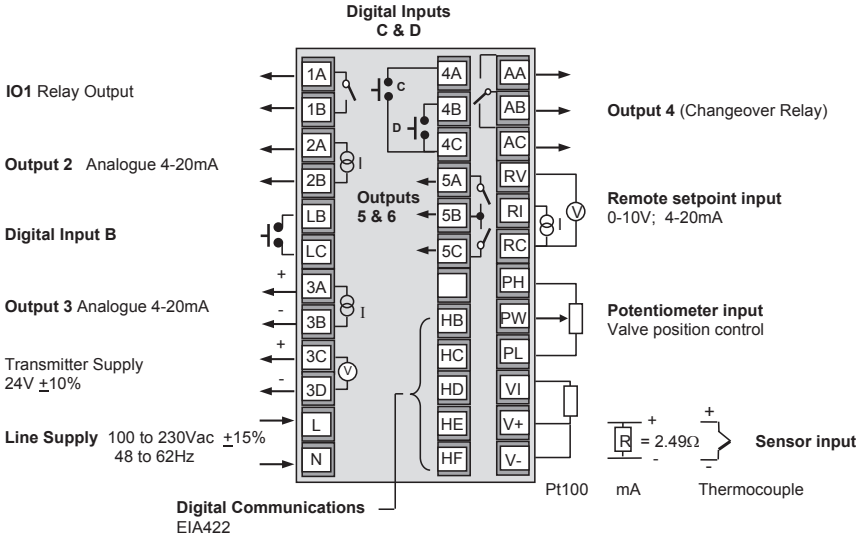
2.1 Terminal Layout SX80 Controller

> ⚠ **Ensure that you have the correct supply for your controller**



2.2 Terminal Layout SX90 Controller

> ⚠ **Ensure that you have the correct supply for your controller**



2.3 Wire Sizes

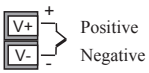
The screw terminals accept wire sizes from 0.5 to 1.5 mm (16 to 22AWG). Hinged covers prevent hands or metal making accidental contact with live wires. The rear terminal screws should be tightened to 0.4Nm (3.5lb in).

2.4 Precautions

- Do not run input wires together with power cables
- When shielded cable is used, it should be grounded at one point only
- Any external components (such as zener barriers, etc) connected between sensor and input terminals may cause errors in measurement due to excessive and/or un-balanced line resistance or possible leakage currents
- Not isolated from the logic outputs & digital inputs
- Pay attention to line resistance; a high line resistance may cause measurement errors

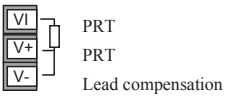
2.5 Sensor Input (Measuring Input) SX80 and SX90

2.5.1 Thermocouple Input



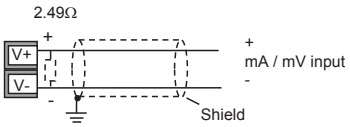
- Use the correct compensating cable preferably shielded

2.5.2 RTD Input



- The resistance of the three wires must be the same. The line resistance may cause errors if it is greater than 22Ω

2.5.3 Linear Input (mA or mV)



- If shielded cable is used it should be grounded in one place only as shown
- For a mA input connect the 2.49Ω burden resistor supplied between the V+ and V- terminals as shown

2.6 Relay Output (IO1) SX80 and SX90

Output 1 is supplied as standard as a normally open relay configured for temperature alarm.

- Isolated output 300Vac CATII
- Contact rating: 2A 264Vac resistive
- For alarm type see Quick Code Set 3.

2.7 Output 2 (OP2) (4-20mA) SX80 and SX90

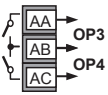
OP2 is supplied as standard as a 4-20mA analogue output. For functionality see Quick Code Set 2.

- Isolated output 300Vac CAT II
- Configurable 0-20mA or 4-20mA
- Max load resistance: 500Ω
- Calibration accuracy: < +(1% of reading +200µA)

2.8 Outputs 3 & 4 (OP3/4) SX80 only

Outputs 3 and 4 are normally open (Form A) relays which share a common connection. They are intended to control motor driven valves.

For function see Quick Code Set 2.



- Isolated output 300Vac CATII
- Contact rating: 2A 264Vac resistive - any terminal limited to 2A

2.9 Transmitter Power Supply SX80

The transmitter power supply provides an 18V supply to power an external transmitter.

- Isolated output 300Vac CATII
- Output 18V +15%

2.10 Output 3 (OP3) 4-20mA - SX90 only

OP3 is a 4-20mA analogue output in SX90 only.
For functionality see Quick Code Set 2.

- Isolated output 300Vac CATII
- Configurable 0-20mA or 4-20mA
- Max load resistance: 500Ω
- Calibration accuracy: < ±(1% of reading +200μA)

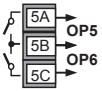
2.11 Output 4 (OP4) - SX90 only

Output 4 is a changeover (Form C) relay fitted in SX90 only.
For functionality see Quick Start Code.

- Isolated output 300Vac CATII
- Contact rating: 2A 264Vac resistive

2.12 Outputs 5 & 6 (OP5/6) - SX90 only

Outputs 5 and 6 are supplied as normally open (Form A) relays and are to control motor driven valves.
They share a common connection and are, therefore, not isolated from each other.
For alarm type see Quick Code Set 3.



- Isolated output 300Vac CATII
- Contact rating: 2A 264Vac resistive - any terminal limited to 2A

2.13 Transmitter Power Supply- SX90 only

The transmitter power supply provides an 24V supply to power an external transmitter.

- Isolated output 300Vac CATII
- Output 24V ±10%, 30mA

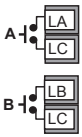
2.14 Potentiometer Input - SX90 only

The potentiometer input provides feedback of the valve position

- Potentiometer resistance: 100-10kΩ
- Excitation voltage: 0.46 to 0.54V
- Short circuit detection: <25Ω
- Open circuit detection: >2MΩ
- Open circuit wiper detection >5MΩ

2.15 Digital Inputs A & B – SX80 only

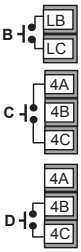
These are contact closure inputs which may be configured for functions listed in section 9.1.11.



- Switching:
  LA 12Vdc at 12mA max
  LB 12Vdc at 40mA
- Contact open > 1200Ω.
- Contact closed < 300Ω

2.16 Digital Inputs B. C & D - SX90 only

These are contact closure inputs which may be configured for functions listed in section 9.1.11.



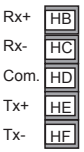
- **Not isolated** from the sensor input
- LC and LD not isolated from each other
- Switching:
- LC/LD 12Vdc at 6mA max
- LB 12Vdc at 12mA
- Contact open > 1200Ω. Contact closed < 300Ω

2.17 Remote Setpoint Input - SX90 only

- There are two inputs; 4-20mA and 0-10 Volts which can be fitted in place of digital communications
- It is not necessary to fit an external burden resistor to the 4-20mA input
- If the 4-20mA remote setpoint input is connected and valid (>3.5mA; < 22mA) it will be used as the main setpoint (if configured). If it is not valid or not connected the controller will try to use the Volts input. Volts sensor break occurs at <-1; >+11V. The two inputs are not isolated from each other
- If neither remote input is valid the controller will fall back to the internal setpoint, SP1 or SP2 and flash the alarm beacon. The alarm can also be configured to activate a relay (see section 12.1.1) or read over digital communications.
- To calibrate the remote setpoint, if required, see section 16.5.4
- A local SP trim value is available in access level 3 (see section 10.1).
- Isolated 300Vac CATII.

2.18 Digital Communications - SX90 only

Digital communications uses Modbus protocol. It is available in SX90 only as **EIA422** (EIA485 5-wire).



- EIA422 (5-wire)
- Isolated 300Vac CATII.

2.18.1 General Note About Relays and Inductive Loads

High voltage transients may occur when switching inductive loads such as some contactors or solenoid valves. Through the internal contacts, these transients may introduce disturbances which could affect the performance of the instrument.

For this type of load it is recommended that a 'snubber' is connected across the normally open contact of the relay switching the load. The snubber recommended consists of a series connected resistor/capacitor (typically 15nF/100Ω). A snubber will also prolong the life of the relay contacts.

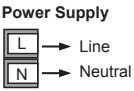
A snubber should also be connected across the output terminal of a triac output to prevent false triggering under line transient conditions.

WARNING

When the relay contact is open or it is connected to a high impedance load, the snubber passes a current (typically 0.6mA at 110Vac and 1.2mA at 230Vac). You must ensure that this current will not hold on low power electrical loads. If the load is of this type the snubber should not be connected.

2.19 Controller Power Supply

1. Before connecting the instrument to the power line, make sure that the line voltage corresponds to the description on the identification label.
2. Use copper conductors only.
3. The power supply input is not fuse protected. This should be provided externally



- High voltage supply: 100 to 230Vac, +/-15%, 48 to 62 Hz
- Recommended external fuse ratings are:- Fuse type: T rated 2A 250V.

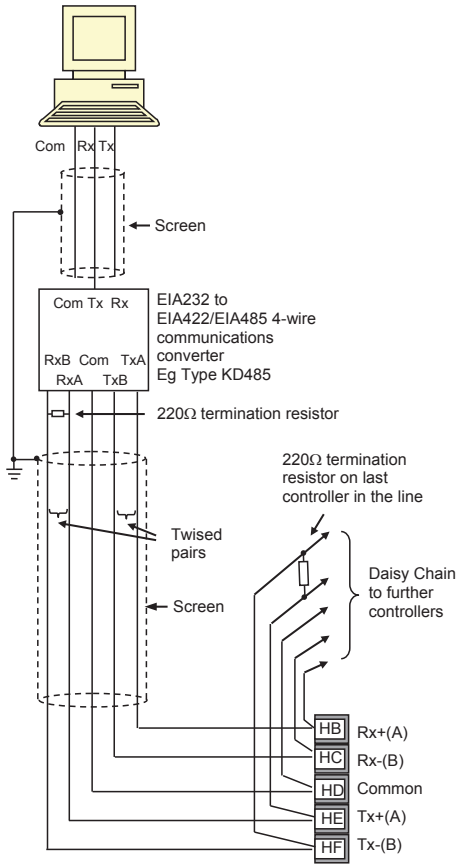
2.20 Digital Communications

Digital communications uses the Modbus protocol. The interface is EIA422 (5-wire).

☺ Cable screen should be grounded at one point only to prevent earth loops.

- Isolated 240Vac CAT II.

2.20.1 EIA422 Connections - SX90 only



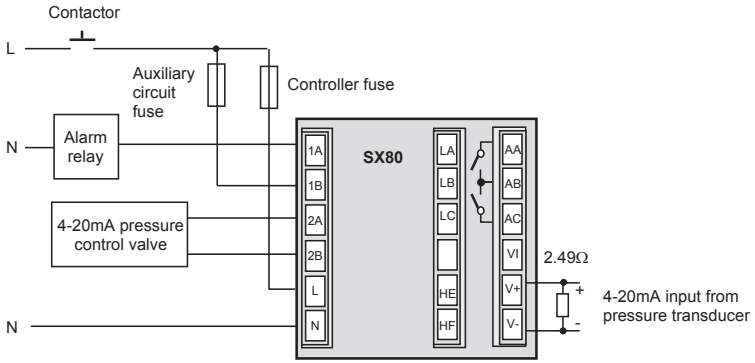
☺ The KD485 communications converter is recommended for:

- Interfacing 5-wire to 2-wire connections.
- To buffer an EIA422 network when more than 32 instruments on the same bus are required

2.21 Wiring Examples

2.21.1 Pressure Control

This example shows a controller connected to a 4-20mA pressure control valve.



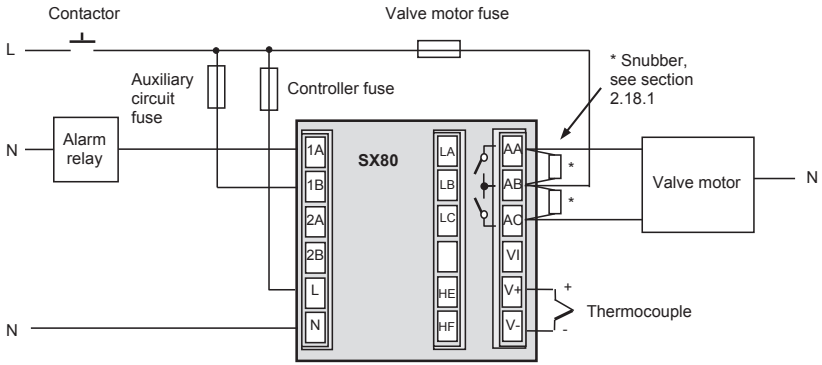
Safety requirements for permanently connected equipment state:

- A switch or circuit breaker shall be included in the building installation
- It shall be in close proximity to the equipment and within easy reach of the operator
- It shall be marked as the disconnecting device for the equipment

☺ A single switch or circuit breaker can drive more than one instrument

2.21.2 Valve Position

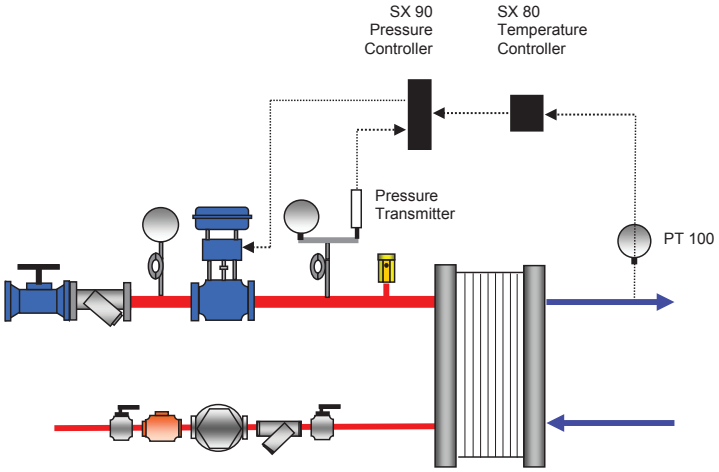
This diagram shows an example of wiring for a valve position motor.

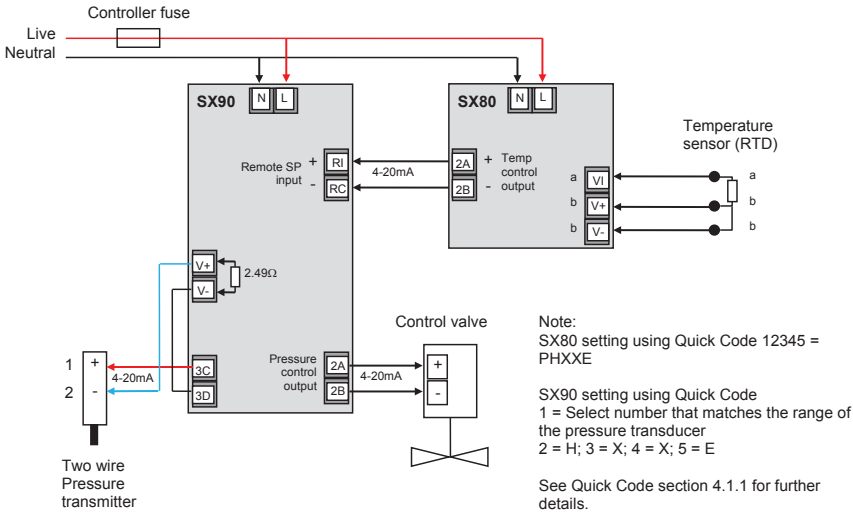


All wiring diagrams are intended for general guidance only.

The application of temperature control, with pressure limitation can be used when there is a pressure or temperature limit on an item of equipment, or a temperature limit of a sensitive product. This application is described as Cascade Control.

The application uses a single control valve to control both temperature and pressure. The example below shows the physical layout and the associated wiring connections for a typical temperature/pressure application:





Note:
SX80 setting using Quick Code 12345 = PHXXE

SX90 setting using Quick Code
1 = Select number that matches the range of the pressure transducer
2 = H; 3 = X; 4 = X; 5 = E

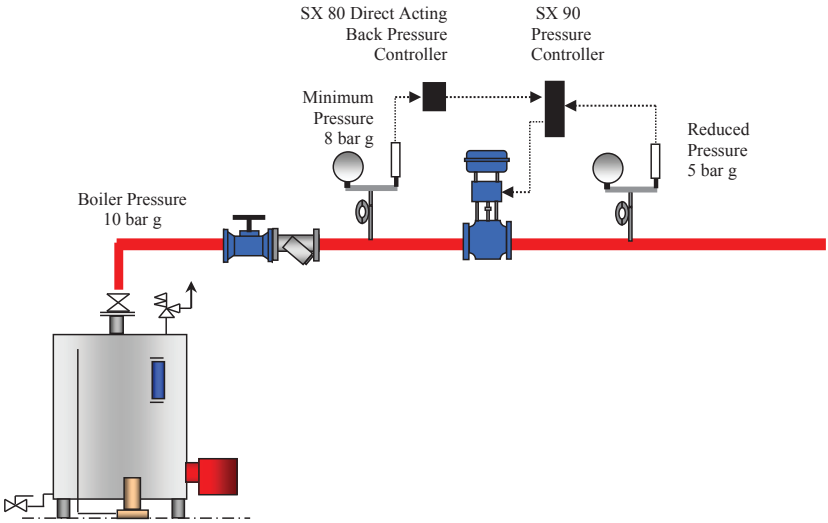
See Quick Code section 4.1.1 for further details.

2.21.4 Cascade Control Back Pressure/Pressure Reduction

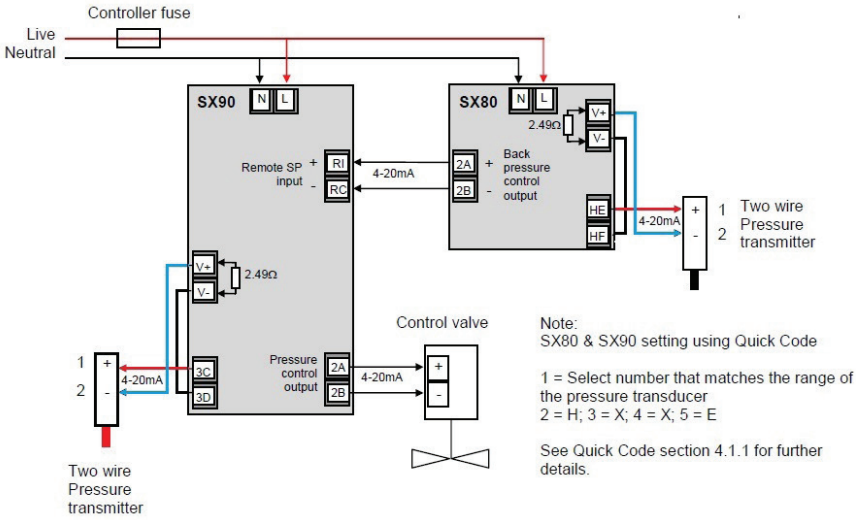
The objective here is to reduce the steam pressure but not to exceed the output of the boiler.

The SX80 is set to the pressure necessary to maintain good boiler operating conditions. If the load exceeds the boiler capacity and the pressure at the boiler drops the control valve closes and maintains a suitable upstream pressure. When the steam demand falls, and allows the boiler pressure to return to its normal operating pressure, the valve will re-open.

Consider the boiler pressure to be 10 bar g and the reduced pressure 5 bar g. The minimum allowable boiler pressure is 8 bar g which means that if this pressure is reached the valve is fully shut.



The SX90 remote setpoint limit will represent the downstream setpoint, 5 bar g
The SX80 local setpoint will represent the upstream setpoint, 8 bar g



3. Safety and EMC Information

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 manual may impair safety or EMC. The installer must ensure the safety and EMC of any particular installation.

Safety

This controller complies with the European Low Voltage Directive 2006/95/EC, by the application of the safety standard EN 61010.

Electromagnetic compatibility

This controller conforms with the essential protection requirements of the EMC Directive 2004/108/EC, by the application of a Technical Construction File. This instrument satisfies the general requirements of the industrial environment defined in EN 61326. For more information on product compliance refer to the Technical Construction File.

GENERAL

The information contained in this manual is subject to change without notice. While every effort has been made to ensure the accuracy of the information, your supplier shall not be held liable for errors contained herein.

Unpacking and storage

The packaging should contain an instrument mounted in its sleeve, two mounting brackets for panel installation and an Installation & Operating guide. Certain ranges are supplied with an input adapter.

If on receipt, the packaging or the instrument are damaged, do not install the product but contact your supplier. If the instrument is to be stored before use, protect from humidity and dust in an ambient temperature range of -30°C to +75°C.

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. It may be convenient to partially withdraw the instrument from the sleeve, then pause before completing the removal. In any case, avoid touching the exposed electronics of an instrument when withdrawing it from the sleeve.

Failure to observe these precautions may cause damage to components of the instrument or some discomfort to the user.

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.

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.

3.1 Installation Safety Requirements

Safety Symbols

Various symbols may be used on the controller. They have the following meaning:

⚠ Caution, (refer to accompanying documents)

⧈ Equipment protected throughout by DOUBLE INSULATION

☺ Helpful hints

Personnel

Installation must only be carried out by suitably qualified personnel in accordance with the instructions in this manual.

Enclosure of Live Parts

To prevent hands or metal tools touching parts that may be electrically live, the controller must be enclosed in an enclosure.

Caution: Live sensors

The controller is designed to operate if the temperature sensor is connected directly to an electrical heating element. However you must ensure that service personnel do not touch connections to these inputs while they are live. With a live sensor, all cables, connectors and switches for connecting the sensor must be mains rated for use in 230Vac ±15%.

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Wiring

It is important to connect the controller in accordance with the wiring data given in this guide. 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 UK use the latest version of the IEE wiring regulations, (BS7671). In the USA use NEC Class 1 wiring methods.

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.

Overcurrent protection

The power supply to the system should be fused appropriately to protect the cabling to the units.

Voltage rating

The maximum continuous voltage applied between any of the following terminals must not exceed 230Vac ±15%:

- relay output to logic, dc or sensor connections;
- any connection to ground.

The controller must 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.

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.

This product has been designed to conform to BSEN61010 installation category II, pollution degree 2. These are defined as follows:-

Installation Category II (CAT II)

The rated impulse voltage for equipment on nominal 230V supply is 2500V.

Pollution Degree 2

Normally only non conductive pollution occurs. Occasionally, however, a temporary conductivity caused by condensation shall be expected.

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.

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.

Installation requirements for EMC

To ensure compliance with the European EMC directive certain installation precautions are necessary as follows:

- For general guidance an EMC Installation Guide is available - contact your supplier.
- When using relay outputs it may be necessary to fit a filter suitable for suppressing the emissions. The filter requirements will depend on the type of load.
- If the unit is used in table top equipment which is plugged into a standard power socket, then it is likely that compliance to the commercial and light industrial emissions standard is required. In this case to meet the conducted emissions requirement, a suitable mains filter should be installed.

Routing of wires

To minimise the pick-up of electrical noise, the low voltage DC connections and the sensor input wiring 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. In general keep cable lengths to a minimum.

4. Switch On

A brief start up sequence consists of a self test during which the software version number and the Spirax instrument type is shown.

The way in which the controller starts up depends on factors described below in sections 4.1, 4.2 and 4.3.

4.1 New Controller

If the controller is new AND has not previously been configured it will start up showing the 'Quick Configuration' codes. This is a built in tool which enables you to configure the input type and range, control type and output functions alarm operation and language.

⚠ Incorrect configuration can result in damage to the process and/or personal injury and must be carried out by a competent person authorised to do so. It is the responsibility of the person commissioning the controller to ensure the configuration is correct.

4.1.1 Quick Start Code

The quick start code consists of a 'SET' of five characters. The upper section of the display shows the set selected (in the SX series there is only one set), the lower section shows the five digits which make up the set.

Adjust these as follows:-.

1. Press any button. The characters will change to '-', the first one flashing.
2. Press ▲ or ▼ to change the flashing character to the required code shown in the quick code tables – see below. Note: An ✗ indicates that the option is not fitted.
3. Press ⊙ to scroll to the next character.

☺ You cannot scroll to the next character until the current character is configured.

☺ To return to the first character press ◉

4. When the last digit has been entered press ⊙ again, the display will show 

. To repeat the process press either ◉ or ⊙.

When satisfied with the configuration, press ▲ or ▼ to 

The controller will then automatically go to the operator level 1, section 4.3.

SET 1 — 1 2 3 4 5

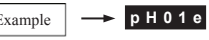
1. Input type, range and DP		
–		
P	PT100 RTD	99.9 to 300.0°C, 2DP
K	K t/c	-200 to 1372 °C, 2DP
0	4-20mA	0 to 1.60 BAR, 2DP
1	4-20mA	0 to 2.50 BAR, 2DP
2	4-20mA	0 to 4.00 BAR, 2DP
3	4-20mA	0 to 6.00 BAR, 2DP
4	4-20mA	0 to 10.00 BAR, 2DP
5	4-20mA	0 to 16.00 BAR, 2DP
6	4-20mA	0 to 25.00 BAR, 2DP
7	4-20mA	0 to 40.00 BAR, 2DP
8	4-20mA	-50 to 500 °C 0DP
9	4-20mA	0 to 100 °C 0DP
A	4-20mA	100 to 250 °C 0DP

2. Control type and I/O		
–		
D	Boundless VP, on OP3/4 (SX80) Boundless VP, on OP5/6 (SX90)	Alarm relay on IO1
V	SX90 only Bounded VP on OP5/6	Alarm relay on IO1. Analogue feedback
P	SX90 only Bounded VP on OP5/6	Alarm relay on IO1. Potentiometer feedback
A	SX90 only Analogue Heat/Cool PID output on OP2/OP3	Alarm relay on IO1 Alarm relay on OP4
H	Analogue Heat only PID output on OP2 (SX80) OP2 tracks OP3 (SX90)	Alarm relay on IO1 Alarm relay on OP4
S	Analogue OP PID heat only, split output on OP2/OP (Only SX90)	Alarm relay on IO1 Alarm relay on OP4

3. IO1 alarm relay Manual Latching	
X	Unconfigured
–	
0	Full scale high
1	Full scale low
2	Deviation high
3	Deviation low
4	Deviation band
5	OP High
6	OP Low

OP4 alarm relay (not if SX80 and VP) Manual Latching	
X	Unconfigured
–	
0	Full scale high
1	Full scale low
2	Deviation high
3	Deviation low
4	Deviation band
5	OP High
6	OP Low

5. Language *	
–	
E	English
F	French
S	Spanish
I	Italian
G	German

Example → 

* Language - scrolling alarm and timer messages are in the language selected. Names of parameters are in English.

4.2 To Re-Enter Quick Code mode

If you need to re-enter the 'Quick Configuration' mode this can always be done as follows:-

1. Power down the controller
2. Hold down the ⊙ button, and power up the controller again.
3. Keep the button pressed until `codE` is displayed.
4. Enter the configuration code (this is defaulted to 4 in a new controller)
5. The quick start codes may then be set as described previously

☺ Parameters may also be configured using a deeper level of access. This is described in later chapters of this manual.

☺ If the controller is started with the ⊙ button held down, as described above, and the quick start codes are shown with dots (e.g. K.D.0.1.E), this indicates that the controller has been re-configured in a deeper level of access and, therefore, the quick start codes may not be valid. If the quick start codes are accepted by scrolling to YES / CNIT then the quick start codes are reinstated.

4.3 Pre-Configured Controller or Subsequent Starts

After the brief start up sequence the quick start codes are normally shown.

It will then proceed to **Operator Level 1**.

You will see the display similar to the one shown below. It is called the **HOME** display.

4.4 Front Panel Layout

`ALM1`	Alarm active (Red)
`OP1`	lit when output 1 is ON (heating or VP raise)
`OP2`	lit when output 2 is ON (cooling or VP lower)
`OP3`	not used
`OP4`	not used
`SPX`	Alternative setpoint in use (e.g. setpoint 2)
`REM`	Remote digital setpoint. Also flashes when digital communications active
`RUN`	Timer is running
`RUN`	(flashing) Timer is in hold
`MAN`	Manual mode selected

Measured Temperature or Pressure (Process Value 'PV')

Target Temperature or Pressure (Working Setpoint 'SP')

Meter (SX90 only) by default this shows valve position.

