



BC 3000 Controller

Installation and Maintenance Instructions

IMPORTANT - SAFETY INFORMATION: PLEASE READ CAREFULLY

Hazards to be considered when installing/using/maintaining Spirax Sarco products

1. Access

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

2. Lighting

Ensure adequate lighting, particularly where detailed or intricate work is required e.g. electrical wiring.

3. 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 .

4. 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.

5. The system

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

6. Pressure systems

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

7. Temperature

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

8. Tools and consumables

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

9. Protective clothing

Consider whether any protective clothing is required to protect against the hazards of, for example, chemicals, high/low temperature, noise, falling objects, dangers to eyes/face.

10. Permits to work

All work must be carried out or be supervised by a suitably competent person.

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 knows what work is going on and where necessary arrange to have an assistant whose primary responsibility is safety. Post warning notices if necessary.

11. Electrical work

Before starting work study the wiring diagram and wiring instructions and note any special requirements. Consider particularly; mains supply voltage and phase, local mains isolation, fuse requirements, earthing, special cables, cable entries/cable glands, electrical screening.

12. Commissioning

After installation or maintenance ensure that the system is fully functioning. Carry out tests on any alarms or protective devices.

13. Disposal

Unwanted equipment should be disposed of in a safe manner.

NOTE: The products supplied by Spirax Sarco Ltd are classified as components and are not affected by the Machinery Directive 89/392/EEC.

Customers and stockists are reminded that under UK and EC Health, Safety and Environmental 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.

Installation & Maintenance Instructions

Application

Installation

Wiring

Setting up the Controller

Commissioning

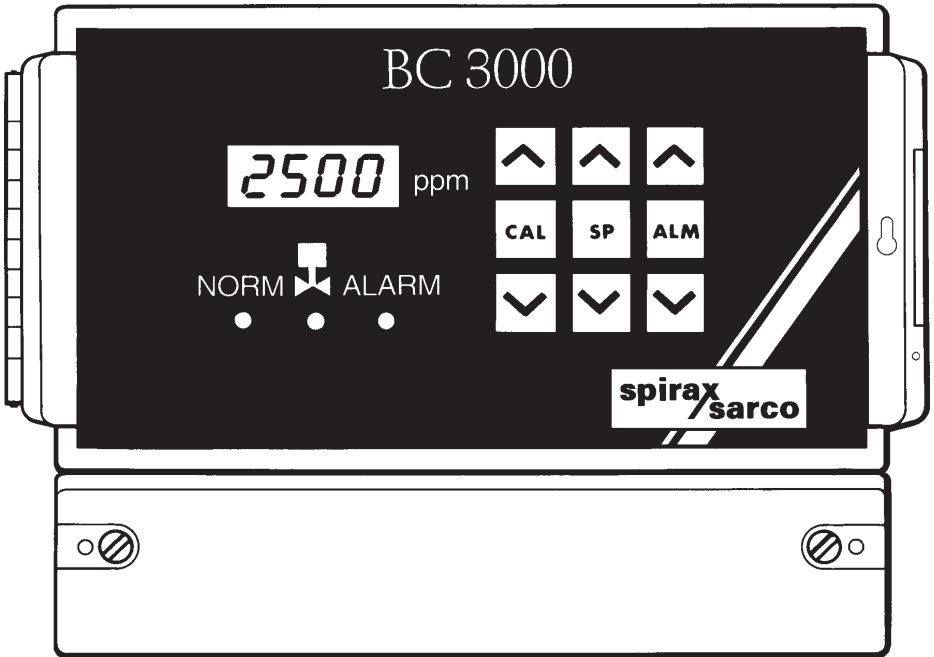
Operation

Maintenance

Fault Finding



BC 3000 Controller



Application

The BC 3000 controller continuously monitors, displays, and controls the level of total dissolved solids (TDS) in steam boilers or other water systems.

The controller is used with a probe which senses water conductivity (closely related to TDS).

The BCS 3 system described here has the probe mounted directly in the boiler.

Another system, the BCS 2, provides blowdown control for coil boilers.

This has a probe which senses the feedwater conductivity.

The BC 3000 can also be used for monitoring the conductivity of condensate.

These systems are described in separate literature.

Control of the blowdown is normally achieved

by means of an electrically actuated valve which opens when the TDS rises above the set level and closes when the TDS returns to normal.

An adjustable high TDS alarm with relay output and an isolated 0-20 or 4-20mA output are included as standard.

Some versions of the BC 3000 are available with a 'self-cleaning', or probe conditioning circuit (Patent Applied For) which allows the system to operate where less than ideal feedwater treatment is causing some boiler scaling to occur. A label on the controller defines the range and calibration units.

