700B
Oxygen Analyser

Instruction Manual

Ref : 00700 / 001B / 9
Order as part No. 00700 001B

NOTES

GENERAL SAFETY INFORMATION

Servomex oxygen analysers are sophisticated devices intended for use by qualified personnel only. It is necessary that this manual be read and understood by those who will install, use and maintain this equipment.

USE OF WARNING, CAUTION AND NOTE

This publication includes WARNING, CAUTION and NOTE information where appropriate to point out safety related or other important information.

WARNING - Hazards which may result in personal injury or death.

CAUTION - Hazards which may result in equipment or property damage.

NOTE - Alerts to pertinent facts and conditions.

ELECTRICAL SAFETY WARNING

1. THE ELECTRICAL POWER USED IN THIS EQUIPMENT IS AT A VOLTAGE HIGH ENOUGH TO ENDANGER LIFE.
2. BEFORE CARRYING OUT MAINTENANCE OR REPAIR, PERSONS CONCERNED MUST ENSURE THAT THE EQUIPMENT IS DISCONNECTED FROM THE ELECTRICAL SUPPLY AND TESTS MADE TO VERIFY THAT THE UNIT IS DISCONNECTED.
3. WHEN THE SUPPLY CANNOT BE DISCONNECTED, FUNCTIONAL TESTING, MAINTENANCE AND REPAIR OF THE ELECTRICAL UNITS IS TO BE UNDERTAKEN ONLY BY PERSONS FULLY AWARE OF THE DANGER INVOLVED AND WHO HAVE TAKEN ADEQUATE PRECAUTIONS.

WARNING

This 700B analyser is not suitable for use in hazardous areas without a suitable purge.

CAUTION

To maintain the analyser's performance only spares of suitable quality should be used to repair this analyser. These should be obtained from either Servomex, its associated companies or local agents.

NOTICE

RETAIN THIS MANUAL FOR FUTURE REFERENCE

The 00700B Oxygen and Combustibles Analyser complies with the European Community "Electromagnetic Compatibility Directive" 89/336/EEC by the application of the following:

A Technical Construction File No. 00700-P-004-1 dated 20.11.95 and
Test Reports No. 5044/9Y7 and 5044/9N8 issued by:

ERA Technology Ltd, Cleeve Road, Leatherhead, Surrey, KT22 7SA

The 00700B complies with the European Community "Low Voltage Directive" 73/23/EEC and the "CE Marking Directive" 93/68/EEC and are rated in accordance with:

IEC664 for "Installation Category II" which is characterised as being local level (i.e. not distribution level), appliances and portable equipment with over-voltage impulse withstand up to 2500V.

The 00700B is CE marked (when fitted with external mains filter) for the European Community "Electromagnetic Compatibility Directive" 89/336/EEC only. It also complies with the transitional arrangements of the European Community "ATEX Directive" 94/9/EC.

700B OXYGEN ANALYSER

INSTRUCTION MANUAL CONTENTS

SECTION

1	INTRODUCTION
2	ANALYSER DESCRIPTION
3	INSTALLATION
4	OPERATION
5	MAINTENANCE
6	FUNCTIONAL DESCRIPTION AND SPECIFICATION
7	RECOMMENDED SPARES AND PARTS LIST

APPENDICES

APPENDIX

1	INTERCONNECTIONS - OXYGEN ONLY
2	INTERCONNECTIONS - OXYGEN AND COMBUSTIBLES
3	CABLE SCHEDULES
4	PURGE DETAILS

NOTES

SECTION 1 : INTRODUCTION

LIST OF CONTENTS

SECTION		PAGE
1.1	**INTRODUCTION TO 700B**	1.3
1.2	**ANALYSER OVERVIEW**	1.3
	1.2.1 Product Identification	1.3
1.3	**HAZARDOUS AREA USE**	1.4
1.4	**OPTIONS**	1.4

NOTES

SECTION 1 INTRODUCTION

1.1 INTRODUCTION TO 700B

This manual provides descriptive information, installation and maintenance instructions for the Servomex 700B combustion gas analysers.

It is divided into the following sections covering :

Section 1	Introduction to the 700B
Section 2	Description of the analyser, its operating principle and options
Section 3	Installation of the analyser and user connections
Section 4	Operating instructions
Section 5	Maintenance, fault diagnosis and repairs
Section 6	Functional description and specification
Section 7	Recommended spares and parts lists

1.2 ANALYSER OVERVIEW

The Servomex 700B Zirconia Oxygen analyser measures combustion and similar gases to provide an analysis of oxygen concentration. Where the relevant option is fitted, indication of the level of unburned combustibles is given.

The system comprises two units, a sensor head and a control unit with display and keypad.

A comprehensive range of sample probes and filters is available to enable the analyser to be used in a wide range of applications and process conditions, including sample gas temperatures of up to 1800^{O}C (3200^{O}F). It can be adjusted to operate on all common supply voltages and frequencies.

1.2.1 Product Identification

The individual units of the analyser (sensor head and control unit) all have serial numbers. The serial number of the sensor head will be found in the centre of the sensor head cover. It is in the form 714/XYZ/NNN where 714 is the model number of the sensor head, XYZ is the model variant and NNN is the serial number.

The serial number of the control unit will be found on a label attached to the inside of the door. It is of the form 722/NNN where 722 is the model number of the control unit and NNN is the serial number.

A label identifying the analyser as a whole is also fixed to the control unit. This label has the following information:

Identification number	e.g. 807387
Software	e.g. 722/652/2
Date tested	
Picture code	

When ordering spare parts it will assist if the identification number and the serial number of the relevant unit are quoted.

1.3 HAZARDOUS AREA USE

The standard unpurged 700B is suitable only for use in safe areas.

The 700B control unit and sensor head for installation in hazardous areas may also be purged.

1.4 OPTIONS

Options available include isolated analogue output and alarms, a data link, facilities for calculating and displaying flue gas temperature and combustion efficiency (using an external thermocouple).

The analyser requires a supply of compressed air to aspirate the sample. A range of air regulator sets are available.

SECTION 2 : ANALYSER DESCRIPTION

LIST OF CONTENTS

SECTION **PAGE**

2.1 INTRODUCTION 2.3

2.2 CONTROL UNIT DESCRIPTION 2.3

2.2.1 Keypad 2.3
2.2.2 Display 2.3
2.2.3 Control Unit Functions 2.4

2.3 SENSOR HEAD DESCRIPTION 2.5

2.4 AIR REGULATOR UNITS 2.7

2.4.1 Oxygen Analyser 2.7
2.4.2 Oxygen and Combustibles Analyser 2.7
2.4.3 Oxygen and Combustibles Analyser with Auxiliary Air and Calibration 2.7

2.5 MOUNTING FLANGE 2.8

2.5.1 Welded Flange 2.8
2.5.2 Bolt-On Flange 2.8

2.6 PROBE TUBES 2.9

2.7 OUTPUTS AND ALARMS 2.9

2.7.1 Standard Outputs 2.9
2.7.2 Isolated Oxygen and Combustibles Output Card 2.9
2.7.3 Isolated Oxygen Output and Alarm Card 2.9
2.7.4 Data Link 2.10
2.7.5 Temperature and Efficiency Card 2.10

LIST OF ILLUSTRATIONS

FIGURE **PAGE**

2.1 Analyser Block Schematic 2.4

2.2 Sensor Head Flow Schematic 2.6

2.3 Flow Schematic - Air Supply and Calibration Unit 2.8

NOTES

SECTION 2 ANALYSER DESCRIPTION

2.1. INTRODUCTION

The analyser comprises two separate units, the sensor head and the control unit, which may be mounted up to 300m apart. Refer to Appendix 3.

The sensor head mounts directly onto the flue with a probe tube which projects through the duct wall into the process gas to draw out a sample for analysis. It contains a zirconia cell to measure the oxygen content of the flue gases and a flow sensor to monitor the flow of the sample gas. An optional combustibles sensor may also be fitted. The power for the sensor head is derived from the control unit.

The control unit, which is remote from the sensor head, provides power supplies to the sensors and heaters. It also processes the output signals from the measuring cells to provide the output indications, and houses the option cards to provide additional features.

2.2 CONTROL UNIT DESCRIPTION

The control unit houses the power supplies, microprocessor, membrane keypad, display, option cards, output circuits for the system and the combustibles electronics, when specified. The unit is designed for surface mounting.

The basic control unit contains two circuit boards. The first is mounted on the door and carries the membrane keypad and the display with associated electronics.

The second board is the main motherboard and is mounted on a chassis in the rear of the enclosure. It carries the analogue input and output circuits and, at the right hand, the power supply for the electronics and the low voltage ac power for the zirconia cell heater.

The supply voltage is monitored by the microprocessor. If the voltage falls to a level at which the electronics cannot operate, the instrument puts itself in a safe condition and then ceases normal operation. When possible, in this condition a 'POWER FAIL' message is displayed. Normal operation is automatically resumed when sufficient voltage is restored.

2.2.1 Keypad

The keypad is used to control the display and operating parameters of the system. Certain functions, which affect the output and control signals from the unit, are accessible only by entering a password.

2.2.2 Display

The unit has a 12 character alphanumeric display. Normally this displays the oxygen and/or combustible content of the sample; but, when the instrument is being calibrated or the operating parameters are being adjusted, it displays prompt messages to ensure that the correct sequence of operations is carried out. It will display messages which permit diagnosis of faults and interrogation of alarms which may arise within the analyser. If the temperature and efficiency option is fitted, flue gas temperature and combustion efficiency can be displayed.

2.2.3 Control Unit Functions

The main board of the control unit inputs the analogue signals from the sensors via a 12 bit A to D converter. The microprocessor processes the signals, provides temperature control of the zirconia cell and the sample block and generates outputs to the display, alarms and analogue outputs.

Data is stored in a permanent memory (EEPROM) which does not require battery back-up.

The programme run by the microprocessor is monitored by a Watchdog. In the event of a malfunction a microprocessor reset is automatically performed by the Watchdog.

If either the zirconia cell or sample block temperature goes out of limits for more than 30 minutes the control unit shuts down and generates a 'SYS. FAIL' message to protect the analyser and indicate a fault.

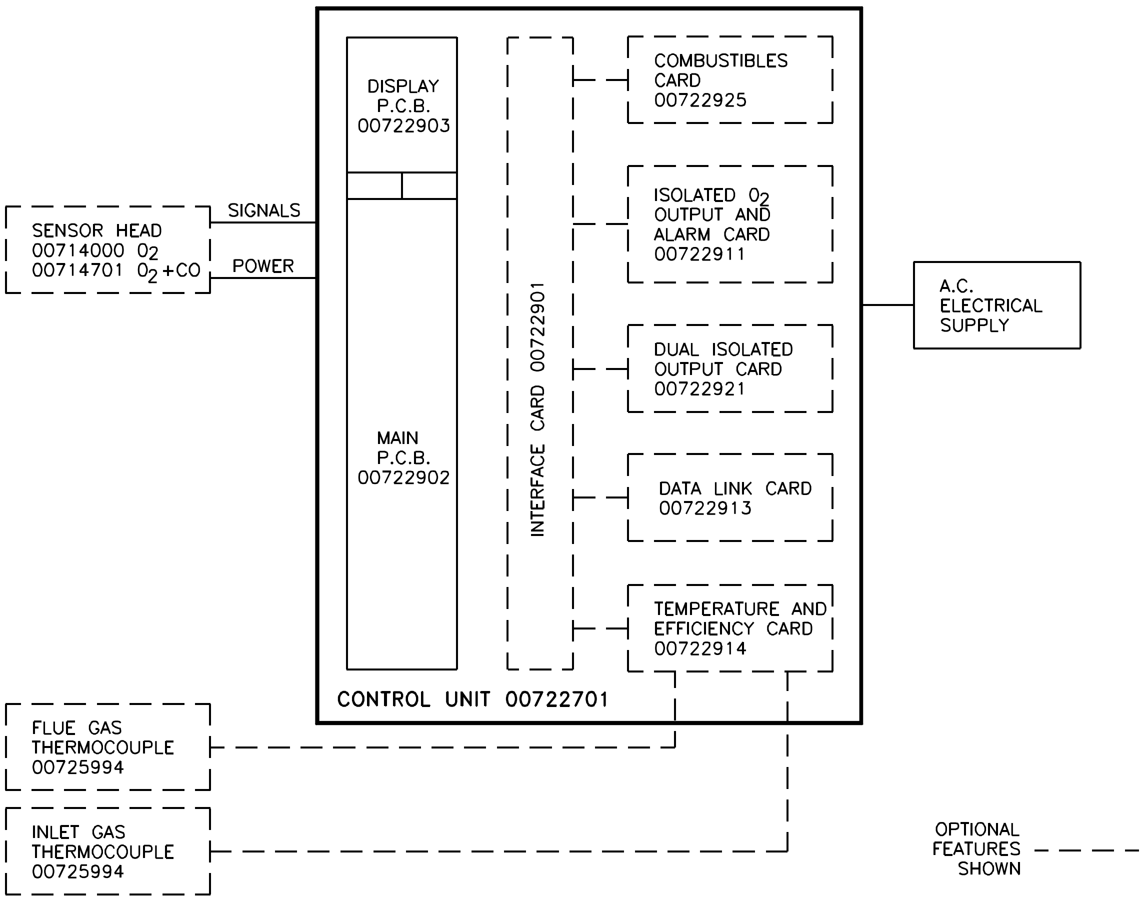


Figure 2.1 Analyser Block Schematic

An interface adaptor card, to which option cards may be plugged, is fitted when options are specified. Up to 6 cards may be fitted to the interface adaptor card. See Figure 2.1.

When the optional combustibles sensor is fitted, its temperature is controlled independently by the combustibles card which occupies two positions on the interface adaptor card.

2.3 SENSOR HEAD DESCRIPTION

The sensor head is designed for industrial use in process plants. It is designed to IP55 (NEMA 4) to withstand dust concentration and spray water.

Parts containing sample gas within the sensor head are maintained at 200^{o}C (392^{o}F) to avoid sample condensation.

The oxygen and optional combustible sensors are mounted external to the flue. Sample gas is drawn through the sensors by means of an air driven aspirator.

The oxygen content of the sample is measured with the well-proven Servomex zirconia cell.

The optional combustibles sensor is a Constant Temperature Catalytic (CTC) sensor and is used to determine the level of combustible gases (expressed as carbon monoxide) in the sample stream.

The oxygen and combustibles sensors are independently temperature controlled. The operating principles of the sensors are described in Section 6.

In order to provide a reading of combustible gases in the sample under reducing conditions, Servomex has adopted a parallel arrangement of the sensors. In this arrangement an optional supplementary air bleed to the combustibles sensor can be provided to ensure complete oxidation of the combustible gases when the oxygen content of the sample gas is low.

It is recommended that exhaust gases are returned to the process. Some probe options do allow venting to atmosphere.