The meter may be configured to show other functions - see section 17.1.4 Meter Configuration - Access List

Operator Buttons:-

⊙	From any display - press to return to HOME
⊙	Press to select a new parameter. If held down it will continuously scroll through parameters**.**
▲	Press to decrease a value
▲	Press to increase a value

4.4.1 To Set The Target Temperature.

The controller can be run from either internal or remote setpoints.

Depending on the configuration, the Working Setpoint will show:

1. The Local Setpoint value (SP1, SP2 or SP3 depending on the setpoint selected)
2. The Remote Setpoint value
3. A combination of both Local and Remote setpoints
4. Local setpoint with the Remote as a trim
5. Remote setpoint with the Local as a trim

If mode 1 above is selected, then from the HOME display:-

Press ▲ to raise the setpoint

Press ▼ to lower the setpoint

The new setpoint is entered when the button is released and is indicated by a brief flash of the display.

When a Remote setpoint is configured (modes 2, 3, 4 or 5 above) the REM beacon is illuminated and the setpoint can only be adjusted by the voltage or current level on the Remote Input terminals or by adjusting the internal setpoints SP1, SP2 or SP3 shown in section 10.

4.4.2 Alarms

Up to two process alarms may be configured using the Quick Start Codes section 4.1.1. Each alarm can be configured for:-

Full Scale Low	The alarm is shown if the process value falls below a set threshold
Full Scale High	The alarm is shown if the process value rises above a set threshold
Deviation Low	The alarm is shown if the process value deviates below the setpoint by a set threshold
Deviation High	The alarm is shown if the process value deviates above the setpoint by a set threshold
Deviation Band	The alarm is shown if the process value deviates above or below the setpoint by a set threshold

If an alarm is not configured it is not shown in the list of operator level parameters, section 4.4.7 and 5.3.

It is also possible to configure two further alarms, see section 12, by selecting configuration level.

Additional alarm messages may be shown such as CONTROL LOOP BROKEN. This occurs if the controller does not detect a change in process value following a change in output demand after a suitable delay time.

Another alarm message may be INPUT SENSOR BROKEN (SBr). This occurs if the sensor becomes open circuit; the output level will adopt a 'SAFE' value which can be set up in Operator Level 3, see section 11.11.

☺ Two further alarm types are also available. These are:-

Rising rate of change rrc	An alarm will be detected if the rate of change (units/minute) in a positive direction exceeds the alarm threshold
Falling rate of change Frc	An alarm will be detected if the rate of change (units/minute) in a negative direction exceeds the alarm threshold

These alarms cannot be configured by the Quick Start Code – they can only be configured in Configuration Mode, see section 12.3.

4.4.3 Alarm Indication

If an alarm occurs, the red ALM beacon will flash. A scrolling text message will describe the source of the alarm. Any output (usually a relay) attached to the alarm will operate. When configured using the Quick Start Code the relay is de-energised in alarm so that an alarm is indicated if power to the controller fails. Also using the Quick Start Code alarms are configured as manual latching.

Manual Latching	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 condition causing the alarm is removed.

4.4.4 To Acknowledge an Alarm

Press ◉ and ○ (ACK) together.

If the alarm is still present when acknowledged it is still indicated as above.

If the alarm is no longer present when acknowledged the ALM beacon will go off, the scrolling message disappears and the relay is reset.

To configure any other type of alarm, refer to section 12.3.1. These may be:-

Non latching	A non latching alarm will reset itself when the alarm condition is removed.
Auto Latching	An auto latching alarm requires acknowledgement before it is reset. The acknowledgement can occur BEFORE the condition causing the alarm is removed.

4.4.5 Auto, Manual and Off Mode

The controller can be put into Auto, Manual or Off mode – see next section.

Auto mode is the normal operation where the output is adjusted automatically by the controller in response to changes in the process value.

In Auto mode all the alarms and the special functions (auto tuning, soft start and timer) are operative

Manual mode means that the controller output power is manually set by the operator. The input sensor is still connected and reading the process value but the control loop is 'open'.

In manual mode the MAN beacon will be lit, Band and deviation alarm are masked, the auto-tuning, timer and programmer functions are disabled.

The power output can be continuously increased or decreased using the ▲ or ▼ buttons.

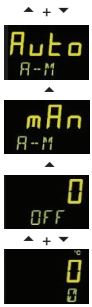
⚠ **Manual mode must be used with care. The power level must not be set and left at a value that can damage the process or cause excess process condition. The use of a separate 'over-process controller is recommended.**

Off mode means that the heating and cooling (or raise/lower) outputs are turned off. The process alarm and analogue retransmission outputs will, however, still be active while Band and deviation alarm will be OFF.

4.4.6 To Select Auto, Manual or Off Mode

Press and hold ▲ and ▼ (Mode) together for more than 1 second.

This can only be accessed from the HOME display.



1. 'Auto' is shown in the upper display. After 5 seconds the lower display will scroll the longer description of this parameter. ie 'LOOP MODE – AUTO MANUAL OFF'
2. Press ▼ to select 'mAn'. Press again to select 'OFF'. This is shown in the upper display.
3. When the desired Mode is selected, do not push any other button. After 2 seconds the controller will return to the HOME display.
4. If **OFF** has been selected, 'OFF' will be shown in the lower display and the heating/cooling (raise/lower) outputs will be off
5. If manual mode has been selected, the **MAN** beacon will light. The upper display shows the process value and the lower display the demanded output power.

☺ The transfer from Auto to manual mode is 'bumpless'. This means the output will remain at the current value at the point of transfer. Similarly when transferring from Manual to Auto mode, the current value will be used. This will then slowly change to the value demanded automatically by the controller.

6. To manually change the power output, press ▲ or ▼ to lower or raise the output. The output power is continuously updated when these buttons are pressed
7. To return to Auto mode, press ▲ and ▼ together. Then press ▲ to select 'Auto'.

4.4.7 Level 1 Operator Parameters

A minimal list of parameters are available in operator Level 1 which is designed for day to day operation. Access to these parameters is not protected by a pass code.

Press ⊙ to step through the list of parameters. The mnemonic of the parameter is shown in the lower display. After five seconds a scrolling text description of the parameter appears.

The value of the parameter is shown in the upper display. press ▲ or ▼ to adjust this value. If no key is pressed for 30 seconds the controller returns to the HOME display

The parameters that appear depend upon the functions configured, for example, the Timer and Alarm parameters are not shown if the function is not configured. They are:-

Parameter Mnemonic	Scrolling Display and Description	Alterability
WRKOP	WORKING OUTPUT The active output value	Read only. Appears when the controller is in AUTO or OFF mode. In a motorised valve controller this is the 'inferred' position of the valve
WKG.SP	WORKING SETPOINT The active setpoint value.	Read only. Only shown when the controller is in MAN or OFF mode.
SP1	SETPOINT 1	Alterable
SP2	SETPOINT 2	Alterable
SP3	SETPOINT 3	Alterable
DWELL	SET TIME DURATION Timer set time	Alterable. Only shown if the timer is configured.
TREMTM	TIME REMAINING Time to end of set period	Read only 0:00 to 99.59 hh:mm or mm:ss
A1XXX	ALARM 1 SETPOINT	Read only. Only shown if the alarm is configured. xxx = alarm type as follows:- HI = High alarm LO = Low alarm d.HI = Deviation high d.LO = Deviation low d.HI = Deviation high rrc = Rising rate of change (units/minute) Frc = Falling rate of change (units/minute) OHi = Output high OLo = Output low
A2XXX	ALARM 2 SETPOINT	
A3XXX	ALARM 3 SETPOINT	
A4XXX	ALARM 4 SETPOINT	

Note: Alarm 3 and 4 can only be configured in CONF (Configuration) level and, therefore, are not normally shown.

Alarms 1 and 2 can only be configured as rate of change alarms in CONF level. rrc and Frc will not, therefore, normally be seen.

5. Operator Level 2

Level 2 provides access to additional parameters. Access to these is protected by a security code.

5.1 To Enter Level 2

1. From any display press and hold ⊙.
2. After a few seconds the display will show:-

3. Release ⊙.

(If no button is pressed for about 45 seconds the display returns to the HOME display)

4. Press ▲ or ▼ to choose LEU 2 (Level 2)

5. After 2 seconds the display will show:-

6. Press ▲ or ▼ to enter the pass code. Default = '2'

- If an incorrect code is entered the controller reverts to Level 1.

5.2 To Return to Level 1

1. Press and hold ⊙
2. Press ▲ to select LEU 1

The controller will return to the level 1 HOME display.
Note: A security code is not required when going from a higher level to a lower level.

5.3 Level 2 Parameters

Press ⊙ to step through the list of parameters. The mnemonic of the parameter is shown in the lower display. After five seconds a scrolling text description of the parameter appears.

The value of the parameter is shown in the upper display. Press ▲ or ▼ to adjust this value. If no key is pressed for 30 seconds the controller returns to the HOME display.

☺ **Backscroll** is achieved when you are in this list by pressing ▲ while holding down ⊙.

The following table shows a list of all possible parameters available in Level 2.

Mnemonic	Scrolling Display and description	Range	
WKG.SP	WORKING SETPOINT is the active setpoint value and appears when the controller is in Manual mode. It may be derived from SP1 or SP2, or, if the controller is ramping (see SP.RRT or SP.FRT), it is the current ramp value.	Settable between SP.HI to SP.LO	
WRK.OP	WORKING OUTPUT is the output from the controller expressed as a percentage of full output. It appears when the controller is in Auto mode. In a motorised valve controller it is the 'inferred' position of the valve For a time proportioning output, 50% = relay output on or off for equal lengths of time. For On/Off control: OFF = <1%. ON = >1%	Read only value 0 to 100% for heating 0 to –100% for cooling -100 (max cooling) to 100% (max heating	
UNITS	DISPLAY UNITS - Temperature display units. 'Percentage' is provided for linear inputs.	°C	Degrees C
		°F	Degrees F
		°K	Degrees K
		none	None
		PErc	Percentage
SP.HI	SETPOINT HIGH - High setpoint limit applied to SP1 and SP2.	Alterable between the controller range limits. These are defined in the Quick Code section 4.1.1.	
SP.LO	SETPOINT LOW - Low setpoint limit applied to SP1 and SP2		
	By default the remote setpoint is scaled between SP.HI and SP.LO. Two further parameters (REM.HI and REM.LO) are available in access level 3 to limit the Remote SP range if required. See section 10.1.		
SP1	SETPOINT 1 allows control setpoint 1 value to be adjusted	Alterable: SP.HI to SP.LO	
SP2	SETPOINT 2 allows control setpoint 2 value to be adjusted	Alterable: SP.HI to SP.LO	
SP3	SETPOINT 3 allows control setpoint 3 value to be adjusted	Alterable: SP.HI to SP.LO	
SP.RRT	SETPOINT RISING RATE LIMIT - This allows a rate of change to be applied to the setpoint value in an increasing direction. It allows the process (temperature or pressure) to increase at a controlled rate.	OFF to 3000 display units per minute. Default OFF.	
SP.FRT	SETPOINT FALLING RATE LIMIT - This allows a rate of change to be applied to the setpoint value in an decreasing direction. It allows the process (temperature or pressure) to decrease at a controlled rate.	OFF to 3000 display units per minute. Default OFF.	
HOLDB	HOLDBACK - SX90 ONLY. This stops the setpoint ramp if the deviation between the setpoint and the actual process value is greater than the limit set by this parameter.	Range OFF or 1 to 9999. Default OFF.	
TM.CFG	TIMER CONFIGURATION - Configures the timer type:- Soft Start or none. The timer type can only be changed when the timer is reset. The Programmer option only appears if the programmer has been ordered.	none	None
		SFSt	Soft start
If the timer is configured the following five parameters are available. The Timer operation is described in section 5.4.			
TM.RES	TIMER RESOLUTION - Selects the resolution of the timer. This can only be changed when the timer is reset.	Hour	Hours
		min	Minutes
SS.PWR	SOFT START POWER LIMIT - This parameter sets a power limit which is applied until the process variable reaches a threshold value (SS.SP) or the set time (DWELL) has elapsed. The timer starts automatically on power up.	-100 to 100%	
SS.SP	SOFT START SETPOINT - This parameter sets the threshold value below which the power is limited. It operates on the difference between the setpoint (SP) and the process variable (PV). If SP - PV > SS.SP the power will be limited to that set by SS.PWR. If the PV is within these limits during power up, soft start will not activate.	Between SP.HI and SP.LO	
DWELL	SET TIME DURATION - Sets the dwell timing period. It can be adjusted while the timer is running.	0:00 to 99.59 hh:mm: or mm:ss	
T.REMTN	TIME REMAINING - Timer time remaining. This value can be increased or decreased while the timer is running	0:00 to 99.59 hh:mm: or mm:ss	

Mnemonic	Scrolling Display and description						Range
The next section applies to Alarms only see also section 12. If an alarm is not configured the parameters do not appear.							
A1.--- A2.--- A3.--- A4.---	ALARM 1 (2, 3 or 4) SETPOINT - sets the threshold value at which an alarm occurs. By default only alarms 1 and 2 can be configured using the Quick Start Codes (section 4.1.1). Up to four alarms may be configured in Conf level and are available and are then shown as A3.--- and A4.---. The last three characters (---) in the mnemonic specify the alarm type:-						SP.HI to SP.LO
	LO	Full Scale Low	HI	Full Scale High			
	DHI	Deviation High	DLO	Deviation Low	DNB	Deviation Band	
	RRC	Rising rate of change	FRC	Falling rate of change	FRC and RRC can only be configured in ConF level.		1 to 9999 units/minute
	OHI	Output high	OHL	Output low			0 to 100% for heat only -100% to +100% for heat/cool
The following parameter is present if a motorised valve controller has been configured							
MTR.T	MOTOR TRAVEL TIME - Set this value to the time that it takes for the motor to travel from its fully closed to its fully open position. Note: In motorised valve control only the PB and TI parameters are active – see below.						0.0 to 999.9 seconds
This section applies to the control parameters. A further description of these parameters is given in section 11.							
A.TUNE	AUTOTUNE - automatically sets the control parameters to match the process characteristics.						OFF Disable On Enable
PB	PROPORTIONAL BAND - sets an output which is proportional to the size of the error signal. Units may be % or display units, set in Conf level.						1 to 9999 display units Default 20
TI	INTEGRAL TIME - removes steady state control offsets by ramping the output up or down in proportion to the amplitude and duration of the error signal.						OFF to 9999 seconds Default 360
TD	DERIVATIVE TIME - determines how strongly the controller will react to the rate of change in the process value. It is used to prevent overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.						OFF to 9999 seconds Default 60 for PID control Default 0 for valve position control
MR	MANUAL RESET - applies to a PD only controller i.e. the integral term is turned off. Set this to a value of power output (from +100% heat, to -100% cool which removes any steady state error between SP and PV.						-100 to 100% Default 0
R2G	RELATIVE COOL GAIN - adjusts the cooling proportional band relative to the heating proportional band. Particularly necessary if the rate of heating and rate of cooling are very different. (Heat/Cool only)						0.1 to 10.0 Default 1.0
O.BAND	CHANNEL 2 DEADBAND - adjusts a zone between heating and cooling outputs when neither output is on. Off = no deadband. 100 = heating and cooling off.						OFF or 0.1 to 100.0% of the cooling proportional band
The following parameters are not shown if the controller is configured by the Quick Start Codes. They are shown if control is configured as On/Off in Conf level.							
HYSTH	HEATING HYSTERESIS - sets the difference in temperature units between heating turning off and turning on when ON'OFF control is used. Only appears if channel 1 (heating) control action is On/Off						0.1 to 200.0 display units Default 1.0
HYST.C	COOLING HYSTERESIS - sets the difference in temperature units between cooling turning off and turning on when ON/OFF control is used. Only appears if channel 2 (cooling) control action is On/Off						0.1 to 200.0 display units Default 1.0

☺ Press ⓟ at any time to return immediately to the HOME screen.

☺ Hold ⌄ down to continuously scroll through the above list

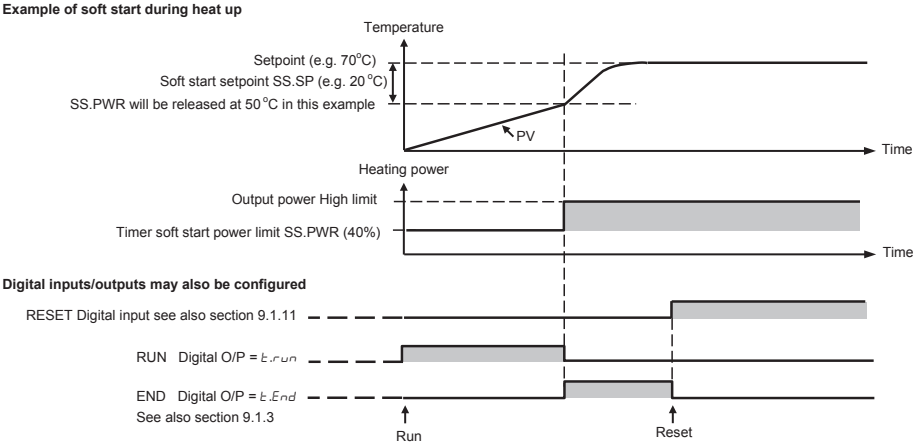
5.4 Soft Start Timer

If the controller is configured for PID, Soft Start limits the output power for a fixed duration after power up or when the controller is changed from configuration level to an operator level or when the timer is set to Run. When the timer is running the RUN beacon is illuminated. The Duration (TWELL), Power Limit (SS.PWR) and Limit Levels (SS.SP) may be set by the user in Level 2. The limit level is set as a deviation from setpoint, so if PV < (SP - SS.SP) or > (SP + SS.SP) the soft start will be active during start up or when the timer is set to RUN. In the heating example below the setpoint is set to 70°C, the limit level is set to 20°C and the power limit is set to 40%. This means that the soft start will be active if the process variable (PV) is less than 50°C (SP - SS.SP) or greater than 90°C (SP + SS.SP). During this period the power will be limited to 40%.

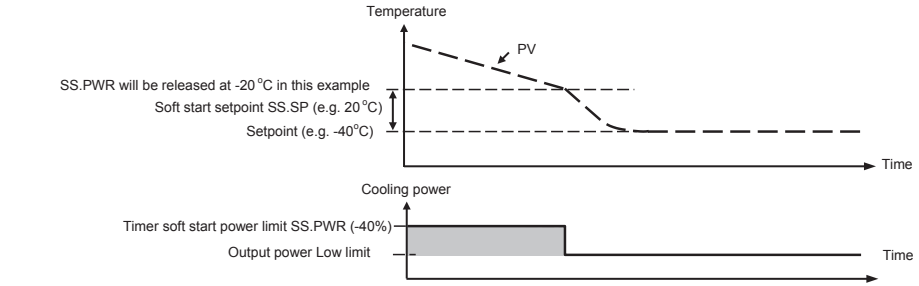
If the PV is within these limits during power up, soft start will not activate.

Soft start is achieved by an internal timer. It can be enabled or disabled in Level 2 (also Level 3 and Configuration Level) by the **'TM.CFG'** (timer configuration) parameter set to 'SS.St' or 'nonE'.

Example of soft start during heat up



Example of soft start during cool down



5.4.1 To Operate the Timer Manually

The soft start timer operates every time the controller is switched on or every time it is changed from Conf mode to an Operator Level. It may also be operated manually as follows (although this is not normally intended):-

Operation	Action	Indication	Comments
To Run the timer	Press and quickly release ▲ + ▼	Beacon -- RUN = On	The timer will not run if PV is within the limits SP ± SS.SP.
To Hold the timer	Press and quickly release ▲ + ▼	Beacon -- RUN = Flashing	
To Reset the timer	Press and hold ▲ + ▼ for more than 1 second	Beacon -- RUN = Off	

The timer can also be RUN, HELD or RESET by the parameter 'T.STAT' (Timer status) in Level 3 - see section 13.1. In SX90 the timer can also be controlled via digital inputs (if configured) see section 9.1.11.

6. Access to Further Parameters

Parameters are available under different levels of security and are defined as Level 1 (LEV1), Level 2 (LEV2), Level 3 (LEV3) and Configuration (Conf).

Level 1 has no passcode since it contains a minimal set of parameters generally sufficient to run the process on a daily basis.

Level 2 allows access to parameters which may used where the application requires more operator intervention or to change settings between different products or batches.

Level 1 and Level 2 operation has been described in the previous sections.

Level 3 and Configuration level parameters are also available as follows:-

6.1.1 Level 3

Level 3 makes all operating parameters available and alterable (if not read only). It is typically used during the initial commissioning of a controller.

Examples are setting:-

Range limits; scaling offsets; digital communications address, baud rate, etc.

The instrument will continue to control when in Levels 1, 2 or 3.

6.1.2 Configuration Level

This level makes available all parameters including the operational parameters. It is used to set up additional functions in the instrument which are not available in the Quick Code Configuration. These functions may be required to match a particular process.

Examples of parameters available in Configuration level are:-

Input type; alarm type; calibration, etc.

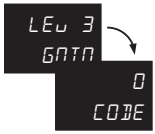
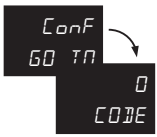
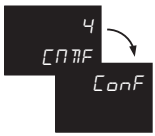
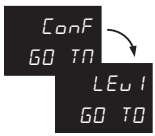
WARNING

Configuration level gives access to a wide range of parameters which match the controller to the process. Incorrect configuration could result in damage to the process being controlled and/or personal injury. It is the responsibility of the person commissioning the process to ensure that the configuration is correct.

In configuration level the controller is not controlling the process or providing alarm indication. Do not select configuration level on a live process.

Operating Level	Home List	Full Operator	Configuration	Control
Level 1	✓			Yes
Level 2	✓			Yes
Level 3	✓	✓		Yes
Conf	✓	✓	✓	No

6.1.3 To Select Access Level 3 or Configuration Level

Do This	The Display You Should See	Additional Notes
1. From any display press and hold ▣ for more than 5 seconds	**To Select Level 3** 	The display will pass from the current operating level, for example, LEV 1 to LEV 3 as the button is held down. (If no button is then pressed for about 50 seconds the display returns to the HOME display)
2. Press ▲ or ▼ to enter the passcode for Level 3		The default code is 3: If an incorrect code is entered the display reverts to 'GOTO', otherwise, the controller is now in the level 3 and will revert to the HOME display.
3. When the LEV3 GOTO view is shown, as in paragraph 1 above, press ▼ to select 'ConF'	**To Select Configuration level** 	Note: ▼ must be pressed quickly before the controller requests the code for level 3
4. Press ▲ or ▼ to enter the passcode for Configuration level		The default code is 4: If an incorrect code is entered the display reverts to 'GOTO'. The controller is now in Configuration level and will now show ConF.
5. Press and hold ▣ for more than 3 seconds 6. Press ▼ to select the required level eg LEV 1	**To Return to a Lower Level** 	The choices are: LEV 1 Level 1 LEV 2 Level 2 LEV 3 Level 3 ConF Configuration It is not necessary to enter a code when going from a higher level to a lower level. Alternatively, press ▣ and scroll to the ACCES list header, then press ↑ to select the required level. The controller will then go through its start up sequence, starting in the level selected.

☺ A special case exists if a security code has been configured as '0' If this has been done it is not necessary to enter a code and the controller will enter the chosen level immediately.

☺ When the controller is in configuration level the ACCESS list header can be selected from any view by holding down the ▣ button for more than 3 seconds. Then press ▣ again to select 'ACCES'

6.2 Parameter lists

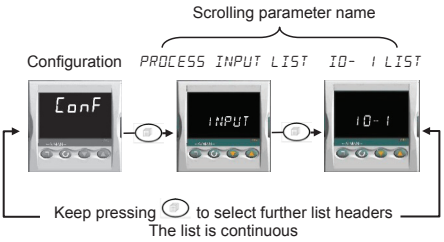
Parameters are organised in lists. The top of the list shows the list header only. The name of the list header describes the generic function of the parameters within the list. For example, the list header 'ALARM' contains parameters which enable you to set up alarm conditions.

6.2.1 To Choose Parameter List Headers

Press . Each list header is selected in turn every time this key is pressed.

The name of the list header appears in the lower display, followed, after a few seconds, by a scrolling longer description of the name.

The following example shows how to select the first two list headers. (Views are shown for SX80 controllers).



6.2.2 To Locate a Parameter

Choose the appropriate list, then press . Each parameter in the list is selected in turn each time this button is pressed. The following example shows how to select the first two parameters in the ALARM List. All parameters in all lists follow the same procedure. (Views are shown for SX80 controllers).

Alarm List Header

Parameter 'Value'. In this case set to Full Scale High Alarm

Parameter mnemonic 'A1.TYP' followed by a scrolling message 'ALARM1 TYPE'

Parameter 'Value'. In this case a 'numerical' value, set to '112'

Parameter mnemonic 'A1.HI' followed by a scrolling message ALARM 1 SETPOINT'

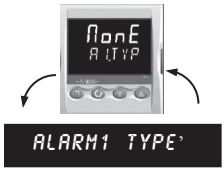
Further parameters

Press to jump back to the list header.

6.2.3 How Parameters are Displayed

As shown above. whenever a parameter is selected it is displayed as a mnemonic, of four or five characters, for example 'A1.TYP'.

After a few seconds this display is replaced by a scrolling banner which gives a more detailed description of the parameter. In this example 'A1.TYP' = 'ALARM 1 TYPE'. The scrolling banner is only shown once after the parameter is first accessed. (Views are shown for SX80 controllers).



The name of the list header is also displayed in this way.

The upper part of the display shows the value of the parameter.

The lower part shows its mnemonic followed by the scrolling name of the parameter.

6.2.4 To Change a Parameter Value

With the parameter selected, press to increase the value, press to decrease the value. If either key is held down the analogue value changes at an increasing rate.

The new value is entered after the key is released and is indicated by the display blinking. The exception to this is output 'Power' when in manual. In this case the value is entered continuously.

The upper display shows the parameter value the lower display shows the parameter name.

6.2.5 To Return to the HOME Display

In operator levels:-

Press + .

6.2.6 Time Out

A time out applies to the 'Go To' and 'Control Mode' parameters. If no key presses are detected within a period of about 50 seconds the display will revert back to the HOME list.

Press and hold to scroll parameters forward through the list. With depressed, press to scroll parameters backward.

6.3 Navigation Diagram

The diagram below shows the all list headings available in configuration level for SX90 controllers.

The parameters in a list are shown in tables in the following sections of this manual together with explanations of their meanings and possible use.

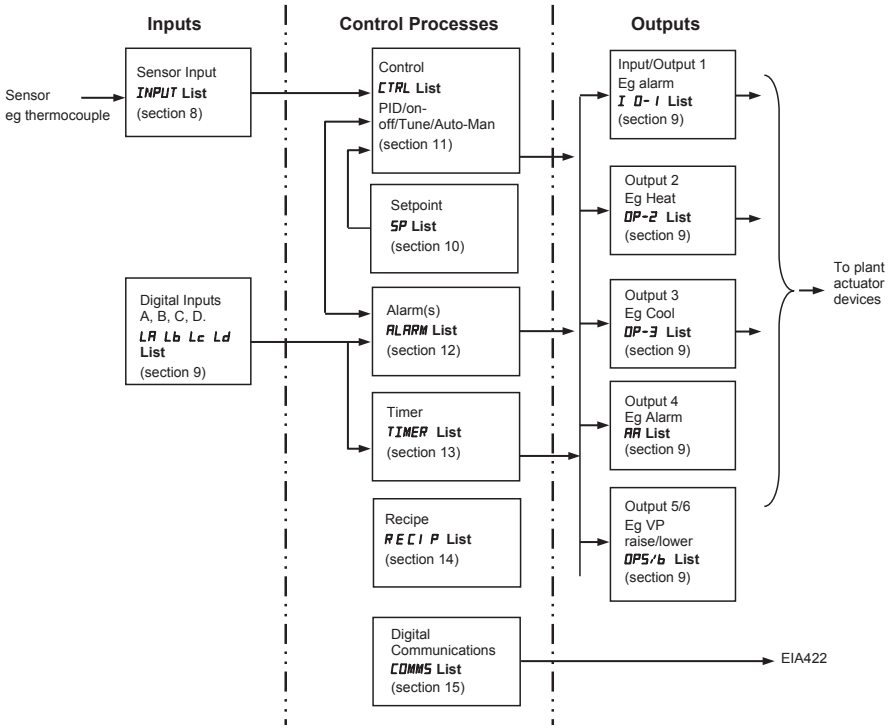
In SX80 controllers some lists are not available, for example Output 5, Output 6, and Digital Communications.

