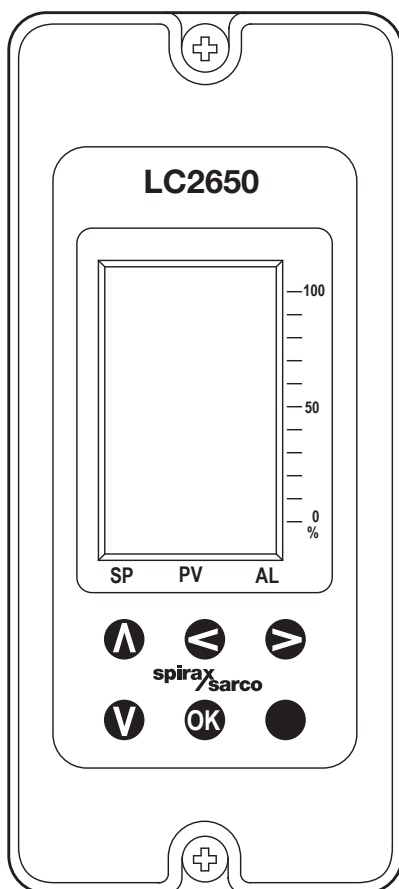


LC2650**Level controller****Installation and Maintenance Instructions**

1. *Safety information*
2. *General product and delivery information*
3. *System overview*
4. *Mechanical installation*
5. *Electrical installation*
6. *Commissioning*
 - *Quick set-up*
 - *Full*
7. *Communications*
8. *Maintenance*
9. *Fault finding*
10. *Technical information*
 - *Default settings*
11. *Appendix*
 - *Summary of the Modbus protocol*
12. *Menu map*

1. Safety information


Safe operation of this product can only be guaranteed if it is properly installed, commissioned, used and maintained by qualified personnel (see Section 1.11) in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

In the UK, your attention is drawn to IEE Regulations (BS 7671). Elsewhere, other regulations will normally apply.

All wiring materials and methods shall comply with relevant EN and IEC standards where applicable.

Warning

This product is designed and constructed to withstand the forces encountered during normal use. Use of the product other than as a boiler controller, or failure to install the product in accordance with these Instructions, product modifications or repair could:

- Cause injury or fatality to personnel.
- Cause damage to the product / property.
- Invalidate the  marking.

These instructions must be stored in a safe place near the product installation at all times.

Warning

This product complies with Electromagnetic Compatibility Directive 2004/108/EC and all its requirements.

This product is suitable for Heavy Industrial Environments. A fully detailed EMC assessment has been made and has the reference number UK Supply BH LC2650 2008.

The product may be exposed to interference above the limits of Heavy Industrial Immunity if:

- The product or its wiring is located near a radio transmitter.
- Excessive electrical noise occurs on the mains supply. Power line protectors (ac) should be installed if mains supply noise is likely. Protectors can combine filtering, suppression, surge and spike arrestors.
- Cellular telephones and mobile radios may cause interference if used within approximately 1 metre (39") of the product or its wiring. The actual separation distance necessary will vary according to the surroundings of the installation and the power of the transmitter.

This product complies with Low Voltage Directive 2006/95/EC by meeting the standards of:

- EN 61010-1:2001 Safety requirements for electrical equipment for measurement, control, and laboratory use.

This product has been type tested as a level control by meeting the standard:

- Vd TÜV requirements for water level control and limiting devices, water level 100 (07.2006).

Static precautions (ESD)

Static precautions must be observed at all times to avoid damage to the product.

Level control and level limiting products in steam boilers

Products/ systems must be selected, installed, operated, and tested in accordance with:

- Local or National standards and regulations.
- Guidance Notes, (Health and Safety Executive BG01 and INDG436 in the UK).
- The requirements of Approvals Authorities.
- Boiler Inspection Bodies.
- Boiler manufacturer's specifications.

Two independent low water limiting systems must be installed on steam boilers.

Level probes must be installed in separate protection tubes /chambers, with sufficient clearance between the tips, and earth.

Each probe must be connected to an independent controller. The alarm relays must isolate the boiler heat supply at low alarm status.

A high water alarm may be part of the water level control, or a separate system.

An independent high water alarm system must be fitted if it is considered a safety requirement.

In this case, the relays must simultaneously isolate the feedwater supply and the boiler heat supply at high alarm status. All boiler water limiters require regular functional testing.

The level probe and controller is only part of the control system. To complete the system, additional circuitry (wiring, relays, alarm bell / lamp etc.) is required.

A suitable water treatment regime must be used to ensure continuous safe and correct operation of the control and limiter systems. Consult the above authorities and a competent water treatment company.

Symbols



Equipment protected throughout by double insulation or reinforced insulation.



Functional earth (ground) terminal, to enable the product to function correctly.
Not used to provide electrical safety.



Clean earth / ground.



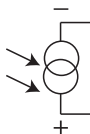
Safety earth.



Caution, risk of electric shock.



Caution, risk of danger, refer to accompanying documentation.



Optically isolated current source or sink.



Caution, Electrostatic Discharge (ESD) sensitive circuit. Do not touch or handle without proper electrostatic discharge precautions.



ac, alternating current.

1.1 Intended use

- i) Check that the product is suitable for use with the intended fluid.
- ii) Check material suitability, pressure and temperature and their maximum and minimum values. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or overtemperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) Spirax Sarco products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protection covers from all connections and protective film from all name-plates, where appropriate, before installation on steam or other high temperature applications.

1.2 Access

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product. Arrange suitable lifting gear if required.

1.3 Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required.

1.4 Hazardous liquids or gases in the pipeline

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider: flammable materials, substances hazardous to health, extremes of temperature.

1.5 Hazardous environment around the product

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

1.6 The system

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

1.7 Pressure systems

Ensure that any pressure is isolated and safely vented to atmospheric pressure. Consider double isolation (double block and bleed) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

1.8 Temperature

Allow time for temperature to normalise after isolation to avoid danger of burns.

1.9 Tools and consumables

Before starting work ensure that you have suitable tools and /or consumables available. Use only genuine Spirax Sarco replacement parts.

1.10 Protective clothing

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

1.11 Permits to work

All work must be carried out or be supervised by a suitably competent person. Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.

Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.

Post 'warning notices' if necessary.

1.12 Handling

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

1.13 Residual hazards

In normal use the external surface of the product may be very hot.

Many products are not self-draining. Take due care when dismantling or removing the product from an installation.

1.14 Freezing

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

1.15 Disposal

On disposal of the unit or component, appropriate precautions should be taken in accordance with Local/National regulations.

Unless otherwise stated in the Installation and Maintenance Instructions this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

1.16 Returning products

Customers and stockists are reminded that under EC Health, Safety and Environment Law, when returning products to Spirax Sarco they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

2. General product and delivery information

2.1 General description

The Spirax Sarco LC2650 is a level controller for conductive liquids. It has two alarm channels that can be independently configured high or low.

Warning: The minimum conductivity when used with the LP20/PA20 is 5 μ S/cm or 5 ppm.

The product can be panel, DIN rail, or chassis mounted and is powered by a 99 - 264 Vac mains supply.

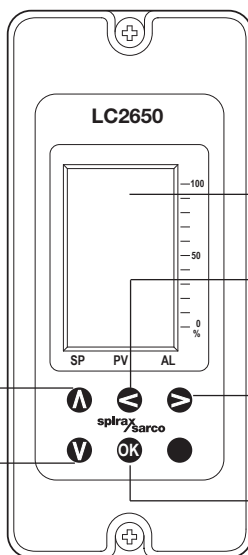
2.2 Front panel

The front panel has an LCD graphics display and five-button keypad.

Fig. 1 Front panel and keypad definitions

Scroll up menus / sub-menus.
Increase digits.

Scroll down menus /sub-menus.
Decrease digits.



Graphic display

Exit sub-menus and shift left to the next digit when the parameter or digit is flashing.

Enter sub-menus and shift right to the next digit when the parameter or digit is flashing.

Enters parameters when the parameter or digit is flashing. Hold down for 5 seconds to enter commissioning mode.

2.3 Using the buttons

The  and  buttons are used to:

- scroll up and down through the menus and sub-menus.
- increase or decrease digits when in a menu or sub-menu.




The  and  buttons are used to:

- exit and enter sub-menus.
- shift left and right to a flashing digit or parameter when in a menu or sub-menu.

The  button is used to:

- enter your choice of digit or parameter, when the digit or parameter is flashing.
- enter the commissioning mode (press and hold for five seconds).

Commissioning sets the product parameters, and allows the user to set and test the outputs, and to change the pass code - see Section 6.

Data to be edited is always displayed on the bottom right of the screen. Pressing the  button will enter new data. Pressing the  and  buttons will scroll through the available data and the previously entered selection will flash.

2.4 Run mode

In run mode, (normal), the display is divided into three sections:

- Four large digits, displaying the process variable and control parameters.
- Information line. Displays the various control states and process units.
- Three bar graphs, which show a percentage of full scale (percentage of the gauge glass).

After initially applying power to the product, it will automatically enter its run mode. The current level (PV) will be displayed.

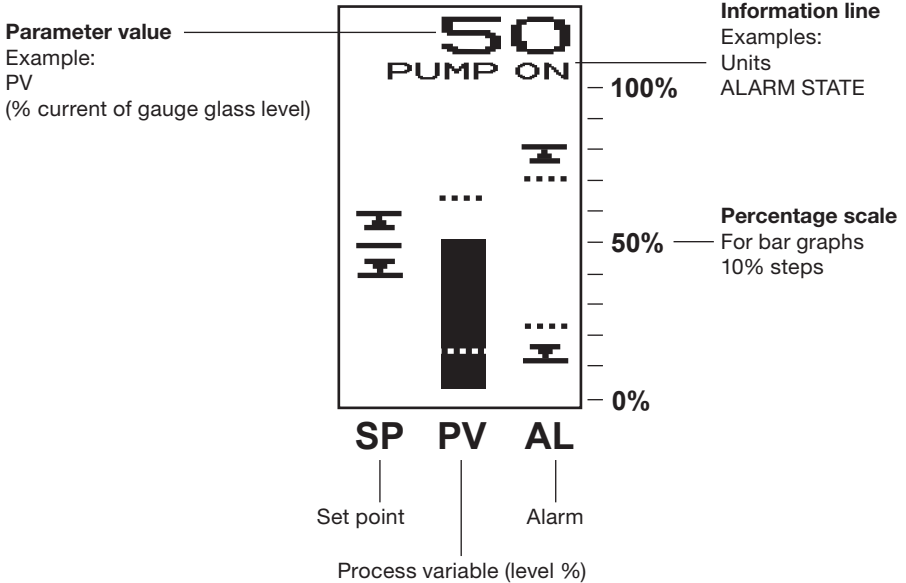


Fig. 2 Graphics display definitions - Bar graph mode

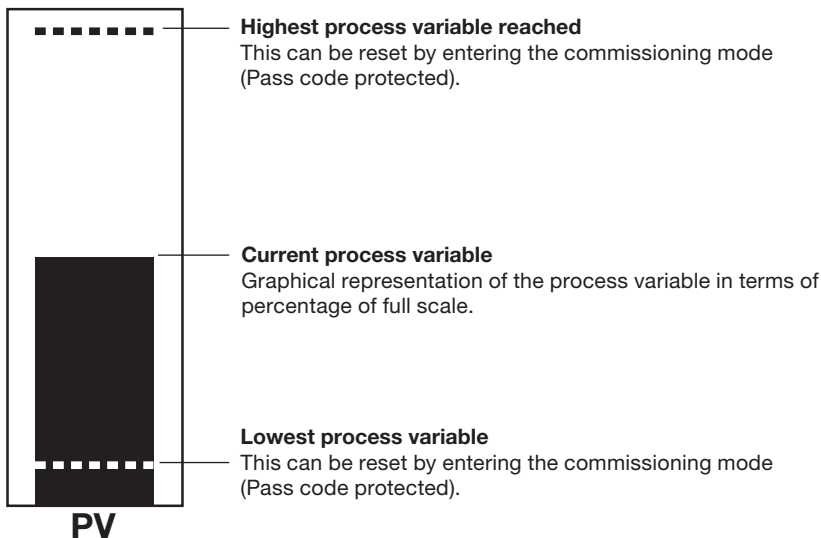


Fig. 3 PV (level %) bar graph definitions

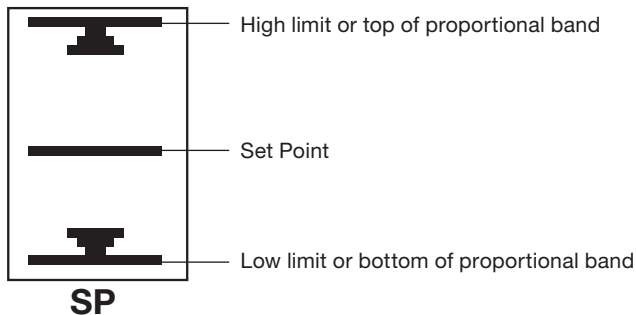


Fig. 4 Set Point bar graph definitions

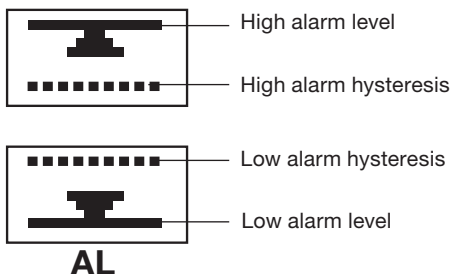
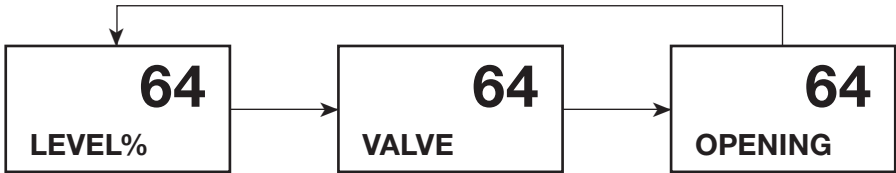


Fig. 5 Alarms bar graph definitions

2.5 Information line

The information line will show level and will alternate with information about alarms and the pump or valve status.