A Pt 100 temperature probe is also available to compensate the conductivity measurement for boilers where the working pressure varies, for coil boiler feed tanks, or for condensate systems.

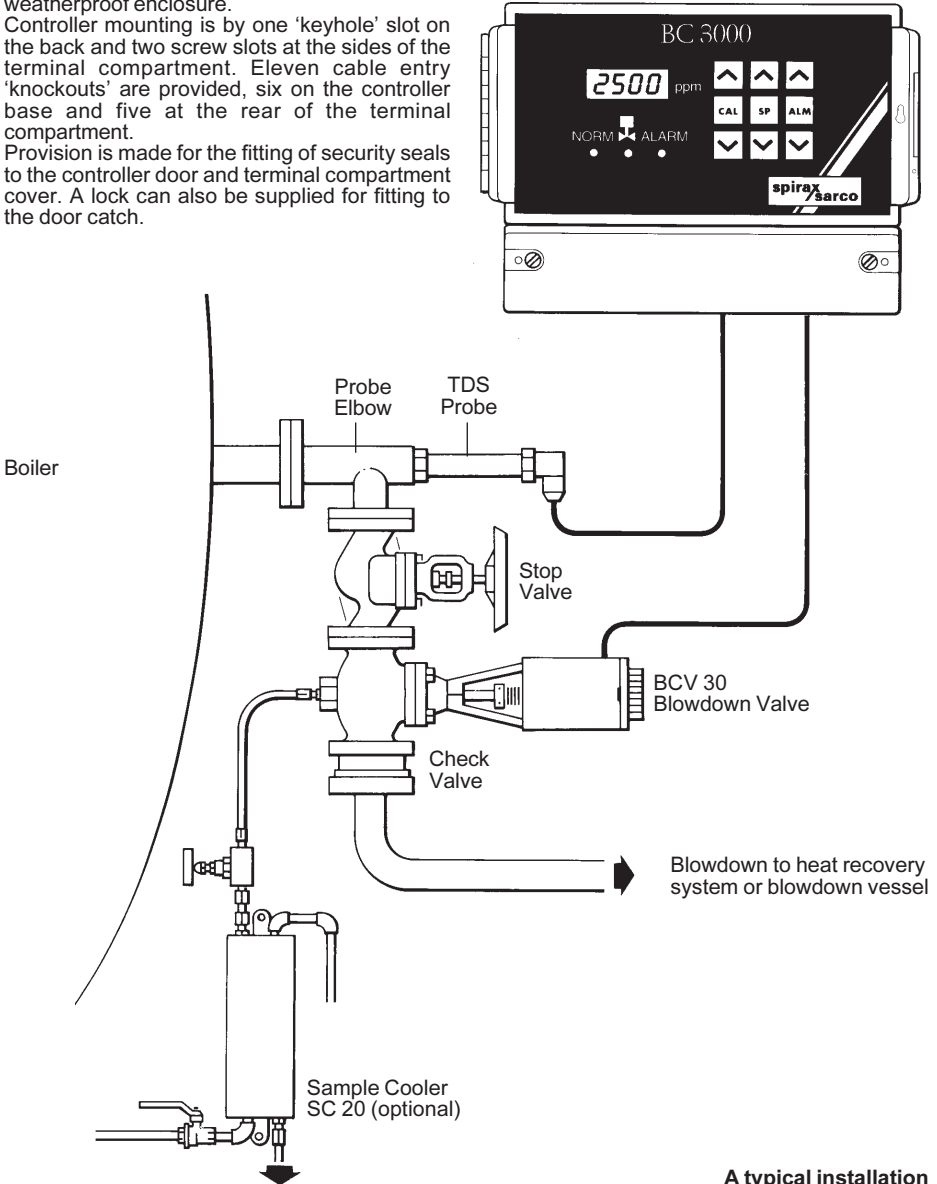
Installation

The controller is protected to IP65, and can be wall-mounted or installed adjacent to the boiler control panel in a position where it does not receive excessive radiation from hot surfaces. Maximum ambient temperature 55°C.

For outdoor applications install inside a weatherproof enclosure.

Controller mounting is by one 'keyhole' slot on the back and two screw slots at the sides of the terminal compartment. Eleven cable entry 'knockouts' are provided, six on the controller base and five at the rear of the terminal compartment.

Provision is made for the fitting of security seals to the controller door and terminal compartment cover. A lock can also be supplied for fitting to the door catch.



A typical installation

Wiring - BCS 3 System

1. TDS probe wiring

The probe requires a 4 core screened cable connection. A suitable cable is Pirelli FP 200 or Delta Crompton Firetuf OHLS, 1mm². Whilst pairs of conductors are linked at the probe, the four wire connection compensates for voltage drop along the cable. Connect the screen only as shown; do not connect at the probe. Maximum cable length 100m.