In SX80 Logic Inputs A and B are available, Logic Inputs C and D are not available .

7. Controller Block Diagram

The block diagram shows the simple building blocks which make up the controller. Each block has a list of parameters headed by a list name. For example the 'Input List' contains parameters which define the input type.

The quick start code automatically sets the parameters to match the hardware.



The Process Value 'PV' (temperature or pressure) is measured by the sensor and compared with a Setpoint (SP) set by the user.

The purpose of the control block is to reduce the difference between SP and PV (the error signal) to zero by providing a compensating output to the plant via the output driver blocks.

The timer and alarms blocks may be made to operate on a number of parameters within the controller, and digital communications provides an interface to data collection and control.

The way in which each block performs 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 process which is to be controlled.

These parameters are found in lists and the name of each list corresponds with the name of the function block shown in the above diagram.

The above block diagram applies to SX90 controller.

For SX80 Outputs 5 and 6, Digital and Communications are not available. Digital input A and B is available in SX80. Digital inputs B, C and D are available in SX90.

8. Process (Temperature or Pressure) Input

Parameters in the input list configure the input to match your sensor. These parameters provide the following features:-

Input Type and linearisation	Thermocouple (TC) and 3-wire resistance thermometer (RTD) temperature detectors Linear input (-10 to +80mV). mA assumes a 2.49Ω external shunt. See the table in section 8.1.1. for the list of input types available
Display units and resolution	The change of display units and resolution will all the parameters related to the process variable
Input filter	First order filter to provide damping of the input signal. This may be necessary to prevent the effects of excessive process noise on the PV input from causing poor control and indication. More typically used with linear process inputs.
Fault detection	Sensor break is indicated by an alarm message 'Sbr'. For thermocouple it detects when the impedance is greater than pre-defined levels; for RTD when the resistance is less than 12Ω.
User calibration	Either by simple offset or by slope and gain. See section 8.1.3. for further details.
Over/Under range	When the input signal exceeds the input span by more than 5% the PV will flash indicating under or over range. If the value is too high to fit the number of characters on the display 'HHHH' or 'LLLL' will flash. The same indications apply when the display is not able to show the PV, for example, when the input is greater than 999.9°C with one decimal point.

8.1 Process Input Parameters

INPUT LIST 'INPUT'						
Name	Scrolling Display	Parameter Description	Value		Default	Access Level
IN.TYP	INPUT TYPE	Selects input linearisation and range	See section 8.1.1. for available input types			Conf alterable L3 R/O
UNITS	DISPLAY UNITS	Display units shown on the instrument	none	No units - only for custom linearisation	°C	L3 alterable
			°C	Celsius		
			°F	Fahrenheit		
			°K	Kelvin		
			PErc	%		
DEC.P	DISPLAY POINTS	Decimal point position	nnnn	No DP	nnnn	Conf alterable L3 R/O
			nnn.n	One DP		
			nn.nn	Two DP		
MV.HI	LINEAR INPUT HIGH	High limit for mV (mA) inputs only	-10.00 to +80.00mV		80.00	Conf alterable
MV.Lo	LINEAR INPUT LOW	Low limit for mV (mA) inputs only	-10.00 to +80.00mV		-10.00	Conf alterable
RNG.HI	RANGE HIGH LIMIT	Range high limit for thermocouple RTD and mV inputs	From the high limit of the selected input type to the 'Low Range Limit' parameter minus one display unit.			Conf alterable L3 R/O
RNG.LO	RANGE LOW LIMIT	Range low limit for thermocouple RTD and mV inputs	From the low limit of the selected input type to the 'High Range Limit' parameter minus one display unit.			Conf L3 R/O
PV.OFS	PV OFFSET	A simple offset applied to all input values. See section 8.1.3.	Generally one decimal point more than PV			L3
FILT.T	FILTER TIME	Input filter time	OFF to 100.0 seconds		1.6	L3
CJ.TYP	CJC TYPE	Configuration of the CJC type	Auto	Automatic	Auto	Conf and if T/C L3 R/O
			0°C	Fixed at 0°C		
			50°C	Fixed at 50°C		

INPUT LIST 'INPUT'						
Name	Scrolling Display	Parameter Description	Value		Default	Access Level
SB.TYP	SENSOR BREAK TYPE	Defines the action which is applied to the control output if the sensor breaks (open circuit). See also section 8.1.2	oFF	No sensor break will be detected	on	Conf L3 R/O
			on	Open circuit sensor will be detected		
			LAt	Latching		
CJC.IN	CJC TEMPERATURE	Temperature measured at the rear terminal block. Used in the CJC calculation.	Read only. Applicable to thermocouple input types only.			Conf and L3
PV.IN	PV INPUT VALUE	Current measured temperature.	Minimum display to maximum display range			Conf L3 R/O
MV.IN	MILLIVOLT INPUT VALUE	Millivolts measured at the rear PV Input terminals	xx.xx mV - read only			Conf L3 R/O
RC.FT	ROC FILTER TIME	This provides a first order filter for the Rate Of Change filtering function and can be used to avoid nuisance alarm triggers due to short duration noise on the calculated rate of change.	oFF to 0.1 to 999.9 minutes Off means no filtering applied		1.b	Conf and L3
RC.PV	PV DERIVATIVE	Provides a measure of the calculated rate of change of the temperature or measurement input as used by the Rate of Change Alarm functions. Useful when commissioning to determine the level of filtering required on the Rate of Change alarm.				Conf and L3
POT.P	POT POSITION	Read only indication of the feedback potentiometer position.	0.0 to 100.0%			Conf and L3

8.1.1 Input Types and Ranges

Input Type		Min Range	Max Range	Units	Min Range	Max Range	Units
J.tc	Thermocouple type J	-210	1200	°C	-346	2192	°F
K.tc	Thermocouple type K	-200	1372	°C	-328	2502	°F
L.tc	Thermocouple type L	-200	900	°C	-328	1652	°F
r.tc	Thermocouple type R	-50	1700	°C	-58	3092	°F
b.tc	Thermocouple type B	0	1820	°C	32	3308	°F
n.tc	Thermocouple type N	-200	1300	°C	-328	2372	°F
t.tc	Thermocouple type T	-200	400	°C	-328	752	°F
S.tc	Thermocouple type S	-50	1768	°C	-58	3215	°F
rtd	Pt100 resistance thermometer	-200	850	°C	-328	1562	°F
mu	mV or mA linear input	-10.00	80.00				
Cms	Value received over digital communications (modbus address 203). This value must be updated every 5 seconds or the controller will show sensor break						

Note:- In SX series controllers thermocouple Type K is configurable using the Quick Start Codes. Other thermocouples can only be configured in ConF level.

8.1.2 Operation of Sensor Break

Sensor break type (SB.TYP) can be set to operate in three different modes:-

1. Off
2. On
3. Latching

SB.TYP = Off

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	OP.HI (100%) Safe value has no effect	No sensor break alarm indication will be displayed
For heat only OP.HI and OP.LO can be set between 0.0% and +100%	OP.HI (100%) Safe value has no effect	
For cool only OP.HI and OP.LO can be set between -100.0% and 0%	OP.HI (0%) Safe value has no effect	

SB.TYP = on

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	'SAFE' value provided it is not set outside the output limits, otherwise it will adopt OP.HI	ALM beacon flashes when a sensor break alarm occurs. Output alarm relay activates. ACK has no effect. When the sensor break condition is no longer applicable the Sbr alarm indication and output cancel.
For heat only OP.HI and OP.LO can be set between 0.0% and +100%		
For cool only OP.HI and OP.LO can be set between -100.0% and 0%		

SB.TYP = Lat (Alarm latching)

Type of Output	Output in Sensor Break	Alarm State
For heat + cool, OP.HI and OP.LO can be set between ±100%	'SAFE' value provided it is not set outside the output limits. i.e. the same as Sbrk = on	ALM beacon flashes when a sensor break alarm occurs. Output alarm relay activates. ACK has no effect. When the sensor break condition is no longer applicable it is necessary to press ACK to cancel the alarm.
For heat only OP.HI and OP.LO can be set between 0.0% and +100%		
For cool only OP.HI and OP.LO can be set between -100.0% and 0%		

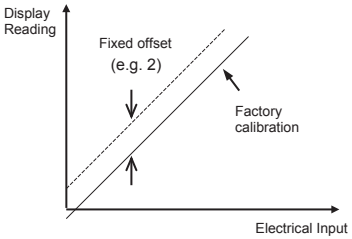
Note:- When the SAFE output value is outside the OP.LO and OP.HI limits it will be clipped into range and the controller will use the value (i.e. adjusting OP.LO or OP.HI changes the SAFE value so that it is in range).

It could take either the lower or higher OP limit depending on its value and which limit has changed. Therefore, if SAFE = 0 and OP.LO is changed to 10, SAFE will also be set to 10. If SAFE = 50 and OP.HI is changed to 40, SAFE will change to 40.

8.1.3 PV Offset

All ranges of the controller have been calibrated against traceable reference standards. This means that if the input type is changed it is not necessary to calibrate the controller. There may be occasions, however, when you wish to apply an offset to the standard calibration to take account of known errors within the process, for example, a known sensor error or a known error due to the positioning of the sensor. In these instances it is not advisable to change the reference (factory) calibration, but to apply a user defined offset.

PV Offset applies a single offset to the temperature or process value over the full display range of the controller and can be adjusted in Level 3. It has the effect of moving the curve up a down about a central point as shown in the example below:-



8.1.3.1 Example: To Apply an Offset:-

Connect the input of the controller to the source device which you wish to calibrate to

Set the source to the desired calibration value

The controller will display the current measurement of the value

If the display is correct, the controller is correctly calibrated and no further action is necessary. If you wish to offset the reading:-

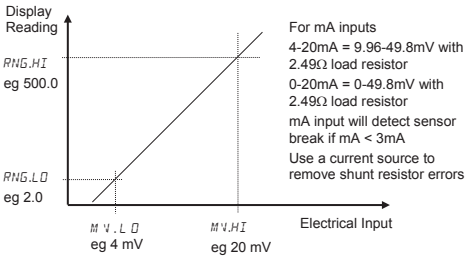
Do This	Display	Additional Notes
1. Select Level 3 or Conf as described in Chapter 2. Then press ⓟ to select 'INPUT'	INPUT	Scrolling display 'PROCESS INPUT LIST'
2. Press ⊙ to scroll to 'PV/OFS' 3. Press ▲ or ▼ to adjust the offset to the reading you require	2.0 PV.OFS	Scrolling display 'PV OFFSET' In this case an offset of 2.0 units is applied

It is also possible to apply a two point offset which adjusts both low and high points. This is done in Level 3 using the CAL List, and the procedure is described in the Calibration section 16.

8.1.4 PV Input Scaling

Input scaling applies to the linear mV input range only. This is set by configuring the INPUT TYPE parameter to mV and has an input range of –10 to 80mV. Using an external burden resistor of 2.49Ω, the controller can be made to accept 4-20mA from a current source. Scaling of the input will match the displayed reading to the electrical input levels from the transducer. PV input scaling can only be adjusted in Configuration level and is not provided for direct thermocouple or RTD inputs. The graph below shows an example of input scaling, where it is required to display 2.0 when the input is 4mV and 500.0 when the input is 20mV .

If the input exceeds ±5% of the mV.Lo or mV.Hi settings, sensor break will be displayed.



8.1.4.1 Example: To Scale a Linear Input

Select Configuration level as described in Chapter 2. Then:-

Do This	Display	Additional Notes
1. Then press ⓟ to select 'INPUT'	INPUT	Scrolling display 'PROCESS INPUT LIST'
2. Press ⊙ to scroll to 'IN.TYP' 3. Press ▲ or ▼ to 'MV'	mV IN.TYP	Scrolling display 'INPUT TYPE'
4. Press ⊙ to scroll to 'MV.HI' 5. Press ▲ or ▼ to '20.00'	20.00 MV.HI	Scrolling display 'LINEAR INPUT HIGH'
6. Press ⊙ to scroll to 'MV.LO' 7. Press ▲ or ▼ to '4.00'	4.00 MV.LO	Scrolling display 'LINEAR INPUT LOW'
8. Press ⊙ to scroll to 'RNG.HI' 9. Press ▲ or ▼ to '500.0'	500.0 RNG.HI	In operator level the controller will read 500.0 for a mV input of 20.00
10. Press ⊙ to scroll to 'RNG.LO' 11. Press ▲ or ▼ to '2.0'	2.0 RNG.LO	In operator level the controller will read 2.0 for a mV input of 4.00

9. Output Parameters

Press ⓔ to select the next list header IO- 1.

9.1 Relay Output List (IO-1) - SX80 and SX90

This is supplied as a normally open relay. Connections are made to terminals 1A and 1B. Using the Quick Start Codes this output can either be disabled or configured as an alarm. In ConF level it can be re-configured as raise or lower output for valve position. OP1 beacon is operated from the IO-1 channel.

INPUT/OUTPUT LIST 1 'I O -1 '							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
1..1 O	I/O 1 TYPE	I/O channel 1 hardware type defined by the hardware fitted	rELY	Relay output			Read only
1.FUNC	I/O 1 FUNCTION	I/O channel function.	nonE	Disabled. If disabled no further parameters are shown		Depends on Quick Start Code	Conf
			d.outt	Digital output			
			UP	Raise output	Only if control type is valve position		
			dwn	Lower output			
			HEAt	Heating output	Only if control type is PID or on/off		
			CooL	Cooling output			
1.SRC.A	I/O 1 SOURCE A	These parameters only appear when the channel function is a Digital output, i.e. 1.FUNC = d.outt Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.3	nonE	No event connected to the output		Depends on Quick Start Code	Conf
1.SRC.B	I/O 1 SOURCE B		AL 1	Alarm 1	If the alarm type is configured the display will show the alarm number followed by the alarm type. For example Idlo = alarm 1 deviation low.		
1.SRC.C	I/O 1 SOURCE C		AL2	Alarm 2			
1.SRC.D	I/O 1 SOURCE D		AL3	Alarm 3			
			AL4	Alarm4			
			ALL.A	All alarms			
			nw.AL	Any new alarm			
			Ct.AL	CT alarm, load, leak & overcurrent. This parameter is not applicable to SX80/90.			
			Lbr	Loop break alarm			
			Sbr	Sensor break alarm			
			t.End	Timer end status			
			t.run	Timer run status			
			mAn	Manual status			
			rmt.F	Remote fail - see section 9.1.1			
			Pwr.F	Power fail - see section 9.1.4			
			PrG.E	Programmer event. This parameter is not applicable to SX80/90.			
1.PLS	OUTPUT 1 MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs only and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 0.1 to 150.0 seconds Auto = 100mS.		5.0 sec	Conf
1.SENS	I/O 1 SENSE	To configure the sense of the output. See also section 9.1.2	nor Inv	Normal Inverted		nor	Conf

9.1.1 Remote Digital Setpoint Select and Remote Fail

These parameters are associated with the retransmission of remote setpoint through master comms (see section 15.4). '*rmt*' allows the remote setpoint to be selected via a digital input and '*rmt.F*' is a flag which is set if no comms activity is detected for 5 seconds or more when writing to the remote setpoint. The flag is reset when writing to the remote setpoint resumes.

9.1.2 Sense

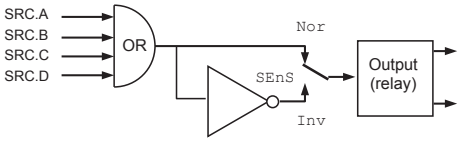
'Normal' means the relay output is energised for 100% PID demand. For a heating or cooling output, set this parameter to '*nor*'.

'Inverted' means the relay output is energised for 0% PID demand

For an alarm output set this parameter to '*Inv*' so that it de-energises to the alarm state.

9.1.3 Source

The four parameters SOURCE A, SOURCE B, SOURCE C, and SOURCE D appear when the output is configured as a digital output i.e. '*-.FUNC*' = '*d.Out*' and provide the facility to connect up to four alarms or events to operate a single output (normally configured as a relay). If any one of the events becomes true then the output relay will operate.



9.1.4 Power Fail

An output, configured as a digital output, can be made to operate following a power fail. It can be acknowledged in the same manner as an alarm but no alarm message is given.

9.1.5 Example: To Configure IO-1 Relay to Operate on Alarms 1 and 2:-

Do This	Display	Additional Notes
1. From any display, press (menu) as many times as necessary to select '*IO-1*'	IO-1	Scrolling display '*IO LIST*'
2. Press (scroll) to scroll to '*1.ID*'	rELY 1.ID	This is the identification of the hardware fitted and cannot be adjusted.
3. Press (scroll) to scroll to '*1.FUNC*' 4. Press (up) or (down) to select '*d.out*'	d.out 1.FUNC	The output is configured as a digital output function. Scrolling display '*IO 1 FUNCTION*'
5. Press (scroll) to scroll to '*1.SRC.A*' 6. Press (up) or (down) to select the event which you want to operate the output, eg '*AL.1*'	AL 1 1.SRC.A	The output will activate if either alarm 1 or alarm 2 occur . Scrolling display '*IO 1 SOURCE A*'
7. If a second event is required to operate the same output, press (scroll) to select '*1.SRC.B*' 8. Press (up) or (down) to select the second event which you want to operate the output, eg '*AL.2*'	AL 2 1.SRC.B	Scrolling display '*IO 1 SOURCE B*' Continue to select up to four events if required using *1.SRC.C* and *1.SRC.D*
9. Press (scroll) to scroll to '*1.SENS*' 10. Press (up) or (down) to select '*Inv*'	Inv 1.SENS	'Inverted' means a relay output is energised for 0% PID demand 'Normal' means a relay output is energised for 100% PID demand Scrolling display '*IO 1 SENSE*'

9.1.6 Output List 2 (OP-2) - SX 80 and SX90

Press ⓜ to select OP-2.

This is a mA output which is available on terminals 2A and 2B of both SX80 and SX90. It can be configured in Conf level as 0-20 or 4-20mA.

OUTPUT LIST 2 'OP-2'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
2.1 O	OUTPUT 2 TYPE	Output channel 2 hardware type	dC.rt	0-20mA or 4-20mA output. See note 1 below. This may be a control or retransmission output.		dC.rt	Read only
2.FUNC	OUTPUT 2 FUNCTION	Output channel 2 function. See Note 1 below.	nonE	Disabled		Depends on Quick Start Code	Conf
			HEAt	Heat output	Only if control type is PID or on/off		
			CooL	Cool output			
			w.SP	Working setpoint re-transmission. See Note 3 below.			
			PV	Process variable re-transmission			
			OP	Output power demand re-transmission			
			SL 1	Split output 1. See section 11.10			Conf. SX90 only
			SL2	Split output 2. See section 11.10			
2.RNG	DC OUTPUT RANGE	To configure 0-20mA or 4-20mA output	0.20	0-20mA output		4.20	Conf
			4.20	4-20mA output			

Note 1:

If the controller is configured for valve position the output is available as retransmission only (HEAt and CooL not available). If it is configured as a Heat/Cool controller then the output function defaults to HEAt but it can be configured to the other choices shown.

A DC output may require calibration. This is described in section 16.6.

9.1.7 Output List 3 (OP-3) - SX90 only

Press ⓜ to select OP-3.

This is a mA output available on terminals 3A and 3B. It can be configured in Conf level as 0-20mA or 4-20mAdc either as a control output or retransmission output.

OUTPUT LIST 3 'OP-3'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
3.1 O	OUTPUT 3 TYPE	Output channel 3 hardware type	dC.OP	0-20mA output. See note 1 above.			Read only
3.FUNC	OUTPUT 3 FUNCTION	Output channel 3 function. See Note 2 below.	nonE	Disabled		d.out	Conf
			HEAt	Heat output	Only if control type is PID or on/off		
			CooL	Cool output			
			w.SP	Working setpoint re-transmission. See Note 3 below.			
			PV	Process variable re-transmission			
			OP	Output re-transmission			
			SL 1	Split output 1. See section 11.10			Conf. SX90 only
			SL2	Split output 2. See section 11.10			
3.RNG	DC OUTPUT RANGE	To configure 0-20mA or 4-20mA output	4.20	4-20mA		4.20	Conf
			0.20	0-20mA			

Note 2:

If the controller is configured for valve position the output is available as retransmission only (HEAt and CooL not available). If it is configured as a Heat/Cool controller then the output function defaults to CooL but it can be configured to the other choices shown.

A DC output may require calibration. This is described in section 16.6.

Note 3:

Range is equal to the display limits of -1999 to 9999 with the PV input resolution set to zero decimal places (0DP). The display limits change depending upon the input resolution and are defined below.

0DP ROP.LO/ROP.HI -1999/9999

1DP ROP.LO/ROP.HI -1999/3000

2DP ROP.LO/ROP.HI -199.9/300.0

9.1.8 AA Relay (AA) (Output 4) - SX90 only

Press ⓟ to select AA.

This is a changeover relay. Connections are made to terminals AA, AB, and AC. Using the Quick Start Codes this output can either be disabled or configured as and alarm. In Conf level it can be re-configured as a heat or cool output.

AA RELAY 'AA'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
4.TYPE	OUTPUT 4 TYPE	Output channel 4 hardware type	rELY	Relay output		rELY	Read only
4.FUNC	OUTPUT 4 FUNCTION	Output channel 4 function	nonE	Disabled		As Quick Start Code	Conf
			d.out	Digital output			
			HEAt	Heat output	Only if control type is PID or on/off		
			CooL	Cool output			
			UP	Valve raise	Only if control type is valve position		
			dwn	Valve lower			
4.SRC.A	I/O 4 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 4.FUNC = d.Out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.3.	nonE	No event connected to the output		As Quick Start Code	Conf
4.SRC.B	I/O 4 SOURCE B		AL 1	Alarm 1	If the alarm type is configured the display will show the alarm number followed by the alarm type. For example IdLo = alarm 1 deviation low.		
4.SRC.C	I/O 4 SOURCE C		AL2	Alarm 2			
			AL3	Alarm 3			
			AL4	Alarm4			
4.SRC.D	I/O 4 SOURCE D		ALL.A	All alarms			
			nw.AL	Any new alarm			
			Ct.AL	CT alarm, load, leak & overcurrent This parameter is not applicable to SX80/90.			
			Lbr	Loop break alarm			
			Sbr	Sensor break alarm			
			t.End	Timer end status			
			t.run	Timer run status			
			mAn	Manual status			
			rmt.F	Remote fail - see section 9.1.1.			
			Pwr.F	Power fail - see section 9.1.4			
			Prg.E	Programmer event. This parameter is not applicable to SX80/90.			
4.PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 0.1 to 150 seconds Auto = 100msec		5.0 sec	Conf
4.SENS	SENSE	To configure the polarity of output channel 4 See also section 9.1.2	nor	Normal		nor	Conf
			Inv	Inverted			

9.1.9 OP-5 and OP-6 (Outputs 5 and 6) SX90 only

Press ⓜ to select OP-5 and again to select OP-6.

Outputs 5 and 6 are two single relays connected to terminals 5A, 5B, and 5C - 5B being common to both relays.

Using the Quick Start Codes, if the control type is configured as Boundless or Bounded VP, this output pair provides raise and lower motor drives.

In Conf level, however, they can be re-configured as a heat or cool outputs, if control type is PID or on/off, or additional alarms (alarms 3 and 4, for example).

Outputs 5 and 6 have the same function as Outputs 3 and 4 in the SX80.

OP5 or OP6 RELAY 'OP5' 'OP6'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
5/6.TYPE	OUTPUT 5/6 TYPE	Output channel 5/6 hardware type	rELY	Relay output		rELY	Read only
5/6.FUNC	OUTPUT 5 FUNCTION	Output channel 5/6 function	nonE	Disabled		As Quick Start Code	Conf
			d.out	Digital output			
			HEAt	Heat output	Only if control type is PID or on/off		
			CooL	Cool output			
			UP	Valve raise	Only if control type is valve position		
			dwn	Valve lower			
5/6.SRC.A	I/O 5/6 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 5/6.FUNC = d.Out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.3.	nonE	No event connected to the output		As Quick Start Code	Conf
5/6.SRC.B	I/O 5/6 SOURCE B		AL 1	Alarm 1	If the alarm type is configured the display will show the alarm number followed by the alarm type. For example IdLo = alarm 1 deviation low.		
5/6.SRC.C	I/O 5/6 SOURCE C		AL2	Alarm 2			
			AL3	Alarm 3			
			AL4	Alarm4			
5/6.SRC.D	I/O 5/6 SOURCE D		ALL.A	All alarms			
			nw.AL	Any new alarm			
			Ct.AL	CT alarm, load, leak & overcurrent This parameter is not applicable to SX80/90.			
			Lbr	Loop break alarm			
			Sbr	Sensor break alarm			
			t.End	Timer end status			
			t.run	Timer run status			
			mAn	Manual status			
			rmt.F	Remote fail - see section 9.1.1.			
			Pwr.F	Power fail - see section 9.1.4			
			PrG.E	Programmer event. This parameter is not applicable to SX80/90.			
5/6.PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 0.1 to 150 seconds Auto = 100msec		5.0 sec or 1.0 sec if the control is valve position	Conf
5/6.SENS	SENSE	To configure the polarity of output channel 5/6 See also section 9.1.2.	nor	Normal		nor	Conf
			Inv	Inverted			

9.1.10 OP-3 and OP-4 (Outputs 3 and 4) SX80 only

Press ⓔ to select OP-3 and again to select OP-4.

Outputs 3 and 4 are two single relays connected to terminals AA, AB, and AC - AB being common to both relays.

Using the Quick Start Codes, if the control type is configured as Boundless VP this output pair provides raise and lower motor drives.

In Conf level, however, they can be re-configured as a heat or cool output or additional alarms (alarms 3 and 4, for example).

Outputs 3 and 4 have the same function as Outputs 5 and 6 in the SX90.

AA RELAY 'AA'							
Name	**Scrolling Display**	**Parameter Description**	**Value**			**Default**	**Access Level**
3/4.TYPE	OUTPUT 3/4 TYPE	Output channel 3/4 hardware type	rELY	Relay output		rELY	Read only
3/4.FUNC	OUTPUT 6 FUNCTION	Output channel 3/4 function	nonE	Disabled		As Quick Start Code	Conf
			d.out	Digital output			
			HEAt	Heat output	Only if control type is PID or on/off		
			CooL	Cool output			
			UP	Valve raise	Only if control type is valve position		
			dwn	Valve lower			
3/4.SRC.A	I/O 3/4 SOURCE A	These parameters only appear when the channel function is a Digital OP, i.e. 3/4.FUNC = d.out Selects an event status to be connected to the output channel. The output status is the result of an OR of Src A, Src B, Src C, and Src D Up to four events can, therefore, operate the output See section 9.1.3.	nonE	No event connected to the output		As Quick Start Code	Conf
3/4.SRC.B	I/O 3/4 SOURCE B		AL 1	Alarm 1	If the alarm type is configured the display will show the alarm number followed by the alarm type. For example IdLo = alarm 1 deviation low.		
5/6.SRC.C	I/O 3/4 SOURCE C		AL2	Alarm 2			
			AL3	Alarm 3			
			AL4	Alarm4			
5/6.SRC.D	I/O 3/4 SOURCE D		ALL.A	All alarms			
			nw.AL	Any new alarm			
			Ct.AL	CT alarm, load, leak & overcurrent This parameter is not applicable to SX80/90.			
			Lbr	Loop break alarm			
			Sbr	Sensor break alarm			
			t.End	Timer end status			
			t.run	Timer run status			
			mAn	Manual status			
			rmt.F	Remote fail - see section 9.1.1.			
			Pwr.F	Power fail - see section 9.1.4			
			PrG.E	Programmer event. This parameter is not applicable to SX80/90.			
3/4.PLS	OUTPUT MINIMUM PULSE TIME	Minimum output on/off time. Only applies to time proportioning outputs and prevents relays from switching too rapidly	0.0 to 150.0	Auto or 0.1 to 150 seconds Auto = 100msec		5.0 sec or 1.0 sec if the control is valve position	Conf
3/4.SENS	SENSE	To configure the polarity of output channel 3/4 See also section 9.1.2.	nor	Normal		nor	Conf

9.1.11 Digital Input Parameters LA and LB – SX80 and LB, LC and LD - SX90

In SX80, press ⓟ to select LA and again to select LB.