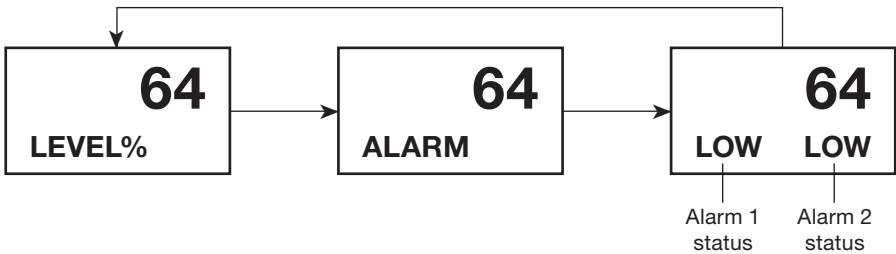
Example of valve status:



If an alarm occurs, the pump or valve status will not show.

'ALARM' will be shown first followed by the type of alarm. See Section 9 - 'Fault finding' for types of errors. The last information line is split into two.

Example of two low alarms:



2.6 View parameter mode

Press the **A** button in run mode to view and step through the parameters selected. Each parameter will remain on view for a further 2 minutes unless the button is pressed again. After initially applying power to the product, it will automatically enter its run mode. The current level (percentage) will be displayed. In run mode the general data is displayed on several screens, which can be accessed by pressing the up or down buttons. The parameter will appear on the display, alternating with the value. The controller is supplied with the following default settings:- **Security code (pass code) 7452**

LEVEL% 64	Process Variable - the level, shown as a percentage of the gauge glass.
SP% 50	The Set Point - as shown in commissioning mode. Normally 50% of the gauge glass - the valve will be at 50% at this level.
CTL BAND% 20	Sets the Proportional Band. This is the upper and lower limit over which the valve operates. The proportional band is set as a percentage of the gauge glass, with the Set Point being at 50%.
AL1 HIGH% 85	Alarm 1 can be set as a HIGH or LOW water alarm. Its value is a percentage of the gauge glass.
AL1 HYST% 5	Shows the hysteresis (damping effect) selected for alarm 1. Its value is a percentage of the gauge glass.
AL1 DEL S 0	Shows the delay in seconds (damping effect for turbulent conditions), chosen for ALARM 1.
AL2 LOW% 20	Alarm 2 is set to a LOW or HIGH water alarm. Its value is a percentage of the gauge glass.
AL2 HYST% 5	Shows the hysteresis (damping effect) selected for alarm 2. Its value is a percentage of the gauge glass.
AL2 DEL S 0	Shows the delay in seconds (damping effect for turbulent conditions), chosen for ALARM 2. Default setting is 0 s.
OFFSET% 0	Only shows if steam meter selected, (two element control). Shows % offset of steam meter. Its value is a percentage of the gauge glass.

The display will always revert to displaying the current level percentage if a button has not been pressed for 5 minutes.

Two element control - Split set point

The Split Set Point is visible only if a STEAM OFFSET percentage is selected in the INPUT menu.

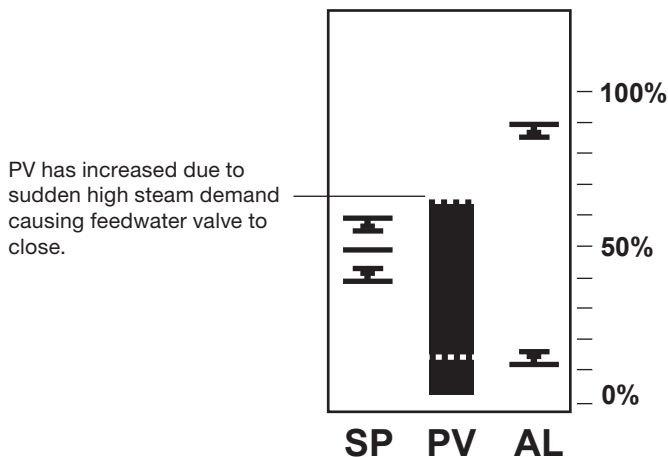


Fig. 6 Graphics display - Set Point raised to 65% - no steam meter compensation

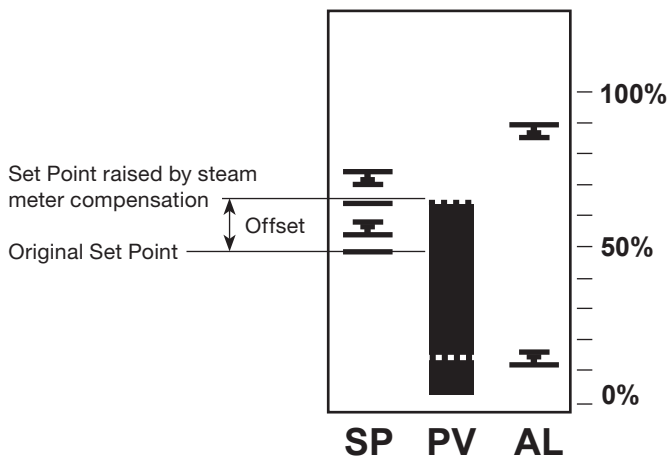


Fig. 7 Graphics display with steam meter compensation


A second display is superimposed on the SP graph to show the offset caused by the action of the steam meter.

With no steam flow, the SP and control band will show a single display.

At 100% steam demand, the superimposed display will move up the column to the maximum percentage set in the menu. The original SP will still be visible, to indicate the offset 2.

2.7 Trend screen

A trend graph appears if the  button is pressed in run mode.

The  and  buttons are used to toggle between the run mode and trend graph.

The trend graph displays a record of the variation in level over a set time. The most recent event/value is to the left of the graph.

Time can be set in minutes, hours or days, up to 8 units. Time base setting is carried out via the TREND menu.

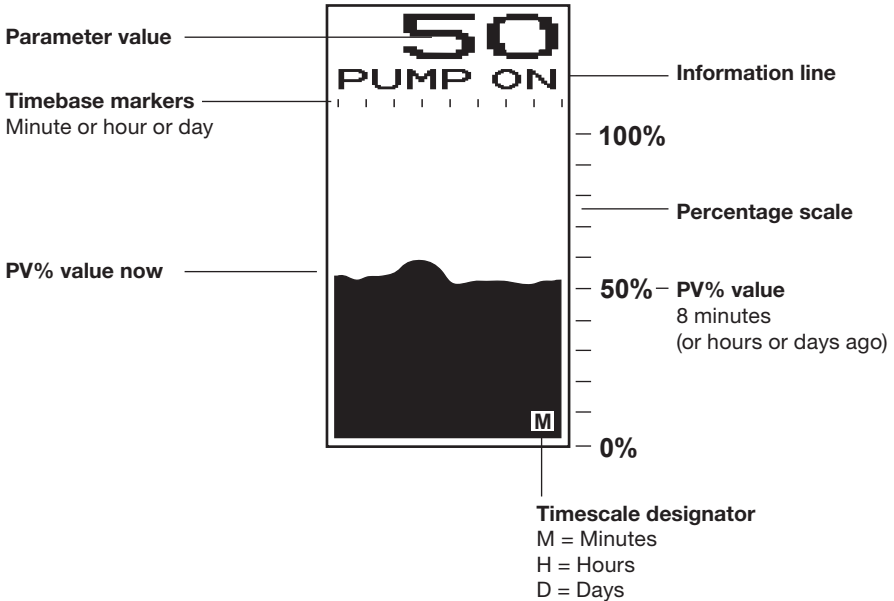



Fig. 8 Graphics display definitions - Trend graph mode

2.8 Alarm / Error display messages

If an error occurs, the details of the error or alarm will appear on a message screen, which can be accessed by scrolling through the run menu. Pressing and holding the  button for 3 seconds can clear a message and re-energize the alarm relay(s). If the cause has not been corrected, the same message will reappear. If the error or alarm is of a latching type, only the message will disappear. The alarm relay will remain de-energised until the correct pass code is entered in the commissioning menu. If more than one error or alarm has occurred, the next message will appear (in priority order) after the previous one has been cleared. See Section 9 - 'Fault finding'.

2.9 Equipment delivery, handling and storage

Factory shipment

Prior to shipment, the product is tested, calibrated and inspected to ensure proper operation.

Receipt of shipment.

Each carton should be inspected at the time of delivery for possible external damage. Any visible damage should be recorded immediately on the carrier's copy of the delivery slip.

Each carton should be unpacked carefully and its contents checked for damage. If it is found that some items have been damaged or are missing, notify Spirax Sarco immediately and provide full details. In addition, damage must be reported to the carrier with a request for their on-site inspection of the damaged item and its shipping carton.

Storage

If the product is to be stored for a period prior to installation, the environmental storage conditions should be at a temperature between 0°C and 65°C (32°F and 149°F), and between 10% and 90% relative humidity (non-condensing).

Before installing and connecting the power ensure there is no condensation within the unit.

3. System overview

3.1 Function

The product compares the input signals with the Set Point to control the water level in the boiler tank, or vessel, by operating a pump, valve, or solenoid.

On/off control

- Pump control.
- Two alarm outputs.
- 4 - 20 mA level output (isolated).

Note: A solenoid valve may be used instead of a pump.

Modulating control

Modulating valve control using valve motor drive (VMD) or 4 - 20 mA control signals:

- Two alarm outputs.
- 4 - 20 mA level output (isolated).

Two or three element modulating control

Modulating valve control using valve motor drive or 4 - 20 mA control signals:

- Two alarm outputs.
- 4 - 20 mA level output (isolated).
- Feedback from steam meter.
- Feed forward from water meter.

3.2 Inputs

The product has three inputs to accept the following signals:

- **Level probe or transmitter 1-6 V or 4-20 mA outputs.**
Note: The level probe must be long enough to sense over the complete level range.
- **Steam meter 4-20 mA** output to compensate for the rise in water level due to increased steam demand (Two element control).
- **A signal from a water meter** to compensate for variations in feedwater flow rate (Three element control).

3.3 Outputs

The product control signal can be configured / wired to work with a pump or a modulating control valve. It also provides relay outputs for high and low level alarms and can provide an isolated 0-20 mA or 4-20 mA retransmission output.

Parameters can be remotely accessed via the RS485 / MODBUS communications.

3.4 Other features

An additional filter can be selected to increase the damping effect for turbulent conditions.

A test function provides the operator with a diagnostic feature. Inputs can be measured and outputs can be set from the front panel.

To prevent unwanted or inadvertent changes being made, all commissioning parameters are protected with a pass code. The operator can change this.

The LC2650 can communicate via an infra-red link between adjacent controllers - see Section 7 - 'Communications'.

3.5 Typical applications

Two element control

When a sudden increase in steam demand occurs, boiler pressure will drop, and the steam bubbles in the water will expand. This causes the water level to rise, and the feedwater valve to close. Although the measured level of water has increased, the mass of water will be decreasing, requiring the feedwater valve to open. A two element control system (probe / controller and steam flowmeter) uses the output from the steam flowmeter to alter the control action and prevent the valve closing, by increasing the Set Point. For effective control, it is important to make an accurate assessment of the rise in water level under full steam flow (maximum demand). This rise in water level can vary according to operating conditions, e.g. steady maximum steam demand, or intermittent, sudden demand, as well as factors such as boiler pressure and water TDS level. There will also be a difference in level between the boiler and the gauge glass under different firing conditions and steam demand.

Fig. 9
**Two element control -
electric valve**

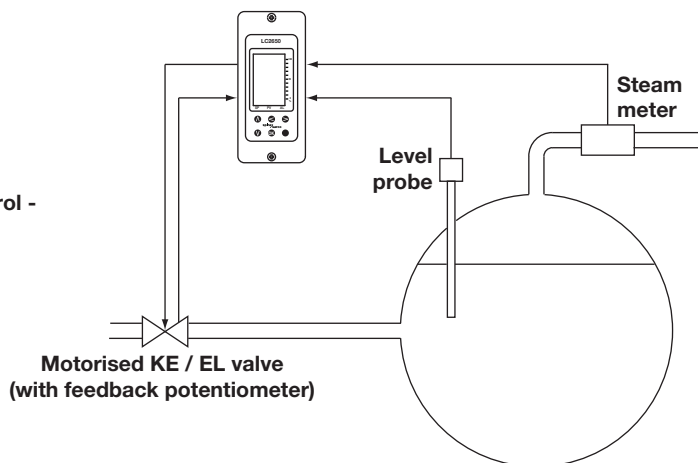
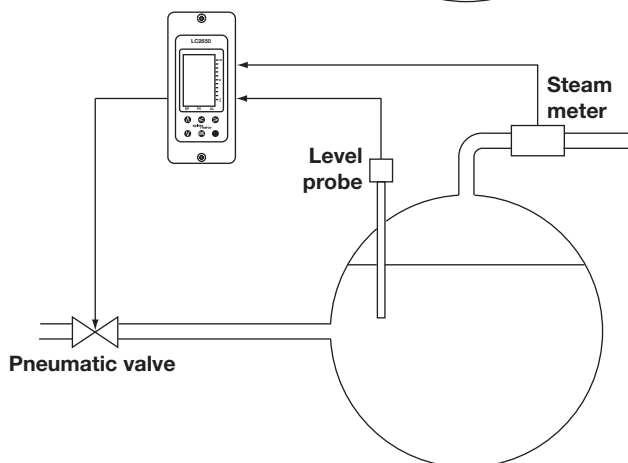
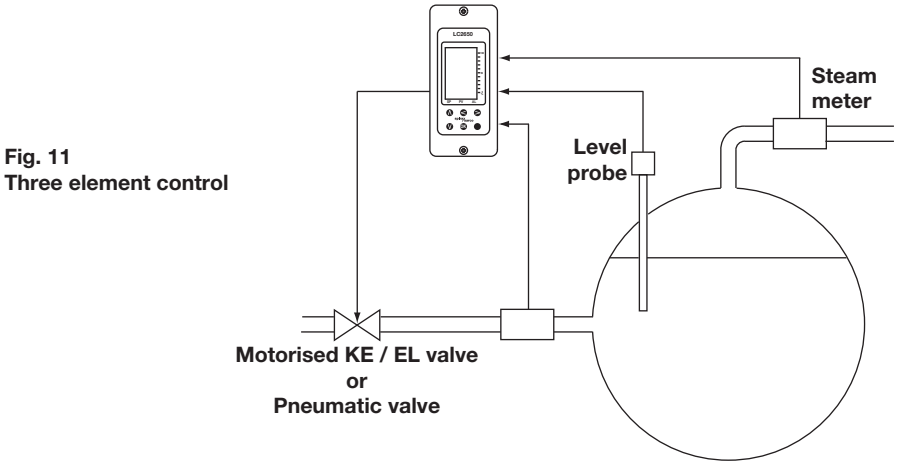


Fig. 10
**Two element control -
pneumatic valve**



Three element control

Under certain conditions where the boiler feedwater pressure varies considerably, perhaps due to other boilers drawing water, three-element control is used. A water flowmeter is added to compensate for variations in flow due to pressure variations.