Referring to Figure 2.2, the following description assumes that the combustibles option is fitted.

The aspirator (10), operated by compressed air, draws sample gas from the flue at a flow of about 300ml/min through the filter (1). The flow is divided in the ratio 2:1 by the restrictors (3). These restrictors and the one down stream of the oxygen measuring cell (6) also act as flame traps to isolate the hot cell from the process. This prevents the possibility of an explosion should a high concentration of flammable gases be present in the sample at high oxygen levels.

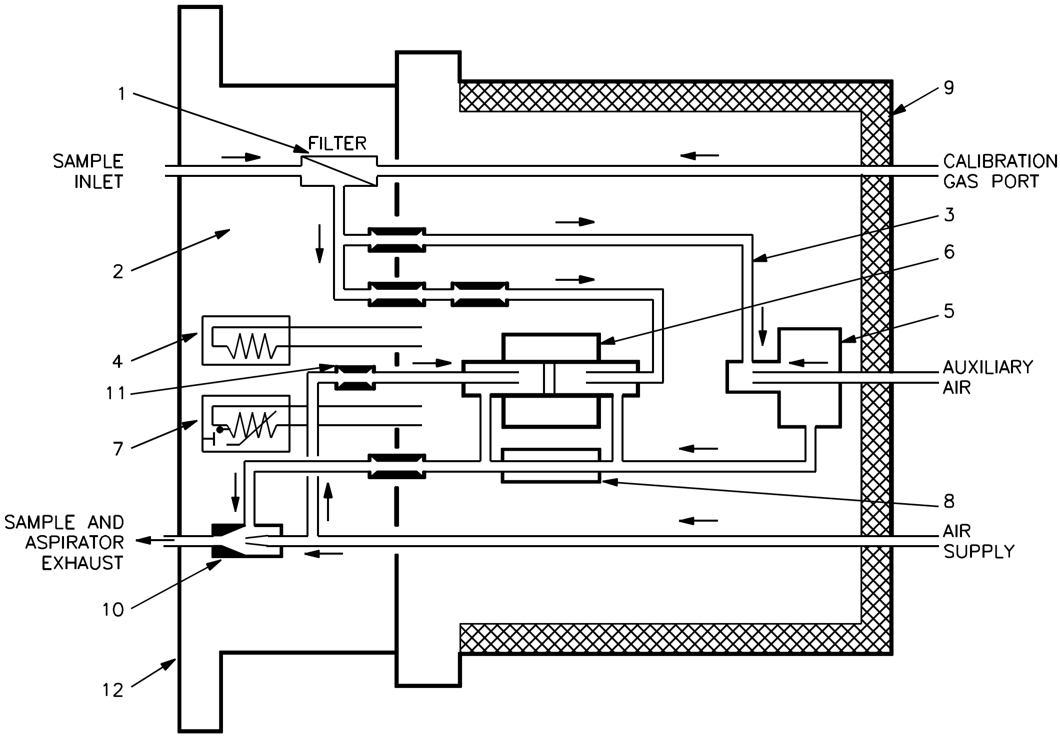


Figure 2.2 Sensor Head Flow Schematic

A small portion of the aspirator air supply is tapped via the capillary restrictor/flame trap (11) to provide a reference oxygen level in the reference side of the oxygen measuring cell (6).

The total sample gas flow is monitored by the flow sensor (8) which initiates an alarm if the sample flow drops below a preset level.

Sensor (5) is fitted to measure the combustibles content of the sample. Should there be insufficient air in the sample to ensure complete combustion of the gases an auxiliary air supply can be fitted. The auxiliary air flow rate, which has to be strictly controlled, is mixed thoroughly with the sample gas before being presented to the combustibles sensor in order to obtain a true reading.

If combustibles analysis is not required, the sensor is replaced by a bypass tube to maintain the same sample flow rate.

The sample block (2) is heated by the cartridge heater (4). The block temperature is monitored by the temperature sensor (7).

The sensor head is mounted onto the flue by the flange (12).

The insulated cover (9) reduces the heat loss from the sensor head.

Calibration gases are introduced via the calibration gas port at a pressure above that in the flue.

The calibration gas port, filter and probe tube are arranged in-line so that the probe tube may be tested without the need to demount the sensor head from the process.

The terminal block on the sensor head contains voltage selector links to adapt the unit to the local supply voltage.

2.4 AIR REGULATOR UNITS

Three types of air regulator unit are available which are designed for different applications. In all cases inlet air pressure should be in the range 0.6 - 6 barg (10 - 100 psig).

2.4.1 Oxygen Only Analysers

This is a simple air pressure regulator which controls the air pressure applied to the aspirator in the sensor head to within ± 70mbarg (±1psig).

2.4.2 Oxygen and Combustibles Analysers

When the combustibles content of a sample is being measured, the output of the combustibles sensor is proportional to the quantity of combustible gas flowing through the sensor. This depends on two factors:

a) The absolute concentration of combustible components in the sample.

b) The flow rate of the sample.

Therefore, to obtain a stable measurement, it is necessary to control the flow rate of the sample accurately. This is achieved by controlling the aspirator supply pressure closely using a precision regulator which maintains this pressure to within ±7mbarg (±0.1psig)

2.4.3 Oxygen and Combustibles Analyser with Auxiliary Air and Calibration Unit

In those cases where the concentration of combustible gases means that there is an insufficient quantity of oxygen available in the sample stream to perform the combustibles analysis, an auxiliary air supply is necessary to obtain a true measurement. This enables measurement of up to 5% carbon monoxide in the absence of oxygen in the process.

As the output of the combustibles detector depends upon rate of air flow this unit regulates the air flow to tight tolerances. It also includes facilities for introducing calibration gases.

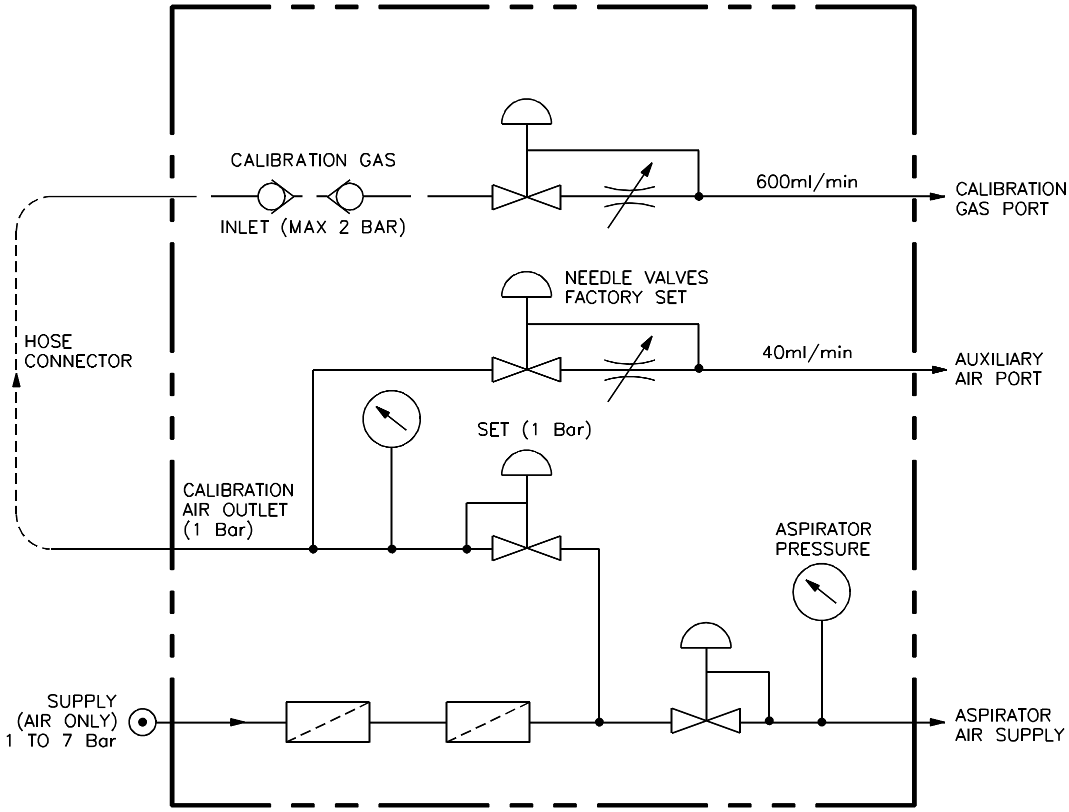


Figure 2.3 Flow Schematic - Air Supply and Calibration Unit

2.5 MOUNTING FLANGE

The flue has to be fitted with a flange for attachment of the sensor head.

The standard flanges are suitable for a skin temperature up to 350°C (662°F). Flanges with a stand-off are used for skin temperatures of 350 - 500°C (662 - 932°F).

Two mounting flange options are available for both standard and stand-off flanges.

2.5.1 Welded Flange

This flange may be either welded directly on to the surface of the flue when it is flat, or to a short length of 4 inch O.D. tube when the flue surface is curved.

2.5.2 Bolt-On Flange

This flange is for bolting to the flue wall when welding is impracticable.

2.6 PROBE TUBES

A wide range of probe tubes, with or without filters, is available. Servomex can advise on the choice of probe for a specific application. Standard probes include:

a) Unsupported filter probes up to 1 metre long for a maximum flue gas temperature of 500°C (932°F).

b) Supported filter probes up to 3 metres long for a maximum flue gas temperature of 500°C (932°F).

c) High temperature alloy probes up to 1m length for a maximum flue gas temperature of 1000°C (1832°F). Longer probes can be used at temperatures below 1000°C, 1.5m up to 800°C, 2m up to 750°C. External filters can be fitted to these probes to suit dusty applications.

d) Ceramic probes up to 1.5 metres long for maximum flue gas temperatures of 1600°C (2912°F).

e) Ceramic probes up to 1.5 metres long for maximum flue gas temperature of 1800°C (3272°F).

2.7 OUTPUTS AND ALARMS (See Section 6 for specifications)

The standard analyser has non-isolated analogue output available from the main board. Option boards can be fitted to give isolated outputs and alarms for gas concentration and analyser status/fault.

2.7.1 Standard Outputs

The standard outputs for oxygen, and combustibles if fitted, are non-isolated and can be selected via the keypad as 0-20 mA or 4-20mA and 0-10V or 2-10V for oxygen ranges of 2.5, 5, 10 and 25% and combustibles ranges of 0.25, 0.5, 1 and 5%

2.7.2 Isolated Oxygen and Combustibles Output Card 00722921

This option card provides isolated current outputs for the oxygen and combustible signals. These outputs can be selected via the keypad as 0-20 mA or 4-20 mA. See Section 6.

2.7.3 Isolated Oxygen Output and Alarm Card 00722911

This option card provides an isolated current and voltage output for oxygen level and a volt free, normally closed contact, to open on alarm, for oxygen level or analyser fault. The output can be selected via the keypad as 0-20mA or 4-20 mA and 0-10V or 2-10V. See Section 6.

The analyser fault alarm will warn of the following:

Low sample flow
Sensor head under or over temperature
Oxygen cell under or over temperature
Oxygen cell output out of limits

In addition to the volt-free contact alarm there are three non-isolated alarms for:

Oxygen high
Oxygen low
Analyser fault (alarms as above)

2.7.4 **Data Link** 00722913

The data link card option enables full duplex communication between the control unit and a computer or dumb terminal via isolated RS232, RS423 or 20mA current loop. The Baud rate is user selectable between 300 and 9600 Baud dependent on the interface and cable distance. Data display modes are selectable. Section 6 gives full details of data protocol.

2.7.5 **Temperature and Efficiency Card** 00722914

This option card provides non-isolated outputs for both combustion efficiency and flue gas temperature (requires the installation of thermocouple in the flue), or when requested from the keyboard, a display of the air inlet temperature (requires a second thermocouple to monitor the air inlet temperature). No electrical output is available for air inlet temperature. Where no inlet temperature thermocouple is fitted an assumed value of ambient temperature may be entered manually. This is necessary for the analyser to perform the efficiency calculation.

The outputs can be selected via the keypad as 0-20mA or 4-20 mA and 0-10V or 2-10V.

Calculation of the efficiency is according to the Siegert equation (BS 845.1972). See Section 6.

Also provided is a non-isolated output for flue gas temperature high alarm.

SECTION 3 : INSTALLATION

LIST OF CONTENTS

SECTION **PAGE**

3.1 INTRODUCTION 3.5

3.1.1 General 3.5
3.1.2 Assembly of 700B System 3.5
3.1.3 Recommended Installation Procedure 3.6

3.2 INSTALLATION OF CONTROL UNIT AND OPTION CARDS 3.7

3.2.1 Control Unit 3.7
3.2.2 Interface Card 3.8
3.2.3 Fitting Option Cards 3.8

3.3 INSTALLATION OF SENSOR HEAD AND PROBE TUBE 3.9

3.3.1 General 3.9
3.3.2 Mounting Flange 3.10
3.3.3 Mounting Flange Orientation 3.11
3.3.4 Weld-on Flange 3.11
3.3.5 Bolt-on Flange 3.12
3.3.6 Sensor Head Orientation Details 3.13

3.4 SENSOR HEAD TO CONTROL UNIT INTERCONNECTIONS 3.13

3.4.1 General 3.13
3.4.2 Heater/Power Cable 3.14
3.4.3 Signals Cable 3.15
3.4.4 AC Electrical Supply 3.16

3.5 OUTPUT CONNECTIONS 3.19

3.5.1 General 3.19
3.5.2 Main Board Oxygen Output 3.19
3.5.3 Combustibles Outputs 3.19
3.5.4 Isolated Outputs 3.20

3.6 DATA LINK CARD 3.22

3.7 TEMPERATURE AND EFFICIENCY OPTION 3.23

3.7.1 Temperature and efficiency card 3.23
3.7.2 Installation of Flue and Inlet Air Thermocouples 3.24

LIST OF CONTENTS (Continued)

SECTION **PAGE**

3.8 ASPIRATOR AIR SUPPLY 3.25

3.8.1 Air Regulator Set (Oxygen only analysers) 3.25
3.8.2 Air Regulator Set (Oxygen and combustible analysers) 3.25
3.8.3 Air Regulator Set (Oxygen and combustible analysers with Auxiliary Air) 3.25

3.9 ASSEMBLY OF PROBE TUBES AND SENSOR HEAD 3.29

3.9.1 General 3.29
3.9.2 Unsupported Filter Probe 3.29
3.9.3 Supported Filter Probe 3.31
3.9.4 High Temperature Probe 3.33
3.9.5 High Temperature Probe with Stand-off 3.35

3.10 CALIBRATING GASES 3.37

3.11 CALIBRATION GAS CONNECTIONS 3.37

3.12 COMMISSIONING PROCEDURE 3.37

3.12.1 Initial start-up 3.38

3.13 SHUT DOWN PROCEDURE 3.38

LIST OF ILLUSTRATIONS

FIGURE **PAGE**

3.1 Control Unit Dimensions 3.7

3.2 Fitting Options Cards 3.9

3.4 Sensor Head Dimensions 3.10

3.5A Mounting Flange Orientation - Flat Flue Ducting (Welded Flange) 3.11
3.5B Mounting Flange Orientation - Circular Flue Ducting 3.12
3.5C Mounting Flange Orientation - Flat Flue Ducting (Bolted Flange) 3.12

3.6 Preferred Sensor Head Orientation 3.13

3.7 Interconnection Schematic 3.14

LIST OF ILLUSTRATIONS (Continued)

FIGURE		PAGE
3.7A	Control Unit Signal Connections	3.15
3.8	Split Electrical Supply	3.16
3.9	Supply Voltage Adjustment - Control Unit	3.18
3.10	Supply Voltage Adjustment - Sensor Head	3.18
3.11	Non-isolated Oxygen Output Signal	3.19
3.12	Non-isolated Combustibles Output Signal	3.20
3.13	Open Collector Interface Relay Connections	3.20
3.14	Dual Isolated Oxygen and Combustibles Output Signals	3.21
3.15	Isolated Oxygen Output and Alarm Signals	3.22
3.16	Data Link Connections	3.23
3.17	Temperature and Efficiency Connections	3.23
3.18	Installation of Thermocouples	3.24
3.19	Air Supply Regulator (oxygen only)	3.26
3.20	Air Supply Regulator (oxygen and combustibles)	3.27
3.21	Aspirator, Auxiliary Air and Calibration Unit	3.28
3.22	Installation of Unsupported Filter Probe	3.30
3.23	Installation of Supported Filter Probe	3.32
3.24	Installation of High Temperature Probe	3.34
3.25	Installation of High Temperature Probe with Stand-off	3.36

NOTES

SECTION 3 INSTALLATION

3.1 INTRODUCTION

3.1.1 General

This Section gives details on the installation of the Model 700B analyser and the various options which are available.

