2700C Combustion Gas Analyser
Service Manual

Reference: 02700/002C/0
Order as Part No. 02700002C

WARNINGS, CAUTIONS AND NOTES

This publication includes WARNINGS, CAUTIONS AND NOTES which provide information relating to the following:

WARNINGS	**:**	**Hazards which could result in personal injury or death.**
CAUTIONS	**:**	**Hazards which could result in equipment or property damage.**
NOTES	**:**	**Alert the user to pertinent facts and conditions.**

WARNING

The electrical power used in this equipment is at a voltage high enough to endanger life. Servicing should only be performed by trained personnel. Service training is available from Servomex.

Before carrying out servicing or repair the equipment should be disconnected from the electrical power supply. Tests must be made to ensure that disconnection is complete. Note that the relay contacts in the control unit may be supplied from a separate source of electrical power.

It may be necessary to fault find with the electrical power connected. Where this is necessary extreme caution should be exercised.

The analyser sensor head may contain toxic, corrosive, flammable or asphyxiant gases. Flush the analyser pipe work with clean dry air, via the calibration port, before commencing work.

Flanges and flange adaptors supplied by Servomex DO NOT conform to ANSI or any other Standards body and must only be used in Servomex specified applications with process pressure not greater than 5psig.

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1 INTRODUCTION

1.1 Introduction

NOTE

This manual refers to the 2700C analysers.
The analyser Serial Number is marked on both the Sensor Head (on the terminals enclosure lid) and the Control Unit (on the side of the main enclosure), on the main identification label.

This manual contains essential information for the servicing of the Servomex 2700 Combustion Gas Analysers.

This service manual is intended for use by Servomex trained service personnel. The manual contains technical descriptions, fault diagnosis information, parts removal, refitting and test instructions. Electronic circuit diagrams are bound at the rear of this manual.

1.2 Service philosophy

WARNING

All servicing should be referred to qualified personnel.

Repairs to printed circuit boards are affected by module replacement. Component replacement is not recommended. The only exceptions to this are the mains fuses on the control unit and terminal box PCB’s, and the heater fuses on the control unit PCB.

1.3 General description

NOTE

All Servomex adaptor flanges, interface flanges, probe support tubes, stand-offs and thermal spacers, including the integral flange on the sensor head, are suitable for fitting onto the standard flanges that their descriptive names imply, either raised face (<1.6mm) or flat faced.

Servomex flanges do not comply with any national or international standards and the analysers maximum process pressure is limited to 5psig.

The Servomex 2700 Combustion Gas Analyser measures combustion and similar gases to provide an analysis of the oxygen concentration and / or the level of unburned combustibles. The analyser comprises two separate units:

- A sensor head mounted directly onto the flue wall.
- A control unit mounted remotely from the sensor head.

These may be mounted up to 300m (975ft) apart or, 100m (325ft) when the combustible measurement option is fitted.

In addition, an optional utilities unit is available to supply the sensor head with calibration gases and compressed air.

The sensor head is flange mounted on to the flue wall and houses the measurement sensors in a heated epoxy painted aluminium enclosure. A probe assembly projects through the duct wall into the process gas to extract a gas sample for analysis. A comprehensive range of sample probes and filters are available to enable the analyser to be used in a wide range of applications and process conditions. Electrical connections are made to a terminal enclosure located on the side of the sensor head.

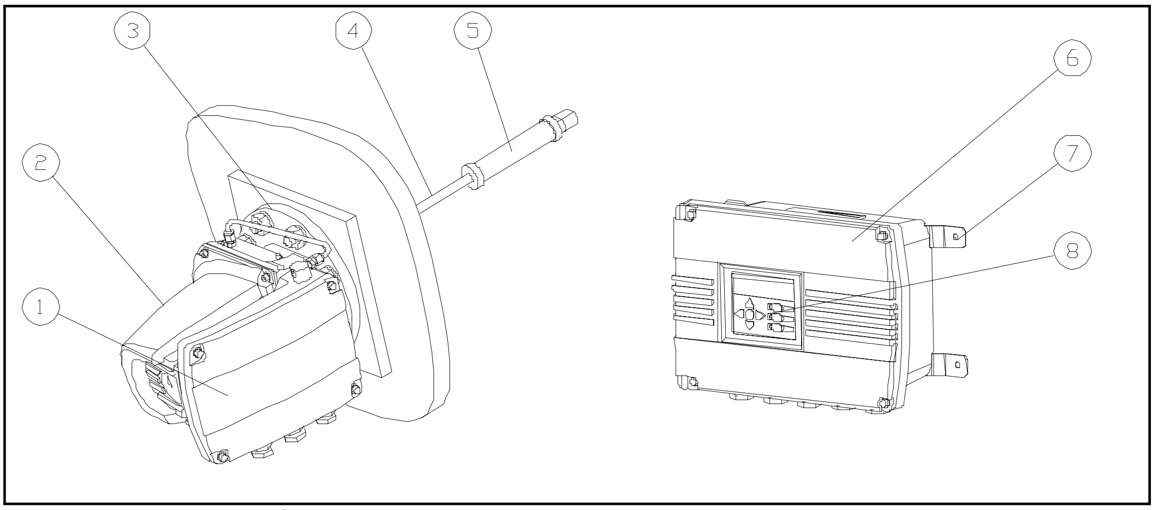

Figure 1.1 2700 product components

Key to Figure 1.1			
1	Terminals enclosure	5	Sample probe filter
2	Sensor head	6	Control unit
3	4" mounting flange	7	Wall mounting brackets
4	Sample probe	8	Keypad and display

The control unit houses the sensor electronics, microprocessor, keypad, display and user wiring connections in an epoxy painted aluminium enclosure. The control unit may be either wall or panel mounted. Cable entries are located on the bottom of the control unit enclosure.

2700 units are available in three versions based on Servomex Zr703 zirconia oxygen transducer and the Servomex Tfx 1750 thick film calorimeter combustibles sensor.

- Oxygen only.
- Combustibles only.
- Both oxygen and combustibles measurement.

Isolated current outputs (0-20mA or 4-20mA) are provided to allow the analyser to be connected to a chart recorder, data logger, PLC, PC, DCS or ESD system as required. The analyser is provided with a single analogue output for each measurement provided. Each output has a minimum and maximum output range. For the oxygen sensor 0-1% is the minimum range and 0-25% is the maximum. For the 1750702 combustibles sensor 0-500ppm is the minimum range and 0-2000ppm is the maximum (over range of 5000ppm). For the 1750703 sensor 0-500ppm is the minimum range and 0-6000ppm is the maximum (over range 15000ppm). The analogue outputs may be independently set to have live zero (4-20mA) or true zero (0-20mA), to freeze or follow during calibration and blowback, and to jam either high or low during analyser fault conditions.

The analyser has four software configurable relay outputs. The user may assign any of these relay outputs to be either concentration alarms, analyser fault alarms, auto calibration relay drives, blowback relay drives, calibration in progress signals or blowback in progress signals.

The analyser has two digital inputs, suitable for voltage free relay contact actuation, to trigger either an autocalibration or a blowback sequence remotely.

The 2700 is designed for use in modern industrial environments with emphasis on durable, rugged construction, low cost of ownership, reliable performance, simple operation and ease of service.

A number of optional features are available for the 2700. These include the following:

- Sample probes.
- Internal sample filters.
- Differently threaded entries for electrical connections.
- Air purge fittings.
- Sensor head flange mounting options.
- Control unit mounting options.
- Utilities panels.

1.4 Location of components

Figure 1.2 identifies the location of the key components for the sensor head. Figure 1.3 identifies the location of the key components of the control unit. Refer to Section 5 for replacement procedures.

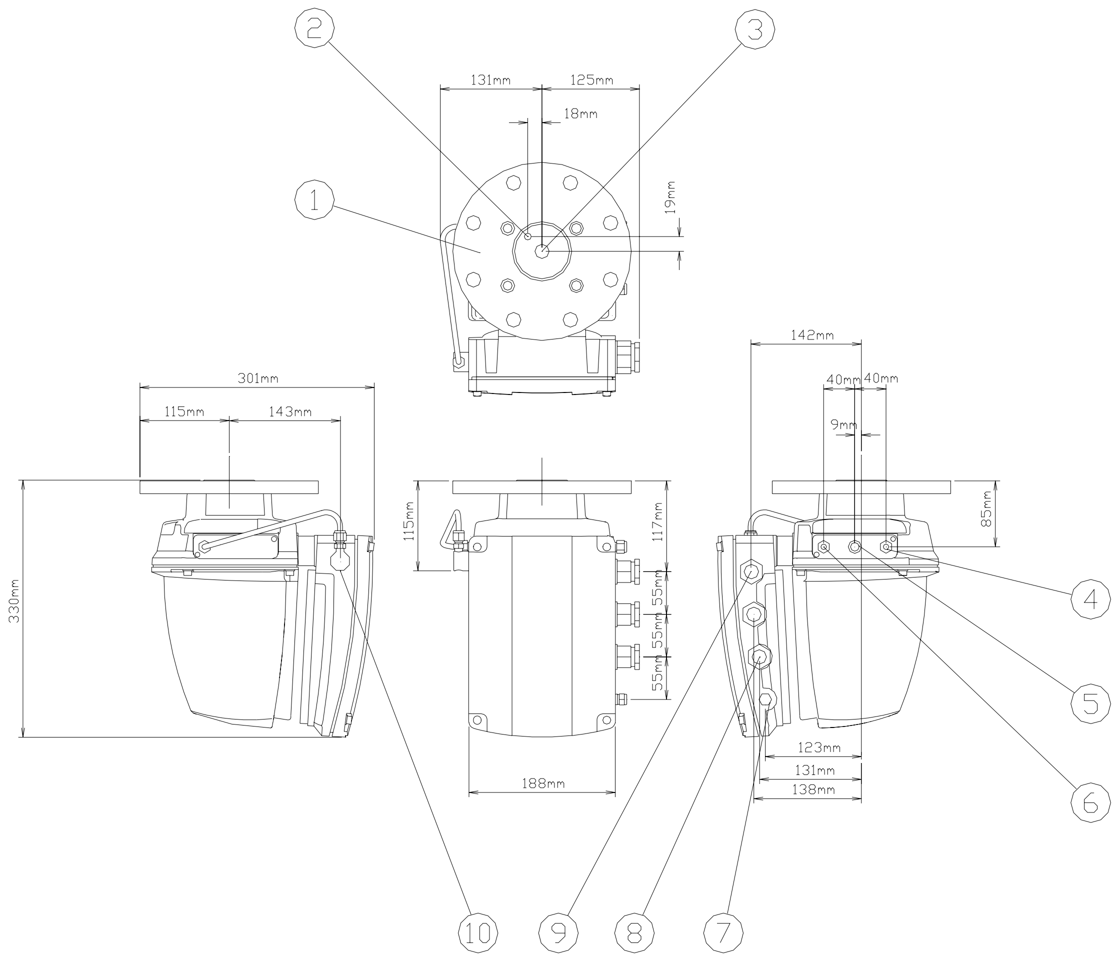

Figure 1.2 Sensor head over view

Key to Figure 1.2

1	Analyser mounting flange 4”.
2	Sample vent port 1/8” NPT (INT).
3	Sample probe connection 1/2” NPT (INT).
4	Calibration gas inlet 1/4” OD compression fitting.
5	Purge gas exit, 1/4” NPT (INT), or breather fitting.
6	Spare inlet (Blanked)
7	Purge gas entry, 1/4” NPT (INT) or blanking plug.
8	Signal cable entry 3/4” NPT (INT) or specified adaptor (2 off).
9	Mains cable entry 3/4” NPT (INT) or specified adaptor.
10	Aspirator air supply inlet 1/8” NPT (INT).

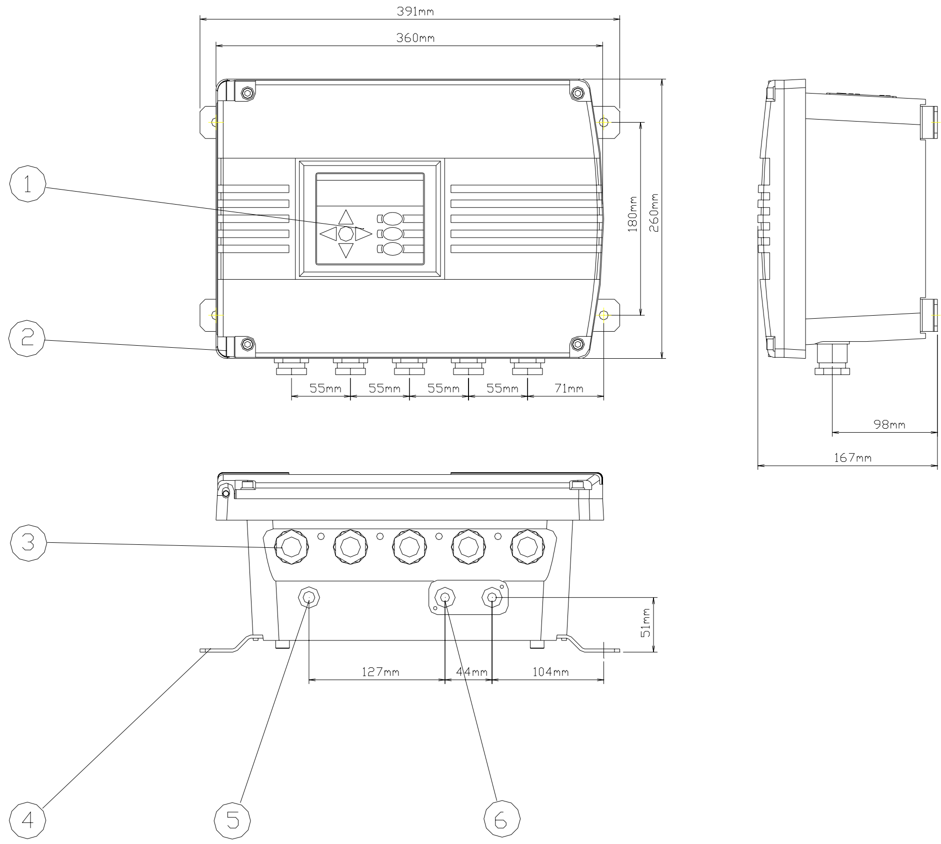

Figure 1.3 Control unit over view

Key to Figure 1.3

1 LCD display and keypad.
2 Door hinge.
3 3/4” NPT (INT) threaded cable conduit entries or optional adaptors as required (5 off).
4 Wall mounting brackets (optional).
5 Enclosure breather fitting (optional) or blanking port.
6 1/4” NPT (INT) threaded enclosure purge fittings (optional) or blanking screws.

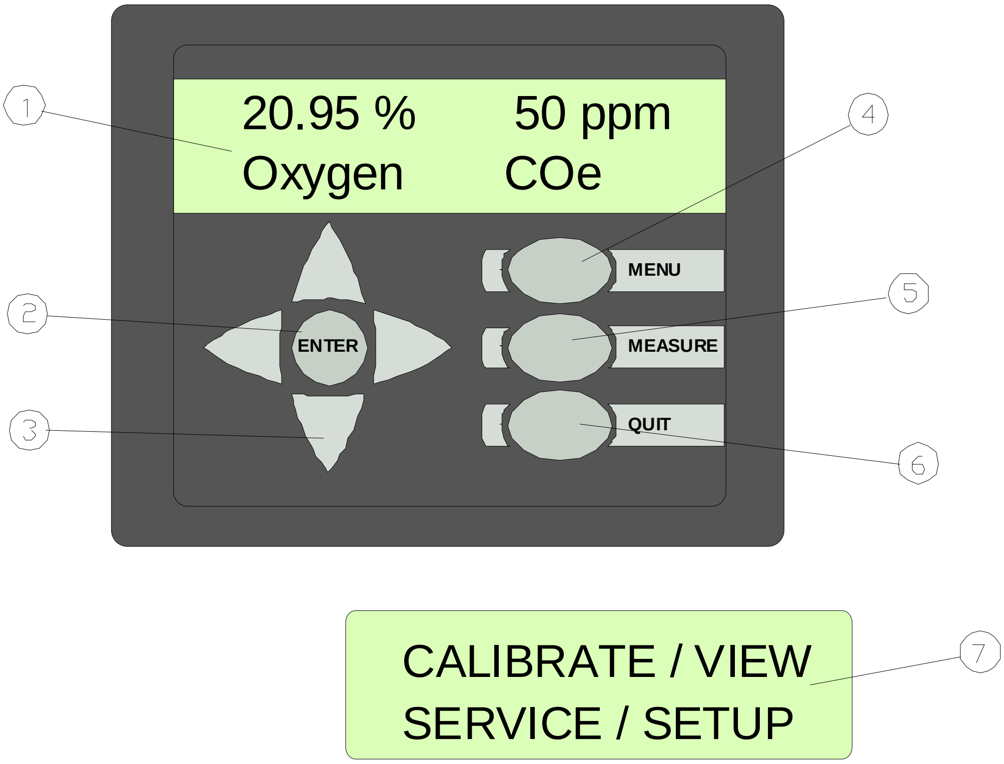

Figure 1.4 2700 keypad display

Key to Figure 1.4

1	LCD showing measurement display.
2	ENTER key.
3	ARROW keys.
4	MENU key.
5	MEASURE key.
6	QUIT key.
7	Alternative main menu display.

1.5 Introduction to the 2700 user interface

Refer to figure 1.4. The 2700 control unit has a tactile, 8 button keypad and back lit LCD (2 lines x 16 characters). During normal use the LCD will display either the measurement display or a menu based screen editor display. A user can toggle between the menu display and measurement display and access the menu based screen editor using the keypad.

The functions of the keys on the keypad are:

MEASURE Returns the analyser to the measurement display.

MENU Activates the top level menu of the screen editor.

QUIT Aborts the current activity and returns to the previous menu level.

←↑↓→ Arrow keys select the desired option. When entering numeric information, the left and right arrow keys are used to move between digits and the up and down arrow keys are used to change the value of each digit. The active digit is highlighted by blinking. The user presses the '**ENTER**' key to indicate that the numeric input is complete and the data is to be saved. If the '**QUIT**' key is pressed then the data is not saved and the input is aborted.
In the measurement display the ↑↓ scrolls through any alarm and/or fault messages active.

ENTER Indicates that the menu selection is to be processed or that numerical input is complete.

To initiate any menu operation the **MENU** key should be pressed. The LCD will then present the top level menu, which in turn leads on to other menus.

At each menu, the user highlights the desired option using the arrow keys and then presses **ENTER**. Blinking is used to highlight the selected menu option. During any menu operation, the fundamental measurements are still being made by the analyser and all relevant outputs, alarms and diagnostics remain active.

Some menu operations require the use of a password. There are two passwords, a supervisor password (2700) which gives access to **SETUP, SERVICE, VIEW** and **CALIBRATION** and an operator password (2000) which gives access to **CALIBRATION** only. Both passwords are factory set and may be changed if required.

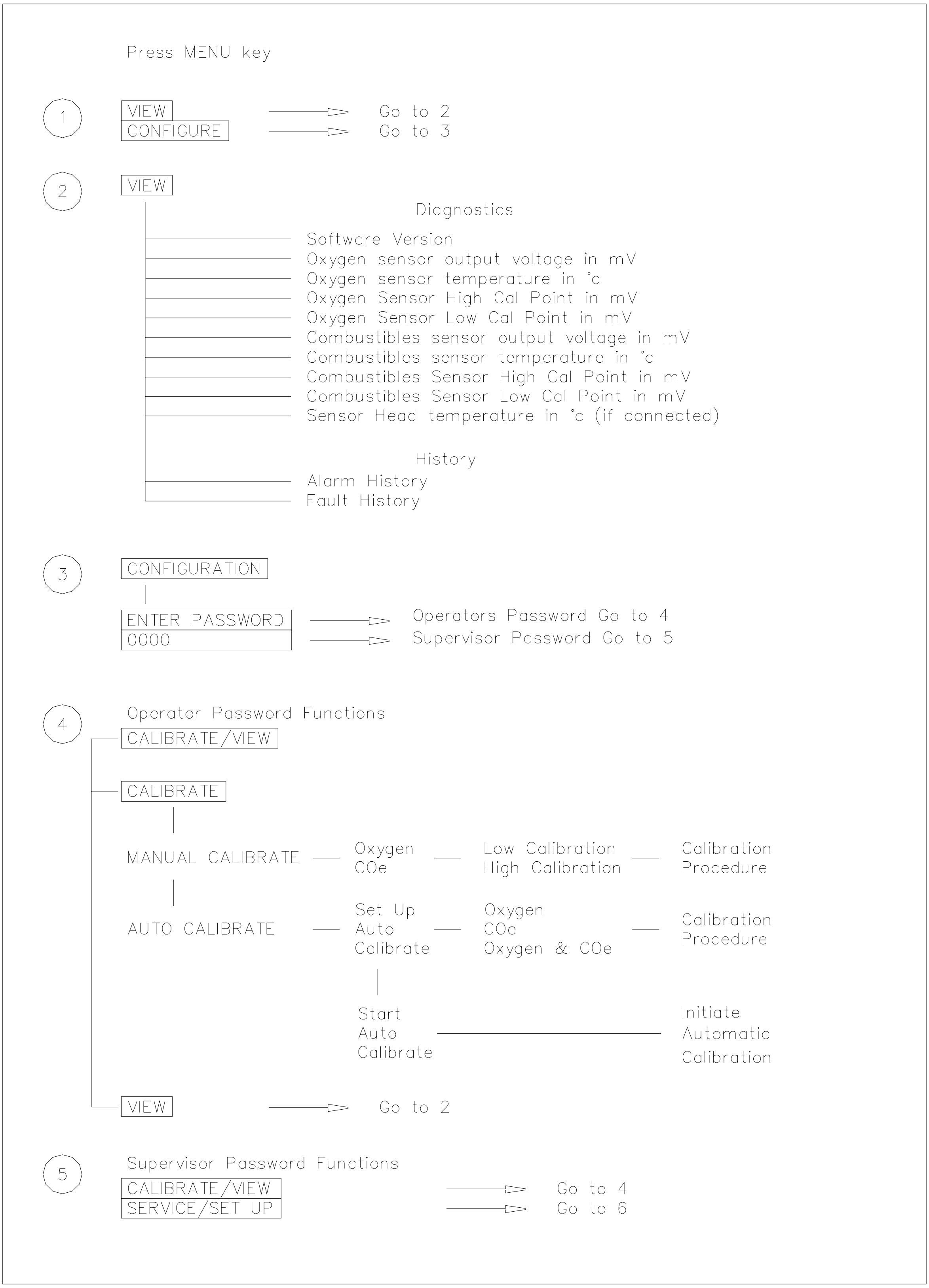

Figure 1.5a Menu Structure

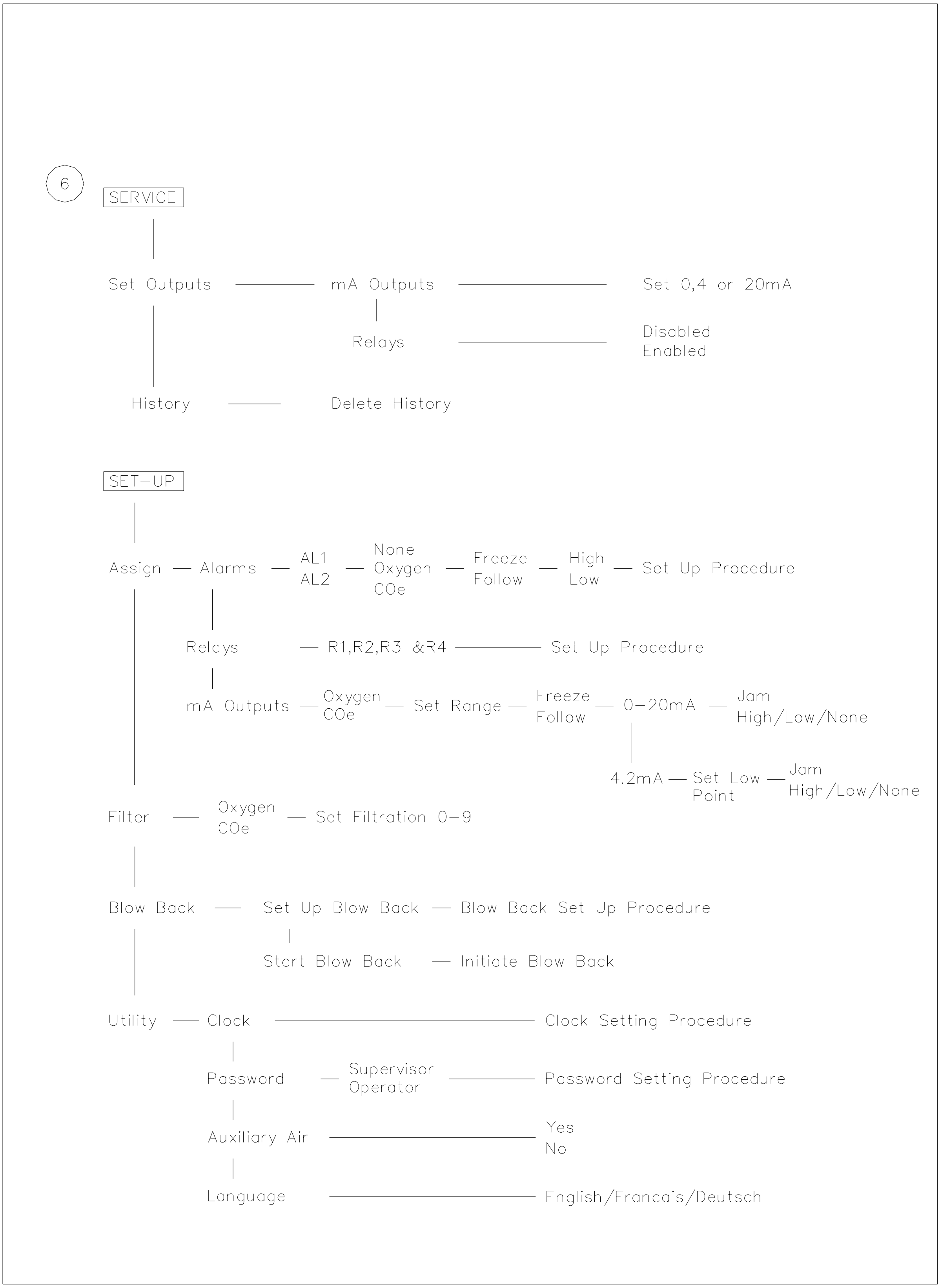

Figure 1.5b Menu Structure

It is advised that the parameters for calibration Tolerances, Combustibles Output Ranges and Filters are set as follows.

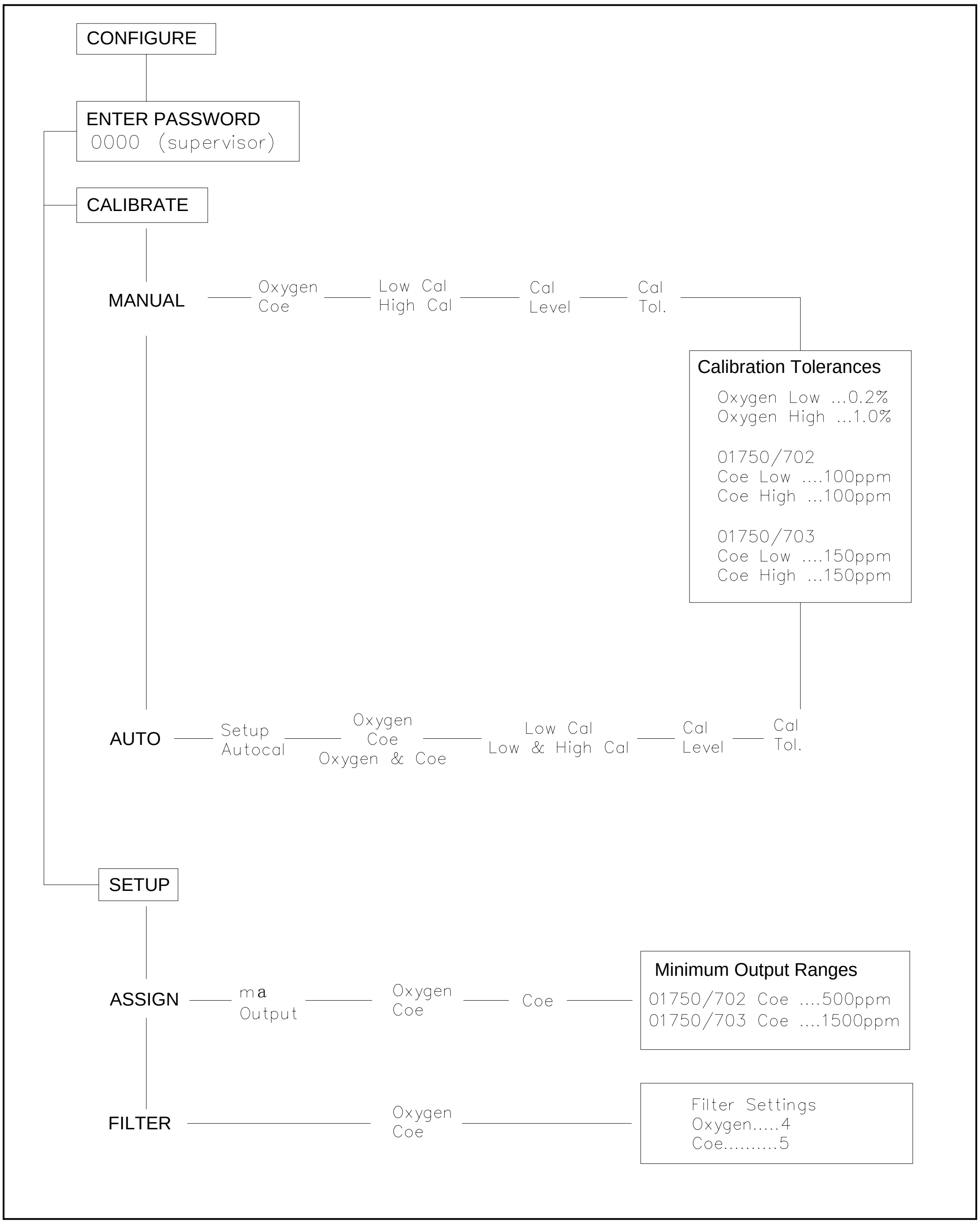

Figure 1.5c Menu Structure

The measurement display is shown in figure 1.4. The top line of the display shows the current measured value (with its units) for each of the sensors fitted. In normal operation the bottom line of the display labels the gases measured.

The **MEASURE** key may be used to return the analyser to the measurement display at any time. Further details on the operation of the user interface are available from the Quickstart manual.

1.6 Displaying faults or alarms present

In normal operation the bottom line of the measurement display labels the gases measured. Should a fault or alarm occur then the lower line of the display will detail the nature of the fault or alarm. Should more than one fault and/or alarm be active then arrows are shown in the last character of the bottom line. If both a fault and an alarm are present then the fault display will take precedence. It will not be possible to view any alarms present until the fault is cleared. The up and down arrow keys on the keypad may be used to scroll through these messages.

The fault messages that may appear are as follows:

OXYGEN LOW	Oxygen too low for COe measurement.
OXYGEN °C LOW	Oxygen sensor temperature low.
OXYGEN °C HIGH	Oxygen sensor temperature high.
COe mV LOW	Combustibles sensor output voltage low.
COe mV HIGH	Combustibles sensor output voltage high.
COe °C LOW	Combustibles sensor temperature low.
COe °C HIGH	Combustibles sensor temperature high.
COe mV OUTPUT LOW	Combustibles sensor sensitivity low (updates after calibration only).
COe CONC HI	Combustibles sensor has been exposed to very high COe levels.
SENSOR °C HIGH	Sensor head temperature high.
SENSOR °C LOW	Sensor head temperature low.
AUTO CAL FAIL	Auto calibration out of tolerance error.
COe WARMING	Combustibles sensor is warming up.
O2 WARMING	Oxygen sensor warming up.
DISP OVER RANGE	Combustibles reading exceeds sensor f.s.d.
mV OUT OF TOLERANCE	Combustibles sensor coarse zero is incorrectly set.

See section 4 of this manual for further details and remedial actions.

1.7 Displaying diagnostics.

The view function allows the user to interrogate the analyser diagnostics. No password is required to access the view function. The view functions are updated dynamically and values may change while they are being viewed.

To access this display, press the **MENU** key and select **VIEW** then select **DIAGNOSTICS** from the view menu. The **VIEW** option is also available from the **CONFIGURE** menu.

The diagnostics appear as a scrolling list of values and associated descriptions. There are up to six diagnostics depending on which sensors are fitted. The ↑↓ keys are used to switch between the following diagnostic measurements:

OXYGEN SENSOR mV	Oxygen sensor output voltage in mV.
OXYGEN SENSOR °C	Oxygen sensor temperature in °C.
COe SENSOR mV	Combustibles sensor output voltage in mV.
COe SENSOR °C	Combustibles sensor temperature in °C.
PROBE HEAD °C	Optional sensor head temperature in °C.
COe SENSOR HIGH	Combustibles sensor output voltage in mV, at high point calibration.
COe SENSOR LOW	Combustibles sensor output voltage in mV, at low point calibration.
OXYGEN SENSOR HIGH	Oxygen sensor output voltage in mV, at high point calibration.
OXYGEN SENSOR LOW	Oxygen sensor output voltage in mV, at low point calibration.

NOTE: The difference between SENSOR HIGH and SENSOR LOW mV values, is the sensitivity (or cell output). See sections 4.4.1.2.6 and 4.5.1.2.2. These values are only updated after a successful High or Low calibration is performed and are mV's per calibration gas concentration.

Pressing the **MEASURE** key will return the analyser to the default measurement display.

1.8 Displaying faults or alarm histories

The view function allows the user to interrogate the analyser alarm or fault histories in addition to the analyser diagnostics.

No password is required to access the view function. The view functions are updated dynamically and values may change while they are being viewed.