4. Mechanical installation

Note: Read the 'Safety information' in Section 1 before installing the product.

The product must be installed in a suitable industrial control panel or fireproof enclosure to provide impact and environmental protection. A minimum of IP54 (EN 60529) or Type 3, 3S 4, 4X, 6, 6P and 13 (UL50/NEMA 250) is required.

This product meets the requirements of clause 23.2 of UL508 and can be considered part of the 5 VA fire enclosure for industrial use.

4.1 Environmental conditions

Install the product in an environment that minimises the effects of heat, vibration, shock and electrical interference (see Section 1 - 'Safety information').

Do not install the product outdoors without additional weather protection.

Do not attempt to open the product - it is sealed and has no replaceable parts or internal switches.

4.2 Installation on a DIN rail

The product is provided with a clip and a set of self-tapping screws to secure it to a 35 mm DIN rail. On the rear of the enclosure, two sets of holes are provided to give two height positions. The clip can be adjusted to give further positions. Locate the clip onto one set of holes and secure it using the two screws provided. Ensure the spring clip is fully engaged with the rail.

Warning: Only use the screws provided with the product.

4.3 Installation on a chassis plate:

- Drill holes in the chassis plate as shown in Figure 12.
- Fit unit to chassis plate and secure with 2 screws, nuts and washers, using the slots provided at the top and bottom of the case.

Warning: Do not drill the product case or use self-tapping screws.

4.4 Installation in a panel cutout:

(Minimum panel thickness 1 mm if the bezel is used).

- The product has integral threaded inserts (M4 x 0.7) at the top and bottom of the front panel.
- Two M4 x 25 mm screws are provided, together with fibre washers and a bezel.



Warning:

Do not use screws over 25 mm in length – danger of electric shock.

- Cut the panel to the dimensions given in Figure 12. Drill the screw holes in the panel in the positions indicated.
- Remove the backing from the gasket supplied and apply to front face of the product.
- The bezel can be used to enhance the appearance of the panel cutout. If required, fit this to the outside of the panel.
- Fit the unit from the rear of the panel, and secure using the screws, washers (and bezel) provided.
- Tighten the M4 screws to 1.0 - 1.2 Nm.

WARNING: Do not drill the product case or use self-tapping screws.

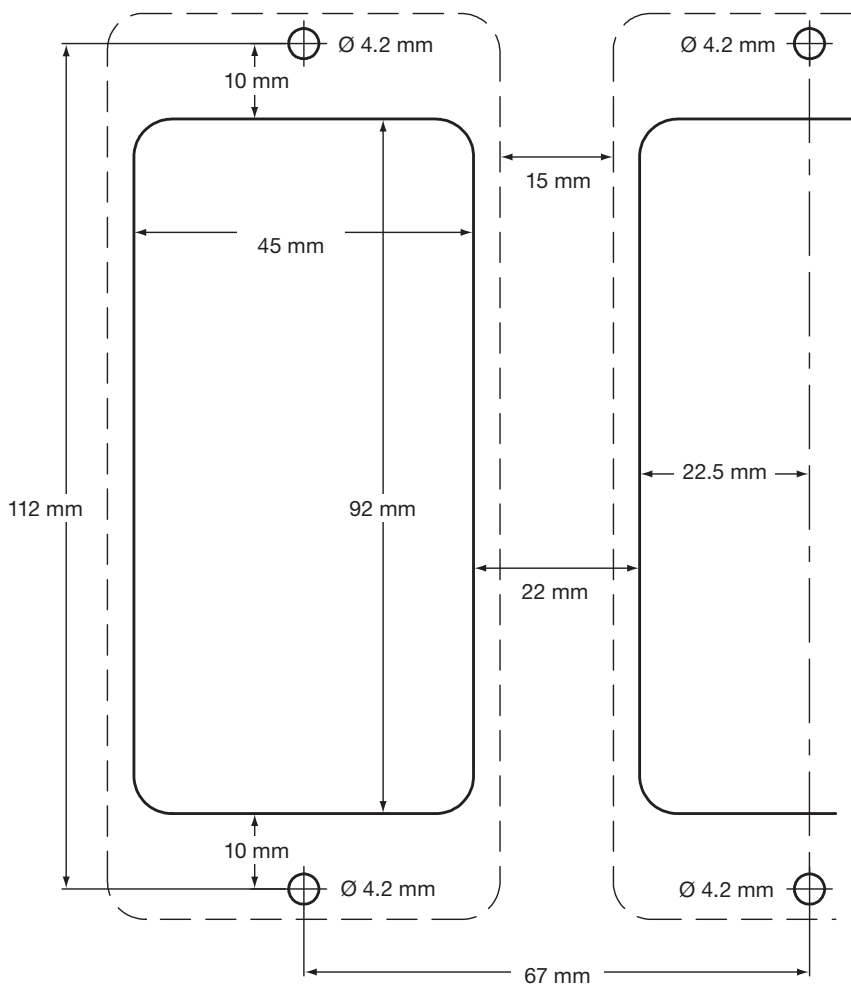


Fig. 12 Chassis plate/panel – cutout diagram

Fixing template cutout notes:

- Solid line indicates cutout required for panel mounting.
- Broken line indicates product outline.
- A minimum gap of 15 mm between units must be provided for product cooling.
- Mounting hole dimensions are the same for both panel and wall mounting.

5. Electrical installation

Note: Before installing read the 'Safety Information' in Section 1.



Warning:

Isolate the mains supply before touching any of the wiring terminals as these may be wired to hazardous voltages.

Use only the connectors supplied with the product, or spares obtained from Spirax Sarco Limited. Use of different connectors may compromise product safety and approvals. Ensure there is no condensation within the unit before installing and connecting the power.

Caution: Do not cover or obstruct the infrared beam between products.

5.1 General wiring notes

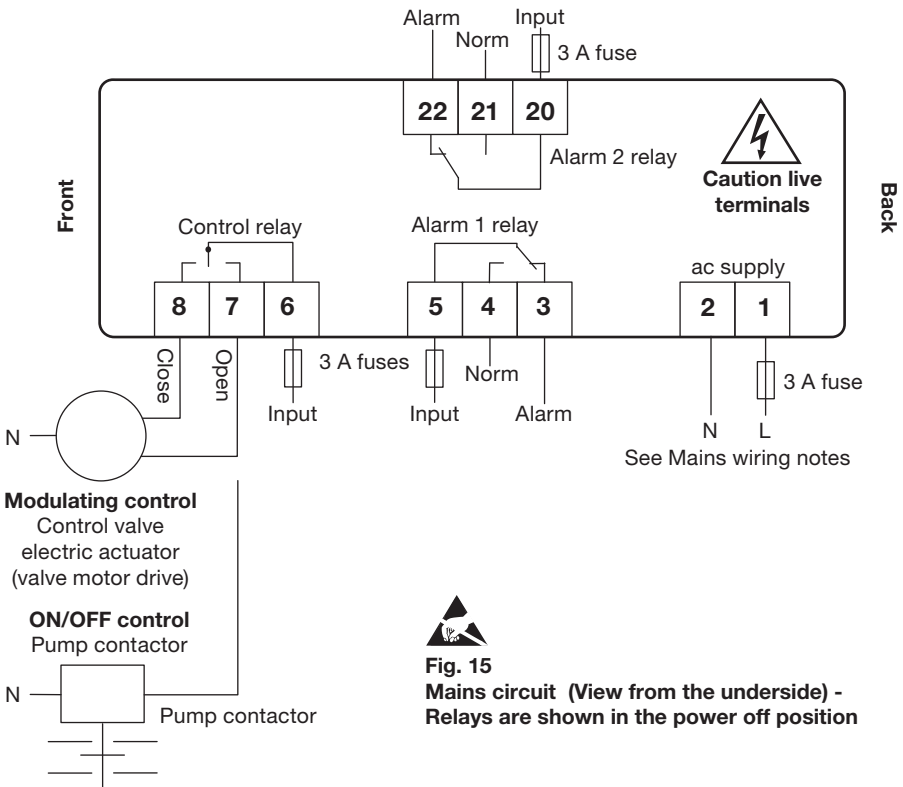
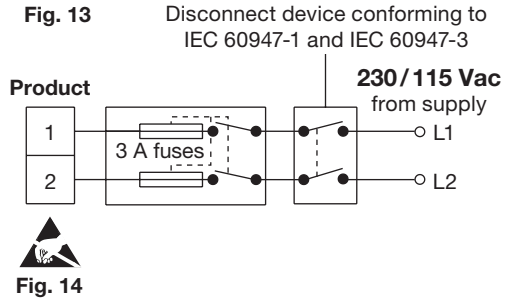
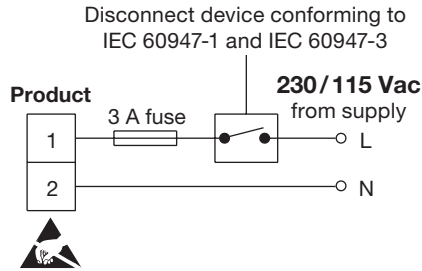
Every effort has been made during the design of the product to ensure the safety of the user but the following precautions must be observed:

1. Maintenance personnel must be suitably qualified to work with equipment having hazardous live voltages.
2. Ensure correct installation. Safety may be compromised if the installation of the product is not carried out as specified in this IMI.
3. The design of the product relies on the building installation for overcurrent protection and primary isolation.
4. Overcurrent protection devices rated at 3 amps must be included in all phase conductors of the installation wiring. If overcurrent protection is included in both supply wires then the operation of one must also cause the operation of the other. Refer to IEC 60364 (Electrical Installations of Buildings) or National or Local standards for full details of requirements for overcurrent protection.
5. A 3 A quick-blow overcurrent protection device must be fitted to the relay circuit(s).
6. Relay contacts must be supplied on the same phase as the mains supply.
7. The product is designed as an installation category III product.
8. Install wiring in accordance with:
 - IEC 60364 - Low-voltage electrical installations.
 - EN 50156 Electrical Equipment for furnaces and ancillary equipment.
 - BS 6739 - Instrumentation in Process Control Systems: Installation design and practice or local equivalent.
 - National and Local Electrical Code (NEC) or Canadian Electrical code (CEC) for the US and Canadian markets. Note; use NEC Class 1 wire with a temperature rating greater than 75°C. If the cable is to be exposed to a higher temperature, then a higher temperature rating needs to be selected.

-
9. It is important that the cable screens are connected as shown in order to comply with the electromagnetic compatibility requirements.
 10. All external circuits must meet and maintain the requirements of double/reinforced installation as stated in IEC 60364 or equivalent.
 11. Additional protection must be provided to prevent accessible parts (e.g. signal circuits) from becoming Hazardous Live if a wire or screw is accidentally loosened or freed. Ensure all wires are secured to at least one other wire from the same circuit. The attachment must be as close to the terminal block as possible but must not apply undue stress on the connection. Example: Use a cable tie to secure the live and neutral wire together. If one wire becomes loose the other wire will prevent it from touching accessible parts.
 12. A disconnecting device (switch or circuit breaker) must be included in the building installation. It must:
 - Have a rating with sufficient breaking capacity.
 - Be in close proximity to the equipment, within easy reach of the operator, but not fitted in a position that makes it difficult to operate.
 - Disconnect all phase conductors.
 - Be marked as the disconnecting device for the product.
 - Not interrupt a protective earth conductor.
 - Not be incorporated into a mains supply cord.
 - Comply with the requirements for a disconnecting device specified in IEC 60947-1 (Specification for low-voltage switchgear and control gear – General rules) and IEC 60947-3 (Switches, disconnectors, switch-disconnectors and fuse-combination units).
 13. See Section 10 – 'Technical information' for terminal and cable specification.

5.2 Mains wiring notes:

1. Read Section 5.1 - 'General wiring notes', before attempting to wire the supply to the product.
2. The wiring connections are identified on the terminal plugs.
3. Fuses should be fitted in all live conductors, see Figures 13 and 14.
4. Double or reinforced insulation must be maintained between:
 - Hazardous live conductors (mains and relay circuits) and
 - Safety extra low voltages (All other components/ connectors/ conductors).
5. The wiring diagrams show relays and switches in the **Power off** position.