Specific standards of safety are not included in this manual, since requirements of relevant authorities vary widely.

The safety precautions described in the following installation instructions ensure that the existing safety features of the analyser are not impaired during installation. The precautions do not guarantee a safe installation if other relevant safety codes are ignored.

WARNING

The installer must satisfy himself that the installation of the analyser and system meets the safety requirements of the relevant local authorities and that the installation is safe. Refer to the general safety information at the front of this manual.

CAUTION

The analyser is not fitted with a switch or other means of disconnecting the electrical supply.

The sensor head must not be left unpowered when exposed to flue gas.

3.1.2 Assembly of 700B System

When unpacking the analyser, remove any packing material from the inside of the control unit and check that the printed circuit boards are securely fixed.

The two units which comprise the analyser are mounted separately. The sensor head and probe tube are mounted directly to the flue and detailed procedures are given later in this Section. The control unit may be mounted at a convenient location up to 300m away. See Appendix 3.

Whenever possible, the system should be assembled and electrical work completed before the sensor head is mounted on the flue. It is recommended thaa sufficient loop of spare cable be provided adjacent to the sensor head. This will allow for the sensor head to be removed from the flue for servicing without the need to disconnect the power and signal cables.

Electrical commissioning and testing can be completed before the sensor head is mounted on the flue. For safety and correct operation, the sensor head must be effectively earthed (grounded).

Two cables are used to connect the sensor head to the control unit . These cables are specified in the Cable Schedules (see Appendix 3). These schedules should be completed when the cables are installed to provide a permanent record of both cables, and as a check that the installation is correct. Cables must comply with local electrical safety requirements.

Cable glands and unused gland holes should be weatherproof to IP standards, see Section 6.1.2.7. Adaptors are included to enable 20mm glands to be used. A gland kit for the 700B is available (part no. 00700999).

Correct installation employing good engineering practice will ensure reliable service and will facilitate maintenance.

Once installed on a working flue, the analyser should be kept powered continuously. A cold, unpowered sensor head should not be mounted on a flue which is being used. This may result in corrosion of the sensor head.

A block schematic diagram of the analyser showing the various options which may be fitted is at Figure 2.1.

3.1.3 Recommended Installation Procedure (for basic analyser without options)

1. Install control unit. (Refer section 3.2)

2. Cut sensor head mounting hole and install flange. Use blanking plate to cover hole. (Refer to section 3.3)

3. Lay cables between control unit and sensor head location.
(Refer to section 3.4)

4. Install air supply and calibration units local to sensor head.
(Refer to section 3.9)

5. Connect cables and air supply to sensor head. (Refer to sections 3.4 & 3.9)

6. Connect external outputs as required. (Refer to section 3.5)

7. Power up analyser and perform function check. (Refer to section 3.13).
Allow 12 hours to warm up.

8. Without powering down, assemble probe tubes and attach sensor head to the mounting flange assembly. (Refer to section 3.10)

9. Fully calibrate analyser and set up parameters as required. (Refer to sections 4.6 & 4.7)

10. The analyser is now fully operational and should be left powered up continuously.

Note : Where options are fitted, the additional installation, both mechanical and electrical, should be incorporated with the above as convenient. (Refer to Sections 3.5, 3.6, 3.7 and 3.8)

3.2 INSTALLATION OF CONTROL UNIT AND OPTION CARDS

3.2.1 Control Unit

The control unit is designed for surface mounting only. Adequate space should be allowed on the left hand side to permit the door to open fully. For details of dimensions, see Figure 3.1.

If the control unit was ordered with options then these will have been fitted by the factory. Sections 3.2.2 to 3.2.4 can be ignored.

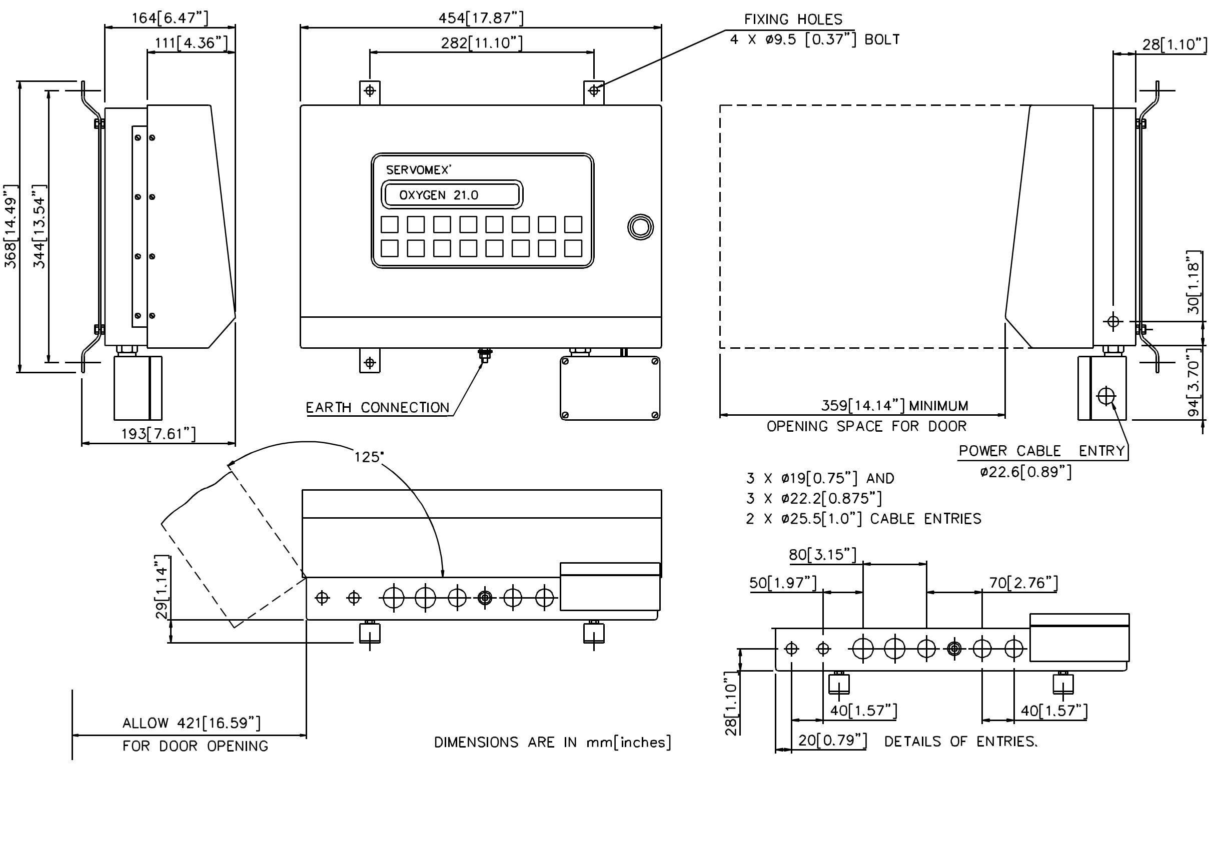


Figure 3.1 Control Unit Dimensions

3.2.2 Interface Card

> **WARNING**
>
> Disconnect the electrical supply before fitting this or any option card.

1. Open the control unit case and plug the interface adaptor card (00722901) into the main board, making sure that the card is correctly orientated, see Figure 3.2 (this card will already be fitted if options were specified originally).

2. Secure the card with the six M3 screws and washers supplied.

3.2.3 Fitting Option Cards

The option cards are fitted to the interface adaptor card (00722901) which is located at the top of the control unit case and plugs in to the multi-pin connectors on the main board (see Figure 3.2).

The interface card has two decks on which option cards may be fitted. Option cards 00722925 combustible and 00722911 isolated oxygen output must not be fitted above one another. The remote keypad option must be fitted in either slot 1 or slot 2. Apart from these exceptions all other options can be fitted in any position.

The option cards can be either single or double size, i.e. they will occupy either one or two option positions.

Remove and retain the nuts and washers from the main board in the position to be occupied by the option card. Fit the spacers (two for single size cards, four for double size cards), where the nuts and washers were removed.

Plug the option card into the multi-way connector, component side to the front. Ensure that the card is correctly positioned on the connector, that all the pins are connected and that the threaded part of the spacers protrudes fully through the card. Secure the card with nuts and washers previously removed.

The software instructions for a given option card installed in a given position is unique to that card/position combination. Therefore, if a card is moved to another position, its parameters and calibration data will have to be re-entered.

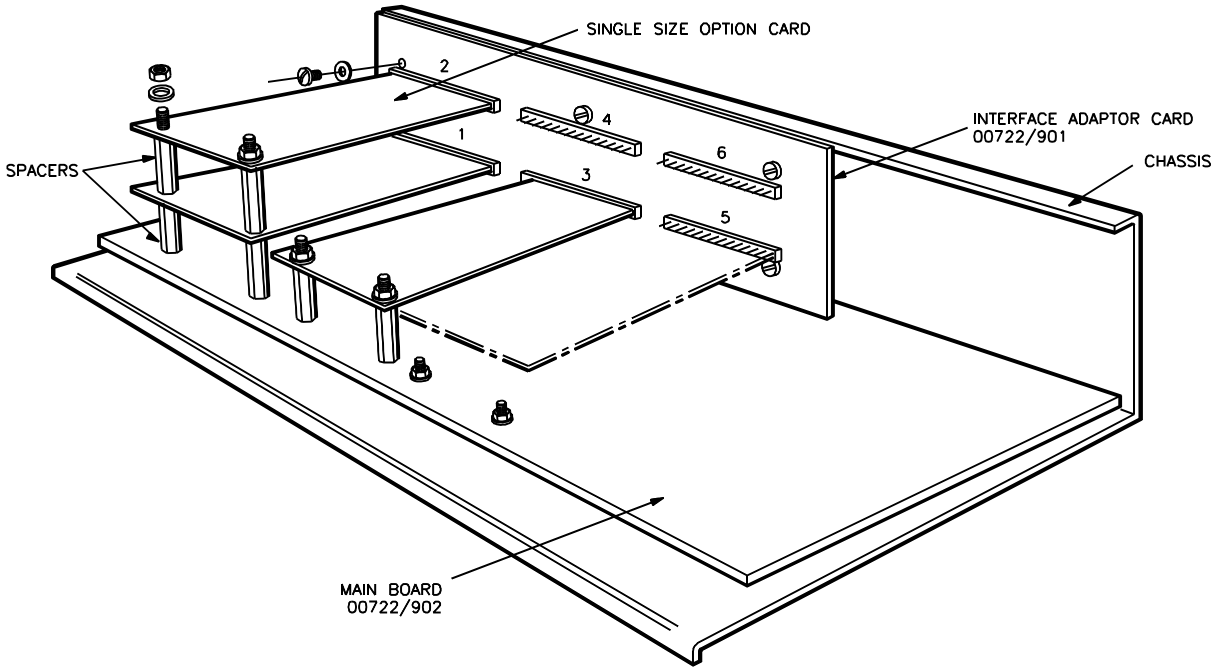


Figure 3.2 Fitting Option Cards

3.3 INSTALLATION OF SENSOR HEAD AND PROBE TUBE

3.3.1 General

The sensor head is designed with a flange to mount to the flue/process duct. It is essential that all the mounting bolts are tightened evenly during installation to prevent the sensor head tilting and thus causing a leak.

Sensor head flange : Outside diameter - 152 mm
4 x M10 (0.375") clearance holes on 120 mm PCD
Material, mild steel

3.3.2 Mounting Flange

Two mounting flange options are available for mating surface temperature up to 350°C.

One flange is designed for use with flues where the wall is thick enough to permit the flange to be welded to it.

The second flange is designed to be bolted to the flue wall where it is either inconvenient or too thin to permit welding. This option should not be used with supported filter probes over 1.5m long.

When the flue skin temperature is between 350°C and 500°C, a stand-off can be used to prevent the sensor head from being overheated.

CAUTION

The user should assure himself that the flue wall is strong enough to support the weight of the sensor head and probe tube.

