Instruction Manual

IM/9435_8

Low Level Dissolved Oxygen Monitor

9435

ABB

The Company

EN ISO 9001:1994

Cert. No. Q05907

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

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

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

EN 29001 (ISO 9001)

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

Stonehouse, U.K.

0255

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

Electrical Safety

This equipment complies with the requirements of CEI/IEC 61010-1:2001-2 'Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use'. If the equipment is used in a manner NOT specified by the Company, the protection provided by the equipment may be impaired.

Symbols

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

	**Warning –** Refer to the manual for instructions
	**Caution –** Risk of electric shock
	Protective earth (ground) terminal
	Earth (ground) terminal

	Direct current supply only
	Alternating current supply only
	Both direct and alternating current supply
	The equipment is protected through double insulation

Information in this manual is intended only to assist our customers in the efficient operation of our equipment. Use of this manual for any other purpose is specifically prohibited and its contents are not to be reproduced in full or part without prior approval of the Technical Publications Department.

Health and Safety

To ensure that our products are safe and without risk to health, the following points must be noted:

1. The relevant sections of these instructions must be read carefully before proceeding.
2. Warning labels on containers and packages must be observed.
3. Installation, operation, maintenance and servicing must only be carried out by suitably trained personnel and in accordance with the information given.
4. Normal safety precautions must be taken to avoid the possibility of an accident occurring when operating in conditions of high pressure and/or temperature.
5. Chemicals must be stored away from heat, protected from temperature extremes and powders kept dry. Normal safe handling procedures must be used.
6. When disposing of chemicals ensure that no two chemicals are mixed.

Safety advice concerning the use of the equipment described in this manual or any relevant hazard data sheets (where applicable) may be obtained from the Company address on the back cover, together with servicing and spares information.

CONTENTS

1 INTRODUCTION

1.1 General

Model 9435 is a microprocessor-controlled on-line monitor for measuring dissolved oxygen in deaerated waters, e.g., boiler feed water.

Four ranges are available: 0 to 19.9, 0 to 199 $\mu g\,kg^{-1}$, 0 to 1.99 and 0 to 19.9 $mg\,kg^{-1}$; range change is automatic.

The monitors consist of two discrete units, the electronics control section, (transmitter unit) and the liquid handling section, (sensor unit). The units can be mounted side by side or up to 100 meters (325 feet) apart.

Two types of instrument are available: a CE approved version and a version without CE approval.

The CE approved version mainly includes the addition of a user's terminal box on the side of the transmitter unit, containing electrical filtering on all inputs and outputs.

1.2 Sensor Unit

The Liquid Handling System features an airtight flow cell housing a disposable oxygen sensor which can be changed simply and rapidly when exhausted. Calibration is achieved by draining the flow cell and exposing the oxygen sensor to air. This is carried out automatically and involves no manual operation. The flow cell is self cleaning and designed to prevent air bubble entrapment and minimum particle deposition around the sensor.

This flow cell incorporates a temperature sensor for thermal compensation and for thermal protection of the oxygen sensor, diverting the sample to waste if its temperature should exceed 55 °C.

1.3 Transmitter Units

The microprocessor electronics section performs three main functions: it interprets and displays a reading of dissolved oxygen received from the sensor unit, controls the calibration sequence and provides the various outputs to remote equipment.

The display is a seven segment l.e.d. type indicating the level of dissolved oxygen and also providing information on the operating mode of the instrument. It informs the operator when it is in the calibration mode, when the sample is too hot and when the sensor is nearing the end of its life.

Two concentration alarm points are available, which are set up by the operation of push-buttons on the monitor facia. The desired alarm values are displayed by the readout when the respective push-button is depressed.

Calibration can be manually initiated when required or set to automatically occur every seven days. The oxygen partial pressure, and hence the sensor current, in air is a function of the atmospheric pressure. Before a calibration routine is initiated, the relevant atmospheric pressure can be programmed into the monitor by the use of push-buttons on the monitor facia. This introduces a correction factor into the final calculation of dissolved oxygen concentration.

...1 INTRODUCTION

The customer programmable information is retained for a period of up to ten years in power down conditions by means of an internal battery.

On the left hand side of the CE approved transmitter is a terminal box fitted with cable glands for the power input cable, the cable to the sensor unit and cables for alarm signals and other signal outputs. The terminal box lid is secured by six screws.

The transmitter unit, without CE approval, has a provided cable gland fitted to the gland plate on the left hand side of the case for the cable to the sensor unit. The gland plate is also drilled with five other holes which may be enlarged to accept customer's cable glands suitable for the cables carrying the alarm signals and other signal outputs. The maximum gland size is PG21.

2 INSTALLATION

2.1 Location and Fixing of Units (Fig. 2.1)

Both units should be mounted in a clean, vibration-free situation, avoiding direct radiant heat, sunlight and drafts. Areas containing chlorinating equipment should be avoided.

The sensor unit should be mounted not more than ten meters (30 feet) from its associated sample cooler. The transmitter may be mounted alongside or up to 100 meters (325 feet) away from the sensor unit.

The holes for wall-mounting both units are suitable for 8 mm diameter bolts and are located as shown in Fig. 2.2. Sufficient space must be left in front of the cases for access, and to the side for making cable connections to the transmitters.

2.1.1 Sensor Unit

The sensor unit consists of a metal case which houses the liquid handling equipment. This equipment is mounted on a panel which is secured to the back of the case with four M6 captive bolts. Holes in the case for wall-mounting the unit are suitable for 8 mm diameter fasteners. Sufficient space must be left in front of the case for access.

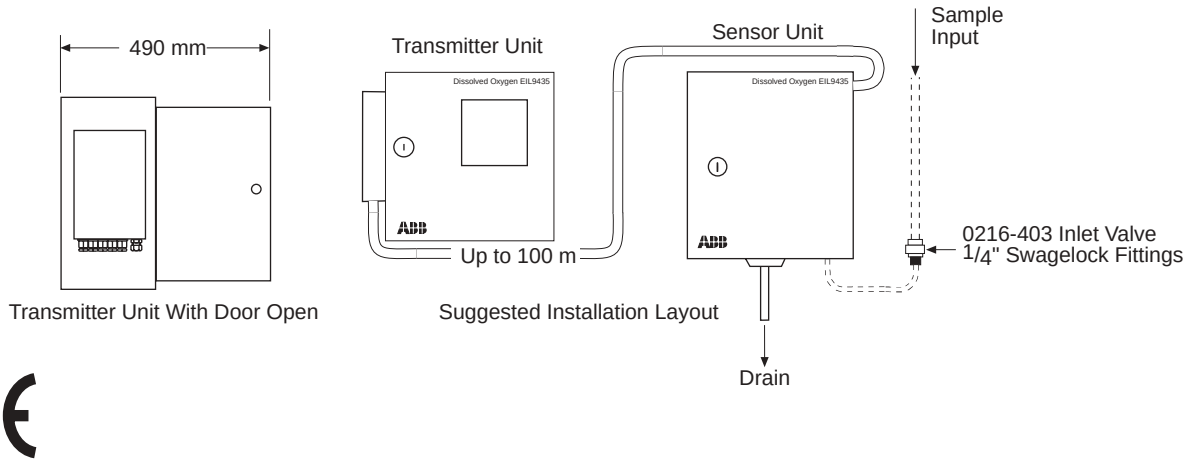


Fig. 2.1 System Layout [CE approved version]

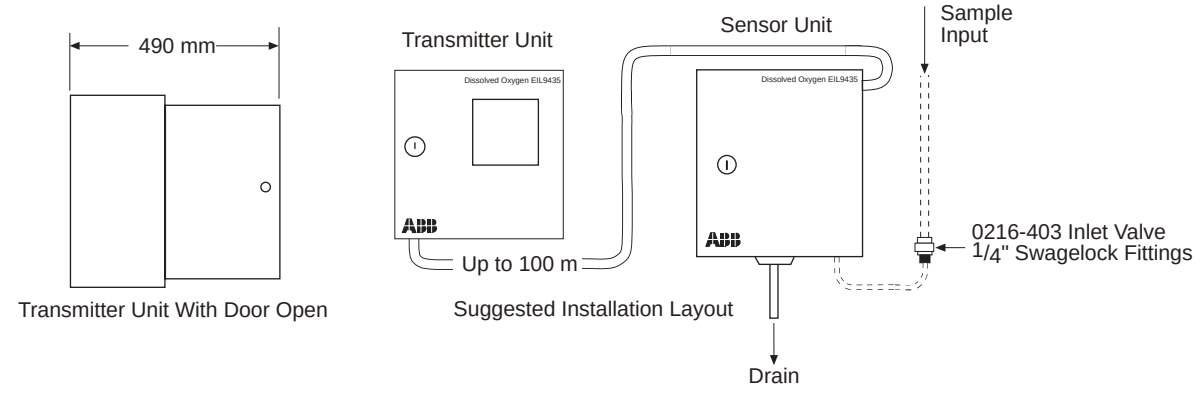


Fig. 2.2 System Layout [Version without CE approval]

2.1.2 Transmitter Units

The transmitter units consist of a metal case of similar construction to the sensor case, with a chassis unit supporting circuit boards and other electrical subassemblies. Wall mounting is by four 8 mm diameter fasteners on 230 x 230 mm centres – see Fig. 2.4 and Fig. 2.5.

For access and fitting of the CE approved version transmitter, proceed as follows, and for the version without CE approval refer to the instructions in Fig. 2.5:

a) Unlock the door and open fully.

b) To release the escutcheon plate, remove all the 17 screws, and with a small coin or similar tool, turn the four black fasteners by 1/4 turn (either direction).

c) Hold the escutcheon plate with two fingers through the slot at the left side. Ease the escutcheon plate forward over the range switch knob.

d) Remove the safety earth (ground) bonding leads attached to the metal case.

e) Release the captive screws securing the chassis assembly to the back of the case and ease the chassis forwards.

f) After recording the position of the connection blocks on the circuit boards – see Fig. 2.9, remove the connection blocks from the analog and digital boards by applying force outwards from the face of the boards. To remove the connector from the PSU board, slide the connector sideways towards the vertical edge of the board.