In SX90, press ⓟ to select LB and again to select LC or LD.

These inputs are typically from voltage free contacts and can be configured to operate a number of functions as determined by parameters in the LA, LB, LC or LD lists below.

In SX80, digital input A is available on terminals LA/LC and digital input B on terminals LB/LC.

In SX90, digital input B is available on terminals LB/LC, digital input C on terminals 4A/4C and digital input D on terminals 4B/4C.

They are not isolated from the sensor input. LC and LD in SX90 and LA and LB in SX80 are not isolated from each other since they share a common terminal (4C and LC respectively).

Digital inputs are supplied un-configured. They can only be configured in Conf level.

The functions are identical as shown below:-

LOGIC INPUT LIST 'LA' 'LB' 'LC' 'LD'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
L.TYPE	LOGIC INPUT TYPE	Input channel type	L.IP	Logic input		Conf Read only
L.d.i n	LOGIC INPUT FUNCTION	To configure the function of the digital input	nonE	Input not used	nonE	Conf
			Ac.AL	Alarm acknowledge		
			SP2	Setpoint 2 select		
			Loc.b	Front keypad disable		
			trES	Timer/programmer reset		
			trun	Timer/programmer run		
			trrS	Timer/programmer run/reset. Make to run, break to reset		
			tHLd	Timer/programmer hold		
			mAn	Manual status		
			Sby	Standby mode. In this mode control outputs go to zero demand		
			rmt	To allow a remote setpoint to be selected through the digital input.		
			REc	Recipe select. See Note 2.		
			UP	Remote key 'Up'		
			dwn	Remote key 'Down'		
			SP.d 1	Digit 1 - Setpoint select	See Note 1	
			SP.d2	Digit 2 - Setpoint select		
L.SENS	LOGIC INPUT SENSE	To configure the polarity of the input channel	nor	Normal	nor	Conf
			Inu	Inverted		

Note 1:-

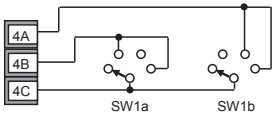
SP1, SP2 or SP3 can be selected according to the table below:-

SP.d 1	SP.d2	**Setpoint select**
0	0	SP1
0	1	SP2
1	0	SP3
1	1	Select through the instrument panel

These may be wired using a rotary switch as shown in the example:-

Note 2:-

For setpoint configurations Loc.t and rEn.t, the digital input functionality will switch between local setpoint and the derived setpoint.



10. Setpoint Generator

Press ⓟ to select SP.

The setpoint generator provides the target value at which it is required to control the process. It is shown in the controller block diagram, section 7. The following functions are available:-

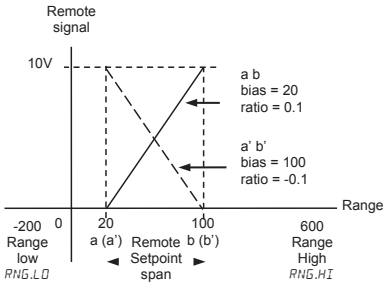
Number of setpoints	Three - setpoint 1 (SP1), setpoint 2 (SP2) or setpoint 3 (SP3). Each may be selected by a dedicated parameter or externally switched as described in the previous section. An application example might be to use SP1 for normal operation and SP2 to maintain a low overnight temperature.
Setpoint limits	High and low limits can be pre-set to prevent inadvertent adjustment of the setpoint beyond that allowable for the process
Set point rate limit	Allows the setpoint to change from its current level to a new level at a fixed rate. This may be useful when switching between setpoints using, for example, external switches as described in the previous section.
Direct setpoint access	The selected setpoint is accessible directly from the HOME display by pressing the raise or lower buttons

10.1 Setpoint Parameters

SETPOINT LIST 'SP'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
SP.SEL	SETPOINT SELECT	This enables the main or second or third setpoint to be selected form the front panel buttons.	SP1	Setpoint 1 selected	SP1	L3
			SP2	Setpoint 2 selected		
			SP3	Setpoint 3 selected		
SP1	SETPOINT 1	Main or normally selected setpoint	Low to high setpoint limits		0	L3
SP2	SETPOINT 2	Secondary or standby setpoint	Low to high setpoint limits		0	L3
SP.HI	SETPOINT HIGH LIMIT	Maximum allowable setpoint setting	Setpoint low limit (SP.LO) to high range limit. Also limited by the RNG.HI and RNG.LO parameters		Range High Limit	L3
SP.LO	SETPOINT LOW LIMIT	Minimum allowable setpoint setting	Low range limit to Setpoint high limit (SP.HI). Also limited by the RNG.HI and RNG.LO parameters		Range Low Limit	L3
REM.SP	REMOTE SETPOINT	Reads the current remote setpoint value when remote setpoint is in use.				Read only
L-R	REMOTE SETPOINT SELECT	To select the remote digital communications setpoint	Loc	Local selected. The controller will only use SP1, SP2 or SP3	Loc	L3 Read only
			rEn	Remote Selected. The controller will use SP1, SP2, SP3, REM.SP or a derived setpoint. The REM beacon lights when the remote setpoint is selected.		
SP.RRT	SETPOINT RISING RATE LIMIT	Limits the rate of change of setpoint in an increasing direction. Operates on all setpoints. See also section 10.2.	Step change (OFF) or 0.1 to 3000 display units per minute. Resolution one decimal place more than PV		OFF	L3
RAMPU	SETPOINT RAMP UNITS	To set the units for the setpoint rate limits	min	Minutes	min	L3
			Hour	Hours		
			SEC	Seconds		
LOC.T	LOCAL SETPOINT TRIM	Local trim on remote setpoint. Applies a fixed offset to the remote setpoint	-199.9 to 300.0		0.0	L3
REM.HI	REMOTE INPUT HIGH SCALAR	Sets the maximum scale limit for the remote setpoint	The values can be varied within the entire instrument range. This allows, for example, a 0-5V device to be used with a 0-10V input such that the 5V can correspond to the full setpoint range.			L3
REM.LO	REMOTE INPUT LOW SCALAR	Sets the minimum scale limit for the remote setpoint				
ROP.HI	SETPOINT RETRANS HIGH	Sets the upper limit for the setpoint retransmission	Setpoint Retransmission High & Low allow the retransmitted setpoint to be scaled against a sub-range. The values correspond to the setpoint transmitted at 4 and 20mA – if the setpoint is outside this range then it is clipped.			Conf L3 read only
ROP.LO	SETPOINT RETRANS LOW	Sets the lower limit for the setpoint retransmission				

SETPOINT LIST 'SP'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
SP3	SETPOINT 3	Secondary or standby setpoint	Low to high setpoint limits		0	L3
SP.FRT	SETPOINT FALLING RATE LIMIT	Limits the rate of change of setpoint in a decreasing direction. Operates on SP1 SP2 and SP3. See also section 10.2.	Step change (OFF) or 0.1 to 3000 display units per minute. Resolution one decimal place more than PV		OFF	L3
HOLD.B	HOLDBACK See also section 10.3.	Available in SX90 only. This is a band deviation value which stops the setpoint ramp if the PV deviates from the current setpoint by more than this value.	Off or 1 to 9999 units		OFF	L3
SP.TYP	SETPOINT TYPE	This parameter defines the setpoint to be used for the Working Setpoint. The Remote Setpoint Select parameter L-r must be set to rEn for these choices to become active. If L-r = Loc it is still possible to select any one of these options but only the Local Setpoint can be used in Operator level.	Loc	Working setpoint derived from the local setpoint (SP1, SP2, SP3). It cannot be switched into remote setpoint.	rEnt	L3
			Loc.t	The working setpoint is derived from the local setpoint plus the remote setpoint scaled via the ratio and bias settings		
			rEn.t	The working setpoint is derived from the remote setpoint plus the local setpoint scaled via the ratio and bias settings		
			L-r	Standard local/remote setpoint selection (allows the user to switch between a local setpoint and the remote setpoint, either via the front panel or a digital input). The remote setpoint value for this setting is unaffected by Ratio and Bias.		
			rEn	Working setpoint derived from the alternate setpoint only (the instrument cannot be switched to local setpoint although they can be adjusted prior to availability).		
RATIO		Applies a multiplying factor to the trim. Ratio can be set to a negative number to allow for reverse action on the remote setpoint.	Low to High Setpoint Limits		1.00	L3
BIAS		Applies a bias to the trim	-1999 to 9999 (as per local setpoint)		0	L3

The diagram shows how the remote setpoint input signal is converted to its component of the combined setpoint using the two parameters Bias and Ratio.



When both local setpoint and remote setpoint are combined there are two ways this can be used. In both of these modes the working setpoint is the sum of the individual components. The resulting Target Setpoint, tSP, is calculated using the following equations:

Loc.t

Here the Local Setpoint is treated as the main component and the remote setpoint is viewed as a trim on this value. The actual setpoint used by the loop is given by:

tSP = SL + (Ratio*Rem) + Bias

rEn.t

Here the remote signal is treated as the main component and the Local setpoint is viewed as a trim on this value. The actual setpoint used by the loop is given by:

tSP = Rem + (Ratio * SL) + Bias

As can be seen Bias is applied <u>after</u> Ratio.

Loc.t and rEn.t may be used where two controllers are operated as a cascade pair. For example, one controller is controlling or limiting the steam pressure supply to a heat exchanger and the second is controlling the steam flow as a way to control the output temperature of the fluid being heated in the exchanger. A similar requirement occurs when two temperatures are cascaded.

10.1.1 Examples

The following four examples show the working setpoint for various settings:

Setpoint Type	Setpoint select = SP1	SP1 = 100	Remote setpoint = 60	Ratio = 1	Bias = 0
Loc	Working setpoint = 100 Remote SP has no effect				
rEn	Working setpoint = Remote SP taken from a 0-10V external source eg 60. Internal setpoints are not available although they can be set for future use.				
rEn.L	Working setpoint = 160 ie Remote setpoint + Local setpoint (SP1) = 60 + 100				
Loc.L	Working setpoint = 160 ie Local setpoint (SP1) + Remote setpoint = 100 + 60				
L-r	RemSP (60) if Remote Setpoint Select (L-R) = rEm or SP1 (100) if Remote Setpoint Select (L-R) = Loc				

Setpoint Type	Setpoint select = SP1	SP1 = 100	Remote setpoint = 60	Ratio = 0.5	Bias = 0
rEn.L	Working setpoint = 110 ie Remote setpoint + Local setpoint (SP1) = 60 + 50				
Loc.L	Working setpoint = 130 ie Local setpoint (SP1) + Remote setpoint = 100 + 30				

Setpoint Type	Setpoint select = SP1	SP1 = 100	Remote setpoint = 60	Ratio = -1.0	Bias = 0
rEn.L	Working setpoint = -40 ie Remote setpoint + Local setpoint (SP1) = 60 + (-100)				
Loc.L	Working setpoint = +40 ie Local setpoint (SP1) + Remote setpoint = 100 + (-60)				

Setpoint Type	Setpoint select = SP1	SP1 = 100	Remote setpoint = 60	Ratio = 1	Bias = 7
rEn.L	Working setpoint = 167 ie re Remote setpoint m + Local setpoint (SP1) = 60 + 107				
Loc.L	Working setpoint = 167 ie Local setpoint (SP1) + Remote setpoint = 100 + 67				

10.1.2 Example: To Set an Increasing Rate of Change of Setpoint

This is available in Level 3.

Do This	The Display You Should See	Additional Notes
1. Press ⓟ as many times as necessary to select 'SETPOINT LIST'		
2. Press ⌒ as many times as necessary to scroll to 'SP1' 3. Press ▲ or ▼ to adjust setpoint 1		This step can be repeated for the lower setpoint limit 'SP.LO'
4. Press ⌒ to scroll to 'SP2' 5. Press ▲ or ▼ to adjust setpoint 2		
6. Press ⌒ as many times as necessary to scroll to 'SP.RRT' 7. Press ▲ or ▼ to set the rate at which you require the setpoint to increase.		Whenever the setpoint is changed from a lower to higher value, the setpoint will servo to the current PV (even if the PV is not close to the SP) then ramp to the new value at the rate set in units per second, minute or hours as set by the 'RAMPU' parameter. The setpoint rate resolution is generally one decimal point more than setpoint/PV resolution.

If it is required to ramp from a high value setpoint to a lower value, select SP.FRT and adjust its value to the required ramp rate.

Setpoint ramping servos from PV. This is to ensure that the ramp operates to limit the rate of change of the PV even when the PV is not close to the setpoint.

10.2 Servo to PV

By default the controller is set to servo to PV. This means, in general, that whenever the setpoint is changed the new setpoint takes the current value of the PV, then ramps at the chosen rate to the requested setpoint. In SX80 and SX90 there are some exclusions to the general rule as listed below:-

1. If working setpoint derived from remote setpoint or with a contribution from the remote setpoint (in either trim mode) the setpoint will never servo to PV. This is different behaviour from the existing V1.03 firmware and has been requested by Spirax. (Example 3).
2. Changes to the local setpoint with the setpoint ramp disabled will not cause a servo to PV.
3. Changes to the local setpoint with the setpoint ramp enabled and the working setpoint not ramping will cause a servo to PV. (Example 1).
4. Changes to the local setpoint with the setpoint ramp enabled and the working setpoint ramping will only cause a servo to PV if the change in setpoint will cause the ramp direction to change. If the ramp direction will continue in the same direction, the setpoint will not servo to PV.
5. Changes (via digital communications) to the target setpoint will always cause a servo to PV. (Example 2).

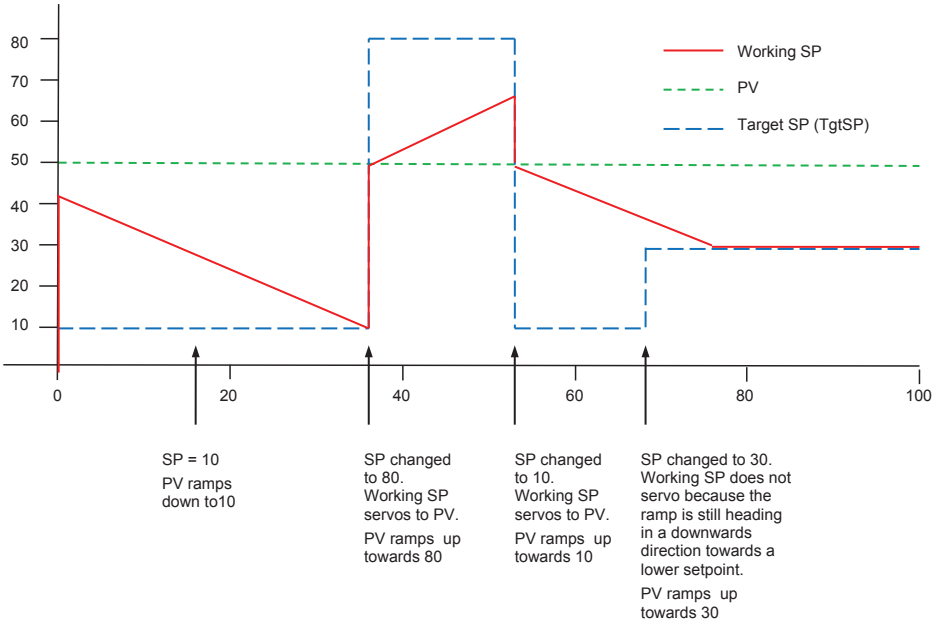
For additional clarity, the diagrams illustrate the action for the various conditions.

10.2.1 Example 1, changes to the Local Setpoint(s) SP1, SP2 or SP3

Initial settings:

Process Variable (PV) fixed at 50.

Rising and Falling Ramp Rate to any value (other than OFF).

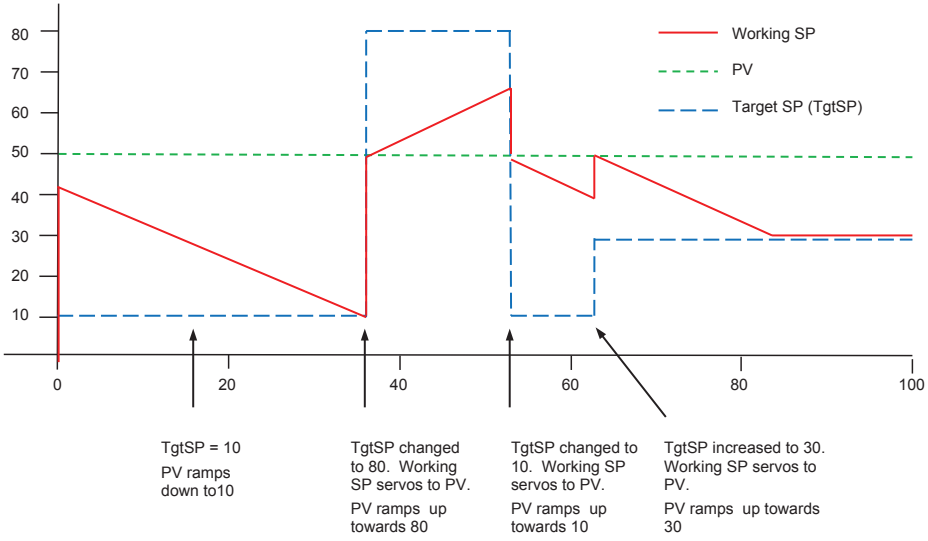


10.2.2 Example 2, changes writing directly to the Target Setpoint (TgtSP)

Initial settings:

Process Variable (PV) fixed at 50.

Rising and Falling Ramp Rate to any value (other than OFF).

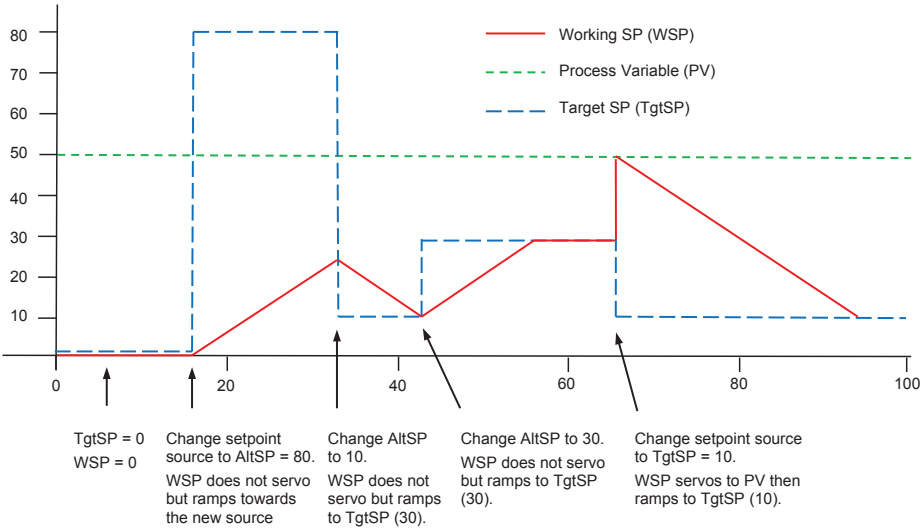


10.2.3 Example 3, changes writing directly to the Alternate (Remote) Setpoint (AltSP)

Initial settings:

Process Variable (PV) fixed at 50.

Rising and Falling Ramp Rate to any value (other than OFF).



10.3 Holdback

Holdback freezes a ramping setpoint if the Process Variable (PV) does not follow the ramp. This is generally due to the ramp rate being set too fast for the process to follow. By keeping the PV and the SP close to the same value, ensures that the dwell period starts at the correct temperature (generally referred to as guaranteed soak).

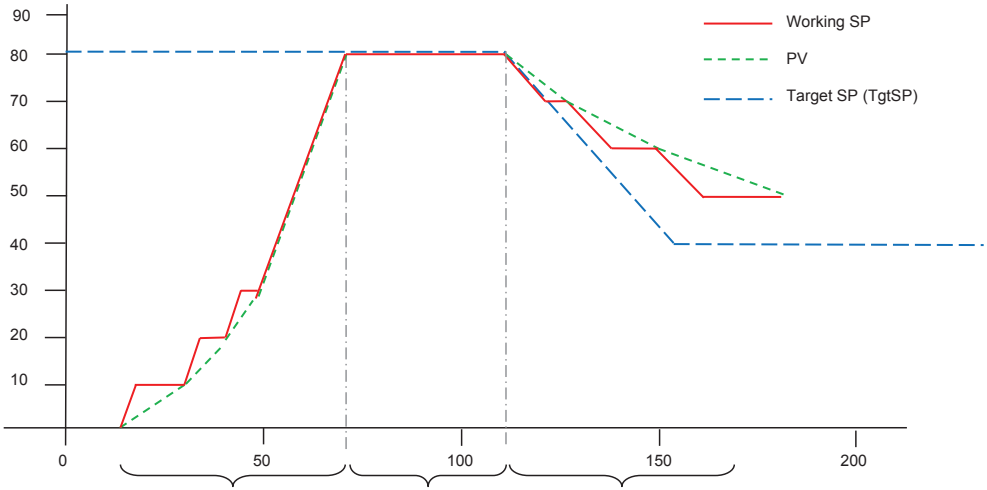
Example

The diagram below is shown for various conditions of setpoint and process variable. It uses the Alternate Setpoint (AltSP) where the Working Setpoint (WSP) does not servo to PV.

Initial Settings

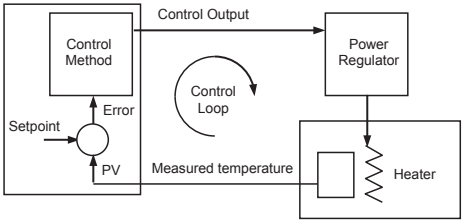
Target Setpoint (TgtSP) = 90

Holdback (HLD.B) = 10



11. Control

Parameters in this section allow the control loop to be set up for optimum control conditions. An example of a temperature control loop is shown below:-



The actual temperature measured at the process (PV) is connected to the input of the controller. This is compared with a setpoint (or required) temperature (SP). If there is an error between the set and measured temperature the controller calculates an output value to call for heating or cooling. The calculation depends on the process being controlled. This may be a simple On/Off algorithm, a PID algorithm or a valve positioning algorithm. The output(s) from the controller are connected to devices on the plant which cause the heating (or cooling) demand to be adjusted which in turn is detected by the temperature sensor. This is referred to as the control loop or closed loop control.

11.1 PID Control

The PID controller consists of the following parameters:-

Parameter	Meaning or Function
Proportional Band	The proportional term, in display units or %, delivers an output which is proportional to the size of the error signal.
Integral Time	Removes steady state control offsets by ramping the output up or down in proportion to the amplitude and duration of the error signal.
Derivative Time	Determines how strongly the controller will react to the rate of change in the measured value. It is used to prevent overshoot and undershoot and to restore the PV rapidly if there is a sudden change in demand.
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.
Relative Cool Gain	Only present if cooling has been configured. Sets the cooling proportional band, which equals the heat proportional band value divided by the cool gain value.

11.2 Tuning

In tuning, you match the characteristics (PID parameters) 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 is normally done automatically by setting the 'AUTO-TUNE ENABLE' parameter to 'On'.

11.2.1 Automatic Tuning

This controller uses a one-shot tuner which automatically sets up the initial values of the parameters listed in section 11.1.

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.

Following a tune, the instrument will modify the control parameters to match the characteristics of the load. On starting the tune, there is a one minute delay while the loop is allowed to settle. During this time you may edit the loop setpoint.

Care should be taken to ensure that the oscillations of the process value will not damage the process being tuned. It is recommended to set the setpoint for tuning purposes below the normal running setpoint value.

If the process cannot tolerate full heating or cooling being applied, then the levels can be restricted by setting the high power limit ('OP.HI') and low power limit ('OP.LO'). 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.

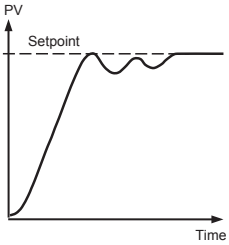
It is best to start tuning with the process at ambient temperature. This allows the tuner to calculate more accurately the low cutback and high cutback values which restrict the amount of overshoot, or undershoot.

11.2.2 How To Tune

1. Set the setpoint to the value at which you will normally operate the process.
2. In Level 2 press ⌄ to select 'ATUNE'. In level 3 select the 'CTRL' list, select 'ATUNE' and set it to 'On'.
3. Press ▤ and ⌄ together to return to the Home display. The display will flash 'TunE' to indicate that tuning is in progress.
4. The controller induces an oscillation in the temperature by first turning the heating on, and then off. The first cycle is not complete until the measured value has reached the required setpoint.
5. After two cycles of oscillation the tuning is completed and the tuner switches itself off.
6. The controller then calculates the tuning parameters and resumes normal control action.

If you want 'Proportional only', 'PD', or 'PI' control, you should set the 'TI' or 'TD' parameters to off before commencing the tuning cycle. The tuner will leave them off and will not calculate a value for them.

Typical automatic tuning cycle



Autotune starts 1 minute after being turned on to determine steady state conditions.

Tuning normally takes place at a PV which has a value of setpoint x 0.7.

The power is automatically turned on and off to cause oscillations.

From the results the values shown in the table are calculated

11.2.3 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.

To tune the cutback values, first set them to values other than Auto, then perform a tune as usual.

11.2.4 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:

Set the Integral Time and the Derivative Time to OFF.

Set High Cutback and Low Cutback to 'Auto'.

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

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 'P' and the period of oscillation 'T'.

Set the proportional band, integral time and derivative time parameter values according to the calculations given in the table below:-

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

11.2.5 Setting the Cutback Values

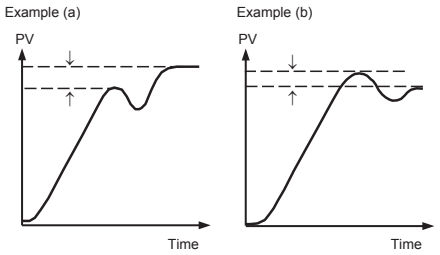
The above procedure sets up the parameters for optimum steady state control. If unacceptable levels of overshoot or undershoot occur during start-up, or for large step changes in PV, then manually set the cutback parameters.

Proceed as follows:

Set the low and high cutback values to three proportional bandwidths (that is to say, CB.HI = CB.LO = 3 x PB).

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



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

11.3 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 as a P or PD controller, the integral term will be set to 'OFF'. Under these conditions the measured value may not settle precisely at setpoint.

The Manual Reset parameter (MR) 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.

11.4 Relative Cool Gain

The proportional band parameter 'PB' adjusts the proportional band for the heating output. Relative cool gain adjusts the cooling proportional band relative to the heating proportional band. If the rate of heating and rate of cooling are widely different it may be necessary to manually adjust Relative Cool Gain to achieve the optimum settings for the cooling proportional band.

(This parameter is set automatically when Autotune is used). A nominal setting of around 4 is often used.

11.5 Control Action

When set to reverse (REV) the output increases when the PV is below setpoint. This is the best setting for heating control.

For cooling control only set to direct (DIR).

11.6 On/Off Control

On/Off control simply turns heating power on when the temperature is below setpoint and off when it is above setpoint. If cooling is used, cooling power is turned on when the temperature is above setpoint and off when it is below. The outputs of such a controller will normally be connected to relays – hysteresis may be set in the same way as described in the Alarms section to prevent relay chatter or to provide a delay in the control output action.

11.7 Valve Position Control

In the SX series controllers, two relay outputs may be configured to drive a valve in the open direction (UP) or the close direction (dwn) via a reversing motor drive. It operates in boundless (SX80 and SX90) or bounded (SX90 only) mode. It does not require a feedback from a potentiometer to define the valve position although this can be used with the SX90 to provide indication of the valve position. The control is performed by delivering an Up pulse, a Down pulse or no pulse at all in response to the control demand signal via the relay outputs.

11.8 Loop Break

The loop is considered to be broken if the PV does not respond to a change in the output. Since the time of response will vary from process to process the **Loop Break Time** parameter allows a time to be set before a **Loop Break Alarm** is initiated. In these circumstances the output power will drive to high or low limit. For a PID controller, if the PV has not moved by 0.5 x Pb in the loop break time the loop is considered to be in break. The loop break time is set by the Autotune, a typical value is 12 x Td. For an On/Off controller Loop Break Time is not shown and loop break alarm is inhibited.