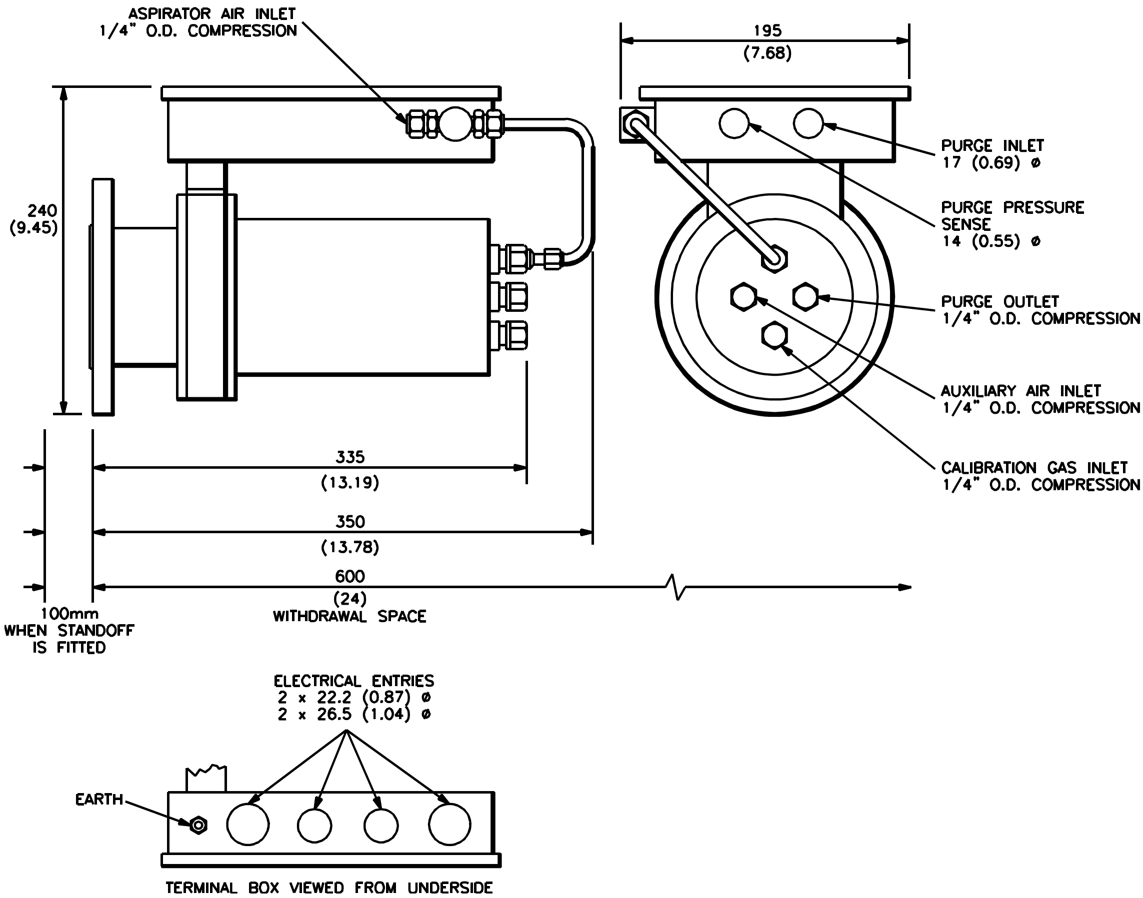


Fig 3.4 Sensor Head Dimensions

Note : 1. If the flue is brick lined, ensure that the full diameter of the probe hole is maintained through the brickwork and is in line with the flange.

2. If the probe is not to be fitted immediately, the blanking plate and gasket provided should be fitted to the mounting flange. Do not plug the hole with the sensor head. The sensor head must not be left unpowered when mounted on an active flue.

3.3.3 Mounting Flange Orientation

Particular attention must be paid to the orientation of the mounting flange as shown in Figure 3.5A, 3.5B and 3.5C. Plain holes must be positioned on the vertical and horizontal diameters of the flange attached to the flue wall.

3.3.4 Weld-on Flange

Cut a hole 102mm (4 inches) diameter in the wall of the flue and weld the flange to the wall of the duct (refer to figure 3.5A). If the duct is circular, it is suggested that a suitable length of 4 inch O.D tube is used with the ends cut square and welded through the flue wall with about 25 mm protruding from the wall. The flange is then welded to the free end of this pipe. This pipe is not supplied by Servomex. For dimensions see Figure 3.5B.

Note : When a length of tube is used on a circular duct it should be lagged to prevent problems occurring due to excessive heat loss to the atmosphere.

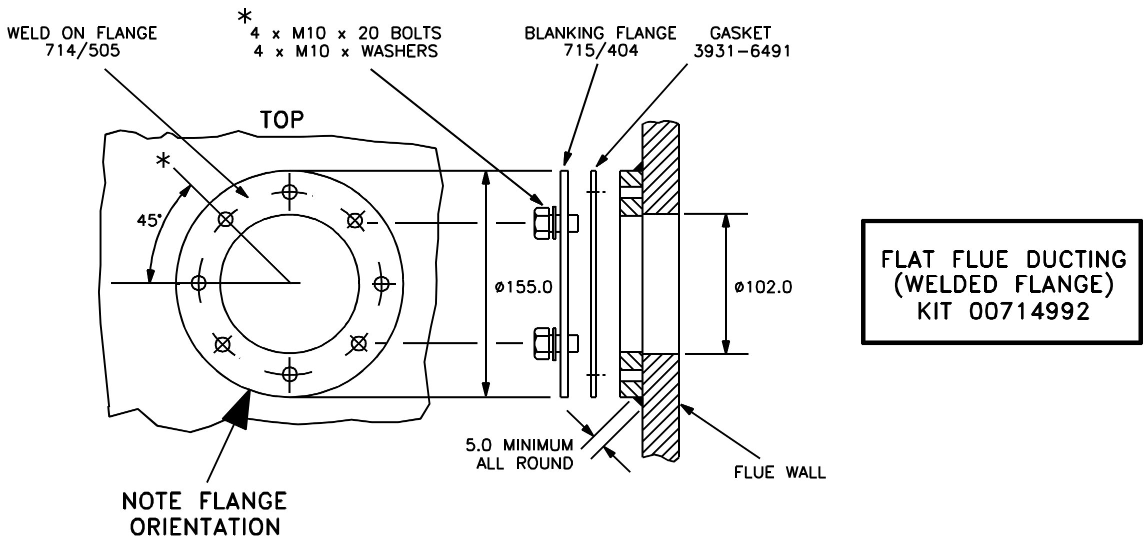


Figure 3.5A Mounting Flange Orientation - Flat Flue Ducting (Welded Flange)

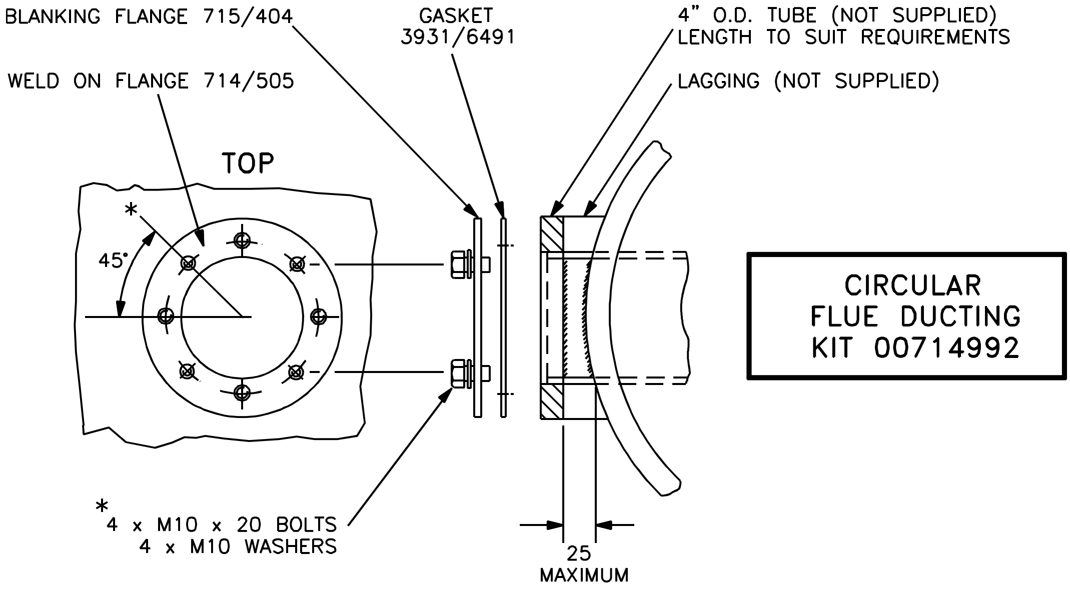


Figure 3.5B Mounting Flange Orientation - Circular Flue Ducting

3.3.5 Bolt-on Flange

This flange may be bolted to the flue wall using screws into tapped holes or by using screws through clearance holes with securing nuts on the inner flue wall. Refer to figure 3.5C.

Cut a hole 96mm in diameter in the wall of the flue. Using the flange as a template drill either four 11mm clearance holes or drill and tap four holes for 10mm studs.

Note that the flange orientation must be correct.

Bolt the flange to the wall of the flue using one of the gaskets provided with the mounting kit and the four M10 caphead screws, nuts and washers. The heads of the screws must be below the mating face of the flange. For dimensions see figure 3.5C.

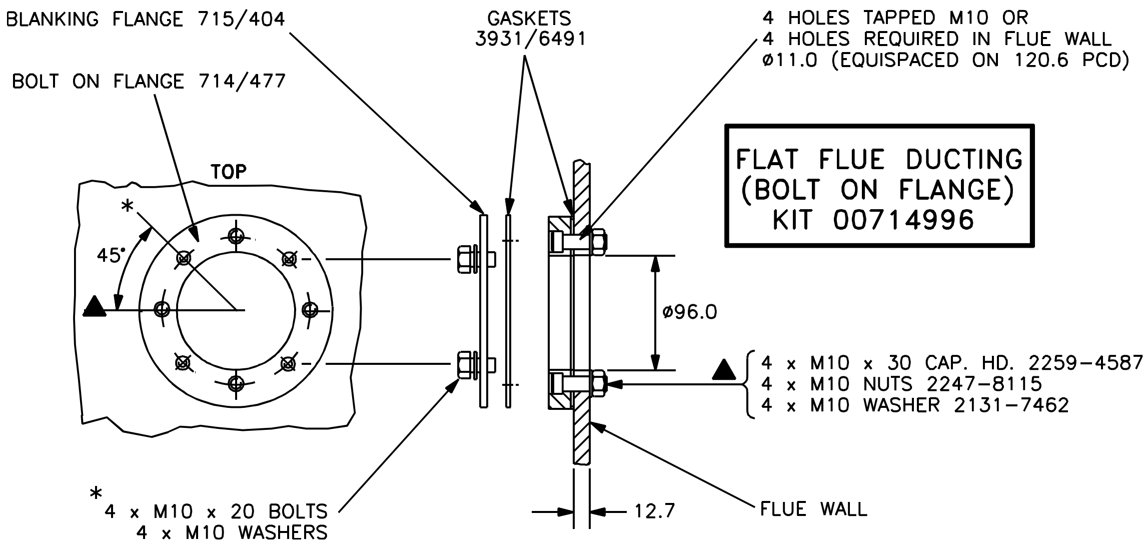


Figure 3.5C Mounting Flange Orientation - Flat Flue Ducting (Bolt-on flange)

3.3.6 Sensor Head Orientation Details

The preferred orientations of the sensor head are shown in Figure 3.6.

If the sensor head is mounted in a non-preferred orientation the accuracy or service life may be reduced.

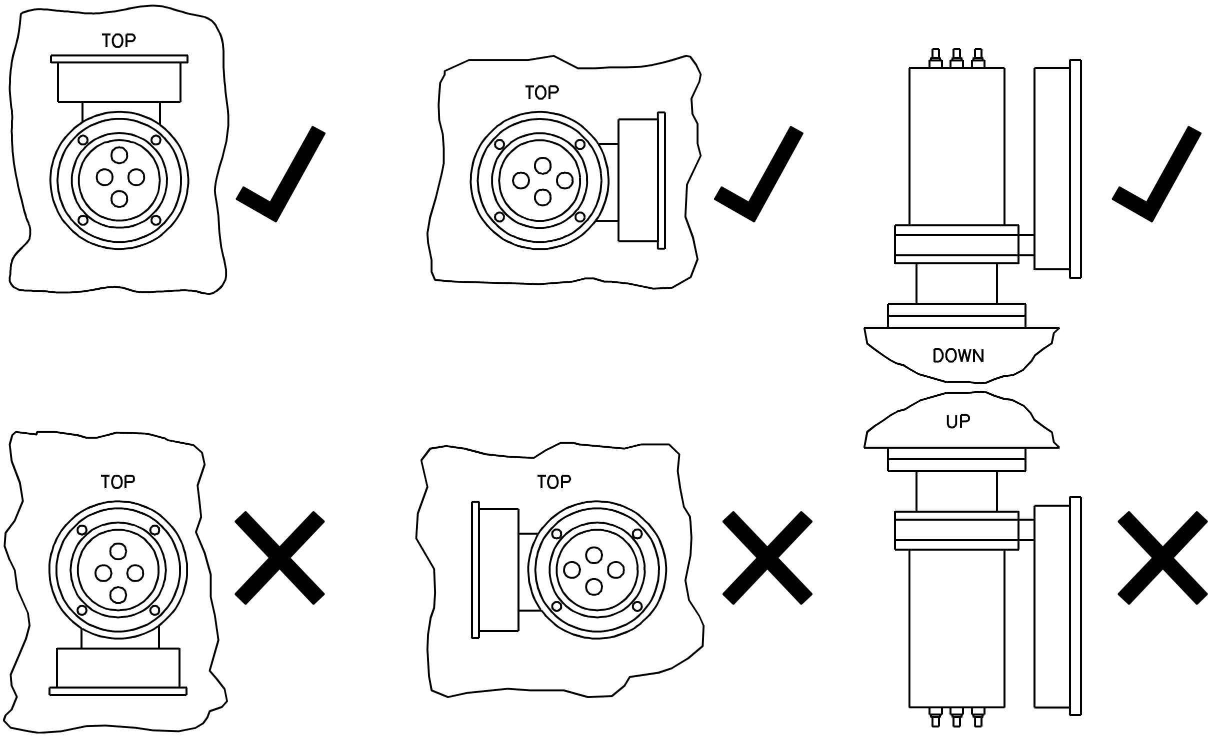


Figure 3.6 Preferred Sensor Head Orientations

3.4 SENSOR HEAD TO CONTROL UNIT INTERCONNECTION

3.4.1 General

Two cables are used to interconnect the sensor head and the control unit. One cable is for heater/power, the other cable is for signals. See Figure 3.7.

Details of the interconnecting cables are in the appendices to this manual.

Appendix 1 - Interconnections - oxygen only

Appendix 2 - Interconnections - oxygen and combustibles

Appendix 3 - Cable Schedules giving details of number of cores and core sizes.

All connections must be made by reference to the appropriate cable schedule which should be completed at the time of installation.

The cable core sizes vary according to cable lengths. Refer to the cable schedules in Appendix 3 for details.

Ensure that link LK9 on the main circuit board is installed. See Figure 5.1

Ensure that terminals 9 and 10 on TB3 in the control unit are linked as shown in the wiring diagram in appendices 1 and 2. See Figure 5.1

If the auxiliary air option is used, the link LK1 on the combustibles card 00722925 must be removed. If the auxiliary air option is not used, then the link must be inserted. See Figure 5.1.

WARNING

All cables should comply with the local electrical regulations.