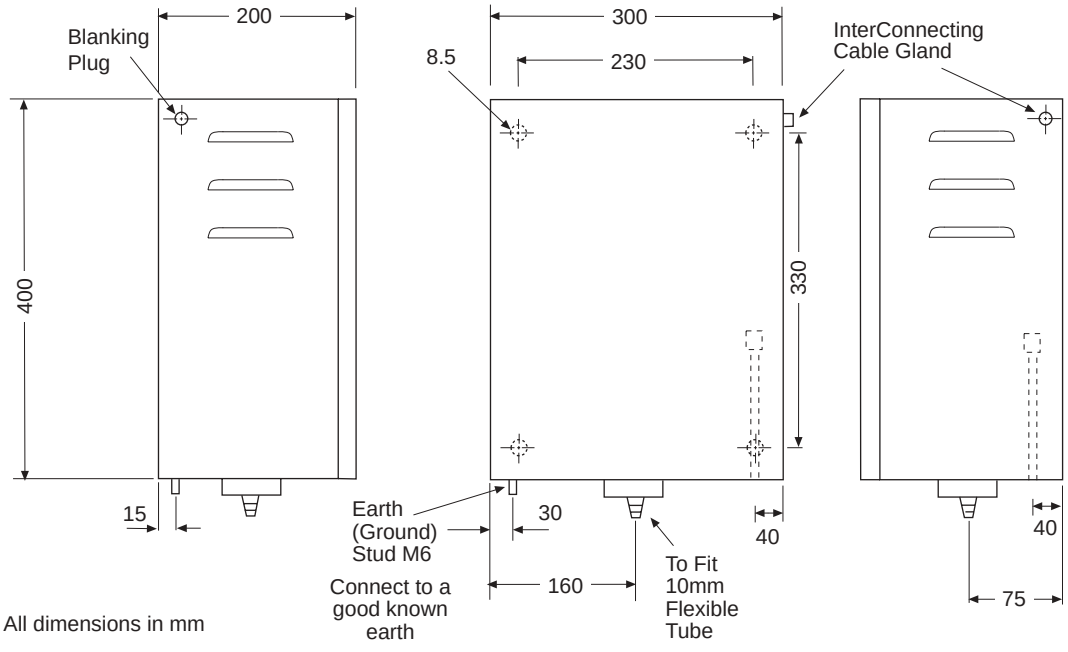


Fig. 2.3 Sensor Unit Dimension and Installation Detail

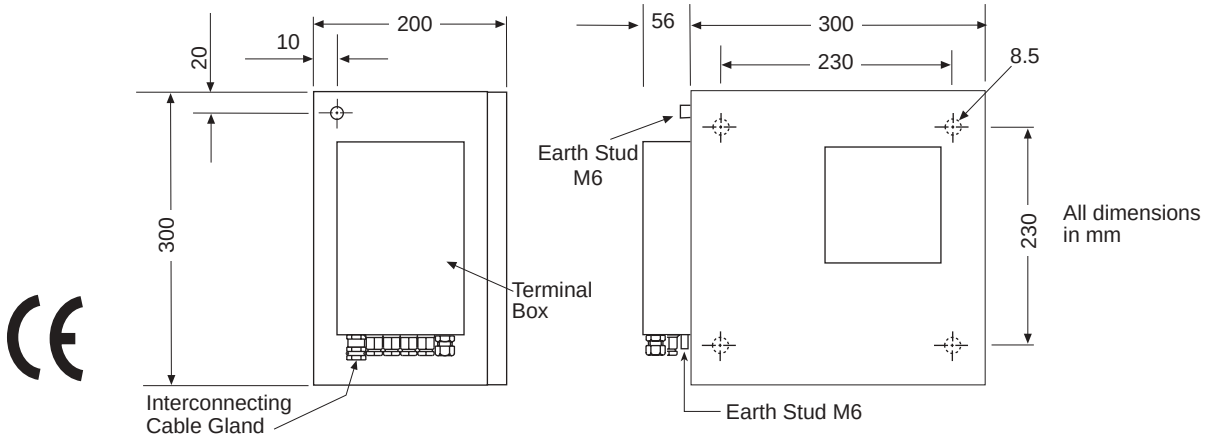


Fig. 2.4 Transmitter Unit Dimension and Installation Detail [CE Approved Version]

g) Disconnect the three wires from the mains input connector on the PSU Board – see Fig. 2.9.

h) Remove chassis completely and fix case as required.

Note. Before fitting the chassis unit, check that the voltage selector is set to the correct value before connecting the unit to the supply, and refer to Section 2.6 for procedures required before Start-up.

Caution. When replacing the connection blocks, care should be taken to ensure that the blocks are aligned correctly to cover all the associated connecting pins.

i) Offer the chassis to the case and wire the mains connection. Fit the connection blocks onto the circuit boards.

j) Fully replace the chassis unit, secure it with the captive screws, and replace the earth (ground) bonding leads.

k) Position the escutcheon plate and secure it with the four plastic fasteners. Fit all 17 screws.

2.2 Sample Requirements

Warning. The maximum pressures and temperatures specified must not be exceeded.

Where pressure reducing equipment is being used it is recommended, for safety reasons, that a pressure relief valve be installed between this and the sample inlet to the monitor.

The sample should be brought to the temperature and pressure suitable for measurement – see Section 7.

If necessary use sample cooling and pressure reducing equipment.

2.3 External Pipe Connections

2.3.1 Inlet

Sample should be connected to the sensor unit by means of 18/8 descaled stainless steel tube, 6 mm ($^1/_4$") o.d. approximately. Connect this to the sample inlet coupling on the right-hand side of the panel via the grommet in the floor of the case.

Note. The grommet is of a much larger diameter than the inlet pipe. This is to allow ingress of air to the case for air calibration of the sensor and the annular space must, therefore, not be closed up.

For access to wall mounting holes remove the chassis unit as follows:

1. Unlock the door and open it fully.
2. To release the escutcheon plate, remove all the 17 screws, and with a small coin or similar tool, turn the four black fasteners $^1/_4$ turn in either direction.
3. Hold the front panel with two fingers through the slot at the left side. Ease the front panel forward over the Range Switch knob.
4. Remove the safety earth (ground) bonding leads attached to the metal case.
5. Release the captive screws securing the chassis assembly to the back of the case and remove the chassis.

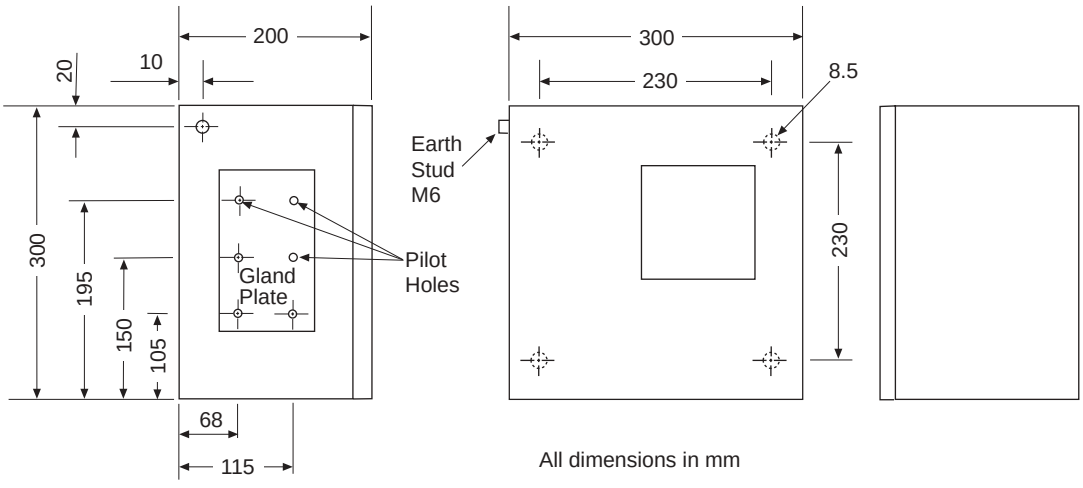


Fig. 2.5 Transmitter Unit Dimension and Installation detail [Version without CE approval]

The inlet tubing should be of sufficient wall thickness to withstand the highest sample pressure and the pipe lengths should be kept short to minimize the possibility of loss of oxygen. The inlet pipe should be bent to a right angle outside the case to allow future removal of the liquid handling panel when required.

An isolator valve (not supplied) is necessary in the sample inlet line to the sensor unit.

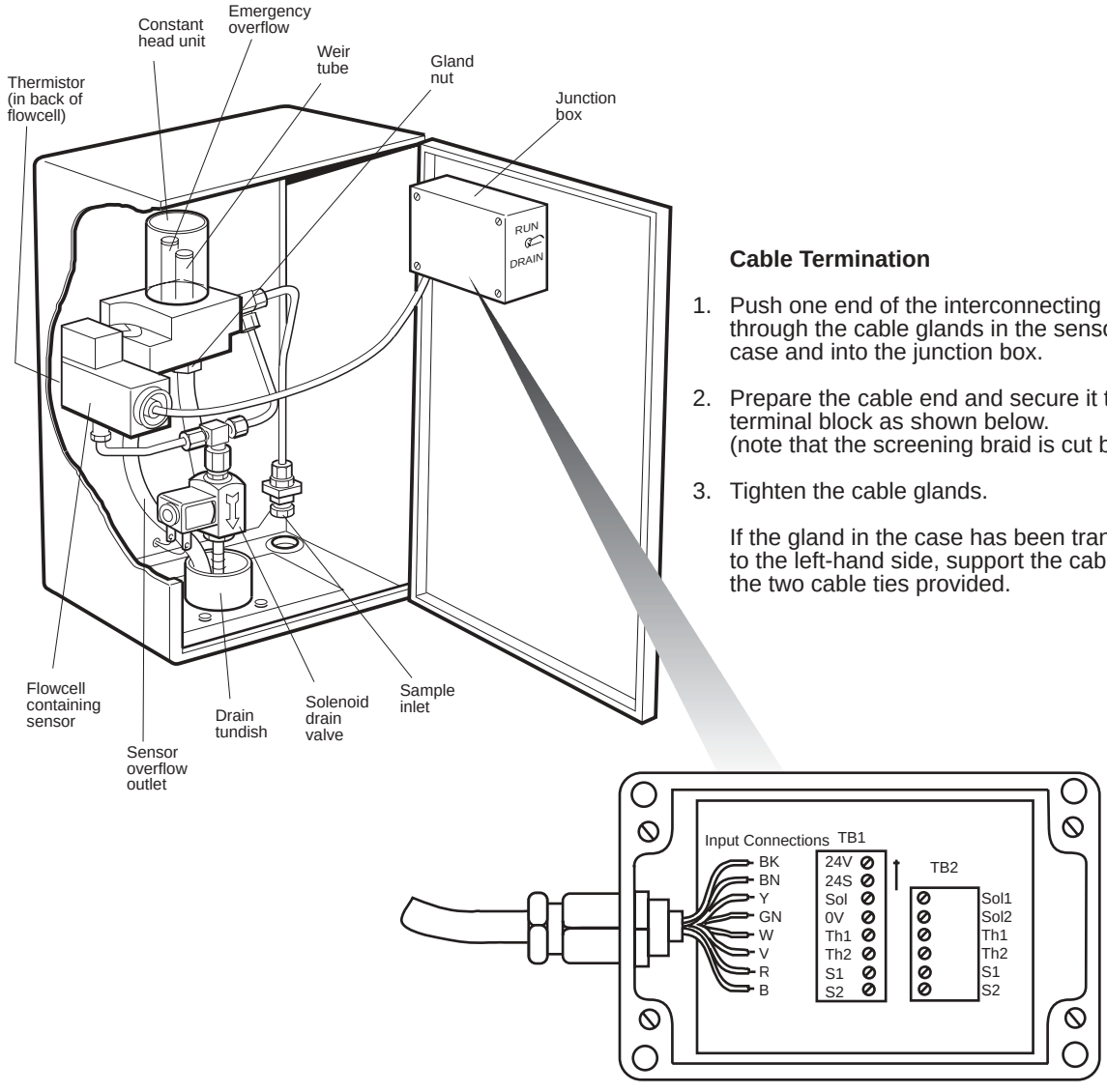
2.3.2 Drain

The outlets from the split drain tundish at the bottom of the sensor unit case are stub pipe connections suitable for 10 mm ($^3/_8$") bore plastic or rubber tubing. The monitor does not affect the sample except to expose it to air and hence the outflow can be led to the clean drain for return to the feedwater supply.