11.9 Cooling Algorithm

The method of cooling may vary from application to application.

For example, an extruder barrel may be cooled by forced air (from a fan), or by circulating water or oil around a jacket. The cooling effect will be different depending on the method. The cooling algorithm may be set to linear where the controller output changes linearly with the PID demand signal, or it may be set to water, oil or fan where the output changes non-linearly against the PID demand. The algorithm provides optimum performance for these methods of cooling.

11.10 Split Output

From firmware version 1.05 and above the controller has the ablility to split a heat only PID output into two physical outputs. The outputs must be analogue and use OP2 and OP3. This feature is, therefore, only available in SX90.

The function is selected by setting a new enumeration (SPL.T) which has been added to the Heating Type parameter (CTR.H) in the Control List, section 11.11. The Cooling Type (CTRL.C) is set to OFF and the Control Action (CTR.L) is set to Reverse acting (rEV). These two parameters are then hidden.

Two further parameters are available in the CTR.L list (SLT.1 and SLT.2) and, after the heat only PID value has been generated, they are used to proportion the two outputs in accordance with the following calculations:

If PID < SLt1

SL1 output = PID * (SLt1/100)

else

SL1 output = 100

If PID < SLt2

SL2 output = 0

else

SL2 output = PID * ((100-SLt2)/100)

PID is the value normally output by the control block.

The two outputs may be set independently to reverse or direct acting by the addition of two more parameters (SL1.Ac and SL2.AC)

If SL1.AC is se t to rEV, the value of SL1 (calculated above) is adjusted as follows:

New SL1 = 100 – old SL1

If SL1.AC is se t to dIr, the value of SL1 is unchanged.

The same applies to SL2.

11.11 Control Parameters

The following table shows the parameters available.

CONTROL LIST 'CTRL'					
Parameter Name	SCROLLING DISPLAY Parameter Description	Value		Default	Access Level
CTRL.H	HEATING TYPE Selects the channel 1 control algorithm. Different algorithms may be selected for channels 1 and 2. In temperature control applications, Ch1 is usually the heating channel, Ch2 is the cooling channel.	PID	PID	As Quick Start Code	Conf
		oFF	Heating off		
		on.oF	On/Off		
		mtr	Boundless Valve position control		
		bmtr	Bounded Valve position control not available in SX80.		
		SPL.t	Split output. A heat only PID output is split into two outputs SL1 and SL2. When CTRL.H = SPL.t Then CTRL.C (below) is set to oFF and hidden.		
CTRL.C See the picture, P48 table	COOLING TYPE Selects the channel 2 Control algorithm. Different algorithms may be selected for channels 1 and 2. This cannot be changed if the instrument is a valve position controller.	oFF	Cooling disable	As Quick Start Code	Conf Hidden when CTR.H = SPL.t
		PId	PID		
		on.oF	On/Off		
CTRL.A	CONTROL ACTION Selects the direction of the control. i.e. reverse or direct acting.	rEV	Reverse acting. Output decreases as PV increases	rEV	Conf Hidden when CTR.H = SPL.t
		dir	Direct acting. Output increases as PV decreases		
PB.UNT	PROPORTIONAL BAND UNITS	EnG	In engineering units	EnG	Conf
		PErc	In percent		
SLT.1	SPLIT 1 To set the threshold to scale the output value. The Heat only PID output is split between the two outputs for dir/dir control action. See section 11.10.	5 to 95		30%	Conf
SLT.2	SPLIT 2 To set the threshold to scale the output value. The Heat only PID output is split between the two outputs for dir/dir control action. See section 11.10.		SLT.2 has a low limit of (SLt.1-10) or 5% whichever is the greater and a high limit set by SLt.1.	30%	Conf
SL1.AC	S1 CONTROL ACTION Selects the direction of the control. i.e reverse or direct acting for Split Output 1. See section 11.10.	0	Reverse acting sometimes called Negative Feedback		L3
		1	Direct acting sometimes called Positive Feedback		
SL2.AC	S2 CONTROL ACTION Selects the direction of the control. i.e reverse or direct acting for Split Output 2. See section 11.10.	0	Reverse acting sometimes called Negative Feedback		L3
		1	Direct acting sometimes called Positive Feedback		
VPB.IN	VPB INPUT SOURCE. This is only displayed when control type is Bounded Valve position and applies to SX90 only.	dc	The remote dc input is used to read the feedback potentiometer position measured as an analogue voltage or current.	As quick start code	Conf
		Pot	The feedback potentiometer is used directly to show valve position.		

CONTROL LIST 'CTRL'					
Parameter Name	SCROLLING DISPLAY Parameter Description	Value		Default	Access Level
ATUNE	AUTOTUNE ENABLE	OFF	Autotune off	OFF	L3
		On	Set to 'on' to start auto-tuning		
PB	PROPORTIONAL BAND	0.1 to 9999 display units or 1 to 999.9% if proportional band expressed as %		20	L3
TI	INTEGRAL TIME	OFF to 9999 seconds		360 sec	L3
TD	DERIVATIVE TIME	OFF to 9999 seconds TD defaults to OFF for valve position control		60 sec	L3
R2G	RELATIVE COOL GAIN See also section 11.4	0.1 to 10.0		1.0	L3
CBHI	CUTBACK HIGH See also section 11.1.	Auto or 1to 3000 display units		Auto = 3xPb	L3
CBLO	CUTBACK LOW See also section 11.1.	Auto or 1 to 3000 display units		Auto = 3XPb	L3
MR	MANUAL RESET	0.0 to 100.0% (heat only) -100.0 to 100.0% (heat/cool)		0.0%	L3
LBT	LOOP BREAK TIME The loop break alarm attempts to detect loss of restoring action in the control loop by checking the control output, the process value and its rate of change. Loop break detection works for all control algorithms: PID, VP and ON-OFF. Note: This is not to be confused with load failure and partial load failure.	OFF	Setting loop Break Time to OFF disables the Loop Break Alarm	OFF	L3
		1 to 9999 minutes			
OP.HI	OUTPUT HIGH Adjust to limit the maximum heating power applied to the process	0 to 100% if control type is valve position or heat only. ±100.0% if control type is heat/cool		100.0%	L3
OP.LO	OUTPUT LOW Adjust to limit the maximum cooling power applied to the process or to apply a minimum heating power	0 to -100% if control type is valve position or cool only. ±100.0% if control type is heat/cool		0.0 (heat only) -100 (cool)	L3
MTR.T	MOTOR TRAVEL TIME Set this value to the time that it takes for the motor to travel from its fully closed to its fully open position.	0.0 to 999.9 seconds Note: In motorised valve control only the PB and TI parameters are active. The TD parameter is turned off.		22.0	L3
POTP.1	CH1 VALVE POSITION This is valve position used for control purposes and may be sourced from the feedback potentiometer or from the remote input. It is only displayed when control type is Bounded Valve position and applies to SX90 only.				
POTB.1	CH1 POT BRK If any leg of the feedback potentiometer becomes open circuit a pot break indication is active. The measurement uses the remote mA or Volts input so that Pot Break becomes active if the input is out of range, e.g. <4mA or >20mA. It is only displayed when control type is Bounded Valve position and applies to SX90 only.	OFF	Potentiometer within limits		L3 Read only
		on	Potentiometer out of limits		

CONTROL LIST 'CTRL'						
Parameter Name	SCROLLING DISPLAY Parameter Description		Value		Default	Access Level
PMOD	POTENTIOMETER BREAK MODE. This is only displayed when control type is Bounded Valve position and applies to SX90 only.		nonE	Attempts to control	rSt	L3
			uP	Valve drives open		
			dwn	Valve drives closed		
			rSt	Valve remains in current position		
M.HI	NUDGE RAISE. To enable the valve to be opened by small amounts each time the raise button is pressed. Only shown if the control type is Boundless Valve Position.		No	Disabled	Disabled	
			YES	Enabled		
M.LO	NUDGE LOWER. To enable the valve to be closed by small amounts each time the lower button is pressed. Only shown if the control type is Boundless Valve Position.		No	Disabled	Disabled	
			YES	Enabled		
D.BAND	CHANNEL 2 DEAD BAND Period when no output is demanded from either channel 1 or channel 2 Adjust, for example, to increase the period when no heating or cooling power is applied		OFF or 0.1 to 100.0% of the cooling proportional band		OFF	L3
HYST.H	HEATING HYSTERESIS	Sets the difference between relay on to relay off. It is used to prevent relay chatter.	1 to 9999 display units. Applies to on/off control only.		1	L3 On/off control only
HYST.C	COOLING HYSTERESIS					
SAFE	SAFE OUTPUT POWER To set the output level in a sensor break (open circuit) condition		-100.0 to 100.0% limited by OP.HI and OP.LO		0.0%	L3
F.MOD	FORCED MANUAL OUTPUT MODE Selects how the loop behaves on transfer from Auto to Manual. Transfer from Manual to Auto is always bumpless.		nonE	Transfer between Auto/Manual/Auto is bumpless	nonE	L3
			StEP	Transfer from Auto to Manual, the output goes to a pre-set value (F.OP)		
			LASt	Transfer from Auto to Manual, the output goes to the previously set manual value		
COOL.T	NONOLINEAR COOLING TYPE This selects an algorithm most suited to the type of cooling. Typically used in extruders.		Lin	Linear	Lin	Conf
			OIL	Oil cooling		
			H2O	Water cooling		
			FAn	Forced air cooling		
F.OP	FORCED OUTPUT To pre-set a value for the Manual output when F.MOD = STEP		-100.0 to 100.0% limited by OP.HI and OP.LO		0.0	L3
A-M	LOOP MODE – AUTO MANUAL OFF see also section 4.4.5.		Auto	To select automatic operation		L3
			MAn	To select manual operation		
			OFF	Control outputs inhibited		
LBR	LOOP BREAK STATUS		No	Shows the current status of loop break.		Read only
			YES			
TU.HI	TUNE HIGH LIMIT. Set this to limit the maximum output during Autotune.		Range between OP.HI and OP.LO			L3
TU.LO	TUNE LOW LIMIT. Set this to limit the minimum output during Autotune.					L3

11.12 Example: To Configure Heating and Cooling

Enter configuration level as described. Then:-

Do This	The Display You Should See	Additional Notes
1. Press ⊙ as many times as necessary to select 'CTRL'		
2. Press ⊙ to scroll to 'CTRLH' 3. Press ▲ or ▼ to select the Heating Type		Heating Type choices are:- PId PID (3 term) control. on.oF On/Off control. oFF No heating output configured. bmtr Bounded Valve position control not available in SX80. Mtr Boundless valve position control.
4. Press ⊙ to select 'CTRL.C' 5. Press ▲ or ▼ to select the Cooling Type		Cooling Type choices are:- oFF No cooling output configured. Cannot be changed if 'CTRLH' is valve position. PId PID (3 term) control. on.oF On/Off control.
6. Press ⊙ to select 'CTRL.A' 7. Press ▲ or ▼ to 'rEV'		Control Action choices are:- rEV Reverse - heating control. dIr Direct - cooling only control.
8. Press ⊙ to scroll to 'PB.UNIT' 9. Press ▲ or ▼ to choose units		Proportional Band Units choices are:- EnG Engineering units. PErc Percentage.
10. Continue to select parameters using ⊙ for example 'OP.HI' 11. Press ▲ or ▼ to change their values		When PID control is selected, this places a limit on the output demand from the PID which can be applied to the heating circuit. 'OP.LO' can be set up in the same way if required. If on/off control is selected these parameters do not apply. They are replaced by 'HYST.H' and 'HYST.L' to set the difference between the output switching off to switching on.

11.12.1 Effect of Control Action, Hysteresis and Deadband

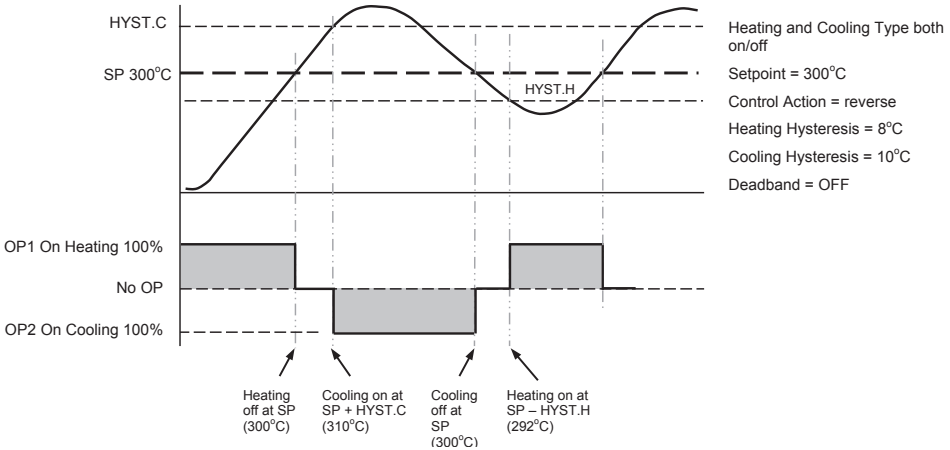
For temperature control 'CONTROL ACTION' will be set to 'rEV'. For a PID controller this means that the heater power decreases as the PV increases. For an on/off controller output 1 (usually heat) will be on (100%) when PV is below the setpoint and output 2 (usually cool) will be on when PV is above the setpoint

Hysteresis applies to on/off control only. It defines the difference in temperature between the output switching off and switching back on again. The examples below shows the effect in a heat/cool controller.

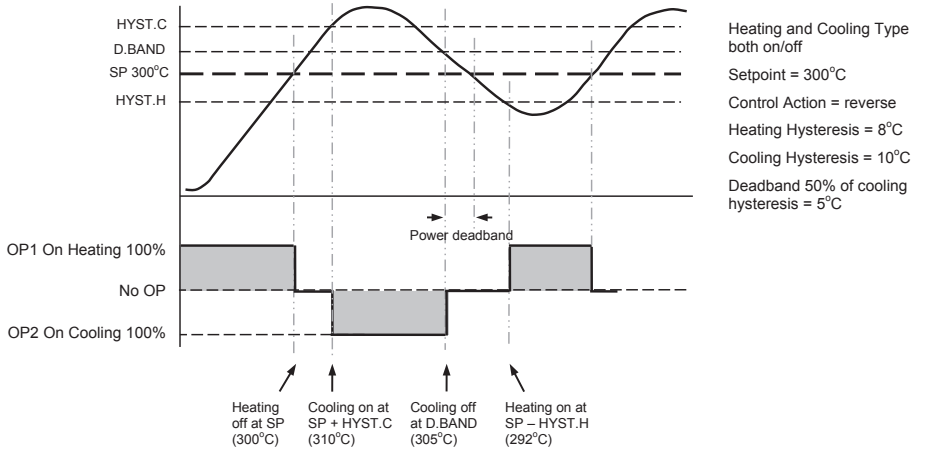
Deadband can operate on both on/off control or PID control where it has the effect of widening the period when no heating or cooling is applied. However, in PID control its effect is modified by both the integral and derivative terms. Deadband might be used in PID control, for example, where actuators take time to complete their cycle thus ensuring that heating and cooling are not being applied at the same time. Deadband is likely to be used, therefore, in on/off control only. The second example below adds a deadband of 20 to the above example.

In an on/off controller, if CONTROL ACTION = rev then OP2 will be on when PV is below SP. OP1 will be on when the PV is above SP. The outputs are, therefore, reversed in the above example.

Deadband OFF



Deadband ON



12. Alarms

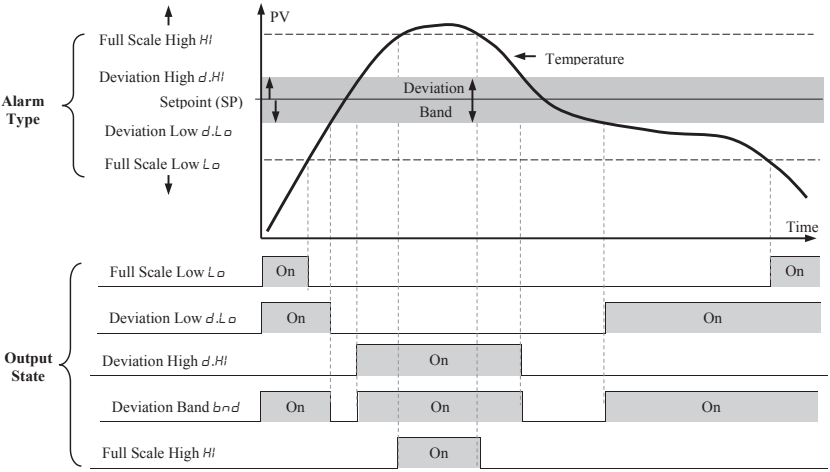
Alarms are used to alert an operator when a pre-set level has been exceeded. They are indicated by a scrolling message on the display and the red ALM beacon. They may also switch an output– usually a relay (see section 12.1.1) – to allow external devices to be operated when an alarm occurs. Alarms only operate if they have been configured.

Up to seven different alarms are available:-

- **Alarm 1**: configurable as full scale high or low, band or deviation high or low
- **Alarm 2**: configurable as full scale high or low, band or deviation high or low
- **Alarm 3**: configurable as full scale high or low, band or deviation high or low
- **Alarm 4**: configurable as full scale high or low, band or deviation high or low
- **Sensor Fault alarm.** An alarm condition - INPUT SENSOR BROKEN (5.br) is indicated if the sensor or the wiring between sensor and controller becomes open circuit. the output level will adopt a 'SAFE' value which can be set up in Operator Level 2, see section 11.11.
- For a PRT input, sensor break is indicated if any one of the three wires is broken.
  For mA input sensor break will not be detected due to the load resistor connected across the input terminals.
  For Volts input sensor break may not be detected due to the potential divider network connected across the input terminals.
- **Loop Break alarm.** Displayed as CONTROL LOOP BROKEN. This occurs if the controller does not detect a change in process value following a change in output demand after a suitable delay time.
- **Remote Fail Alarm.** This alarm operates on the remote setpoint input. If a value is not received after a period of 5 seconds, then the Remote Fail Alarm is shown.

12.1 Alarm Types

This section shows graphically the operation of different types of alarm used in the controller. The graphs show changes in temperature plotted against time. (Hysteresis set to zero)



From firmware versions XXX and above two further alarm types are available. These are:

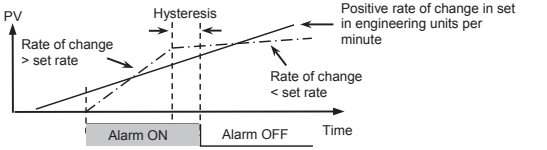
OHI the alarm activates if the output value becomes greater than the threshold set by the user.

OLo the alarm activates if the output value becomes lower than the threshold set by the user.

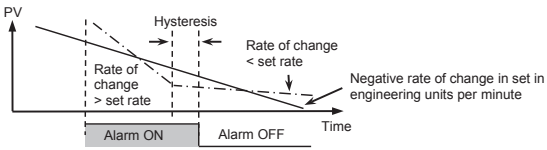
Hysteresis	is the difference between the point at which the alarm switches 'ON' and the point at which it switches 'OFF'. It is used to provide a definite indication of the alarm condition and to prevent alarm relay chatter.		
Latching Alarm	is used to hold the alarm condition once an alarm has been detected. It may be configured as:-		
	nonE	Non latching	A non latching alarm will reset itself when the alarm condition is removed
	AutO	Automatic	An auto latching alarm requires acknowledgement before it is reset. The acknowledgement can occur **BEFORE** the condition causing the alarm is removed.
	mAn	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 condition causing the alarm is removed. **Manual latching is supplied by default.**
	Evt	Event	ALM beacon does not light but an output associated with this parameter will activate. A scrolling message may be configured using external configuration tools (iTools). If a message has been configured it will scroll across the display while the event is true.
Blocking Alarms	The alarm may be masked during start up. Blocking prevents the alarm from being activated until the process has first achieved a safe state. It is used to ignore start up conditions which are not representative of running conditions. A blocking alarm is re-initiated after a setpoint change. See section 12.2 for an explanation of the behaviour of blocking alarms under different conditions.		

Two rate of change alarms are available.
These are:-

Rising rate of change - rrc (units/minute)	An alarm will be detected if the rate of change in a positive direction exceeds the alarm threshold

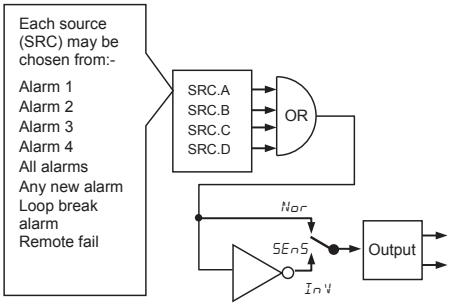


Falling rate of change - Frc (units/minute)	An alarm will be detected if the rate of change in a negative direction exceeds the alarm threshold



12.1.1 Alarm Relay Output

Alarms can operate a specific output (usually a relay). Any individual alarm can operate an individual output or any combination of alarms, up to four, can operate an individual output. They are supplied pre-configured in accordance with the Quick Start Code but they can also be set up in configuration level.



12.1.2 Alarm Indication

- ALM beacon flashing red = a new alarm (unacknowledged)
- This is accompanied by a scrolling alarm message. A typical default message will show the source of the alarm followed by the type of alarm. For example, 'ALARM 1 FULL SCALE HIGH'. This message is language dependent.
- Specific messages can be customised - contact your supplier if this is required.
- If more than one alarm is present further messages are flashed in turn in the main display. The alarm indication will continue while the alarm condition is present and is not acknowledged.
- ALM beacon on continuously = alarm has been acknowledged

12.1.3 To Acknowledge An Alarm

Press and together.

The action, which now takes place, will depend on the type of latching, which has been configured. By default the controller is supplied as Manual Latching which is described in the previous section. If other alarm types are configured, as described in this chapter, alarm acknowledge acts as follows:-

Non-Latched Alarms

Alarm condition present when the alarm is acknowledged.

- ALM beacon on continuously.
- The alarm message(s) will continue to scroll

This state will continue for as long as the alarm condition remains. When the alarm condition disappears all indication also disappears.

If a relay has been attached to the alarm output, it will de-energise when the alarm condition occurs and remain in this condition until acknowledged or the alarm is no longer present.

If the alarm condition disappears before it is acknowledged the alarm resets immediately.

Latched Alarms

See description in section 12.1.

12.2 Behaviour of Alarms After a Power Cycle

The response of an alarm after a power cycle depends upon the latching type, whether it has been configured to be a blocking alarm, it's state and the acknowledge status of the alarm.

The response of active alarms after a power cycle is as follows:

For a non-latching alarm or an event alarm blocking will be re-instated, if configured. If blocking is not configured the active alarm will remain active. If the alarm condition has gone safe during the down time the alarm will return inactive.

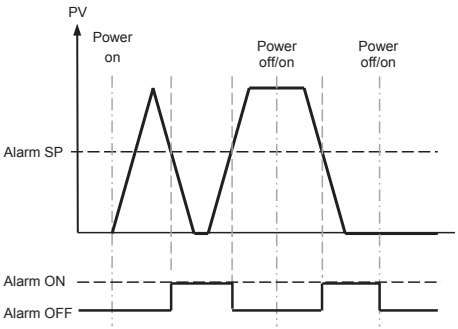
For an auto-latching alarm blocking will be re-instated, if configured, only if the alarm had been acknowledged prior to the power cycle. If blocking is not configured or the alarm had not been acknowledged the active alarm will remain active. If the alarm condition has gone safe during the downtime the alarm will return inactive if it had been acknowledged prior to the power cycle else it will return safe but not acknowledged. If the alarm was safe but not acknowledged prior to the power cycle the alarm will return safe but not acknowledged.

For a manual-latching alarm blocking will not be re-instated and the active alarm will remain active. If the alarm condition has gone safe during the downtime the alarm will return safe but not acknowledged. If the alarm was safe but not acknowledged prior to the power cycle the alarm will return safe but not acknowledged.

The following examples show graphically the behaviour under different conditions:-

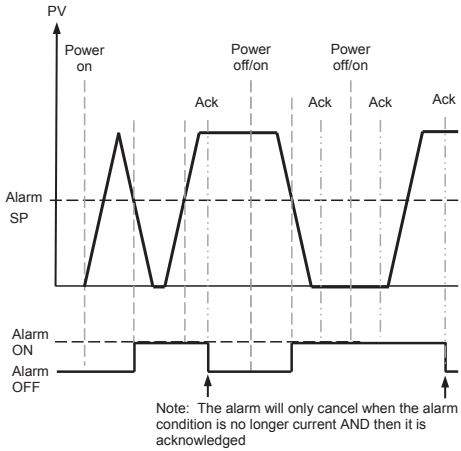
12.2.1 Example 1

Alarm configured as Absolute Low; Blocking: No Latching



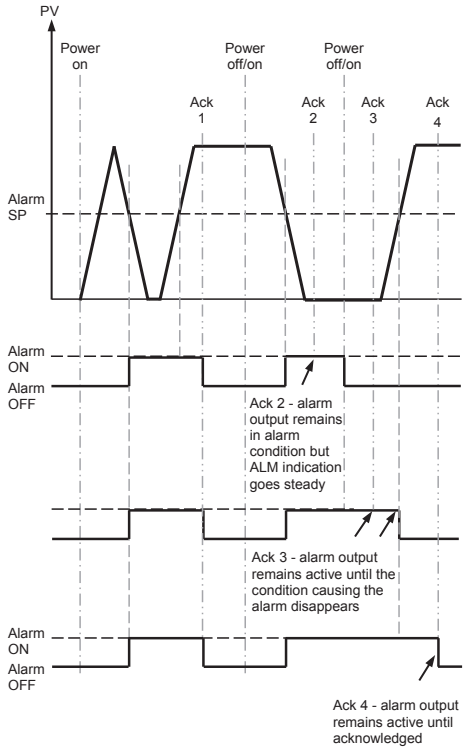
12.2.2 Example 2

Alarm configured as Absolute Low; Blocking: Manual Latching



12.2.3 Example 3

Alarm configured as Absolute Low; Blocking: Auto Latching



12.3 Alarm Parameters

Four alarms are available. Parameters do not appear if the Alarm Type = None. The following table shows the parameters to set up and configure alarms.

ALARM LIST 'ALARM'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
A1.TYP	ALARM 1 TYPE	Selects the type of alarm	nonE	Alarm not configured	As order code	Conf
			HI	Full Scale High		
			Lo	Full Scale Low		
			d.HI	Deviation High		
			d.Lo	Deviation Low		
			bnd	Deviation band		
			rrc	Rising rate of change, set in 1-9999 eng units/min		
			Frc	Falling rate of change set in 1-9999 eng units/min		
			OHI	Output absolute high The alarm is triggered when the output value is greater than the threshold.		
			OLo	Output absolute low The alarm is triggered when the output value is lower than the threshold.		
A1.OOO	ALARM 1 SETPOINT	Alarm 1 threshold value. The last three characters show the type of alarm configured from the above list	Instrument range for process alarms. 0 to 100% for heat only output alarms. -100% to +100% for heat/cool output alarms.		0	L3
A1.STS	ALARM 1 OUTPUT	Indicates the status of the alarm	OFF	Alarm off		Read only
			On	Alarm on		
A1.HYS	ALARM 1 HYSTERESIS	See description at the beginning of this section	0 to 9999			Conf
A1.LAT	ALARM 1 LATCHING TYPE	See description at the beginning of this section	MAn	Latching with manual resetting	mAn	Conf
			Evt	Event (no alarm flashing beacon but messages can be displayed)		
			nonE	Non-latching		
			Auto	Latching with automatic resetting		
A1.BLK	ALARM 1 BLOCKING	See description at the beginning of this section	No	No blocking	No	Conf
			YES	Blocking		
The above parameters are repeated for Alarm 2, A2; Alarm 3, A3; Alarm 4, A4						

12.3.1 Example: To Configure Alarm 1

Enter configuration level as described. Then:-

Do This	The Display You Should See	Additional Notes
1. Press ⓟ as many times as necessary to select 'ALARM'		
2. Press ⓒ to select 'A1.TYP' 3. Press ▲ or ▼ to select the required alarm type		Alarm Type choices are:- nonE Alarm not configured HI Full Scale High Lo Full Scale Low d.HI Deviation High d.Lo Deviation Low Bnd Deviation Band Rrc Rising rate of change Frc Falling rate of change
4. Press ⓒ to select 'A1.- - -' 5. Press ▲ or ▼ to set the alarm trip level		This is the alarm threshold setting for. The last three characters (---) will show the type of alarm configured from the above list. The alarm threshold is shown in the upper display. In this example the high alarm will be detected when the measured value exceeds 215.
6. Press ⓒ to select 'A1 STS'		This is a read only parameter which shows the status of the alarm output.
7. Press ⓒ to select 'A1 HYS' 8. Press ▲ or ▼ to set the hysteresis		In this example the alarm will cancel when the measured value decreases 2 units below the trip level (at 213 units).
9. Press ⓒ to select 'A1 LAT' 10. Press ▲ or ▼ to select the latching type		Latching Type choices are:- MAn Manual Evt Event nonE No latching Auto Automatic See the introduction to the alarm section for an explanation.
11. Press ⓒ to select 'A1 BLK' 12. Press ▲ or ▼ to 'YES' or 'No' 13. Repeat the above to configure alarms 2, 3 and 4 if required		

12.4 Diagnostic Alarms

Diagnostic alarms indicate a possible fault within the controller or connected devices.