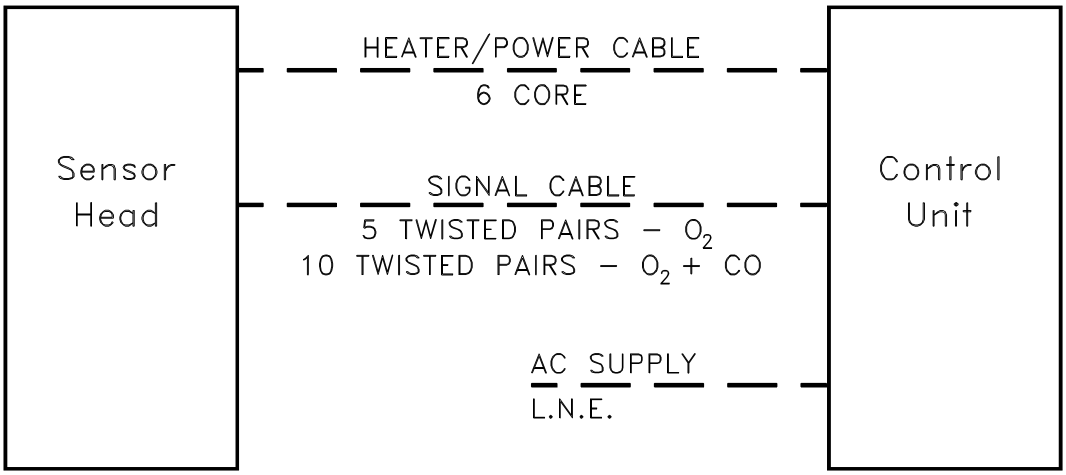


Figure 3.7 Interconnections Schematic

3.4.2 Heater/Power Cable

A cable with 6 cores is used for supplying electrical power for cell heater, enclosure heater and solenoid valve from the control unit to the sensor head.

3.4.3 Signals Cable

A cable with 5 twisted pairs is used for signals from the sensor head to the control unit . If the analyser has the combustibles option then 10 twisted pairs are required.

Note:
All the signal cables must have a braided overall screen or a foil overall screen and drain wire. On cables not connected to the sensor head, the screen should be terminated at the earth bus bar as shown in Figure 3.7A The cables connected to the sensor head should be terminated at the capacitive earth terminals on the ends of the earth bus bar as shown - two are provided, one for use with the heater cable, and one for the signal cable.

Each signal cable should have the inner cores of the cable fed through a tubular ferrite from the ferrite kit supplied, as shown in Figure 3.7A. The ferrite should be secured with the cable tie supplied in the kit.

At the sensor head the cable screens should be terminated to the earth terminal provided.

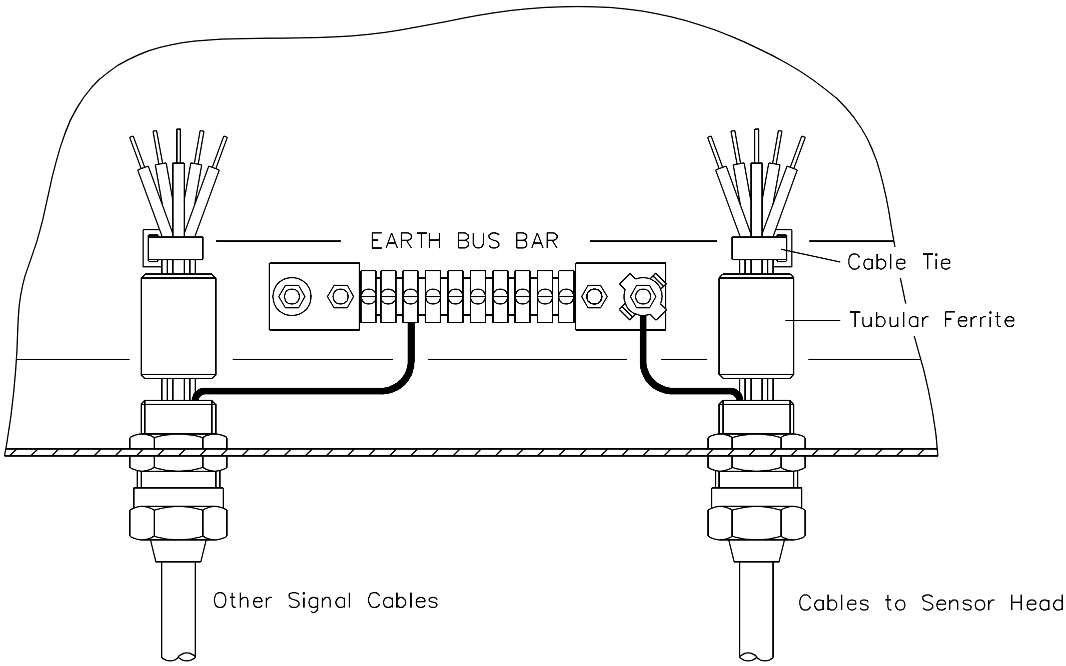


Figure 3.7A Control Unit Signal Connections

3.4.4 AC Electrical Supply

The analyser is not fitted with a switch for disconnecting the electrical supply. A suitable isolating switch must be installed by the user.

Caution

Ensure that the voltage selector links in the control unit and sensor head are correct for the supply voltage (see Figs 3.9 and 3.10).

Ensure that the correct fuse is fitted to F2 in the control unit - 1.6A for 230V or 3.2A for 110V operation. See Section 7 for specification and part numbers.

Both the control unit and sensor head must be locally earthed (grounded).

Note : 1. If a split supply (eg 55V-0-55V) is used, or a supply that is not referenced to earth (ground), a suitable isolating transformer should be fitted and the secondary winding suitably earthed. See Figure 3.8.

2. Each pole of split supply should be switched and fused in accordance with local regulations.

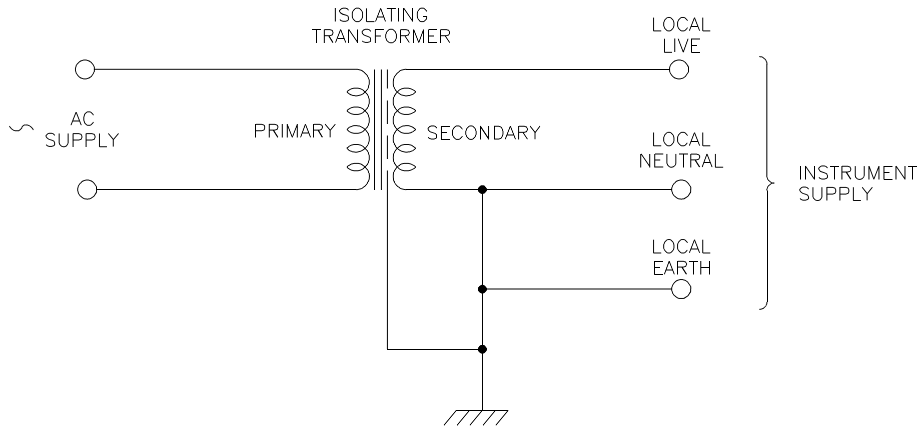


Figure 3.8 Split Supply

3.4.4.1 CE Marked Analyser

The mains power connection to this instrument is made via an electrical filter unit attached to the bottom of the case. The power cable into this unit does not need to be screened.

To connect the Control Unit to the mains supply:

(a) Isolate the mains supply at source.

(b) Remove filter unit cover.

(c) Fit suitable cable gland to the mains filter unit.

(d) Insert cable through gland and secure.

(e) Wire to terminals marked L, N and E inside filter unit.

Signal cables must be terminated as described in Section 3.4.3.

3.4.4.2 Non-CE Marked Analyser

The AC electrical supply is connected to TB-7 in the control unit . The live (hot) line is connected to the terminal marked 'L', the neutral to the terminal marked 'N' and the earth (ground) conductor to the earth safety stud (E3).

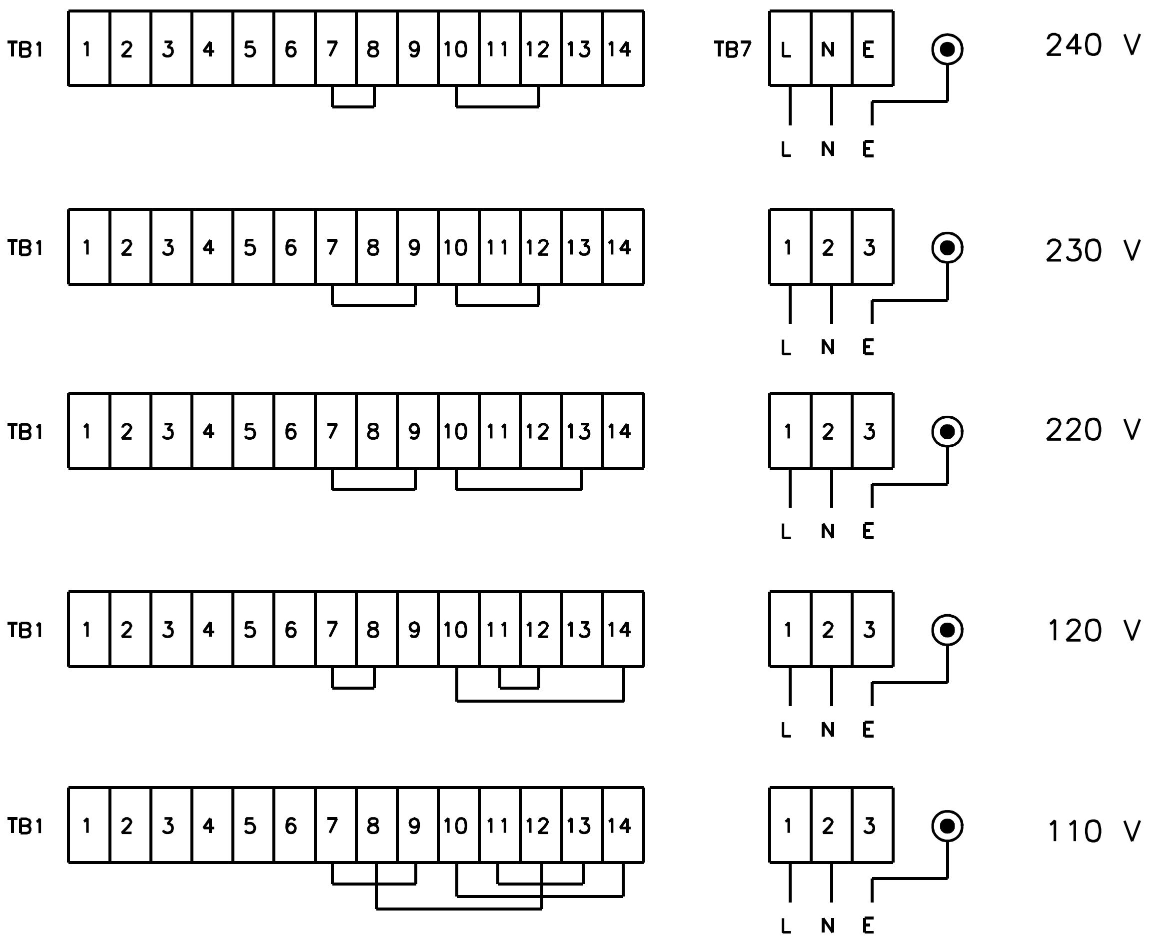


Figure 3.9 Supply Voltage Adjustment - Control Unit

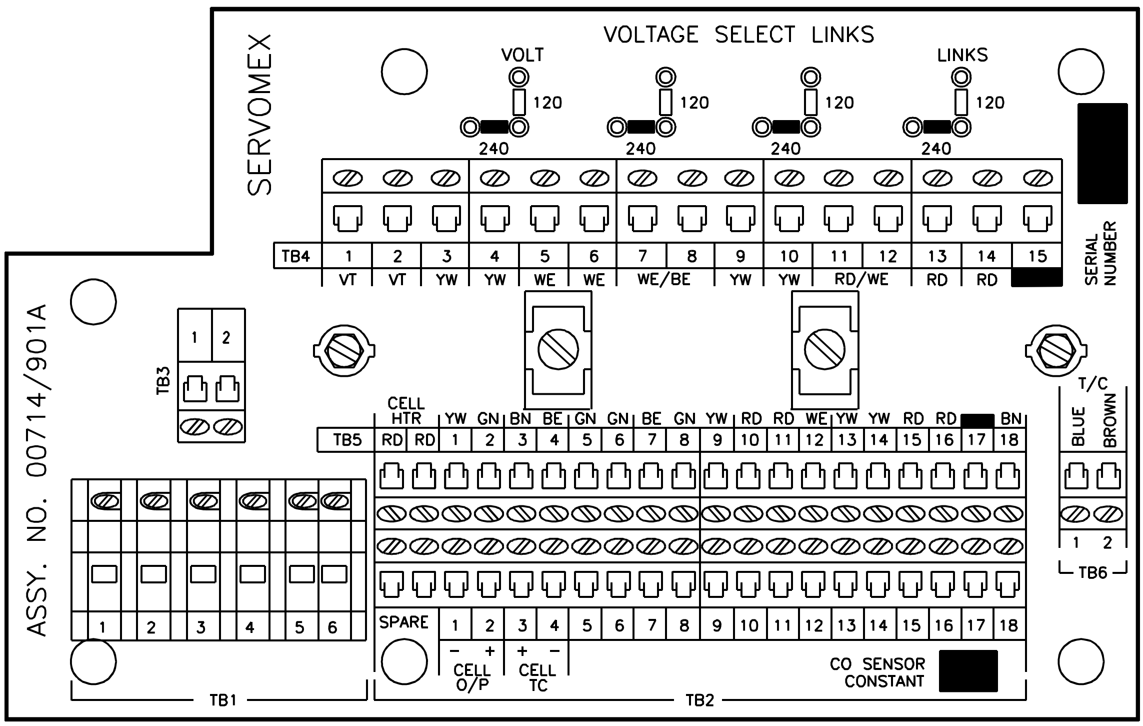


Figure 3.10 Supply Voltage Adjustment - Sensor Head

3.5 OUTPUT CONNECTIONS

3.5.1 General

CAUTION
Connections to isolated output signal terminals should not exceed 30V RMS (42.4 V peak) or 60 V dc to earth when connected to associated equipment.

Output cables must have an overall screen which must be connected to earth (ground) at one point only, preferably at the control unit . The cable should have one twisted pair for each output signal required from the analyser. The core size must be adequate for the transmission distance.

3.5.2 Main Board Oxygen Output

Unless output options are fitted, the analyser provides non-isolated output signals for oxygen level. The output signal is taken from TB2 in the control unit : Terminals 1 and 3 for voltage outputs or terminals 2 and 3 for current outputs. Terminal 3 is connected to ground. See Figure 3.11.