2.4 Electrical Interconnections

Warning.

- Although certain instruments are fitted with internal fuse protection, a suitably rated external protection device, e.g. fuse or miniature circuit breaker (m.c.b.), must also be fitted by the installer.
- Before making any connections, ensure that the power supply and high voltage power operated control circuits are switched off.
- The equipment operates on a.c. mains supply voltage electricity; suitable safety precautions must always be taken to avoid the possibility of electric shock.



Cable Termination

1. Push one end of the interconnecting cable through the cable glands in the sensor unit case and into the junction box.
2. Prepare the cable end and secure it to the terminal block as shown below.
   (note that the screening braid is cut back).
3. Tighten the cable glands.

   If the gland in the case has been transferred to the left-hand side, support the cable using the two cable ties provided.

Fig. 2.6 Location of Items and Interconnections in the Sensor Unit

2.4.1 Sensor Unit

The cable gland for connections within the sensor unit is situated at the top right hand side of the case, but may be transferred to the opposite side if this is more convenient – see Fig. 2.3.

A two meter length of 8-way overall screened cable is normally supplied for interconnecting the sensor and transmitter units; longer lengths may be ordered separately. The interconnecting cable is routed to a terminal block in a junction box on the inside of the case door – see Fig. 2.6.

Connections in the junction box are as follows:

TB1			**Colors**
Terminal	1	24V	Black
	2	24V Sense	Brown
	3	Solenoid Valve	Yellow
	4	0V	Green
	5	Thermistor 1	White
	6	Thermistor 2	Violet
	7	S1, +ve Sensor	Red
	8	S2, - ve Sensor	Blue

Earthing (Grounding)
A stud terminal is fixed to the bottom of the sensor unit for a bus-bar earth (ground) connection.

2.4.2 The CE Approved Transmitter Unit

To gain access to make the necessary connections remove the six screws from the terminal box lid on the side of the transmitter and remove the lid. Then:

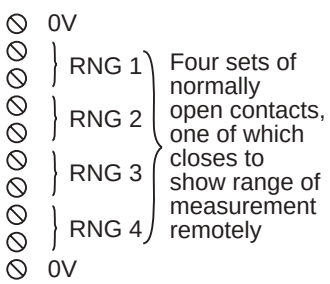
a) Cut the cable from the sensor unit, to a length to reach the transmitter, to terminate on terminal block TB4 inside the terminal box, via the metal cable gland.

b) Push the end of the cable through the metal gland in the base of the terminal box.

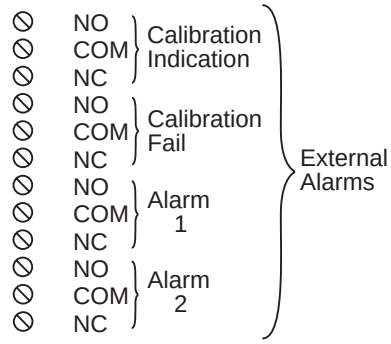
c) Noting that the screening braid terminates at the cable gland and is prepared as shown in Fig. 2.7, prepare the cable end and attach it to the terminal block TB4.

Pass the cables, necessary for the supply, output signals, alarms and remote function, through the plastic glands and connect the cables as follows:

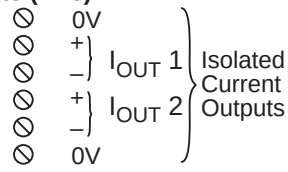
Range Relays (TB1)



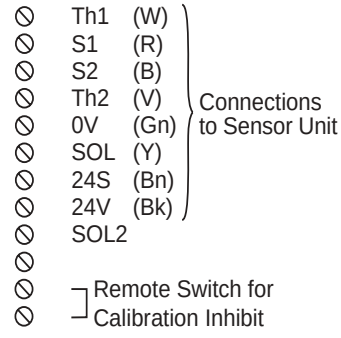
Alarm Relays (TB2):



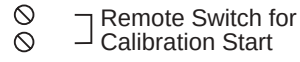
Current Outputs (TB3):



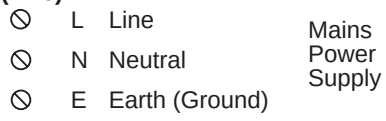
Sensor Unit (TB4):



Remote Calibration (TB5):



Power Supply (TB6):



Not Used (TB7):

Not Used
Not Used
Not Used
Not Used

Chassis

> **Warning.** The power supply earth (ground) **must** be connected to ensure safety to personnel, reduction of the effects of radio frequency interference and correct operation of the power supply interference filter.

A voltage selector is located next to the supply terminals and this must be set to the correct value before connecting the instrument to the supply – see Fig. 2.9.

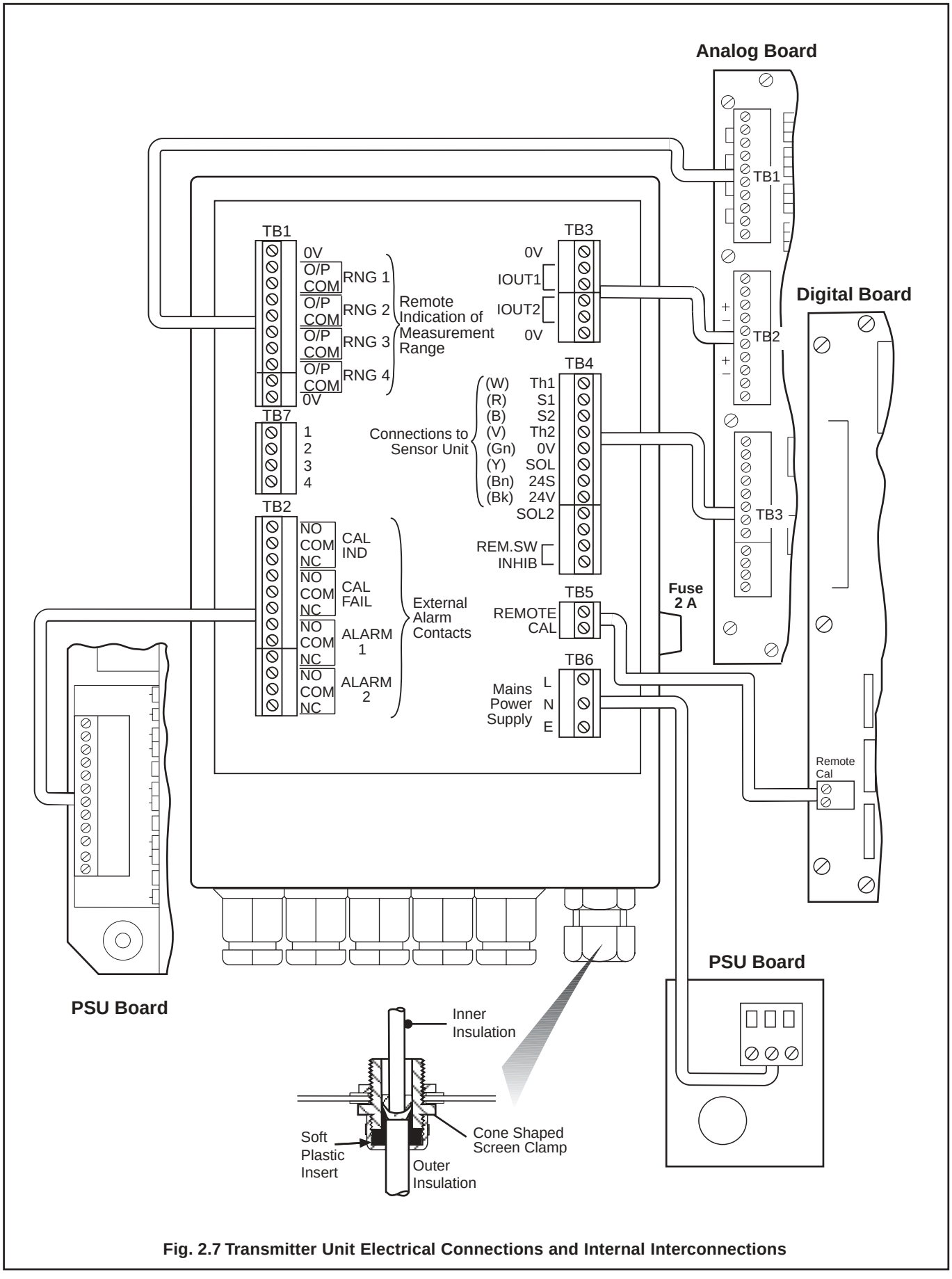


Fig. 2.7 Transmitter Unit Electrical Connections and Internal Interconnections

Earthing (Grounding)
A stud terminal is fixed to the bottom of the Terminal Box for a bus-bar earth (ground) connection.

Fuse
The mains input fuse is mounted on the side of the terminal box. A spare fuse is provided inside the terminal box.

Caution. Replace the fuse only with the correct value and type: i.e. 2 A Quick Blow – see Section 6.

2.4.3 Transmitter Unit (Fig. 2.8)
For the CE Approved Transmitter Unit, see Section 2.4.2.

To gain access to make the necessary connections, proceed as follows:

a) Remove the six screws securing the gland plate to the left-hand side of the transmitter case. Fit suitable cable glands to the plate, to take the cables necessary for the supply, output signals, alarms and remote function, if used.

b) Open the transmitter door and remove the escutcheon plate – see Section 2.1.2, paragraphs a, b and c.

c) Cut the cable from the sensor unit to a length to reach the transmitter easily to terminate on terminal block TB3 on the analog board.

d) Push the end of the cable through the supplied gland in the gland plate.

e) Noting that the screening braid terminates at the cable gland and is prepared as shown in Fig. 2.8, prepare the cable end and attach it to the terminal block TB3. The terminal block may be pulled off the pins on the board if required.

Caution. The terminal block for sensor unit connection has eight terminals, whereas there are 12 pins on the board. Ensure that the correct eight pins are chosen for connection; these are marked, on the PCB, with a separate 'box' – see the following text and Fig. 2.8.

Pass the remaining cables through the glands. Note that Pin 1 of each block is nearest the top of the case. Prepare the cable ends and attach them to the terminal blocks as follows – see also Fig. 2.8.

Digital board (nearest front panel).

PIN			
	1	REMOTE	To Remote Calibration Switch
	2	CAL	

Analog board TB1 (top edge):

PIN				
	1	0V		
	2	NO	R4	Four sets of normally open contacts, one of which closes to show range of measurement remotely.
	3	COM		
	4	NO	R3	
	5	COM		
	6	NO	R2	
	7	COM		
	8	NO	R1	
	9	COM		
	10	0V		

See Section 2.5 for further details regarding the wiring of the TB1 connector.