To access this display, press the **MENU** key and then select **VIEW**. From the view menu select **HISTORY** then choose between **ALARM HISTORY** and **FAULT HISTORY**.

1.9 Software revision history

Model C

02710/652/1	December 2006	Release.

1.10 Overview of the service manual

The various Sections of this service manual cover the following topics:

SECTION 2 Provides a mechanical and electrical overview. This should be read to provide an overall understanding of the equipment before carrying out servicing operations.

SECTION 3 Lists the available spares.

SECTION 4 Describes fault finding procedures.

SECTION 5 Describes procedures to remove and replace parts.

SECTION 6 Electronic circuit diagrams.

2 EQUIPMENT OVERVIEW

2.1 Mechanical overview

2.1.1 Sensor head

Refer to figure 2.1.

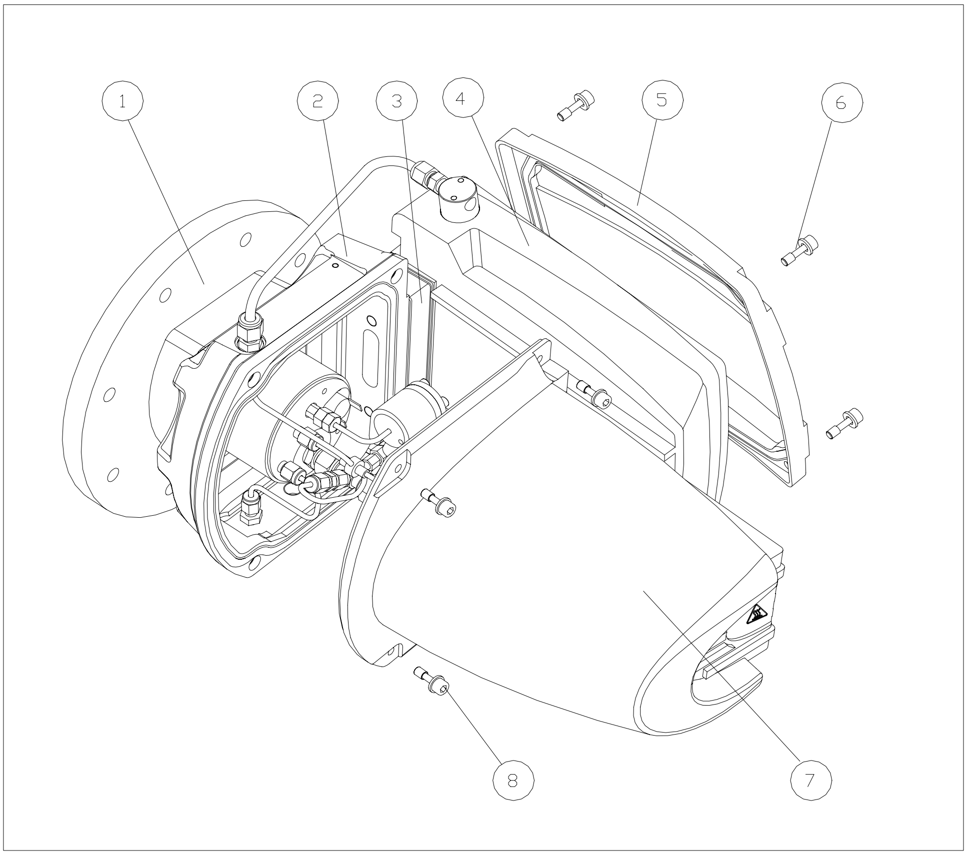

Figure 2.1 Sensor head overview

Key to Figure 2.1

1	Mounting flange	5	Terminal box cover
2	Sensor head base casting	6	Terminal cover screws
3	Insulation spacer	7	Sensor head cover
4	Terminal box casting	8	Sensor cover screws

The sensor head assembly mounts directly onto the flue wall via a 4" flange (1).The sensor head assembly consists of two main components, the sensor compartment and the terminal box. The sensor head base casting (2) and cover casting (7) form a heated oven housing the sensors and interconnecting pipes.

All gas sampling and measurement takes place within this heated sensor compartment. The terminal box casting (4) and terminal box cover casting (5) form an enclosure housing the sensor head PCB and all interconnecting and user electrical connections. The terminal box casting (4) is screwed to the sensor head base casting (2) by two bolts. An insulating spacer (3) provides thermal isolation between the sensor compartment and the terminal box. O ring seals on the covers and appropriate cable glands (not supplied) make the two compartments weatherproof (IP66 and NEMA 4X).

2.1.1.1 Sensor compartment

Refer to figure 2.2.

The sensor compartment cover is secured by four captive M6 screws and is sealed by an ‘O’ ring. With the cover removed, access is given to the gas sensors and sampling pipe work. The figures and text describe a dual sensor analyser (oxygen and combustibles sensors fitted). For the oxygen only and combustibles only versions then the sensor compartment construction is similar but with the unused sensor removed.

The sensor head base and cover form an insulated oven (insulation not shown for clarity). The oven is heated by a 500W band heater (1) located around the filter block (4). The temperature of the filter block is controlled at approximately 245 °C via the thermistor (12). An over temperature thermostat (5) is fitted to prevent overheating should the temperature control fail.

The gas sample is extracted from the flue using a compressed air aspirator (2) screwed into the filter block. For analysers incorporating a Zr703 zirconia sensor, a reference air sample is derived from the compressed air supply to the aspirator, via a capillary tube (7).

Refer to figure 2.3.

A solenoid valve (7), interlocked to the sensor head temperature, is provided as standard to prevent sample gases condensing in the sensor head pipe work when the sensor head temperature is too low.

A flame trap (3) and flame arrestor (10) are provided to prevent accidental ignition of the flue by the hot sensors should the flue gas become flammable. The reference air capillary tube (7) also behaves as a flame arrestor. An option internal filter (not shown) may be attached to the sintered flame trap to prevent dust ingress.

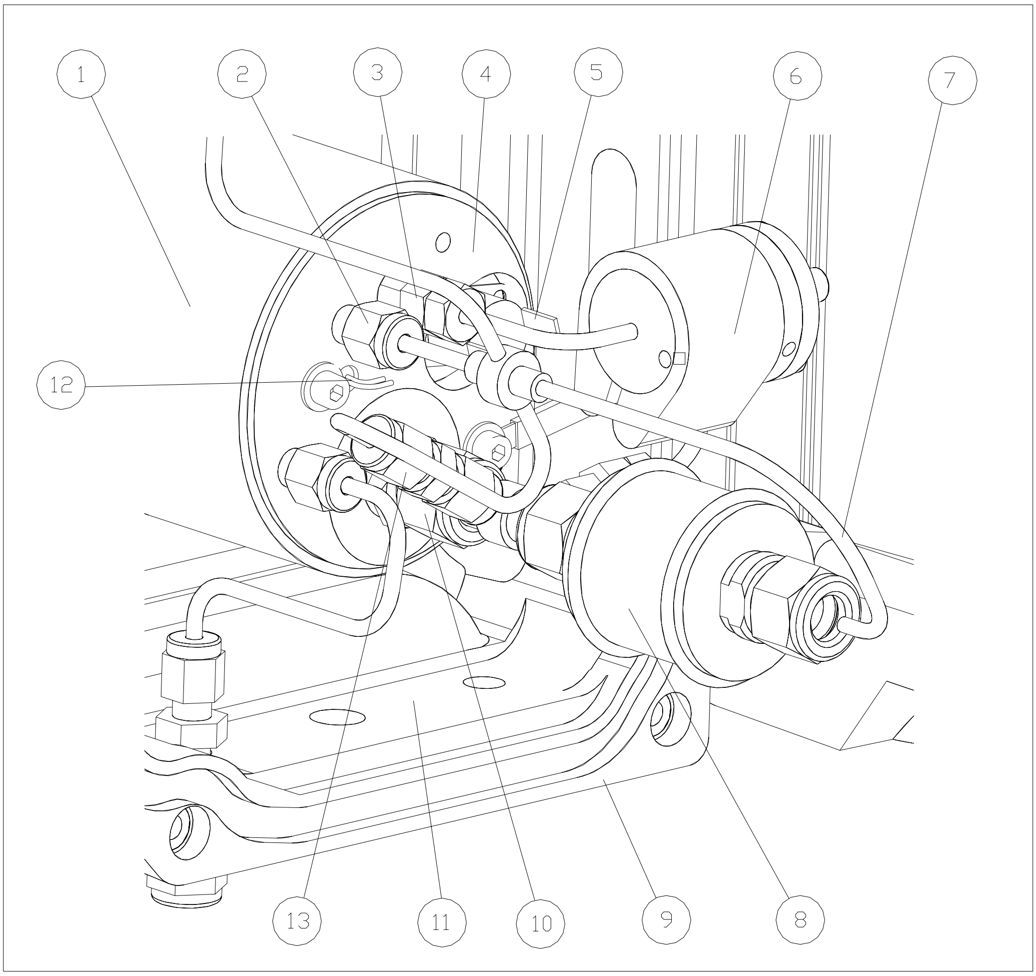

Figure 2.2 Dual sensor assembly

Key to Figure 2.2

1	Band heater.	7	Aspirator/reference air pipe.
2	Aspirator assembly.	8	Zr703 oxygen sensor.
3	Dog bone flame trap.	10	Sintered flame arrestor.
5	Over temp. thermostat.	11	Base casting.
6	Tfx1750 combustible sensor.	12	Thermistor.
		13	Auxiliary air restrictor

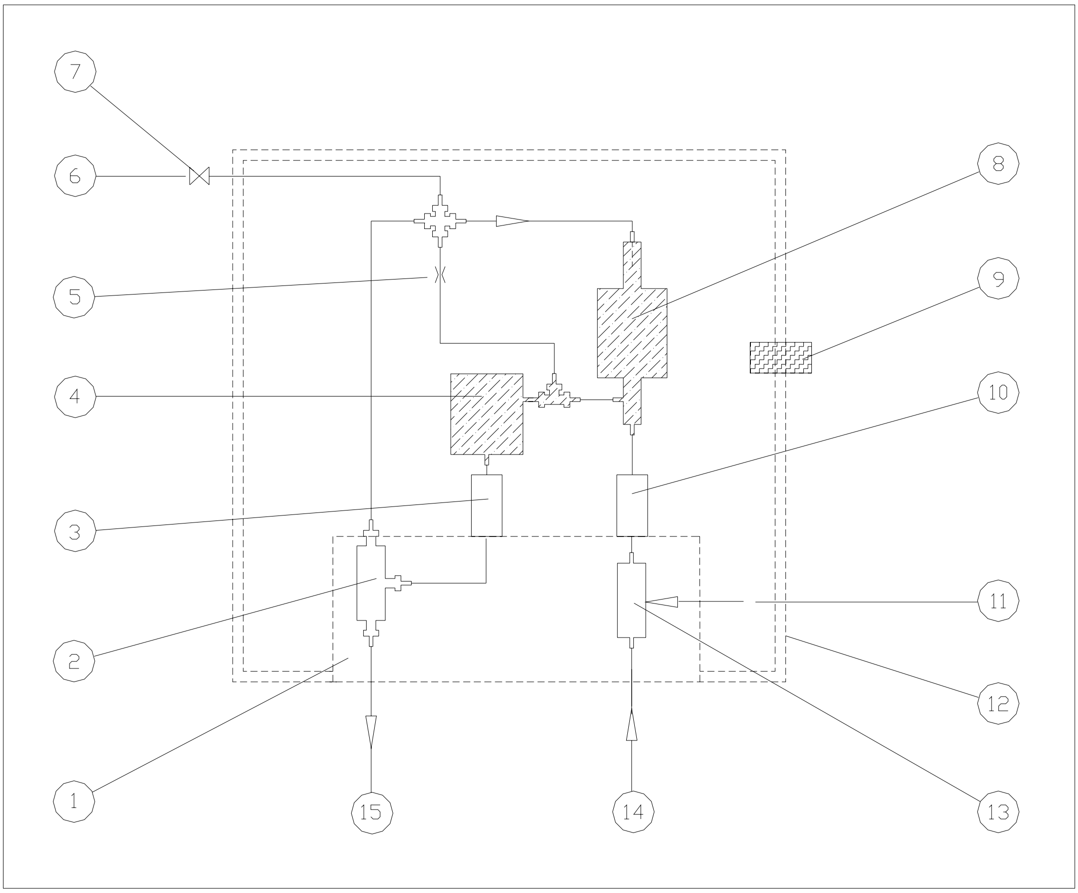

Figure 2.3 Sensor head flow schematic

Key to Figure 2.3

1	Heated filter block	9	Breather
2	Sample aspirator	10	Sintered flame arrestor
3	Flame trap	11	Calibration/blowback inlet
4	Tfx 1750 sensor	12	Oven assembly
5	Auxiliary air restrictor	13	Internal filter
6	Aspirator/reference air inlet	14	Sample gas inlet
7	Solenoid valve	15	Sample gas outlet
8	Zr 703 sensor		

2.1.1.2 Terminal compartment

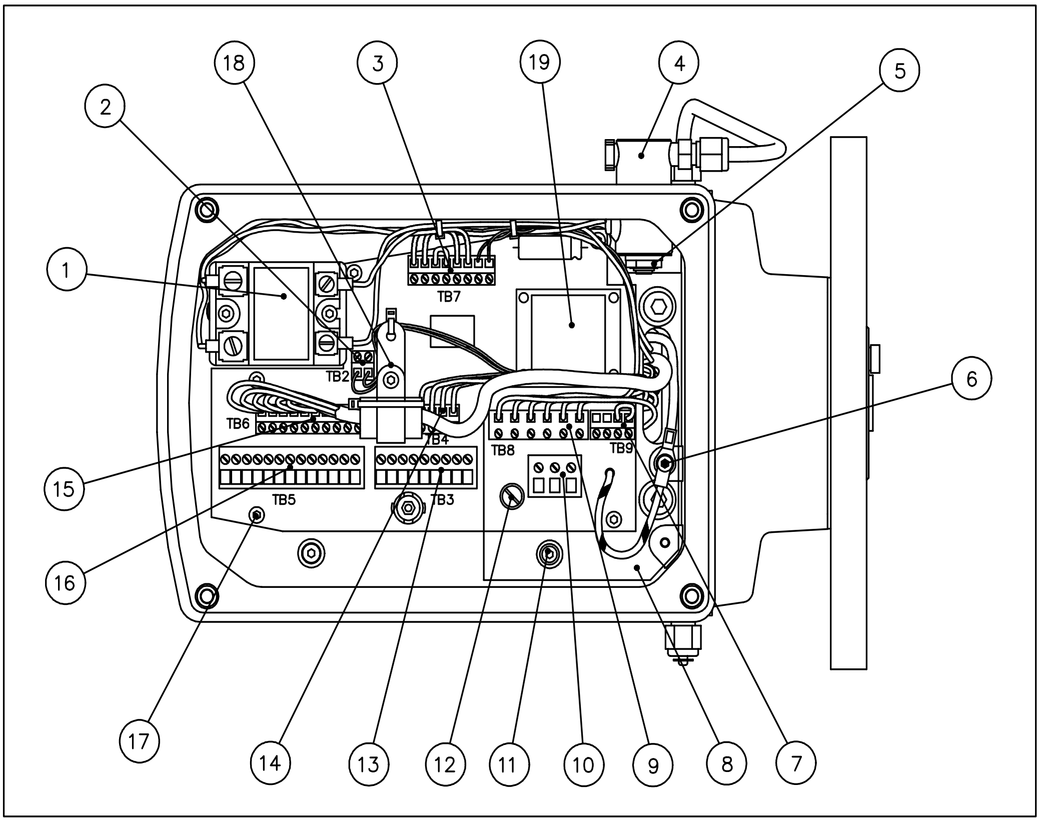

Figure 2.4 Sensor head terminal enclosure detail.

Key to Figure 2.4

1. Solid state relay.
2. Terminal block TB2.
3. Terminal block TB7.
4. Solenoid valve.
5. Solenoid valve retaining nut.
6. Terminal PCB earth connection.
7. Terminal block TB9.
8. Transparent protection cover.
9. Terminal block TB8.
10. Terminal block TB1
11. M4 cover fixing screw.
12. Mains fuse F1.
13. Terminal block TB3.
14. Terminal block TB4.
15. Terminal block TB6.
16. Terminal block TB5.
17. M4 Terminal PCB fixing screws (6).
18. Wiring support P clip + EMC ferrite.
19. Transformer.

Removal of the 4 screws and lid gives access to the sensor head PCB and user electrical connections. Electrical cables fitted with suitable glands are fed through the appropriate entry holes and wired to the terminals shown in figure 2.4. Any unused cable entries should be fitted with appropriate blanking plugs.

2.1.2 Control unit

Refer to figure 2.5.

The housing consists of a die cast aluminium enclosure (16) with a hinged die cast aluminium door (3) secured by four captive M6 screws (2) and sealed by an O ring (5). This enclosure houses most of the control electronics for the 2700 analyser. Three holes into the enclosure are provided for optional purge connections (13), a breather fitting (15) or sealed plugs. An electrical earth connection is provided (not shown in figure 2.5) on the outside of the enclosure.

Control input and display of results is via a tactile keypad and backlit LCD display assembly (1) secured onto the hinged door using six M4 hex head screws and sealed using an O ring (4). The control electronics and user wiring connections (7) are contained on a single PCB (10) screwed directly onto the enclosure casting. A toroidal transformer (11), attached to the enclosure casting, is mounted underneath the control PCB. A protection cover (6) protects the PCB from accidental damage. A transparent cover (8) is provided to protect the user from hazardous voltages.

User and interconnecting wiring to the control unit is via the 3/4" NPT (internal) threaded entries (14) on the bottom side of the enclosure casting.

The control unit may be mounted on to a wall via either mounting straps (12) or alternatively into a rack or panel (panel mounting kit not shown).

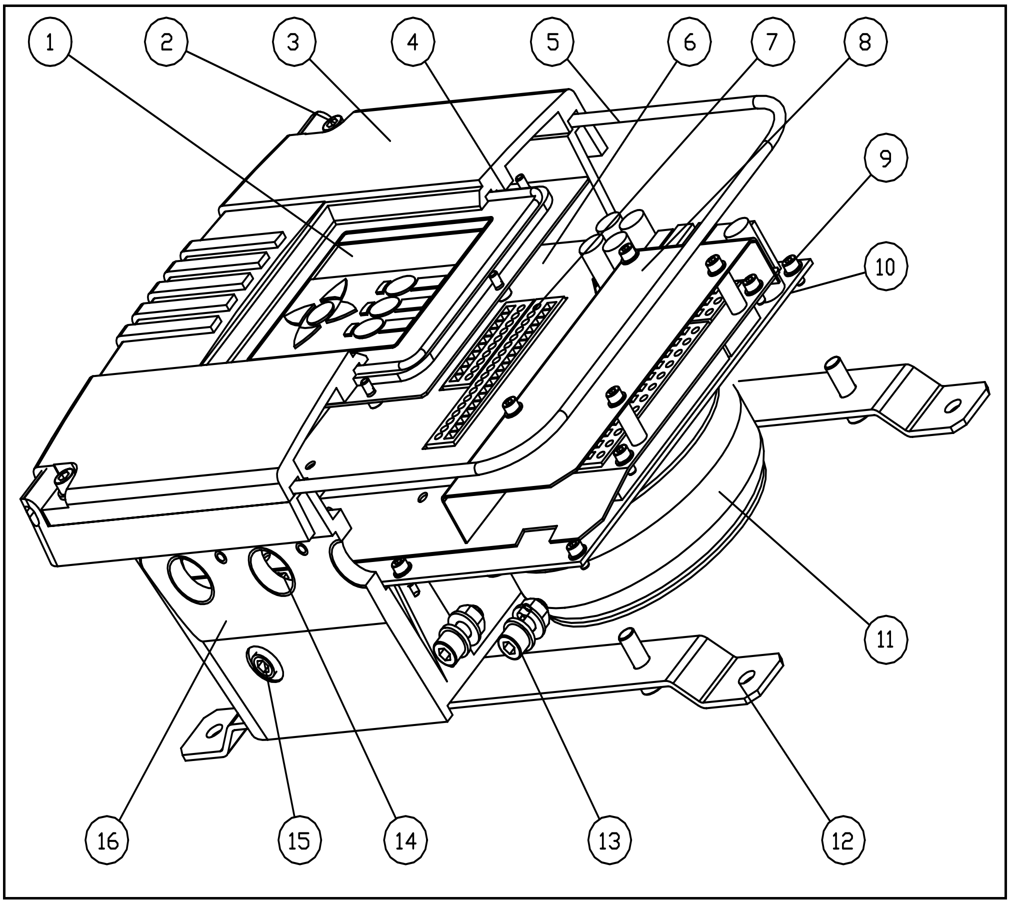

Figure 2.5 Control unit overview

Key to Figure 2.5

1	Display and keypad.	9	PCB fixing screws.
2	Captive screws for door.	10	Control PCB.
3	Cast aluminium hinged lid.	11	Transformer.
4	O ring seal.	12	Wall mounting straps.
5	O ring seal.	13	Optional purge ports.
6	PCB protection cover.	14	Wiring entry ports.
7	User wiring connections.	15	Optional breather fitting.
8	Mains protection cover.	16	Cast aluminium enclosure.

2.2 Electrical overview

2.2.1 Control unit PCB

2.2.1.1 Power supplies and relay outputs

Mains power connects to the PCB via terminal block TB3. The “live” side is fused by F1. Fused mains power is fed to connectors PL6 and PL7 where the mains transformer primary is connected.

The transformer secondaries connect to PL5, supplying a 18-0-18V heater supply, and a 10.5-0-10.5V supply for the +/-5V regulated DC supplies.

There is a dedicated regulated +5V DC supply for the relay coils, 4-20mA output DC-DC converters and the LCD back-light. The rest of the control unit electronics is powered from a separate +5V and -5V DC supply.

Fuses F2, F3, F4 and F5 protect both sides of the 18-0-18V AC supplies to the Zirconia and Tfx cell heaters.

There are four relay outputs controlled by the micro controller. Each relay provides a single-pole changeover function on terminal block TB4 and is driven by an individual control line from the micro controller .

2.2.1.2 Micro controller

The micro controller has external flash EEPROM which contains the system software, the analyser configuration and calibration data. The flash EEPROM is fitted in a socket to allow software changes in the field.

The micro controller directly drives the LCD display, an analog input multiplexer and an analog-to-digital converter. There are two PWM outputs from the micro controller which are used to drive the isolated current outputs.

A serial data chain monitors the keypad, ‘autocal’ and ‘blowback’ inputs, configuration links and drives the Zirconia and Tfx cell heater inhibit signals, ‘system OK’ LED and relay outputs.

A real-time clock/calendar IC with its own 32.768kHz crystal is connected to the micro controller via an SPI synchronous serial data link. A 0.1F “Supercap” capacitor provides power for the real-time clock when there is no mains power.

A supply voltage supervisor/reset IC is used to drive the micro controller reset line. The IC provides a clean power-up reset, brown out protection and a manual reset input (SW1). There is a red LED on the RESET line which turns on when the micro controller is reset. The LED can be seen through a hole in the metal cover over the PCB.

The green “System OK” LED is toggled on and off by the software to indicate correct operation. The LED can be seen through a hole in the metal cover over the PCB.

The configuration links (LK3, LK4) are surface-mount links which tell the software whether the PCB is for an oxygen-only, combustibles-only or dual gas analyser. These links are fitted during manufacture and are not field-alterable.

The Zirconia cell heater inhibit (ZINH) only enables the heater when the cell temperature is above 50°C. This is to ensure that the sensor head is connected and working and the cell temperature measurement signals are working. The Zirconia cell will be heated to 50°C by the sensor head heater. This interlock ensures that the cell heater controllers do not operate if their temperature feedback signals are broken, as this could damage the cell by overheating it. Note that if the system software is not running, both cell heaters will be inhibited.

Preset potentiometer RV2 adjusts the LCD contrast/viewing angle. The display may disappear altogether if this potentiometer is not correctly adjusted.

NOTES

If the PCB is removed from the enclosure, the “Autocal” and “Blowback” inputs will only work if the PCB centre mounting hole is electrically connected to the PCB Earth strap.

Operation of the sensors with the PCB removed from the enclosure is not recommended as the enclosure provides the heat sink.

2.2.1.3 Analogue current outputs

There are two identical galvanically isolated current output circuits, one assigned to each gas measurement. Single-gas analysers only have one output.

The “Oxygen” current output will be described (also referred to as Channel A):

An isolated +/-15V dc supply is generated by two DC-DC converters, with their outputs connected in series. The PWM output from the micro controller is fed via an opto-isolator to control an analog multiplexer. A voltage, 3V above the -15V rail is generated and used as the “signal 0V” and ensures that signals are always within the common-mode range of the mux and op-amp. A 2.5V reference voltage (with respect to “signal 0V”), trimmed by RV4, is fed to one input of the mux. The other mux input is connected to “signal 0V”. The mux output is fed to a passive low-pass filter which produces a DC voltage proportional to the duty cycle of the PWM waveform. The op-amp and mosfet transistor convert this voltage to a current sink at TB2 pin 16. Current is sourced at TB2 pin 15 from the isolated +15V rail.

The current output is calibrated by RV4 to give 20mA at 95% duty cycle, thus limiting the maximum current (even under fault conditions) to 21mA. The current output will work with load resistances up to 1kΩ (21V maximum output).

2.2.1.4 ADC Subsystem

Five analog signals are monitored by the micro controller via the ADC subsystem.

- Zirconia sensor output mV;
- Zirconia sensor temperature;
- Combustibles sensor output mV;
- Combustibles sensor temperature;
- Sensor head temperature (optional)

The five inputs and a reference 0V are fed to an analog multiplexer. A 2.5V reference is provided for the ADC, a -0.25V level is derived from the 2.5V and the mux output is amplified and offset by 2xVin+0.25V. This allows the ADC to handle slightly negative voltages from the mux.

The ADC is clocked at 245 kHz; this clock is derived from the micro controller system clock output. The multiplexer and ADC are controlled by the micro controller, the ADC output data is transmitted to the micro controller via a serial data link.

2.2.1.5 Zirconia sensor electronics

Sensor output signal processing:

The zirconia cell output is amplified by an instrumentation amplifier with a gain of 6, then filtered by a 4-pole active low pass filter with a cut off frequency of about 1Hz. The filter output is fed to the ADC subsystem.

Heater control and temperature signal processing:

The zirconia cell heater is powered by the 18-0-18V AC supply from the mains transformer, controlled by a triac in each side. The cell temperature is sensed by a thermocouple. The thermocouple amplifier is situated in the sensor head terminal box and provides a 10mV/°C temperature signal to the control PCB via TB2 pins 9 and 10. This signal is buffered and fed into the heater control loop, and attenuated to a level suitable for the ADC.

The temperature set-point is defined by a -2.5V reference (derived from the ADC 2.5V reference) applied via a 3.57KΩ precision resistor. The temperature feedback is the thermocouple output voltage (1V/100^{o}C) applied via a 10KΩ precision resistor. The error amplifier subtracts one from the other and gives an output of 1V/^{o}C which is applied to a 267KΩ resistor to generate a heater demand current. A differentiator subtracts from the heater demand current if the rate of rise of cell temperature exceeds 250°C/minute. This is in order to prevent damage to the cell caused by extreme thermal shocks. The heater demand current is then inverted and integrated and the integrator output voltage is compared with 0V.

To keep the cell electrically symmetrical, only complete cycles of AC are applied to the heater, so the controller output is synchronised to the mains zero-crossings. If the integrator output is negative then power is applied to the heater, if the output is positive then no power is applied. When power is applied to the heater current is drawn from the integrator via a 267KΩ resistor which causes the integrator output to ramp positive.

There is a hardware over temperature shutdown which disables the heater if the measured temperature goes above about

830°C. The heater may also be disabled by the micro controller via a comparator and FET switch.

A separate rectifier and voltage regulator provides a +10V supply for the cell temperature buffer amplifier.

The sensor head temperature signal is buffered and attenuated and fed to the ADC via the analog mux.

2.2.1.6 Combustibles sensor electronics

Sensor output signal processing:

The Combustibles transducer is in the form of a resistive bridge which is driven by a chopped constant-current supply. The supply is chopped at 218 Hz, the timing is controlled by a small micro-controller, to ensure accurate timing of the glitch-blanking function (see below). The current source is mirrored to keep the bridge common-mode voltage low.

The bridge output is buffered by a difference amplifier and then fed to two gain stages. The gain blocks have a DC gain of 1 so as not to amplify offset voltage errors. A synchronous detector is used to null out offset errors and amplifier noise. When the bridge is driven with current the synchronous detector has a gain of +1, when the bridge is not driven the synchronous detector is switched to a gain of -1. The output of the synchronous detector is integrated over several cycles by a second-order low-pass filter with a cut off frequency of 0.1 Hz.

Thus the output is:

((signal + noise + offsets) - (noise + offsets)) = signal.

An analog switch is placed between the synchronous detector and the low-pass filter to provide blanking of the large transients which are generated when the bridge drive is switched on and off. The transients occur due to the finite response time of the current mirror. The switch is driven by the micro controller to ensure that the blanking control is “locked” to the chopping of the bridge drive current, and to ensure that a constant percentage of the signal is blanked out since any variation in this would appear as a variation in system gain.

A zero-offset adjustment circuit is provided which sinks a current from one side of the bridge to compensate for the course offset error inherent in the bridge. Rotary switch SW2 provides approximately 15000 ppm adjustment in 1000 ppm steps, the exact step size depends on cell sensitivity and calibration. Switch SW3 selects which side of the bridge the current is taken from, and hence the polarity of the adjustment. The software zero calibration removes the remaining zero offset.

Heater control and temperature signal processing:

The cell temperature is controlled by a PID controller. The output of the controller is modified by the power applied to the heater to ensure that the controller is stable over the full range of heater supply voltage.

A platinum resistance temperature (PRT) sensor monitors the cell temperature, as part of a resistive bridge. The bridge output is an error voltage which is fed to the PID controller. The PRT voltage is buffered and fed to the ADC. The heater set point is fixed at 300°C. The set point is defined by the parallel combination of R19 and R20.

The output of the PID controller (modified by the heater power) is integrated and fed to the heater drive circuit. The drive circuit is almost identical to that used in the Zirconia heater circuit (see section 2.2.1.5).

2.2.2 Sensor head terminals PCB

2.2.2.1 Power supply

Mains power connects to the board assembly via terminal block TB1. The “live” side is fused by F1. The fused mains power is routed to the primary winding of the mains transformer via the voltage selector terminals TB9. Fused mains power also connects to TB8 where the sensor head heater, solid state relay and over-temperature thermostat are connected in series. Capacitors C14, C15 and C18 provide RF suppression.

The transformer secondary provides a nominal 15-0-15 V ac to the rectifier diodes D1 to D4. IC1 is a conventional linear regulator providing a nominal 12V dc at TP1 with respect to TP2. Note that 0V (TP2) is not connected to ‘chassis’ at the sensor head.

Vc is an unregulated supply of nominally 20Vdc connected only to IC5.

+V is a rectified ac supply of nominally 14Vdc connected only to the solenoid valve via R13 and TB7.

2.2.2.2 Thermocouple amplifier

The thermocouple from the zirconia oxygen sensor connects to IC2 via TB2. IC2 is a thermocouple amplifier which incorporates the cold junction reference and provides an output of 10mV per °C at TB3, terminals 7 and 8. Under normal operating conditions, the output is nominally 7.00V dc and this signal is transmitted to the temperature control circuit located in the Control unit. Should either or both of the sensor thermocouple wires become disconnected, the amplifier output will increase to some value within the range 8 to 12 V dc. This will cause the temperature controller circuit to shut off and protect the cell from damage.

2.2.2.3 Sensor head temperature control

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The aspirator block within the sensor head is temperature controlled at nominally 240 °C using a thermistor sensor located in the block and connected to the circuit at TB7 terminals 7 and 8. This sensor has a nominal value of 750 ohms at 240 °C and is connected in a full bridge configuration with R1, RN1 and RN2. IC3a (1, 2 and 3) and IC3b (5, 6 and 7) form a voltage to pulse generator. While operating within the proportional control band, there will be a pulsed output from IC3 pin 7 which is inverted by one of the drivers of IC5. This output at IC5 pin 10 switches the solid state relay at TB7 terminals 3 and 4. Visual indication of the heater operation is provided by D10, which should be pulsing on-off about one or two times per second when the temperature controller is controlling normally.

2.2.2.4 Sensor head temperature monitor

A voltage representing the sensor head temperature is available at TB3 terminals 1 and 2 and may be transmitted to the control unit for diagnostic purposes. This has a non-linear relationship with temperature and is approximately 1.6V dc at room temperature (and below), increasing to approximately 6.6V dc at the control temperature of 240 °C.

2.2.2.5 Solenoid valve interlocks

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The solenoid valve connected to TB7 terminals 1 and 2 is a 12V dc valve which turns on the air supply to the aspirator when the sensor head and sensor temperatures are satisfactory. The solenoid valve is powered via the ‘driver’ circuit IC5 and diode logic D5, D6, D7 and D8.

IC4 amplifiers are used as level comparators in which all 4 outputs must switch ‘high’ for the solenoid valve to be energised. IC4 pin 14 will switch high when the Sensor head thermistor reaches approximately 215 °C (1.3k ohms). IC4 pin 1 will switch ‘high’ when the Zirconia sensor exceeds 600 °C. IC4 pin 7 will switch ‘high’ when the auxiliary thermistor connected at TB7 terminals 5 and 6 reaches 195 °C (2.2k ohms). For oxygen only assemblies, TB7 terminals 5 and 6 are linked. In each case, hysteresis is provided to ensure a clean transition at the switching threshold.