2. Temperature sensor wiring

If a temperature sensor is not to be used, link terminals 5 and 9, and 6 and 7.

Wiring to the temperature sensor requires a 3 core screened cable with the screen connected as shown. Suitable cable is Pirelli FP 200 or Delta Crompton Firetuf OHLS, 1mm². Maximum cable length 100m.

A 4 wire sensor must be linked as shown for 3 wire connection.

3. Transmitter output

The transmitter output represents the controller range e.g. 0-6000 ppm and may be used for remote TDS display, as a chart recorder input, or as an input to a computer monitoring system. The output is isolated and floating and either side may be connected to earth if required. If the transmitter output is not to be used there is no need to link terminals 10 and 11.

4. Alarm relay

The relay is volt-free and goes to the alarm position when the TDS is above the alarm set point and also when the controller is switched off.

5. Control relay

The control relay is also volt-free and goes to the high position when the TDS is above the control set point. When the controller is switched off the relay goes to the low TDS position. Remember to link a live supply into terminal 17. To ensure the blowdown valve closes on boiler shut-down, this supply may be taken from a separate source which is live only when the boiler is on.

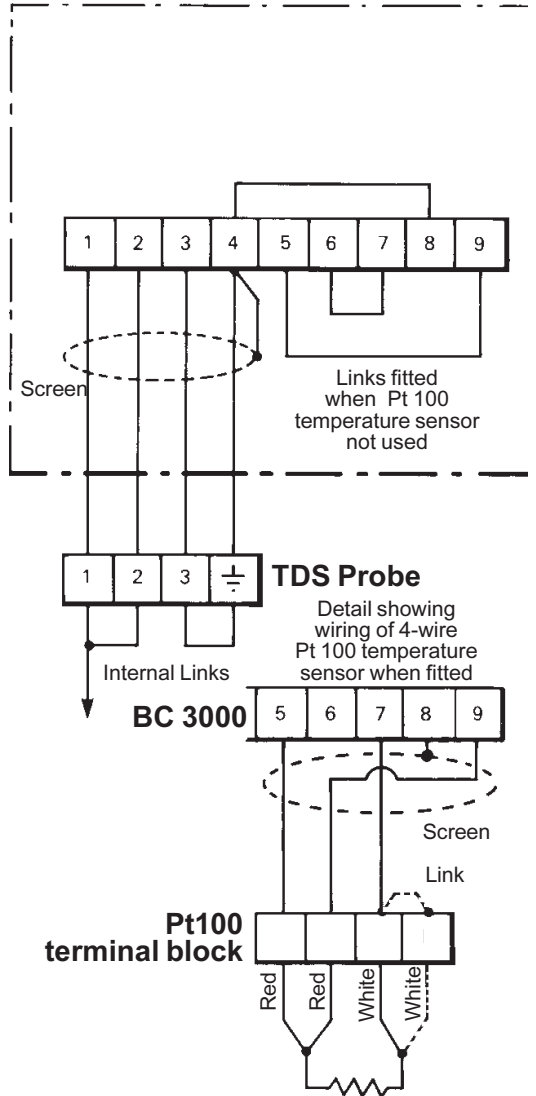
Caution: Mains supplies must be on the same phase.