Analog board TB2 (middle):

PIN			
	1	0V	Isolated current outputs
	2	Not used	
	3	+	
	4	–	
	5	Not used	
	6	Not used	
	7	+	
	8	–	
	9	Not used	
	10	0V	

Analog board TB3 (bottom edge):

PIN			
	1		Connections to sensor unit
	2	+	Pre-amp Thermistor
	3	–	
	4		
	5	0V	
	6	Solenoid valve	
	7	24V sense	
	8	24V	
	9	Not used	
	10	Not used	
	11	Remote Switch for Calibration Inhibit	
	12		

PSU board TB3:

PIN				
	1	NO	Calibrate Indication	External alarm contacts
	2	COM		
	3	NC		
	4	NO	Calibrate failure alarm	
	5	COM		
	6	NC		
	7	NO	Alarm 2	
	8	COM		
	9	NC		
	10	NO	Alarm 1	
	11	COM		
	12	NC		

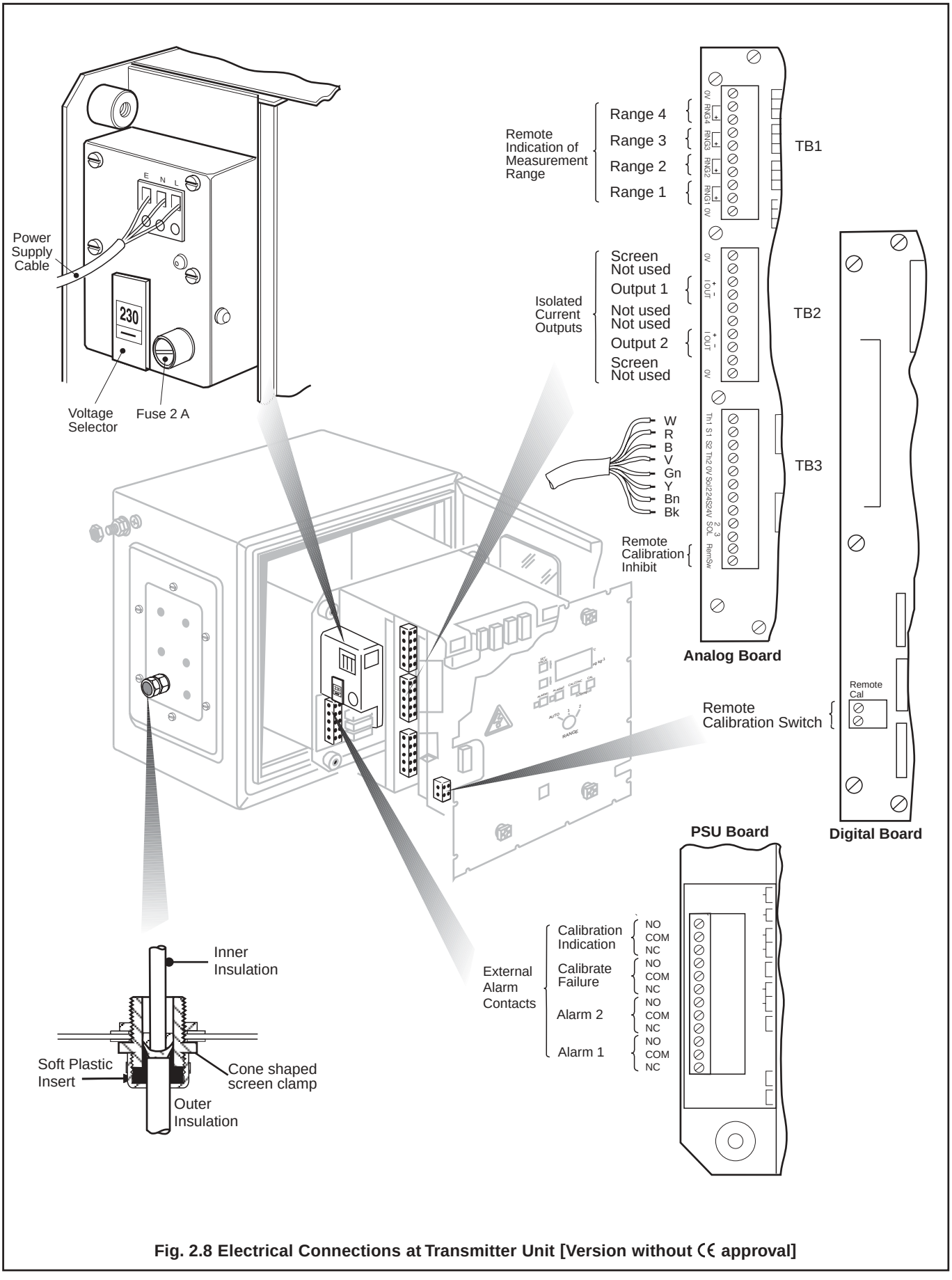


Fig. 2.8 Electrical Connections at Transmitter Unit [Version without CE approval]

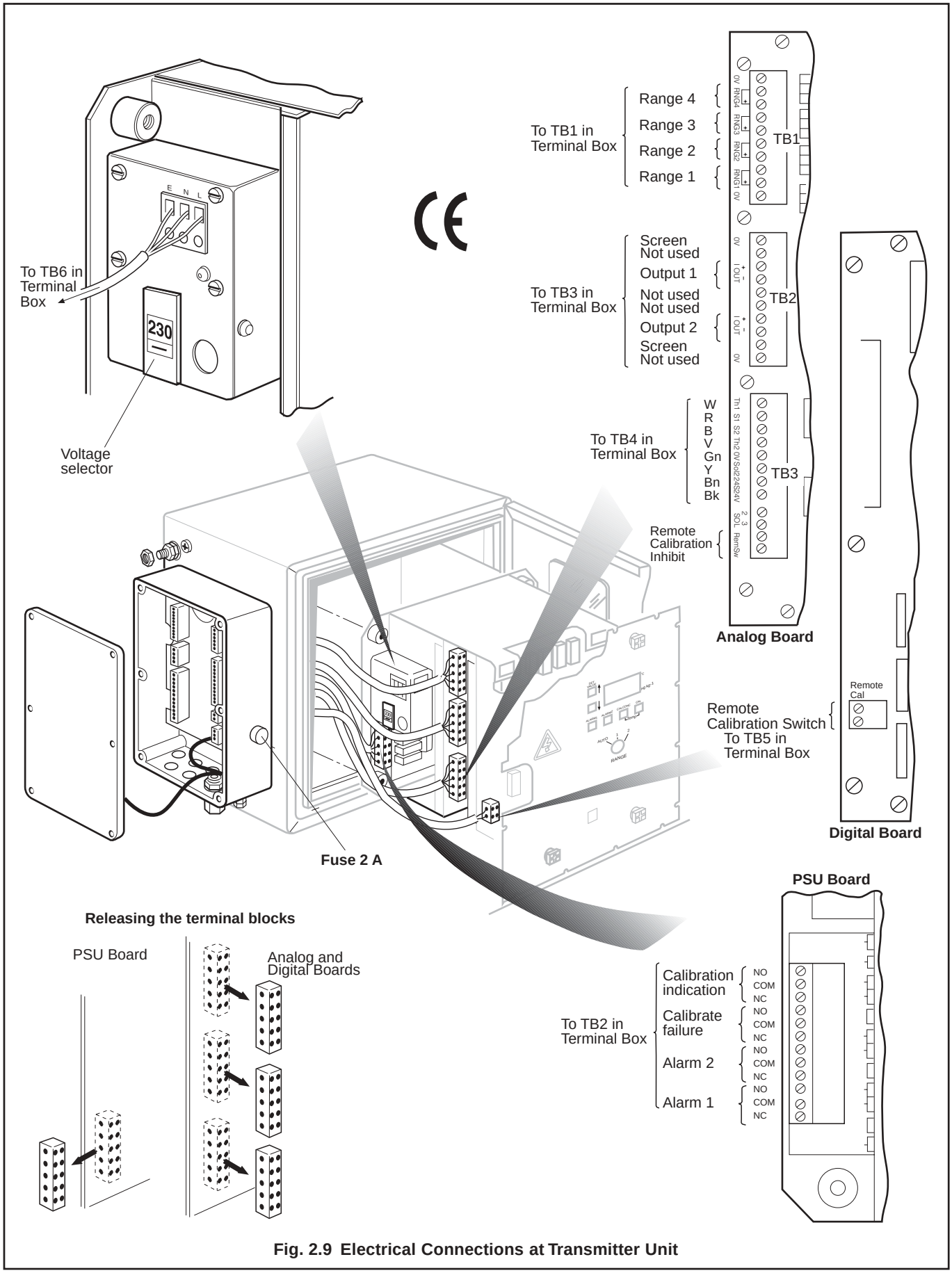


Fig. 2.9 Electrical Connections at Transmitter Unit

Chassis

Warning. The power supply earth (ground) must be connected to ensure safety to users, reduction of the effects of radio frequency interference, and correct operation of the power supply interference filter.

A voltage selector is located next to the supply terminals. This voltage selector must be set to the correct value before connecting the instrument to the supply – see Fig. 2.8.

Tidy the cables in the gland plate and fit the gland plate to the transmitter. Tighten the gland nuts.

2.5 Ancillary Equipment

2.5.1 Recorders

The choice of two different isolated recorder output signals enables the instrument to be used with a wide variety of recording and data processing equipment. The load requirements are shown in Section 7, and the positions of the circuit board switches for the various outputs are given in Section 3.2.2.

2.5.2 Range Indication

The remote range indication relays (TB1 connections) can be used in several different arrangements to suit the requirements of the installation. The relays can, for example, be wired directly into the PLC or data logger, but if a recorder is used, a method of indicating the set range is required. A 2-pen recorder is necessary; pen 1 indicating the oxygen concentration as above, and pen 2 recording the instrument range.

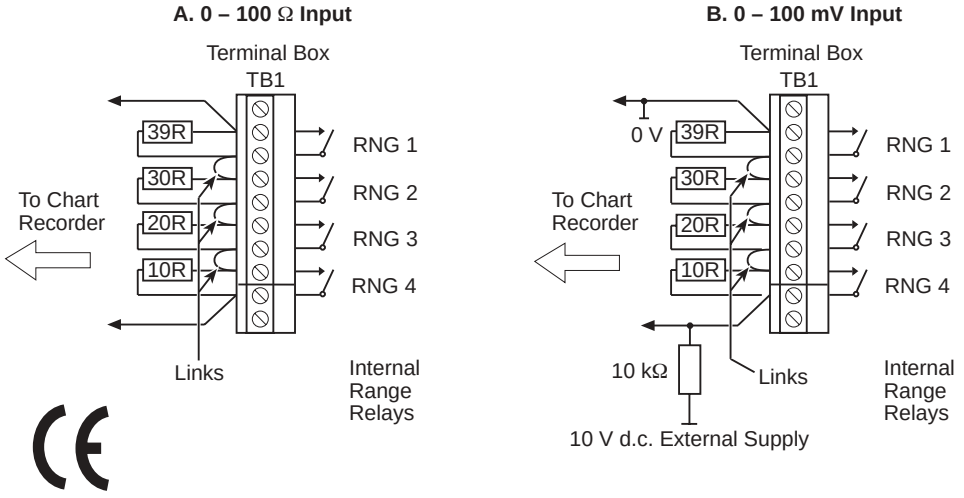


Fig. 2.10 Resistor Network for Remote Range Indication [CE Approved Version]

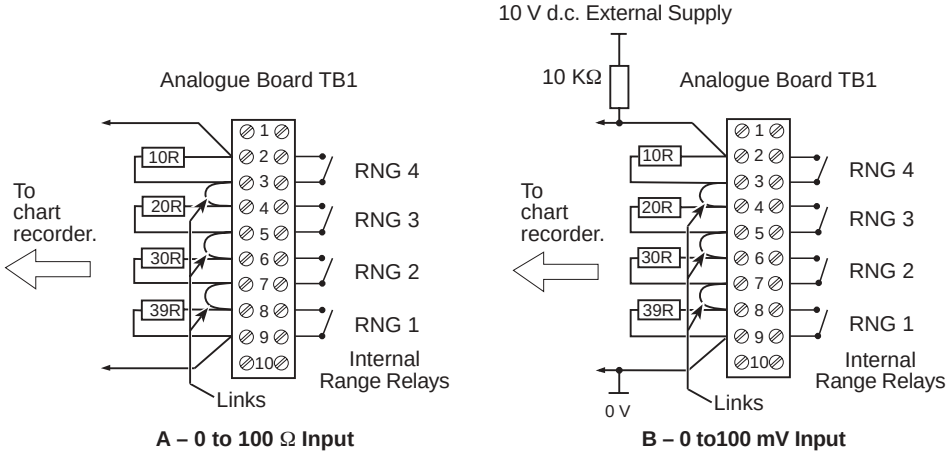


Fig. 2.11 Resistor Network for Remote Range Indication [Version without CE approval]

Suitable range indication input can be achieved using a resistor network, connected as shown in the examples in Fig. 2.10 or 2.11, and consists of four 1/4 watt resistors. A suitable resistor network kit is listed in Section 6. A recorder with suitable voltage and resistance inputs can be provided by the Company. The recorder gives 60, 70, 80 and 90% scale deflection for ranges 1 to 4 respectively.