Display shows	What it means	What to do about it
E.ConF	A change made to a parameter takes a finite time to be entered. If the power to the controller is turned off before the change has been entered then this alarm will occur. Do not turn the power off to the controller while ConF is flashing.	Enter configuration mode then return to the required operating mode. It may be necessary to re-enter the parameter change since it will not have been entered in the previous configuration.
E.CAL	Calibration error.	Re-instate Factory calibration.
E2.Er	EEPROM error.	Return for repair.
EE.Er	Non-vol memory error.	Note the error and contact your supplier.
E.Lin	Invalid input type. This refers to custom linearisation which may not have been applied correctly or may have been corrupted.	Go to the INPUT list in configuration level and set a valid thermocouple or input type.
Emod	IO1, OP2, or OP3 has been changed.	If this has been field changed by the installation of a new board, enter config level, then exit back to operator level. If the message occurs at any other time return for repair.
E.CPU	Microprocessor fault.	Return for repair.

12.4.1 Out of Range Indication

If the input is too high HHHHH will be displayed

If the input is too low LLLLL will be displayed

12.4.2 EEPROM Write Frequency Warning, E2.Fr

The EEPROM used in this instrument has a limited number of write cycles. If any parameter writing to the EEPROM (typically over digital communications) starts to approach the limit specified for the EEPROM, an advanced warning alarm is activated. The alarm is displayed in a similar manner to other alarms. It consists of the scrolling message 'EEPROM WRITE FREQUENCY xxxx', where xxxx is the four digit HEX Modbus address of the first parameter that has caused the warning. The identifier is the parameter Modbus address (scaled integer address in HEX). Should this alarm occur, it is essential that the parameter(s) identified are removed from the communications and, where possible, substituted by alternatives such as those stated in section 15.4 – 'Broadcast Communications'. In the unlikely event that the identifier shows an address of Hex 4000 or above, this indicates that an internal parameter has exceeded the write rate and you should contact your supplier.

The calculation for the warning to be displayed is based upon a worst case write cycle of 100,000 over a 10 year minimum life span.

The hourly write rate to give a minimum 10 year life is calculated as follows:

10 year rate = Worst case life cycles / the number of hours in 10 years

= 100,000 / (10 * 365 * 24)

= 1.1 writes per hour

When configuring, commissioning or starting/completing an operation it is conceivable for the number of writes to be greater than this limit. However, as this is not expected to continue for a long period, the warning will not be activated until a period of 6 hours has elapsed. The 6 hour check is overridden if the number of writes in a single hour is greater than a maximum threshold. This threshold has been set at 30 writes i.e. one every 2 minutes. This is to help conserve EEPROM cell life by informing the user early of a potential issue.

12.4.3 Remote Setpoint Fail, rEm.F

If the remote setpoint is enabled (address 276, section 15.6) then the Remote Setpoint parameter AltSP (address 26, section 15.6) is used as a setpoint provided that a value has been reached within a window of about 5 seconds. If no value is received then the controller falls back to the currently selected setpoint (SP1 or SP2) and an alarm is generated. The alarm consists of the mnemonic rEm.F which is flashed in sequence with other active alarms in the second line of the display. The ALM beacon blinks at the same time.

The message disappears when remote setpoint values are sent within the time period.

13. Timer

A timer can be disabled or configured to operate in Soft Start mode. The timer can be configured in Level 2 (also 3 and CONF). Operation of the timer has been described in section 5.4.

13.1 Timer Parameters

The full list of all available parameters in configuration level is given in the following table.

TIMER LIST	"TIMER"					
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
TM.CFG	TIMER CONFIGURATION	To enable the soft start timer	NONE	Timer disabled	NONE	L3
			SFST	Soft start		
The following parameters are not shown when the timer is not configured.						
TM.RES	TIMER RESOLUTION	To set the time units	HOUR	Hours		Conf R/O L3
			MIN	Minutes		
SS.SP	SOFT START SETPOINT	This parameter sets the threshold value below which the power is limited. It operates on the difference between the setpoint (SP) and the process variable (PV). If PV is between SP ± SS.SP the power will be limited to that set by SS.PWR.	Off or 1 to 9999		OFF	L3
SS.PWR	SOFT START POWER LIMIT	Sets the limit to the power output during start up	Between High and Low power limits (OP.HI and OP.LO) set in CTRL list. -100% to 100% for heat/cool and no limits set		0	L3
T.STAT	TIMER STATUS	Timer status	RES	Reset		L3
			RUN	Running (counting)		
			HOLD	Running (hold)		
			END	Timed out		
DWELL	SET TIMER DURATION	To set the time duration	0:00 to 99:59 hh:mm or mm.ss		0	L3
T.ELAP	ELAPSED TIME	Time elapsed from when the timer starts to run	0:00 to 99.59 hh:mm or mm.ss			L3 read only
T.REMN	TIME REMAINING	Time remaining to reach the set time.	0:00 to 99.59 hh:mm or mm.ss			L3
The timer can be restarted from the Reset condition by changing the time remaining parameter.						

14. Recipe

A recipe, available in Level 3, can take a snapshot of the current values and store these into a recipe number. This helps to reduce set up time, for example, where a number of different products are to made which require different parameter values.
There are five recipes available. Each recipe can store the current values of the parameters listed in the following table:-

14.1 List of Default Recipe Parameters:

Instrument resolution is always saved and restored, as are instrument units, proportional band units and dwell resolution. The following parameters are the other default recipe parameters.

PB	Proportional Band	A1.XX	Alarm 1 threshold1
TI	Integral time	A2.XX	Alarm 2 threshold2
TD	Derivative time	A3.XX	Alarm 3 threshold3
D.BAND	Channel 2 deadband	A4.XX	Alarm 4 hreshold4
CB.LO	Cutback low	LBT	Loop break time
CB.HI	Cutback high	HYST.H	Channel 1 hysteresis
R2G	Relative cool gain	HYST.C	Channel 2 hysteresis
SP1	Setpoint 1	HOME	Home Display
SP2	Setpoint 2	SP.HI	Setpoint High limit
MR	Manual reset On/off only	SP.LO	Setpoint Low limit
OP.HI	Output high limit	TM.CFG	Timer configuration
OP.LO	Output low limit	TM.RES	Timer reset
SAFE	Safe Output	SS.SP	Soft start setpoint
SP.RAT	Setpoint rate limit	SS.PWR	Soft start power limit
A1.HYS	Alarm 1 hysteresis	DWELL	Set time duration
A2.HYS	Alarm 2 hysteresis	THRES	Timer Threshold
A3.HYS	Alarm 3 hysteresis	END.T	Timer End Type
A4.HYS	Alarm 4 hysteresis	RAMPU	Ramp Units
		T.STAT	Programmer/Timer status

14.2 To Save Current Values in a Recipe

Do This	The Display You Should See	Additional Notes
1. Press ⓟ as many times as necessary to select 'RECIP'		Scrolling display RECIPE LIST
2. Press ⓒ to scroll to 'STORE' 3. Press ▲ or ▼ to choose the recipe number to store eg 1		Scrolling display RECIPE TO SAVE The current parameter values are stored in Recipe 1

14.3 To Save Values in a Second Recipe

In this example the proportional band will be changed and stored in recipe 2. All other values will remain the same as recipe 1:-

Do This	The Display You Should See	Scrolling display Additional Notes
1. Press ⓜ to scroll to 'CTRL'		Scrolling display CONTROL LIST
2. Press ⓒ to scroll to PB 3. Press ▲ or ▼ to change the value e.g. 22		Scrolling display PROPORTIONAL BAND
4. Press ⓜ to scroll to 'RECIP'		Scrolling display RECIPE LIST
5. Press ⓒ to 'STORE' 6. Press ▲ or ▼ to 2		Scrolling display RECIPE TO SAVE

14.4 To Select a Recipe to Run

Do This	The Display You Should See	Additional Notes
1. Press ⓜ as many times as necessary to select 'RECIP'		Scrolling display RECIPE LIST
2. Press ⓒ to select 'REC.NO' 3. Press ▲ or ▼ to choose recipe number e.g. 1		Scrolling display CURRENT RECIPE NUMBER The values stored in Recipe 1 will now be loaded. If a recipe number is chosen which has not been saved then FAIL will be displayed

15. Digital Communications

Digital Communications (or 'comms' for short) is available in SX90 only. It allows the controller to communicate with a PC or computer system.

This product conforms to MODBUS RTU protocol a full description of which can be found on www.modbus.org.

Two ports are available both using MODBUS RTU communication facilities:

1. a configuration port - intended to communicate with a system to download the instrument parameters and to perform manufacturing tests and calibration.
2. an EIA422 (5-wire) port on terminals HB to HF - intended for field communications using, for example, a PC running a SCADA package.

The two interfaces cannot operate at the same time.

Each parameter has its own unique Modbus address. A list of these is given at the end of this section.

15.1 Wiring EIA422 (EIA485 5-wire)

To use EIA422, buffer the EIA232 port of the PC with a suitable EIA232/EIA422 converter. The KD485 Communications Converter unit is recommended for this purpose. Instruments on a EIA422 communication network should be chain connected and not star connected.

To construct a cable for EIA422 operation use a screened cable with two twisted pairs plus a separate core for common. Although common or screen connections are not necessary, their use will significantly improve noise immunity.

Connect the SX90 controller to the PC as shown in section 2.20.

15.2 Digital Communications Parameters

The following table shows the parameters available.

DIGITAL COMMUNICATIONS LIST 'COMMS'						
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
ID	MODULE IDENTITY	Comms identity	r422	EIA422 Modbus SX90 only	r422	Conf and L3 R/O
ADDR	ADDRESS	Communications address of the instrument	1 to 254		1	L3
BAUD	BAUD RATE	Communications baud rate	1200	1200	9600	Conf L3 R/O
			2400	2400		
			4800	4800		
			9600	9600		
			19.20	19,200		
PRTY	PARITY	Communications parity	nonE	No parity	nonE	Conf L3 R/O
			EuEn	Even parity		
			Odd	Odd parity		
DELAY	RX/TX DELAY TIME	To insert a delay between Rx and Tx to ensure that drivers have sufficient time to switch over.	OFF	No delay		Conf L3 R/O
			on	Fixed delay applied		
RETRN	TRANSMITTED PARAMETER	Master comms broadcast parameter. See section 15.4	nonE	None	nonE	
			w.SP	Working setpoint		
			PV	Process Variable		
			OP	Output demand		
			Err	Error		
REG.AD	DESTINATION ADDRESS	Parameter added in the Slave address to which the master communications value will be written See section 15.4.	0 to 9999		0	

15.3 Example To Set Up Instrument Address

This can be done in operator level 3:-

Do This	The Display you should see	Additional Notes
1. Press (▤) as many times as necessary to select 'COMMS LIST'		Scrolling display 'COMMS LIST'
2. Press (○) to scroll to 'ID'		This displays the type of communications board fitted. Scrolling display 'ID'.
3. Press (○) to scroll to 'ADDR' 4. Press . (▲) or (▼) to select the address for this controller		Up to 254 can be chosen but note that no more than 33 instruments should be connected to a single link. Scrolling display 'ADDRESS'

For more information contact your supplier.

15.4 Broadcast Communications

Broadcast communications as a simple master. Broadcast master communications allows the SX90 controller to send a single value to any number of slave instruments. Modbus broadcast using function code 6 (Write single value) must be used. This allows the SX90 to link with other products, without the need for a supervisory PC, to create a small system solution. Example applications include multi-zone setpoint programming applications or cascade control using a second controller. The facility provides a simple and precise alternative to analogue retransmission.

The retransmitted parameter can be selected from Setpoint, Process Variable, Output Demand or Error. The controller will cease broadcast when it receives a valid request from a Modbus master.

⚠ **Warning**

In common with most instruments in its class, the SX80/90 Range uses a non-volatile memory with a limited number of specified writes. Non-volatile memory is used to hold information that must be retained over a power cycle, and typically, this includes setpoint and status information, including alarm latch status.

Please ensure that parameters which do not require updating on a regular basis (for example, setpoints, alarm trip levels, hysteresis, etc) are only written to when a change in the parameter value occurs. Failure to do this could result in permanent damage to the internal EEPROM.

When using the SX80/90 Range, use the 'AltSP' variable at Modbus address 26 if you need to write to a temperature setpoint. This has no write restrictions and may also have a local trim value applied using the 'SPTrim' parameter at Modbus address 27.

A further explanation is given in section 15.4.3.

15.4.1 Broadcast Master Communications

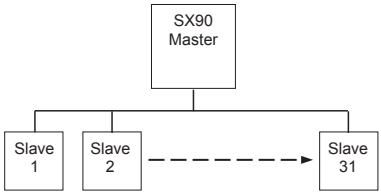
The SX90 broadcast master can be connected to up to 31 slaves if no segment repeaters are used. If repeaters are used to provide additional segments, 32 slaves are permitted in each new segment. The master is configured by setting the 'RETRAN' parameter to `w.SP`, `PV`, `OP` or `Err`.

Once the function has been enabled, the instrument will send this value out over the communications link every control cycle (250ms).

Notes:-

1. The parameter being broadcast must be set to the same decimal point resolution in both master and slave instruments.
2. If iTools *, or any other Modbus master, is connected to the port on which the broadcast master is enabled, then the broadcast is temporarily inhibited. It will restart approximately 30 seconds after iTools * is removed. This is to allow reconfiguration of the instrument using iTools * even when broadcast master communications is operating.

* iTools is proprietary software used to configure instruments. For more information contact your supplier.



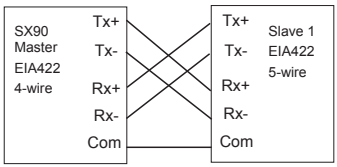
15.4.2 Wiring Connections

The Digital Communications module for use as a master or slave is fitted in Comms Module slot H and uses terminals HA to HF.

☺ **EIA422 (5-wire) SX90**

Rx connections in the master are wired to Tx connections of the slave

Tx connections in the master are wired to Rx connections of the slave



15.4.3 EEPROM Write Cycles

By specification the EEPROM memory used in this range allows 100,000 changes (although typically much more). If this write cycle count is exceeded the instrument will display an E2.Er message and the it will become unusable and must be returned for repair.

In order to provide the user with advanced warning of a potential problem a warning alarm is generated if a parameter write cycle approaches a threshold (section 12.4.2).

The following sections give examples of parameters which could cause this limit to be exceeded over a period of time.

Setpoint Ramping

Continuous changing of setpoint via digital communications – for example a ramping value – is the most common cause of EEPROM wear.

One solution, given in the section above 'Master/Slave (Broadcast) Communications', is to select "Remote Setpoint" in the Variables list in iTools, and write values to Modbus address 26 (hex 001A).

An approximately 5 second timeout is applied to writes to Modbus address 26 so that if values are not received within this period, a remote fail alarm will be generated (section 12.4.3) – this can also trigger a problem with EEPROM wear - see 'Alarms and other Status Changes' below.

This problem may be avoided by using the Target Setpoint at address 02 which avoids this problem, but note that any value written to this parameter will not be retained over a power fail. In order to access the Target setpoint it is also necessary to enable the remote Setpoint (iTools STATUS list address 276).

It is **critically important** to select the remote setpoint if updating the setpoint on a regular basis otherwise the setpoint change will be saved to non-volatile memory and EEPROM wear will result.

Alarms and other Status Changes

Alarm status is saved in non-volatile memory and this includes status alarms such as sensor break, loop break, remote fail and individual alarm and alarm latching status. Every transition into and out of an alarm condition triggers an EEPROM write. Thus, if there is any fast toggling of an alarm status, EEPROM wear can result within the expected lifetime of an instrument.

An example of this is where event alarms are used to provide an on/off control loop. SX80/90 instruments should on no account be used in this manner since the toggling of the output will rapidly use up the 100,000 writes. The On/Off control in the PID algorithm should be used instead. However, any situation where alarm states can change rapidly should be avoided.

Mode and Timer/Programmer Changes

Rapid changes to instrument mode (Auto/Manual) or the Timer/Programmer operation can cause EEPROM wear because the status (run/hold/reset) or the segment number are stored in EEPROM on each transition.

In normal use where segments or timer sequences are relatively long, it is unlikely that problems will be seen. However, in some applications where a sequence is run frequently, EEPROM wear will occur. An example of this is where a digital input is used in an application to trigger a timer sequence and the operation is performed as fast as possible by an operator, EEPROM wear occurred after a few years.

Digital Inputs

Care should be taken with any rapid cycling digital inputs. Typically a digital input triggering timer or mode changes (as above) should be carefully considered so that they do not switch more than 100,000 times during the expected lifetime of the instrument.

15.5 DATA ENCODING

☺ Note that the iTools* OPC server provides a straightforward means of accessing any variable in the controller in the correct data format without the need to consider data representation. However if you wish to write your own communications interface software, you will need to take the format used by the instrument comms software into account.

Modbus data is normally encoded into a 16 bit signed integer representation.

Integer format data, including any value without a decimal point or represented by a textual value (for example 'off', or 'on'), is sent as a simple integer value.

For floating point data, the value is represented as a 'scaled integer', in which the value is sent as an integer which gives the result of the value multiplied by 10 to the power of the decimal resolution for that value. This is easiest to understand by reference to examples:

FP Value	Integer Representation
FP Value	Integer Representation
9.	9
-1.0	10
123.5	1235
9.99	999

It may be necessary for the Modbus master to insert or remove a decimal point when using these values.

It is possible to read floating point data in a native 32 bit IEEE format. For more information contact your supplier.

For **time** data, for example, the length of a dwell, the integer representation depends on the resolution. For 'hours' resolution, the value returned is the number of minutes the value represents, so for example a value of 2:03 (2 hours and three minutes) would be returned as an integer value of 123. For 'minutes' resolution, the value used is the number of seconds the value represents, so that 12:09 (12 minutes and 9 seconds) would be returned as 729.

It is possible to read time data in a native 32 bit integer format, in which case it returns the number of milliseconds the variable represents regardless of the resolution. For more information contact your supplier.

* iTools is proprietary software used to configure instruments. For more information contact your supplier.

15.6 Parameter Modbus Addresses

Parameter Mnemonic	Parameter Name	Modbus Address
PV.IN	PV (Temperature) Input Value (see also Modbus address 203 which allows writes over Modbus to this variable).	1
TG.SP	Target Setpoint. ***NB – do not write continuously changing values to this variable. The memory technology used in this product has a limited (100,000) number of write cycles. If ramped setpoints are required, consider using the internal ramp rate function or the remote comms setpoint (Modbus address 26)in preference.***	2
MAN.OP	Manual Output Value	3
WRK.OP	Working Output	4
WKG.SP	Working Setpoint (Read Only)	5
PB	Proportional Band	6
CTRL.A	Control Action 0 = Reverse Acting 1 = Direct Acting	7
TI	Integral Time (0 = No Integral Action)	8
Td	Derivative Time (0 = No Derivative Action)	9
RNG.LO	Input Range Low Limit	11
RNG.HI	Input Range High Limit	12
A1.---	Alarm 1 Threshold	13
A2.---	Alarm 2 Threshold	14
SP.SEL	Active Setpoint Select 0 = Setpoint 1 1 = Setpoint 2	15
D.BAND	Channel 2 Deadband	16
cB.Lo	Cutback Low	17
cB.HI	Cutback High	18
R2G	Relative Cool/Ch2 Gain	19
MTR.T	Motor Travel Time	21
T.STAT	Timer Status 0 = Reset 1 = Run 2 = Hold 3 = End	23
SP1	Setpoint 1 ***NB – do not write continuously changing values to this variable. The memory technology used in this product has a limited (100,000) number of write cycles. If ramped setpoints are required, consider using the internal ramp rate function or the remote comms setpoint (Modbus address 26)in preference.***	24
SP2	Setpoint 2	25
SP3	Setpoint 3	29
ALTSP	Alternative setpoint	26
LOC.t	Local Trim – added to the remote setpoint to compensate for local temperature variations in a control zone.	27
MR	Manual Reset	28
OP.HI	Output High Limit	30

Parameter Mnemonic	Parameter Name		Modbus Address
OP.LO	Output Low Limit		31
HOLD.B	Holdback 0 - Off		32
SAFE	Safe Output Value for Sensor Break or other fault conditions.		34
SP.RAT	Setpoint Rising Rate Limit Value (0 = no rate limit)		35
SP.FAT	Setpoint Falling Rate Limit Value (0 = no rate limit)		36
P.Err	Calculated Error (PV-SP)		39
A1.HYS	Alarm 1 Hysteresis		47
N.HI	Valve nudge raise 0 - No; 1 - Yes		48
N.LO	Valve nudge lower 0 - No; 1 - Yes		49
POTP.1	Channel 1 valve position		50
POTB.1	Potentiometer break 0 - off	1 - on	51
PMOD	Potentiometer break mode 0 - up	1 - down 2 - rest	52
VPB.IN	VPB input source 0 - dc input	1 - Pot input	53
A2.HYS	Alarm 2 Hysteresis		68
A3.HYS	Alarm 3 Hysteresis		69
A4.HYS	Alarm 4 Hysteresis		71
STAT	Instrument Status. This is a bitmap: B0 – Alarm 1 Status B1 – Alarm 2 Status B2 – Alarm 3 Status B3 – Alarm 4 Status B4 – Auto/Manual Status B5 – Sensor Break Status B6 – Loop Break Status B7 – CT Low load current alarm status (not applicable to SX series)	B8 – CT High leakage current alarm status (not applicable to SX series) B9 – Program End (not applicable to SX series) B10 – PV Overrange (by > 5% of span) B11 – CT Overcurrent alarm status (not applicable to SX series) B12 – New Alarm Status B13 – Timer/Ramp Running B14 – Remote (comms) SP Fail B15 – Autotune Status In each case, a setting of 1 signifies 'Active', 0 signifies 'Inactive'.	75
InVERSE STATUS	Inverted Instrument Status. This is an inverted (bitwise) version of the preceding parameter and is provided so that scrolling messages can be triggered when a condition is not active. Bit mappings are as the "Instrument Status", Modbus address 75		76
InST STATUS2	Instrument Status 2. This is a bitmap similar to InstStatus and provides a summary of the main instrument status indicators. B0 – EEPROM Write Frequency Warning Flag No further bits are used in the current firmware		77
A3.---	Alarm 3 Threshold		81
A4.---	Alarm 4 Threshold		82
LBT	Loop Break Time		83
F.OP	Forced manual output value		84

Parameter Mnemonic	Parameter Name		Modbus Address
F.MOD	Forced manual output mode 0 – None 1 - Step 2 - Last		85
HYST.H	Ch1 On/Off Hysteresis in Eng Units		86
DI.IP	Digital Inputs Status. This is a bitmap: B1 – Logic input LA B2 – Logic input LB B3 - Logic input LC B4 - Logic input LD B7 – Power has failed since last alarm acknowledge A value of 1 signifies the input is closed, otherwise it is zero. Values are undefined if options are not fitted or not configured as inputs.		87
HYST.C	Ch2 On/Off Hysteresis in Eng Units		88
FILT.T	Input Filter Time		101
RC.FT	Filter time constant for the rate of change alarm.		102
RC.PV	Calculated rate of change of the temperature or process variable in engineering units per minute.		103
HomE	Home Display. 0 – Standard PV and SP display 1 – PV and Output Power display 2 – PV and Time remaining display 3 – PV and Timer elapsed time display 4 – PV and Alarm 1 setpoint	5 – PV and Load Current 6 – PV only 7 – PV and Composite SP/Time remaining 8 – Target setpoint 9 – No PV 10 – PV is not displayed when controller in Standby	106
-	Instrument version number. Should be read as a hexadecimal number, for example a value of 0111 hex is instrument V1.11		107
LangUAGE	Instrument language 0 - English 1 - French	2 - Italian 3 - Spanish 4 - German	108
SP.HI	Setpoint High Limit		111
SP.LO	Setpoint Low Limit		112
-	Instrument type code.		122
ADDR	Instrument Comms Address		131
PV.OFS	PV Offset		141
C.Adj	Calibration Adjust		146
IM	Instrument Mode 0 – Operating mode - all algorithms and I/O are active 1 – Standby - control outputs are off 2 – Config Mode - all outputs are inactive		199
MV.IN	Input value in millivolts		202
PV.CM	Comms PV Value. This may be used to write to the Process Variable (temperature) parameter over Modbus when a linearisation type of 'Comms' is selected, allowing the instrument to control to externally derived values. If sensor break is turned on, it is necessary to write to this variable once every 5 seconds. Otherwise a sensor break alarm will be triggered as a failsafe. If this is not required, turn sensor break off.		203
POT.P	Pot position		204

Parameter Mnemonic	Parameter Name		Modbus Address
CJC.IN	CJC Temperature		215
SBR	Sensor Break Status (0 = Off, 1 = Active)		258
NEW.AL	New Alarm Status (0 = Off, 1 = Active)		260
LBR	Loop Break (0 = Off, 1 = Active)		263
A.TUNE	Autotune Enable (0 = Off, 1 = Enabled)		270
TU.HI	Autotune high power output limit		271
TU.LO	Autotune low power output limit		272
A-M	Mode of the Loop (0 = Auto, 1 = Manual)		273
Ac.ALL	Acknowledge all alarms (1 = Acknowledge		274
L-R	Local Remote (Comms) Setpoint Select		276
	Remote setpoint in percent		277
REM.HI	Remote input high scalar – sets high range for setpoint input, corresponding to 20mA or 10V depending on input type.		278
REM.LO	Remote input low scalar – sets low range for setpoint input, corresponding to 4mA or 0V depending on input type.		279
ROP.HI	Sets the high range limit for the retransmitted setpoint. Allows a subset of the setpoint range to be retransmitted, and also allows the SX90 setpoint range meter to display a range indication other than full scale. By default this is set to the setpoint high limit.		280
ROP.LO	Sets the low range limit for the retransmitted setpoint. Allows a subset of the setpoint range to be retransmitted, and also allows the SX90 setpoint range meter to display a range indication other than full scale. By default this is set to the setpoint low limit.		281
A1.STS	Alarm 1 Status (0 = Off, 1 = Active)		294
A2.STS	Alarm 2 Status (0 = Off, 1 = Active)		295
A3.STS	Alarm 3 Status (0 = Off, 1 = Active)		296
A4.STS	Alarm 4 Status (0 = Off, 1 = Active)		297
REC.NO	Recipe to Recall 0 - None	6 - Done 7 - Fail	313
StOrE	Recipe to Save 0 - None	6 - Done 7 - Fail	314
TM.CFG	Timer type configuration 0 – No Timer	3 – Soft Start Timer	320
TM.RES	Timer Resolution 0 – Hours:Mins	1 – Mins:Secs	321
SS.SP	Soft Start Setpoint		322
SS.PWR	Soft Start Power Limit		323
DWELL	Requested Timer Duration		324
T.ELAP	Elapsed Time		325
T.REMN	Time Remaining		326
CTRL.H	Heat/Ch1 Control Type 0 – Off	2 – PID Control 3 – Boundless motor Valve Position Control (MTR)	512