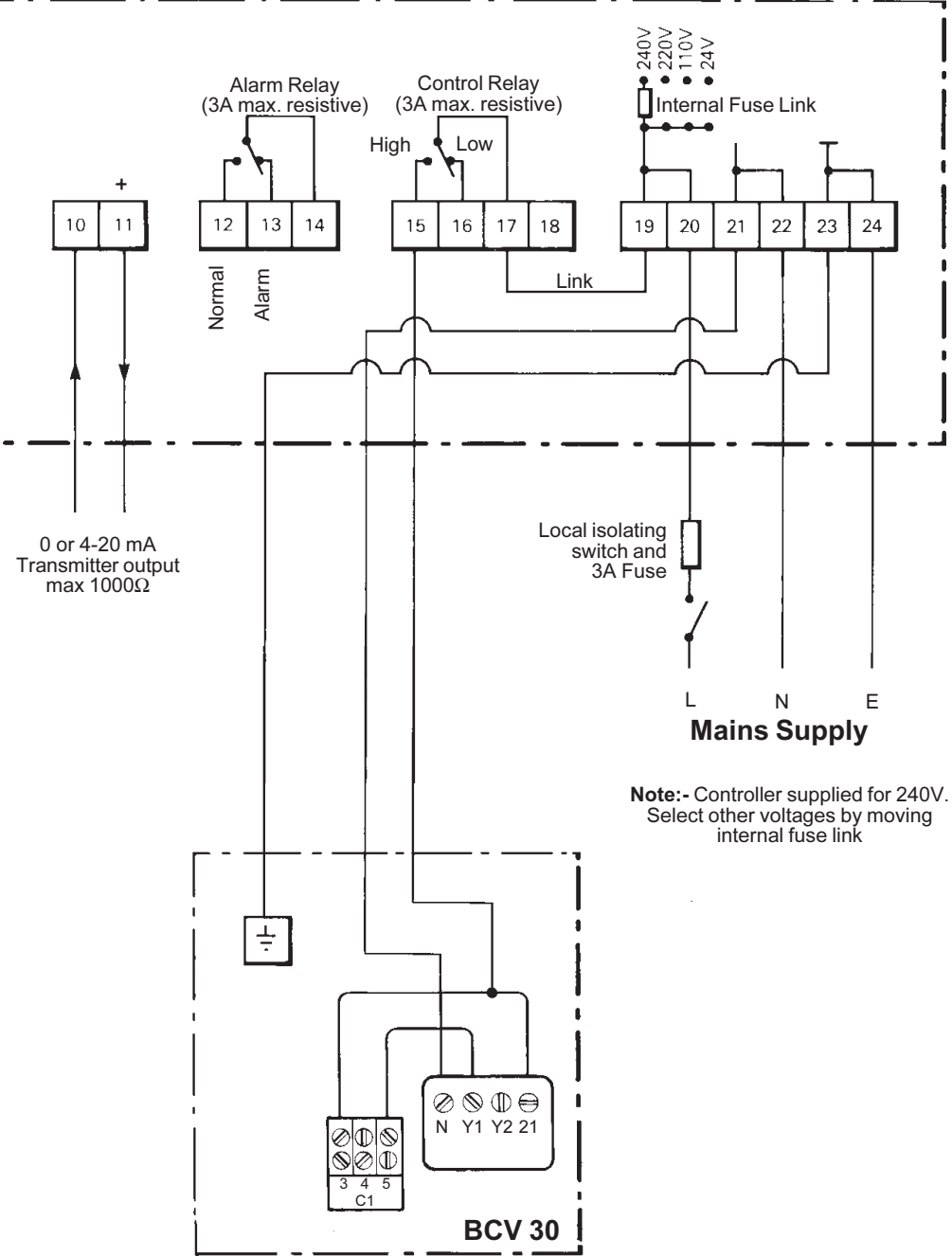
6. Mains supply

The controller should normally be supplied from the boiler control panel control phase although a separate mains supply may be provided if preferred. In this case fit a local isolating switch and fuse as shown and ensure that it is on the same phase as the rest of the boiler controls.

The controller is supplied for 240V mains supply. To change the mains supply voltage refer to 'Setting up the Controller'.

Wiring Diagram - 4 terminal TDS probe





Wiring - BCS 2 and condensate contamination detection systems

1. TDS sensor wiring

Ensure that the fibre joint washer is in place then insert the plug tail PT2 into the TDS sensor and tighten the brass union nut. The heat resisting cable is 1.25m long and for most applications will need to be extended via a junction box. When the layout permits the plug tail cable may be connected directly to controller terminals 2 and 3 but it is then essential to link terminals 1 to 2 and 3 to 4. When mechanical protection of the heat resisting cable is required the nut may be removed from the plug tail revealing an M16 thread to suit a flexible conduit adaptor.

When a cable length longer than 1.25m is needed a junction box and a 4 core screened cable is required. Note that whilst pairs of the cable are linked at the junction box, the 4 wire connection is required to compensate for voltage drop along the cable. Connect the screen only as shown, do not connect at the junction box. A suitable cable is Pirelli FP 200 or Delta Crompton Firetuf OHLS, 4 core, 1mm².

2. Temperature sensor wiring

Should a temperature sensor not be used, link terminals 5 and 9, and 6 and 7, as shown on page 4.

The Pt 100 temperature sensor cable is also 1.25m long and may be connected directly to the controller, but in most applications a junction box and 3 core screened cable will be required. Connect the screen only as shown, do not connect at the junction box. A suitable cable is Pirelli FP 200 or Delta Crompton Firetuf OHLS, 3 core 1mm². Maximum cable length 100m.