Other arrangements should be designed to suit the requirements of the system.

Ensure that all external equipment is set up and working according to the relevant instructions supplied with it.

2.6 Start-up

a) Open the case door and remove the escutcheon plate if this has not already been done – see Section 2.1.2.

b) Set the battery switch SW10 to 'ON' – see Fig. 3.5.

c) Replace the escutcheon plate and secure with the plastic fasteners and 17 screws.

d) Switch on the power at the external source and set the range switch to 'AUTO'. A calibration sequence starts immediately. This causes a Calibration Fail Alarm ('CF' on the display), which should be ignored at this stage.

e) Remove the sensor capsule from its container, unscrew the sensor from the sealing plug and carefully plug the sensor onto the connector body ensuring that the O-ring is in place – see Fig. 3.2. Retain the sealing plug for any shutdown procedure required in the future. Hand-tighten the connector nut onto the capsule.

Caution.

- Take special care to line up the two pins in the sensor capsule with their respective sockets before making the connection and tightening.
- Take care not to damage the delicate membrane on the end of the capsule.
- Ensure that the mating faces (carrying the electrical connection) of the sensor and connector body are clean and completely dry.

f) Insert the sensor assembly into the flow cell, ensuring that the O-ring is in place, and tighten the clamping screw firmly.

g) Transfer the sensor overflow outlet tube from the drain tundish to a 100 ml measuring vessel.

h) Ensure that the toggle switch on the junction box inside the door is at 'RUN'.

i) Open the shut-off valve upstream of the sensor unit and adjust until sample is overflowing through the weir tube but is not fast enough to reach the emergency overflow.

j) Loosen the gland nut holding the weir tube in the constant head unit and move the weir tube up or down until the sample flow into the measuring vessel is 70 (±5) ml per minute, then tighten the gland nut.

k) Return the sensor overflow outlet tube to the drain tundish and mop up any spillage.

l) Close and lock the door.

m) If an accurate figure for the atmospheric pressure at the sensor location is known, enter this value by pressing ENTER ATM at the same time as SET VALUE until the display reads the pressure value in mm Hg.

n) Carry out a manual calibration by pressing the CAL button on the front panel – see Section 3.2.1.

o) Press the ALARM 1 button and the SET VALUE until the desired value of the lower alarm is shown on the digital display – see Section 3.2.3.

p) Repeat for Alarm 2.

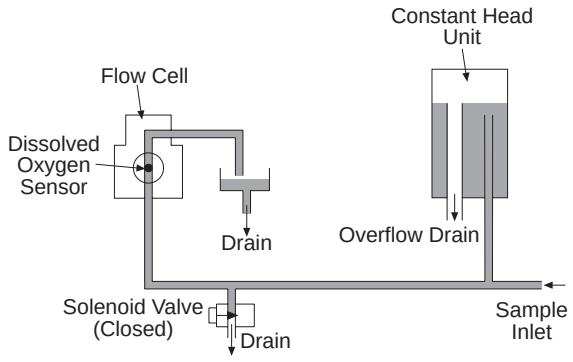
q) After the calibration sequence has ended (see Section 4.1) the monitor operates without further attention, the lamp adjacent to the relevant unit of measurement being illuminated. A calibration sequence is repeated every seven days if SW1.6 is 'OFF'.

r) If desired, turn the range switch to one of the non-auto ranges.

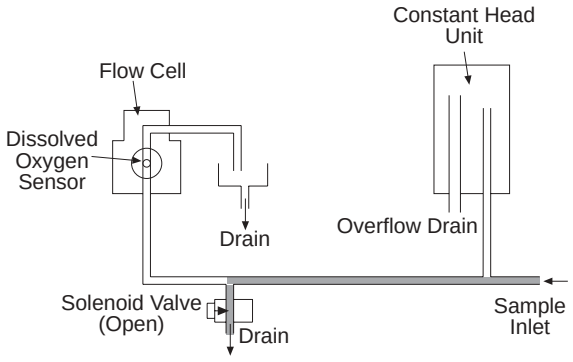
s) Close and lock the door of the transmitter unit.

Note: If the display flashes or shows anything other than the expected oxygen level, refer to Section 5.2.

3 OPERATION



Sample flow during normal operating conditions



Sample flow during calibration or thermal overload mode

Fig. 3.1 Schematic Flow Diagram

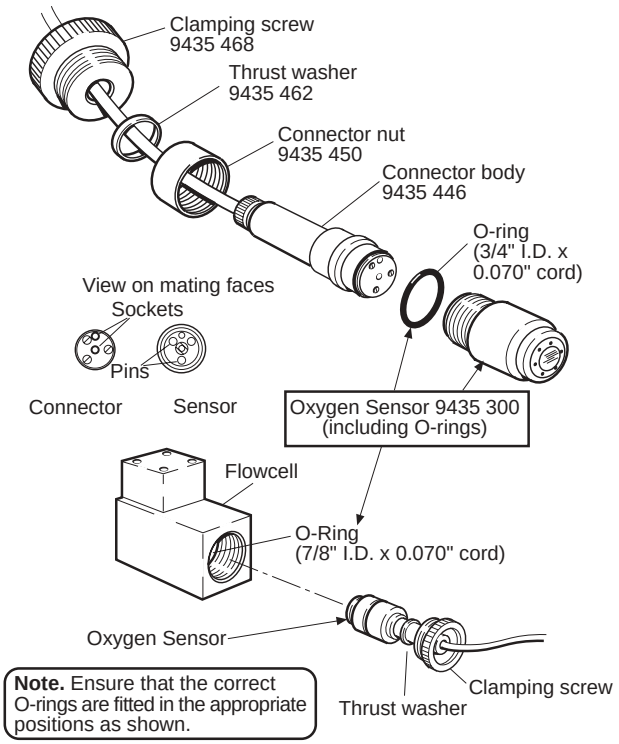


Fig. 3.2 Sensor and Flowcell

3.1 Sensor Unit

The Model 9435-500 sensor unit is shown in Fig. 2.6. It consists of a metal case of similar construction to the transmitter case, with the pipework carrying the sample mounted on a panel bolted to the back with four M6 captive bolts.

Sample enters through a grommet in the bottom of the case and travels to the sensor flow cell via two T-pieces. The other arm of the first T-piece is connected to a header tank which provides an adjustable constant head of sample. The second T-piece is connected to the solenoid valve which allows the flow cell to drain during the calibration sequence – see Section 4.1. Overflows from the constant head unit and the flow cell together with the drained sample from the solenoid valve fall to a tundish in the bottom of the case. A schematic diagram of the sample flow is given in Fig. 3.1.

The oxygen sensor comprises a membrane-covered galvanic cell in the form of a disposable capsule with an expected lift of at least six months of continuous operation; the galvanic cell utilizes a silver cathode and a lead anode to generate a current output proportional to oxygen partial pressure. The sensor capsule fits onto a plastic connector carrying the connecting cable and electrical contacts. The capsule assembly is clamped into the flow cell by a knurled clamping screw (see Fig. 3.2).

The flowcell also contains a thermistor for measurement of sample temperature and for automatic compensation of the variation in sensor output with temperature.

3.2 Transmitter Units

3.2.1 Description

Electronics chassis

The chassis contains three circuit boards:

Digital board - nearest the front panel, contains the central processor unit, together with the controls and the display.

Analog board - middle, contains the analog input and current output circuits.

P.S.U. board - rear, the power supply and relay board.

Refer to Fig. 3.3 for an indication of signal and power flows between these boards.

Controls

The controls are mounted on the front circuit board of the chassis. They protrude through the holes in the front panel which is secured to the chassis by four plastic fasteners and 17 screws – see Fig. 3.4.

A $2^1/_2$-digit red LED display shows the oxygen level in milligrams or micrograms per kilogram.

The controls have the following functions:

RANGE switch: (3) 5 position: AUTO, 1, 2, 3 & 4. Positions 1, 2, 3 and 4 are the manual ranges corresponding to 0 to 19.9, to 0 to 1.99 mg kg^{-1}, 0 to 199 and 0 to 19.9 μg kg^{-1} respectively. At AUTO the monitor