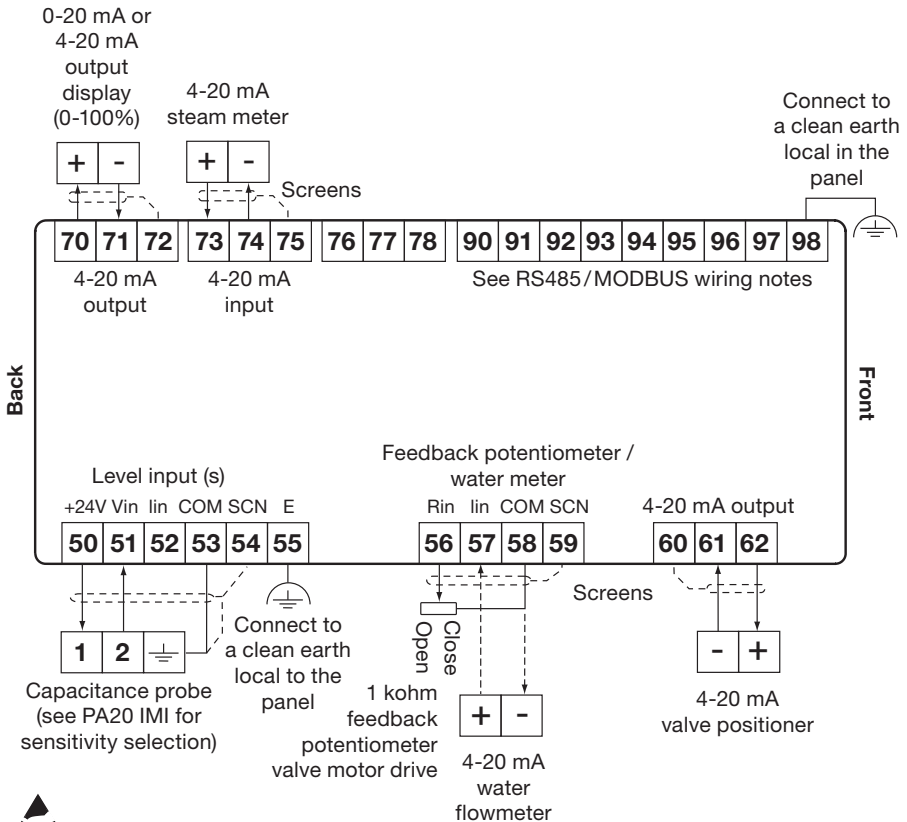


5.3 Signal wiring notes

An earth current loop is created if a wire or screen is connected between two earth points that are at different potential (voltage). If the wiring diagram is followed correctly, the screen will only be connected to the earth at one end.

The earth terminal is a functional earth rather than a protective earth.

A protective earth provides protection from electric shock under a single fault condition. This product has double insulation and therefore does not require a protective earth. A functional earth is used in order for the product to operate. In this application, the earth is used as a sink or drain for any electrical interference. The earth terminal must be connected to a local earth in order to conform to the EMC directive.



Notes:

E = Functional earth – Connect these pins to a clean earth local to the panel

Fig. 16 Signal circuit (view from the top)

5.4 Probe wiring

The maximum cable length for all transducers is 100 m (328 ft).

Note: It is essential to select the correct sensitivity on the PA20 preamplifier, (see the PA20 Installation and Maintenance Instructions for details).

5.5 Level input options

The level output from a PA20/LP20 capacitance probe can be 'daisy chained' to more than one instrument (see examples below).

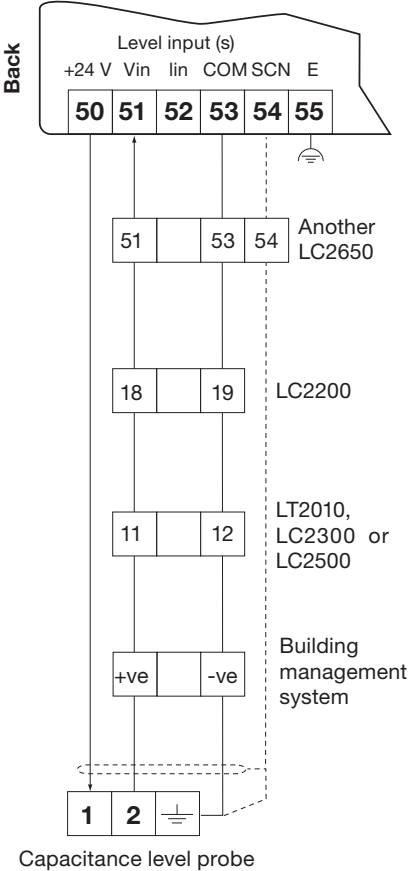


Fig. 17
Multiple controller
connection to a PA20 (daisy chained)

Each instrument must be capable of receiving a 1 - 6 Vdc signal. Only one of the instruments needs to provide a 24 V nominal supply. In the above example, the LC2650 is supplying the power for the PA20.

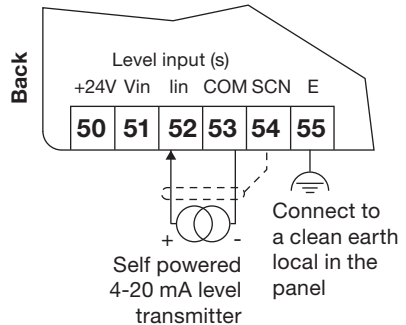
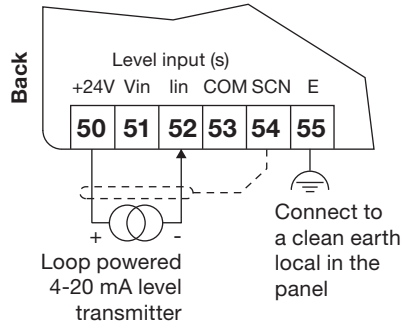


Fig. 18 4 - 20 mA level transmitter

5.6 Wiring diagram for the UL version of the PA20

PA20 preamplifier and LP20 capacitance probe (see PA20 and LP20 Installation and Maintenance Instructions).

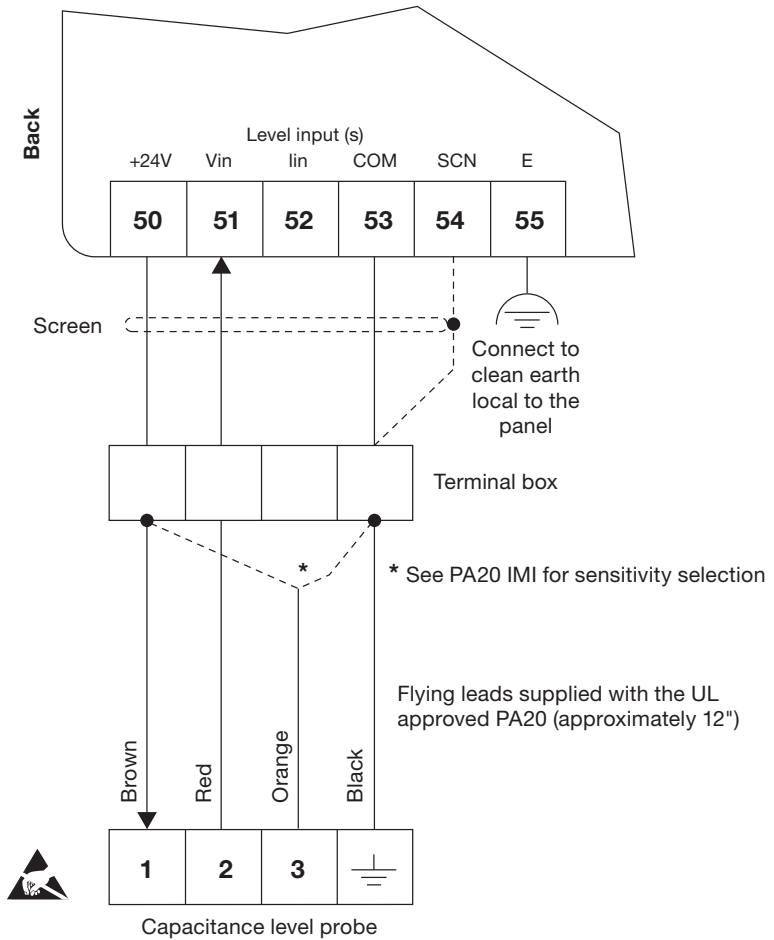


Fig. 19

5.7 EIA/TIA-485 communication wiring diagram

The product can be connected as a slave to a two or four-wire EIA/TIA-485 multi-drop network.

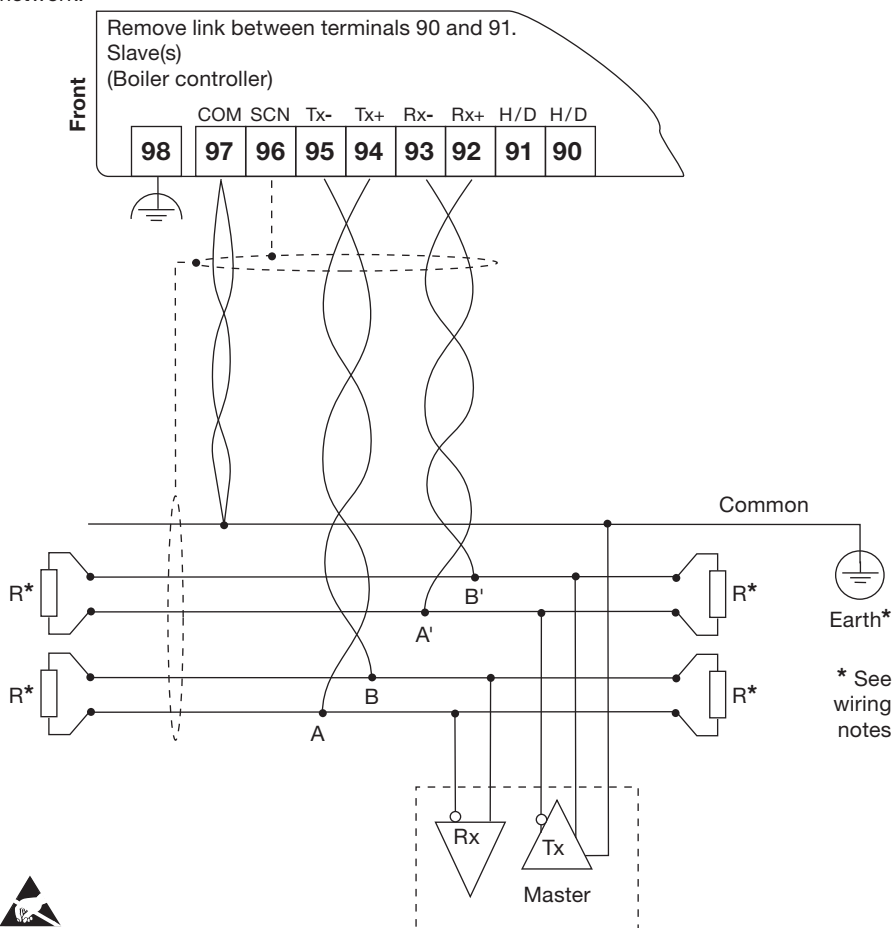


Fig. 20 RS485 Modbus full duplex circuit (view from the top)

EIA/TIA-485 wiring notes:

EIA / TIA-485 symbols are used (A = Tx-, B = Tx+ and A' = Rx-, B' = Rx+)

The signal direction is relative to the product being the Modbus slave, i.e. Tx+ from the product (slave) is to be connected to the Rx+ of the master.

- Twisted pair cable should not be required for short lengths of cable < 1.5 m (< 5 ft). Standard screened cable should suffice.
- The H/D (Half duplex) pins are used to select two or four-wire Modbus:
 - i) For two-wire mode, connect terminal 91 and 90 together.
 - ii) For four-wire mode, **do not connect terminals 91 and 90 together.**

Continued on page 27

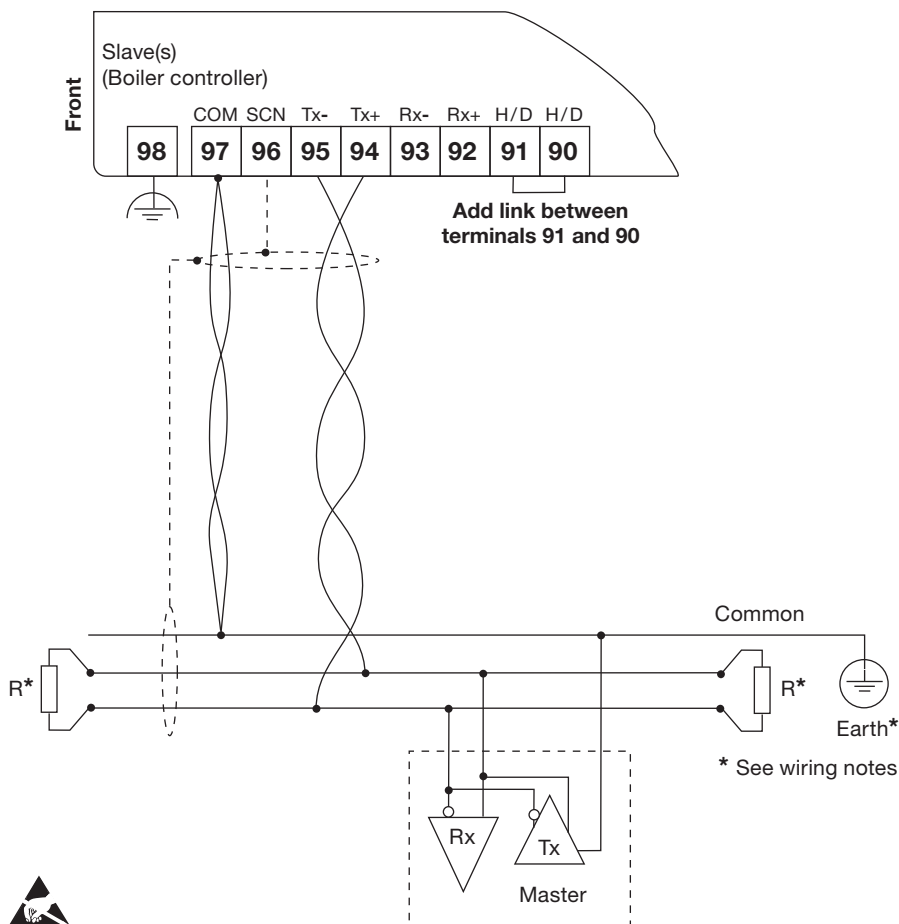


Fig. 21 RS485/Modbus half-duplex circuit (view from the top)

EIA/TIA-485 wiring notes continued:

- The bus common must be connected directly to protective ground/earth at one point only. Generally this point is at or near the master device.
- Consider terminating the two furthest ends of the bus to match the transmission line impedance. A 150 ohm (0.5 W) resistor or a 120 ohm (0.25 W) resistor, which is in series with a 1 nF (10 V) capacitor is commonly used, but ideally the line impedance should be matched to each individual installation. Termination for short lengths of cable should not be necessary < 300 m (< 1 000 ft) @ 9 600 Baud.
- See Section 6 – 'Technical information' for cable details.