Voltage output: 0/2 - 10V for range selected
R (min) = 2 kohm

Current output: 0/4 - 20mA for range selected
R (max) = 500 ohm

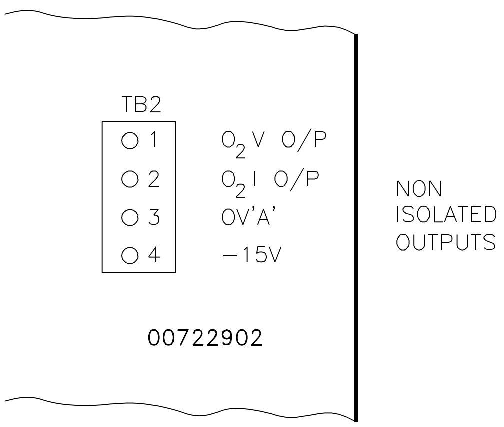


Figure 3.11 Non-isolated Oxygen Output Signal

3.5.3 Combustibles Outputs

When the combustibles option is installed, the output is available from TB50 on the combustibles board 00722925. Terminals 2 and 3 for voltage outputs or terminals 1 and 2 for current outputs. Terminal 2 is connected to ground. A combustibles alarm level output is available from terminals 5 and 6 on the same block. Terminal 6 is connected to ground. See Figure 3.12.

Voltage output: 0/2 - 10V for range selected
R (min) = 2 kohm

Current output: 0/4 - 20mA for range selected
R (max) = 500 ohms

Alarm output: Open drain
I (max) = 225mA
V (max) = 24V
VA (max) = 600mW

Open circuit in alarm condition (see Figure 3.13)

For operating external alarm annunciators a + 5V supply is available at terminal 4. Maximum current that can be taken is 100mA. See Figure 3.13.

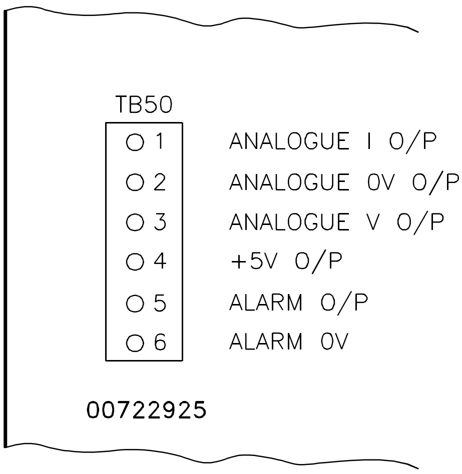
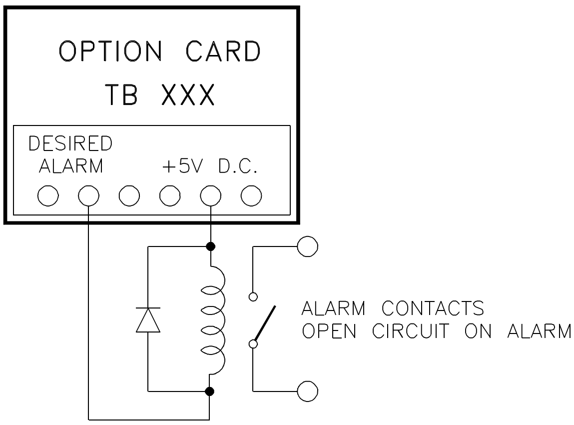


Figure 3.12 Non-isolated Combustibles Output Signal



The relay is not supplied by Servomex.

The selected relay must comply with the specification given for the alarm output and internal 5V supply.

Figure 3.13 Open Drain Interface Relay Connections

3.5.4 Isolated Outputs

3.5.4.1 Isolated Oxygen and Combustibles Output Card (See Figure 3.14)

The outputs from this card are available from TB210 for oxygen and TB211 for combustibles. Positive terminals are marked '+'.

Current output: 0/4 - 20mA for range selected
R (max) = 1000 ohms
Max isolation voltage = 500V peak

It is good practice for the current output loop to be connected either to earth (ground) or to within a low potential of earth.

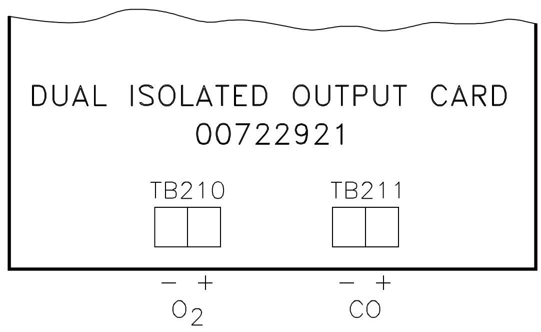


Figure 3.14 Isolated Oxygen and Combustibles Output Connections

3.5.4.2 Isolated Oxygen Output and Alarm Card (See Figure 3.15)

The isolated oxygen output is available from TB11 terminals 3 and 4 for current and terminals 5 and 6 for voltage (terminals 4 and 6 are positive).

Voltage output: 0/2 - 10V for range selected
R (min) = 2 kohm

Current output: 0/4 - 20mA for range selected
R (max) = 500 ohms
Max isolation voltage = 500V peak.

The alarm is available from TB11 terminals 1 and 2.

Alarm output: Volt free contact
I (max) = 1.5A DC
V (max) = 50V DC
VA (max) = 20W

Open circuit in alarm condition

Non-isolated status alarms are available from TB10 for:

Oxygen high - terminal 4
Oxygen low - terminal 3
Analyser fault - terminal 2

Terminal 1 is connected to ground.

Alarm output:	Open collector I (max) = 500mA V (max) = 24V VA (max) = 600mW
	Open circuit in alarm condition (see Figure 3,13)

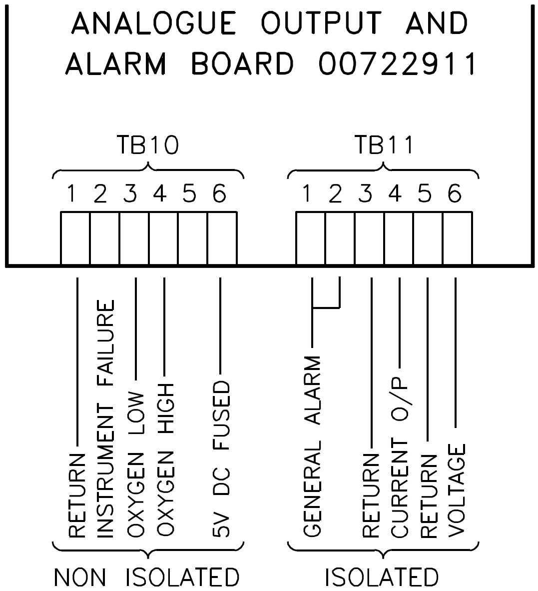


Figure 3.15 Isolated Oxygen Level and Alarm Connections

3.6 DATA LINK CARD

This card (see Figure 3.16) requires both output and input connections. The output is taken from TB30:

Current loop:	Terminals 1(+) and 2(-)
RS232:	Terminals 3(+) and 4(-)
RS423:	Terminals 5(+) and 6(-)

The input is connected to the corresponding terminals on TB31.

The cable must comply with UL 2493.

The cable should be routed as far as possible from electrically noisy environments as this may corrupt the data.

The cables attached to this card must be screened and earthed (grounded) only to the control unit earth (ground) bus bar.

See Section 6 for data protocol and specifications.

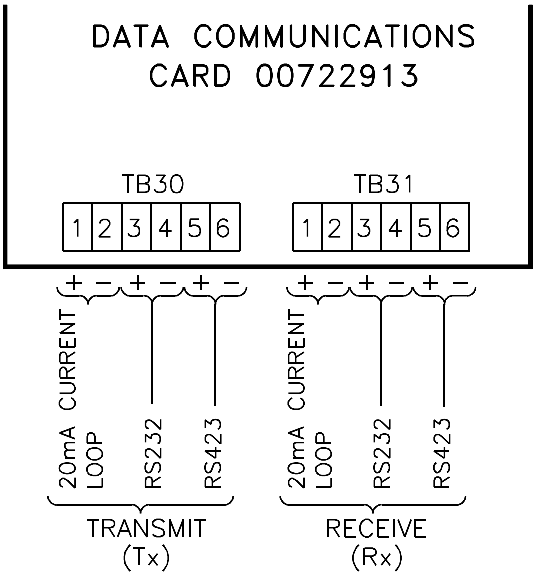


Figure 3.16 Data Link Connections

3.7 TEMPERATURE AND EFFICIENCY OPTION

3.7.1 Temperature and Efficiency Card

Temperature can be in displayed in Celsius or Fahrenheit. For a Celsius display the link LK1 (located at the top left of the card) is removed. For a Fahrenheit display a link is fitted at LK1.

The card is calibrated for Type K (Chromel-Alumel) thermocouples.

The thermocouple measuring flue gas temperature is connected to TB40, terminals 1 and 2. The connection between the thermocouple and the card must be made using a screened twisted pair Type K compensating cable. The screen must be earthed at the control unit only. See Figure 3.17.

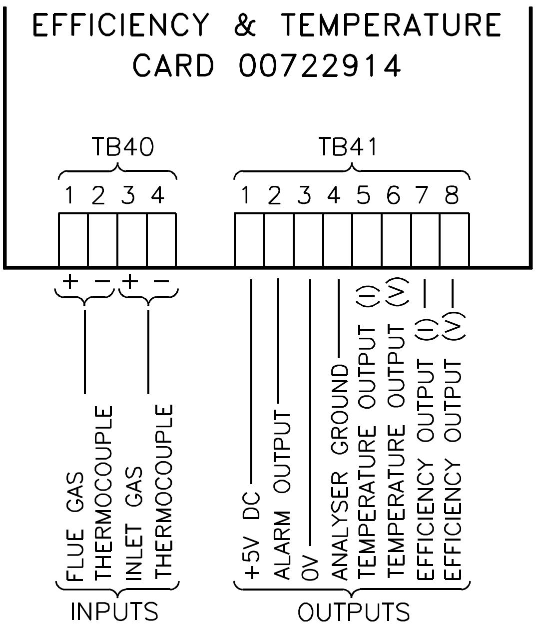


Figure 3.17 Temperature and Efficiency Connections

A second type K thermocouple may be connected to terminals 3 and 4 of TB40 to measure the temperature of the inlet air.

Type K compensating cable can be supplied by Servomex, part no. 1582-0998

The outputs from the card are taken from TB41:

Efficiency:	(Current) Terminals 4 and 7 (Voltage) Terminals 4 and 8	Temperature:	(Current) Terminals 4 and 5 (Voltage) Terminals 4 and 6

Terminal 4 is connected to ground.

Voltage output: 0/2 - 10V for range selected
R (min) = 2 kohm

Current output: 0/4 - 20mA for range selected
R (max) = 500 ohms

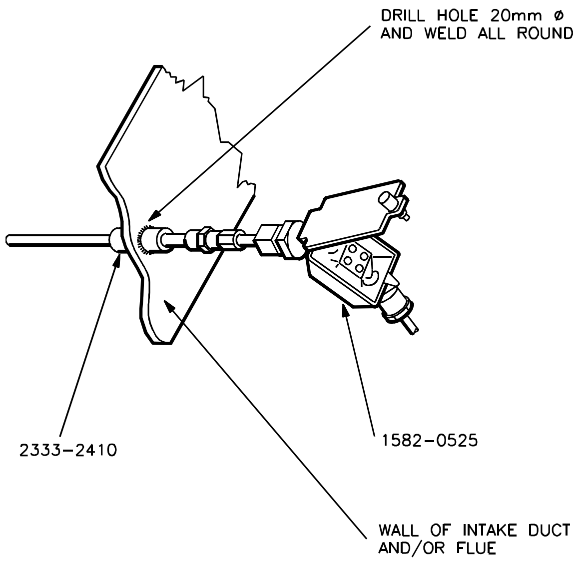
Flue Temperature Alarm: Terminals 2 and 3, terminal 3 is connected to ground.

Alarm output: Open collector
I (max) = 225mA
V (max) = 24V
VA (max) = 600mW
Open circuit in alarm condition (see Figure 3.13)

For operating external alarm annunciators a + 5V supply is available at terminal 1. Maximum current that can be taken is 100mA

3.7.2 Installation of Flue and Inlet Air Thermocouples

The flue gas thermocouple and air inlet thermocouple (if required) are installed as shown in Figure 3.18.



Make union nuts finger tight, then a further 3/4 turn to seal.

Figure 3.18 Installation of Thermocouples

3.8 ASPIRATOR AIR SUPPLY

Servomex supply three air regulator sets to control the air supply to the aspirator to the close tolerances necessary to ensure consistent and accurate operation of the analyser.

The compressed air supply should be within the pressure range 0.6 - 10 barg (10 - 150 psig) and be clean dry and free of combustibles. Plant compressed air may be used providing it is clean and free of oil and water vapour. Air consumption is less than 2.5 litres/min.

If an air supply pump is supplied by Servomex, it must be mounted and operated in accordance with the manufacturers specifications supplied with the unit, in order to ensure trouble free service.

The air regulator sets should be mounted close to the sensor head and connected to the solenoid valve by 1/4" O.D. tubing.

Set the aspiration air pressure to the value shown on the label inside the terminal box on the side of the sensor head. This will normally be within the range 0.2 to 0.4 barg (3 to 6 psig).

3.8.1 Air Regulator Set (oxygen only analysers) Part no. 00790986 See Figure 3.19

This is supplied as a kit of parts for local assembly as shown in Figure 3.19 and comprises:

Item
1. Filter regulator unit
2. Coalescing circuit
3. Pressure gauge
4. Mounting bracket

3.8.2 Air Regulator Set (oxygen and combustibles analysers) Part No. 00714990 See Figure 3.20

This unit is similar to the unit above but has a precision pressure regulator to control the air flow to the close tolerances which are required when the combustibles option is fitted. See Figure 3.20.

3.8.3 Air Regulator Set (oxygen and combustibles analysers with auxiliary air). See Figure 3.21

As well as controlling aspirator air this unit also supplies auxiliary air to the combustibles detector to ensure that the reading will be correct when the sample gas is deficient in oxygen. It also has the facility for introducing calibration gas to the sensor head at a controlled flow of 600ml/min.

See Figure 3.21 for dimensions. Connection to the auxiliary air port on the sensor head is made with 1/8" tubing.

Quick disconnects are fitted to the calibration line for connection of calibration gases. Gas pressures should be in the range 0.5 to 2 barg (7 to 30 psig).

Note :
1. When auxiliary air is used link LK1 on the combustibles card (00722925) in the control unit must be removed.
2. The precision regulators are factory set. Do not change the settings.