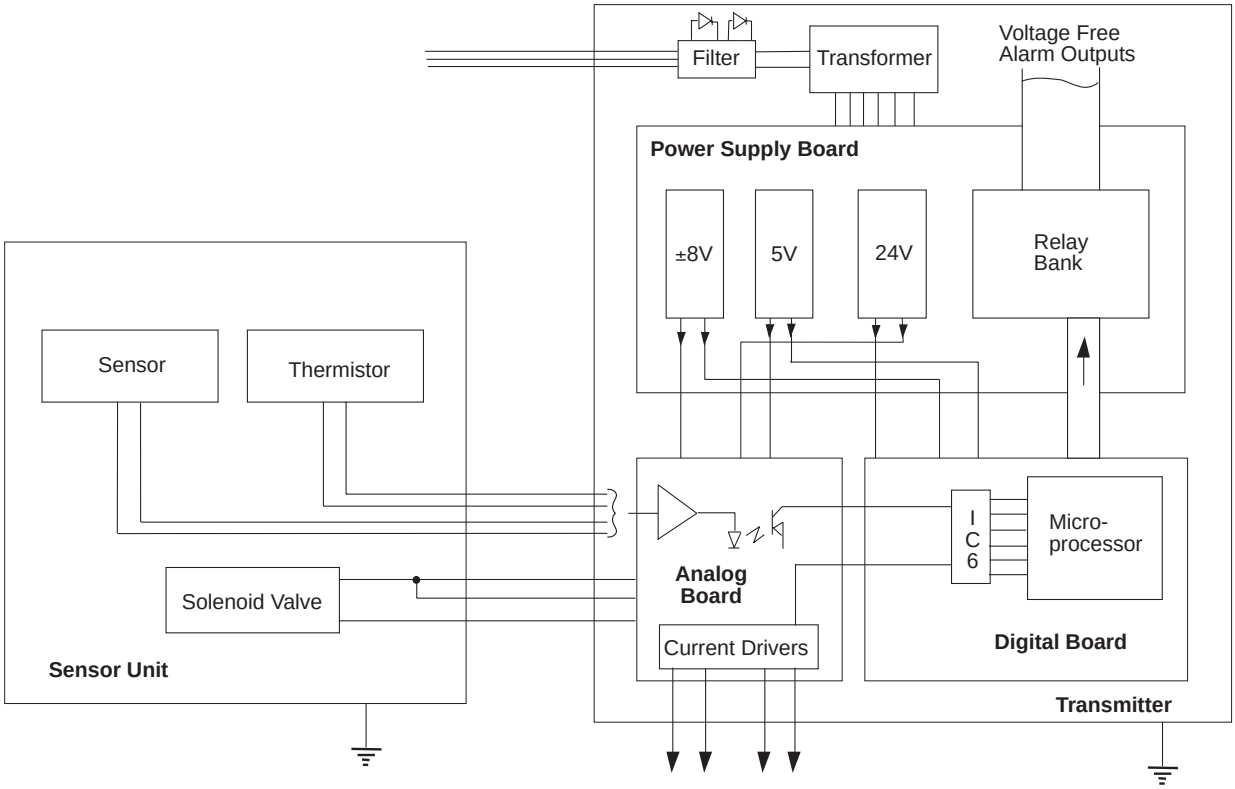


Fig. 3.3 Monitor Signal and Power Systems – Flow Diagram

automatically switches to a range suitable for the oxygen level being measured. Remote range indication is provided – see Section 2.5.2.

CAL: ⑤ When this button is pressed a calibration sequence occurs – see Section 4.1.

SET VALUE: ① These buttons increase or decrease the value displayed on the digital indicator; used for setting the alarms and atmospheric pressure values.

ALARM 1): ② **ALARM 2** Used to set the values at which the alarm relays operate – see Section 3.2.3.

ENTER ATM: ⑥ This button allows the exact value of the local atmospheric pressure to be set into the monitor. With the ENTER ATM button depressed, the digital indicator display is adjusted to the desired value with the SET VALUE buttons see Section 3.2.4.

RESET : ⑦ Used to regain control of the instrument in the unlikely event of malfunction due to high power supply transients, etc. (The button is not visible when the cabinet door is closed.) The RESET button must be pressed after any switch position on SW1 is changed. See Section 3.2.2.

TEMP ② ⑥ Pressing both ALARM 2 and ENTER ATM buttons together displays the sample temperature in °C.

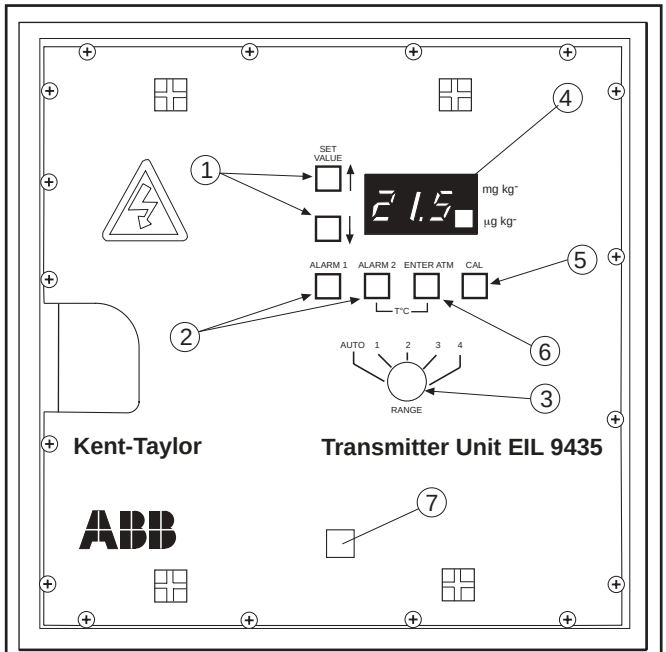


Fig. 3.4 Transmitter Controls

3.2.2 Printed Circuit Board Settings

Digital circuit board (Fig. 3.5)
A series of eight on/off switches in a dual-in-line package is read by the microprocessor and provides controlling functions for the alarms, output current and auto calibration. The function of the switches are shown in Table 3.2.

Note. SW1 switch positions are only read by the microprocessor when the unit is powered up or after pressing RESET. After changing any of the settings the RESET must be pressed.

Analog outputs
Two identical isolated current outputs are available at terminal block TB3 in the Terminal Box (CE approved transmitter) or TB2 on the analog board of the transmitter without CE approval. Both outputs may be set to one of the three current ranges by means of switches SW1.1 and SW1.2 on the digital board. In each case the upper current limit corresponds to the full-scale reading of the range displayed on the front panel. The switch settings are shown in Table 3.1.

3.2.3 Alarms
Two oxygen level alarm control relays are provided, each having one pair of changeover contacts rated at 2 A 250 V a.c.

Table 3.1* Analog Output Current Selections at SW1 on the Digital Board

Output Current	SW1.1	SW1.2
0 to 10 mA	ON	ON
0 to 20 mA	OFF	OFF
4 to 20 mA	OFF	ON

* If SW1.1 is set to ON and SW1.2 to OFF, no valid output is produced.

Table 3.2 Circuit Board Function Switch

Switch SW1	Function	ON	OFF
.1	Set output current – See 'Analog outputs'		
.2	Set output current – See 'Analog outputs'		
.3	No Function		
.4	No Function		
.5	No Function		
.6	Calibrate	Manual only	Auto / 7 days
.7	Alarm 2	Normal	Fail-safe – See 'Alarms'
.8	Alarm 1	Normal	Fail-safe – See 'Alarms'

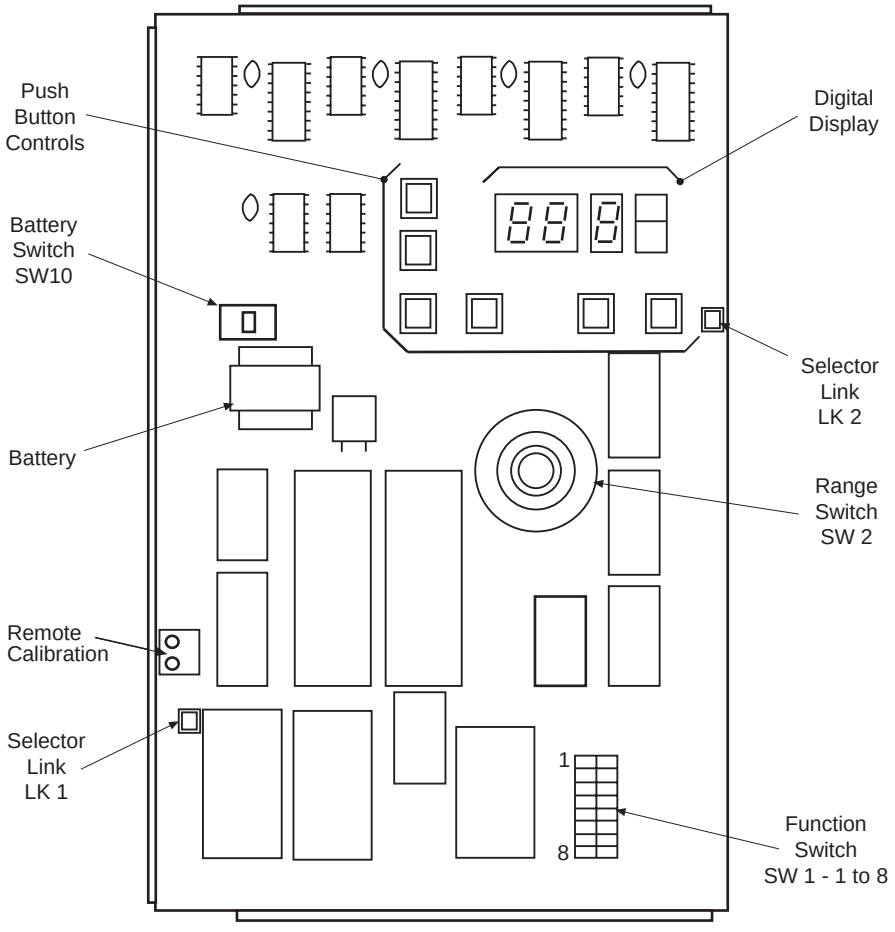


Fig 3.5 Location of items on Digital Board

(noninductive). It is intended that both should operate as 'high' alarms, i.e., when the oxygen level increases beyond the set value. For example, the lower setting may act as a warning that the oxygen level has increased beyond a reasonable level, and the higher setting may be used in a shutdown capacity. The alarm values are set by pressing the relevant ALARM button in conjunction with the SET VALUE buttons.

The terminal connections are at TB2 in the Terminal Box – see Section 2.4.2. In 'normal' operation the relay coil is energized causing the NO contacts to close when the displayed oxygen level is greater than the relevant alarm setting.

When set to 'fail-safe', by means of switches SW1.7 and SW1.8 of the function switch on the Digital Board, the relay coil is energized during normal non-alarm relay states and is de-energized upon recognition of an alarm condition. Thus if the power source fails, both external alarms are flagged indicating a malfunction.

SW1.7 is for Alarm 2 (high): SW1.8 is for Alarm 1 (low)
SW 'OFF' is FAIL-SAFE: SW 'ON' is NORMAL.

Two other sets of relay contacts are provided. One set changes over during a calibration sequence and the other set changes over to indicate failure to calibrate.

3.2.4 Atmospheric Pressure Compensation

The initial value is chosen when the instrument is commissioned to correspond to the normal atmospheric pressure at the geographical location of the site.

The approximate value as set by the switches may be improved upon by the use of the ENTER ATM push-button on the front panel, in conjunction with the SET VALUE buttons. The atmospheric pressure value is only used by the microprocessor during an autocalibration, which is carried out in air. Day-to-day variation in pressure due to changes in the weather do not affect the normal reading.