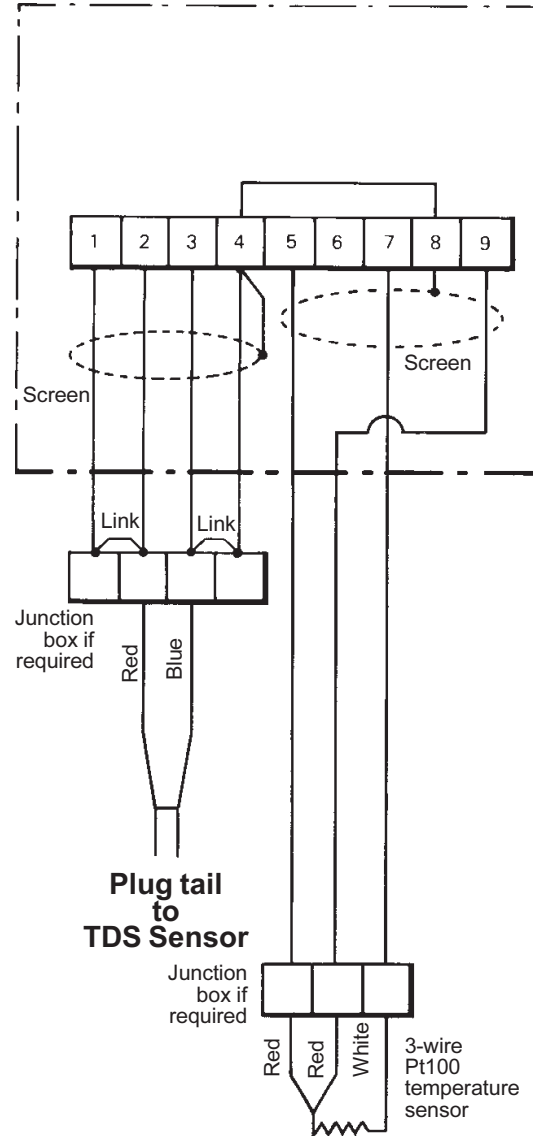
3. Control relay

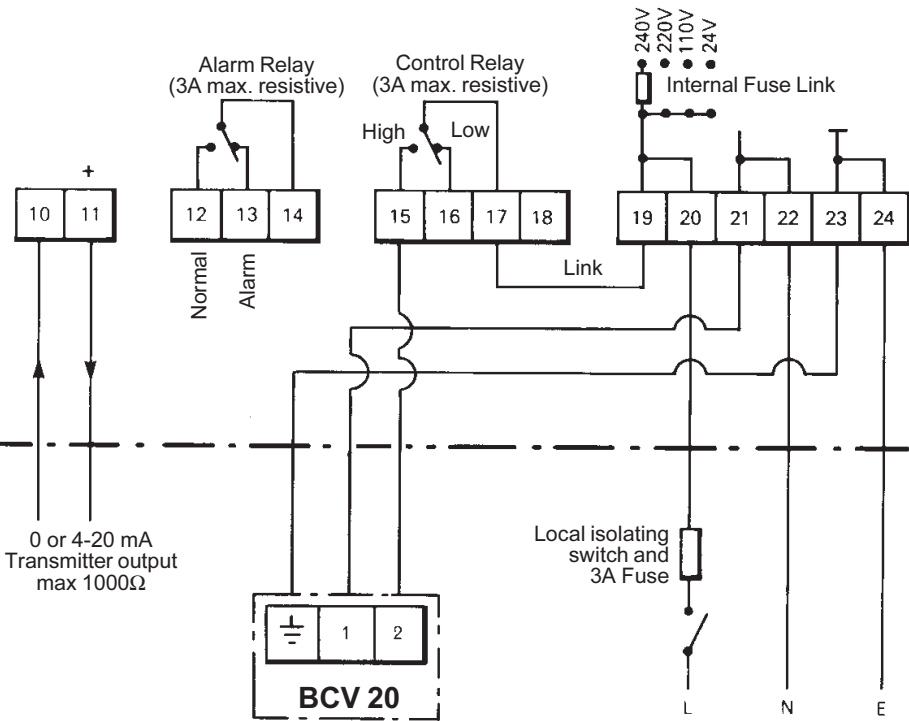
The control relay is volt-free and goes to the high position to open the blowdown valve when the TDS is above the control set point. When the TDS is low the valve closes. Remember to link a live supply into terminal 17.

On multi-boiler installations where there is a blowdown valve on each boiler, to ensure that there is no live supply to the blowdown valve when the boiler is switched off, a contactor or relay is recommended as shown. The supplies from each boiler should only be live when the boiler is running (from the feed pump circuit for example). Since there are multiple live supplies in the relay enclosure a suitable warning label should be applied.