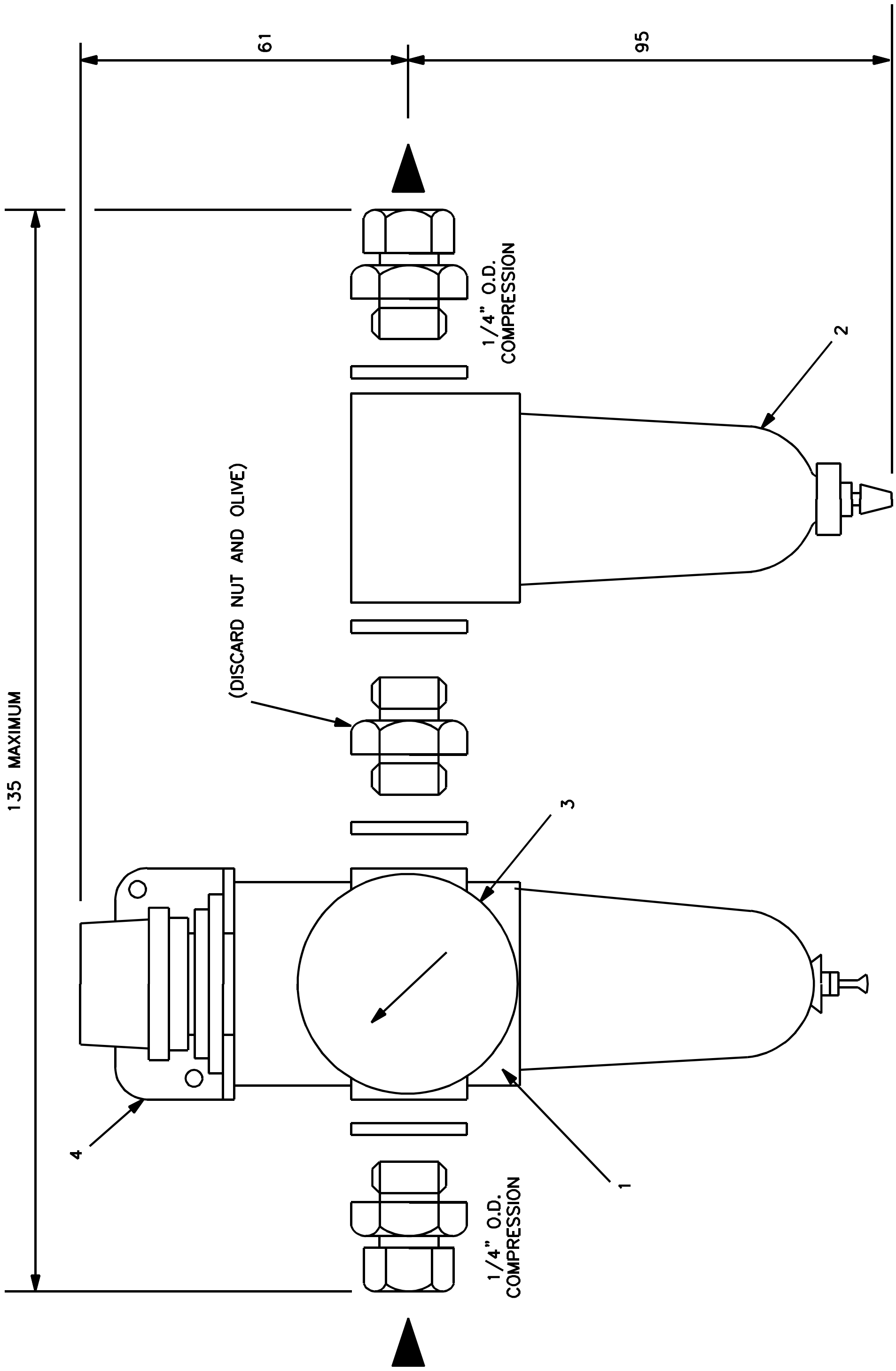


Figure 3.19 Air Supply Regulator (oxygen only)

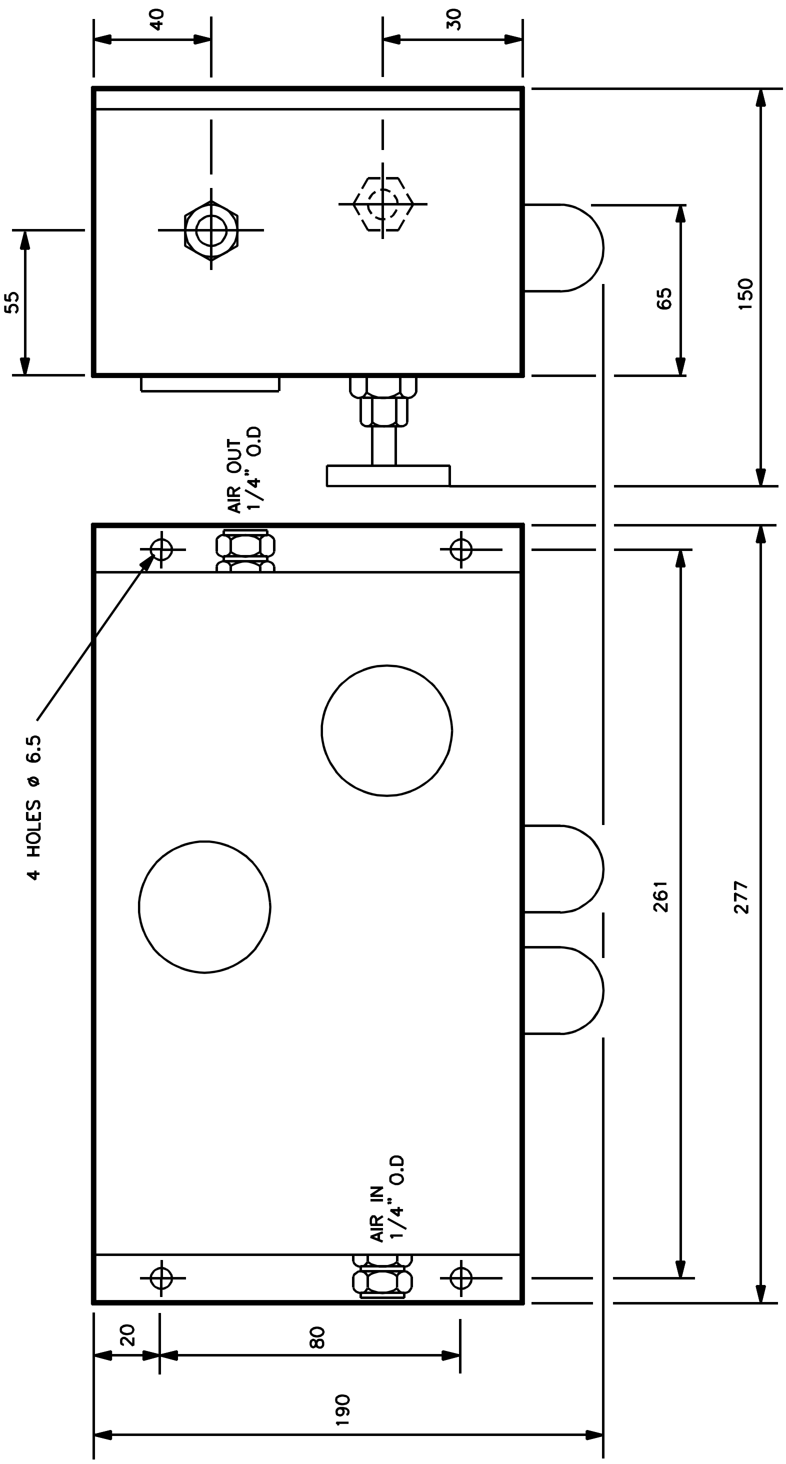


Figure 3.20 Air Supply Regulator (oxygen and combustibles)

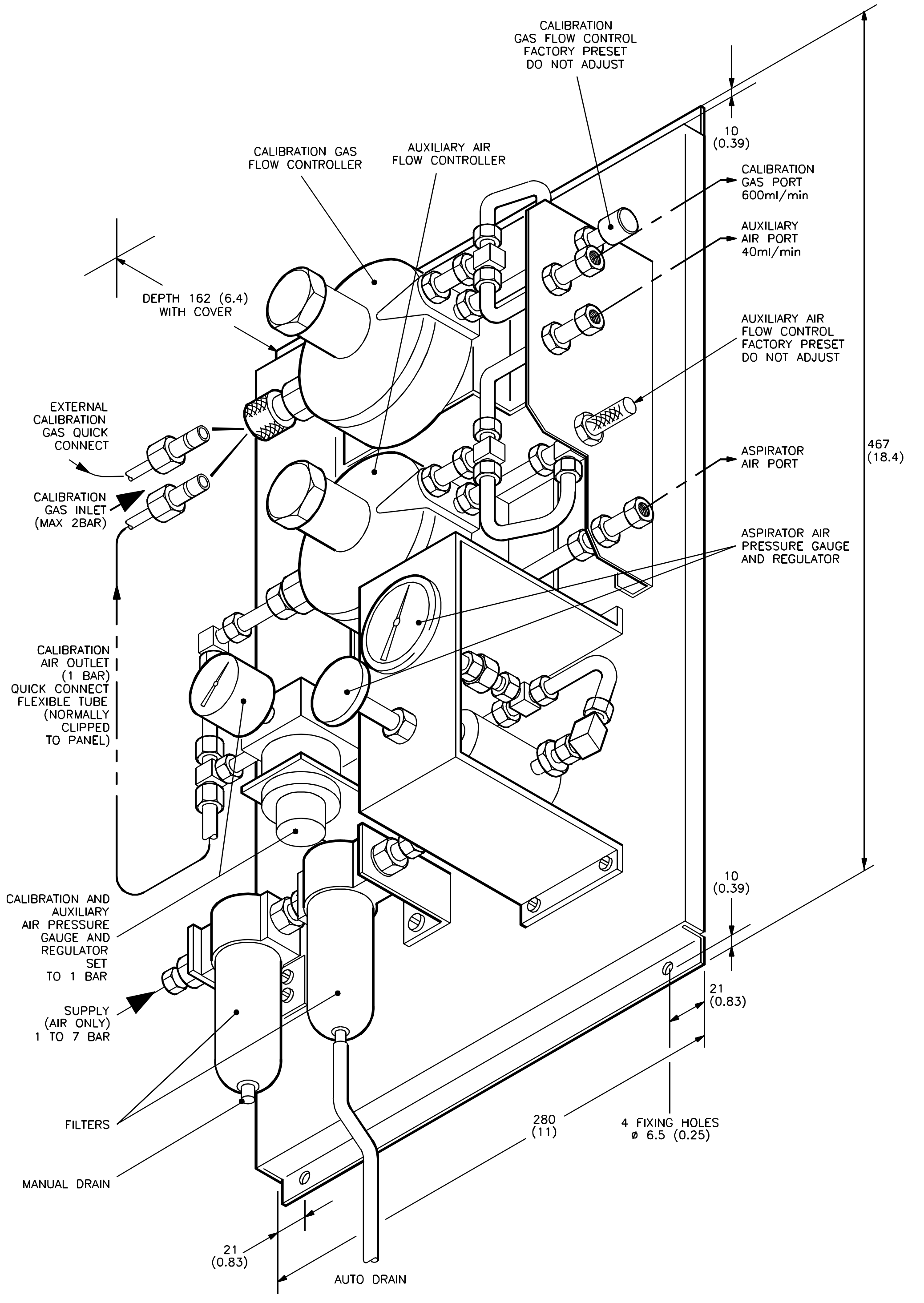

CALIBRATION GAS FLOW CONTROL FACTORY PRESET DO NOT ADJUST
CALIBRATION GAS FLOW CONTROLLER
AUXILIARY AIR FLOW CONTROLLER
10 (0.39)
CALIBRATION GAS PORT 600ml/min
AUXILIARY AIR PORT 40ml/min
DEPTH 162 (6.4) WITH COVER
AUXILIARY AIR FLOW CONTROL FACTORY PRESET DO NOT ADJUST
EXTERNAL CALIBRATION GAS QUICK CONNECT
467 (18.4)
ASPIRATOR AIR PORT
CALIBRATION GAS INLET (MAX 2BAR)
ASPIRATOR AIR PRESSURE GAUGE AND REGULATOR
CALIBRATION AIR OUTLET (1 BAR) QUICK CONNECT FLEXIBLE TUBE (NORMALLY CLIPPED TO PANEL)
CALIBRATION AND AUXILIARY AIR PRESSURE GAUGE AND REGULATOR SET TO 1 BAR
10 (0.39)
21 (0.83)
SUPPLY (AIR ONLY) 1 TO 7 BAR
FILTERS
280 (11)
4 FIXING HOLES ø 6.5 (0.25)
MANUAL DRAIN
21 (0.83)
AUTO DRAIN

Figure 3.21 Air Regulator Set (oxygen and combustibles analyser with auxiliary air).

3.9 ASSEMBLY OF PROBE TUBES AND SENSOR HEAD

3.9.1 General

There are many possible configurations for the probe assemblies but for clarity only the most commonly used versions are shown.

It is recommended that the analyser should be powered-up before the sensor head is fitted to the flue. See commissioning procedure in section 3.13.

The sensor head, as supplied, vents back to the flue. With the exception of the unsupported probe version, it is possible to vent to atmosphere providing the flue pressure is within +/- 50mmwg. To convert to vent to atmosphere the plug (14) in figure 3.23 and (10) in figures 3.24 and 3.25 should be removed and replaced in the vent hole on the front face of the sensor head.

Note : 1. The sensor head has a raised face flange. It is essential that all the mounting bolts are tightened evenly during installation to prevent the sensor head tilting and causing a leak.

2. Included in the installation kits is a tube of anti-seize compound (Part no 1761-3211) which must be used on the sensor head mounting bolts and studs.

3.9.2 Unsupported Filter Probe See Figure 3.22

This probe is supplied as either 0.5m or 1.0m long. The tube may be cut to obtain intermediate lengths as required.

1. Cut the probe tube (4) to length if required. The cut should be square and any burrs and swarf must be removed.

2. Fit the nut (9) and ferrule (10) from the filter (1) to the tube (4) and insert the tube into the filter as far as the stop. Tighten the nut to finger tight and then a further one and a quarter turns with a spanner.

3. Fit the tube coupling (8) to the sensor head sealing the thread with PTFE tape.

4. Fit the probe tube into the tube coupling. Swage the coupling ferrule onto the tube by tightening the coupling nut finger tight plus a further 3/4 to 1 turn.

5. Remove the blanking plate from the aperture in the flue (if fitted) and fit the four studs (7) and gasket (6) to the flange.

6. Insert the probe tube carefully through the gasket. The sensor head must be orientated correctly - see Figure 3.6. Secure it with four M10 nuts and washers.