Parameter Mnemonic	Parameter Name		Modbus Address
	1 – On/Off Control	4 - Bounded motor Valve Position Control (BMTR)	
CTRL.C	Cool/Ch2 Control Type 0 – Off 1 – On/Off Control	2 – PID Control	513
PB.UNT	Proportional Band Units 0 – Engineering Units 1 – Percent of Span		514
LEV2.P	Level 2 Code		515
UNITS	Display Units 0 – Degrees C 1 – Degrees F	2 – Kelvin 3 – None 4 – Percent	516
LEV3.P	Level 3 Code		517
ConF.P	Config Code		518
CoLd	If set to 1 instrument will reset to factory defaults on next reset or power cycle.		519
PASS.C	Feature passcode C		520
PASS.2	Feature passcode 2		521
COOL.t	Cooling Algorithm Type: 0 – Linear 1 – Oil	2 – Water 3 – Fan	524
DEC.P	Decimal Point Position 0 – XXXX.	1 – XXX.X 2 – XX.XX	525
STBY.T	Standby Type 0 – Absolute Alarm Outputs Active – others off	1 – All outputs inactive	530
RAMP UNITS	0 – Ramp per Minute 1 – Ramp per Hour	2 – Ramp per Second	531
METEr	(SX90 Only). Ammeter configuration 0 – No ammeter 1 – Heat Output (0-100%) 2 – Cool Output (0-100% cooling) 3 – Working Setpoint (scaled within SP limits)	4 – PV (scaled within range) 5 – Output Power (scaled within Op Low and OP High limits) 6 – Output centered between –100% and 100% 7 – Error (PV-SP) (scaled between +/- 10 degrees) 10 - Potentiometer position (PPOS)	532
uCAL	User Calibration Enable		533
A1.TYP	Alarm 1 Type 0 – Off 1 –Absolute High 2 – Absolute Low	3 – Deviation High 4 – Deviation Low 5 – Deviation Band	536
A2.TYP	Alarm 2 Type (as Alarm 1 Type)		537
A3.TYP	Alarm 3 Type Enumerations as Alarm 1 Type		538
A4.TYP	Alarm 4 Type Enumerations as Alarm 1 Type		539
A1.LA	Alarm 1 Latching Mode 0 – No latching	1 – Latch - Automatic Reset 2 – Latch – Manual Reset	540
A2.LAT	Alarm 2 Latching Mode. Enumerations as Alarm 1 Latching Mode		541
A3.LAT	Alarm 3 Latching Mode. Enumerations as Alarm 1 Latching Mode		542

Parameter Mnemonic	Parameter Name		Modbus Address
A4.LAT	Alarm 4 Latching Mode. Enumerations as Alarm 1 Latching Mode		543
A1.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)		544
A2.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)		545
A3.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)		546
A4.BLK	Alarm Blocking Mode Enable (0 = OFF, 1 = BLOCK)		547
DI.OP	Digital Outputs Status. This is a bitmap: B0 – Output 1A B1 – Output 2A B2 – Output 3 on SX 80 and SX90 controllers B3 – Output 4/AA B4 - Output 5 B5 - Output 6 It is possible to write to this status word to use the digital outputs in a telemetry output mode. Only outputs whose function is set to 'none' are affected, and the setting of any bits in the Digital Output Status word will not affect outputs used for heat (for example) or other functions. Thus it is not necessary to mask in the settings of these bits when writing to this variable.		551
OFS.HI	Adjust High Offset		560
OFS.LO	Adjust Low Offset		561
PNT.HI	Adjust High Point		562
PNT.LO	Adjust Low Point		563
CT.RNG	CT Range (this parameter is not applicable to SX series)		572
SB.EYP	Sensor Break Type 0 – No Sensor Break	1 – Non-Latching Sensor Break 2 – Latching Sensor Break	578
Id	Customer ID – May be set to any value between 0-9999 for identification of instruments in applications. Not used by the instrument itself.		629
PHASE	Calibration Phase 0 – None 1 – 0 mv 2 – 50 mv 3 – 150 Ohm 4 – 400 Ohm 5 – CJC 6 – CT 0 mA 7 – CT 70 mA 8 – Factory Defaults	9 – Output 1 mA low cal 10 – Output 1 mA high cal 11 – Output 2 mA low cal 12 – Output 2 mA high cal 13 – Output 3 ma low cal (SX90 only) 14 – Output 3 ma high cal (SX90 only) 15 – Remote setpoint input low volts 16 - Remote setpoint input high volts 17 - Remote setpoint input low current 18 - Remote setpoint input high current	768
GO	Calibration Start 0 – No 1 – Yes (start cal) 2 – Cal Busy	3 – Cal Pass 4 – Cal Fail Note values 2-4 cannot be written but are status returns only	769
-	Analogue Output Calibration Value		775
POT.L	Potentiometer low point calibration 0 - Rest 1 - Up	2 - Down 3 - End	780
POT.H	Potentiometer high point calibration 0 - Rest 1 - Up	2 - Down 3 - End	781

Parameter Mnemonic	Parameter Name		Modbus Address
K.LOC	Allows instrument to be locked via a key/digital input 0 - unlocked, 1 – all keys locked 2 – Edit keys (raise and lower) disabled	3 – Mode key disabled 4 – Manual mode disabled 5 – Enter standby mode when Mode combination pressed 6 – Timer keys disabled	1104
IN.TYP	Input Sensor Type 0 – J Type Thermocouple 1 – K Type Thermocouple 2 – L Type Thermocouple 3 – R Type Thermocouple 4 – B Type Thermocouple 5 – N Type Thermocouple	6 – T Type Thermocouple 7 – S Type Thermocouple 8 – RTD 9 – millivolt 10 – Comms Input (see Modbus address 203) 11 – Custom Input (Downloadable)	12290
CJ.TYP	CJC Type 0 – Auto	1 – 0 Degrees C 2- 50 Degrees C	12291
mV.HI	Linear Input High		12306
mV.LO	Linear Input Low		12307
L.TYPE (LA)	Logic Input A channel hardware type (not applicable to SX series) 0 – None 1 – Logic Input		12352
L.D.IN (LA)	Logic input A function		12353
L.SENS (LA)	Configures the polarity of the logic input channel A (0 = Normal, 1 = Inverted)		12361
L.TYPE (LB)	Logic Input B channel hardware type (SX90 only) 0 – None 1 – Logic Inputs		12368
L.D.IN (LB)	Logic input B function (SX90 only) 40 – None 41 – Acknowledge all alarms 42 – Select SP2 43 – Lock All Keys 44 – Timer Reset 45 – Timer Run 46 – Timer Run/Reset 47 – Timer Hold	48 – Auto/Manual Select 49 – Standby Select 50 – Remote setpoint 51 – Recipe select through IO1 52 – Remote key UP 53 – Remote key DOWN 54 – Digit 1 - Setpoint select (SP.d1) 55 – Digit 2 - Setpoint select (SP.d2)	12369
L.SENS (LB)	Configures the polarity of the logic input channel B (0 = Normal, 1 = Inverted) (SX90 only)		12377
L.TYPE (LC)	Logic Input C channel hardware type (SX90 only) 0 – None 1 – Logic Inputs		12384
L.D.IN (LC)	Logic input C function (SX90 only). Enumerations as L.D.IN (LB)		12385
L.SENS (LC)	Configures the polarity of the logic input channel C (0 = Normal, 1 = Inverted) (SX90 only)		12393
L.TYPE (LD)	Logic Input D channel hardware type (SX90 only). 0 – None 1 – Logic Inputs		12400
L.D.IN (LD)	Logic input D function (SX90 only) Enumerations as L.D.IN (LB)		12401

Parameter Mnemonic	Parameter Name		Modbus Address
L.SENS (LD)	Configures the polarity of the logic input channel D (0 = Normal, 1 = Inverted) (SX90 only)		12409
ID	Comms Module Type 0 – None	3 – EIA422 4 – Remote setpoint input	12544
BAUD	Baud Rate 0 – 9600 1 – 19200	2 – 4800 3 – 2400 4 – 1200	12548
PRTY	Parity setting 0 – None	1 – Even 2 – Odd	12549
DELAY	RX/TX Delay – (0 = no delay, 1 = delay) Select if a delay is required between received and transmitted comms messages. Sometimes required when intelligent EIA232 adaptors are used.		12550
RETRN	Comms Retransmission Variable selection: 0 – Off 1 – Working Setpoint	2 – PV 3 – Output Power 4 – Error	12551
REG.AD	Modbus register address to broadcast retransmission to. For example if you wish to retransmit the working setpoint from one 3200 to a group of slaves, and receive the master working setpoint into the slaves' remote setpoint, set this variable to 26 (the address of the remote setpoint in the slave units).		12552
1.ID	IO channel 1 hardware type 0 – None 1 – Relay		12672
1.FUNC	I/O Channel Function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position	10 – DC Output no function	12675
1.SRC.A	Output AA source A 0 – None 1 – Alarm 1 2 – Alarm 2 3 – Alarm 3 4 – Alarm 4 5 – All Alarms (1-4) 6 – New Alarm 7 – CT Alarm (Load, Leak or Overcurrent)	8 – Loop Break Alarm 9 – Sensor Break Alarm 10 – Timer End (or Not Ramping) 11 – Timer Run (or Ramping) 12 – Auto/Manual 13 – Remote fail 14 – Power fail 15 – Programmer event	12678
1.SRC.B	Output AA source B As IO Channel 1 Source A (Modbus address 12678)		12679
1.SRC.C	Output AA source C As IO Channel 1 Source A (Modbus address 12678)		12680
1.SRC.D	Output AA source D As IO Channel 1 Source A (Modbus address 12678)		12681
1.PLS	Output 1 minimum pulse time 0 - Auto		12706
1.SENS	Output Polarity (0 = Normal, 1 = Inverted)		12682
2.ID	Output 2 Type 0 – None 19 – DC.RT mA output		12736
2.FUNC	Output 2 Channel function 0 – None (or Telemetry Output)	11 – DC Output Heat 12 – DC Output Cool	12739

Parameter Mnemonic	Parameter Name		Modbus Address
	1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position 10 – DC Output no function	13 – DC Output WSP retransmission 14 – DC Output PV retransmission 15 – DC Output OP retransmission	
2.RNG	IO Channel 2 DC Output Range 0 – 0-20mA	1 – 4-20mA	12740
3.ID	Output 3 Type 0 – None	3 – DC OP	12800
3.FUNC	Output 3 Channel function 0 – None (or Telemetry Output) 1 – Digital Output 2 – Heat or UP if valve position 3 – Cool or DOWN if valve position 10 – DC Output no function	11 – DC Output Heat 12 – DC Output Cool 13 – DC Output WSP retransmission 14 – DC Output PV retransmission 15 – DC Output OP retransmission	12803
3.RNG	IO Channel 3 DC Output Range 0 – 0-20mA	1 – 4-20mA	12804
4.TYPE	Output AA Type 0 – None	1 – Relay	13056
4.FUNC	Output 4 Channel function 0 – None (or Telemetry Output) 1 – Digital Output	2 – Heat or UP if valve position 3 – Cool or DOWN if valve position	13059
4.SRC.A	Output AA source A. As IO Channel 1 Source A (Modbus address 12678)		13062
4.SRC.B	Output AA source B. As IO Channel 1 Source A (Modbus address 12678)		13063
4.SRC.C	Output AA source C. As IO Channel 1 Source A (Modbus address 12678)		13064
4.SRC.D	Output AA source D. As IO Channel 1 Source A (Modbus address 12678)		13065
4.SENS	Output Polarity (0 = Normal, 1 = Inverted)		13066
4.PLS	Output AA Time proportioning Output minimum pulse time. 0 - Auto		13090
5.TYPE	Output 5 Type 0 – None	1 – Relay	13184
5.FUNC	Output 5 Channel function 0 – None (or Telemetry Output) 1 – Digital Output	2 – Heat or UP if valve position 3 – Cool or DOWN if valve position	13187
5.SRC.A	Output 5 source A. As IO Channel 1 Source A (Modbus address)		13190
5.SRC.B	Output 5 source B. As IO Channel 1 Source A (Modbus address)		13191
5.SRC.C	Output 5 source C. As IO Channel 1 Source A (Modbus address)		13192
5.SRC.D	Output 5 source D. As IO Channel 1 Source A (Modbus address)		13193
5.SENS	Output Polarity (0 = Normal, 1 = Inverted)		13194
5.PLS	Output AA Time proportioning Output minimum pulse time 0 - Auto		13195
6.TYPE	Output 6 Type 0 – None	1 – Relay	13312
6.FUNC	Output 6 Channel function 0 – None (or Telemetry Output) 1 – Digital Output	2 – Heat or UP if valve position 3 – Cool or DOWN if valve position	13315
6.SRC.A	Output 6 source A. As IO Channel 1 Source A (Modbus address)		13318

Parameter Mnemonic	Parameter Name	Modbus Address
b.SRC.B	Output 6 source B. As IO Channel 1 Source A (Modbus address)	13319
b.SRC.C	Output 6 source C. As IO Channel 1 Source A (Modbus address)	13320
b.SRC.D	Output 6 source D. As IO Channel 1 Source A (Modbus address)	13321
b.SENS	Output Polarity (0 = Normal, 1 = Inverted)	13322
b.PLS	Output AA Time proportioning Output minimum pulse time 0 - Auto	13323

16. Calibration

The following adjustments can be made:-

1. Offset the input to compensate for known errors in the sensor.
2. Calibration of the feedback potentiometer for valve position control.

Both of these adjustments are available to the user, since they may be made during the commissioning phase or, for example, when a sensor is changed. They are, therefore, available in Operator level 3.

16.1 Offsets

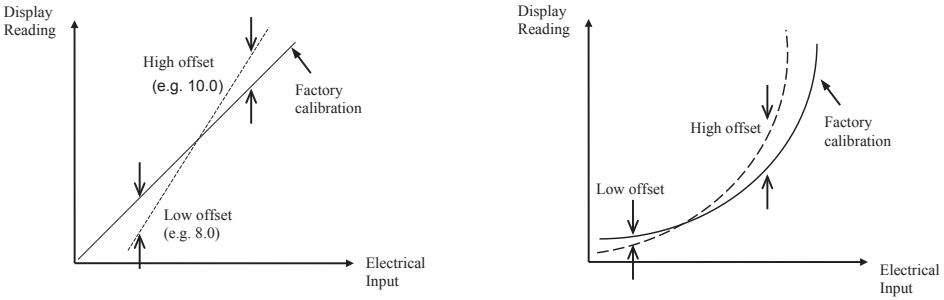
The process value can be offset to take into account known errors within the process. The offset can be applied to any Input Type (mV, V, mA, thermocouple or RTD).

A single offset can be applied - the procedure is carried out in the *INPUT* list and has been described in section 8.1.3.

It is also possible to adjust the low and high points as a two point offset. This can only be done in **Level 3** in the '*CAL*' list and is described below.

16.1.1 Two Point Offset

A two point offset adjusts both a low point and a high point and applies a straight line between them. Any readings above and below the calibration points will be an extension of this straight line. For this reason it is best to calibrate with the two points as far apart as possible as shown in the example below:-



Two Point Offset Applied to Linear and Non-linear Inputs

16.1.2 To Apply a Two Point Offset

Assume the instrument is set up (as described in section 8.1.4.1) to display 0.0 for an input of 4.00mV and 500.0 for an input of 20.00mV. Assume that a particular sensor in use has known errors such that the instrument is required to read 8.0 for an input of 4.00mV and 490.0 for an input of 20.00mV. To compensate for these errors in the process a low point offset of 8.0 and a high point offset of 10.0 can be set as follows:- ▲ or ▼ ·

Operation	Do This	Display View	Additional Notes
Select the Calibration list header	1. Select Level 3 as described in Chapter 2. Then press ▤ to select 'CAL'	CAL	Two pint offset can only be carried out in Level 3
Set mV input to 4.00mV			
Select User Calibration	2. Press · to scroll to 'U.CAL'	IdLE UCAL	Scrolling 2message user calibration
Select Low calibration point	3. Press ▲ or ▼ to 'LO'	Lo UCAL	
Set the low offset value	4. Press · to scroll to 'C.ADJ' 5. Press ▲ or ▼ to set the low offset value eg 8.0	8.0 C.ADJ	This applies an offset over the whole range in the same way as a simple offset section 8.1.3.
	The controller then reverts to the CAL list header	CAL	This is the same as 1 above
Set mV input to 20.00mV			
Select User Calibration	6. Press · to scroll to 'U.CAL'	IdLE UCAL	This is the same as 2 above
Select the high calibration point	7. Press ▲ or ▼ to 'HI'	HI UCAL	
Select the high calibration offset parameter	8. Press S to scroll to 'C.ADJ'	508.0 C.ADJ	The reading will show 508.0
Set the high offset value	9. Press ▲ or ▼ to set the high offset value to read 490.0	490.0 C.ADJ	
Under normal operating conditions the controller will now read 8.0 for an input of 4.000mV and 490.0 for an input of 20.000mV.			

16.1.3 To Remove the Two Point Offset

Operation	Do This	Display View	Additional Notes
In level 3 select the Calibration list header	1. In Level 3, press ▤ to select 'CAL'	CAL	Two point offset can only be carried out in Level 3
Select User Calibration	2. Press · to scroll to 'U.CAL'	IdLE UCAL	Scrolling message user calibration
Reset to no offset	3. Press ▲ or ▼ to select 'r.SEt'	rSEt UCAL	
The display will revert to 2 above and the two point offsets will be removed.			

16.2 Feedback Potentiometer (Valve Position Control)

A feedback potentiometer may be connected to SX90 only to provide indication of the position of the valve. For bounded mode the potentiometer is necessary to control the position of the valve. In boundless control it is not necessary for control purposes but it can be used to provide indication of the valve position on the front panel meter.

16.2.1 To Calibrate the Feedback Potentiometer.

Operation	Do This	Display View	Additional Notes
Select the Calibration list header	1. Select Level 3 as described in Chapter 2. Then press ⓘ to select '*CAL*'		Two pint offset can only be carried out in Level 3
Calibrate the low calibration point.	2. Press ⊙ to select '*POT.L*' 3. Press ▲ or ▼ to position the valve to its minimum travel. This may be fully closed or partly open. The valve may be nudged by momentarily pressing the raise a lower buttons.		When the button is released the calibration position is entered and stored and is indicated by a brief flash of the display. The meter will indicate 0% to 100% of the valve travel.
Calibrate the high calibration point	4. Press ⊙ to select '*POT.H*' 5. Press ▲ or ▼ to position the valve to its maximum travel. This may be fully open or partly closed. The valve may be nudged by momentarily pressing the raise a lower buttons.		

16.3 Input Calibration

The controller is calibrated during manufacture using traceable standards for every input range. It is, therefore, not necessary to calibrate the controller when changing ranges. Furthermore, the use of a continuous automatic zero correction of the input ensures that the calibration of the instrument is optimised during normal operation.

However, to comply with some statutory procedures it may be necessary to verify calibration on a regular basis.

16.4 To Verify Input Calibration

The PV Input may be configured as mV, mA, thermocouple or platinum resistance thermometer.

16.4.1 Precautions

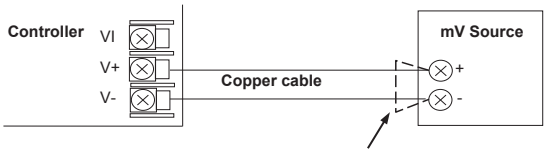
Before checking or starting any calibration procedure the following precautions should be taken:-

1. When calibrating mV inputs make sure that the calibrating source output is set to less than 250mV before connecting it to the mV terminals. If accidentally a large potential is applied (even for less than 1 second), then at least one hour should elapse before commencing the calibration.
2. RTD and CJC calibration must not be carried out without prior mV calibration.
3. 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.
4. Power should be turned on only after the controller has been inserted in the sleeve of the pre-wired circuit. Power should also be turned off before removing the controller from its sleeve.
5. Allow at least 10 minutes for the controller to warm up after switch on.

16.4.2 To Verify mV Input Calibration

The input may have been configured for a process input of mV, Volts or mA and scaled in Level 3 as described in section 8.1.4. The example described in section 8.1.4.1 assumes that the display is set up to read 2.0 for an input of 4.000mV and 500.0 for an input of 20.000mV.

To check this scaling, connect a milli-volt source, traceable to national standards, to terminals V+ and V- using copper cable as shown in the diagram below.



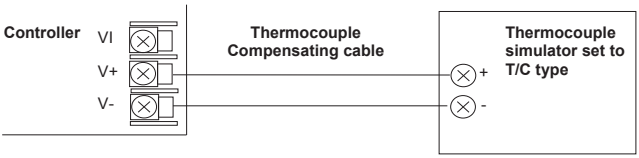
☺Ensure that no offsets (see sections 8.1.3.1 and 16.1) have been set in the controller.

Set the mV source to 4.000mV. Check the display reads 2.0 ±0.25% ± 1LSD (least significant digit).

Set the mV source to 20.000mV. Check the display reads 500.0 ±0.25% ± 1LSD.

16.4.3 To Verify Thermocouple Input Calibration

Connect a milli-volt source, traceable to national standards, to terminals V+ and V- as shown in the diagram below. The mV source must be capable of simulating the thermocouple cold junction temperature. It must be connected to the instrument using the correct type of thermocouple compensating cable for the thermocouple in use.



Set the mV source to the same thermocouple type as that configured in the controller.

Adjust the mV source for to the minimum range. For a type K thermocouple, for example, the minimum range is -200^{O}C.

However, if it has been restricted using the Range Low parameter, then set the mV source to this limit. Check that the reading on the display is within $\pm$0.25% of reading $\pm$ 1LSD.

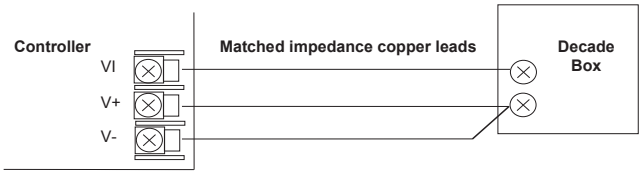
Adjust the mV source for to the maximum range. For a type K thermocouple, for example, the maximum range is 1372^{O}C.

However, if it has been restricted using the Range High parameter, then set the mV source to this limit. Check that the reading on the display is within $\pm$0.25% of reading $\pm$ 1LSD.

Intermediate points may be similarly checked if required.

16.4.4 To Verify RTD Input Calibration

Connect a decade box with total resistance lower than 1K and resolution to two decimal places in place of the RTD as indicated on the connection diagram below **before the instrument is powered up**. If at any instant the instrument was powered up without this connection then at least 10 minutes must elapse from the time of restoring this connection before RTD calibration check can take place.



The RTD range of the instrument is -200 to 850^{O}C. It is, however, unlikely that it will be necessary to check the instrument over this full range.

Set the resistance of the decade box to the minimum range. For example 0^{O}C = 100.00Ω. Check the calibration is within $\pm$0.25% of reading $\pm$ 1LSD.

Set the resistance of the decade box to the maximum range. For example 200^{O}C = 175.86Ω. Check the calibration is within $\pm$0.25% of reading $\pm$ 1LSD.

16.5 To Re-calibrate an Input

If it considered necessary to calibrate the input or output this can only be carried out in configuration level.

In SX series instruments, inputs which can be calibrated are:-

- **mV Input.** This is a linear 80mV range calibrated at two fixed points. This should always be done before calibrating either thermocouple or resistance thermometer inputs. mA range calibration is included in the mV range.
- **Thermocouple** calibration involves calibrating the temperature offset of the CJC sensor only. Other aspects of thermocouple calibration are also included in mV calibration.
- **Resistance Thermometer**. This is also carried out at two fixed points - 150Ω and 400Ω.

16.5.1 To Calibrate mV Input

Calibration of the mV range is carried out using a 50 milli-volt source, connected as described in section 16.4.2. mA calibration is included in this procedure.

For best results 0mV should be calibrated by disconnecting the copper wires from the mV source and short circuiting the input to the controller

To calibrate the mV Input, select **Conf Level** as described in Chapter 2, set the controller input to mV range, then:-

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ⓘ as many times as necessary until the 'CAL' page header is displayed.		Scrolling display 'CALIBRATION LIST'
Select the Calibration Phase	2. Press ⋱ to select 'PHASE'		Scrolling display 'CALIBRATION PhASE'
Set mV source for 0mV			
Select the low calibration point	3. Press ▲ or ▼ to choose '0'		
Calibrate the instrument to the low calibration point (0mV)	4. Press ⋱ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'	  	Scrolling display 'CALIBRATION StArt' The controller automatically calibrates to the injected input mV. The display will show busy then pass, (if calibration is successful.) or 'FAIL' if not. Fail may be due to incorrect input mV
Set mV source for 50mV			
Select the high calibration point	6. Press ⋱ to select 'PHASE' 7. Press ▲ or ▼ to choose '50' 8. Repeat 5 and 6 above to calibrate the high point		The controller will again automatically calibrate to the injected input mV. If it is not successful then 'FAIL' will be displayed

16.5.2 To Calibrate Thermocouple Input

Thermocouples are calibrated, firstly, by following the previous procedure for the mV ranges, then calibrating the CJC.

Connect a mV source as described in section 16.4.3. Set the mV source to '**internal compensation'** for the thermocouple in use and set the output for **0mV**. Then:-

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ⧉ as many times as necessary until the '*CAL*' page header is displayed.		
Select the calibration phase	2. Press ⊙ to select '*PHASE*'		Scrolling display '*CALIBRATION Start*'
Select CJC calibration	3. Press ▲ or ▼ to select '*CJC*'		
Calibrate CJC	4. Press ⊙ to select '*GO*' 5. Press ▲ or ▼ to choose '*YES*'		The controller automatically calibrates to the CJC input at 0mV. The display will show busy then pass, (if calibration is successful) or '*FAIL*' if not. Fail may be due to an incorrect input mV

16.5.3 To Calibrate RTD Input

The two points at which the RTD range is calibrated are 150.00Ω and 400.00Ω.

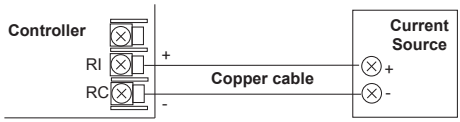
Before starting RTD calibration:

- A decade box with total resistance lower than 1K must be connected in place of the RTD as indicated on the connection diagram in section 16.4.4 **before the instrument is powered up**. If at any instant the instrument was powered up without this connection then at least 10 minutes must elapse from the time of restoring this connection before RTD calibration can take place.
- The instrument should be powered up for at least 10 minutes.
- Before calibrating the RTD input the mV range must be calibrated first

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ▤ as many times as necessary until the 'CAL' page header is displayed.		Scrolling display 'CALIBRATION LIST'
Select the calibration phase	2. Press ⟨'⟩ to select 'PHASE'		Scrolling display 'CALIBRATION PhASE'
Set the decade box for 150.00Ω			
Select the low calibration point (150Ω)	3. Press ▲ or ▼ to choose '150r'		
Calibrate the low point	4. Press ⟨'⟩ to select 'GO' 5. Press ▲ or ▼ to choose 'YES'		Scrolling display 'CALIBRATION StArt'
The controller automatically calibrates to the injected 150.00Ω input. The display will show busy then pass (if calibration is successful) or 'FAIL' if not. Fail may be due to an incorrect input resistance			
Set the decade box for 400.00Ω			
Select the high calibration point (400Ω)	6. Press ▲ or ▼ to choose '400r'		
Calibrate the high point	7. Repeat 5 and 6 above to calibrate the high point		
The controller will again automatically calibrate to the injected 400.00Ω input. If it is not successful then 'FAIL' will be displayed			

16.5.4 To Calibrate Remote Setpoint Input

Connect a milli amp source to terminals RI and RC as shown.