2.3 Operating principles

2.3.1 Zr703 oxygen transducer module

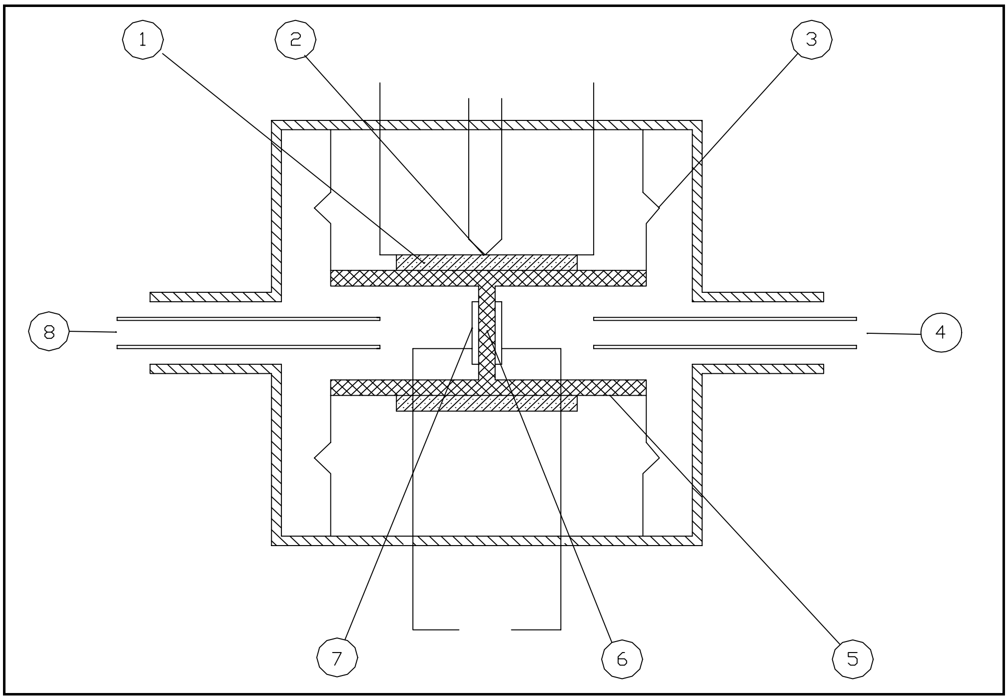


Figure 2.6 Zirconia cell construction

Key to Figure 2.6			
1	Tubular oven	5	Zirconia tube
2	Thermocouple	6	Zirconia disk
3	Diaphragm suspension	7	Platinum electrodes
4	Reference gas inlet	8	Sample gas inlet

The Zr703 cell is a zirconia type oxygen transducer. The sensing element of the transducer is a disk manufactured from yttria stabilised zirconia. When this material is heated to a temperature above 600 °C it becomes permeable to oxygen ions. The passage of oxygen ions through the zirconia produces an electric current that may be sensed by electrodes measuring the voltage across the zirconia disk.

Refer to figure 2.6.

The sensor consists of a yttria stabilised zirconia disk (6) mounted in a tube of the same material (5). The faces of the disk are coated with platinum electrodes (7) and the assembly is mounted in a small temperature controlled tubular oven (1). The temperature of the oven

being measured with a thermocouple (2).
When the two sides of the disk are exposed to gases containing differing concentrations of oxygen, oxygen ions pass through the zirconia disk giving rise to a potential difference across the two platinum electrodes (7). The magnitude of the potential difference is proportional to the logarithm of the ratio of the oxygen concentrations on the two sides of the disk.

In the 2700 analyser ambient air is used as a reference on one side of the disk (4) while the sample gas extracted from the flue is presented to the other side (8). The oxygen content of air is very constant at 20.95%. The output potential from the cell is governed by the Nernst equation:

$$V = KT \ln\left(\frac{20.95}{C} \right)$$

V	=	Voltage across the zirconia disk in mV.
T	=	Absolute temperature of the zirconia in K.
C	=	Concentration of oxygen in the sample gas in %.
K	=	Constant (0.0215 mV/K).

The cell operating temperature in the 2700 is 700 °C (973K). The output voltage from the cell is hence given by:

$$V = 20.9 \ln\left(\frac{20.95}{C} \right) mV$$

When the sample gas contains combustible components then, due to the high temperature of the sensor, these will burn at the sensor disk consuming oxygen. The measured oxygen level will then be reduced accordingly.

2.3.2 Tfx1750 combustibles transducer module

Refer to figure 2.7.

The transducer operates by oxidation of the CO in the gas stream to form CO_2 at the surface of a heated catalyst coated sensor element (1). The process is exothermic and the heat generated raises the temperature of the sensor. The temperature increase is measured electrically to produce a signal that varies linearly with the CO concentration in the sample gas.

Earlier pellistor sensors have been successfully used to measure the lower explosive limit (LEL) of gases. This involves the measurement of percentage levels of combustibles. The use of pellistor sensors for low level CO detection has been limited by cross sensitivity to other combustible gases in the gas sample and poor base line stability resulting in drift.

In the Tfx 1750 thick film calorimeter transducer these problems have been overcome by the following means.

a) More appropriate catalyst design and lower operating temperature resulting in much higher selectivity to CO.

b) Improved oven design with indirect heating of the sensor surface. This ensures that the gas is heated to the same temperature as the sensor element before reaching the catalyst surface.

c) Better sample flow conditions so that the sensor surface is relatively free from convection cooling effects.

The sensor element (1) is suspended from a ceramic disk (2). The sensor and mounting disk are mounted onto a metallic housing (4).

The sensor housing assembly is located within an oven (9). The oven is heated by a band heater (7) and its temperature is controlled by a platinum resistance thermometer (6).

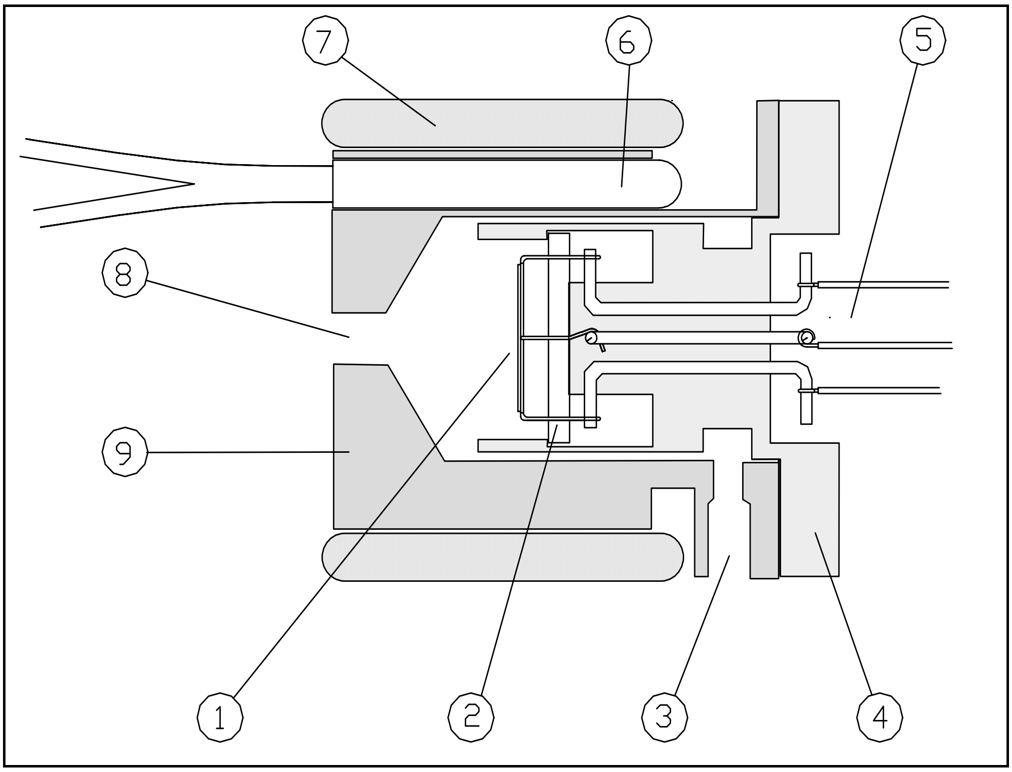


Figure 2.7 Tfx 1750 transducer schematic diagram

Key to Figure 2.7

1	Sensor element	6	Resistance thermometer
2	Ceramic disk	7	Band heater
3	Sample gas inlet	8	Sample gas outlet
4	Metallic housing	9	Oven
5	Electrical connections		

Sample gas flows in through the sample inlet (3). The sample gas passes through a heat exchanger formed by a narrow annular channel between the sensor assembly (4) and the oven body (9). This ensures that the gas is heated to the same temperature as the catalyst before reaching the sensor element. A majority of the sample gas flows through the sample exhaust (8). A small amount of the sample diffuses back to the sensor element (1) where the reaction occurs. The flow of sample through the vent (8) forms an aspirator that removes combustion products away from the sensor surface.

The temperature change of the element is sensed via the four electrical connections (5).

Refer to figure 2.8.

The sensor element consists of a ceramic disk (5) onto which is printed a platinum resistance electrode (4). The sensor is partitioned into 4 quadrants (1, 2, 3, 4). Two of the quadrants (1 and 3) are coated with the catalyst. The other two segments (2 and 4) are not coated with the catalyst. The combustion reaction occurs only at the catalyst coated portions of the sensor changing the resistance of those portions of the resistance electrode. The 4 quadrants of the sensor are electrically connected in a bridge configuration so that the temperature difference between the catalyst coated and non catalyst coated portions can be measured.

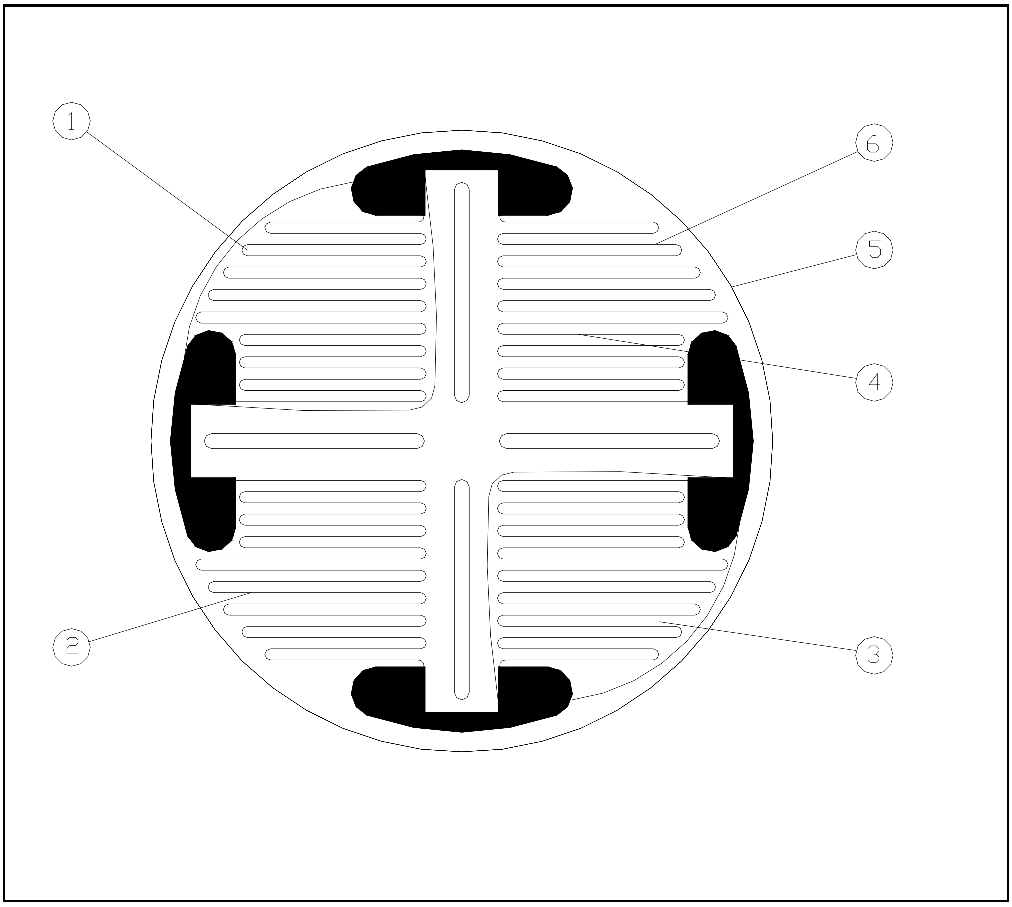


Figure 2.8 Tfx 1750 sensor element detail.

Key to Figure 2.8

1	Coated bridge segment	4	Uncoated bridge segment
2	Uncoated bridge segment	5	Ceramic disk
3	Coated bridge segment	6	Platinum electrode

2.4 Electrical connections

The interconnecting wiring specification is given in table 2.1. Wiring schedules for the oxygen only, the combustibles only, and the dual sensor versions are given in tables 2.2, 2.3 and 2.4 accordingly.

The maximum loop resistance limit of 4 ohms is required only for the sensor heater lines (2 lines per sensor). The sensor outputs, temperature signals and bridge supply wires need not be limited by this restriction on resistance. Depending on installation environment it may prove more cost effective to use interconnecting cables with more twisted pairs but with a smaller cross section per core and where necessary to run heater wires in parallel to produce the required maximum loop resistance.

Table 2.1 - Interconnecting Cable Requirements			
Oxygen only	3 twisted pairs with overall screen. Maximum loop resistance 4 Ohms for heater connections.	1.0 mm^2 1.5 mm^2 2.5 mm^2	100m 150m 300m
Combustibles Only	6 twisted pairs individually screened, minimum 1.0mm^2 cross section. Maximum loop resistance 4 Ohms for heater connections.		100m
Oxygen and Combustibles	Minimum 9 twisted pairs individually screened, minimum 1.0mm^2 cross section. Maximum loop resistance 4 Ohms for heater connections.		100m
Note For optional sensor head temperature display at control unit add 1 extra twisted pair to cable specification.			

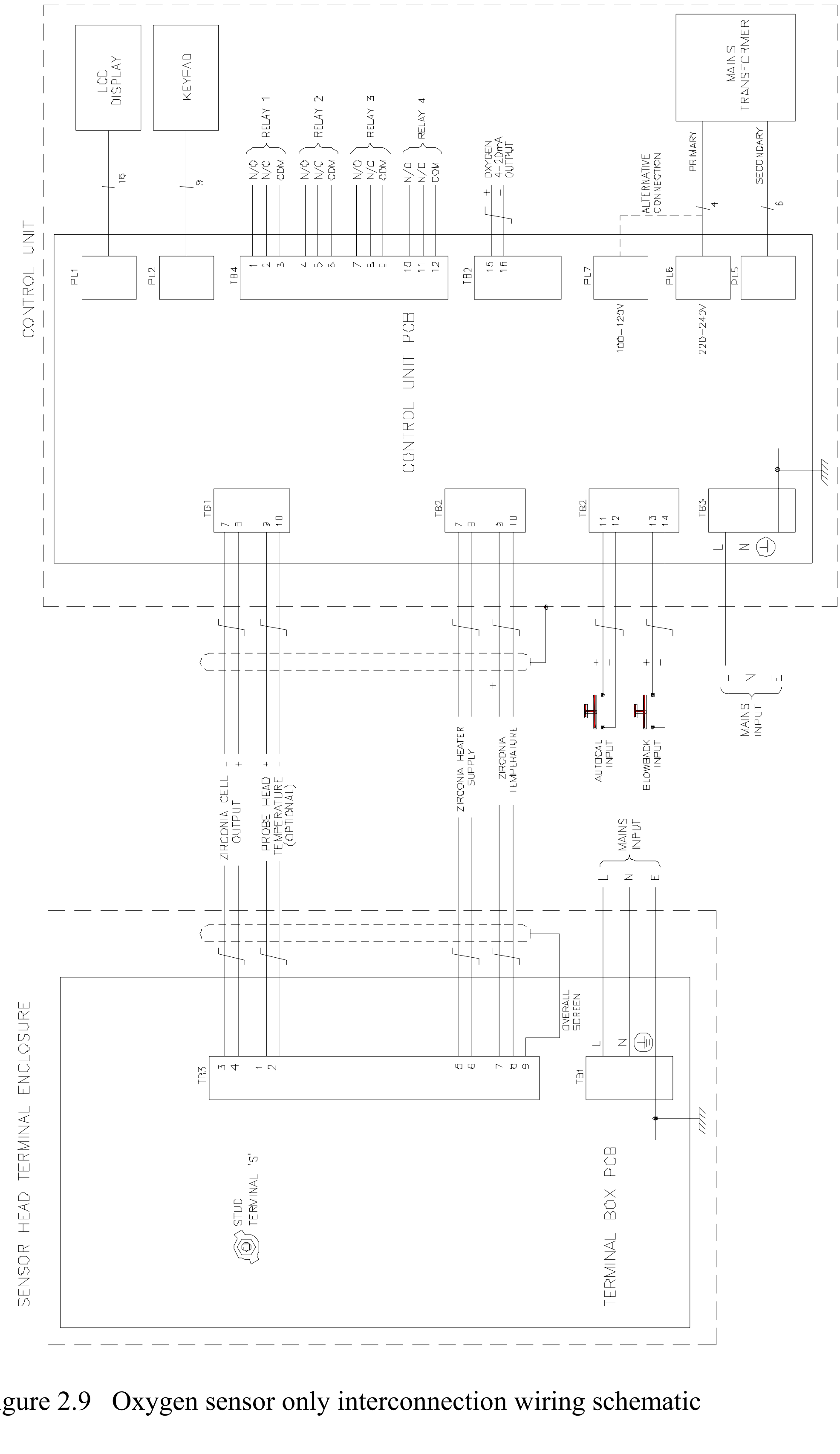


Figure 2.9 Oxygen sensor only interconnection wiring schematic

Table 2.2 - Oxygen sensor only interconnecting wiring			
Sensor Head Terminal	**Function**		**Control Unit Terminal**
TB3-1	Optional sensor head temperature measurement	+ve	TB1-9
TB3-2		-ve	TB1-10
TB3-3	Zirconia cell output	-ve	TB1-7
TB3-4		+ve	TB1-8
TB3-5	Zirconia sensor heater supply (polarity not important)		TB2-7
TB3-6			TB2-8
TB3-7	Zirconia sensor temperature output	+ve	TB2-9
TB3-8		-ve	TB2-10
TB3-9	Overall cable screen connection		Connected to case (earth)

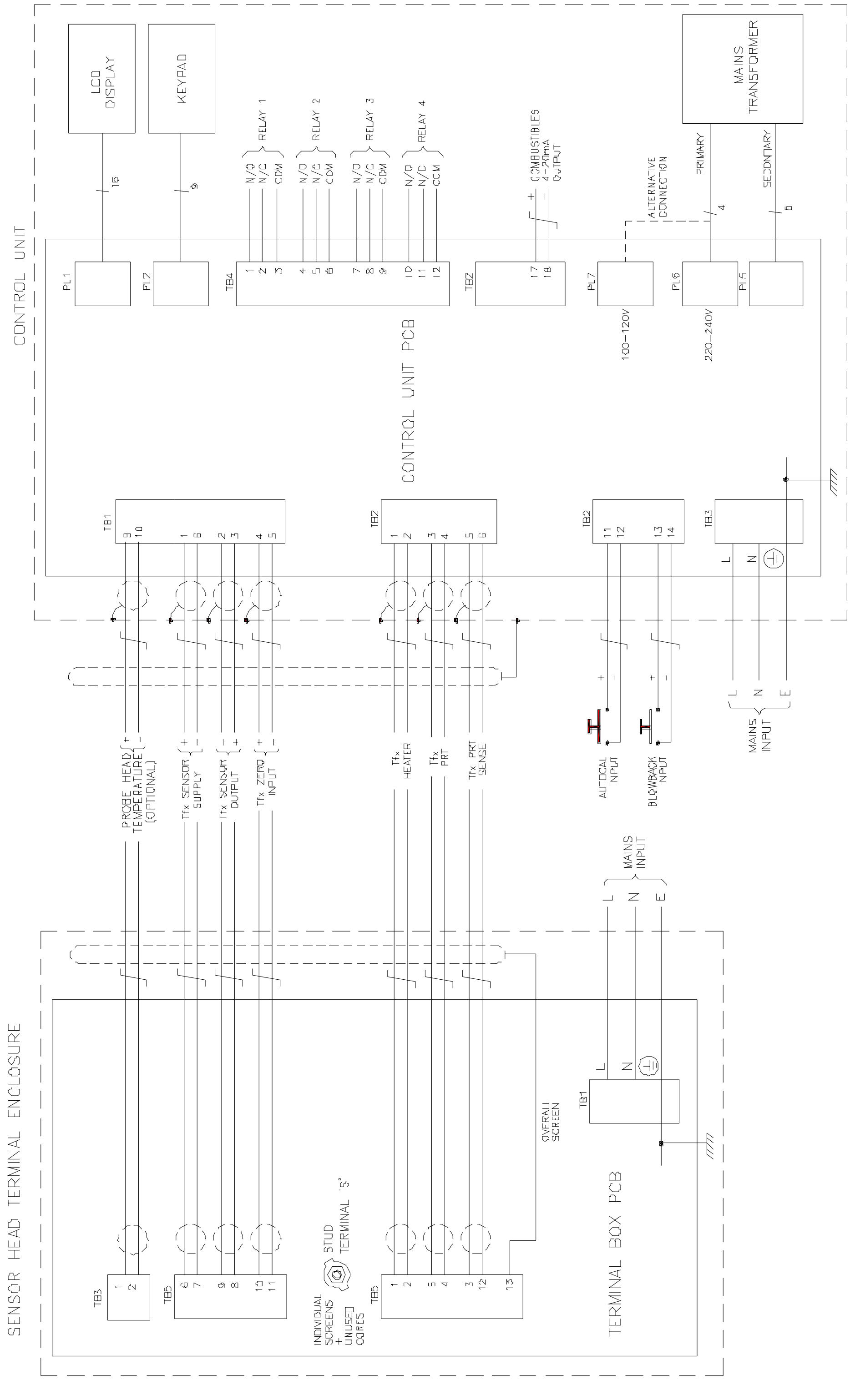


Figure 2.10 Combustibles sensor only interconnection wiring schematic

Table 2.3 - Combustibles sensor only interconnecting wiring			
Sensor Head Terminal	**Function**		**Control Unit Terminal**
TB5-1	Combustibles sensor heater supply (polarity not important)		TB2-1
TB5-2			TB2-2
TB5-3	Combustibles sensor temperature output	ground	TB2-5
TB5-4		-ve	TB2-4
TB5-5		+ve	TB2-3
TB5-6	Combustibles sensor bridge supply	+ve	TB1-1
TB5-7		-ve	TB1-6
TB5-8	Combustibles sensor bridge output	+ve	TB1-3
TB5-9		-ve	TB1-2
TB5-10	Combustibles Sensor Bridge offset correction	+ve	TB1-4
TB5-11		-ve	TB1-5
TB5-12	Combustibles sensor temperature ground		TB2-6
Stud terminal 'S'	Individual screens and unused cores		Connected to case (earth)
TB5-13	Overall cable screen connection		Connected to case (earth)

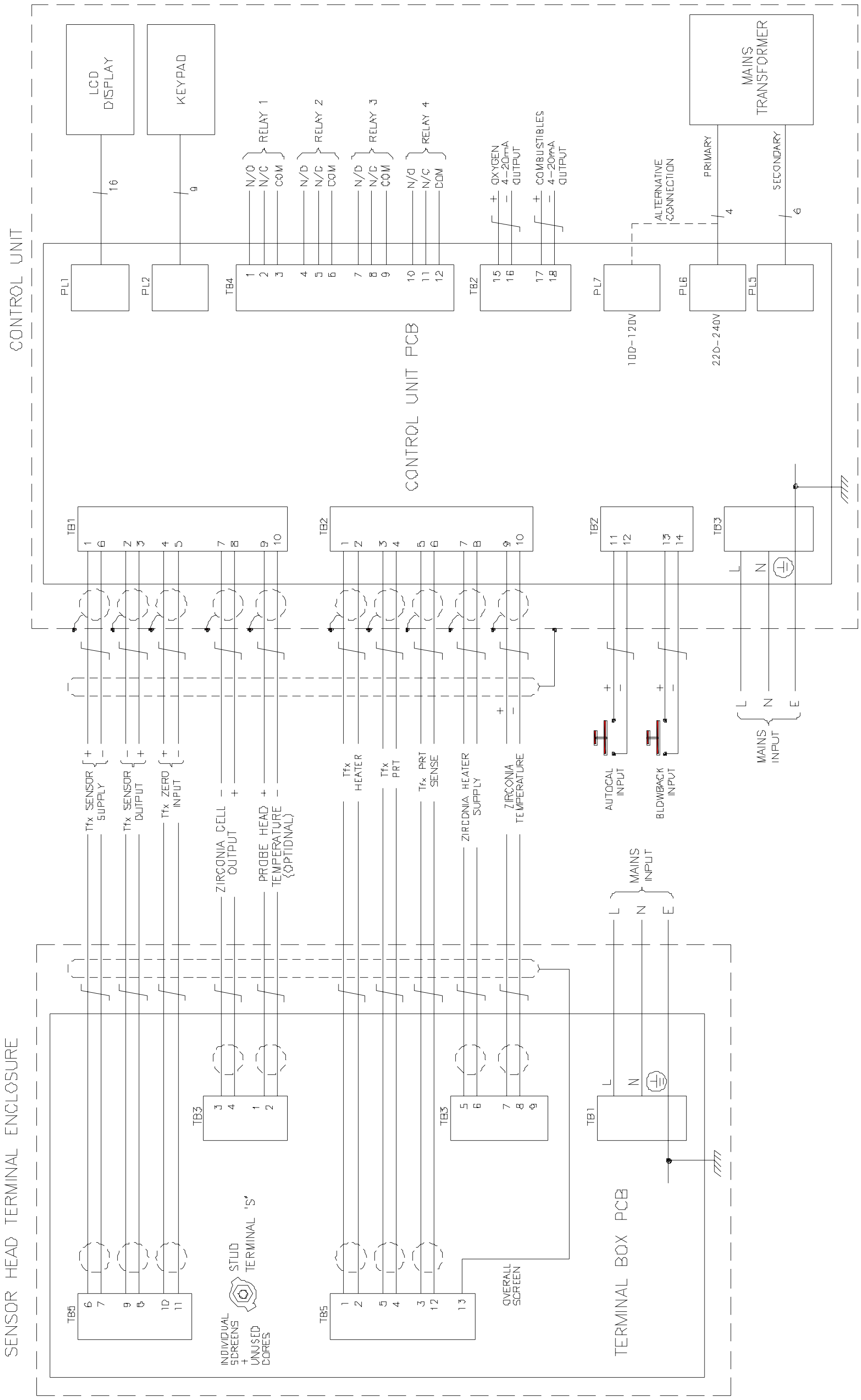


Figure 2.11 Dual sensor interconnection wiring schematic

Table 2.4 - Dual sensor interconnecting wiring			
Sensor Head Terminal	**Function**		**Control Unit Terminal**
TB5-1	Combustibles sensor heater supply (polarity not important)		TB2-1
TB5-2			TB2-2
TB5-3	Combustibles sensor temperature output	ground	TB2-5
TB5-4		-ve	TB2-4
TB5-5		+ve	TB2-3
TB5-6	Combustibles sensor bridge supply	+ve	TB1-1
TB5-7		-ve	TB1-6
TB5-8	Combustibles sensor bridge output	+ve	TB1-3
TB5-9		-ve	TB1-2
TB5-10	Combustibles Sensor Bridge offset correction	+ve	TB1-4
TB5-11		-ve	TB1-5
TB5-12	Combustibles sensor temperature ground		TB2-6
TB5-13	Overall cable screen connection		Connected to case (earth)
TB3-1	Optional sensor head temperature measurement	+ve	TB1-9
TB3-2		-ve	TB1-10
TB3-3	Zirconia cell output	-ve	TB1-7
TB3-4		+ve	TB1-8
TB3-5	Zirconia sensor heater supply (polarity not important)		TB2-7
TB3-6			TB2-8
TB3-7	Zirconia sensor temperature output	+ve	TB2-9
TB3-8		-ve	TB2-10
Stud Terminal ‘S’	Individual screens and unused cores		Connected to case (earth)
TB3-9	Overall cable screen connection		Connected to case (earth)

2.5 Sample connections

Refer to figure 2.12 for the position and type of the gas connections to the sensor head.

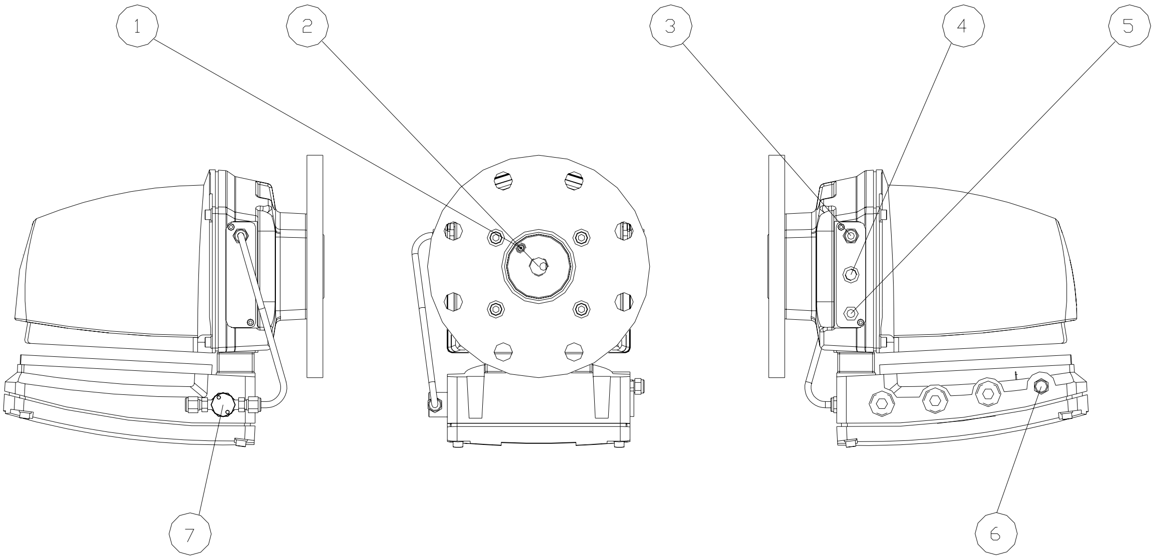


Figure 2.12 Sensor head sample connections

Key to Figure 1.2

1	Sample vent port 1/8” NPT (INT).
2	Sample probe connection 1/2” NPT (INT).
3	Calibration gas inlet 1/4” OD compression fitting.
4	Purge gas exit, 1/4” NPT (INT), or breather fitting.
5	Spare entry.
6	Purge gas entry, 1/4” NPT (INT) or blanking plug.
7	Aspirator air supply inlet 1/8” NPT (INT).

3 SPARES LIST

WARNING

2700 spares must be supplied by Servomex to comply with personnel safety requirements and to maintain performance specification.

NOTES

The spares listed in this section are for 2700 Model C analysers only. For models prior to this, please refer to original documentation (2700 Quickstart manual), supplied with the analyser, or contact Servomex for assistance.