3.2.5 Sample Temperature

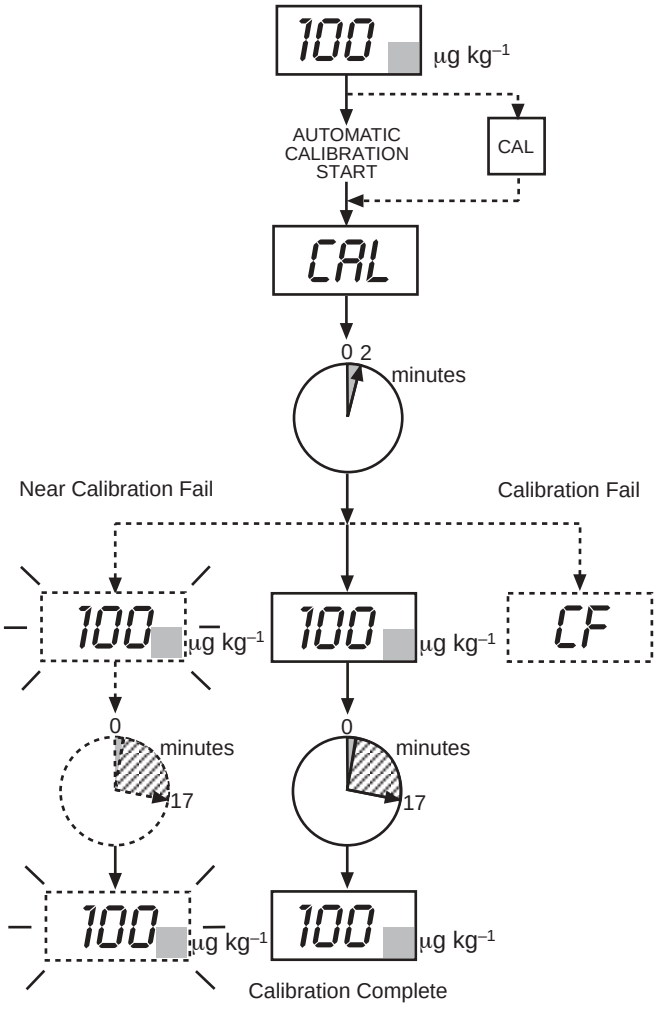
The temperature of the sample water is continuously monitored by means of a thermistor housed in the sensor flow cell. If the temperature of the sample rises above 55 °C, the display reads 'hot' and the solenoid valve opens to drain the flow cell. After 30 minutes the valve closes and the temperature is again measured. This procedure repeats until the sample temperature is less than 55 °C, the monitor then returns to the 'RUN' mode.

If the sample temperature falls below 5 °C the dissolved oxygen concentration is still displayed, but a fixed automatic temperature compensation appropriate to 5 °C is applied.

4 CALIBRATION PROCEDURE

4.1 Calibration Sequence

The monitor is programmed to operate with an automatic calibration sequence once every seven days. This period is timed from the sequence which occurs at switch-on or from a sequence initiated manually by pressing the CAL button, which can be done at any time. The autocalibration facility can be switched out, thus providing manual calibration only, by means of SW1.6 on the top digital board – see Section 3.2.2.



The display is indicating the Dissolved Oxygen Level.

PRESS 'CAL' button to start calibration sequence.

Display changes to 'CAL'.
All alarm functions are disabled and the CAL relay for remote CAL indication is energized.
The current outputs are maintained at the existing value.

NEAR CALIBRATION FAIL is indicated when all display information flashes. This is a warning that the sensor is failing and will soon need replacing.

'CF' displayed indicates a Calibration Failure and the CAL FAIL alarm relay is energized. The sensor needs replacing.

A SUCCESSFUL CALIBRATION is indicated by the display returning to a steady display of the dissolved oxygen reading.

After approximately 15 minutes the system has recovered from exposure to air and the CAL relay is de-energized. The alarms and current outputs are reinstated. The displayed reading flashes if a NEAR CALIBRATION FAILURE has occurred.

A calibration sequence may also be initiated remotely by momentarily closing a pair of contacts connected across the 'REMOTE CAL' input at Terminal Block TB5 in the Terminal Box of the CE approved transmitter – see Section 2.4.2, or across the 'Remote Cal' terminals on the digital board of the transmitter without CE approval – see Section 2.4.3. This action performs exactly the same function as pressing the CAL button on the front panel.

An additional facility is provided whereby the calibration sequence can be inhibited remotely. A contact closure across the 'REM. SW INHIB' (Remote Switch Inhibit) terminals of TB4 in the Terminal Box of the CE approved version – see Section 2.4.2, or across the 'Rem Sw' terminals of TB3 on the Analog Board of the transmitter without CE approval, causes any calibration sequence in progress to be lost and prevents an imminent sequence starting. This facility can be used with an external flow detector to inhibit a calibration sequence upon loss of sample, thereby preventing prolonged exposure of the sensor to air.

5 MAINTENANCE

5.1 Scheduled Servicing

No maintenance of a routine nature is required for this instrument other than periodically pressing the CAL button to initiate a calibration sequence if manual calibration has been chosen.

5.2 Unscheduled Servicing

The monitor indicates that abnormal operation is taking place by means of signals on the digital display. These are listed in Table 5.1.

5.2.1 Replacement of Sensor

a) Open the door to the sensor unit and switch the toggle switch on the junction box inside the door to 'DRAIN'. Leave the switch in this position.

b) When the flow cell has drained, unscrew the clamping screw and remove the sensor assembly from the front of the flow cell.

c) Inspect the sensor. If the membrane is clean, replace the sensor – proceed to d) below.
If deposits are visible on the membrane, remove them by gently wiping the membrane with a moist paper tissue; for oily or greasy deposits, the tissue may be moistened with a mild detergent or, if necessary, with iso-propyl alcohol (propan - 2 - ol). After cleaning, dry the interior of the flowcell with a paper tissue or soft cloth, ensure that the O-ring is correctly positioned against the shoulder near the end of the cavity – proceed to g) below to test the sensor.

d) Unscrew the connector nut, remove the old sensor capsule and discard both capsule and O-ring.

e) Take out the O-ring from the flow cell, dry the interior of the flow cell with a tissue or soft cloth and insert the new O-ring, making sure it is correctly located on the shoulder near the end of the cavity.

f) Remove the new sensor capsule from its container, unscrew the sensor from the sealing plug and carefully plug the sensor onto the connector body ensuring that the new O-ring is in place – see Fig. 3.2. Retain the sealing plug for any shutdown procedure required in the future. Hand-tighten the connector nut onto the capsule.

Caution.

- Take care not to damage the delicate membrane on the end of the capsule.
- Ensure that the mating faces (carrying the electrical connection) of the sensor and connector body are clean and **completely** dry.
- Take special care to line up the two pins in the sensor capsule with their respective sockets before making the connection and tightening.

g) Carefully insert the sensor/holder assembly into the flow cell and tighten the retaining nut firmly.

h) Return the toggle switch to the 'RUN' position.

i) Close and lock the sensor unit door.

j) Press the CAL button on the transmitter unit to start a calibration sequence.

Note. Run/drain switch
This switch is provided to facilitate installation and removal of sensors and should only be used for that purpose. Unnecessary exposure of the sensor to air should be avoided. In addition, the configuration of the system is such that the reading displayed when switched to 'DRAIN' does not represent the dissolved oxygen content of air-saturated water at the prevailing ambient temperature.

5.3 Shut Down Procedure

5.3.1 Sensor Unit

a) Close the valve upstream of the monitor.

b) Set the toggle switch on the junction box inside the door to 'DRAIN'; when the flow cell is empty, return the switch to the 'RUN' position.

c) Unscrew the clamping screw and remove the sensor assembly from the flow cell.

d) Loosen the connector nut, pull the sensor off the connector body and screw the sensor into the sealing plug which was retained during installation.

Table 5.1 Fault Finding Indications on Display

FAULT	POSSIBLE CAUSE
Display reads 'CAL'	Normal reading when calibration taking place - no action required.
Display flashes continuously	Near Calibration Fail - Sensor output low – Clean or replace sensor capsule soon – see Section 5.2.1.
Display reads 'CF'	Calibration Fail - Sensor output too low – Clean or replace sensor capsule immediately – see Section 5.2.1.
Display reads 'hot'	Sample temperature has risen above 55 °C - check cause. (See Section 3.2.5).

e) Store the capsule in its canister so that the membrane is in contact with the sponge pad. Ensure that the pad is wet.

f) Dry the connector assembly and the interior of the flow cell with a tissue or soft cloth.

g) Fit the connector assembly into the clip provided and close the door. Take care not to lose the capsule O-ring.

Caution. The connector body should not be replaced in the flow cell without a capsule attached.

5.3.2 Transmitter Units

Isolate the electrical supply to the unit. In the case of power loss, the programmed data is retained for up to ten years.

5.4 Simple Electronic Check

In the unlikely event that a problem is encountered with the monitor, a current (μA) source and a resistance box may be used to test the transmitter.

A Kent-Taylor Model 9439 950 Sensor Simulator is available to make an overall check on the functioning of the transmitter unit.

The simulator, which connects to the analog board, produces a μA output to simulate the oxygen sensor signal and also provides the necessary resistance to simulate thermistor values. Consult the simulator manual for full details of its use, or connect a μA source plus a resistance box to the transmitter.

Note. The monitor calibration signals are established by read-only software and cannot be changed by users. A simulated calibration must therefore be carried out as indicated below.

Proceed as follows:

a) Open the sensor unit door and locate the junction box mounted on the door – see Fig. 2.6.

b) Open the junction box and disconnect the sensor and thermistor wires as follows:

+ve sensor (R) from:	S1
–ve Sensor (B) from:	S2
Thermistor 1 (W) from:	Th1
Thermistor 2 (V) from:	Th2

c) Connect the appropriate wires of the current source and resistance box to TB2 as follows:

μA source +ve to:	S1
μA source –ve to:	S2
Resistance Box to:	Th1
Resistance Box to:	Th2

d) Set the appropriate resistance value corresponding to the thermistor resistance at the nominal sample temperature, e.g.

20 °C = 12k5 ohms

e) Set the atmospheric pressure compensation to 760.

f) Set the current source to 25 μA.

g) Initiate a calibration sequence by pressing the CAL button.

h) After three minutes the display should read the appropriate concentration value (see below).

i) With different μA values, the monitor range can be checked. The relevant values are as follows:

Current input (μA)	Display Reading
25.00	9.6 mg kg^{-1}
15.00	5.7 mg kg^{-1}
6.00	2.3 mg kg^{-1}
0.40	155.0 μg kg^{-1}
0.018	6.9 μg kg^{-1}

Note. When the electronic systems are operating correctly, the displayed concentration value should be within 5% of the selected value.

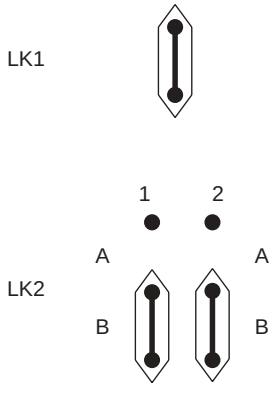
5.5 Replacing the Digital Board

Early versions of the Dissolved Oxygen Monitor were fitted with a digital board, Part No. 9435 180, Issues 1 to 5.

This board has now been replaced with a new type, Part No. 9435 180 Issue 6 (or later) which is common to other Kent-Taylor Monitors.

When fitted to the 9435 Monitor, it is necessary to configure the board correctly using two sets of provided links, LK1 and LK2. See Fig. 3.5.

Link positions on the Model 9435 must be as follows:



When fitting the present digital board as a replacement for an original board, the rotary range switch requires adjustment to reduce the number of operating positions as follows:

a) Remove the operating knob.

b) Rotate the ring on the body of the switch to limit the number of positions to 5.

c) Replace the operating knob.

6 SPARES LIST

The following spare items may be ordered from this Company quoting the Part Number listed below. Orders should be addressed to ABB Kent-Taylor Limited, Oldends Lane, Stonehouse, Glos. GL10 3TA.