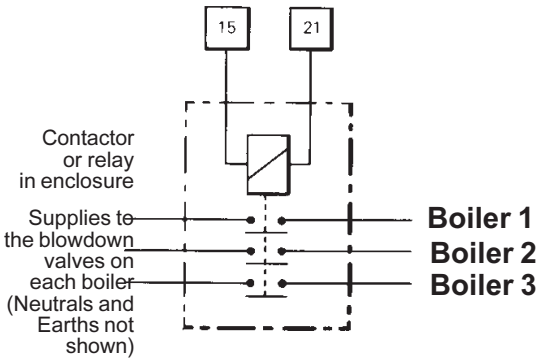
Transmitter output, alarm relay, and mains supply - see page 4.

Wiring Diagram - 2 terminal TDS probe





Suggested wiring layout
on multi-valve installations



Mains Supply
Note: Controller supplied for 240V.
 Select other voltages by moving
 internal fuse link.

Live supplies from
control circuit of each boiler

Setting up the controller

The controller is supplied set up as follows:-

- For a mains supply voltage of 240V
- For the high TDS range
- (See controller label for values)
- For a transmitter output of 4-20mA

Probe conditioning circuit (If fitted)

- Probe conditioning circuit off
- 3 minutes operating time

To change any of these settings proceed as follows:-

WARNING: Ensure mains supply is isolated before removing terminal cover or front panel. Even when the controller is operating on a 24V or 110V supply, 240V will be generated at the 240V fuse socket..

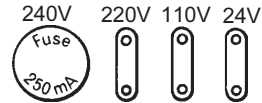
- Remove 4 corner screws securing front panel/upper circuit board assembly.
- Lift out assembly, being careful not to strain the ribbon cable.
- Change settings as required.
- Use a small screwdriver to operate switches on upper circuit board.

After changing settings-

- Refit front panel /upper circuit board assembly.
- Do not overtighten screws.
- Reconnect mains supply

1.-To change the mains supply voltage:- Ensure mains supply is isolated

- Remove terminal cover.
- On the lower circuit board-
- Remove fuse cover to right of terminals.
- Remove the 250mA fuse from its socket
- For 220V or 110V supplies plug the fuse into the required socket.
- For 24V supply discard the 250mA fuse and plug the 2A anti-surge fuse supplied into the 24V socket.

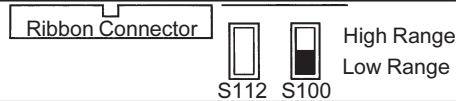


Fuse	Spirax Part No.	Farnell Part No.
250mA	4025781	150-985
2A	4025783	150-990

Spare fuses may be obtained from Spirax Sarco or Farnell Electronics Components, Leeds.
— Replace the fuse cover and terminal cover.

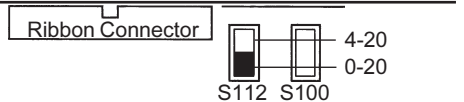
2.-To change the TDS to low range

On the upper circuit board
— Slide switch S100 inwards for low range



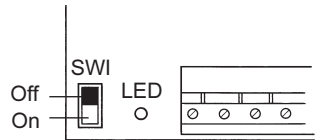
3.-To change transmitter output to 0-20mA

On the upper circuit board
— Slide switch S112 inwards for 0-20mA



4.-To switch on the probe conditioning facility

On the lower circuit board
If this facility is fitted there will be a switch and LED to the left of the terminals.
— Slide switch downwards to switch on.

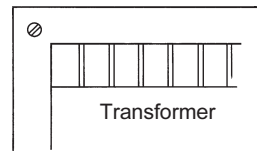
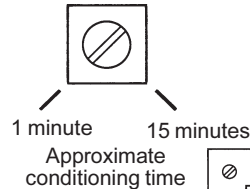


5.-To adjust probe conditioning timer

This should not normally be necessary unless poor feedwater treatment has previously caused boiler and probe scaling. **It is essential to attend to such problems promptly as serious boiler damage could otherwise occur.**

On the lower board-
The conditioning time is adjusted by a potentiometer to the top left of the transformer.
— Turn the potentiometer clockwise to increase the time.

Potentiometer VR9



Commissioning

Digital display normally shows the measured conductivity in parts per million (ppm), or micro-Siemens per centimetre, ($\mu\text{S}/\text{cm}$). The display is updated only every 15 seconds under normal running conditions to avoid a constantly changing display. Note that the final digit of the display is always zero.

Green LED: Lit when the measured conductivity is below the set point. The blowdown control valve is normally closed under these conditions.

Amber LED: Lit when the measured conductivity is above the set point. The blowdown control valve is opened under these conditions.

Flashing Red LED: Flashes when the measured conductivity is above the alarm value. The alarm relay signals alarm under these conditions.

Increase buttons: Increase the displayed value, but only when the relevant calibrate, set point or alarm button is pressed. Value increases slowly for a few steps when first pressed then increases at a greater rate, after a few seconds pause.

Decrease buttons: As above but decreases the value.