3.1 Control unit spares

Item	2700C Control Unit - Description	Spare Part Number	Recommended qty.		
			No. Of analysers		
			1-3	4-9	10+
1	Control Unit PCB O_2 Only	S2710903A	0	1	2
2	Control Unit PCB COe Only	S2710913A	0	1	2
3	Control Unit PCB O_2 & COe	S2710923A	0	1	2
4	Transformer	4961-1173	0	1	1
5	Key Pad Assembly	02710353	0	1	1
6	Display Assembly	2553-9307	0	1	1
7	Mains Protection Cover	S2710994	0	0	0
8	Purge Kit	S2710995	0	0	0
9	Breather	2371-0052	0	0	0
10	Wall Mounting Kit	S2710997	0	0	0
11	Rack Mounting Kit	S2710996	0	0	0
12	Enclosure Gasket Kit	S2700999 (Control Unit & Sensor Head)	1	1	1
13	Fuse Kit (Control Unit & Sensor Head)	S2700998 *	1	1	1
* includes :- F1.6A HRC (5x20mm), F2.5A HRC (5x20mm), F3.15A HRC (5x20mm) & F6.3A HRC (5x20mm)					

3.2 Sensor head spares

Item	2700C Sensor Head - Description	Spare Part Number	Recommended qty.		
			No. Of analysers		
			1-3	4-9	10+
1	Sensor Head O_2 Only, 100 - 120Vac	S2720714A	0	0	1
2	Sensor Head Low COe Only, 100 - 120Vac	S2720715A	0	0	1
3	Sensor Head High COe Only, 100 - 120Vac	S2720716A	0	0	1
4	Sensor Head O_2 & Low COe, 100 - 120Vac	S2720717A	0	0	1
5	Sensor Head O_2 & High COe, 100 - 120Vac	S2720718A	0	0	1
6	Sensor Head O_2 Only, 220 - 240Vac	S2721714A	0	0	1
7	Sensor Head Low COe Only, 220 - 240Vac	S2721715A	0	0	1
8	Sensor Head High COe Only, 220 - 240Vac	S2721716A	0	0	1
9	Sensor Head O_2 & Low COe, 220 - 240Vac	S2721717A	0	0	1
10	Sensor Head O_2 & High COe, 220 - 240Vac	S2721718A	0	0	1
11	Solenoid Valve Kit	S2720993	0	1	1
12	Solid State Relay (SSR) Kit	S2720992	0	1	1
13	Sensor Head PCB O_2only	S2720902A	0	1	2
14	Sensor Head PCB COe Only	S2720912A	0	1	2
15	Sensor Head PCB O_2 & COe	S2720922A	0	1	2
16	Zr 703 Oxygen Cell	S2720995	1	1	2
17	Tfx 1750 Combustibles Cell (**0-2000ppm** range)	S1750702	1	1	2
18	Tfx 1750 Combustibles Cell (**0-6000ppm** range)	S1750703	1	1	2
19	Cell Connector O_2 Only	S2720991	0	0	0
20	Cell Connector COe Only	S2720963	0	0	0
21	Cell Connector O_2 & COe	S2720966	0	0	0
22	Aux/Ref Air Inlet Assembly O_2 & COe	S2720980	0	0	0
23	Aspirator Kit	S2720987	1	2	2
24	Flame Trap Kit	00022907	1	2	3
25	Internal Filter/Flame Arrestor Assembly	S2720955	1	2	3
26	Thermostat Assembly	02720994	0	1	2
27	Thermistor	200317	1	2	3
28	Band Heater - 120Vac	2653-1825	0	1	1
29	Band Heater - 240Vac	2653-1832	0	1	1
30	4" ANSI Mounting Gasket Kit	S2720985	1	2	3
31	4" Weld-On Flange Mounting Kit	S2720984	0	0	0
32	Mains Protection Cover	S2720983	0	0	0
33	Enclosure Gasket Kit (Control Unit & Sensor Head)	S2700999	0	0	0
34	Fuse Kit (Control Unit & Sensor Head)	S2700998 *	0	0	0
35	Ferrite Kit	S2720972	0	0	0
36	Sintered Restrictor	204372	0	0	0

* includes :- F1.6A HRC (5x20mm), F2.5A HRC (5x20mm), F3.15A HRC (5x20mm) & F6.3A HRC (5x20mm)

3.3 Sample probes

Item	2700C Sample Probes – Description	Spare Part Number
1	Silicon Carbide Filter Kit	S2740998
2	Probe Tube Coupling	2344-2294
3	Probe Shroud	S2740996A
4	Probe Support Disc*	S2740995
5	Thermal Spacer Flange Kit	02750997
6	High Temperature Standoff	02750995
7	Probe Retention Flange Kit	02750998
8	<700°C, Probe, Open Ended, 0.5m	S2740701A
9	<700°C, Probe, Open Ended, 1.0m	S2740701B
10	<700°C, Probe, Open Ended, 1.5m	S2740701C
11	<700°C, Probe, Filtered, 0.5m	S2740702A
12	<700°C, Probe, Filtered, 1.0m	S2740702B
13	<700°C, Probe, Filtered, 1.5m *	S2740702C
14	<700°C, Probe, Filtered, 2.0m * & **	S2740702D
15	<700°C, Probe, Filtered, 2.5m * & **	S2740702E
16	<700°C, Probe, Filtered, 3.0m * & **	S2740702F
17	<1000°C, Probe, Open Ended, 0.5m	S2740704A
18	<1000°C, Probe, Open Ended, 1.0m	S2740704B
19	<800°C, Probe, Open Ended, 1.5m	S2740704C
20	<700°C, Probe, Open Ended, 2.0m	S2740704D
21	<1000°C, Probe, Filtered, 0.5m	S2740705A
22	<1000°C, Probe, Filtered, 1.0m	S2740705B
23	<700°C, Probe Support, 1.5m	S2740997C
24	<700°C, Probe Support, 2.0m	S2740997D
25	<700°C, Probe Support, 2.5m	S2740997E
26	<700°C, Probe Support, 3.0m	S2740997F
27	<1750°C, Ceramic Probe, 0.5m	02740707A
28	<1750°C, Ceramic Probe, 1.0m	02740707B
29	<1750°C, Ceramic Probe, 1.5m	02740707C

* - Item 4, Probe Support Disc is required for Items 13 to 16 when replacing the <700°C filtered probe in a Supported Probe Installation.

**-Items 14, 15 and 16. Filter probes exceeding 1.5m in length are only available as part of a supported probe installation and should not be used alone.

3.4 Manuals

Item	Description	Spare Part Number
1	QuickStart Manual - English	02700003C
2	QuickStart Manual - French	02700013C
3	QuickStart Manual - German	02700023C
4	QuickStart Manual - Spanish	02700033C
5	QuickStart Manual - Russian	02700103C
6	Installation Manuals - English	02700005C
7	Installation Manuals - French	02700015C
8	Installation Manuals - German	02700025C
9	Installation Manuals - Spanish	02700035C
10	Installation Manuals - Russian	02700105C
11	Service Manual - English	02700002C

4 FAULT FINDING

4.1 Introduction

This section is included as a guide to possible fault symptoms and their diagnosis. It is based, as far as possible, on field experience but it is acknowledged that guides such as these are never comprehensive. Constructive criticism and suggestions for additions and improvement are always welcome and should be sent to the Analyser Engineering Manager.

Sections 4.2 and 4.3 provide guidance on the fault and diagnostic messages which may be displayed on the analyser control unit. These sections advise the meaning of the messages and the limits within which diagnostic signals should remain during normal operation.

Fault finding advice is found from Sections 4.5 onward and has been sequenced on the basis of an engineer attending site to fix a completely dead analyser. Section 4.5 deals with powering up the analyser and getting the probe head and sensors up to operating temperature. Section 4.6 deals with measurement performance problems. Section 4.7 deals with analyser faults (mainly in the control unit).

The introductory flow charts in each section may also be useful as a set of checks to be carried out during initial commissioning.

Section 4.4 has been included to enable more experienced engineers to find help on specific problems without starting at the beginning on Section 4.5 on every occasion.

WARNING

The electrical power used in this equipment is at a voltage high enough to endanger life. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.

It may be necessary to fault find with the electrical power connected. Where this is necessary extreme caution should be exercised.

Removal of the plastic insulating cover in the control unit may expose the user to potentially lethal voltages resulting from external electrical connections to the relay contacts even when electrical power is disconnected from the control unit itself.

The 2700 sensor head weighs approximately 17Kg (38 lbs), care must be taken when handling.

The analyser may contain toxic, corrosive, flammable or asphyxiant gases. Vent the analyser to a safe area and flush with air before commencing work.

The sensor head is heated and may be attached to a hot flue. The external surfaces will be uncomfortably hot even after power down for several hours. Exercise care when handling the sensor head even when un-powered on a hot flue.

4.2 Fault and Alarm messages

The 2700 software provides for on line monitoring for a number of fault conditions and also provides warning messages when certain parameters are outside normal limits which may result in poor instrument performance. The procedure to display any active fault messages is given in section 1.6 of this manual.

Fault and Alarm histories.
The procedure to display fault and alarm histories is given in section 1.8 of this manual.

Fault/Warning Message	**Notes**
DISP OVER RANGE	This message occurs when the COe reading exceeds preset limits and depend upon the type of combustibles sensor fitted: 01750702 10000vpm 01750703 30000vpm
OXYGEN LOW	This indicates that the oxygen content of the sample stream is insufficient to guarantee acceptable performance of the combustibles sensor. The fault will be displayed when the oxygen level is less than 1% in the measured sample gas. The presence of this fault indicates insufficient auxiliary air supply.
OXYGEN °C LOW	This indicates that the temperature of the zirconia oxygen sensor is too low. The fault will be displayed if the temperature of the zirconia sensor is less than 650 °C.
OXYGEN °C HIGH	This indicates that the temperature of the zirconia oxygen sensor is too high. The fault will be displayed if the temperature of the zirconia sensor is greater than 750 °C.
COe mV LOW	This indicates that the combustibles sensor output voltage is low enough to result in saturation of the analogue to digital convertor. The fault will be displayed if the combustibles sensor output voltage is less than or equal to -109 mV.
COe mV HIGH	This indicates that the combustibles sensor output voltage is high enough to result in saturation of the analogue to digital convertor. The fault will be displayed if the combustibles sensor output voltage is greater than or equal to +1113 mV.

COe °C LOW	This indicates that the temperature of the combustibles sensor is too low. The fault will be displayed if the temperature of the combustibles sensor is less than 275 °C.
COe °C HIGH	This indicates that the temperature of the combustibles sensor is too high. The fault will be displayed if the temperature of the combustibles sensor is greater than 350 °C.
COe mV OUTPUT LOW	This indicates that combustibles sensor sensitivity (span) is too low (message clears after a successful High or Low calibration is performed) and needs replacement.
mV OUT OF TOLERANCE	This indicates that the combustibles sensor mV signal was outside the range -60 to +60 mV during the last low point (Zero) calibration (message clears after a successful low calibration is performed) and that the combustibles sensor coarse zero setting needs adjustment.
COe CONC HI	This indicates that the combustibles sensor has been exposed to a COe concentration exceeding the recommended maximum level. This message is logged in the Fault history. If combustibles sensors are exposed to high levels of COe for long periods, their performance and life will be impaired.
SENSOR °C HIGH	This indicates that the sensor head temperature is too high. This fault should only be seen on analysers where the optional sensor head temperature interconnection is made between the sensor head and the control unit. The fault will be displayed if the temperature of the sensor head filter block is greater than 265°C.
SENSOR °C LOW	This indicates that the sensor head temperature is too low. This fault should only be seen on analysers where the optional sensor head temperature interconnection is made between the sensor head and the control unit. The fault will be displayed if the temperature of the sensor head filter block is lower than 225°C and/or the correct conditions have not been met to energise the sensor head solenoid.
AUTO CAL FAIL	This indicates that an automatic calibration procedure has failed because the resultant change in the calibration parameters was outside of the defined tolerance value. The tolerance value is defined as part of the auto calibration set up procedure.

NOTES

- **It is normal for the analyser to display an "OXYGEN °C LOW" fault during power up of the sensor head. The fault will be displayed until the zirconia sensor achieves its normal operating temperature range.**
- **It is normal for the analyser to display a "COe °C LOW" fault during power up of the sensor head. The fault will be displayed until the combustibles sensor achieves its normal operating temperature range.**
- **It is normal for 2700C1 analysers to display a "SENSOR °C LOW" fault during power up of the sensor head. The fault will be displayed until the sensor head and zirconia sensor achieve their normal operating temperature range.**
- **The COe CONC HI alarm limits are hard coded into the software at 5000vpm for 01750702 sensors and 15000vpm for 01750703 sensors.**

4.3 Diagnostic values

The 2700 software allows the user to interrogate a number of critical diagnostic values. The procedure to display the diagnostic values is given in section 1.7 of this manual.

Diagnostic	Notes
OXYGEN SENSOR mV	This is a measurement of the output voltage, in mV, across the zirconia disk in the oxygen sensor. The principles of operation of the oxygen sensor are given in section 2.3.1. The voltage is related logarithmically to the ratio of the oxygen concentrations at the reference (ambient air) side, and the sample sides of the zirconia disk. The output will be very close to zero at ambient air levels and increases by 48 mV per decade as the oxygen concentration falls.
OXYGEN SENSOR °C	This is a display of the temperature of the zirconia oxygen sensor as measured by its thermocouple. The normal operating value of the sensor is 700±10 °C. The temperature displayed is inaccurate bellow 80 °C with a minimum value that can be displayed of approximately 45 °C due to saturation of the thermocouple amplifier IC on the sensor head terminal PCB. A fault condition will be generated should the temperature be outside of the range 650 to 750 °C.
OXYGEN SENSOR HIGH mV	This is the measurement of the output voltage, in mV, across the zirconia disk in the oxygen sensor at the time of the last successful high point (Span) calibration.
OXYGEN SENSOR LOW mV	This is the measurement of the output voltage, in mV, across the zirconia disk in the oxygen sensor at the time of the last successful low point (Zero) calibration.

COe mV	This is an amplified measurement of the output voltage (AC) across the combustibles sensor bridge circuit. The principles of operation of the combustibles sensor are given in section 2.3.2. The circuit gain is approximately 600. The displayed value is in the range -125 to + 1125 mV. The displayed voltage for a sample with no carbon monoxide should be in the range -60 to +60 mV. The sensitivity of individual combustibles sensors will vary widely depending on the sensor type, age and other factors. The change in the sensor output voltage display should be in the range 25 to 80 mV for a 1000vpm change in the carbon monoxide concentration for 01750702 type sensors, or 10 to 35 mV for a 01750703 sensor.
COe °C	This displays the temperature of the combustibles sensor as measured by its platinum resistance thermometer. The normal operating temperature is 305°C. A fault condition will be generated should the temperature be outside of the range 275 to 350 °C.
COe SENSOR HIGH mV	This is the amplified COe sensor signal level at the time of the last successful high point (Span) calibration.
COe SENSOR LOW mV	This is the amplified COe sensor signal level at the time of the last successful low point (Zero) calibration.
PROBE HEAD °C	This shows the temperature of the sensor head filter block as measured by its controlling thermistor. This is only available if the optional interconnecting wiring is fitted between the sensor head and the control unit. The normal operating temperature is 245±10 °C. A fault will be generated if the filter block temperature exceeds 265 °C. Due to the logarithmic temperature response of the thermistor device (see figure 4.1) the displayed temperature value is unreliable bellow 150 °C and has a minimum display limit of approximately 100 °C.
SOFTWARE VERSION	This shows the software part number and revision level fitted in the Control Unit. Refer to Section 1.8 for software revision history.

4.4 Fault Symptoms Shortcut Guide

This section categorises the fault symptoms observed, however, it should be noted that certain faults listed under one sub-section may also occur at another phase of testing.

Category/Symptom	Reference
Initial Inspection/Start Up	See Section 4.5
Instrument does not power up	See Section 4.5.1
Instrument blows fuses	
Display not illuminated and no text displayed	See Section 4.5.2 & 4.5.3
Text displayed but backlight not illuminated	See Section 4.5.3
Display illuminated but no text	
Incorrect or no response to key presses	See Section 4.5.4
Sensor Head temperature incorrect or will not warm up.	See Section 4.5.5
Zirconia Sensor temperature incorrect or will not warm up.	
Combustibles Sensor temperature incorrect or will not warm up.	
Measurement Faults	See Section 4.6
Oxygen reading incorrect or outside specification	See Sections 4.6.2 and 4.6.3
Combustibles reading incorrect or outside specification	See Sections 4.6.2 and 4.6.4
Analyser Faults	See Section 4.7
Analogue output readings not working or inaccurate	See Section 4.7.1
Relay outputs not operating	See Section 4.7.2
Analyser does not start an Auto calibration	See Section 4.7.3
Auto calibration fault indicated	
Analyser does not start Blowback	
Analyser does not keep correct time and date	See Section 4.7.4
Auto calibration or Blowback timings slip	

4.5 Initial Inspection/Start Up Problems

4.5.1 Initial Checks

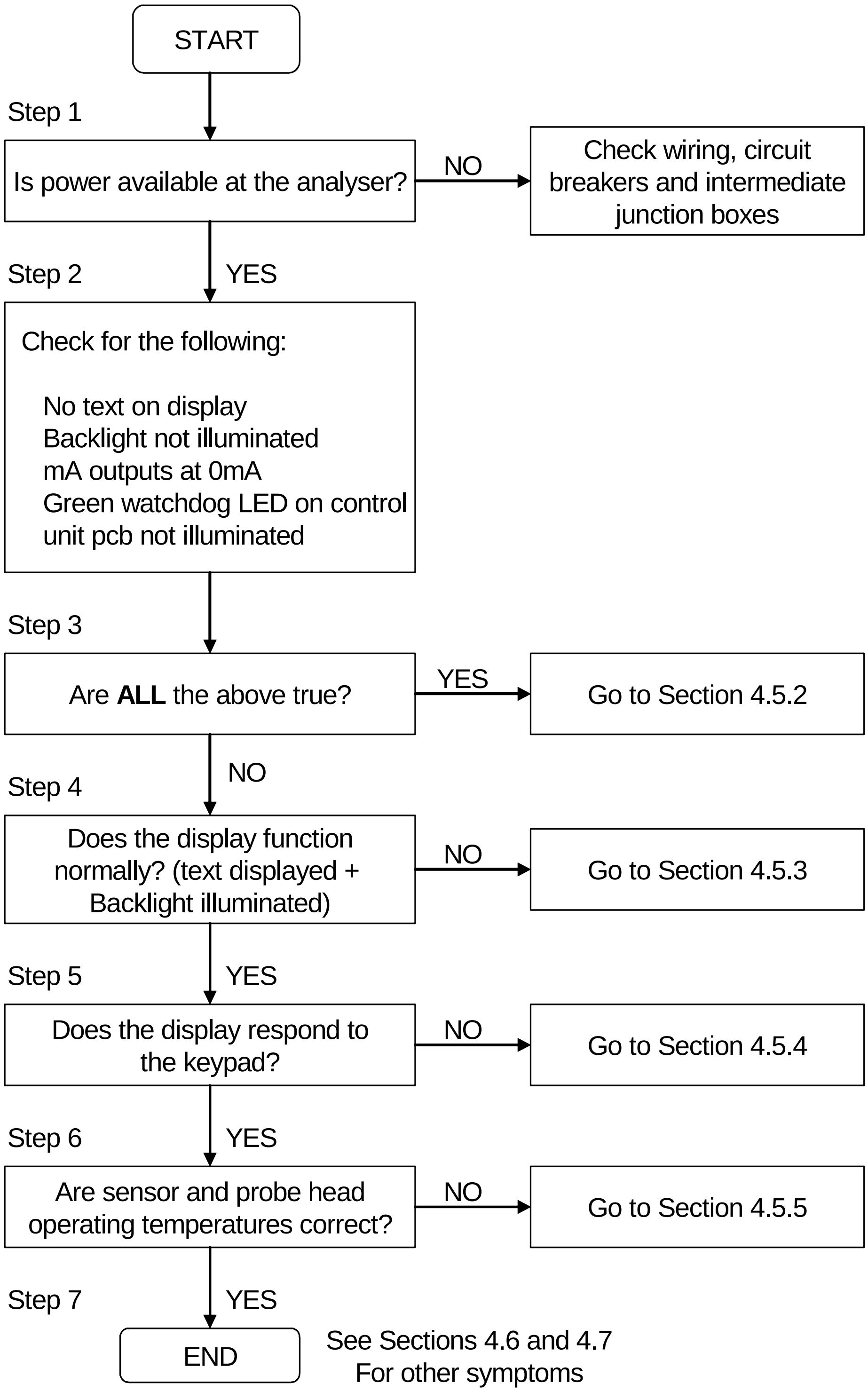


Figure 4.1 Initial Checks

4.5.2 Control Unit AC Power Supply Checks

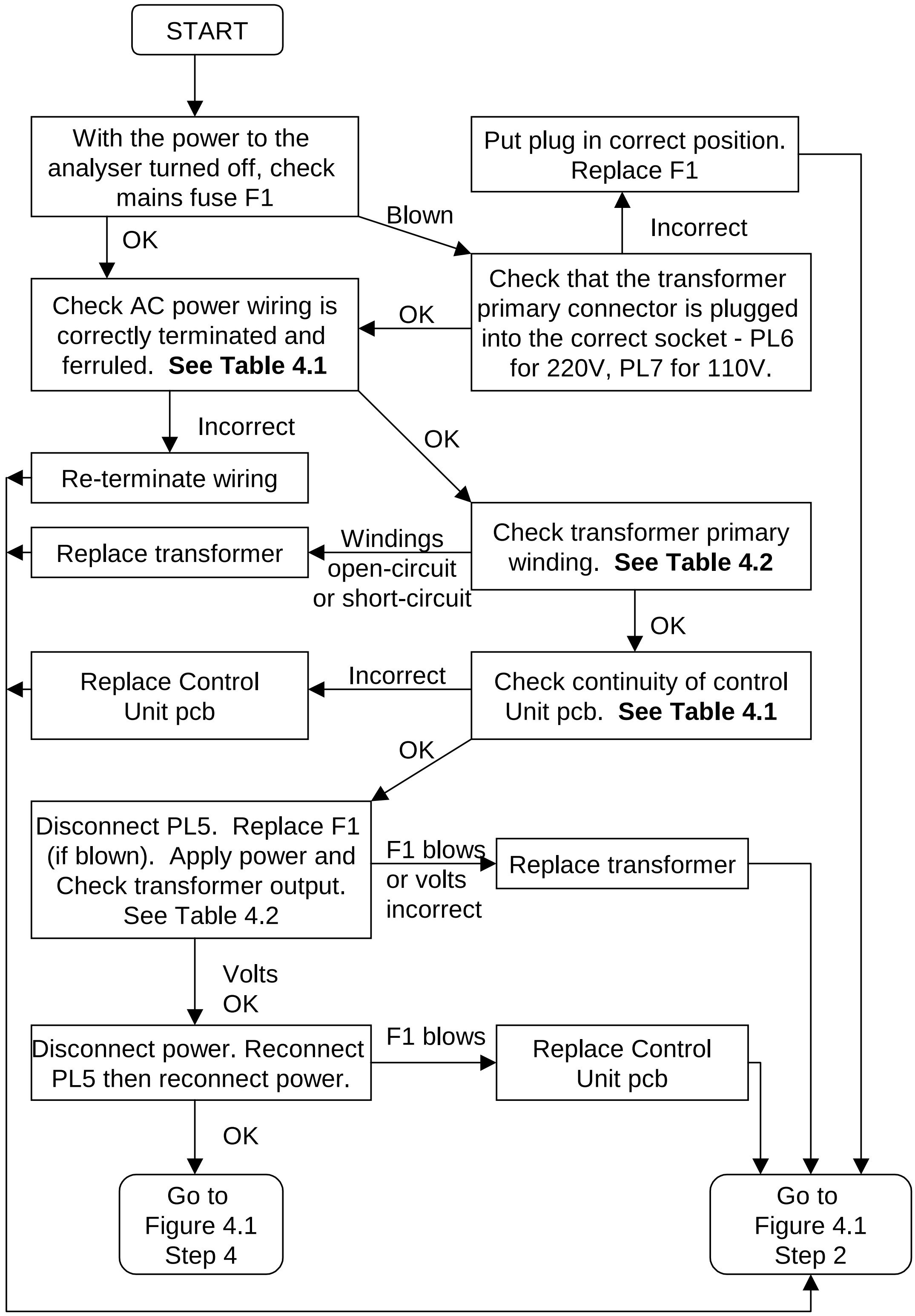


Figure 4.2 Control Unit AC Power Supply Checks

AC Power Terminals	Function	110V Operation	220V Operation
TB3 Pin 1	Live	PL7 Pins 2 & 4	PL6 Pin 4
TB3 Pin 2	Neutral	PL7 Pins 1 & 3	PL6 Pin 1
TB3 Pin 3	Earth	Chassis/Case	Chassis/Case
			PL6 Pins 2 & 3 are linked

Table 4.1 Analyser AC Power Connections

Winding	Pin No	Wire Colour	Resistance	Open-circuit Voltage @115 or 230V
Connector 1				
Secondary 1	7	Orange + Sleeve		Centre-tap
	6	Orange	0.5Ω ±10%	21V
	5	Orange		
	4	NO CONNECTION		
Secondary 2	3	Green + Sleeve		Centre-tap
	2	Green	0.8Ω ±10%	36V
	1	Green		
Connector 2				
Primary 1	4	Blue	9.3Ω ±10%	N/A
	3	Red		
Primary 2	2	Purple	9.3Ω ±10%	
	1	Brown		

Table 4.2 Transformer connection and winding details

4.5.3 Control Unit Display and DC Power Supply Checks

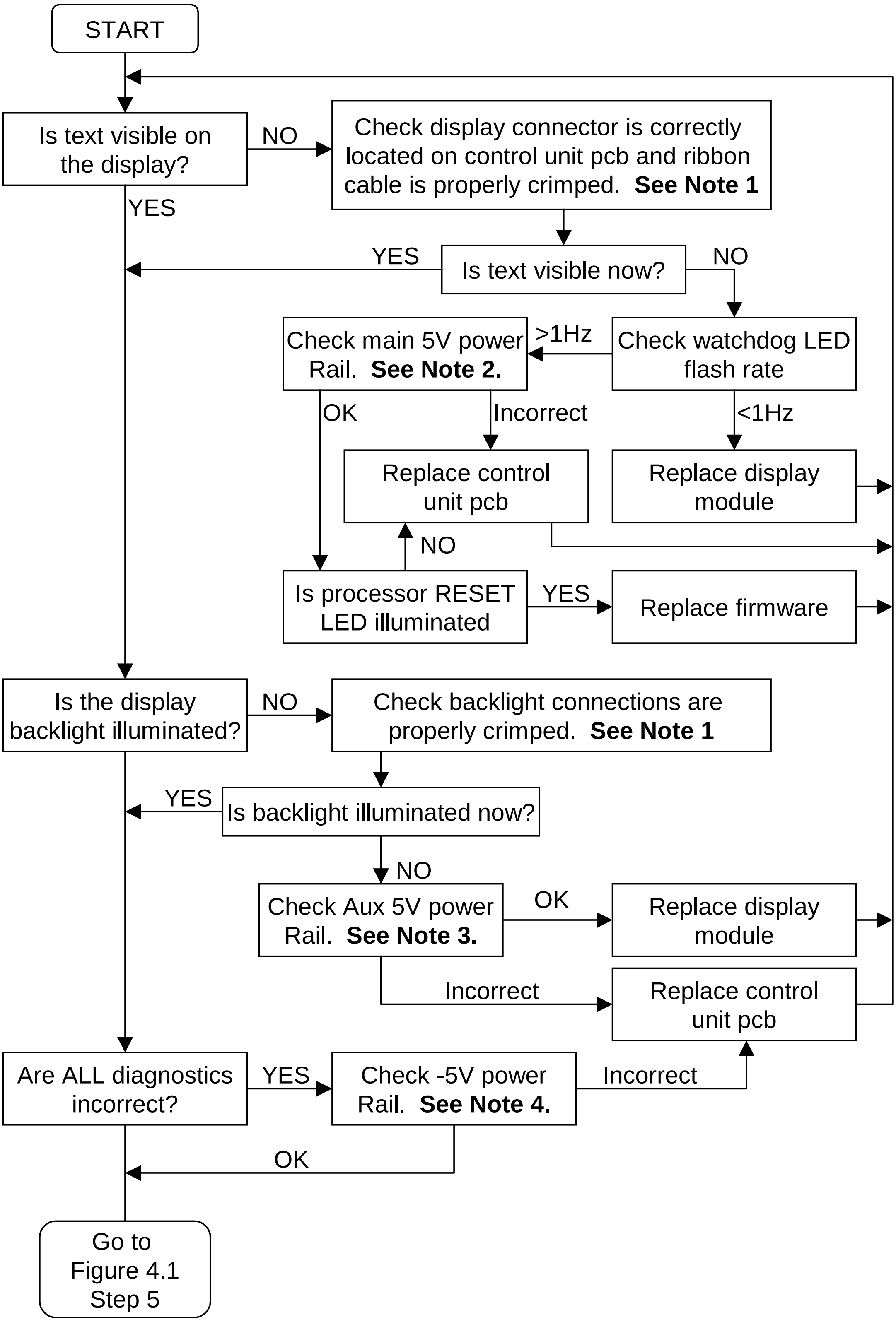


Figure 4.3 Display and DC power supply checks

DC power is distributed through the control unit by 3 major supply rails. Their function is a follows:

Main +5V — Provides power to the microcontroller, LCD and signal processing circuitry. If this rail fails, no text will be displayed on the LCD, the microcontroller watchdog LED will not flash and mA outputs will read 0mA.

Auxiliary +5V — Provides power to the LCD backlight, relay coils and mA output circuits. If this rail fails, display text will not be backlit, no relays will energise and mA outputs will read 0mA.

-5V — Provides power to the signal processing circuitry. If this rail fails the LCD and watchdog LED can work normally, but all measurements and diagnostic values will be incorrect.

Unless the display module is working correctly, the remainder of the analyser will not function properly. This is because of the way in which display functions are handled in the microcontroller operating system. If the display module is disconnected or unable to respond to display write commands, the microcontroller cannot function normally. In this event, the mA outputs will fall to 0mA and the flash rate of the Watchdog LED decreases from 5 times per second to approximately once every 2 to 3 seconds.

Note 1: A batch of display modules with poorly terminated ribbon cable connectors affected early 2700B1 analysers. Also check the setting of contrast control RV2 (adjacent to the LCD connector). If this is adjusted incorrectly, the display can appear to be blank.

Note 2: With the power to the analyser turned on, measure the voltage between pin 3 of the LCD connector (positive) and TB2 terminal 5 (0V). Pin 1 of the LCD connector is identified by the red stripe on the cable. The voltage should be 5V ±5%.

Note 3: With the power to the analyser turned on, measure the voltage between pin 1 of the LCD connector (positive) and TB2 terminal 5 (0V). Pin 1 of the LCD connector is identified by the red stripe on the cable. The voltage should be 4.2V ±10%.

Note 4: With the power to the analyser turned off, disconnect all field wiring and remove the metal cover over the Control Unit PCB. Reconnect the mains supply, keypad and LCD, then measure the voltage between pin 3 of U2 (negative) and test point TP3 (0V). U2 is mounted on the heat sink in the top-left corner of the PCB. Pin 3 is the rightmost pin of U2. The voltage should be -5V ±5%.

4.5.4 Keypad Checks

1. Check that the keypad connector is correctly plugged into PL2 on the Control Unit PCB. The flexible tail of the keypad should not be twisted. Ensure that the connector is correctly aligned with PL2. It is possible to misalign the connector if care is not taken.

2. Check that the analyser software is operating. A green LED should be visible through one of the small holes in the bottom-left corner of the Control Unit PCB cover. This LED flashes about 5Hz when the software is operating correctly. A red LED is visible through another small hole in the bottom-left corner. This LED should not be illuminated if the software is operating correctly. If the red LED is flashing or on all the time then there is a fault on the PCB or in the software and the PCB should be replaced.

3. Check the operation of the keypad. Disconnect the keypad connector from the Control Unit PCB. Connect one lead of a continuity tester to pin 3 of the keypad connector. (Pin 1 is identified by a small triangle moulded into the connector body.)

   - Check that each key operates correctly. Each key should connect one pin to the common pin 3 according to the following table:

Table 4.3 - Keypad connections

Quit	1	Right	6
Down	2	Up	7
Left	4	Menu	8
Enter	5	Measure	9

   - If the keypad is faulty it must be replaced. Otherwise replace the Control Unit PCB.

4.5.5 Heater Checks

Having ensured that basic control unit functions are working, the next priority is to ensure that the sensor head and sensor(s) are at satisfactory and stable operating temperatures. **This is an essential pre-condition for satisfactory measurement performance.**

Heater Control Algorithms and Interlocks

1. From a **cold** start, heater power is applied immediately to the sensor head band heater. The control unit does not apply power to the zirconia or combustibles sensors until the sensor head temperature reaches 50°C.
2. The aspirator air solenoid valve is interlocked with the sensor head and zirconia sensor temperatures. The solenoid is not energised until the sensor head temperature reaches 235°C and the zirconia sensor (if fitted) reaches 650°C.

The same rules also apply for a **warm** start, but the following should be noted to prevent false diagnosis. When the control first applies power to a sensor, it monitors the rate at which it heats. If the rate is too slow, the processor inhibits heating, waits for a period and then tries again. This means that during a warm start, the sensor temperatures can fall for a few minutes before warming normally. This period is usually less than 15 minutes, but depends upon ambient conditions and starting temperatures.