6.1 Transmitter Units

Description	Part No
Digital circuit board complete with controls and digital display	9435 180
Analog circuit board	9435 170
Power supply circuit board	9435 160
8-way cable (specify length required)	0233 835
Fuse, 2 A Quick Blow 20 x 5 mm	0231 536
Illuminated push switch	0232 971
Resistor kit for remote range indication	9435 040

6.2 Sensor Unit

Description	Part No
Sensor capsule, complete with spare O-rings	9435 300
Sensor mounting assembly	9435 460
Solenoid valve	0232 096
Thermistor assembly	9435 527
O-ring for thermistor assembly	0211 103
1/4" i.d. PVC tube	0212 154
3/8" i.d. PVC tube	0212 156
Drain/Run switch	0232 969

7 SPECIFICATION

Range:	0 to 19.9, 0 to 199 μg kg^{-1}, 0 to 1.99, 0 to 19.9 mg kg^{-1}.
Accuracy:	±5% of reading or ±1 μg kg^{-1}, whichever is the greater.
Response time:	90% of a step change in 1 minute.
Stability:	±5% of reading or ±1 μg kg^{-1} per week, whichever is the greater.
Outputs:	Two isolated current outputs in the range 0 to 10, 0 to 20 or 4 to 20 mA. Maximum impedance 1 kΩ.
Remote range indication:	Four voltage-free contacts rated at 125 V a.c., 0.4 amp noninductive.
External alarms:	Two concentration alarms. Normal or fail-safe. Calibration Mode Indicator, Calibration Fail Indicator, All voltage free contacts rated at 250 V, 2 amp noninductive.
Inputs:	Remote initiation of calibration sequence.
Calibration:	Automatic air calibration every 7 days or manually initiated when required.

Installation Information

Sample temperature:	5 to 55 °C.
Sample flow:	100 to 500 ml min^{-1}.
Sample pressure:	Maximum 30 bar with 0216-403 input valve. 15 mb without input valve.
Ambient temperature:	0 to 55 °C.
Dimensions of sensor unit:	300 mm wide x 400 mm high x 200 mm deep.
Mounting for sensor unit:	Four holes 8.5 mm diameter, spaced 230 mm horizontal, 330 mm vertical.
Weight of sensor unit:	10 kg.
Connections to Sensor Unit:	Sample inlet: 6 mm (1/4") o.d. compression fitting. Sample waste: 10 mm flexible – atmospheric drain. Sample Line Material: Stainless Steel. Electrical: via gland, cable size 7 to 10.5 mm.
Max. cable core size:	Mains 32/0.2 mm Signal 24/0.2 mm
Dimensions of transmitter unit:	300 mm wide x 300 mm high x 200 mm deep.
CE Approved:	356 mm wide x 300 mm high x 200 mm deep.
Mounting for transmitter unit:	Four holes 8.5 mm diameter 230 mm horizontal 230 mm vertical
Weight of transmitter unit:	11 kg. CE Approved: 12 kg.
Electrical connection:	Via glands in Terminal Box.
Power supply requirements:	Volts 115/230 50/60 Hz 100 VA
Power supply tolerances:	Voltage +10%, –20%. Frequency min. 47 Hz, max 65 Hz.
Case protection of transmitter unit:	IP55
Maximum distance between sensor and transmitter unit:	100 meters.

APPENDIX A – EARLY MODELS…

A1 Sensor Panel Model 9435-200 – Fig. A1

The operation of the early sensor panel 9435-200 is very similar to the later 9435-500 panel, the main difference being the adjustment of flow past the sensor. The complete 'preparation for use' procedure for the early panel is given below.

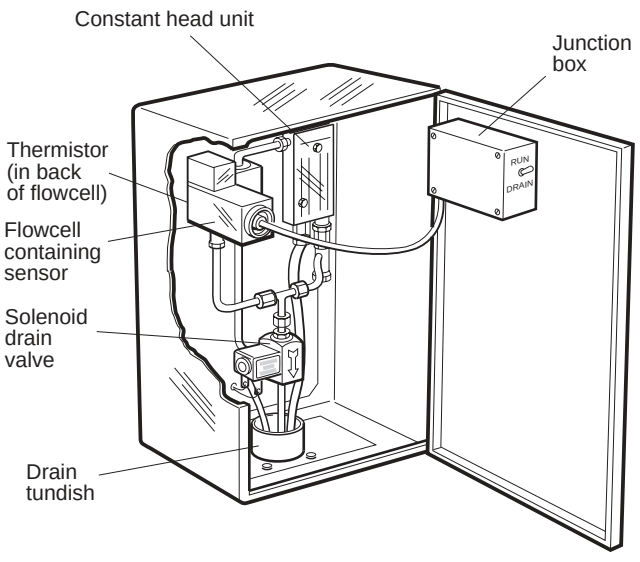


Fig. A1 Sensor Unit 9435-200

A1.1 Preparation for Use

Sensor unit

a) Open the door to the sensor unit and locate the relevant connector components attached to the junction box via their connecting cable.

b) Remove the sensor capsule from its container, unscrew the sensor from the sealing plug and carefully plug the sensor onto the connector body ensuring that the O-ring is in place – see Fig. 3.2. Retain the sealing plug for any shutdown procedure required in the future. Hand-tighten the connector nut onto the capsule.

Caution.

- Take special care to line up the two pins in the sensor capsule with their respective sockets before making the connection and tightening.
- Take care not to damage the delicate membrane on the end of the capsule.
- Ensure that the mating faces (carrying the electrical connection) of the sensor and connector body are clean and completely dry.

c) Insert the sensor assembly into the flow cell, ensuring that the O-ring is in place, and tighten the clamping screw firmly.

d) Undo the four Posidriv screws and remove the rectangular plate in the base of the case which carries the drain tundish.

e) Temporarily fix a piece of rubber or plastic tubing over the clear plastic overflow pipe from the constant head unit so that any liquid from this may be diverted to drain.

f) Place a 100 ml measuring vessel under the drain outlet from the overflow funnel situated at the side of the flow cell.

g) Loosen the gland around the inlet pipe to the constant head unit and also the two screws holding this unit to the back plate.

h) Ensure that the toggle switch inside the door is at ‘RUN’.

i) Open the shut-off valve upstream of the sensor unit and adjust until sample is overflowing from the constant head unit, but not fast enough to reach the emergency overflow.

j) Move the constant head unit up or down until the sample flow into the measuring vessel is 70 (±5) ml per minute, then tighten the two screws and the inlet pipe gland.

k) Remove the temporary tubing on the constant head unit overflow, replace the rectangular plate and mop up any spillage.

l) Close and lock the door.

A2 Transmitter Unit – Fig. A2

A2.1 Digital Circuit Board – (9435 180 - prior to Issue 6, as marked)

This digital board was fitted to earlier versions of the monitor and is now superseded by the board described in the main text of this manual. The principle difference is the extension of the volatile memory. User programmable information on the earlier version is only retained for up to 10 hours in power down conditions. Users of monitors with the earlier version board need to undertake additional tasks on a different board layout to the information given in the main text.

The tasks are as follows:

Setting digital circuit board

Function switch (SW1)
This is situated just below the ALARM 1 push button, and is a series of eight dual-in-line switches – See Fig. A2. This switch is functionally similar and set as described in the main text.

Battery switch (SW10)
This is located at the top of the board – See Fig. A2. This switch is functionally similar and operated as described in the main text. However, SW10 must be switched to the 'OFF' position when the mains supply is switched off for periods greater than 24 hours, to prevent damage to the Nickel-Cadmium battery.

Other switches and controls
These are located as shown in Fig. A2, and are functionally similar and operated as described in the main text.

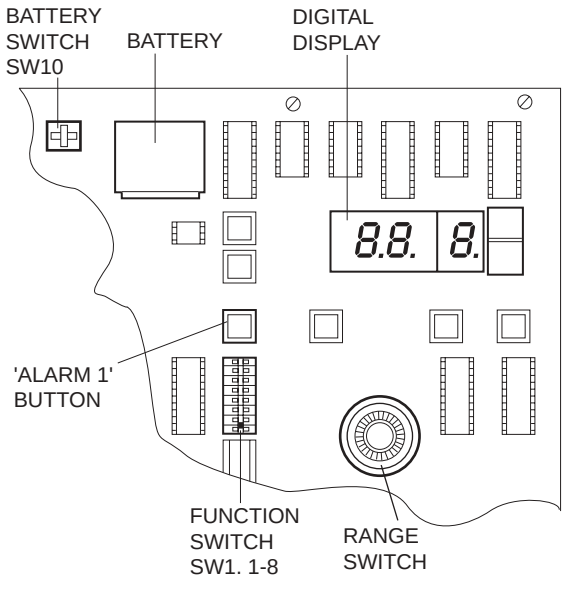


Fig. A2 Part of 9435 180 Digital PCB (Prior to Issue 6)

A2.2 Cold Start and Warm Start

Cold start
This event takes place on reinstatement of the mains supply when:

a) the battery switch (SW10) has also been switched off
or b) the mains supply has been lost for longer than 10 hours.

In both cases the data in the volatile memory is lost, so the microprocessor, during a COLD START, reads the default positions on switch SW1, sets both alarms at 19.9 mg kg^{-1}, and carries out a calibration.

Note.
If a calibration sequence does not start, this means that the nickel-cadmium battery has become fully discharged. To remedy this, leave the instrument switched on for approximately five minutes and then press the RESET button.
A calibration then starts – see Section 4.

Warm start
This event takes place when the mains supply has been lost for a period of less than 10 hours, when data held in the volatile memory is maintained. The instrument returns to normal operation, maintaining the data values entered previously.

The Nickel-Cadmium battery should not be allowed to remain fully discharged for long periods and for this reason a switch (SW10) is situated adjacent to the battery which isolates it when in the 'OFF' position – see Fig. 3.5. SW10 should be set to 'OFF' if the instrument is to be out of commission for longer than, say, one week.

NOTES

PRODUCTS & CUSTOMER SUPPORT

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- *for the following industries:*
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  - Food & Beverage
  - Manufacturing
  - Metals and Minerals
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- *Drive Systems*
- *Force Measurement*
- *Servo Drives*

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- *Paperless Recorders*
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- *Turbine Flowmeters*
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Transmitters

- *Pressure*
- *Temperature*
- *Level*
- *Interface Modules*

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- *Actuators*
- *Positioners*

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- *pH, Conductivity and Dissolved Oxygen Transmitters and Sensors*
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- *Zirconia Oxygen Analyzers, Katharometers, Hydrogen Purity and Purge-gas Monitors, Thermal Conductivity*

Customer Support

We provide a comprehensive after sales service via a Worldwide Service Organization. Contact one of the following offices for details on your nearest Service and Repair Centre.

United Kingdom

ABB Limited
Tel: +44 (0)1453 826661
Fax: +44 (0)1453 829671

United States of America

ABB Inc.
Tel: +1 (0) 775 850 4800
Fax: +1 (0) 775 850 4808

Client Warranty

Prior to installation, the equipment referred to in this manual must be stored in a clean, dry environment, in accordance with the Company's published specification.

Periodic checks must be made on the equipment's condition. In the event of a failure under warranty, the following documentation must be provided as substantiation:

1. A listing evidencing process operation and alarm logs at time of failure.
2. Copies of all storage, installation, operating and maintenance records relating to the alleged faulty unit.

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The Company's policy is one of continuous product improvement and the right is reserved to modify the information contained herein without notice.

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