6. Commissioning

6.1 General information

All commissioning for the product is carried out using the front panel.

Warning: On entering the commissioning mode the product will cease normal control. The control relay will shut the valve or switch off the pump. For safety, the alarm relay will continue to operate as normal. To regain normal control, return to the run menu.

Warning: If during commissioning, the buttons are not pressed for over 5 minutes, the controller will revert to run mode and an error will occur. If the commissioning was incomplete the controller may not provide the correct control.

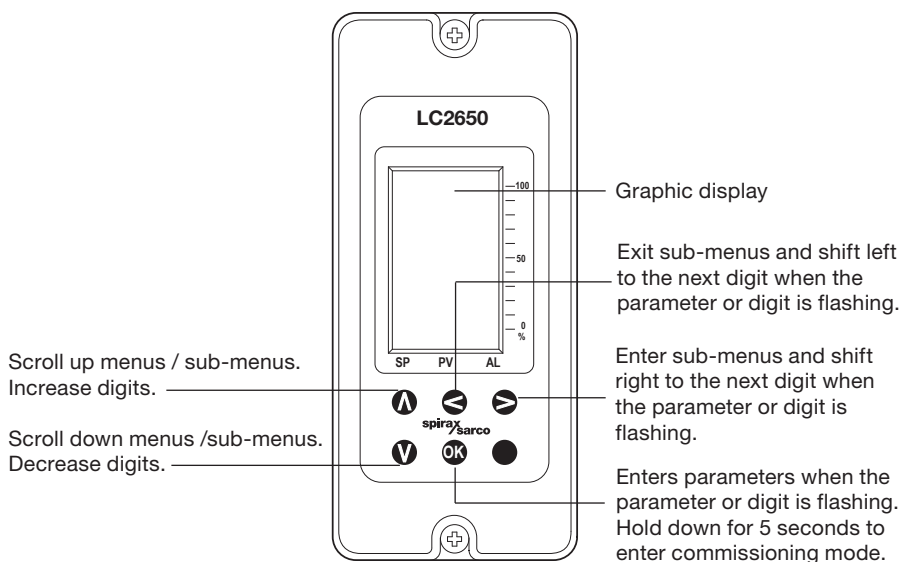


Fig. 22 Display screen and keypad

6.2 Enter commissioning

This is done from the run mode by pressing and holding down the **OK** button for 5 seconds.

The run mode display will disappear and the display will show 'PASS CODE' with '8888' at the bottom right corner of the screen. The flashing leading digit indicates the position of the cursor. The default, or factory set pass code is 7452 but this can be changed from within the commissioning mode. The pass code can be entered by using the **▲** and **▼** buttons to increase or decrease the flashing value and the **◀** and **▶** buttons to move the cursor.

Pressing the **OK** button will enter the pass code. If an incorrect pass code is used, the display automatically returns to the run mode.

PASS CODE

8888

6.2.1 Commissioning mode navigation

After the correct pass code has been entered the display shows:

To exit the commissioning mode at any stage, press and hold the **◀** button to return to the run mode.

Press the **▲** and **▼** buttons to scroll through the first level menus.

Press the **▶** button to enter a particular sub-menu.

The first menu title will remain displayed at the top of the screen and the new sub-menu will appear on the next line. As you progress through the menu, the longer the list becomes. This aids navigation of the menu structure.

MODE

6.2.2 Changing settings (parameters)

If a particular sub-menu requires a parameter to be modified, the corresponding units (if any) will appear on the next line (in brackets) and the parameter itself will appear on the bottom right hand corner. The first digit will start flashing and the parameter can be modified.

If the **OK** button is pressed, the displayed value will be entered into memory. If the button is pressed the value remains unchanged. The sub-menu title, parameter and units will disappear, and the selection on the previous menu will be displayed.

Note: If a number is selected that is outside the parameters, an exclamation mark will appear to the left of the parameter. The value will automatically change to the maximum permitted value.

6.3 Commissioning – Quick set-up

This section allows the user to carry out the minimum commissioning necessary to operate the system.

It accepts the defaults set in the factory, so will only work if the original default settings have not been altered – see Technical Information to confirm.

Settings can then be tailored to suit the individual requirements of the customer / application if required.

Warning

It is essential that you comply with National/Local regulations and Guidance notes, and the boiler manufacturers' recommendations. It is imperative that the settings you have accepted will allow the boiler to operate in a safe manner.

Calibration water level:

- Lower the water level to the lowest point required (water must still be visible in the gauge glass for boiler applications) and **ENTER INPUT LEVEL CAL MIN.**
- Raise the water level to the highest point required, and **ENTER INPUT LEVEL CAL MAX.**

Note: When in the INPUT-LEVEL-CAL menu, the display will show the voltage or current being output by the level transducer.

ON/OFF control (pumping-in) using an LP20/PA20.

From the menu select:

OUTPUTS DRIVE CONTROL	ON-OFF
------------------------------	---------------

Modulating control (pumping in) using an LP20/PA20 and EL5600 series actuator.

OUTPUTS DRIVE CONTROL	PROP
------------------------------	-------------

Calibration feedback potentiometer on the EL5600:

Select INPUT POT CAL MIN.

- The valve will automatically close. When fully closed (voltage will stop decreasing), press **OK**.

Select INPUT POT CAL MAX.

- The valve will automatically open. When fully open (voltage will stop increasing), press **OK**.

Test the system to ensure that it is working correctly.

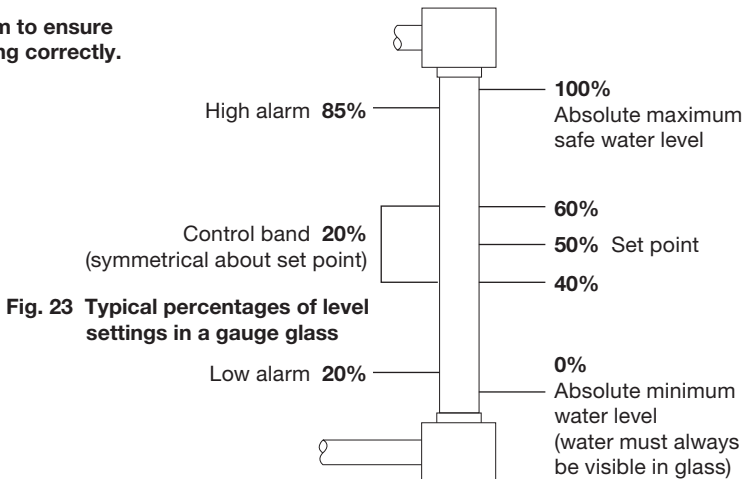


Fig. 23 Typical percentages of level settings in a gauge glass

6.4 Commissioning - Full

Enter commissioning as shown in Section 6.2 and follow the main menu structure to make the changes required.

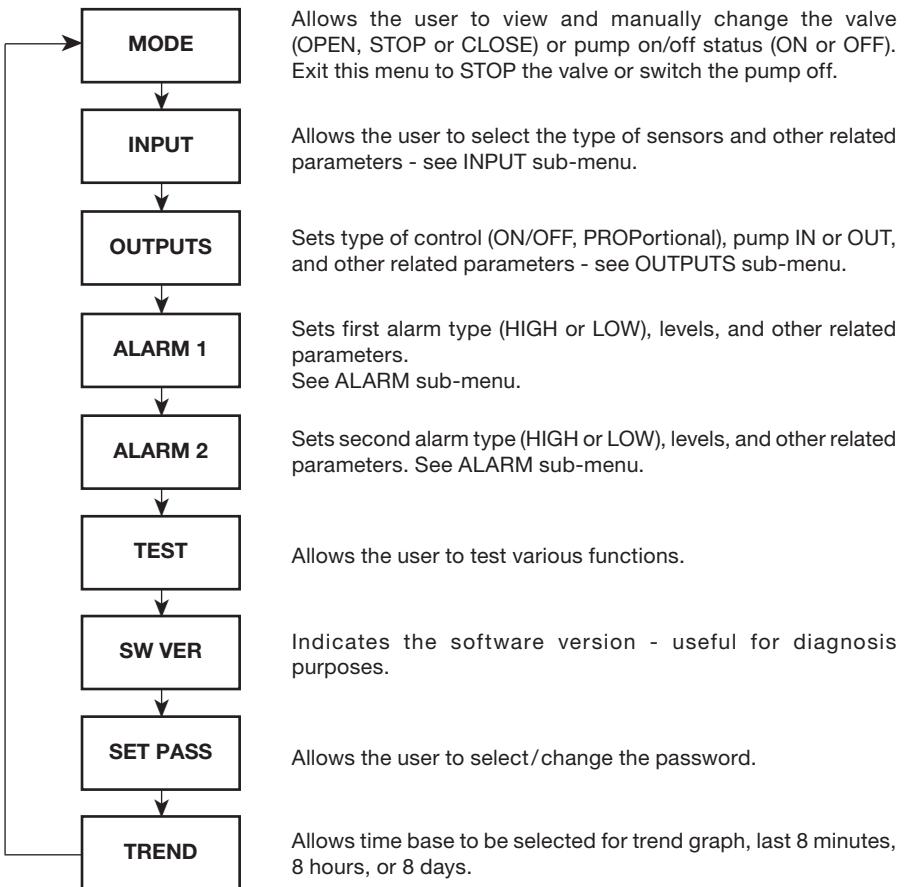
6.4.1 Main menu structure

This IMI indicates your position within the menu by showing the parameter in **bold**, but also shows the path, so it is easy to see where you are within the menu structure, e.g.:


INPUT (main menu)

LEVEL (first sub-menu)

SENSOR (your position within the sub-menu).



6.4.2 MODE sub-menu

Entering this menu (press ) allows the user manual drive the valve or pump to assist in commissioning:

Modulating control:

CLOSED: Drive valve closed

OPEN: Drive valve open


STOP: Stop the valve and leave in current position.


ON/OFF control:

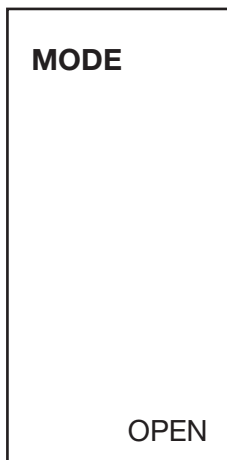
Pump on: Switches the pump on

Pump off: Switches the pump off

Toggle between the settings using the  and  buttons.

Select the required setting by pressing the  button.

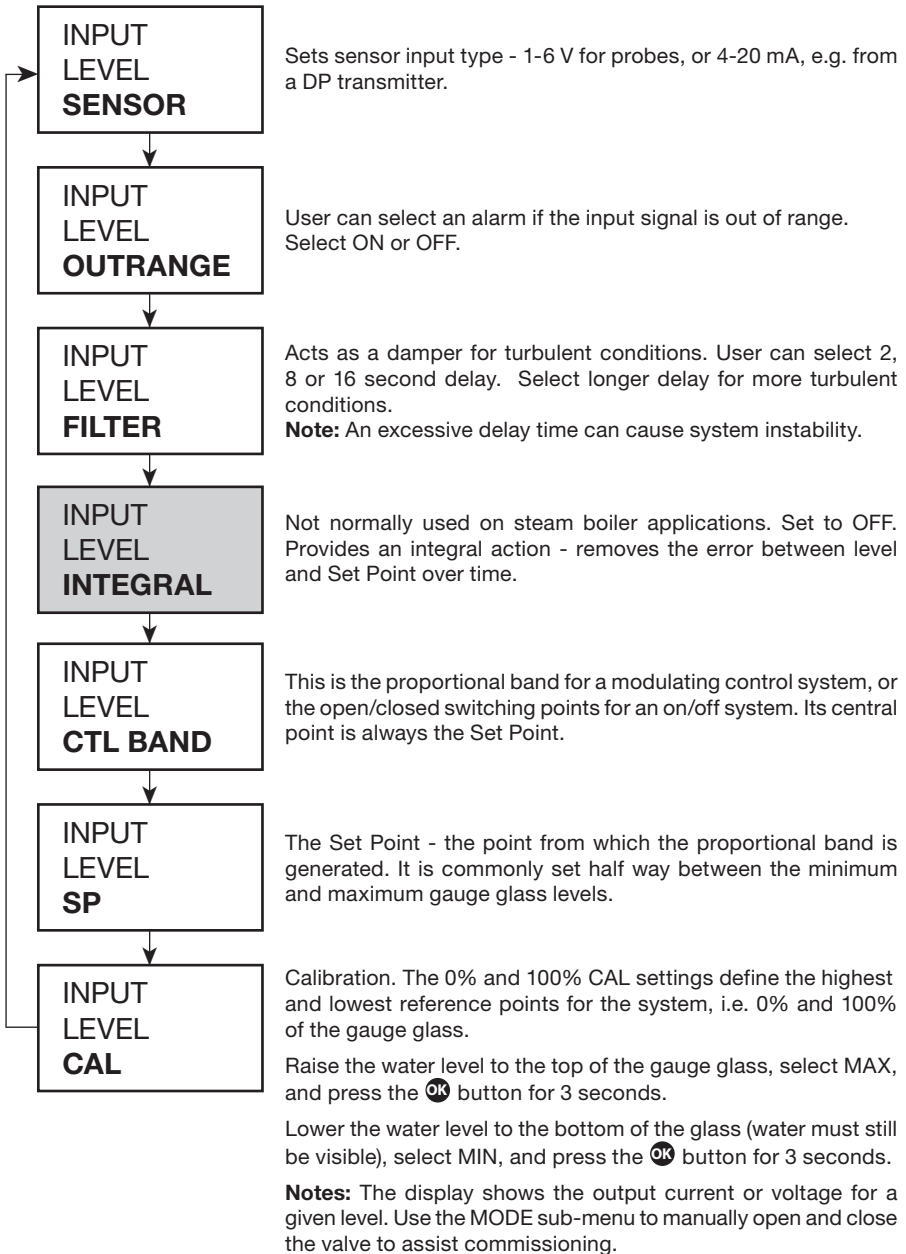
Press the  button to exit the sub-menu and return to the run mode.