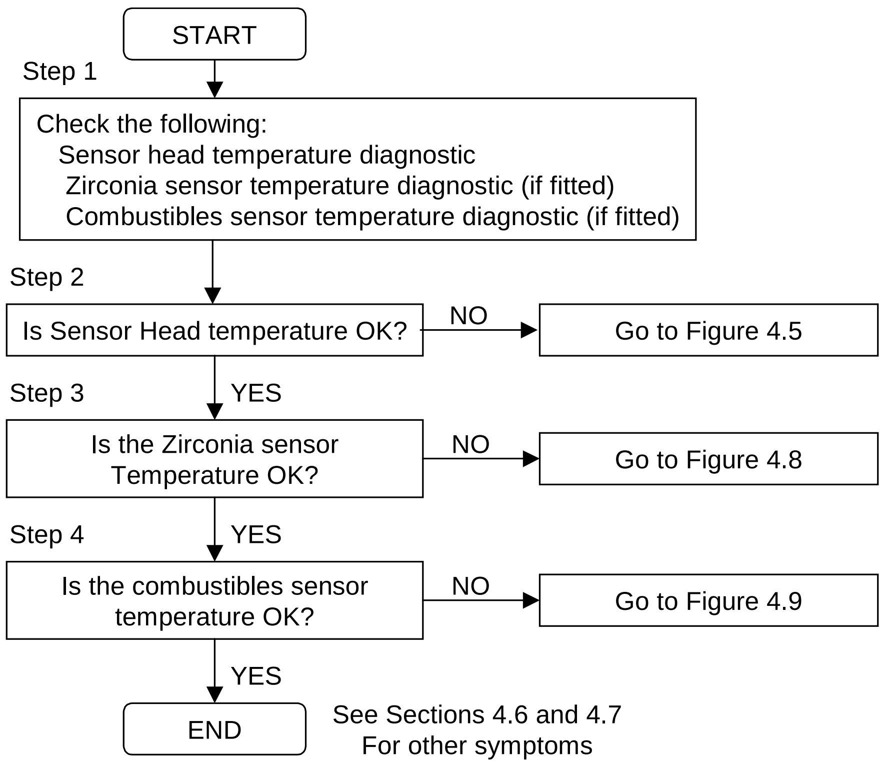


Figure 4.4 Initial Heater Checks

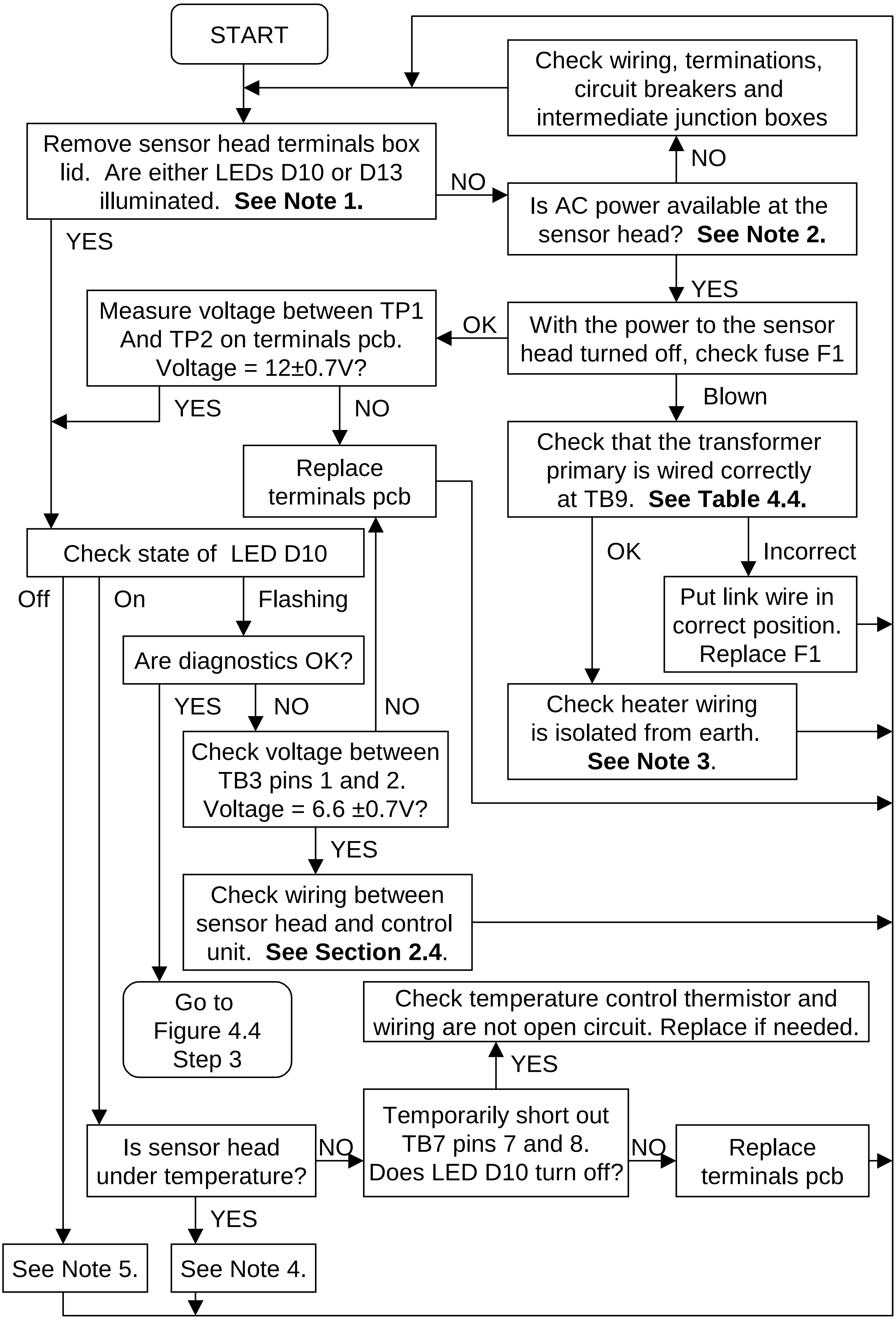


Figure 4.5 Sensor Head Heater Checks

Note 1: - The heater status indicator LED on the terminal PCB should be flashing if the heater is controlling the temperature correctly.

- The LED will be ON if the sensor head is under temperature and OFF if the sensor head is above the control temperature.

Note 2: The power wiring of the 2700 differs from the 700B and 700EX. Power for the 2700 control unit and sensor head should generally be wired from a common isolating switch.

WARNING

Powering down the control unit does not automatically remove power from the sensor head (unless both have been wired from a common isolating switch).

If the sensor head is powered down separately from the control unit, then the control unit will continue to supply heater power to the zirconia and combustibles sensors.

<table>
<tr><th colspan="3">Table 4.4 Sensor Head Voltage Selection at TB9</th></tr>
<tr><td>Pin Number</td><td>Function</td><td rowspan="5">A link wire is fitted to TB9 to select the operating voltage.

For 110/120V operation link Pins 2 and 3.

For 220/240V operation link Pins 1 and 2.</td></tr>
<tr><td>1</td><td>220/240V Tap</td></tr>
<tr><td>2</td><td>AC Supply Input</td></tr>
<tr><td>3</td><td>110/120V Tap</td></tr>
<tr><td>4</td><td>100V Tap</td></tr>
</table>

Note 3: Disconnect AC power wiring from TB1. Check insulation resistance between both Live and Earth, and Neutral and Earth via TB1. If earth is not fully isolated, check the isolation of the band heater, thermostat and SSR. The wiring to each may be isolated via TB8 (for details see drawing number 02720/121 or 02720/122 in the rear of this manual). Replace damaged components and/or wiring as needed. If these 3 components are fully isolated but the fault persists at TB1, replace the terminals pcb. Reconnect AC power wiring to TB1 only when all faults are cleared.

Note 4 If the heater status LED is ON but the sensor head fails to heat correctly, verify the following:-

- The voltage at TB-7 terminal 4 with respect to terminal 3 is in the range +5 V dc to +9 V dc. If necessary change the SSR.

- The over temperature thermostat connected at TB-8 terminals 5 and 6 is closed. If necessary replace the thermostat.

- The heater connected at TB-8 terminals 1 and 2 is not open circuit or intermittent. The ‘240Vac’ heater has a resistance of approximately 110 ohms at room temperature and the ‘120Vac’ heater has a resistance of approximately 28 ohms at room temperature. If necessary replace the heater.

- If the heater status LED is ON, the SSR should also be ON. Check the voltage drop across the SSR, connected at TB-8 terminals 3 and 4, is not greater than 2 Vac. If necessary replace the SSR.

Note 5 If the heater status LED is OFF and the sensor head fails to get hot, verify the following:-

- Check the resistance of the temperature control thermistor (TB-7 terminals 7 and 8) against the curve shown in Figure 4.2. (At least one lead of the thermistor will need to be disconnected for this check.). A low impedance or short-circuit thermistor will cause the control circuit to switch off and the sensor head will fail to heat. Replace the thermistor if necessary.

- Check the control circuit operation. A short circuit between TB-7 terminals 7 and 8 will cause the control LED to switch off, and an open circuit (or high impedance) will cause the control LED to switch ON. Replace the PCB as necessary.

If the heater status LED is OFF but the sensor head is over temperature, proceed as follows. Fit a ***temporary*** short circuit connection between TB-7 terminals 7 and 8, verify the following:-

- If the voltage at TB-7 terminal 4 with respect to terminal 3 exceeds 3.0 V dc replace the terminal PCB.

- If the voltage at TB-7 terminal 4 with respect to terminal 3 is less than 3.0 V dc replace the SSR.

- Remove the temporary short circuit link and ensure correct operation.

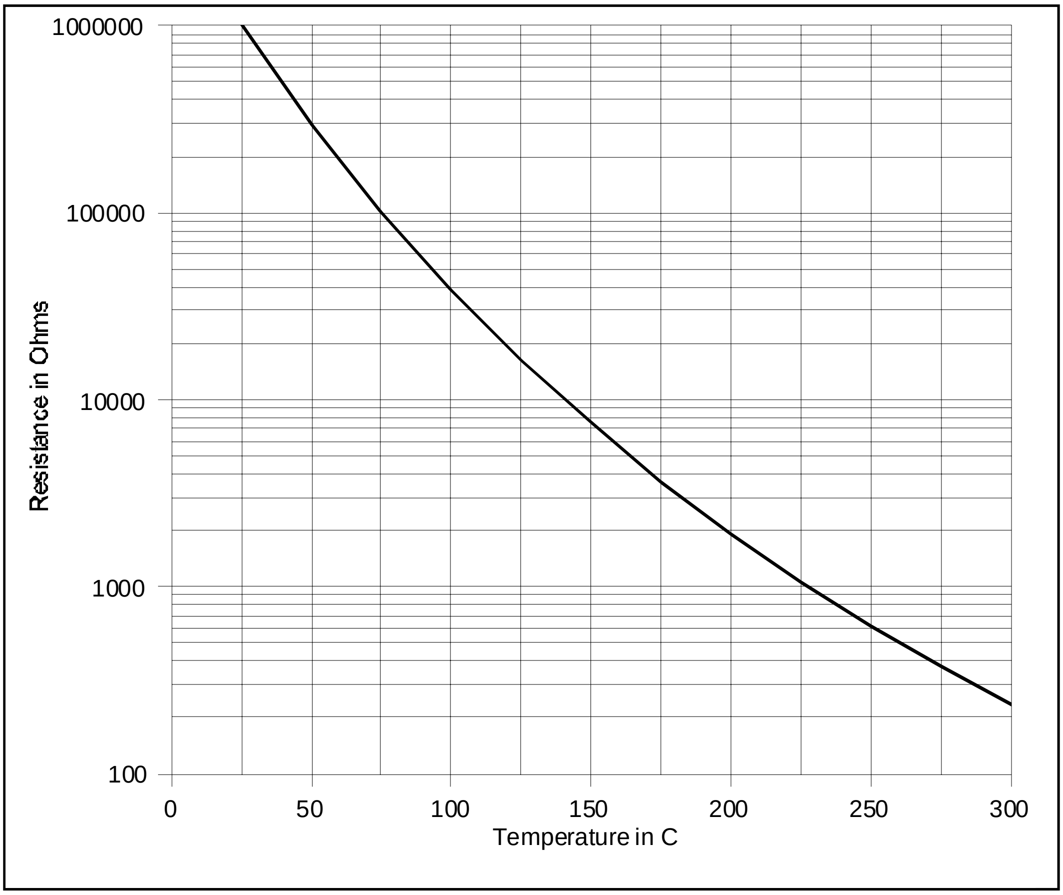


Fig 4.6 Thermistor temperature curve

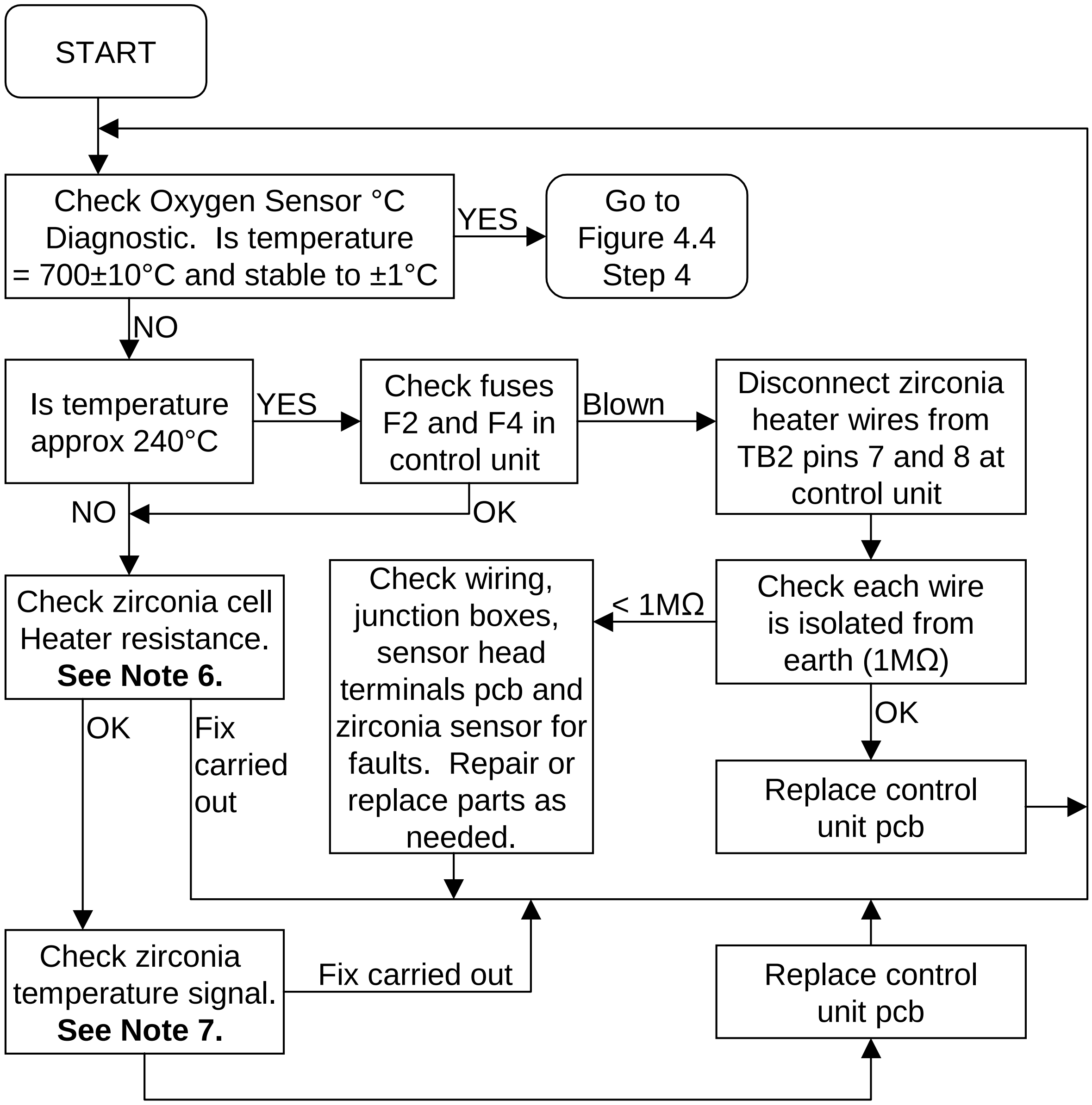


Figure 4.8 Zirconia Sensor Heater Checks

Note 6: With the power to the analyser turned off, measure the resistance between terminals 7 and 8 of terminal block TB2 on the Control Unit. The heater resistance should be 8Ω ±10%. Note that the measured resistance will include the heater cable which could be up to 4Ω. If the heater cable is long and the resistance reading is low, check the heater resistance at the sensor head, terminals 3 & 4 of terminal block TB4, to ensure that the heater is not short-circuit. If the heater is faulty, replace the Zirconia cell.

If the temperature diagnostic is unstable, check that the zirconia heater and temperature signal wiring (as described in Note 7) are isolated from earth.

CAUTION

If a zirconia cell is found to have an open circuit heater coil, ensure correct operation of the zirconia heater control circuit in the control unit and thermocouple amplifier in the sensor head.

This may be checked as follows:

With the zirconia cell disconnected, fit a temporary short circuit between pins 1 and 2 of TB2 in the sensor head, then power up the analyser. The output voltage of the thermocouple amplifier between sensor head TB3 pins 7 and 8 should be 0.4 to 0.7V DC and the heater voltage at TB3 pins 5 and 6 should be approx 36V AC.

Now remove the temporary short circuit. The output of the thermocouple amplifier should rise to between 8 and 12V DC and the heater voltage should fall to zero.

If the thermocouple amplifier does not switch as described, replace the sensor head terminals pcb.

If the heater drive does not react as described, replace the control unit pcb

Note 7: Check the zirconia temperature measurement at the sensor head.

- Ensure the thermocouple connected at TB-2 terminals 1 and 2 is securely connected with the correct polarity. Ensure the thermocouple is not damaged or open circuit. Correct as necessary and verify performance.

- Temporarily disconnect the thermocouple wires from TB2 terminals 1 and 2 and temporarily fit a short circuit link. The correct voltage at TB3 terminal 7 with respect to 8 is +0.4 V to +0.7 V dc. If necessary replace the Terminal PCB.

- Temporarily open-circuit TB2 terminals 1 and 2. The correct voltage at TB3 terminal 7 with respect to 8 is between 8.0 V dc and 12.0 V dc. If necessary replace the Terminal PCB.

Check the zirconia cell temperature measurement at the control unit TB2 terminals 9 and 10. This voltage must be the same as measured at the sensor head.

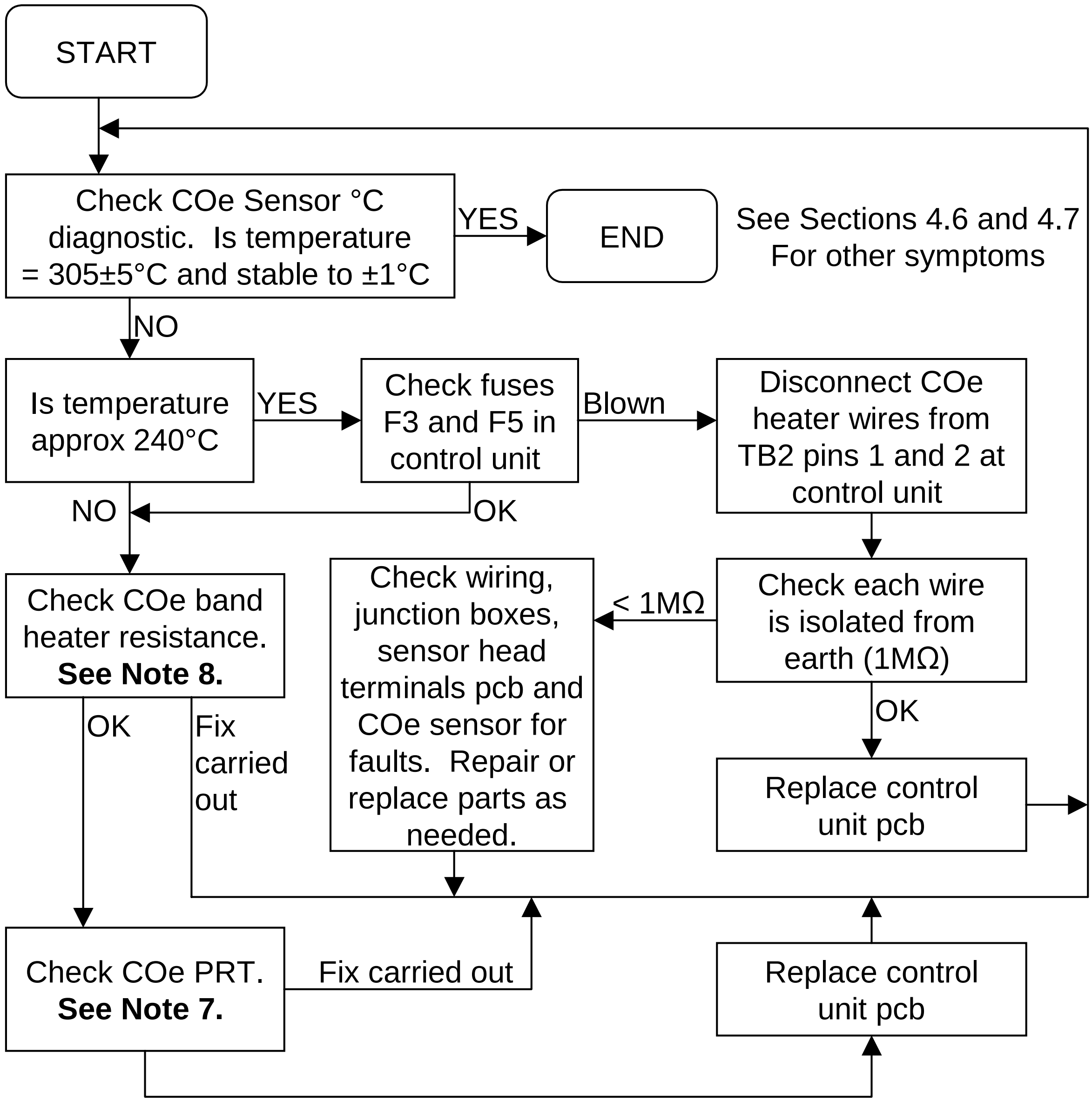


Figure 4.9 COe Sensor Heater Checks

Note 8: With the power to the analyser turned off, measure the resistance between terminals 1 and 2 of terminal block TB2 on the Control Unit. The heater resistance should be 11.4Ω ±10%. Note that the measured resistance will include the heater cable which could be up to 4Ω. If the heater cable is long and the resistance reading is low, check the heater resistance at the sensor head, terminals 1 & 2 of terminal block TB6, to ensure that the heater is not short-circuit. If the heater is faulty, replace the TFX cell.

If the temperature diagnostic is unstable, check that the TFX heater and PRT wiring (as described in Note 9) are isolated from earth. Also visually inspect the Tfx sensor and verify that the gap in the Tfx band heater is not located over the platinum resistance thermometer. If so, rotate the Tfx band heater until the gap is approximately 90° from the PRT.

Note 9: With the power to the analyser turned off, measure the resistance between terminals 3 and 4 of terminal block TB2 on the Control Unit. The resistance should be between 100Ω and 200Ω depending on the temperature of the transducer. If the measured resistance is about 3.3kΩ then the PRT is open-circuit. Measure the resistance between TB2 terminals 4 and 5. The resistance should be less than 10Ω. More than 10Ω indicates an open circuit in the sensor head or interconnecting cable. If the PRT is faulty, replace the TFX cell.

4.6 Measurement Problems

This section assumes that:

- Both the control unit and sensor head are powered.
- The control unit display and keypad are operational.
- The sensor head and sensor(s) are stable at normal operating temperatures.

Work through Section 4.5 if any of the above assumptions are untrue.

4.6.1 Definitions

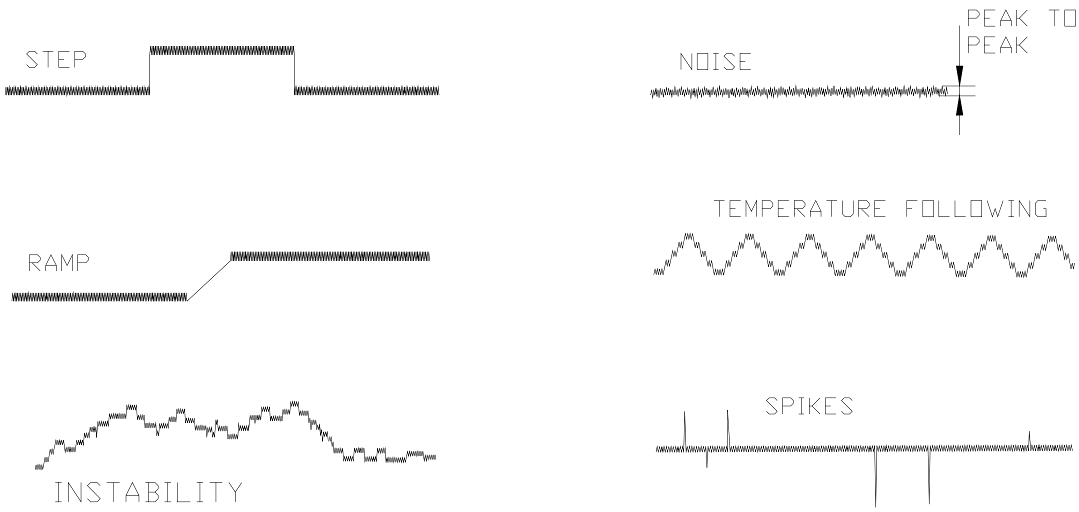
When investigating reported measurement problems it is critical that the customer's terminology matches the examples shown opposite.

Drift is a general long term movement (trend) of the output signal level at constant concentration which appears unrelated to ambient temperature but is systematic (ie: constant, in one direction).

In order to differentiate drift from other potential effects (shown below), **a minimum 36 hour period on chart is required before drift may be diagnosed.**

Other fault symptoms as indicated below should be diagnosed and eliminated before attempting to deal with drift only problems.

Other Phenomena:



4.6.2 Discussion

Since the 2700 uses faster measurement technology than in-situ zirconia, pellistor based CO or cross-stack infra-red analysers, there is considerable scope for confusion because the 2700 will reveal trends in the combustion process which were previously invisible. In some instances the performance of the 2700 is so much at variance to customer expectations that it can be perceived as operating incorrectly.

Drift - The most problematic definition is drift - customers often describe any deviation from expected behaviour as ‘drift’. Language also causes problems - for example the literal translation of the German term used to describe the effect of temperature on the reading is ‘temperature drift’.

If continuous negative drift is reported, change the control unit pcb. Do NOT change the Tfx sensor; there is no known mechanism in the sensor which can produce drift.

Variable Span Sensitivity - To date this phenomena has only been reported on the Combustibles measurement. Some reports have been erroneous because customers have not understood that the Tfx sensor is a partial pressure measurement device and that therefore the span sensitivity is directly proportional to variations in flue and ambient pressure. The majority of remaining instances have been due to poor installation of the utilities panel (check for leaks and pressure drop; particularly if the utilities panel is not co-located with the sensor head) and/or inconsistencies in the calibration method.

If this problem is reported, ensure that the aspirator pressure at the sensor head is correct. If the utilities panel is not co-located with the sensor head, you must take account of the pressure drop in the aspirator air supply line.

Check that the calibration gas flow rate and settling time are consistent each time the analyser is calibrated. Failure to observe these precautions can lead to inconsistent calibration results.

Decreasing Span Sensitivity - Again, this complaint is predominantly made about the combustibles measurement. The Tfx catalyst now has improved stability and resistance to poisoning and carbonisation.

Tfx sensors may lose 10% of span sensitivity is the first few days on process as the catalyst conditions itself. This is entirely normal and is not grounds for replacing the sensor.

Although catalyst sensitivity can be adversely affected by poisons such as SO2, the simplest way to kill a Tfx sensor is to leave it on a process with consistently high levels of CO AND too little auxiliary air. This combination of factors is guaranteed to reduce Tfx sensitivity to zero in a short period of time.

2 versions of the Tfx sensor are available to suit differing process conditions. For well controlled processes where the COe concentration does not routinely exceed 1500vpm for long periods, the 01750702 sensor should be used. For less well controlled applications (typically coal or heavy oil burning plant) the 01750703 sensor should be used.

Temperature Following - In the majority of cases, this will not be visible while the analyser is on process except if the analyser is subject to large daily temperature swings (30 degrees C or more) and the process is known to be well controlled. The temperature co-efficient of the analyser has been improved from earlier models.

If the sensor head build is correct and the problem persists, check that the COe coarse zero is set correctly (ie. 0V ± 60mV). If the coarse zero is outside these limits, the temperature co-efficient of the analyser will be degraded.

Noise - Complaints regarding noise generally have 2 causes:
1. The fast analyser response exceeds customer expectations or the ability of the combustion control system to respond. If the control system is not fast enough, the analyser response time can be slowed by the use of the software filter. If this is necessary, ensure that software revision 4 or later is fitted (see Drift above).
2. Poor electrical installation, particularly between the control unit and sensor head. If non-recommended cables are used or the screens are incorrectly terminated then the combustibles measurement can be extremely susceptible to EMI.

Spiking - The issues discussed in Noise also apply to reports of spiking. Spiking on the combustibles measurement can only be detected when the unit is running on calibration gas or when the combustion process is off. If spiking is only said to occur when the combustibles measurement is on process, then it is most likely that the analyser is working correctly and revealing variations in the process which have not been visible to the customer before.

Instability, Steps and Ramps - There have been relatively few reports of these phenomena. Like drift, the term instability can be used imprecisely. Likely causes of instability in the Oxygen measurement have already been covered under the headings of Temperature Following, Noise and Spiking. However there is one additional issue which affects only the combustibles measurement.

Slow Speed of Response/No Response to Process Changes - If either of these are reported, the pneumatics system must be checked before presuming that either or both sensors need to be replaced (see Section 4.6.5 for details). The 2700 sensor head design has significantly reduced instances of blocked internal pipework compared to the 700B. The only known instances have occurred when the sensor head has been left unheated on the process for a long period. Blockages will affect the Tfx sensor most since its output is more flow dependent than the zirconia sensor. By contrast, because changes in the oxygen level on most processes is relatively slow, sample diffusion within the sensor head will allow the zirconia sensor to track process trends quite closely.

4.6.3 Oxygen Measurement Checks

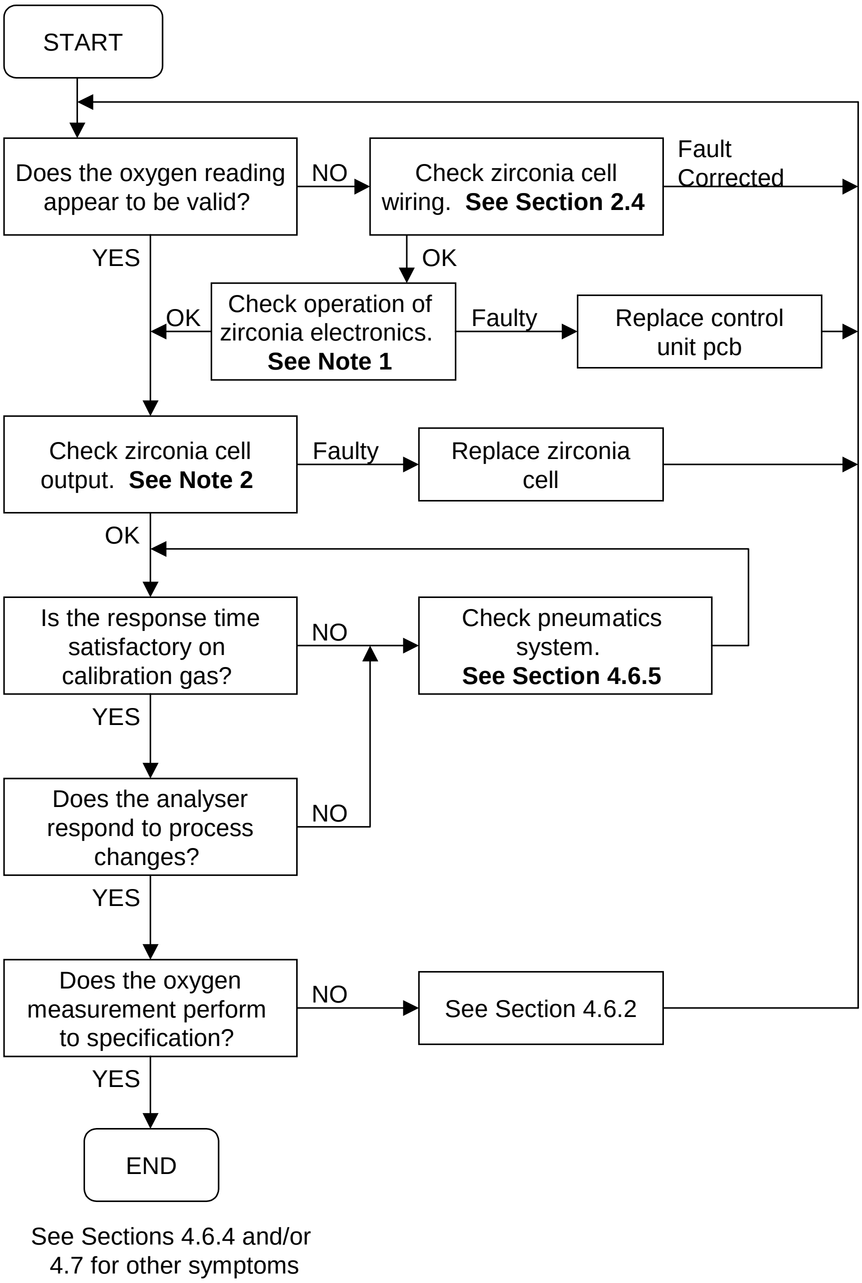


Figure 4.10 Oxygen Measurement Checks

NOTE

The instructions opposite assume that manual calibration gas valves are fitted. If the system uses solenoid valves, use the analyser to drive the valves and monitor the oxygen millivolt readings via TB1 terminals 7 and 8 in the control unit.

Note 1: With the analyser operating and the Zirconia cell at operating temperature, monitor the oxygen sensor output voltage diagnostic. Apply the high calibration gas (air), wait 5 minutes, then check that the diagnostic reading is zero ± 5 mV. Next apply the O_2 low calibration gas (0.3% O_2), wait 5 minutes, then check the diagnostic reading. The reading should be as predicted by the Nernst equation (see section 2.3.1) ± 5 mV. If all is in order, perform a manual high and low calibration of the oxygen sensor, overriding any "out of tolerance" warnings.

If the diagnostic readings are not correct, turn off the power to the Control Unit and disconnect the wiring from terminal block TB1 terminals 7 and 8. Fit a wire link between terminals 7 and 8. Turn on the power to the Control Unit and monitor the oxygen sensor output voltage diagnostic. The reading should be close to 0V and stable to ±0.1mV (drift less than 0.1mV per minute). Remove the wire link and reconnect the field wiring to TB1. If the control unit electronics is faulty, replace the control unit PCB.

Note 2: With the analyser operating and the Zirconia cell at operating temperature, measure the zirconia cell output voltage at the Control Unit TB2 terminals 8 (positive) and 7 (negative). Apply the high calibration gas (air), wait 5 minutes, then check that the cell output is zero ± 5 mV. Next apply the oxygen low calibration gas (0.3% O_2 typical), wait 5 minutes, then check that the change in the cell output is as predicted by the Nernst equation (see section 2.2.1) ± 5 mV. If the cell output is outside specification it must be replaced.

NOTES

A low oxygen reading is a normal instrument response to the presence of combustibles components in the sample gas stream and may not be an instrument fault. The reduction in the oxygen reading reported is dependant on the combustibles level present and cell type. If there is sufficient combustibles in the sample gas to consume all of the oxygen present, resulting in reducing conditions at the cell electrode, then a zero oxygen reading may occur.

The 2700 analyser is designed to withstand conducted and radiated RF interference in accordance with the European EMC directive. However, higher field strengths *may* affect the oxygen reading, usually offsetting the reading from its true value. Good EMC wiring practice and separation / screening of 2700 cables from RF sources should prevent EMC problems from arising.