Calibrate button: Allows the display to update at a faster rate when pressed. Used in conjunction with the increase/decrease buttons for 'calibrating' the controller.

Set point button: Displays the controller set point. When released the display reverts to the

measured conductivity value. Used in conjunction with the increase/decrease buttons for changing the set point.

Alarm button: Displays the alarm value. When released the display reverts to the measured conductivity. Used in conjunction with the increase/decrease buttons for changing the alarm value.

Setting the controller set point.

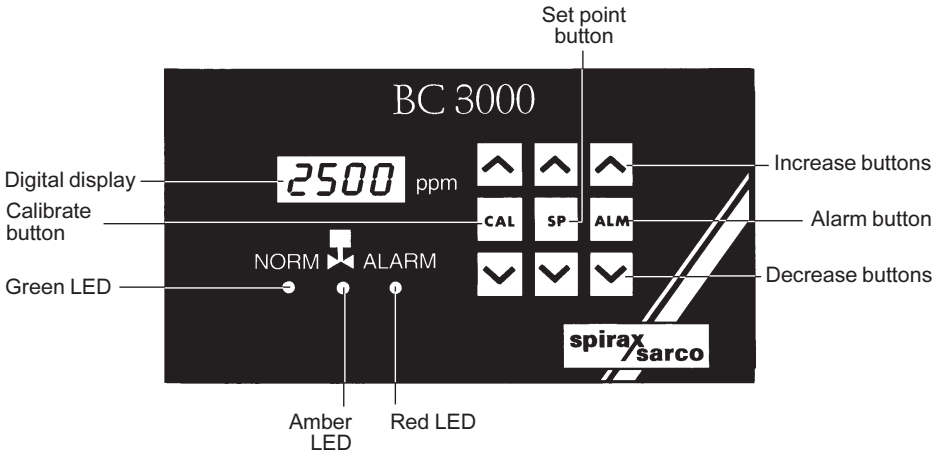
The set point is the conductivity level at which the blowdown valve will open. The valve will close at a conductivity level approximately 4% below the set point.

Press and hold the set point button then use the increase or decrease buttons as necessary to change the displayed set point value.

Note: The 4% operating band is built in to avoid 'hunting' of the blowdown valve and will cause the valve to remain open even though the conductivity level is below the set point. This is normal and can be ignored.

Setting the alarm value.

The alarm value should be set higher than the controller set point so that it gives a high conductivity alarm if the measured conductivity rises too far. To set the alarm value press and hold in the alarm button then use the increase or decrease buttons as necessary to change the displayed alarm value. The alarm resets approx 4% below the alarm value.



Calibrating the controller

The controller must be 'calibrated' before the system is ready for use. Calibration compensates for the various differences between boilers including the effects of:-

- Boiler pressure and temperatures (where temperature compensation is not fitted)
- Boiler water alkalinity.
- The exact 'cell constant' or geometry of the conductivity probe and boiler connection.
- The exact make-up of the impurities in the boiler water.

To calibrate the controller, **with the boiler at normal operating pressure**, proceed as follows:

- Take a sample of boiler water through a sample cooler and measure its conductivity by your normal method. As an example assume the measurement is 2000 ppm.
- Press and hold in the calibrate button then use the increase or decrease buttons as necessary to change the displayed value to 2000 ppm.
- Release the calibrate button. The controller is now calibrated and the display and transmitter output should follow any variations in conductivity.

Note:- For new or recently refilled boilers, the TDS level may be very much lower than the desired set point. If this is so, re-calibration is advised once the boiler has been working for a while and the TDS level has risen nearer to normal.

Operation

During operation the controller will continuously display the boiler water TDS and should control this figure very closely by periodically opening the blowdown control valve to reduce the TDS. This should normally result in consistent TDS readings as measured with a portable conductivity meter such as the Spirax Sarco MS1, typically within the range of plus or minus 10%. Factors reducing the accuracy of control include large variations in boiler pressure (where temperature compensation is not fitted) and wide pH swings.

Checking the controller calibration

Whenever the TDS is measured by taking a sample of boiler water, the figure should be compared with the controller display. If the boiler is operating normally yet the readings differ significantly the controller may simply be re-calibrated to the new TDS reading. If frequent re-calibration becomes necessary then something is wrong. It could be that the water treatment is not sufficiently well controlled to ensure a reasonably steady pH value in the boiler.

Probe conditioning circuit

If scale is forming on the probe tip it is a certain warning that scale will also be forming on the boiler tubes. Boiler water treatment must be investigated.

The probe conditioning circuit (Patent Applied For) is fitted to some versions of the BC 3000, and can help keep the probe working even where boiler water treatment conditions are less than ideal.