Note: When exiting this menu, the product will switch off the pump or stop the valve in its current position.

6.5 INPUT sub-menus

6.5.1 INPUT LEVEL sub-menu



Note: Grey tint indicates features only available under certain conditions.

6.5.2 INPUT POT sub-menu

**INPUT
POT
CAL**

Enables the VMD feedback potentiometer to be calibrated.

INPUT – POT – CAL – MIN

The controller will automatically drive the valve to the closed position. When the valve has reached the closed position, hold down the **OK** button to enter the value.

INPUT – POT – CAL – MAX

The controller will automatically drive the valve to the required 100% flow position. When the valve has reached the fully open position, hold down the **OK** button to enter the value.

6.5.3 INPUT STEAM sub-menu

**INPUT
STEAM
OFFSET**

For two element systems. Adds a % offset to the Set Point proportional to steam output. One steam meter is required per boiler. The offset is shown graphically.

**INPUT
STEAM
MAX**

Only available if an OFFSET percentage is selected, i.e. a steam meter is used (2 element control system). This setting allows the use of steam meter with a capacity greater than the maximum capacity of the boiler.

The steam meter's output needs to be rescaled to the maximum capacity of the boiler. This can be achieved in two ways:

- If available, the steam meter can be rescaled to output 100% (20 mA) to equal the capacity of the boiler. The STEAM MAX is set to 100%.
- Use the product steam max. parameter to rescale the steam meter output. For example, if the maximum boiler capacity is 60% of the maximum on the meter scale, enter '60%'.

Example 1 :-

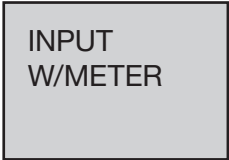
Boiler capacity 10 000 kg/h, steam meter capacity 10 000 kg/h - set STEAM MAX to 100%.

Example 2:-

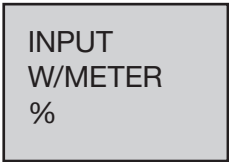
Boiler capacity 10 000 kg/h, steam meter capacity 20 000 kg/h - set STEAM MAX to 50%.

Note: Grey tint indicates features only available under certain conditions.

6.5.4 INPUT WATER METER sub-menu



Enables the feedwater meter (water meter) to be selected.
Only available if proportional control is selected.



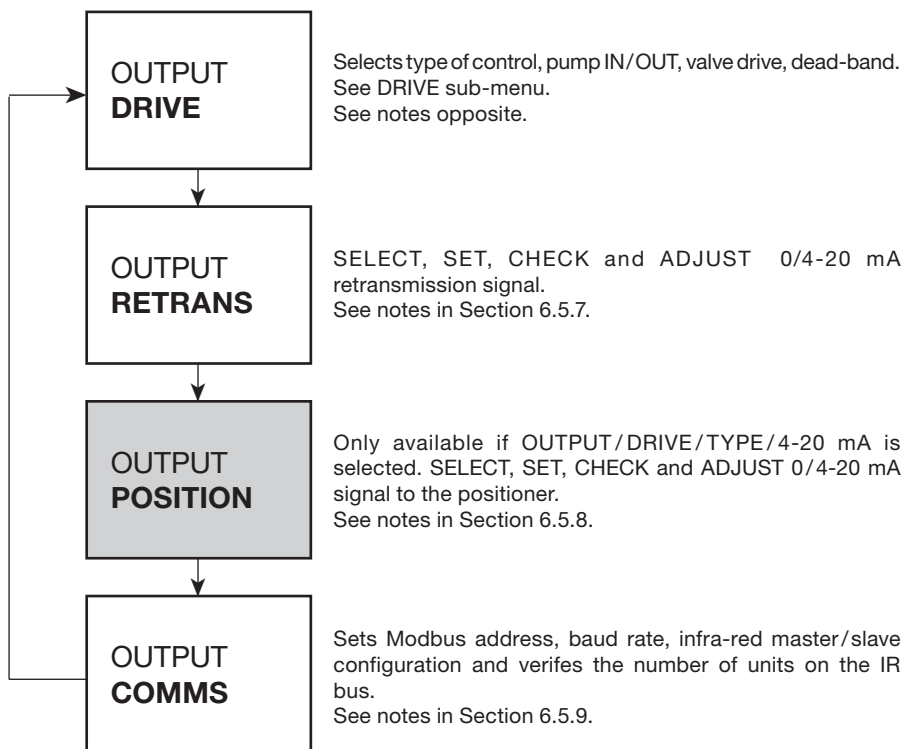
Only available if a water meter is selected. Enables the water meter to be scaled so that it reads 100% at the maximum boiler output.

Example

If the maximum boiler capacity is 60% of the maximum on the meter scale, enter '60%'.

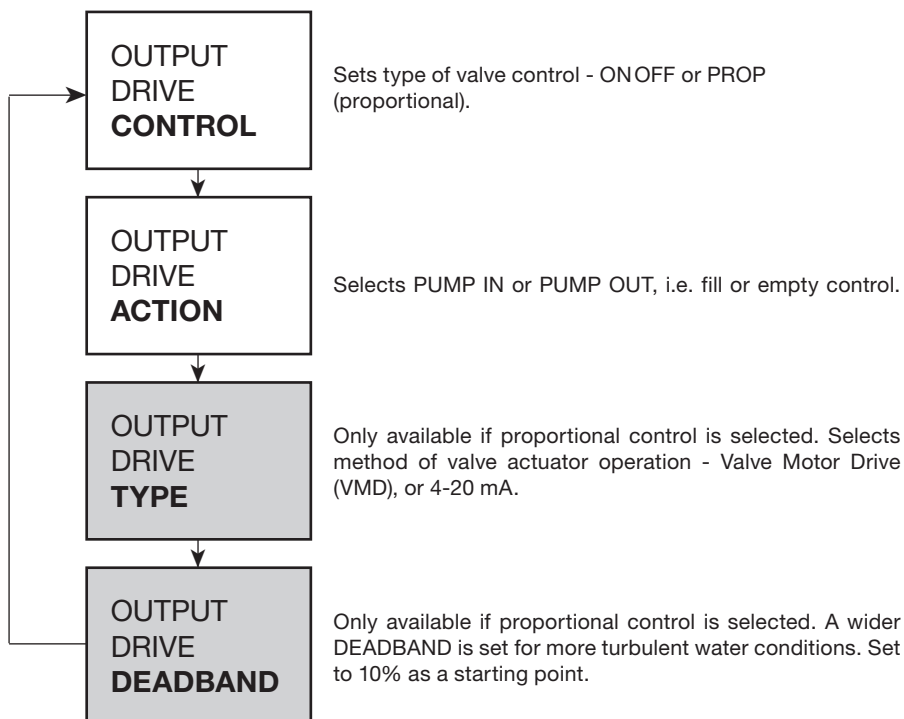
Note: Grey tint indicates features only available under certain conditions.

6.5.5 OUTPUT sub-menu



Note: Grey tint indicates features only available under certain conditions.

6.5.6 OUTPUT DRIVE sub-menu



6.5.7 OUTPUTS RETRANS

Enables the water level to be remotely sensed, recorded or displayed.

0 or 4 mA

This menu enables the user to choose between a 0 or 4 mA minimum setting. Default 4 mA. (4 mA is used so that a 0 mA signal will act as an indication of a fault).

SET

4 mA and 20 mA retransmission levels are set as a percentage of the gauge glass, normally 4 mA = 0% and 20 mA = 100, though this can be changed if required. Setting a 4 mA to a percentage level higher than the 20 mA setting will invert the transmitted. e.g. rising water level, with reducing current.

CHECK

Enables the user to make adjustments to the 4 mA and 20 mA settings, to calibrate to a DVM reading, for example.

6.5.8 OUTPUTS POSITION

Outputs a signal to a 4-20 mA positioner.

0 or 4 mA

This menu enables the user to choose between a 0 or 4 mA minimum setting. Default 4 mA. (4 mA is used so that a 0 mA signal will act as an indication of a fault).

SET

Enables the rescaling of the 4-20 mA signal to the positioner. Normally 4 mA = 0% and 20 mA = 100% of the required valve position. Setting 4 mA to 100% and 20 mA to 0% will invert the transmitted signal.

CHECK

Enables the user to make adjustments to the 4 mA and 20 mA settings, to calibrate to a DVM reading, for example.

6.5.9 OUTPUTS COMMS

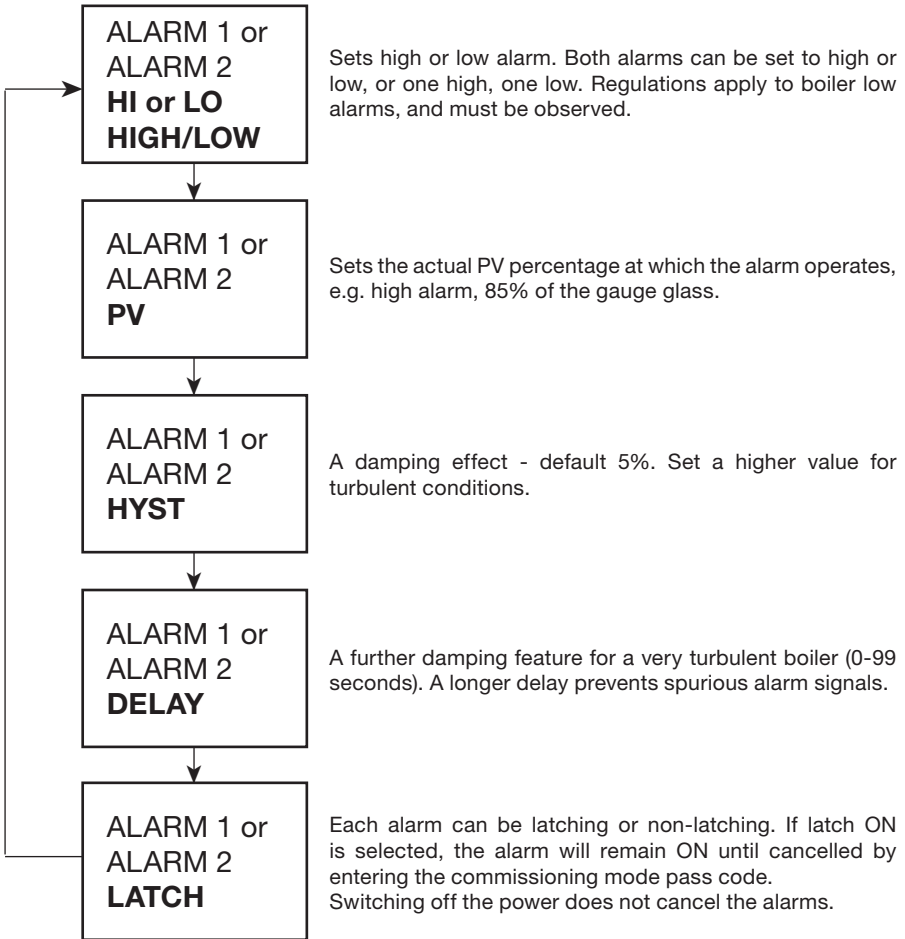
Address is set to 1 unless there are other units on the same system.

Baud rate - Set to match the Baud rate of the line or system.

IR COMMS - Infrared, select as a master or slave device. See Section 7 - 'Communications'.

6.5.10 ALARM 1 and ALARM 2 menus

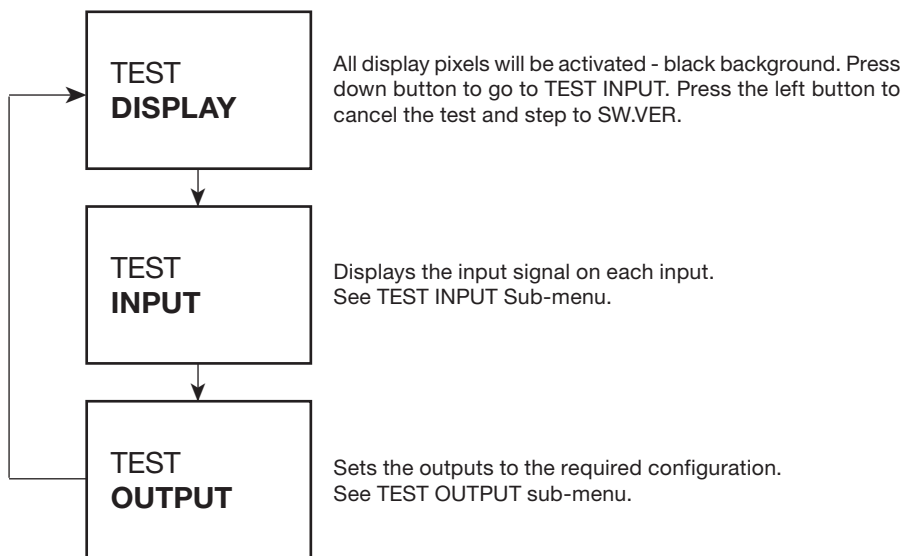
Both alarm menus are identical.