4.6.4 Combustibles Measurement Checks

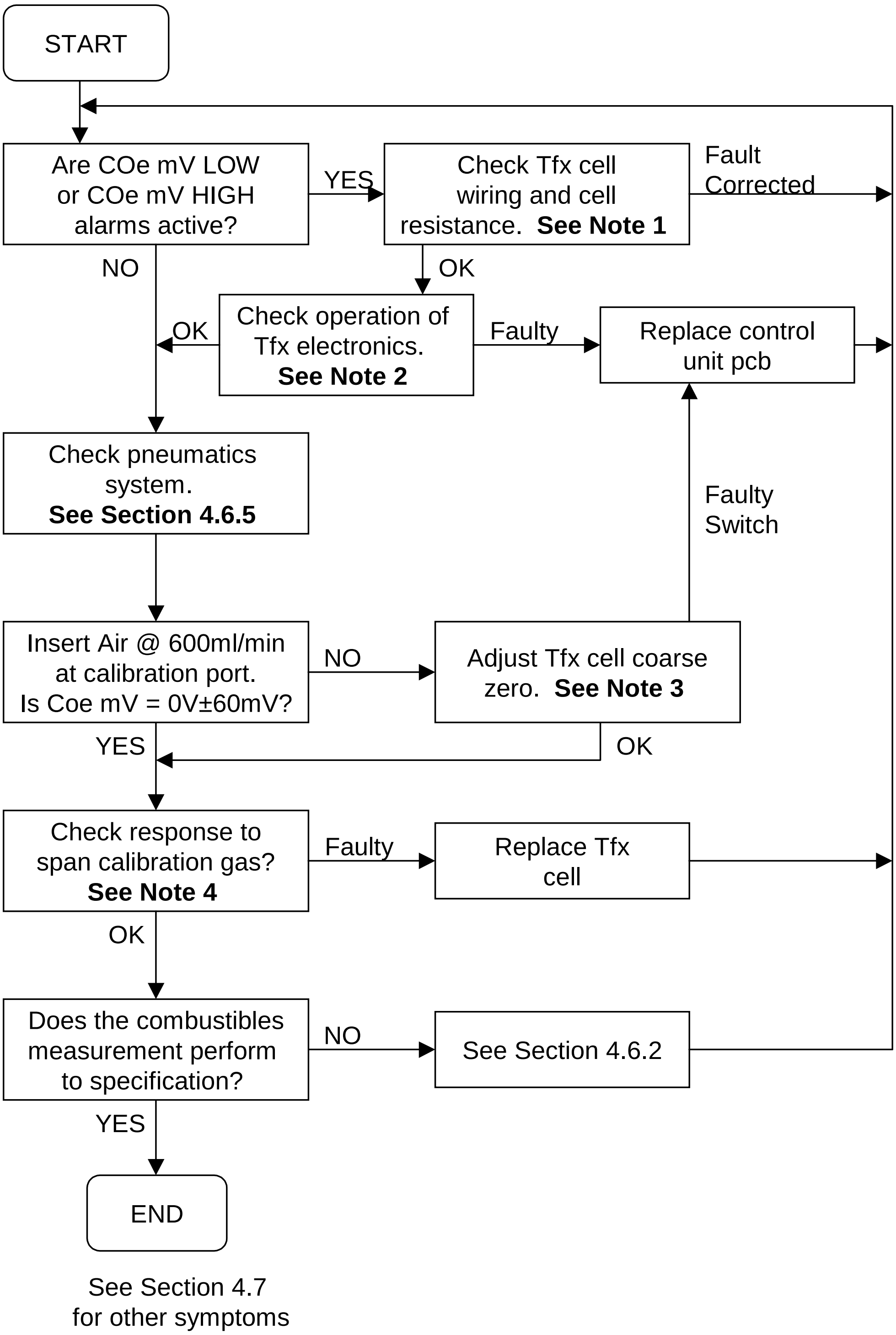


Figure 4.11 Combustibles Measurement Checks

NOTE

The point at which the pneumatics are checked is different from the Oxygen measurement because the response of the Tfx cell is highly dependent on sample flow rate. Whereas diffusion from the calibration port will allow the zirconia sensor to be checked (albeit slowly), the pneumatics system must be fully functional to obtain representative results from the Tfx cell.

Note 1: With the power to the analyser turned off, check the wiring between the sensor head and control unit conforms to Section 2.4. If no faults are found, check the Tfx cell resistance to verify that it is not faulty. Measure the resistance between Sensor Head terminal TB6 terminals 5 and 6, and 7 and 8. Each pair of terminals should measure the same resistance within a few Ohms, from 35Ω at 25°C to 70Ω at 300°C (all ±20%). Measure the resistance between TB6 terminals 6 and 8, and 6 and 9. Each pair of terminals should measure the same resistance within a few Ohms, from 26Ω at 25°C to 52Ω at 300°C (all ±20%). Measure the resistance between Control Unit TB1 terminals 2 and 5, 3 and 4. Each pair of terminals should measure less than 10Ω. Any incorrect measurement indicates a wiring problem in the sensor head or faulty cell.

Note 2: With the power to the analyser turned on, check the drive to the Tfx cell to verify that it is not faulty. Measure the voltage across TB1 terminals 1 and 6. Use a voltmeter on its DC mV range. The voltmeter will measure the average voltage across the Tfx cell, which should be between 170mV and 560mV depending on the resistance of the cell as measured in 4.4.1.2.2 above. Higher resistance gives a higher voltage. If the cell resistances are OK but there is no voltage, replace the Control Unit PCB.

If the cell drive voltage is OK, then with the analyser operating and the TFX cell at operating temperature, monitor the combustibles sensor output voltage diagnostic. Turn the Tfx zero adjust switch SW2 and check that the voltage display changes. The minimum displayed voltage is -125mV and the maximum displayed voltage is +1125mV. Between these two points the voltage should change by approximately 60mV per switch step. Return SW2 to its original setting. If the diagnostic voltage does not change, replace the Control Unit PCB.

Note 3: Refer also to section A11 in appendix A.

With the analyser operating and the TFX cell at operating temperature, monitor the combustibles sensor output voltage diagnostic. Apply the zero calibration gas (air), wait 5 minutes, then check that the diagnostic reading is zero ±60mV. Adjust SW2 and SW3 to improve the zero reading if necessary.

There may be a delay of up to 30 seconds between a switch change and an update to the displayed diagnostic value. If the displayed voltage is below -125mV or greater than +1125mV the analogue to digital convertor input is saturated, so the switch settings may need to be moved several positions before a valid reading can be displayed. If the coarse zero cannot be set within the required limits, change the control unit pcb.

Note 4: Refer also to section A12 in appendix A.

Next apply the CO span calibration gas, wait 5 minutes, then check the diagnostic reading. The difference between the zero and span readings will depend upon the type of sensor fitted and the auxiliary air flow rate. If the difference is less than the values below, change the Tfx cell.

Sensor Type	Recommended Minimum Sensitivity
01750702	25mV
01750703	10mV

If all is in order, perform a manual high and low calibration of the combustibles sensor, overriding any “out of tolerance” warnings.

NOTES

The output signal from the combustibles sensor is proportional to the sample and ambient pressures. Should the process pressure, or ambient pressure change, then the combustibles sensor output will change in direct ratio.

The sensor head will frequently be operating at a pressure just below ambient atmospheric pressure. Any gas leakage through calibration fittings, pipe work, valves, gas regulators and flow metres may affect the measured reading.

The Tfx 1750 sensor will have a small cross sensitivity to other gas species that may be present in the sample stream. Some variation in both zero and span is to be expected if the composition of the sample stream changes.

The 2700 analyser is designed to withstand conducted and radiated RF interference in accordance with the European EMC directive. However, higher field strengths *may* affect the Combustibles reading, usually offsetting the reading from its true value. Good EMC wiring practice and separation / screening of 2700 cables from RF sources should prevent EMC problems from arising.

4.6.5 Pneumatics System Checks

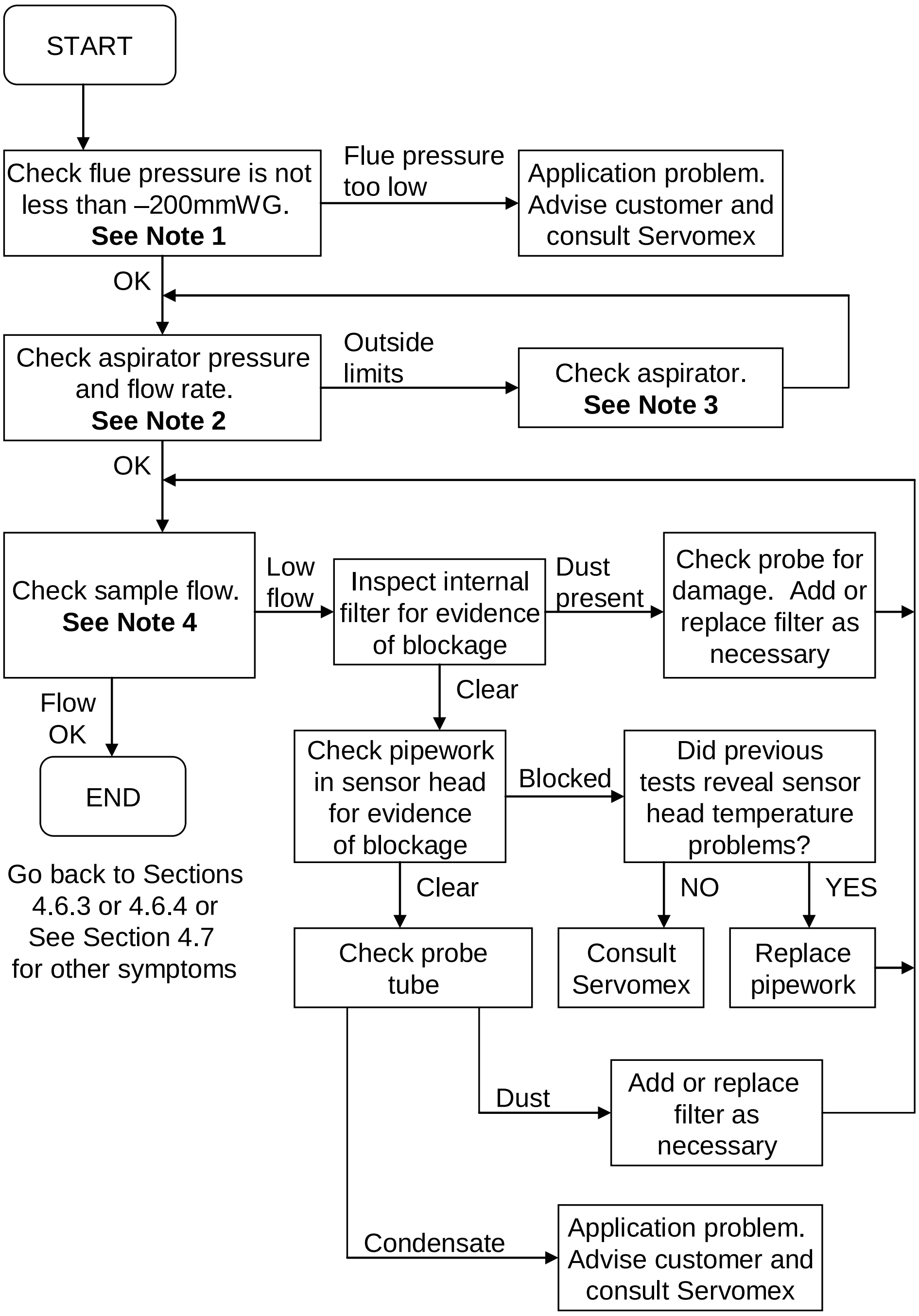


Figure 4.12 Pneumatics System Checks

Note 1: Connect a manometer to the calibration gas port on the sensor head and measure the flue pressure relative to atmosphere. For a completely accurate reading the aspirator air supply should be turned off, however in normal circumstances the influence of the aspirator is minimal.

The internal aspirator is not designed to overcome flue pressures below -200mmWG. If the flue pressure is below this limit then an alternative method of extracting a sample is required.

Note 2: Connect a flow meter in series with the aspirator air supply together with a pressure gauge. Check that the aspirator pressure at the sensor head is equal to the pressure marked in the sensor head terminals compartment; adjust the pressure regulator on the utilities panel if necessary.

Once the aspirator pressure is set correctly, check the flow rate is between 1.0 and 1.5 litres/min.

Note 3: If the aspirator flow rate is >1.5 litres/min, there is probably a leak at the seating of the aspirator assembly.

If the flow rate is <1.0 litres, the aspirator jet is blocked. Clean or replace the aspirator jet as necessary. Also check that the filters in the air line and the line itself are clear of oil before reconnecting the air supply. If contamination is found, verify that the air supply is instrument grade air. If there is no flow at all, check that the sensor head solenoid valve is open. Refer to Section 4.6.6 and clear any faults as necessary.

Note 4: This test estimates the sample flow by introducing a check gas whose composition is markedly different to the sample being drawn by the analyser. The test is best performed with the oxygen measurement (if fitted) since the response of the zirconia sensor is far less flow dependent than the Tfx cell.

With process sample flowing through the analyser, make a note of the current value of oxygen and/or combustibles on the display.

Select a calibration gas which is significantly different from the value given by the process sample (instrument air is normally suitable). Pass 600 cc/min of this calibration gas through a flowmeter and needle valve into the calibration port, the analyser display should now display the calibration gas value.

Gradually reduce the flow of the calibration gas in steps, allowing time for the change in measurement on the display. Now increase the calibration gas flow gradually until the reading approaches the original calibration gas value. At this point, the calibration gas flow is approximately equal to the normal sample gas flow.

The process sample flow through the 2700C should be approximately 300cc/minute for an oxygen only analyser. The combustibles only and dual sensor analysers should have a sample flow of approximately 240cc/minute. Flows significantly below this indicate a partially blocked sample path (sample probe, internal filter, etc.) or an incorrectly set aspirator air supply.

If the analyser reading goes directly to the check gas value then the analyser is not drawing a sample and the cause must be investigated.

4.6.6 Aspirator Interlock Failure

The solenoid valve on the terminal enclosure must be energised for the aspirator air supply to be applied to the aspirator. In order for the solenoid valve to be energised, the gas sensors(s) and the sensor head must all have reached a satisfactory temperature.

Use the **VIEW** menu to determine the temperature of the sensor head (if the optional probe head temperature connections are installed) and also the temperature of the gas sensor(s). Verify the following:-

- The oxygen sensor (if fitted) is at or above 650 °C.
- The sensor head temperature is at or above 235 °C.

If any of these conditions are unsatisfactory, refer to Section 4.5.5 and correct the fault.

If all the temperatures are satisfactory, check the operation of the solenoid valve as follows:-

- Remove the sensor head terminal enclosure cover. (Do not remove any protective covers within the terminal enclosure).
- Temporarily disconnect the solenoid valve wire at TB-7 terminal 2 and ensure the solenoid valve is closed.
- Temporarily reconnect the above solenoid valve wire to TP2 (0V) on the terminal PCB. The solenoid valve should be heard to energise and be open. The resistance of the solenoid valve coil is approximately 80 ohms at room temperatures.
- Re-connect the solenoid valve wire to TB-7 terminal 2 or replace the valve if necessary.

If the temperatures are satisfactory and the solenoid valve operates correctly, replace the terminal PCB.

4.7 Analyser Problems

Fault finding guidance within this section assumes that:

- Both the control unit and sensor head are powered.
- The control unit display and keypad are operational.
- The sensor head and sensor(s) are stable at normal operating temperatures.
- Oxygen and/or combustibles measurements are stable when viewed at the control unit display.

Work through Sections 4.5 and 4.6 if any of the above assumptions are untrue.

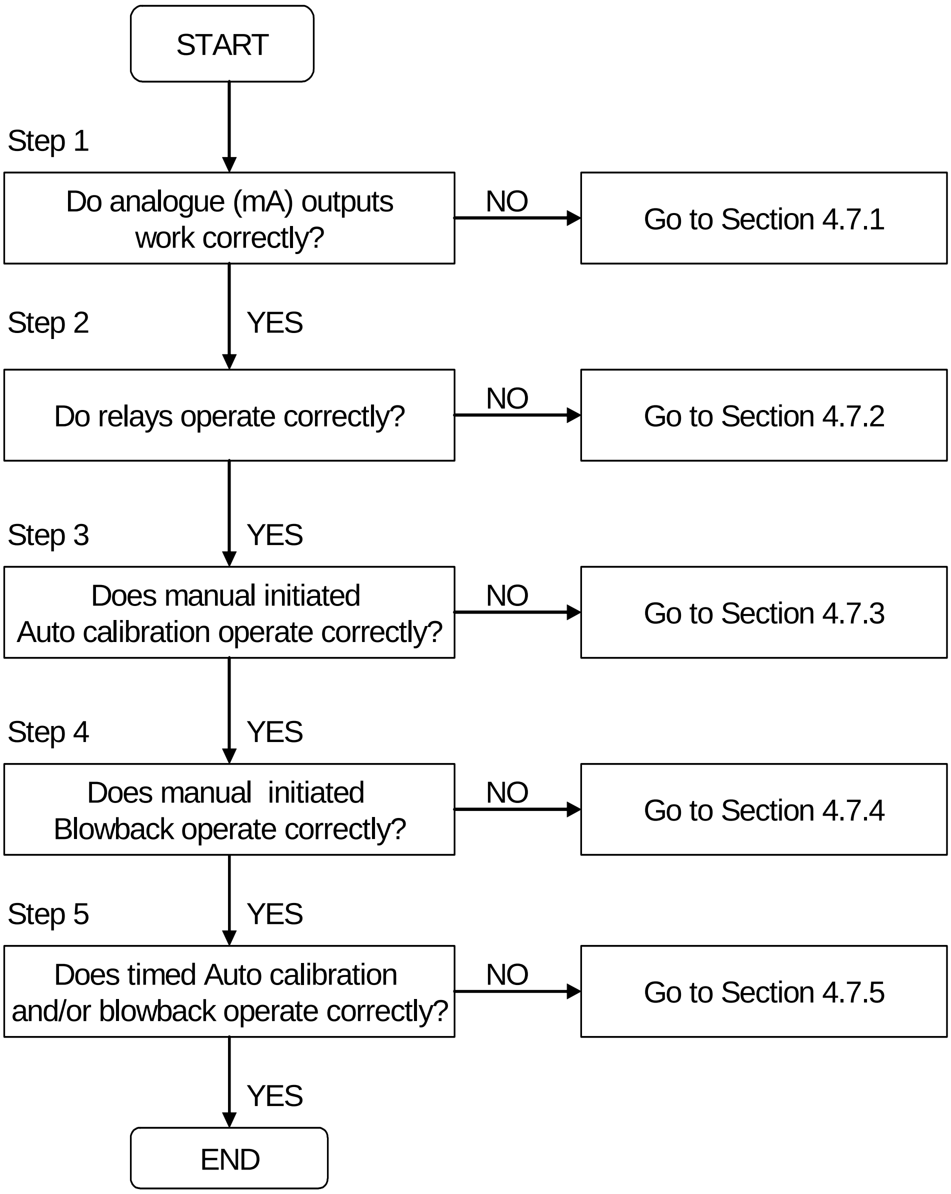


Figure 4.13 Final Analyser Checks

4.7.1 Analogue (mA) output failure

Before carrying out any fault finding, check the following at the control unit:

- Check that the analogue output assignments are correctly configured and enabled within the analyser software.
- In the “Setup” menu, check the range, “0-20/4-20", “freeze/follow” and “jam high/low/none” settings for each analogue output.
- If an output is set to jam high or low, check that there is no condition prevailing that is causing the output to jam.
- If an output is set to freeze, it will freeze during calibration (both manual and automatic) and blowback.

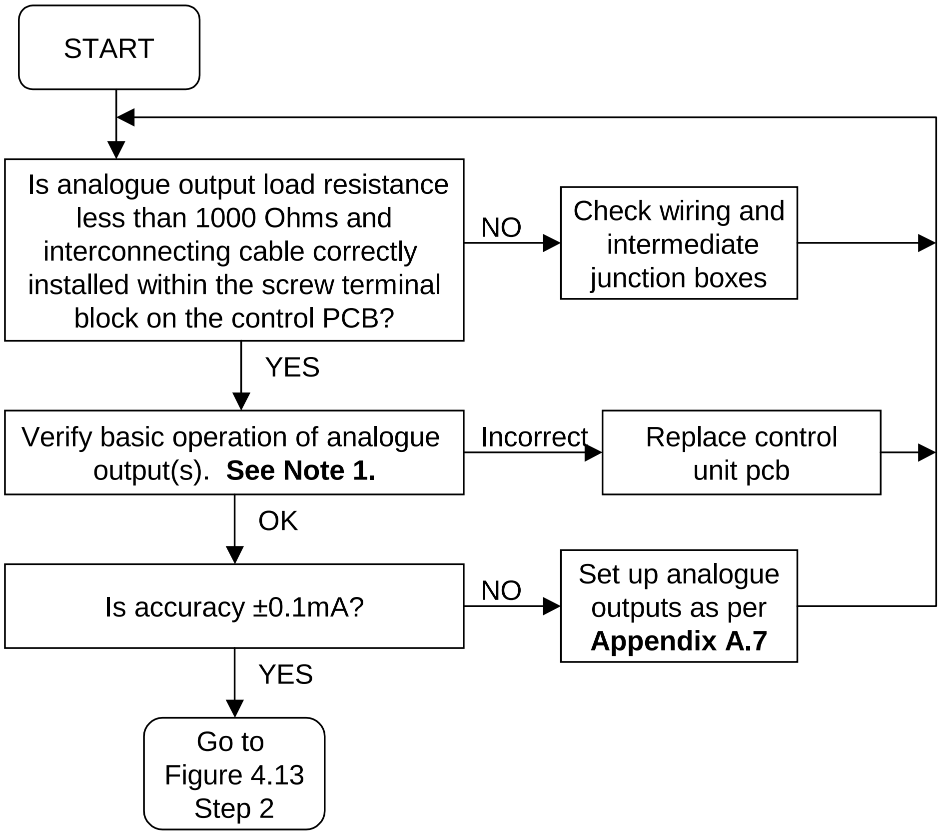


Figure 4.14 Analogue output checks

NOTE

The analyser is provided with a jam on fault facility for the analogue outputs. The jam facility operates by forcing the analogue output to a user configurable high (21mA) or low (0mA) level should any of the possible fault conditions occur. The two possible analogue outputs can be separately configured to either jam high, jam low or not to jam in the analyser software.

Note 1: Verify operation of the analogue outputs using the “SET OUTPUTS” option in the “SERVICE” menu in the analyser software as follows:

- Disconnect the field wiring from the analogue output terminals and connect a mA meter across each pair of terminals. If a mA meter is not available, fit a resistor of 1kΩ or less across each pair of terminals and measure the voltage across the resistor. Divide the measured voltage by the resistance to obtain the current.

- Using the “Service” menu, set the analogue outputs to 0mA and check that each output measures 0.1mA or less.

- Set the analogue outputs to 20mA and check that the readings are 20mA ±0.1mA. If resistors and a voltmeter are used, the calculated current must be based on the measured resistance of the resistor and not its nominal value. The analogue output span can be adjusted with RV3 and RV4, but this should be done with the analogue outputs connected to the equipment that they are to be used with **(Also see Appendix A7).**
- Set the analogue outputs to 4mA and check the readings are 4mA ±0.1mA.

4.7.2 Relay output failure

Before carrying out any other fault finding, check that the relay assignments are correctly configured and enabled within the analyser software.

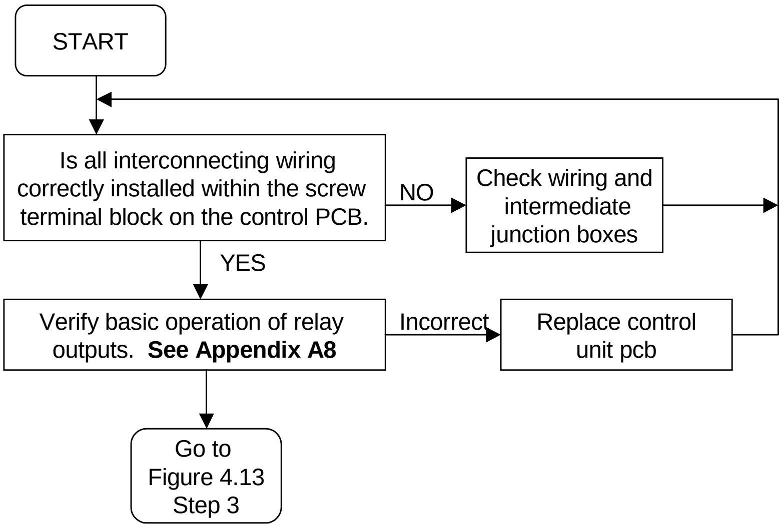


Figure 4.15 Relay output checks

4.7.3 Auto calibration failure

Symptoms

Auto calibration fault indicated.
Analyser does not start an auto calibration.
Poor accuracy following calibration.
Auto calibration is not activated by closure of external contacts.

Measurements and Diagnosis

- Check that the auto calibration configuration is correctly configured and enabled within the analyser software. Check that the contents of the calibration gas samples have been correctly entered into the analyser software.
- Check that the time and date have been correctly set in the analyser software. Check that the auto calibration start time and date have been correctly configured. Check that a blowback procedure has not been configured to start at the same time, or immediately before, the auto calibration. If an auto calibration attempts to start while a blowback is in progress then the auto calibration will be aborted.
- For remote auto calibration actuation via remote contact closure, check that connecting wiring is correctly installed and that the external initiation contacts are closed for at least 15 seconds.
- Check that the calibration gases have been correctly connected to the

calibration gas port. Check that the calibration gases are not empty and have been turned on. Check that the calibration gas flow rate is 600 ± 20 ml/min.

- Check that there are no leaks in the interconnecting calibration gas piping and that any flow meters and needle valves fitted operate correctly.
- Check for correct operation of the calibration gas solenoid valves. Perform a leak test to verify cross seat leakages. Check the wiring between the solenoid valves and the relay outputs. Check that the relay outputs are correctly allocated in the analyser software.
- Check for inappropriate calibration tolerance values (too tight) stored in the software parameters. Increase the calibration tolerances if necessary.

Otherwise refer to the particular transducer measurement error faults in Section 4.6.

NOTE
If an “AUTO CAL FAIL” fault has occurred then the only way to disable the fault is to perform a successful automatic calibration. Perform a single cycle immediate autocalibration to clear the fault.

4.7.4 Blowback failure

Symptoms

Analyser does not start a blowback process.
Blowback is not activated by closure of external contacts.

Measurements and Diagnosis

- Check that the blowback configuration is correctly configured and enabled within the analyser software.
- Check that the time and date have been correctly set in the analyser software. Check that the blowback start time and date have been correctly configured. Check that an auto calibration has not been configured to start at the same time, or immediately before, the blowback. If a blowback attempts to start while an autocalibration is in progress then the blowback will be aborted.
- For remote blowback actuation via remote contact closure check that connecting wiring is correctly installed and that the external initiation contacts are closed for at least 15 seconds.
- Check that there are no leaks in the interconnecting calibration gas piping and that any flow meters and needle valves fitted operate correctly.
- Check for correct operation of the blowback solenoid valve. Perform a leak test to verify cross seat leakage. Check the wiring between the solenoid valves and the relay outputs. Check that the relay outputs are correctly allocated in the analyser software.

4.7.5 Analyser does not keep correct time or date

Symptoms

Time and / or date requires frequent correction or does not work.

Measurements and diagnosis

- Check that the internal clock has been correctly set and the instrument has not been powered down for a period exceeding one month.
- Replace the control PCB and re-validate analyser performance.

5 PARTS REPLACEMENT PROCEDURES

5.1 Control unit access

Refer to figure 5.1

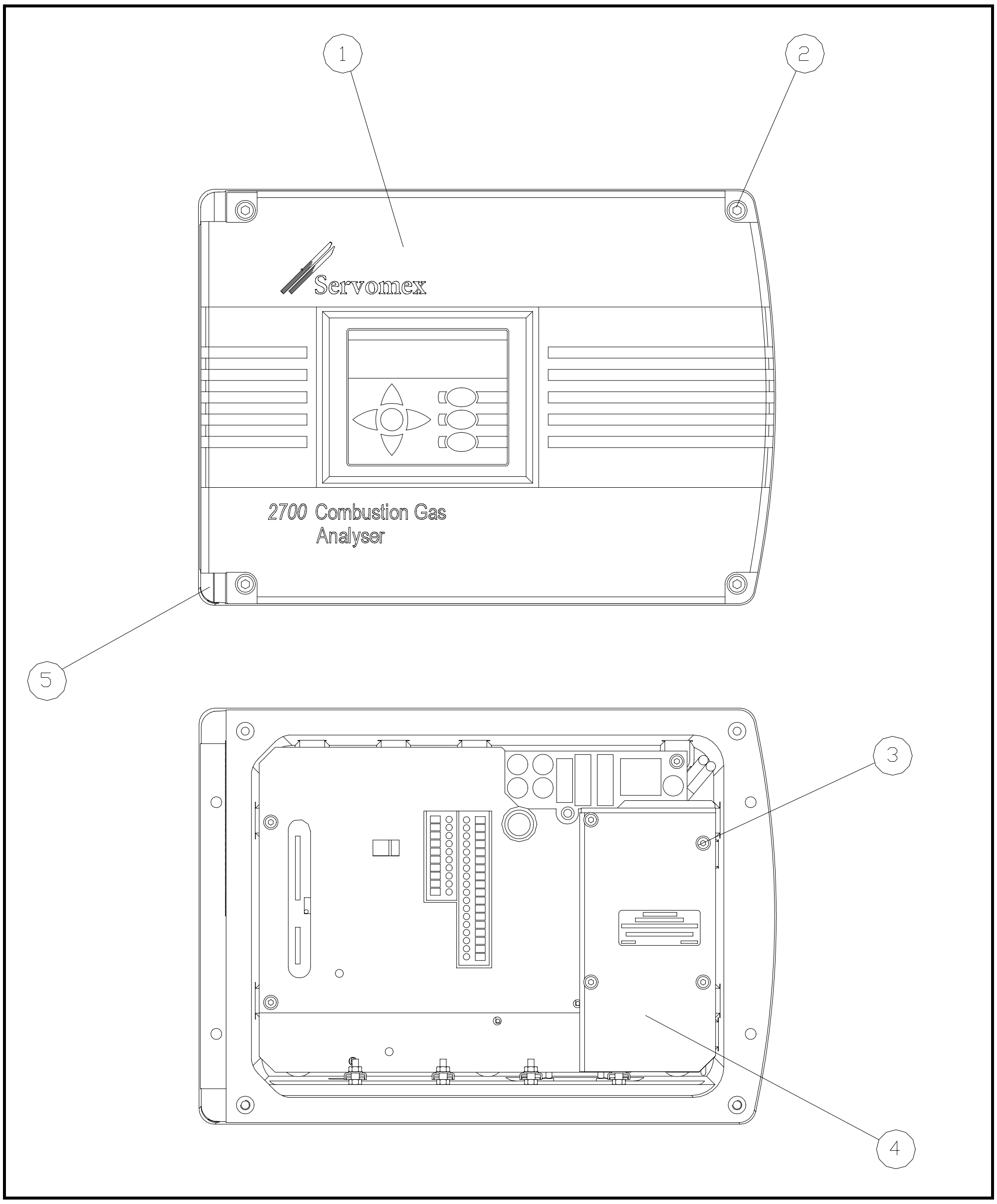


Figure 5.1 Control unit access.

Key to Figure 5.1

1. Door.
2. Captive M6 screws (4 off).
3. M4 retaining screws (4 off).
4. Plastic insulating cover.
5. M6 dowel hinge pins (2 off).

The control unit is fitted with a hinged die cast aluminium door sealed by a silicon rubber 'O' ring and secured by four captive M6 screws. Inside of the control unit a transparent plastic insulating cover protects the user from access to electrical terminals that may be exposed to hazardous high voltages.

Removal

1. Undo the 4 captive M6 screws (2) and open the hinged door (1).

2. To gain access to the electrical power and relay contact terminals, remove the 4 M4 retaining screws (3) and lift out the clear plastic cover (4) which insulates the terminals.

WARNING

Removal of the plastic insulating cover exposes the user to potentially lethal voltages. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.

Refitting

1. Check that all the electrical connections are secure and refit the clear plastic cover (4) and secure it with the 4 retaining screws (3). Do not use any thread lock on these screws.

2. Check that the 'O' ring seal in the door is correctly located and undamaged. Wipe the 'O' ring and mating surfaces to remove any dust or grease.

3. Close the hinged door (1) and secure it with the 4 captive screws (2).

5.2 Control PCB removal and replacement

There are three versions of the control PCB that may be fitted to the analyser defined by the sensor configuration fitted. Section 3 lists the part numbers of the three spare PCB's.