Select **Conf Level** as described in Chapter 2, then:-

Operation	Do This	Display View	Additional Notes
Select the Calibration List header	1. From any display press ⧉ as many times as necessary until the '*CAL*' page header is displayed.	CAL	Scrolling display '*CALIBRATION LIST*'
Select the Calibration Phase	2. Press ⊙ to select '*PHASE*'	none PHASE	Scrolling display '*CALIBRATION LIST*'
Set mA source for 4mA			
Select the low calibration point	3. Press ▲ or ▼ to choose '*rm.CL*'	rm.CL PHASE	
Calibrate the instrument to the low calibration point (4mA)	4. Press ⊙ to select '*GO*' 5. Press ▲ or ▼ to choose '*YES*'	YES GO BUSY GO PASS GO	Scrolling display '*CALIBRATION LIST*' The controller automatically calibrates to the injected input. The display will show busy then pass, (if calibration is successful.) or '*FAIL*' if not. Fail may be due to incorrect mA input.
Set mV source for 20mA			
Select the high calibration point	6. Press ⊙ to select '*PHASE*' 7. Press ▲ or ▼ to choose '*rm.CH*' 8. Repeat 4 and 5 above to calibrate the high point	rm.CH PHASE	The controller will again automatically calibrate to the injected input mV. If it is not successful then '*FAIL*' will be displayed

To calibrate the voltage input, connect a volts source to terminals RC (negative) and RV (positive). The procedure is the same as described above but the calibration points are:-

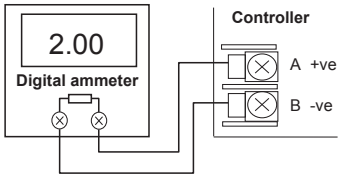
Parameter	Calibration Voltage
rm.VL	0 Volts
rm.VH	10 Volts

16.6 Output Calibration

Calibration of the output can only be carried out in configuration level.

16.6.1 To Calibrate mA Outputs

Output 2 SX80 and SX90 and Output 3 SX90 only are supplied as mA outputs. The outputs may be adjusted as follows:-
Connect an ammeter to the output – terminals 2A/2B or 3A/3B (SX90) as appropriate.



Then, in configuration level:-

Operation	Do This	Display View	Additional Notes
Select low point calibration phase for the mA output to be calibrated (eg OP2)	1. From the 'CAL' list header press ⊙ to select 'PHASE' 2. Press ▲ or ▼ to choose '2mA.L'	2.mA.L PHASE	Scrolling message 'calibration PhASE'
Set the low point output	3. Press ⊙ to select 'VALUE' 4. Press ▲ or ▼ to adjust this value so that it reads the same value as shown on the ammeter. For example if the meter reads 2.06 then set the controller reading for 206. The decimal point is not displayed on the controller so that 200 represents 2.00.	206 VALUE	Scrolling message 'dc outPut rEadinG'
Repeat for the high point as follows: Select high point calibration phase for the mA output to be calibrated (eg OP2)	5. Press ⊙ to go back to 'PHASE' 6. Press ▲ or ▼ to choose '2mA.H'	2.mA.H PHASE	Scrolling message 'calibration PhASE'
Set the high point output	7. Press ⊙ to select 'VALUE' 8. Press ▲ or ▼ to adjust this value so that it reads the same value as shown on the ammeter. The value represents 18.00mA	1800 VALUE	Scrolling message 'dc outPut rEadinG'

The above procedure may be repeated for outputs 2 and 3 if they are fitted with analogue output modules.

16.7 To Return to Factory Calibration

It is always possible to revert to the factory calibration as follows:-

Operation	Do This	Display View	Additional Notes
Select the calibration phase	1. From the 'CAL' list header press ⊙ to select 'PHASE'		
Select factory calibration values	2. Press ▲ or ▼ to choose 'FACt'		
Confirm	3. Press ⊙ to select 'GO' 4. Press ▲ or ▼ to choose 'YES'	 	The controller automatically returns to the factory values stored during manufacture

16.8 Calibration Parameters

The following table gives the parameters available in the Calibration List.

User Calibration is available in Level 3 only and is used to calibrate 'Offset' and feedback potentiometer see sections 16.1 & 16.2.

CALIBRATION PARAMETER LIST			'CAL'			
Name	**Scrolling Display**	**Parameter Description**	**Value**		**Default**	**Access Level**
UCAL	USER CALIBRATION	To select low and high offset state or reset to no offsets. See section 16.1.	IdLE	Normal operating state	IdLE	L3 only
			Lo	Low offset		
			HI	High offset		
			rSET	Remove high and low offsets		
The following parameters appear when calibrating the controller ie UCAL = Lo or Hi						
C.ADJ	CALIBRATION ADJUST	To set an offset value. See section 16.1.2	-1999 to 9999			L3 only
POT.L	POTENTIOMETER LOW POINT CALIBRATION	Calibration of the feedback potentiometer for bounded valve position control. Minimum valve travel.	See also section 16.2.1.			L3
POT.H	POTENTIOMETER HIGH POINT CALIBRATION	Calibration of the feedback potentiometer for bounded valve position control. Maximum valve travel.				

Input and Output calibration can only be done in ConF level.

CALIBRATION PARAMETER LIST			'cAL'			
Name	**Scrolling Display**	**Parameter Description**		**Value**	**Default**	**Access Level**
PHASE	CAL PHASE	To calibrate low and high offset	nonE	Not selected	nonE	Conf only
			0	Select mV low calibration point		
			50	Select mV high calibration point		
			150r	Select PRT low cal point		
			400r	Select PRT high cal point		
			CJC	Select CJC calibration		
			Ct 0	Select CT low cal point *		
			Ct 70	Select CT high cal point *		
			FAct	Return to factory settings		
			ImA.L	Low mA output from I/O 1 *		
			ImA.H	High mA output from I/O 1 *		
			2mA.L	Low mA output from output 2		
			2mA.H	High mA output from output 2		
			3mA.L	Low mA output from output 3		
			3mA.H	High mA output from output 3		
			rm.VL	Remote setpoint input low volts		
			rm.VH	Remote setpoint input high volts		
			rm.CL	Remote setpoint input low current		
			rm.CH	Remote setpoint input high current		
GO		To start the calibration sequence	NO		NO	Conf only
			YES	Start		
			bUSY	Calibrating		
			PASS	Calibration successful		
			FAIL	Calibration unsuccessful		

17. Access Parameters

The following table gives a summary of the parameters available under the ACCESS list header

☺ The Access List can be selected at any time when in configuration level. Hold (M) key down for more than 3 seconds, then press (▲) (▼) with (M) still held down.

ACCESS LIST		'ACCS'				
Name	Scrolling Display	Parameter Description	Values Allowed		Default	Access Level
GOTO	SELECT ACCESS LEVEL	Allows you to change the access level of the controller. Passwords prevent unauthorised change.	CONF	Configuration level	CONF	Conf
			LEV.1	Operator level 1		
			LEV.2	Operator level 2		
			LEV.3	Operator level 3		
LEV2.P	LEVEL 2 PASSCODE	The Level 2 passcode	0-9999 0 = no passcode will be requested		2	Conf
LEV3.P	LEVEL 3 PASSCODE	The Level 3 passcode			3	Conf
CONF.P	CONFIG PASSCODE	To set a Configuration level passcode			4	Conf
ID	CUSTOMER ID	To set the identification of the controller	0-9999			Conf
HOME	HOME DISPLAY See section 17.1.1	To configure the parameter to be displayed in the lower line of the HOME display.	STD	Setpoint	STD	Conf
			OP	Output demand		
			TR	Time remaining		
			ELAP	Time elapsed		
			AL	Alarm 1 setpoint		
			CT	Current - not used in SX series		
			CLR	No parameter		
			tmr	Time remaining		
			t.SP	Target setpoint		
			no.PV	PV is not displayed		
			STBY	PV is not displayed when the controller is in standby mode		
K.LOC	KEYBOARD LOCK	To limit operation of the front panel buttons when in operator levels. ☺ If ALL has been selected, then to restore access to the keyboard, power up the controller with the (M) button held down and enter the configuration level passcode as described in section 6.1.3. This will take you to the Quick Code mode. Press (○) to EXIT and select YES. The front panel buttons can then be operated as normal.	none	Unlocked	none	Conf
			ALL	All buttons locked		
			Edit	Edit keys locked See section 17.1.2		
			Mod	Mode keys locked See section 17.1.3		
			MAn	Manual mode locked		
			STBY	Press (▲) and (▼) to toggle between normal operation and standby mode		
			tmr	Prevents Auto/Manual/Off but allow timer operation using (▲) and (▼)		
COLD	COLD START ENABLE/ DISABLE	**Use this parameter with care.** When set to yes the controller will return to factory settings on the next power up	No	Disable	No	Conf
			YES	Enable		
STBY.T	STANDBY TYPE	Turn ALL outputs off when the controller is in standby mode. Typical use when event alarms are used to interlock a process.	Abs.A	Absolute alarms to remain active	Abs.d	Conf
			OFF	All alarms off in standby		

METER	METER CONFIGURATION SEE SECTION 17.1.4	To configure the analogue meter to indicate any one of the parameters listed. This is only applicable to SX90 controllers.	OFF	Meter display disabled		Conf
			HEAT	Heat Output demand		
			COOL	Cool output demand		
			w.SP	Working setpoint		
			PV	Process value		
			OP	Heat output demand		
			C.OP	Cool output demand		
			Err	Error (SP – PV)		
			AmPS	Amps	Not applicable to the SX series	
			LCur	Load current		
			PPOS	Pot position		
PASS.C	FEATURE PASSCODE	To select chargeable features		Contact your supplier. See also section 17.1.5.		Conf
PASS.2	FEATURE PASSCODE					Conf
LANGU	LANGUAGE	Alarm messages are shown in the selected language. Scrolling Parameter descriptions are always shown in English.	EnG	English		Conf
			FrE	French		
			SPA	Spanish		
			ItA	Italian		
			GEr	German		

17.1.1 Home Display Configuration

The upper display always shows PV, the lower display is configurable.

Std	In automatic control the lower display shows setpoint. In manual mode output power is shown.
OP	Output power is shown in both automatic and manual modes.
Tr	Timer time remaining
ELAP	Timer elapsed time
AL 1	First configured alarm setpoint
CLr	Blank display
Tmr	The display shows setpoint while the timer is not running and time remaining when the timer is active.
t.SP	The display shows target setpoint so that the target for a ramp may be viewed rather than the current working setpoint
no.Pu	The upper display is blank
StbY	The upper display blanks when the controller is in standby mode

17.1.2 Edit keys locked.

Parameters cannot be changed but viewed only. However, it is possible to run, hold and reset timer and acknowledge alarms.

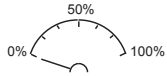
17.1.3 Mode key locked.

Timer run, hold, reset and Auto/Manual cannot be operated from the Mode key.

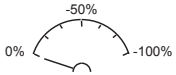
The following sections in this manual describe the parameters associated with each subject. The general format of these sections is a description of the subject, followed by the table of all parameters to be found in the list, followed by an example of how to configure or set up parameters.

17.1.4 Meter Configuration

HEAT The meter shows a representation of the heat output being applied by the control loop to the load. It is scaled between 0 and 100% full scale deflection.



COOL If the controller is configured for cool output only, the meter shows a representation of the cool output being applied by the control loop to the load where fully right is -100%. It is scaled between 0 and -100% full scale deflection.



OP The meter displays the working Control Output setting scaled between the low and high output power limits. If heat and cool are configured the meter is centre zero. If a motorised valve controller is configured the meter shows the 'inferred' position of the valve where fully left is the minimum output.

C.OP The meter displays the working output power setting scaled between the low and high output power limits, so that a value of zero is centred in the display. This indicates whether the controller is currently applying heating or cooling. If a motorised valve controller is configured the meter shows the 'inferred' position of the valve where centre zero the is minimum output.

w.SP The meter shows a representation of the working setpoint, scaled between the setpoint high and low limits. It may be used to indicate at what point in the setpoint range the instrument is currently operating.

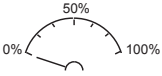
PV The meter displays the current Process Variable scaled between the range high and low values. Provides an indication of the current temperature relative to the range of a process.

Err The meter displays the process error (i.e. the difference between the current temperature and the setpoint), scaled between +10 degrees and -10 degrees. This provides a visual indication of whether the process is close to setpoint.

AmPS This parameter does not apply to the SX series

LCur This parameter does not apply to the SX series.

PPOS Position of feedback potentiometer



17.1.5 Feature Passcodes.

These parameters allow the controller to be field upgraded with additional chargeable features. To upgrade, contact your supplier and provide the existing number codes. 'Pass2' is read only and is required to provide your supplier with the current instrument features. You will be given a numeric code to enter as the new 'PassC' parameter.

18. Appendix A TECHNICAL SPECIFICATION

Analogue Input		
	Sample rate	4Hz (250mS)
	Calibration accuracy	<+0.25% of reading +/- 1LSD
	Resolution	<0.5µV when using a 1.6 second filter
	Linearisation accuracy	<0.1% of reading
	Input filter	Off to 59.9 secs
	Drift with temperature	50ppm typical. 100ppm worst case.
	Input Impedance	100MΩ
	Zero offset	User adjustable over the full display range
	Thermocouple Types	Refer to Sensor inputs and display ranges table
	Cold junction compensation	Automatic compensation typically >30 to 1 rejection of ambient temperature change or external reference 0°C (32°F)
	CJC Calibration accuracy	+/- 1.0°C at 25°C ambient
	Resistance thermometer type	3-wire, Pt100 DIN43760
	Bulb current	0.2mA
	Lead compensation	No error for 22 ohms in all 3 leads
	Process Linear	-10 to 80mV
	User Calibration	2 point gain and offset
Digital inputs		
	Contact closure or Logic	Contact open >1200Ω Contact closed <300Ω LB 12Vdc at 12mA; LC/LD 12V at 6mA - SX90 only LA 12Vdc at 12mA; LB 12V at 40mA - SX80
Outputs		
Relay	Form A (Normally open)	Min: 12V, 100mA dc Max: 2A, 264Vac resistive Max: 2A 264Vac resistive
	Form C, (Change-over) OP4 SX90 and Form A + A (NO + NO)	Min: 12V, 100mA dc Max: 2A, 264Vac resistive Max: 2A 264Vac resistive per terminal
	Application	Heating, cooling, alarms or valve position
	Snubber (22nF & 100Ω)	RC snubber should be fitted externally to prolong relay contacts
DC analogue output	Rating	0-20mA or 4-20mA software configurable
	Maximum load resistance	550Ω
	Isolation	300Vac double insulated from the PSU and communications
	Applications	Heating, cooling or retransmission
	Calibration accuracy	< ±(1% of reading +200µA)
Communications		
Digital	Transmission standard	EIA485 5-wire SX90 only (EIA422 compatible).
	Baud rate	1200, 2400, 4800, 9600, 19,200
	Protocols	Modbus RTU slave
	Isolation	300Vac double insulated
Control functions		
Control	Modes	PID or PI with overshoot inhibition, PD, PI, P only or On/Off or valve position
	Application	Heating and cooling or pressure
	Auto/manual	Bumpless transfer
	Setpoint rate limit	Off to 9999 degrees or display units per minute
Tuning	One-shot tune	Automatic calculation of PID and overshoot inhibition parameters
Alarms	Types	Full scale high or low. Deviation high, low, or band
	Modes	Latching or non-latching. Normal or blocking action Up to four process alarms can be combined onto a single output
Recipes		
	Number	5
	Parameters stored	38
	Selection	Key press or via remote communications
Remote SP input		
	Isolation	300Vac double insulated
	Calibration Accuracy	<+/- 0.25% of reading +/- 1 least significant digit
	Sample rate	4Hz
	Resolution	>14bits with 1.6 second filter 0.5mV for 0-10V input, 2µA for 4-20mA
	Drift with temperature	50ppm typical. 100ppm worst case.
	Input impedance	222kΩ (Volts) 2.49Ω (Current)

	Linear input range	0-10V, 0-20mA
	Zero offset	User adjustable
	User calibration	2 point gain and offset
Pot Input		
	Resistance range	100 to 10k
	Excitation voltage	0.46 to 0.54V
	Resolution	0.006% of span (>14bits)
	Sample rate	1Hz
	Short circuit pot detection	<25Ω
	Open circuit pot detection	>2MΩ
	Open circuit wiper detection	>5MΩ
SX80 Transmitter supply		
	Isolation	300VAC double insulated
	Output Voltage	18V +/- 15%
	Current	30mA max
	Load Regulation	<1V over 25mA
SX90 Transmitter supply		
	Isolation	300VAC double insulated
	Output Voltage	24V +/- 10%
	Current	30mA max
SX90 Remote SP input		
	Isolation	300VAC double insulated
	Calibration Accuracy	<+/- 0.25% of reading +/- 1LSD
	Sample Rate	4Hz
	Resolution	>14 bits, 0.5mV for 0-10V input, 2uA for 4-20mA
	Drift with temperature	50ppm typical, 150ppm worst case
	Input Impedance	>222Kohm (Volts) 2.49R (Current)
	Linear input range	0 – 10V, 0 – 20mA
SX90 Pot Input		
	Potentiometer resistance range	10Ω -10kΩ
	Excitation voltage	0.5V nominal
	Resolution	0.006% of Span (>14Bits)
	Sample Rate	1Hz
	Short circuit pot detection	<25Ω
	Open circuit pot detection	>2MΩ
	Open circuit wiper detection	>5MΩ
General		
	Text Messages	10 x 30 character messages
	Dimensions and weight	48W x 48H x 90Dmm (1.89W x 1.89H x 3.54D in) 8.82oz (250g)
	Power Supply	100 to 230Vac ±15%. 48 to 62Hz. SX80 6 Watts max, SX90 9 Watts max.
	Fusing	Fit a 2A type T fuse in line with this controller
	Temperature and RH	Operating: 32 to 131°F (0 to 55°C), RH: 5 to 85% non-condensing.
	Storage temperature	-30 to 75°C (14 to 158°F)
	Panel sealing	IP 65, plug-in from front panel
	Safety standards	EN61010, installation category II (voltage transients must not exceed 2.5kV), pollution degree 2.
	Electromagnetic compatibility	EN61326-1 Suitable for domestic, commercial and light industrial as well as heavy industrial environments. (Class B emissions, Industrial Environment immunity).
	Atmospheres	Not suitable for use above 2000m or in explosive or corrosive atmospheres.

19. Parameter Index

This is a list of parameters used in SX series controllers in alphabetical order together with the section in which they are to be found.

Mnemonic	Parameter Description	Location
1.ID	I/O 1 TYPE	IO1 List Section 9.1
1.FUNC	I/O 1 FUNCTION	IO1 List Section 9.1
1.PLS	OUTPUT 1 MINIMUM PULSE TIME	IO1 List Section 9.1
1.RNG	DC OUTPUT RANGE	IO1 List Section 9.1.1
1.SENS	I/O 1 SENSE	IO1 List Section 9.1
1.SRC.A	I/O 1 SOURCE A	IO1 List Section 9.1
1.SRC.B	I/O 1 SOURCE B	IO1 List Section 9.1
1.SRC.C	I/O 1 SOURCE C	IO1 List Section 9.1
1.SRC.D	I/O 1 SOURCE D	IO1 List Section 9.1
2.FUNC	FUNCTION	OP2 List Section 9.1.6
2.ID	OUTPUT 2 TYPE	OP2 List Section 9.1.6
2.RNG	DC OUTPUT RANGE	OP2 List Section 9.1.6
3.FUNC	FUNCTION	OP3 List Section 9.1.7
3.ID	OUTPUT 3 TYPE	OP3 List Section 9.1.7
3.RNG	DC OUTPUT RANGE	OP3 List Section 9.1.7
4.FUNC	FUNCTION	AA Relay List (OP4) Section 9.1.8
4.PLS	OUTPUT MINIMUM PULSE TIME	AA Relay List (OP4) Section 9.1.8
4.SENS	SENSE	AA Relay List (OP4) Section 9.1.8
4.SRC.A	I/O 4 SOURCE A	AA Relay List (OP4) Section 9.1.8
4.SRC.B	I/O 4 SOURCE B	AA Relay List (OP4) Section 9.1.8
4.SRC.C	I/O 4 SOURCE C	AA Relay List (OP4) Section 9.1.8
4.SRC.D	I/O 4 SOURCE D	AA Relay List (OP4) Section 9.1.8
4.TYPE	OUTPUT 4 TYPE	AA Relay List (OP4) Section 9.1.8
A1.---	ALARM 1 SETPOINT	Alarm Parameters Section 12.3
A1.BLK	ALARM 1 BLOCKING	Alarm Parameters Section 12.3
A1.HYS	ALARM 1 HYSTERESIS	Alarm Parameters Section 12.3
A1.LAT	ALARM 1 LATCHING TYPE	Alarm Parameters Section 12.3
A1.STS	ALARM 1 OUTPUT	Alarm Parameters Section 12.3
A1.TYP	ALARM 1 TYPE	Alarm Parameters Section 12.3
ADDR	COMMUNICATIONS ADDRESS	Digital Comms Section 15.2
A-M	LOOP MODE - AUTO MANUAL OFF	Control List Section 11.11
ATUNE	INTEGRAL TIME	Control List Section 11.11
BAUD	COMMUNICATIONS BAUD RATE	Digital Comms Section 15.2
BIAS		Setpoint List Section 10.1
C.ADJ	CALIBRATION ADJUST	Calibration Section 16.8
CBHI	CUTBACK LOW	Control List Section 11.11
CBLO	CUTBACK HIGH	Control List Section 11.11
CJ.TYP	CJC TYPE	Input List Section 8.1
CJC.IN	CJC TEMPERATURE	Input List Section 8.1
COLD	COLD START ENABLE/ DISABLE	Access List Section 17
CONF.P	CONFIG PASSCODE	Access List Section 17
COOL.T	NON LINEAR COOLING TYPE	Control List Section 11.11
CTRL.A	CONTROL ACTION	Control List Section 11.11
CTRL.C	COOLING TYPE	Control List Section 11.11
CTRL.H	HEATING TYPE	Control List Section 11.11
CYCLE	PROGRAM CYCLE	Timer Parameters Section 13.1
D.BAND	CHANNEL 2 DEAD BAND	Control List Section 11.11
DEC.P	DISPLAY POINTS	Input List Section 8.1
DELAY	RX/TX DELAY TIME	Digital Comms Section 15.2
DWELL	SET TIMER DURATION	Timer Parameters Section 13.1
F.MOD	FORCED MANUAL OUTPUT MODE	Control List Section 11.11
F.OP	FORCED OUTPUT	Control List Section 11.11
FILT.T	FILTER TIME	Input List Section 8.1
GO	START CALIBRATION	Calibration Section 16.8
GOTO	SELECT ACCESS LEVEL	Access List Section 17
HOLD.B	HOLDBACK	Setpoint Parameters Section 10.1.
HOME	HOME DISPLAY	Access List Section 17
HYST.C	COOLING HYSTERESIS	Control List Section 11.11
HYST.H	HEATING HYSTERESIS	Control List Section 11.11
ID	CUSTOMER ID	Access List Section 17
ID	MODULE IDENTITY	Digital Comms Section 15.2
IN.TYP	INPUT TYPE	Input List Section 8.1
K.LOC	KEYBOARD LOCK	Access List Section 17
LANGU	LANGUAGE	Access List Section 17
L.D.IN	LOGIC INPUT FUNCTION	Logic Input List Section 9.1.11
L.SENS	LOGIC INPUT SENSE	Logic Input List Section 9.1.11
L.TYPE	LOGIC INPUT TYPE	Logic Input List Section 9.1.11
LBR	LOOP BREAK STATUS	Control List Section 11.11
LBT	LOOP BREAK TIME	Control List Section 11.11
LEV2.P	LEVEL 2 PASSCODE	Access List Section 17
LEV3.P	LEVEL 3 PASSCODE	Access List Section 17
LOC.T	LOCAL SETPOINT TRIM	Setpoint List Section 10.1
L-R	REMOTE SETPOINT SELECT	Setpoint List Section 10.1
METER	METER CONFIGURATION	Access List Section 17
MR	MANUAL RESET	Control List Section 11.11
MTR.T	MOTOR TRAVEL TIME	Control List Section 11.11
MV.HI	LINEAR INPUT HIGH	Input List Section 8.1
MV.IN	MILLIVOLT INPUT VALUE	Input List Section 8.1

Mnemonic	Parameter Description	Location
MV.LO	LINEAR INPUT LOW	Input List Section 8.1
OHi	Output absolute high	Alarm List Section 12.3
OLo	Output absolute low	Alarm List Section 12.3
OP.HI	OUTPUT HIGH	Control List Section 11.11
OP.LO	OUTPUT LOW	Control List Section 11.11
PASS.2	FEATURE PASSCODE	Access List Section 17
PASS.C	FEATURE PASSCODE	Access List Section 17
PB	DERIVATIVE TIME	Control List Section 11.11
PB.UNT	PROPORTIONAL BAND UNITS	Control List Section 11.11
PHASE	CAL PHASE	Calibration Section 16.8
POT.H	POTENTIOMETER HIGH POINT CALIBRATION	Calibration Section 16.8
POT L	POTENTIOMETER LOW POINT CALIBRATION	Calibration Section 16.8
POT.P	POT POSITION	Process Input Parameters Section 8.1.
POT.P1	CH1 VALVE POSITION	Control Parameters section 11.10
POT.B1	CH1 POT BREAK	Control Parameters section 11.10
PMOD	POTENTIOMETER BREAK MODE	Control Parameters section 11.10
PRTY	COMMUNICATION S PARITY	Digital Comms Section 15.2
PV.IN	PV INPUT VALUE	Input List Section 8.1
PV.OFS	PV OFFSET	Input List Section 8.1
R2G	INTEGRAL TIME	Control List Section 11.11
RATIO		Setpoint List Section 10.1
RAMPU	SETPOINT RAMP UNITS	Setpoint List Section 10.1
RC.FT	Filter time constant for the rate of change alarm.	Modbus addresses section 15.6
RC.PV	Calculated rate of change of temperature or PV in engineering units per minute.	Modbus addresses section 15.6
REG.AD	COMMS RETRANSMISSION ADDRESS	Digital Comms Section 15.2
REM.HI	REMOTE INPUT HIGH SCALAR	Setpoint List Section 10.1
REM.LO	REMOTE INPUT LOW SCALAR	Setpoint List Section 10.1
RNG.HI	RANGE HIGH LIMIT	Input List Section 8.1
RNG.LO	RANGE LOW LIMIT	Input List Section 8.1
ROP.HI	SETPOINT RETRANS HIGH	Setpoint parameters section 10.1
ROP.LO	SETPOINT RETRANS LOW	Setpoint parameters section 10.1
SAFE	SAFE OUTPUT POWER	Control List Section 11.11
SB.TYP	SENSOR BREAK TYPE	Input List Section 8.1
SL1	SPLIT 1	Control List Section 11.11
SL2	SPLIT2	Control List Section 11.11
SL1.AC	S1 CONTROL ACTION	Control List Section 11.11
SL2.AC	S2 CONTROL ACTION	Control List Section 11.11
SP.HI	SETPOINT HIGH	Setpoint List Section 10.1
	LIMIT	
SP.LO	SETPOINT LOW LIMIT	Setpoint List Section 10.1
SPL.T	SPLIT OUTPUT	Control List Section 11.11
SP.RRT	SETPOINT RISING RATE LIMIT	Setpoint List Section 10.1
SP.fRT	SETPOINT FALLING RATE LIMIT	Setpoint List Section 10.1
SP.SEL	SETPOINT SELECT	Setpoint List Section 10.1
SP1	SETPOINT 1	Setpoint List Section 10.1
SP2	SETPOINT 2	Setpoint List Section 10.1
SP3	SETPOINT 3	Setpoint List Section 10.1
SS.PWR	SOFT START POWER LIMIT	Timer Parameters Section 13.1
SS.SP	SOFT START SETOINT	Timer Parameters Section 13.1
STBY.T	STANDBY TYPE	Access List Section 17
T.ELAP	ELAPSED TIME	Timer Parameters Section 13.1
T.REMN	TIME REMAINING	Timer Parameters Section 13.1
T.STAT	TIMER STATUS	Timer Parameters Section 13.1
TD	DERIVATIVE TIME	Control List Section 11.11
TI	RELATIVE COOL GAIN	Control List Section 11.11
TM.CFG	TIMER CONFIGURATION	Timer Parameters Section 13.1
TM.RES	TIMER RESOLUTION	Timer Parameters Section 13.1
UCAL	USER CALIBRATION	Calibration Section 16.8
UNITS	DISPLAY UNITS	Input List Section 8.1
VPB.IN	VPB INPUT SOURCE	Control list Section 11.11.

20. General Index