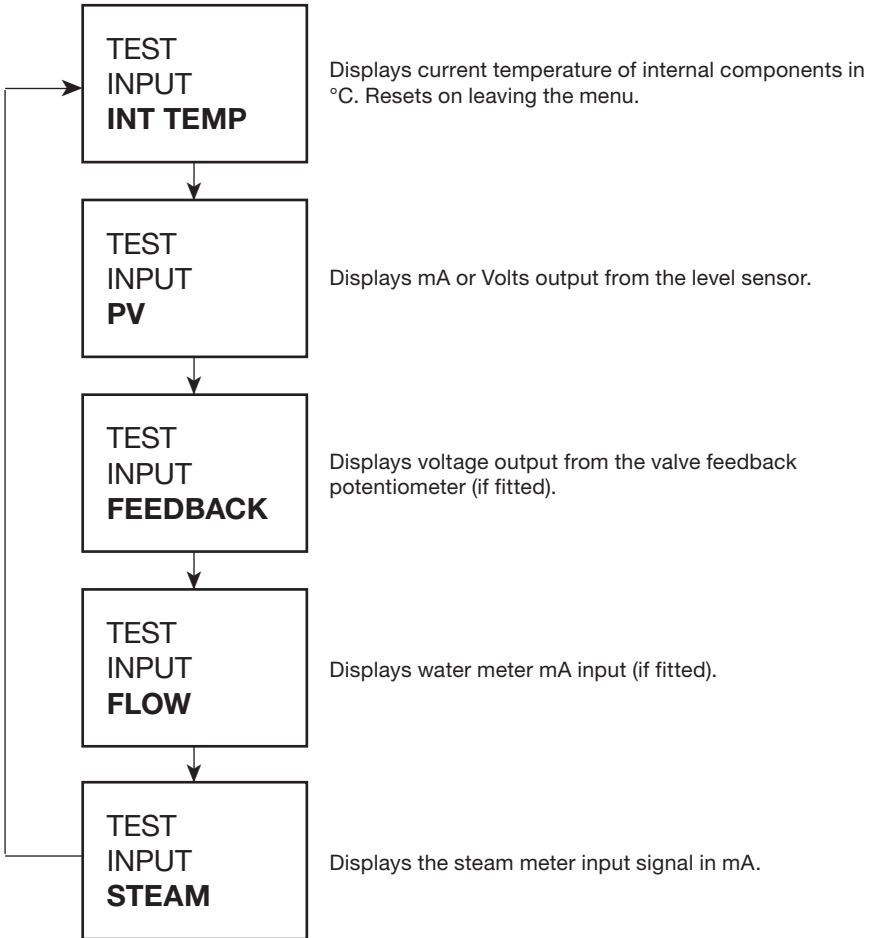
LATCH - Warning: Each time a water level alarm occurs and the **LATCH** feature is selected, the product accesses data from the internal non-volatile memory. This operation has a limited number of cycles and therefore reduces the products lifespan (e.g. if one alarm occurs every day, the product will last approximately 13 years)

6.5.11 Test menu

Allows access to the diagnostic features

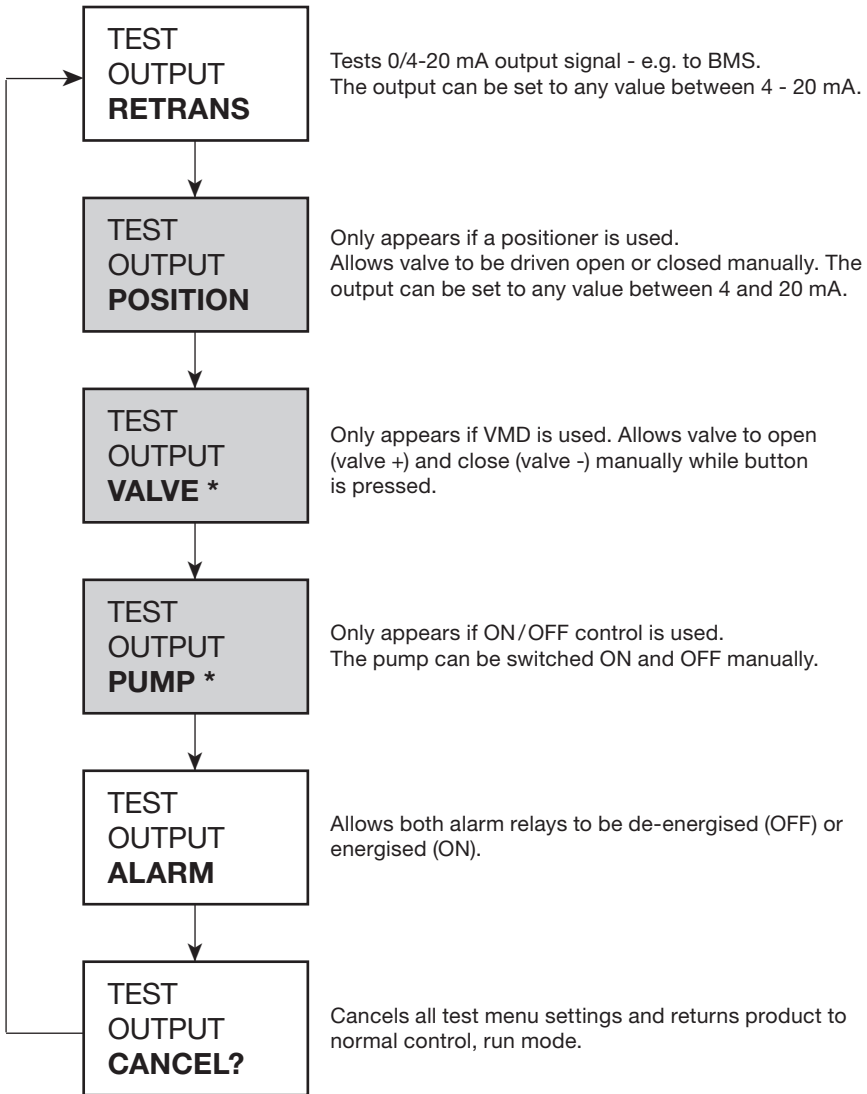


6.5.12 TEST INPUT sub-menu



6.5.13 TEST OUTPUT sub-menu

Test parameters will reset to the normal run mode value or state either after 5 minutes or by selecting the TEST/OUTPUT/CANCEL.



*** Note:** VALVE or PUMP sub-menu are shown depending on which control is selected.
+ VALVE and -VALVE, tests the relay in the ON or OFF position.
Selecting a +VALVE test will cancel a -VALVE and vice versa.
Note: Selecting ON or OFF will return you to the original sub-menu (+VALVE or -VALVE).

6.5.14 SOFTWARE VERSION sub-menu

SW VER

Allows the software version to be viewed - useful for fault diagnosis.

6.5.15 PASS CODE sub-menu

SET PASS

Allows the default pass code to be changed to a user-defined code. It is important that if the default pass code is changed that the new code is noted and kept safe.

7. Communications

7.1 Infrared (IR)

All products in the range can communicate via an infrared bus between adjacent controllers. It enables the parameters of up to seven products to be passed to a product fitted with RS485 (products with a graphics display). The LC2650 can be designated a master or a slave unit.

The product connected to the RS485 networks must be fitted on the left of all the slaves fitted to the IR bus (Figure 24) and have 'master' selected in the 'output-comms' menu.

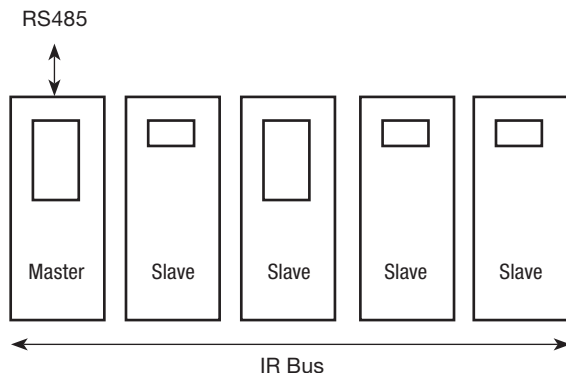


Fig. 24

Two or more IR buses can share the same enclosure or DIN rail by selecting another IR master. Master 2 will ignore bus 1. See Figure 25.

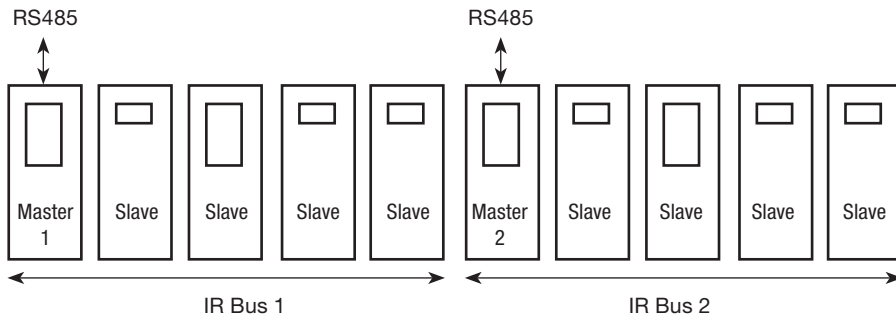


Fig. 25

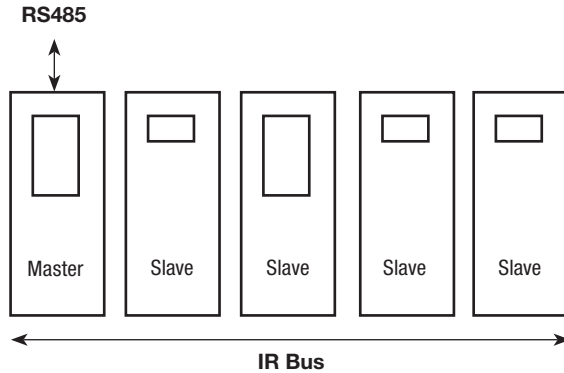
To add another slave into an existing IR bus, re-select 'master'.

Only an IR master can pass the IR bus parameters to the RS485 network. If a slave is also connected to the RS485 network, only its parameters are passed.

Caution: Do not cover or obstruct the infrared beam between products.

7.2 RS485 Addressing

An offset is added to the register addresses (see above) for each device, depending on their position on the IR bus, i.e. the master's offset is 0, the device to its right hand side has an offset of 100, the one to its right 200 and so on.



IR address	1	2	3	4	5
RS485 offset	0	100	200	300	400

Fig. 26

8. Maintenance

Note: Read the 'Safety information' in Section 1 before doing any maintenance.

Caution: Do not cover or obstruct the infrared beam between products.

8.1 Cleaning instructions

Use a cloth dampened with tap/de-ionized water/isopropyl alcohol. Use of other cleaning materials could damage the product and invalidate the marking.

No special servicing, preventative maintenance or inspection of the product is necessary. In many countries, including the UK, legal regulations are in force concerning boiler blowdown.

In particular, attention is drawn to the danger of working on a shut-down boiler while other boilers are operating.

8.2 Level controls

Boiler water level controls and level alarms, however, do require testing and inspection. General guidance is given in Health and Safety Executive Guidance Notes BG01 and INDG436. For specific instructions for the Spirax Sarco system please see separate literature.

9. Fault finding

WARNING:

Before fault finding read the Safety information in Section 1 and the General wiring notes in Section 5.1.

Please note that there are hazardous voltages present and only suitably qualified personnel should carry out fault finding.

The product must be isolated from the mains supply before touching any of the terminals.

Safety may be compromised if the fault finding procedures are not carried out in line with this manual.

9.1 Introduction

The most likely time for faults to occur is during installation and commissioning. The most common fault is incorrect wiring. If after applying power to the product an error message is displayed, it may be necessary to fault find. To simplify and aid in this process, the product has a Test menu (see Sections 2.8 and 6.4.1).

There are six viewable input channels. This will prove whether or not the product is functioning correctly.

9.2 System faults

Symptom	Action
1 Display not illuminating	<ol style="list-style-type: none">1. Switch off the mains supply to the product.2. Check all wiring is correct.3. Check external fuse(s) are intact. Replace if necessary.4. Check the mains voltage is within specification.5. Switch on mains supply. <p>If symptoms are still present return product for examination. Consider the likelihood that the product has been damaged from mains borne surges/spikes. Consider installing an additional ac power line protector between the product and the mains supply. The protector needs to be positioned close to the product to gain full protection.</p>

Symptom	Action
<p>2</p> <p>Display flashes on and off (1 second approx.)</p>	<ol style="list-style-type: none"> 1. Switch off the mains supply to the product. 2. Disconnect all signal wires. 3. Switch the mains supply on: If symptoms are still present, return the product for examination. 4. Replace each signal wire in turn until the fault occurs. 5. Investigate and rectify any faults in the wiring, external sensors/ transducers and modules associated with that connection. <p>Explanation</p> <p>The internal power supply is unable to power up. If the voltages cannot be generated, the power supply switches off for approx. 1 second. The power supply then attempts to power up again. If the fault is still present, the cycle is repeated until the fault is removed. This is a safety feature and does not damage the product.</p>
<p>3</p> <p>Product powers up for a period of time (greater than 1 minute), then switches off</p>	<ol style="list-style-type: none"> 1. Monitor the mains supply and ensure it is continuous and within the specification limits. 2. Measure the ambient temperature and ensure it is less than specified. 3. Investigate symptom 2. <p>Explanation</p> <p>A re-settable thermal cut-out device will operate if one or more of the following occurs:</p> <ul style="list-style-type: none"> - The power drawn exceeds the specification. - The input mains voltage is lower than specified. - The ambient temperature is higher than specified. - The internal power supply will switch off until the product temperature drops below 65°C. This is a safety feature and does not damage the product.

9.3 Operational error messages

Any operational errors that occur will be displayed in the run mode, on the alarms and errors screen.

Error message	Cause	Action
1 Power out	There has been a loss of power to the product during operation.	<ol style="list-style-type: none">1. Remove the power from the product.2. Check that all the wiring is correct.3. Check that the power supply is secure, i.e. does not suffer from 'brown outs'.4. Reapply power.
2 Setup menu time out	The operator has entered the commissioning mode and has not pressed a button for 5 minutes or more.	<ol style="list-style-type: none">1. Re-enter the commissioning mode if required.
3 Outrange high	The level input signal has increased to above the products specifications.	<ol style="list-style-type: none">1. Using a multimeter, check the input currents or voltages do not exceed the product specifications. See Section 6 - 'Input technical data'.
4 Outrange low	The level input signal has increased to above the products specifications.	<ol style="list-style-type: none">1. Using a multimeter, check the input currents or voltages do not exceed the product specifications. See Section 6 - 'Input technical data'.
5 Alarm 1	A high or low water alarm has occurred.	<ol style="list-style-type: none">1. Check the boiler operation.2. Check the boiler set-up and operation of alarm and boiler water supply systems.3. Check setup of alarm 1.
6 Alarm 2	A high or low water alarm has occurred.	<ol style="list-style-type: none">1. Check the boiler operation.2. Check the boiler set-up and operation of alarm and boiler water supply systems.3. Check setup of alarm 2.
7 Alarm is latched!	Some errors latch the alarm relay for safety. Clearing the error from the screen just removes the message.	<ol style="list-style-type: none">1. Enter the commissioning (setup) mode. If the correct password is entered all the latched alarms will be cleared.