Refer to figure 5.2

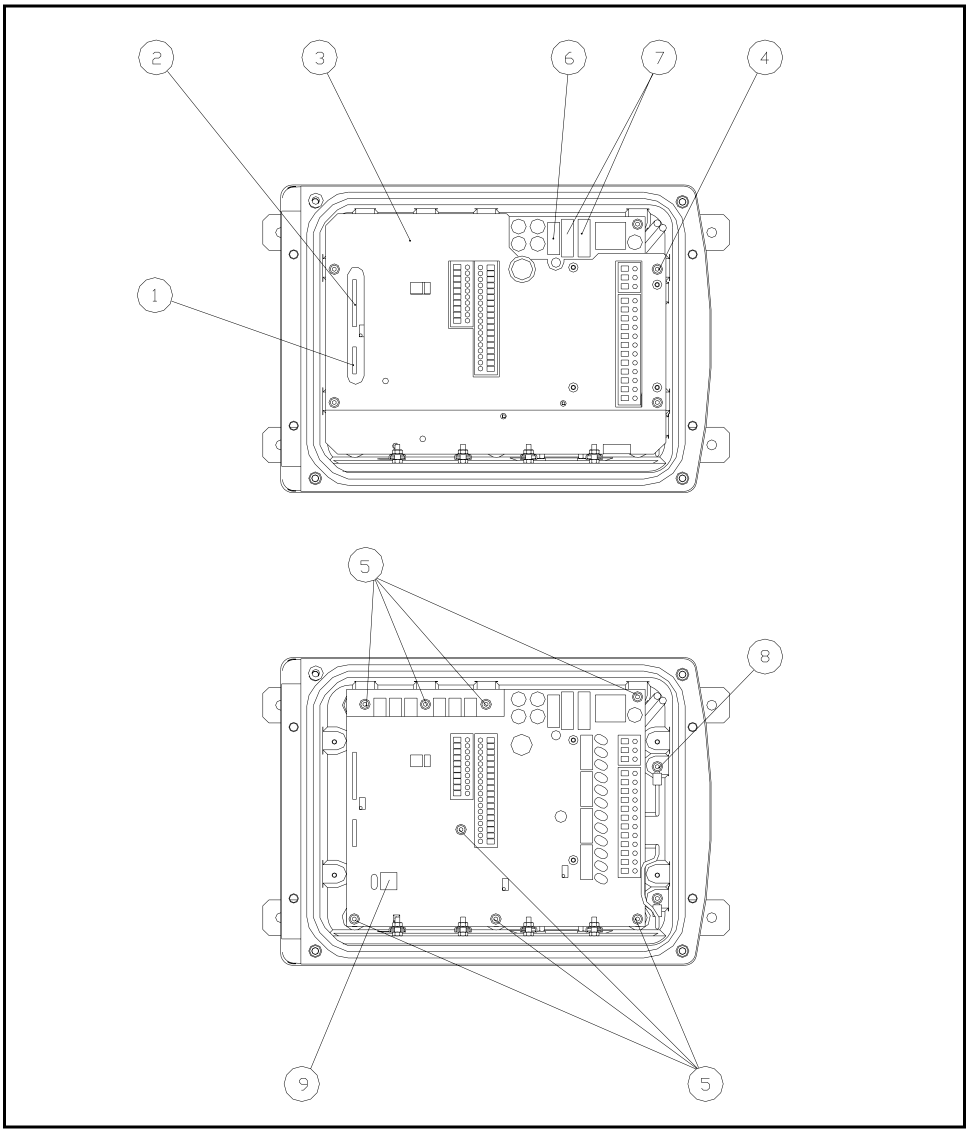


Figure 5.2 Control unit internals

Key to Figure 5.2

1. Keypad ribbon cable connection.
2. LCD ribbon cable connection.
3. Metal protection cover.
4. M4 Mains protection cover retaining screws (4 off).
5. M4 PCB retaining screws (8 off).
6. Transformer secondary connection.
7. Transformer primary connection.
8. M4 PCB earth wire connection.
9. FLASH memory chip.
10. M4 Transformer earth connection.

Removal

1. If a new control PCB is to be fitted after removal, then note the analyser software settings before proceeding.

2. Switch off all electrical power to both the control unit and sensor head. Isolate any power sources connected to the relay terminals.

3. Refer to Section 5.1. Open the control unit door and remove the transparent plastic insulation cover.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages resulting from external electrical connections to the relay contacts even when electrical power is disconnected from the control unit itself. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**

4. Disconnect all the wires from the terminals and withdraw the cables to allow clearance for removal of the metal protection cover and the PCB.

5. Unplug the keypad ribbon cable (1) and the LCD ribbon cable (2) from the control PCB.

6. Remove the 5 off M4 cover retaining screws (4) retaining the metal cover (3) to the control box casting. Remove the metal cover (3) from the control box.

7. Remove the M4 screw (8) for the PCB earth wire connection.

8. Unplug the transformer primary (7) and secondary (6) connectors from the control PCB.

9. Remove the 7 off M4 PCB retaining screws (5) and the hexagonal pillar and lift out the control PCB.

Refitting

1. Replace using the reverse procedure.

> **NOTES**
>
> **Locate and secure the PCB earth connection onto the cast boss on the control unit enclosure before locating the PCB in the control unit.**
>
> **When refitting the PCB ensure that the heat sink plate locates securely on the bosses on the control unit casting before tightening fixings.**
>
> **Ensure that the transformer wires, transformer earth and PCB earth wires are not trapped under the PCB before tightening fixings.**

2. Ensure that the transformer primary connection (PL6 or PL7 in figure 5.2) and the main power fuse rating are appropriate for the electrical supply voltage (see table 5.1).

Table 5.1 - Control unit electrical power voltage selection

Nominal Voltage	Transformer primary connection	Main power fuse (F1) rating
100 / 110 / 120 Vac	PL7	T 3.15A HRC
220 / 240 Vac	PL6	T 1.6A HRC

3. If a new control PCB has been fitted, then this will have a default software configuration. Refer to the 2700 QuickStart Manual, for detailed instructions on setting software parameters.

4. Refer to appendix A for detailed analyser performance checking.

5. Refer to Appendix B if a 0-6000ppm combustibles sensor (01750703) is fitted in the sensor head.

5.3 Control unit transformer removal and replacement

The control unit is provided with a toroidally wound twin primary, dual secondary, transformer mounted underneath the control PCB in the control unit.

Refer to figure 5.3.

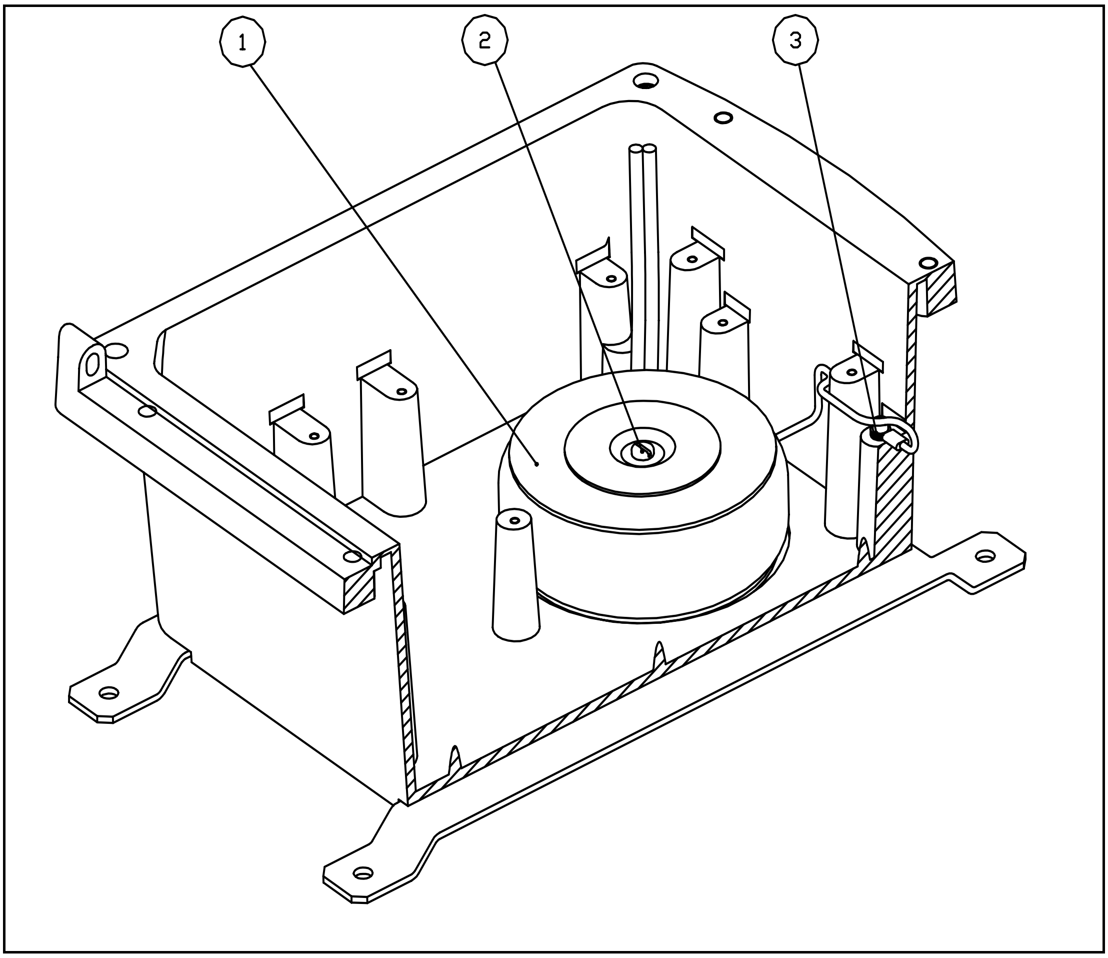


Figure 5.3 Control unit transformer detail.

Key to Figure 5.3

1.	Transformer.	3.	Earth connection.
2.	M6 retaining screw.		

Removal and refitting

1. Refer to Section 5.2. Remove the control PCB from the control unit.

2. Disconnect the M4 transformer earth connection (3) from the boss inside of the control box enclosure.

3. Remove the M6 retaining screw (2) and lift out the transformer.

4. Replace using the reverse procedure. When refitting the transformer, rotate the transformer so that the wires route towards the top right hand corner of the control unit enclosure.

5.4 Firmware installation

The 2700 analyser is supplied with firmware, with a user selectable interface in English, French or German. The firmware is supplied preloaded into a FLASH memory chip.

Refer to figure 5.2.

Removal and refitting

1. Switch off all electrical power to both the control unit and sensor head. Isolate any power sources connected to the relay terminals.

2. Refer to Section 5.1. Open the control unit door and remove the transparent plastic insulation cover.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages resulting from external electrical connections to the relay contacts even when electrical power is disconnected from the control unit itself. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**

3. Disconnect all the wires from the terminals and withdraw the cables to allow clearance for removal of the metal protection cover.

4. Unplug the keypad ribbon cable (1) and the LCD ribbon cable (2) connectors from the control PCB.

5. Remove the 5 off M4 cover retaining screws (4) retaining the metal cover (3) to the control box casting. Remove the metal cover (3) from the control box.

6. Using an appropriate extraction tool remove the micro controller chip from the control PCB.

NOTES

When fitting a new memory chip in the control PCB ensure that the chamfered corner on the chip is correctly located within the socket on the PCB.

Also refer to Appendix B if a 0-6000ppm range Combustibles sensor (01750703) is fitted in the sensor head.

7. Replace using the reverse procedure.

5.5 LCD removal and replacement

Refer to figure 5.4.

Removal and replacement.

1. Switch off all electrical power to the control unit.

2. Refer to Section 5.1. Open the control unit door. Do not remove the transparent mains protection cover.

WARNING

Removal of the plastic insulating cover may expose the user to potentially lethal voltages resulting from external electrical connections to the relay contacts even when electrical power is disconnected from the control unit itself. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.

3. Remove the 2 off M3 cover retaining screws and washers (2) and remove the display protection cover (1) from the display(4).

4. Unplug the display ribbon cable (8) from the control PCB. Release the display ribbon cable (8) from the ribbon cable clamp (9).

5. Remove the 2 off M3 cover spacers and washers (3). Remove the 2 off M3 display retaining screws and washers (5). Lift off the liquid crystal display (4) from the keypad (7).

6. Replace using the reverse procedure, ensure that the display module is fitted with the cable at the bottom of the module.

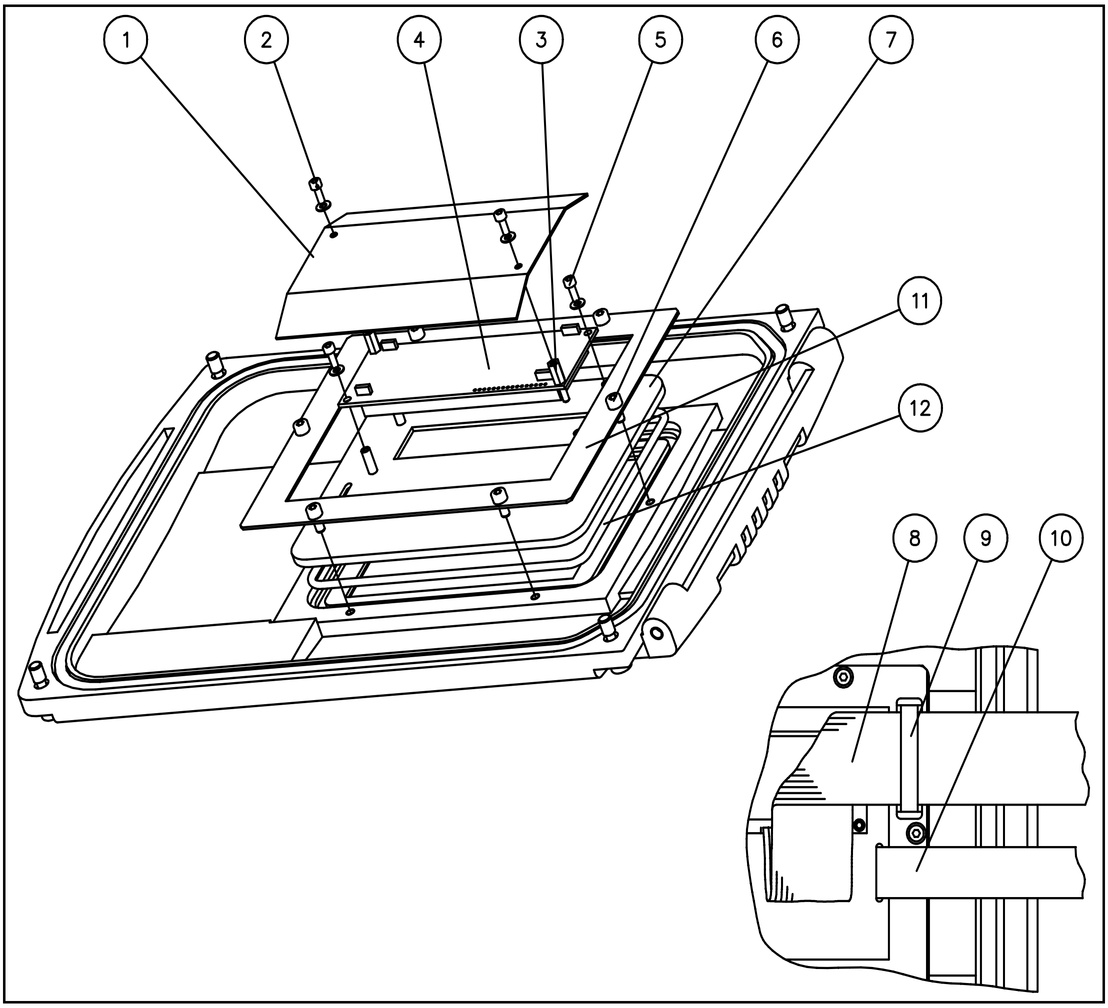


Figure 5.4 Display and keypad mounting details

Key to Figure 5.4

1.	Display protection cover.	7.	Key pad.
2.	M3 cover retaining screws (2).	8.	Display ribbon cable.
3.	M3 cover spacers (2).	9.	Display ribbon cable clamp.
4.	Liquid crystal display.	10.	Keypad ribbon cable.
5.	M3 display retaining screws (2).	11.	Keypad retaining frame.
6.	M4 keypad retaining screws (6).	12.	'O' ring seal.

NOTES

1. **When refitting the LCD with the 2 off M3 retaining screws (5) and M3 cover spacers (3) then ensure that the washers are fitted in order to prevent the screws bottoming out in the threaded spacers.**

2. **When fitting the protection cover (1) with the 2 off M3 retaining screws (2) then ensure that the washers are fitted in order to prevent the screws bottoming out in the threaded spacers. Do not use thread lock on these screws.**

3. **Examine the ribbon cable clamp (9) and replace if damaged. If the keypad has been replaced then fit a new ribbon cable clamp in all cases.**

5.6 Keypad removal and replacement

Refer to figure 5.4.

Removal and replacement.

1. Switch off all electrical power to the control unit.

2. Refer to Section 5.5. Remove the liquid crystal display.

3. Unplug the keypad ribbon cable (10) from the control PCB.

4. Remove the 6 off M4 keypad retaining screws (6). Remove the keypad retaining frame (11) and lift out the keypad (7) from the recess in the hinged door

5. To replace, check that the ‘O’ ring seal (12) in the door is correctly located and undamaged. Wipe the ‘O’ ring and mating surfaces to remove any dust or grease. Replace the keypad using the reverse procedure.

5.7 Sensor head and terminal box cover removal and replacement

Refer to figure 5.5.

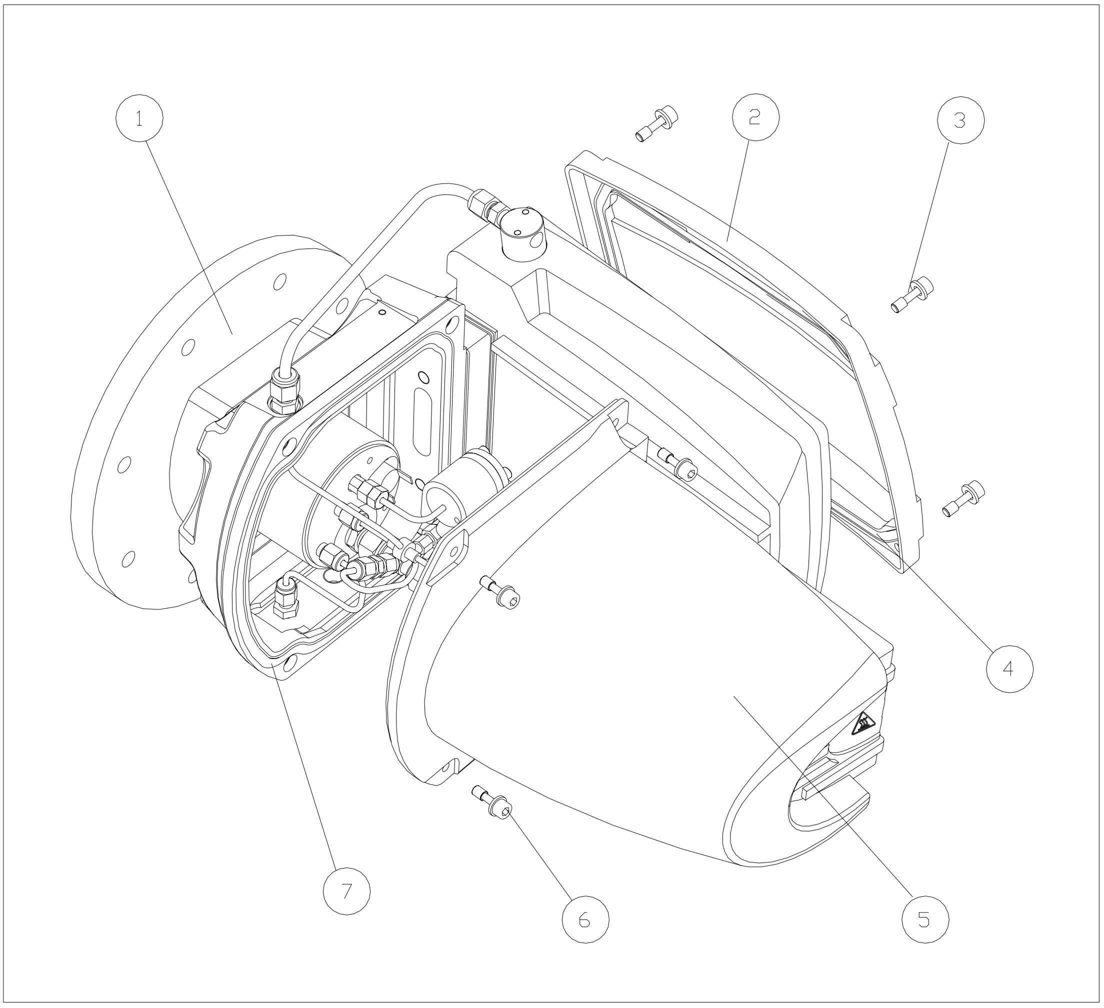


Figure 5.5 Sensor head over view.

Key to Figure 5.5

1. 4" mounting flange.
2. Terminal box cover.
3. M6 captive retaining screws (4).
4. Terminal box O ring seal.
5. Sensor head cover.
6. M6 captive retaining screws (4).
7. Sensor head O ring seal.

The sensor head is designed to be flange mounted directly on to the flue wall and is heated. Service access to the sensor head and its terminal enclosure may hence be restricted. Depending on installation location it may be advisable to remove the sensor head from the flue wall to provide convenient service access. The installation details for the sensor head vary depending on the sample probe type in use and the specific flange mounting arrangement. Refer to the 2700 installation manual for specific details on the mounting arrangement in use.

The terminals compartment is sealed for dust and moisture ingress by an ‘O’ ring secured into the terminal compartment lid. The sensor compartment is similarly sealed by an ‘O’ ring located in the sensor head base.

Removal

> **WARNING**
>
> **The 2700 sensor head, excluding the probe assembly, weighs approximately 17Kg (38 lbs), care must be taken when handling.**
>
> **The analyser may contain toxic, corrosive, flammable or asphyxiant gases. Vent the analyser to a safe area and flush with air before commencing work.**
>
> **The sensor head is heated and may be attached to a hot flue. The external surfaces will be uncomfortably hot even after power down for several hours. Exercise care when handling the sensor head even when un-powered on a hot flue.**

1. Connect an air supply or other inert gas to the calibration gas port at a flow rate of 600 ml/min. Allow the sensor head to flush for 10 minutes to remove potentially toxic and flammable gases from the sensor head pipe work.

2. Turn off the aspirator air supply and then disconnect the electrical supply to the sensor head.

3. If service access to the sensor head is limited when attached to the flue then remove the sensor head from the flue.

4. To gain access to the sensor head Terminal PCB and the electrical terminations proceed as follows: Undo the 4 off captive M6 screws (3) and remove the terminal box cover (2). To gain access to the electrical power terminals remove the M4 retaining screw and lift out the clear plastic cover which insulates the terminals.

> **WARNING**
>
> **Removal of the plastic insulating cover when the sensor head is powered exposes the user to potentially lethal voltages. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**

5. To gain access to the sensor head oven compartment proceed as follows: Undo the 4 off captive M6 screws (6) and remove the sensor compartment cover (5).

> **WARNING**
>
> **The sensor compartment is heated to a temperature of 250 °C and may be attached to a hot flue. Removal of the sensor compartment cover exposes the user to potentially hazardous hot components. If the sensor compartment cover is to be removed then it is recommended that the sensor head be left for 2 hours to cool down first.**

Replacement

1. Check that the electrical connections to the terminals PCB are secure and refit the clear plastic insulating cover. Do not use thread lock on these screws.

2. Check the ‘O’ ring seals in the terminal compartment lid and in the sensor head base are correctly located and undamaged. Wipe the ‘O’ rings and mating surfaces to remove any dust or grease.

3. Refit the terminal compartment lid and sensor compartment lid and secure with the M6 captive screws.

4. If necessary remount the sensor head to the flue and power up the sensor head using the procedure detailed in the installation manual.

> **CAUTION**
>
> **If the sensor is mounted with the terminal box vertically above the sensor head body then the accuracy and service life may be reduced.**

NOTES

- **Ensure that mounting bolts are tightened evenly to prevent the sensor head from tilting and causing leaks.**
- **The sensor head must not be left unpowered when mounted on an active flue. If the sample probe is not to be fitted immediately then a blanking flange should be used. Do not plug the hole with the sensor head.**
- **A sachet of anti-seize compound (part number 1761-3211) is available for use on the sensor head mounting bolts and studs. Failure to use the anti seize compound may make the fittings difficult to remove.**

5.8 Terminals PCB removal and replacement

Refer to figure 5.6.

There are three versions of the terminals PCB that may be fitted to the analysers defined by the sensor configuration fitted. Section 3 lists the part numbers of the three spare PCB's.

Removal

1. Refer to Section 5.7. Remove terminal compartment cover and disconnect the electrical power from both the control unit and sensor head. Remove the M4 protection cover retaining screw (11) and remove the protection cover that insulates the mains rated electrical power connection beneath it.

WARNING

Removal of the plastic insulating cover may expose the user to potentially lethal voltages if the electrical supply is not disconnected first. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.

2. Disconnect all mains power and electrical interconnecting wiring from terminal blocks TB1, TB3 and TB5 and withdraw the cables to allow clearance for removal of the PCB. Disconnect any interconnecting wiring shield connections from the ground post at the bottom edge of the PCB. Make a note of the schedule of the interconnecting wiring to facilitate later reconnection.

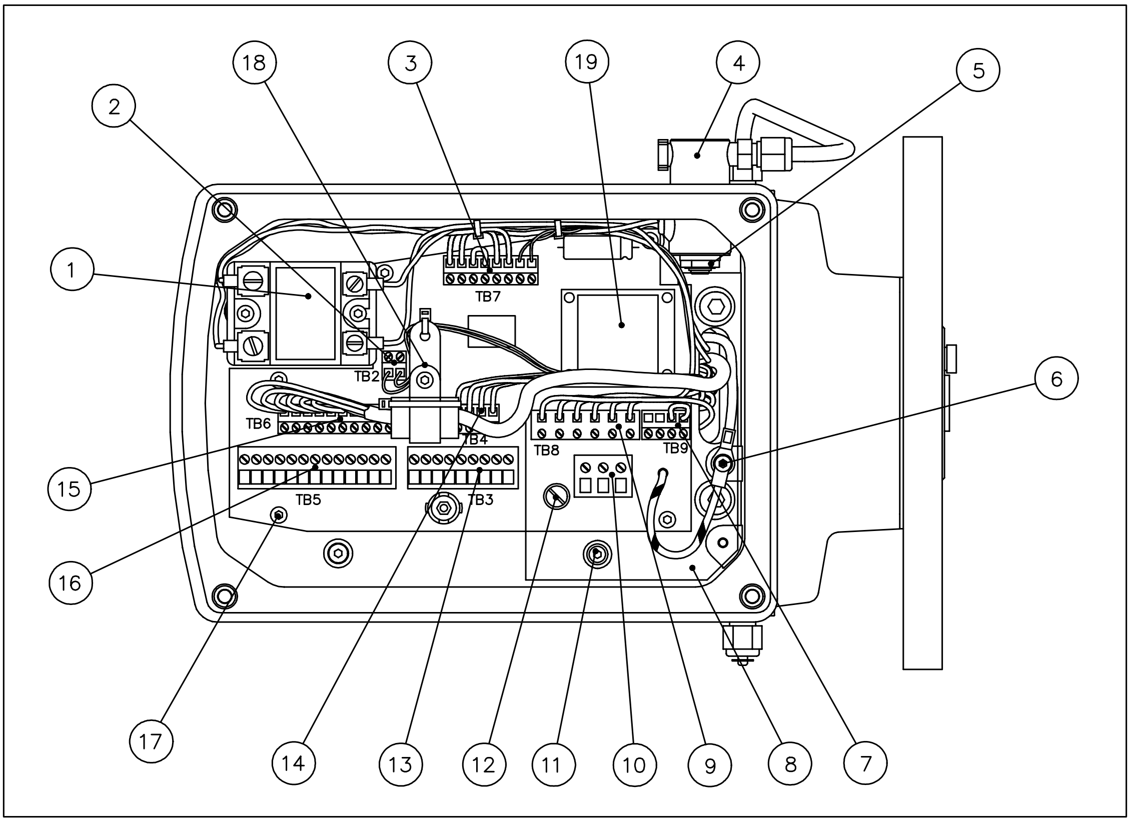


Figure 5.6 Sensor head terminal enclosure detail.

Key to Figure 5.6

1. Solid state relay.
2. Terminal block TB2.
3. Terminal block TB7.
4. Solenoid valve.
5. Solenoid valve retaining nut.
6. Terminal PCB earth connection.
7. Terminal block TB9.
8. Transparent protection cover.
9. Terminal block TB8.
10. Terminal block TB1
11. M4 cover fixing screw.
12. Mains fuse F1.
13. Terminal block TB3.
14. Terminal block TB4.
15. Terminal block TB6.
16. Terminal block TB5.
17. M4 Terminal PCB fixing screws (6).
18. Wiring support P clip + EMC ferrite.
19. Transformer.

3. Remove the clip (18) and emc ferrite supporting the internal sensor wiring. Disconnect all internal wiring to the sensor compartment from terminal blocks TB2, TB4, TB6, TB7, TB8 and the sensor wiring screen from PCB fixing screws (if fitted). Withdraw the internal wiring to allow clearance for removal of the PCB.

4. Disconnect the terminal PCB earth wire from the terminal box casting (6).

5. Remove the remaining 5 off M4 PCB fixing screws (17) and lift out the terminal PCB.

Replacement

1. The mains operating voltage is set by connecting together the appropriate terminals in terminal block TB9 (see table 5.2). If a new terminals PCB is being fitted then set the correct mains operating voltage.

Table 5.2 - Terminal PCB voltage selection links

Nominal Voltage	Configuration set up
100V ac	Link TB9/2 to TB9/4
110 / 120V ac	Link TB9/2 to TB9/3
220 / 240 V ac	Link TB9/2 to TB9/1

2. Locate the terminals PCB over the mounting holes and secure with 5 of the 6 M4 fixing screws (17). Do not fit the remaining screw that locates the wiring support P clip (18) until the internal sensor wiring is completed.
Internal sensor wiring must pass through emc ferrite.

3. Reconnect the internal sensor wiring in accordance with the wiring schedule in table 5.3.

4. Reconnect the mains power and interconnecting wiring. Connection details should have been noted on disconnection. Interconnecting wiring schedules and diagrams are given in Section 2.4.

5. Check that all electrical connections are secure and refit the clear plastic cover (8) and secure it with the retaining screw (11). Do not use any thread lock on this screw.

6. Replace the terminal compartment cover as detailed in Section 5.7

7. Follow the start up procedure listed in the installation manual and the basic operational checks detailed in appendix A.

Table 5.3 - Sensor Head Internal Wiring Schedule			
Terminal	**Function**		**Colour**
TB2-1	Zirconia thermocouple	-ve	WHITE
TB2-2		+ve	GREEN
TB4-1	Zirconia cell output	-ve	BLUE
TB4-2		+ve	YELLOW
TB4-3	Zirconia heater output. Polarity not important.		RED
TB4-4			RED
TB6-1	Combustibles cell heater. Polarity not important.		BEIGE/BLACK
TB6-2			BEIGE/BLACK
TB6-3	Combustibles cell temperature. Polarity not important.		RED
TB6-4			RED
TB6-5	Combustibles cell supply voltage	+ve	BROWN
TB6-6		-ve	GREEN
TB6-7	Combustibles cell output	+ve	BLUE
TB6-8		-ve	YELLOW
PCB MOUNTING	Combustibles cell braided screen (chassis earth)		CRIMP LUG
TB7-1	Solenoid valve. Polarity not important.		BLACK
TB7-2			BLACK
TB7-3	Solid state relay drive connection	-ve	BLUE
TB7-4		+ve	RED
TB7-5	Auxiliary protection thermistor. Not used on oxygen only version. Polarity not important		WHITE
TB7-6			WHITE
TB7-7	Block temperature thermistor. Used on all versions. Polarity not important.		WHITE
TB7-8			WHITE
TB8-1	Block band heater. Polarity not important.		BEIGE
TB8-2			BEIGE
TB8-3	Solid state relay power output connection. Polarity not important		GREY
TB8-4			GREY
TB8-5	Over temperature thermostat. Polarity not important.		MAUVE
TB8-6			MAUVE

5.9 Solenoid valve removal and replacement

Refer to figure 5.6.

The 2700 solenoid valve is fitted with a 12V DC actuating coil.

Removal and replacement

1. Refer to Section 5.7. Remove the terminal compartment cover and switch off the electrical power to the sensor head.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages if the electrical supply is not disconnected first. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**

2. Disconnect the compressed air supply to the solenoid valve. Remove the interconnecting pipe to the sensor head aspirator air inlet and associated 1/4" OD compression fitting. Reuse the fitting on the new solenoid valve body.

3. Depending on the type of tool at hand it may be necessary to remove the terminal PCB in order to access the solenoid valve retaining nut (5). Check with the tool being used that the retaining nut can be removed without the tool fouling the terminals PCB. If necessary remove the terminals PCB as described in Section 5.8.

4. Disconnect the electrical supply to the solenoid valve from terminal block TB7 terminal 1 and 2.

5. Remove the solenoid valve retaining nut (5). Lift out the solenoid valve body through the hole machined in the casting. Lift out the solenoid valve actuating coil from the inside of the terminal box.

6. Replace using the reverse procedure. Ensure that the fibre sealing washer is refitted between the valve body and the enclosure.

5.10 Solid state relay removal and replacement

Refer to figure 5.6.

Removal and replacement

1. Refer to Section 5.7. Remove the terminal compartment cover and disconnect the electrical power from the sensor head.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages if the electrical supply is not disconnected first. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**

2. Remove the transparent insulation cover from the top of the solid state relay. Disconnect the four electrical connections from the solid state relay. Remove the 2 off M4 retaining screws and lift out the solid state relay.

3. Replace using the reverse procedure. Ensure that the solid state relay and its transparent insulation cover are fitted in the correct orientation and that the red wire is connected to terminal 3 and the blue wire to terminal 4.

5.11 Zirconia cell removal and replacement

Refer to figure 5.7.

> **CAUTION**
>
> **When undoing or retightening the pipe work associated with the oxygen sensor, always use two spanners and take care not to twist the cell otherwise it may be damaged. The zirconia cell is provided with machined flats to assist in removing fittings without stressing the cell.**

Removal and replacement

1. Refer to Section 5.7. Switch off the electrical power to both sensor head and control unit and remove the terminal compartment cover and sensor compartment cover.

WARNING
Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.