It may not be able to cope with severe sludge and scale conditions, however, and should not be regarded as a substitute for adequate feedwater treatment.

The circuit comes into operation whenever the mains supply is switched on and when first activated (see 'Setting up the controller').

It will continue to operate for the set time, and will then switch off for approximately twelve hours before repeating the cycle.

An LED to the left of the main terminals is lit during this operation.

During this time the display is disconnected from the probe and the reading should be ignored.

It will automatically display the true TDS level when the conditioning cycle finishes.

Maintenance

No special maintenance of the controller is necessary. The following maintenance however, is recommended on the system. For details see separate instructions.

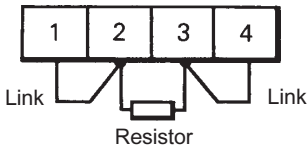
Weekly: Take a sample of boiler water through a sample cooler, measure its TDS and check the controller calibration with the boiler at normal operating pressure. Check that the blowdown control valve shuts off when the green LED is lit or when power is removed. Operate the stop valve to ensure that it shuts off and remains free.

Annually: With the boiler depressurised, vented, and emptied sufficiently, remove the conductivity probe. Clean the tip with fine abrasive paper and the insulation with a brush or cloth. Examine the blowdown control valve, stop valve, check valve and probe elbow. Clean and replace any parts necessary.

Fault Finding

If problems are experienced during commissioning it is very likely that a mistake has been made in the wiring. We recommend that a complete check is made for such faults as the neutral not connected to the supply, the live supply not linked to the controller terminal 17 or the links not fitted (terminals 5 & 9, 6 & 7) when the temperature sensor is not used. Always check the wiring to the conductivity probe particularly carefully since it is easy to make a mistake with the probe terminals.

A simple test may be made on the controller even when the boiler is shut down or empty. Disconnect the conductivity probe and connect



a resistor as shown.

The table below shows the approximate resistor value required to give a half scale reading, allowing the various controller functions to be tested.

Controller range	Half scale	Resistor value (Ohms)
0-2000ppm	1000ppm	68
0-6000ppm	3000ppm	22
0-3000 μ S/cm	1500 μ S/cm	68
0-9000 μ S/cm	4500 μ S/cm	22
0-100 μ S/cm	50 μ S/cm	2200
0-300 μ S/cm	150 μ S/cm	680

In case of problems refer to the following points.

1. The digital display always reads very high and the amber LED and flashing red LED are lit.

This probably indicates a short in the conductivity probe circuit; in the boiler; in the probe itself or in the wiring. The position of the fault may be located by disconnecting the probe plug or the wiring. Note that it takes a minute or so for the displayed value to drop after a short in the probe circuit. A high reading may also be caused by a short circuit in the temperature sensor or its wiring (where fitted) since the controller will receive a low temperature input. If the links 5 & 9, 6 & 7 are disconnected the display will also read high.

2. The digital display always reads very low and the green LED is lit.

If the boiler is empty, has just been filled with pure water, or if the boiler is cold (without a temperature sensor fitted) this should not be

regarded as a fault. As the boiler steams, the boiler water TDS and conductivity will increase and normal operation should follow. If the boiler water TDS is in its normal range, however, the low reading probably indicates an open circuit in the TDS probe, or in the wiring.

3. The boiler water TDS continues to rise above the set point although the amber LED is lit and blowdown is being discharged through the blowdown control valve.

The controller is operating correctly but insufficient blowdown is being discharged. It may be possible to adjust the blowdown control valve to a higher flowrate setting (see separate instructions). Alternatively the valve or pipework may be partially blocked or where a heat recovery system is installed, the blowdown may be contaminating the feedwater system.

An increasing boiler water TDS may also be caused by condensate or feedwater contamination from any source.

4. The boiler water TDS continues to fall although the green LED is lit and the blowdown control valve is closed.

Check that the valve shuts off tight and that other blowdowns are not excessive.

Examples could be a leaking bottom blowdown valve, unnecessary manual blowdown or leaking level control chamber drain valves.

5. The increase or decrease buttons sometimes do not appear to work.

The controller incorporates a pair of digitally controlled potentiometers for the functions calibrate, set point and alarm. For each function there is a coarse and a fine potentiometer arranged so that the fine potentiometer steps for the first few seconds after the increase or decrease button is pressed, followed by steps from the coarse potentiometer. A problem occurs when the fine potentiometer reaches the end of its range since there will be no change of the display for the first few seconds. The answer is simply to hold down the increase or decrease button until the coarse potentiometer takes the display past the required value, then step back in the other direction.

6. The display shows a high reading when first switched on.

This is normal and the controller will take up to 1 minute before the display shows the correct value.

Notes