10. Technical information

10.1 For technical assistance

Contact your local Spirax Sarco representative. Details can be found on order/delivery documentation or on our web site: www.spiraxsarco.com

10.2 Returning faulty equipment

Please return all items to your local Spirax Sarco representative. Please ensure all items are suitably packed for transit (preferably in the original cartons).

Please provide the following information with any equipment being returned:

1. Your name, company name, address and telephone number, order number and invoice and return delivery address.
2. Description and serial number of equipment being returned.
3. Full description of the fault or repair required.
4. If the equipment is being returned under warranty, please indicate:
 - Date of purchase.
 - Original order number.

10.3 Power supply

Mains voltage range	99 Vac to 264 Vac at 50/60 Hz
Power consumption	7.5 W maximum

10.4 Environmental

General	Indoor use only
Maximum altitude	2 000 m (6 562 ft) above sea level
Ambient temperature limits	0 - 55°C (32 - 131°F)
Maximum relative humidity	80% up to 31°C (88°F) decreasing linearly to 50% at 40°C (104°F)
Overvoltage category	III
Pollution degree	2 (as supplied) 3 (when installed in an enclosure) - Minimum of IP54 or UL50 / NEMA Type 3, 3S, 4, 4X, 6, 6P or 13. See Section 4, Mechanical installation.
Enclosure rating (front panel only)	NEMA type 4 hosedown only (UL approval) and IP65 (verified by TRAC Global).
Torque rating for panel screws	1 - 1.2 Nm
LVD (safety)	Electrical safety EN 61010-1 UL61010-1, UL508, Clause 23.2 CAN/CSA C22.2 No.61010-1.
EMC	Immunity/ Emissions Suitable for heavy industrial locations
Enclosure	Material Polycarbonate
Front panel	Material Silicone rubber, 60 shore.
Solder	Tin/lead (60/40%)

10.5 Cable/wire and connector data

Mains and signal connector

Termination	Rising clamp plug-in terminal blocks with screwed connectors (Use only the connectors supplied by Spirax Sarco Ltd. – Safety and Approvals may be compromised otherwise).
Cable size	0.2 mm ² (24 AWG) to 2.5 mm ² (14 AWG).
Stripping length	5 - 6 mm

Level probe, feedback, steam meter and water cable/wires

Type	High temperature
Shield type	Screened
Number of cores	3 (LP20/PA20), 2 or 3 (4-20 mA Transducer)
Gauge	1 - 1.5 mm ² (18 - 16 AWG)
Maximum length	100 m (328 ft)
Recommended type	Pirelli (Prysmian) FP200, Delta Crompton Firetuf OHLS

0/4-20 mA output(s) cable/wire

Type	Twisted pair
Shield type	Screened
Number of pairs	1
Gauge	0.23 - 1 mm ² (24 - 18 AWG)
Maximum length	100 m
Recommended type	Various

RS485 communication cable/wire

Type	EIA RS485 Twisted pair
Shield type	Screened
Number of pairs	2 or 3
Gauge	0.23 mm ² (24 AWG)
Maximum length	1200 m (4000 ft)
Recommended type	Alpha Wire 6413 or 6414

Note: LAN Category 5 or Category 5E ScTP (screened), FTP (foil) or STP (shielded) cable can be used, but limited to 600 m.

10.6 Input technical data

Level voltage

Minimum voltage	0 Vdc or 1 V (with OUTRANGE function selected)
Maximum voltage	6 Vdc (absolute maximum = 7 Vdc)
Input impedance	28 k Ω
Accuracy	5% FSD over operating range
Repeatability	2.5% FSD over operating range
Resolution	14 bit (0.15 mV approx)
Sample time	260 Hz

4-20 mA(s)

Minimum current	0 mA
Maximum current	22 mA
Input impedance	110 Ω
Accuracy	5% FSD over operating range
Repeatability	2.5% FSD over operating range
Resolution	14 bit (1 μ A approximately)
Sample time	260 Hz

Level 'out of range' alarm - voltage

Minimum alarm level	< 0.2 Vdc
Minimum recovery level	> 1 Vdc
Maximum alarm level	> 6.5 Vdc
Maximum recovery level	< 6 Vdc

Level 'out of range' alarm - current

Minimum alarm level	< 2.5 mA
Minimum recovery level	> 4 mA
Maximum alarm level	> 21 mA
Maximum recovery level	< 20 mA

10.7 Output technical data

24 Vdc supply

Maximum voltage	32 Vdc (no load, open circuit)
Maximum current	25 mA
Ripple voltage	10 mV at 264V, full load

4-20 mA(s)

Minimum current	0 mA
Maximum current	20 mA
Open circuit voltage (maximum)	19 Vdc
Resolution	1% FSD
Maximum output load	500 ohm
Isolation	100 V
Output rate	10/second

Relay(s)

Contacts	2 x single pole changeover relays (SPCO)
Voltage Ratings (max)	250 Vac
Resistive load	3 amp @ 250 Vac
Inductive load	1 amp @ 250 Vac
ac motor load	¼ HP (2.9 amp) @ 250 Vac ⅓ HP (3 amp) @ 120 Vac
Pilot duty load	C 300 (2.5 amp) - control circuit/coils
Electrical life (operations)	3 x 10 ⁵ or greater depending on load
Mechanical life (operations)	30 x 10 ⁶

RS485

Physical layer	RS485 4-wire full or 2-wire half duplex
Protocol	Modbus RTU format
Isolation	60 Vac/dc
Receiver unit load	⅓ (256 devices - maximum) - Based on all 256 devices having a ⅓ load input.
Output rate	Up to 10 frames / second

Infrared

Physical layer	IrDA
Baud	38400
Range	10 cm
Working angle	15°
Eye safety information	Exempt from EN 60825-12: 2007 safety of laser products. Does not exceed the accessible limits (AEL) of class 1.

10.8 Programming parameters

The default settings in this table can be used as a 'quick start' guide. See Section 6.

10.8.1 MODE MENU in proportional control

Allows the valve to be manually opened, closed or stopped

Ranges	OPEN, CLOSED or STOP
Default	STOP

In ON/OFF control

Allows the pump to be switched on or off manually

Ranges	PUMP ON or PUMP OFF
Default	PUMP OFF

10.8.2 INPUT MENU

LEVEL - SENSOR (Input signal/type)

Ranges	1 - 6 V or 4 - 20 mA
Default	1 - 6 V

LEVEL - OUTRANGE

Ranges	ON or OFF
Default	OFF

LEVEL - FILTER

Ranges	2, 8 or 16
Default	2
Units	Seconds

LEVEL - INTEGRAL (Integral or reset time)

Ranges	5 - 300
Default	OFF but 120 if ON is selected
Resolution (steps)	1
Units	Seconds

LEVEL - CTL BAND (Control Band)

Ranges	5 - 100 (Interactive with steam offset and SP. control band cannot exceed 100%)
Default	20
Resolution (steps)	1
Units	%

LEVEL - SP (Set Point)

Ranges	3 - 97 (Interactive with steam offset and SP. control band cannot exceed 100%)
Default	50
Resolution (steps)	1
Units	%

STEAM - OFFSET (% increase in water level due to 100% steam demand)

Ranges	0 - 94 (Interactive with steam offset and SP. control band cannot exceed 100%)
Default	0
Resolution (steps)	1
Units	%

STEAM - MAX (Scale steam meter output to maximum steam load)

Ranges	10 - 100%
Default	100
Resolution (steps)	1
Units	%

WATER METER (Feedwater flowmeter)

Ranges	OFF or ON
Default	OFF

WATER METER - ON - MAX (Scale steam meter output to maximum feedwater flow)

Ranges	10 - 100%
Default	100
Resolution (steps)	1
Units	%

10.8.3 OUTPUT MENU

COMMS - ADDRESS (MODBUS communication)

DRIVE - CONTROL

Ranges	PROP or ON/OFF
Default	PROP

DRIVE - ACTION

Ranges	PUMP IN or OUT
Default	PUMP IN

DRIVE - TYPE

Ranges	VMD or 4-20 mA
Default	VMD (Valve Motor Drive)

DRIVE - DEADBAND

Ranges	5 - 20 (Relay hysteresis = 1%)
Default	10
Resolution (steps)	1
Units	%

RETRANS - 0 or 4 mA

Ranges	0 or 4 mA
Default	4 mA

RETRANS - SET - 4 mA

Ranges	0 - 100
Default	0
Units	%

RETRANS - SET - 20 mA

Ranges	0 - 100
Default	100
Units	%

RETRANS - CHECK - 4 mA

Default	4.00
Resolution (steps)	0.01
Units	mA

RETRANS - CHECK - 20 mA

Default	20.00
Resolution (steps)	0.01
Units	mA

POSITION (positioner) - 0 or 4 mA

Ranges	0 or 4 mA
Default	4 mA

POSITION (positioner) - SET - 4 mA

Ranges	0 - 100
Default	0
Units	%

POSITION (positioner) - SET - 20 mA

Ranges	0 - 100
Default	100
Units	%

POSITION (positioner) - CHECK - 4 mA

Default	4.00
Resolution (steps)	0.01
Units	mA

POSITION (positioner) - RETRANS - CHECK - 20 mA

Default	20.00
Resolution (steps)	0.01
Units	mA

COMMS - ADDRESS

Ranges	001 - 247
Default	001

COMMS - BAUD

Ranges	1200, 9600 or 19200
Default	9600
Units	BAUD or bits/second

COMMS - IR (Infrared)

Ranges	MASTER or SLAVE
Default	SLAVE

COMMS - IR UNITS IN NETWORK

Ranges	1 - 8
--------	-------

ALARM 1 or 2 MENU

HI or LO

Ranges	HIGH or LOW
Default	HIGH (alarm 1) and LOW (alarm 2)

LEVEL%

Ranges	0 - 100 (Interactive with HYST)
Default	85% (HIGH), or 20% (LOW)
Resolution (steps)	1
Units	%

HYST (Hysteresis)

Ranges	0 - 100 (Interactive with HYST)
Default	5
Resolution (steps)	1
Units	%

DELAY

Ranges	0 - 99
Default	0
Resolution (steps)	1
Units	Seconds

LATCH

Ranges	OFF or ON
Default	OFF

TEST MENU

DISPLAY

Ranges	Black-on-white or white-on-black
Default	Black-on-white

INPUT - INT TEMP (Internal temperature of the electronics)

Ranges	-40 to 85°C or -40 to 185°F
Resolution (steps)	1
Units	°C or °F

INPUT - LEVEL

Ranges	0.00 - 7.00
Resolution (steps)	0.01
Units	dc voltage

INPUT - FEEDBACK (VMD feedback potentiometer from valve)

Ranges	0.00 - 2.26
Resolution (steps)	0.01
Units	dc voltage

INPUT - FLOW (Signal from water meter)

Ranges	0.00 - 22.73
Resolution (steps)	0.01
Units	dc milliamps

INPUT - STEAM (Signal from steam meter)

Ranges	0.00 - 22.73
Resolution (steps)	0.01
Units	dc milliamps

OUTPUT - RETRANS (Sets the output between 4-20 mA manually)

Ranges	4 - 20 mA
Default	20.00
Resolution (steps)	0.01
Units	mA

OUTPUT - POSITION (Sets the output between 4-20 mA manually)

Ranges	4 - 20 mA
Default	20.00
Resolution (steps)	0.01
Units	mA

OUTPUT - VALVE - +VALVE or -VALVE or PUMP (Manual valve control)

Ranges	ON or OFF
Default	ON

Press the **OK** button to activate the relay - Automatic control of relays is selected by selecting cancel or after 5 minutes has elapsed.

OUTPUT - ALARM (Energises or de-energises the alarm relay manually)

Ranges	ON or OFF
Default	ON

Press the **OK** button to activate the relay - Automatic control of relays is selected by selecting cancel or after 5 minutes has elapsed.

SET PASS MENU (Set pass code)

Ranges	0000 - 9999
Default	7452
Resolution	1

TREND MENU (Sets time base of trend graph)

Ranges	MINS, HRS, DAYS
Default	MINS

11. Appendix - Summary of the Modbus protocol

Format: Byte

Start	1 bit
Data	8 bit
Parity	0 bit
Stop	1 bit

Format: Request frame

Address	1 byte
Function code	1 byte
Start address	2 bytes
Quantity of registers	2 bytes
Cyclic redundancy check (CRC)	2 bytes
Total	8 bytes

Format: Response frame

Address	1 byte
Function code	1 byte (or error code, see below)
Byte count	1 byte (or exception code, see below)
Register data	2 times the quantity of 16-bit register
Error check (CRC)	2 bytes
Total	7 bytes if correct (or 5 bytes if in error)
Only Function Code 03, 'Read holding registers' is allowed.	

Parameters and register data

Register	Parameters
0	3 - Identity Note: When the device is an IR slave and there is a temporary error in the IR Master-Slave comms, an offset of +32768 is added to the identification value of that particular slave stored in the master's database.
1	Water level (%)
2	Set point (SP)
3	Control band (CB)
4	Alarm 1
5	Alarm 1 delay (S)
6	Alarm 2
7	Alarm 2 delay (S)
8	Steam offset (%)
9	Water flowrate (%)

The format of the register data is 16 bit integer, with the most significant byte transmitted first.

Exception codes

01 illegal function

02 illegal data address

Error frame structure (in hex) transmitted by the product

Parameter	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5
	Device Address	Function Code	Exception Code	CRC (LSB)	CRC (MSB)
Illegal function	XX	83	01	XX	XX
Illegal data address	XX	83	02	XX	XX

12. Menu map