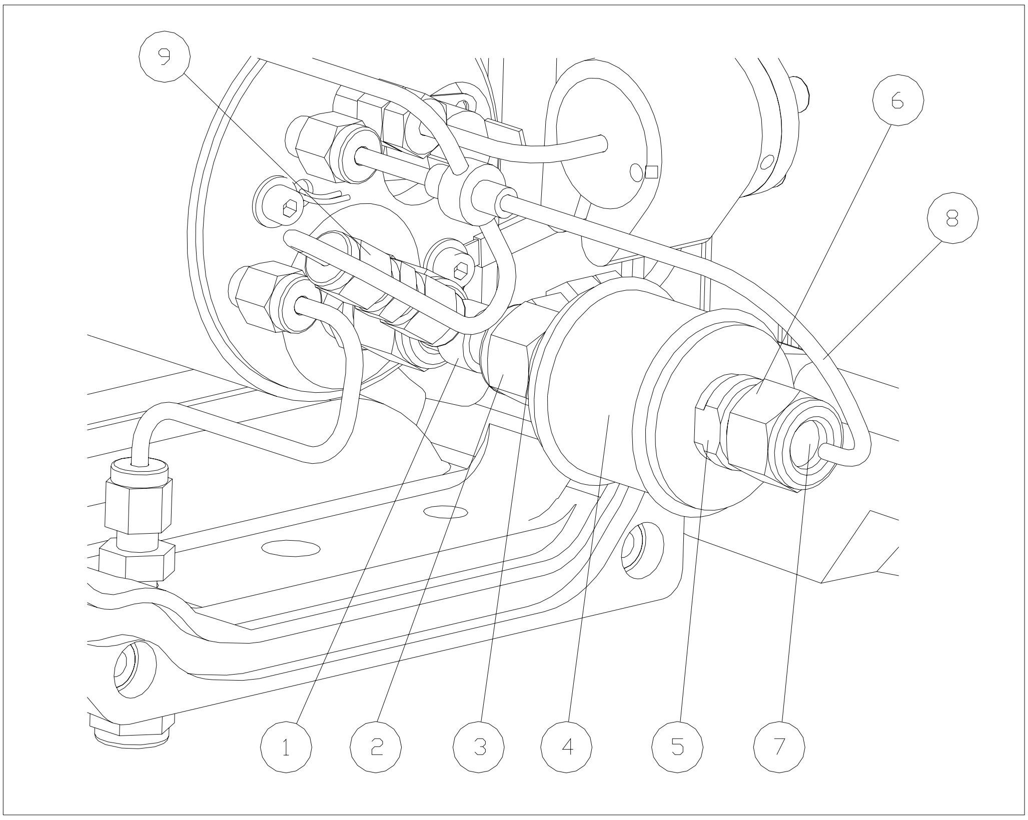


Figure 5.7 Zirconia sensor installation detail

Key to Figure 5.7

1. Cell connector.
2. 3/8" nut, sample side.
3. Flats on cell.
4. Zirconia cell.
5. Flats on cell.
6. 3/8" nut, reference side.
7. Mesh filter.
8. Reference air pipe.
9. Auxiliary air restrictor.

2. Refer to figure 5.6. Disconnect the zirconia sensor wiring from terminal blocks TB2 (thermocouple wires) and TB4 (heater and signal wires) on the terminals PCB. Withdraw the signal wires through the ferrite and back into the sensors compartment. Take note of the wire positions and ensure that the new sensor wires are routed in the same manner.

3. Refer to figure 5.7. Disconnect the reference air pipe (8) compression fittings at the bulk head, auxiliary air restrictor (9) and the flame trap and remove the reference air pipe.

4. Disconnect zirconia cell (4) from the cell connector (1) by undoing the 3/8" compression fitting nut (2). Release this cell nut by using an 11/16" AF spanner on the nut (2) and a 16mm AF spanner on the adjacent flats (3) on the oxygen cell so as not to twist the cell. If the cell connection is stuck, keep undoing the compression nut (2) and use the jacking shoulder to pull the stuck ferrules from the cell.

5. A course mesh filter (7) is attached to the reference side of the zirconia cell using a second 3/8" compression fitting nut (6). Remove the nut (6), and filter (7) using two spanners and the machined flats on the cell (5) in the same manner as above. Retain the filter for reuse on the new cell.

6. Replace using the reverse procedure. The new sensor will be provided with a fibreglass sleeve insulating the cell wires. Refer to table 5.3 for cell wiring connection details. Ensure wires are passed through the emc ferrite.

7. Follow the start up procedure listed in the installation manual and the basic operational checks detailed in appendix A.

5.12 Combustibles cell removal and replacement

Refer to figure 5.8.

Removal and replacement

1. Refer to Section 5.7. Switch off the electrical power to both sensor head and control unit and remove the terminal compartment cover and sensor compartment cover.

> **WARNING**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Refer to figure 5.6. Disconnect the combustibles sensor wiring from terminal block TB6 on the terminals PCB. Withdraw the signal wires through the ferrite and back into the sensors compartment. Take note of the wire positions within the sensor head and ensure that the new sensor wires are routed in the same manner.

3. Refer to figure 5.8. Disconnect the 1/8" compression fitting (4) at the junction between the combustibles sensor (3) and the cell connector (6). Use two spanners on the 1/8" nut (4) and the hexagon on the cell connector (5). Avoid twisting the cell connector fitting.

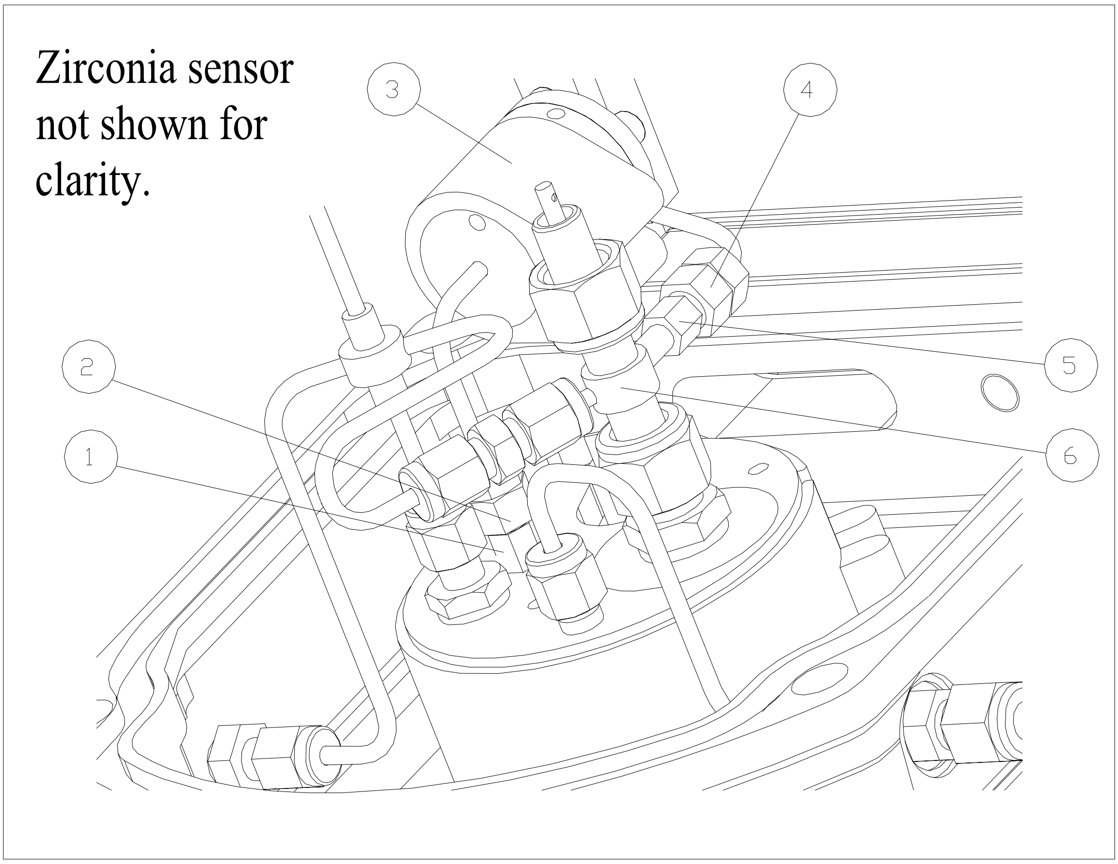


Figure 5.8 Combustibles sensor installation detail

Key to Figure 5.8

1. Flame trap.
2. 1/8" compression fitting, outlet.
3. Combustibles sensor.
4. 1/8" compression fitting, inlet.
5. Flats on cell connector.
6. Cell connector.

4. Disconnect the 1/8" compression fitting (2) at the junction between the combustibles sensor (3) and the flame trap (1). Use two spanners as above to avoid twisting the flame trap.

5. Replace using the reverse procedure. The new sensor comes complete with PTFE sleeving and braided screen over the cell wires. Refer to table 5.3 (page 5.17) for cell wiring connection details. Ensure that the wires are routed away from the filter block and the band heater, and are passed through the emc ferrite.

CAUTION

When fitting a new combustibles sensor ensure that the gap in the combustibles sensor band heater is not located directly over the platinum resistance thermometer. Failure to do this may result in drifting performance.

6. Follow the start up procedure listed in the installation manual and the basic operational checks detailed in appendix A.

NOTE

If changing between 0-2000ppm and 0-6000ppm combustibles sensors, refer to Appendix B for analyser configuration instructions.

5.13 Cell connector removal and replacement

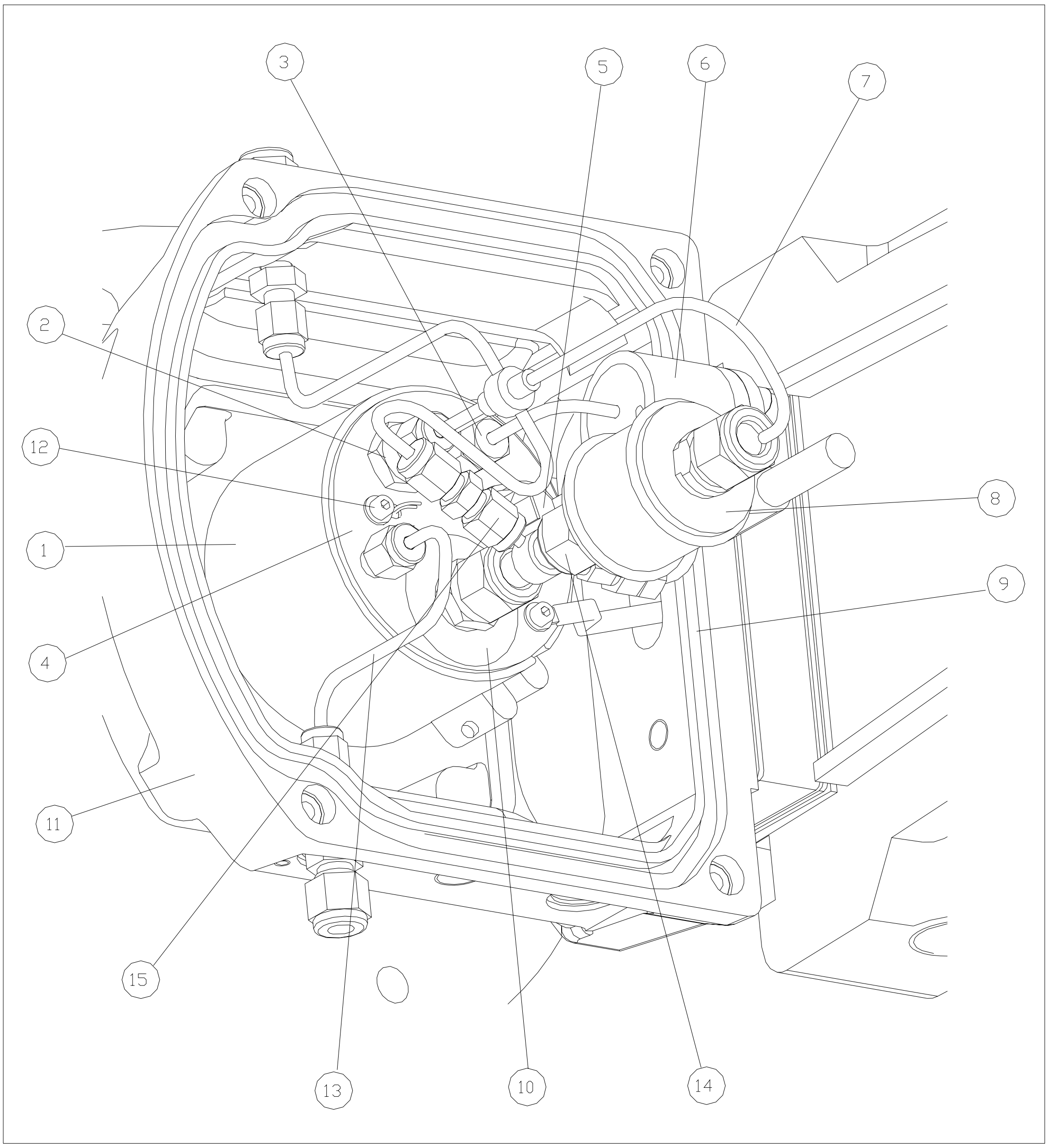


Figure 5.9 Dual gas sensor head layout

Key to Figure 5.9

1. Band heater.
2. Aspirator assembly.
3. Flame trap.
4. Filter block.
5. Over temp. thermostat.
6. Combustibles sensor.
7. Reference air pipe.
8. Zirconia oxygen sensor.
9. 'O' ring seal.
10. Internal filter / Sintered flame arrestor.
11. Base casting.
12. Thermistor retaining screw
13. Calibration / blowback pipe
14. Cell connector mounting nut.
15. Auxiliary air restrictor.

Removal and replacement

1. Refer to Section 5.7. Switch off the electrical power to both sensor head and control unit and remove the sensor compartment cover.

> **WARNING**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Refer to figure 5.9. Disconnect the reference air pipe (7) compression fittings at the bulk head, Restrictor (15) and the aspirator (2) and remove the reference air pipe (7).

3. For the oxygen only and dual sensor versions refer to figure 5.7. Disconnect zirconia cell (4) from the cell connector (1) by undoing the 3/8" compression fitting nut (2). Release this cell nut by using an 11/16" AF spanner on the nut (2) and a 16mm AF spanner on the adjacent flats (3) on the oxygen cell so as not to twist the cell. If the cell connection is stuck, keep undoing the compression nut (2) and use the jacking shoulder to pull the stuck ferrules from the cell. Temporarily support the zirconia cell to prevent rotation so as not to unduly stress the cell wiring.

4. For the combustibles only and dual sensor version refer to figure 5.8. Disconnect the 1/8" compression fitting (4) at the junction between the combustibles sensor (3) and the cell connector (6). Use two spanners on the 1/8" nut (4) and the hexagon on the cell connector (5). Avoid twisting the cell connector fitting.

5. Refer to figure 5.9. Undo the remaining 3/8" compression fitting (14) at the junction between the cell connector and the sintered flame arrestor internal filter (10). Use two spanners to prevent the sintered flame arrestor (10) from twisting during initial breaking of the joint. If the ferrule is stuck, keep undoing the compression nut and use the jacking shoulder to pull the stuck ferrule from the flame arrestor. Temporarily support the cell connector to prevent rotation during this operation.

6. Clean or replace the cell connector as necessary.

7. Replace using the reverse procedure. Ensure that the sintered flame arrestor (10) and flame trap (3) are fully tightened before fitting the cell connector.

5.14 Aspirator removal and replacement

Refer to figure 5.9.

Removal and replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove the sensor compartment cover.

> **WARNING**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Undo the compression fittings connecting the aspirator / reference air pipe (7) to its bulk head fitting, restrictor (15) and to the aspirator (2). Lift out the aspirator / reference air pipe.

3. Unscrew and remove the aspirator (2) from the filter block body (4). Remove and discard the old annealed copper sealing washer.

4. Clean or replace the aspirator as required. Check that the vent hole through the filter block is not blocked. Clean the assembly if necessary.

5. Replace using the reverse procedure, using a new annealed copper sealing washer.

> **NOTES**
>
> **If a new aspirator is fitted, lightly smear some release compound (Servomex part number 1765-0014) on the threads entering the filter block. Failure to do this may make the aspirator difficult to remove in the future.**
>
> **An annealed copper washer is used as a seal between the aspirator and the filter block. These may only be used once and must be replaced when the aspirator is refitted.**

> **CAUTION**
>
> **Use only the recommended release compound, ROCOL ASP dry film anti scuffing paste (Servomex part number 1765-0014), on any heated components. The use of “Silver Goop” or other similar release agents may result in permanent damage to the combustibles sensor (if fitted).**

5.15 Internal filter/sintered flame arrestor removal and replacement

Refer to 5.9.

Removal and Replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove the sensor compartment cover.

> **WARNING**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Disconnect the 1/8" compression fitting at the flame trap (3).

3. Disconnect the reference air pipe (7) compression fittings at the bulk head, restrictor (15) and the aspirator assembly (2) and remove the reference air pipe (7).

4. Disconnect the 3/8" compression fitting (14) at the junction between the cell connector and the sintered flame arrestor internal filter (10). If the ferrule is stuck, keep undoing the compression nut and use the jacking shoulder to pull the stuck ferrule from the flame arrestor. Temporarily support the cell connector to prevent rotation during this operation.

5. Pull back the sensor assembly and temporarily support in order not to over stress the sensor wiring.

6. Unscrew the flame arrestor / internal filter assembly (10) from the filter block (4). Discard the used annealed copper sealing washer.

7. Replace using the reverse procedure, using a new annealed copper washer.

NOTES

If a new flame arrestor / internal filter is fitted, lightly smear some release compound (Servomex part number 1765-0014) on the threads entering the filter block. Failure to do this may make the flame arrestor / internal filter difficult to remove in the future.

An annealed copper washer is used as a seal between the flame arrestor and the filter block. These may only be used once and must be replaced when the flame arrestor is refitted.

CAUTION

Use only the recommended release compound, ROCOL ASP dry film anti scuffing paste (Servomex part number 1765-0014), on any heated components. The use of "Silver Goop" or other similar release agents may result in permanent damage to the combustibles sensor (if fitted).

5.16 Flame trap removal and replacement

Refer to 5.9.

Removal and Replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove the sensor compartment cover.

WARNING

Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.

2. Disconnect the 1/8" compression fitting at the flame trap (3).

3. Disconnect the reference air pipe (7) compression fittings at the bulk head, restrictor (15) and the aspirator assembly (2) and remove the reference air pipe (7).

4. Disconnect the 3/8" compression fitting (14) at the junction between the cell connector and the sintered flame arrestor internal filter (10). If the ferrule is stuck, keep undoing the compression nut and use the jacking shoulder to pull the stuck ferrule from the flame arrestor. Temporarily support the cell connector to prevent rotation during this operation.

5. Pull back the sensor assembly and temporarily support in order not to over stress the sensor wiring.

6. Remove the flame trap (3) and associated double ended ferrules by unscrewing the flame trap from the filter block (4).

7. Replace using the reverse procedure. Ensure that the longer threaded end of the flame trap is inserted into the filter block.

NOTES

If a new flame trap is fitted, lightly smear some release compound (Servomex part number 1765-0014) on the threads entering the filter block. Failure to do this may make the flame trap difficult to remove in the future.

CAUTION

Use only the recommended release compound, ROCOL ASP dry film anti scuffing paste (Servomex part number 1765-0014), on any heated components. The use of “Silver Goop” or other similar release agents may result in permanent damage to the combustibles sensor (if fitted).

5.17 Thermostat removal and replacement

Removal and replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove both the sensor compartment cover and terminal compartment cover. Remove the transparent insulating cover from the terminal enclosure.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages if the electrical supply is not disconnected first. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Refer to figure 5.6. Disconnect the mauve thermostat wires from terminal block TB8 (9) on the terminals PCB. Withdraw the wires back into the sensors compartment. Take note of the wire routing within the sensor head and ensure that the new thermostat wires are routed in the same manner.

3. Refer to figure 5.9. Remove the two M3 screws that retain the over temperature thermostat (5) to the filter block (4). Lift out the over temperature thermostat.

4. Replace using the reverse procedure. The new thermostat will be provided with a fibre glass sleeve insulating the cell wires. This is a safety feature and should not be omitted. Refer to table 5.3 for cell wiring connection details. Ensure that the wires are routed away from the filter block, band heater, and combustibles sensor body (if fitted).

5.18 Thermistor removal and replacement

The thermistor is located within a hole in the filter block and is used a the temperature control for the filter block.

Removal and Replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove both the sensor compartment cover and the terminals compartment cover.

> **WARNING**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Refer to figure 5.6. Disconnect the white wires from terminal block TB7 (3) on the terminals PCB. Withdraw the wires back into the sensors compartment. Take note of the wire route within the sensor head and ensure that the new thermistor wires are routed in the same manner.

3. Refer to figure 5.9. Remove the M4 screw (12) and oversized washer then lift out the thermistor. The washer is designed to overlap a small area of the hole to trap the thermistor in place.

4. Replace using the reverse procedure. Ensure that the wires are routed away from the filter block, band heater, and combustibles sensor body. Ensure that the leads to the block thermistor are not trapped by the oversize washer locating the thermistor within the block.

5.19 Band heater removal and replacement

Removal and replacement

1. Refer to Section 5.7. Disconnect the electrical power from both sensor head and control unit and remove both the sensor compartment cover and terminal compartment cover. Remove the transparent insulating cover from the terminal enclosure.

> **WARNING**
>
> **Removal of the plastic insulating cover may expose the user to potentially lethal voltages if the electrical supply is not disconnected first. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.**
>
> **Removal of the sensor compartment cover may expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.**

2. Refer to figure 5.6. Disconnect the beige band heater wires from terminal block TB8 (1 & 2) on the terminals PCB. Withdraw the heater wires into the sensor compartment. Take note of the wire route within the sensor head and ensure that the new heater wires are routed in the same manner.

3. Refer to figure 5.9. Undo the 2 off 1/8" compression fittings and remove the calibration / blowback pipe.

4. Refer to section 5.11 and remove the zirconia cell (if fitted).

5. Refer to section 5.12 and remove the combustibles cell (if fitted).

6. Refer to section 5.13 and remove the cell connector.

7. Refer to section 5.17 and remove the over temperature thermostat.

8. Refer to section 5.18 and remove any thermistors fitted.

9. Note the orientation of the band heater tensioning screw. Loosen the band heater tensioning screw and slide the band heater off the filter block.

10. Replace using the reverse procedure.

NOTES

When refitting the band heater over the filter block. Orientate the clamping screw at the 45° position as shown in 5.9. For optimum band heater reliability torque the tension screw to 3-5 Nm.

The top of the band heater should be between 0 and 5mm below the top face of the filter block.

6 DIAGRAMS

The following electronic circuit diagrams are included as part of this service manual.

Table 6.1 - Included drawings list

Drawing No.	Description
02720/121	Sensor head terminals PCB circuit diagram (2 sheets),
02710/103	Control unit PCB circuit diagram (8 sheets), *models B & C.*
02720/122	Sensor head terminals PCB circuit diagram (2 sheets), *models B & C.*

APPENDIX A DETAILED ANALYSER PERFORMANCE TESTING

A.1 Notes and conditions

The performance tests detailed in this section are based on the factory test specification for the 2700 analyser.

WARNING

The electrical power used in this equipment is at a voltage high enough to endanger life. It is essential that only suitably trained and competent personnel are allowed access to hazardous live parts.

It may be necessary to fault find with the electrical power connected. Where this is necessary extreme caution should be exercised.

Removal of the plastic insulating covers in the control unit may expose the user to potentially lethal voltages resulting from external electrical connections to the relay contacts even when the electrical power is disconnected from the control unit itself.

Carbon monoxide is a toxic gas. When sampling gases containing carbon monoxide ensure that adequate precautions are taken to ensure that any vented gases are safely extracted.

The sensor head is heated and may be attached to a hot flue. The external surfaces will be uncomfortably hot even after power down for several hours. Exercise care when handling the sensor head even when un-powered on a hot flue.

A.2 Gas samples required

The gas samples required to adjust and test the analyser depend on the configuration of the analyser under test. Refer to table A.1. The gas samples are attached to the calibration gas inlet port. The inlet pressure and flow should be controlled externally to give a gas flow rate of 600 ± 20 ml/min.

Table 11 - Utility gas sample requirements						
Service	**Gas**	**Press. psig**	**Flow l/min**	**O_2**	**COe**	**Dual**
Aspirator supply	Regulated clean dry air	0-10	0-2	✓	✓	✓
Calibration gas O_2 'HIGH CAL' COe 'LOW CAL'	Regulated clean dry air	0-10	0.6 $\pm$0.020	✓	✓	✓
Calibration gas O_2 'LOW CAL'	0.3% O_2 balance N_2 *	0-10	0.6 $\pm$0.020	✓	✗	✓
*calibration gas composition can be between 0.25% and 2.5% O_2 in N_2						
Calibration gas COe 'HIGH CAL FOR 01750702 SENSOR'	1000 ppm(v) CO balance air **	0-10	0.6 $\pm$0.020	✗	✓	✓
Calibration gas COe 'HIGH CAL FOR 01750703 SENSOR'	2500 ppm(v) CO balance air ***					
** calibration gas composition can be between 500 ppm(v) to 1,000ppm(v) in air depending on the measuring range selected ***calibration gas composition can be between 1,000 ppm(v) to 3,000ppm(v) in air depending on the measuring range selected						

A.3 Visual inspection

Check that all wiring is neatly dressed and securely terminated. Check both sensor head and control unit for loose or damaged O ring enclosure seals.

In the sensor head terminal box:-

- Check voltage selection link is set to the appropriate supply voltage and the correct voltage label is fitted.
- Check fuse F1 fitted is 6.3A (voltage independent).

In the control unit:-

- Check that the transformer primary flying lead is connected to the correct socket. PL7 for 110V (nominal) or PL6 for 240V (nominal).
- Check that the fuse F1 fitted is 3.15 A for 110V (nominal) or 1.6 A for 240V (nominal).

A.4 Sensor head leak test

Seal the calibration gas inlet, the aspirator air inlet, sample vent port and the internal reference air pipe (not applicable for COe only version). Connect a manometer to the sample inlet port and pressurise the internal pipework to between 500 and 600 mm WG. Seal the manometer and ensure that the level does not fall by more than 5mm in 2 minutes.

CAUTION

Extreme care should be exercised when using leak detection fluids such as "SNOOP" with the sensor head assembly. Avoid wetting any electrical components. Special care should be exercised to avoid wetting the band heaters, thermistors, thermostats, Tfx ceramics and glass fibre insulated wires.

A.5 Interconnection tests

Connect the controller to the sensor head using test cable looms. Ensure that all interconnections are correctly wired and terminated in accordance with interconnection drawings in section 2 of this manual.

A.6 Initial power up

Connect the sensor head to nominal required power supply. If necessary adjust RV2 on the control PCB (viewing angle adjustment for the LCD display) to give the best display contrast when viewed perpendicularly from the front.

From a cold start, verify that the aspirator solenoid valve operates after a time interval of not less than 15 minutes and not more than 60 minutes after power on. The precise time interval will depend on the sensor head configuration.

A.7 Analogue output span set up

Perform the following tests.

- If a zirconia sensor is fitted then select the set analogue outputs option in the service menu and select 20mA for the oxygen analogue output. If necessary adjust RV4 on the control PCB until the analogue output reads 20.00 ±0.01 mA.
- If a combustibles sensor is fitted then select the set analogue outputs option in the service menu and select 20mA for the combustibles output. If necessary adjust RV3 on the control PCB until the analogue output reads 20.00 ±0.01 mA.

A.8 Relay operation test

Perform the following tests.

- Select the set relay outputs option in the service menu and select "disable". Verify that terminals 2 and 3, 5 and 6, 8 and 9, 11 and 12 on terminal block TB4 are short circuit. Verify that terminals 1 and 3, 4 and 6, 7 and 9, 10 and 12 are open circuit.
- Select the set relay outputs option in the service menu and select "enable". Verify that terminals 2 and 3, 5 and 6, 8 and 9, 11 and 12 on terminal block TB4 are open circuit. Verify that terminals 1 and 3, 4 and 6, 7 and 9, 10 and 12 are short circuit.

A.9 Sensor head temperature control

Wait until both the sensor head and control unit have both been switched on for a minimum of 90 minutes. Perform the following tests.

- Verify that the green LED on the terminal PCB is flashing at approximately equal intervals, indicating that the block temperature is under control.
- Check the final stabilised sensor head temperature by measuring the voltage between pins 1 and 2 (ground) on terminal block TB3 in the sensor head terminal box. This voltage should be 6.6 ±0.4 V.
- Select the VIEW option from the main menu. Check that the zirconia sensor temperature is 700±10 °C.
- Check that the combustibles sensor temperature is 300±20°C.

A.10 Sensor head sample flow and vacuum test

With the sensor head power on and at stable temperature perform the following tests.

- Blank off the calibration gas inlet. Attach a manometer to the sample inlet. Increase the compressed air pressure at the sample inlet to 4 psig. The vacuum at the sample inlet should be greater than 210mm WG.
- Attach a 500 ml/min flow meter to the sample inlet. With the aspirator supply pressure set to 4 psig the sample flow rate should be in the range 250 - 450 ml/min.
- Adjust the aspirator air supply pressure until the flowmeter indicates a flow of 300ml/min (O_2 only) or 240 ml/min (COe only or dual sensor). Check that the aspirator air supply pressure is in the range 3 to 7 psig.

A.11 Combustibles sensor zero adjustment

If a combustibles sensor is fitted then perform the following adjustments:

- Ensure that the unit has been sampling ambient air for at least 5 minutes before making the following adjustments.
- Check that switch SW2 on the control PCB is set to zero position.
- Select the VIEW option in the main menu and observe the combustibles sensor output voltage. If the voltage measured is negative then set switch SW3 to the upper position. If the voltage is positive then set switch SW3 to the lower position.
- Adjust switch SW2 clock wise one step at a time until the voltage is less than 60 mV (positive or negative). Note that there will be a delay of up to 30 seconds between a switch change and a voltage change.

A.12 Sensor calibration

WARNING

Connect analyser vent to an extraction system for the remainder of this test.

With the sensor head power on and at stable temperature perform the following adjustments.

- With an air sample applied to the calibration gas inlet at 600±20 ml/min flow rate perform a HIGH point calibration of the zirconia sensor (if fitted) and a LOW point calibration of the combustibles sensor (if fitted).
- With a nominal 0.3% O_2 in N_2 sample applied to the calibration gas inlet at 600±20 ml/min flow rate perform a LOW point calibration of the zirconia sensor (if fitted). Verify that the analyser display reads within 0.01% O_2 of the given gas concentration.
- If a combustibles sensor is fitted perform the following tests. With a nominal 500ppm CO in air sample applied to the calibration gas inlet at 600±20 ml/min flow rate perform a HIGH point calibration of the combustibles sensor (if fitted). Verify that the analyser display reads within 2 ppm CO of the certified gas concentration.
- Disconnect the calibration gases. With the analyser sampling instrument air through the sample inlet port verify that the analyser display reads 20.95±0.1% O_2 and/or 0±3 ppm combustibles.

APPENDIX B ANALYSER SOFTWARE 'SUPER CALIBRATION' MODE

B.1 Introduction

This section details the super calibration functions of the Servomex 2700 analyser. This includes configuration of the analyser, ie. Installing transducers, as well as the functions available for service and calibration use.

B.2 Menu Structure

To enter supercal mode, use procedure described in Section B.3.

- Configure Coe
  - Coe Range
  - Precision
- Restore Defaults

B.3 Accessing Super Calibration

Access to the Super Calibration function is via a special key sequence. Starting from the Measure screen, the sequence is as follows.

Press <Menu> select the CONFIGURE option.
Press <Enter>.
Enter 1812 as the password in the space provided and then press <MENU>.

This causes the top level Super Calibration menu to be displayed.

NOTE

If 1812 is entered as a password and the <ENTER> key is pressed instead of <MENU> the analyser will enter the normal configuration menu.

B.4 Configuring the Combustibles Sensor

From the top level Super Calibration menu:

CONFIGURE COe
RESTORE DEFAULTS

Select CONFIGURE COe. The screen will then show:

COe RANGE
PRECISION

Select COe RANGE.

> **NOTE**
>
> This is the Display Range setting and must not be confused with the working range of the combustibles sensor. If the combustibles measurement exceeds the value set via this menu, then the DISP OVER RANGE fault message will appear.

The factory default display range is 10000ppm for the 01750702 combustibles sensor. If a 01750703 combustibles sensor is fitted, the display range must be reset to 30000ppm

If a 01750703 sensor is fitted, set the display to read "0 - 030000ppm" and press <ENTER>

The screen will then show:

mV/10000ppm
150mV

This sets the level at which the COe mV OUTPUT LOW fault message appears. 150mV is the default setting and is the correct value for 01750702 sensors. If a 01750703 sensor is fitted, set this value to 50mV, then press <ENTER>.
The analyser will then return to the CONFIGURE COe/RESTORE DEFAULTS menu.

B.5 Setting the Display Precision of the Combustibles Measurement

The combustibles measurement defaults to a display resolution of 1ppm. If this level of resolution is not required, or process conditions are noisy, the display resolution may be rounded to the nearest 10ppm or 100ppm.

To alter the Default setting select CONFIGURE COe. The screen will then show:

COe RANGE
PRECISION

Select PRECISION.

The display will then show:

PRECISION
1/10/100

Move the cursor to 10 for 10ppm resolution (ie 1 digit blanked) or 100 for 100ppm resolution. Then press <ENTER>. The analyser will then return to the CONFIGURE COe/RESTORE DEFAULTS menu.

B.6 Returning to Factory Default Settings

The analyser may be returned to its factory default settings through the Super Calibration menu.

> **NOTE**
>
> This will restore all default settings including relay and analogue output assignments, calibration targets and tolerances and alarm settings in addition to the combustibles sensor settings.

From the CONFIGURE COe/RESTORE DEFAULTS menu, select RESTORE DEFAULTS. The display will then show:

RESTORE DEFAULTS
ACCEPT Y/N

Select Y and press <ENTER> to restore factory default settings. If this is done the display will then show:

RESTORING DATA
PLEASE WAIT

and will then return automatically to the CONFIGURE COe/RESTORE DEFAULTS menu.

B.7 Exiting Super Calibration

Press <MEASURE> at any time to leave the Super Calibration menu.