Item	Description	Part number	Item	Description	Part Number
1	Filter	2377-6777	6	Gasket	3931-6491
2	M10 washer	2131-7462	7	M10 stud	00022451A
3	M10 nut	2247-8115	8	Tube coupling	2354-2060
4	Probe assembly	00714480A-B	9	Nut	00022471
			10	Ferrule 1/4in	2354-8936

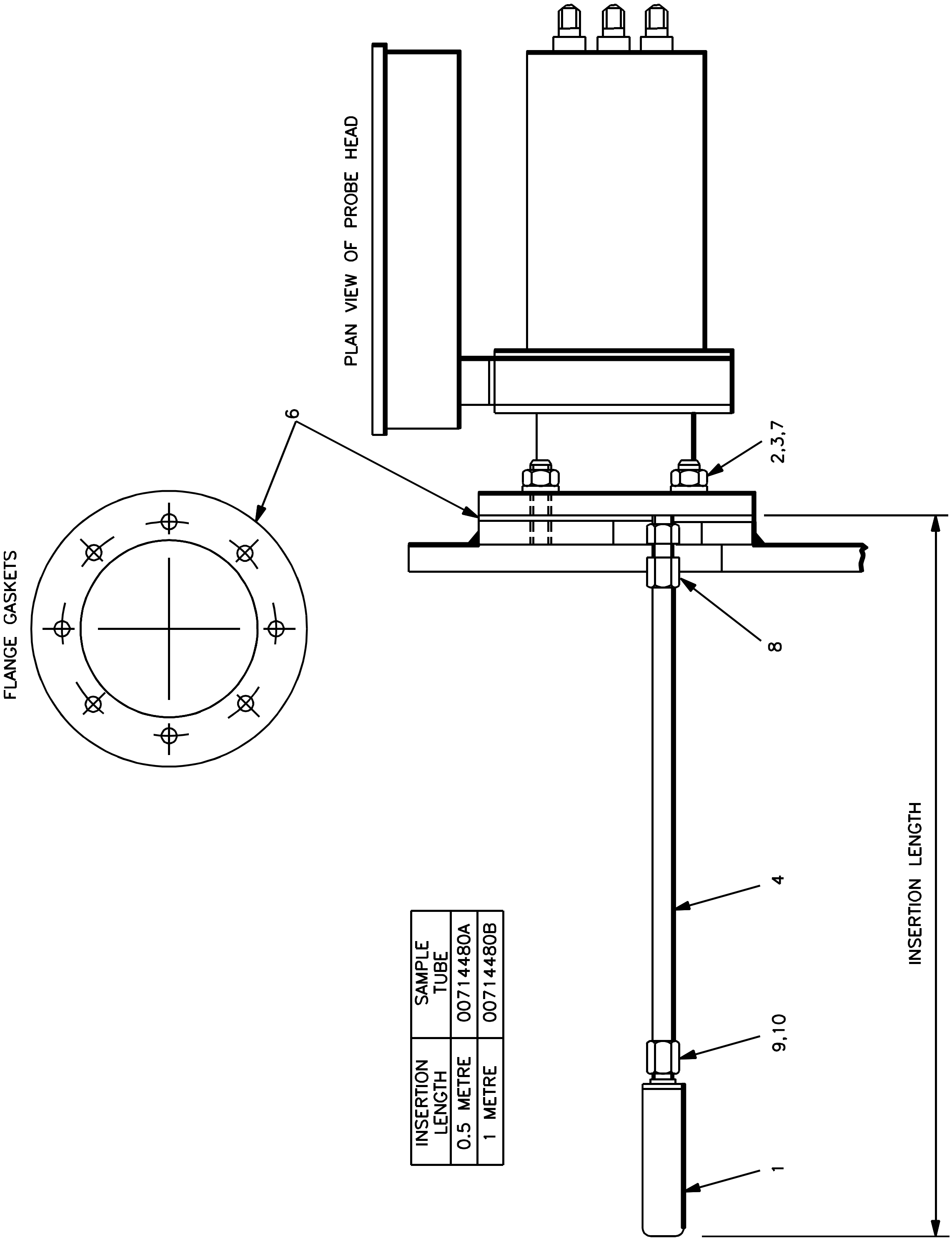


Figure 3.22 Installation of Unsupported Filter Probe

3.9.3 Supported Filter Probe

The probe assembly is normally supplied in a range of lengths from 0.5m to 3.0m in 0.5m steps. The support and sample tubes may be cut to intermediate lengths. The length of the 1/4 inch O.D. probe tube required is equal to: Support Tube + Flange Assembly Length + 48 mm. See Figure 3.23.

1. Cut the support tube (3) and sample tube (4) to length if required. The cuts should be square and any burrs and swarf must be removed. The filter should be fully protected by the shroud.

2. Remove the blanking plate from the aperture in the flue (if fitted). Fit four M10 (10) studs and the gasket 'B' (9) to the flange.

3. Position the plug (14) according to the vent option required. (Note: If the flue pressure exceeds ±50mm w.g. the vent to atmosphere option should not be used).

4. Fit the shroud (2) to the support tube (3) Check for correct positioning before tightening the fixing.

5. Fit the nut (6) and ferrule (12) from the filter (11) to the tube (4), and insert the tube into the filter as far as the stop. Tighten the nut (6) to finger tight and a further 1 1/4 turns with a spanner.

6. Fit the sample tube guide(s) (17) to the sample tube as required (One for tubes up to 1500mm, two for longer lengths). When two guides are used, one must be fitted close to the filter, and the other near the middle of the sample tube.

7. Bolt the support tube assembly to the mounting flange using four of the M10 nuts in the mounting kit (Ensuring that the shroud is correctly oriented).

8. Fit the tube coupling (13) to the sensor head, sealing the thread with PTFE tape.

9. Pre-swage the ferrule at the sensor head end of the sample tube using the union nut. Tighten this nut to finger tight plus 3/4 to 1 turn. Release the union nut from the fitting in the sensor head.

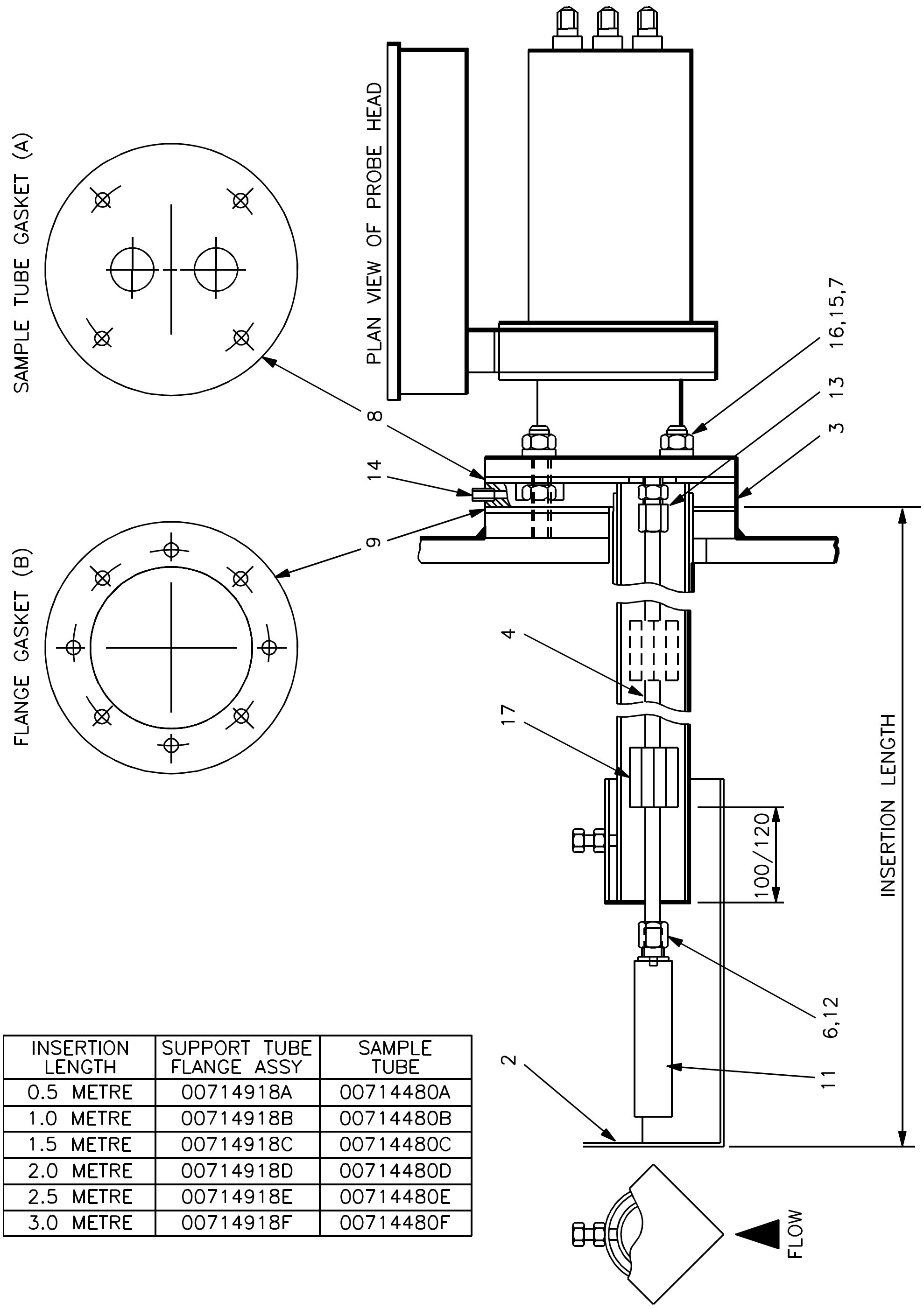
10. Fit the gasket 'A' (8) over the studs on the mounting flange, ensuring that the central gasket holes are aligned with the holes in the probe support flange.

11. Slide the sample tube (filter end first) into the support tube, taking care not to let the union nut fall into the guide tube (this can be prevented by wrapping a length of soft wire or adhesive tape round the 1/4 inch OD tube just behind the union nut inside the tube).

12. Fit the union nut (when the sample tube is nearly completely inserted) to the adaptor on the front of the sensor head, tighten finger tight plus a further 1/4 turn with a spanner.

13. Secure the sensor head to the probe support flange with four M10 nuts (15) and washers (16), tightening evenly and paying attention to the orientation.

Item	Description	Part number	Item	Description	Part Number
2	Shroud assembly	00714919	9	Gasket 'B'	3931-6491
3	Support tube assy	00714918A-F	11	Filter	2377-6777
4	Sample tube	00714480A-F	12	Ferrule 1/4in	2354-8936
6	Nut	00022471	13	Tube coupling	2354-2060
7	M10 stud	00022451B	14	Vent plug	2348-8568
8	Gasket 'A'	3931-6617	15	M10 nut	2247-8115
			16	M10 washer	2131-7462



INSERTION LENGTH	SUPPORT TUBE FLANGE ASSY	SAMPLE TUBE
0.5 METRE	00714918A	00714480A
1.0 METRE	00714918B	00714480B
1.5 METRE	00714918C	00714480C
2.0 METRE	00714918D	00714480D
2.5 METRE	00714918E	00714480E
3.0 METRE	00714918F	00714480F

Figure 3.23 Installation of Supported Filter Probe

3.9.4 High Temperature Probe See Figure 3.24.

1. Fit four studs (7) and the gasket 'B' to the mounting flange. Ensure that the studs are fully screwed in.

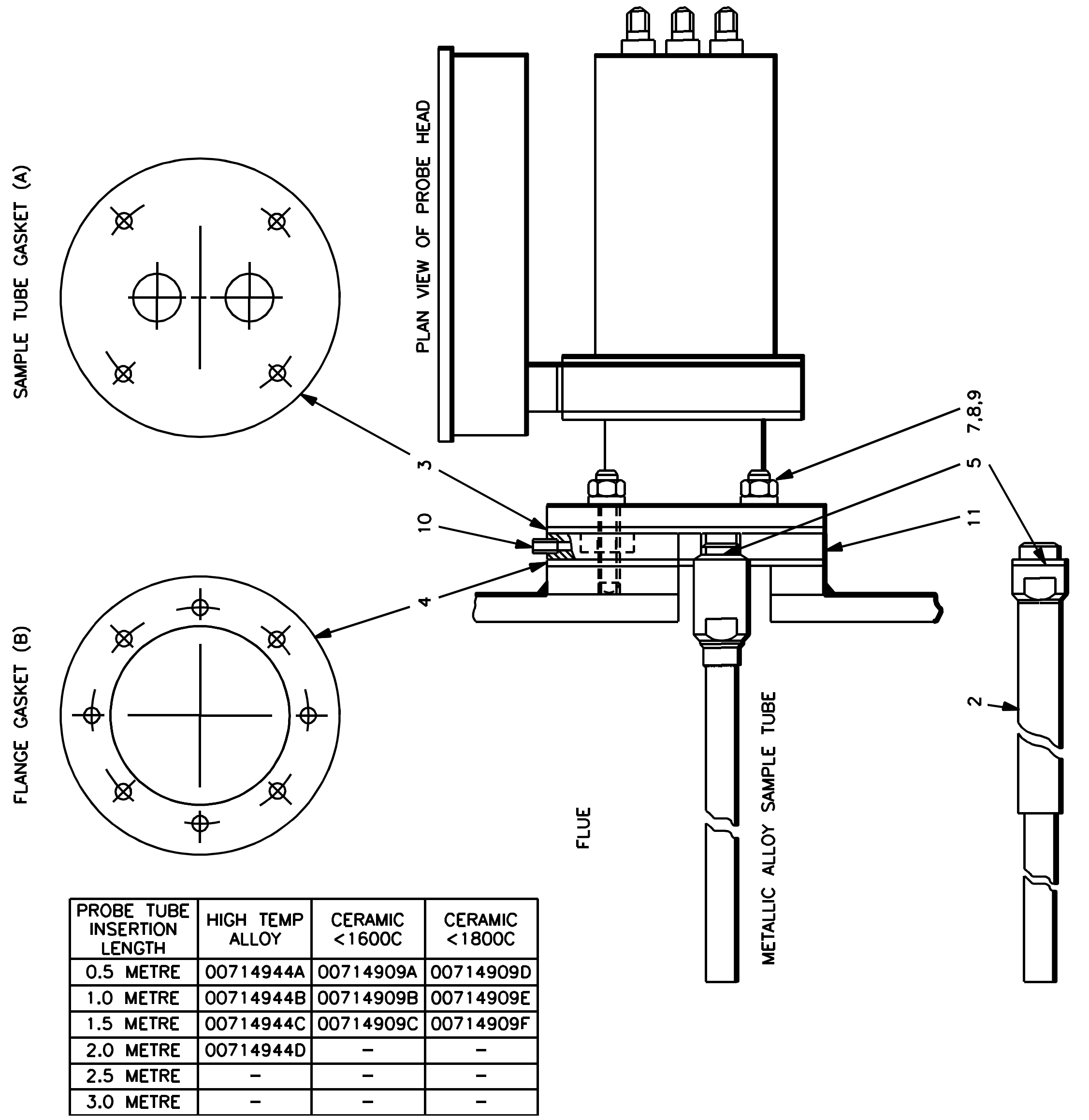
2. Assemble the probe tube to the vent flange using the sealing washer (5).

3. Insert the probe tube in to the flue and secure using four nuts only and the box spanner provided. (If a ceramic probe is being inserted in to a hot flue, this should be done slowly to avoid breaking the tube due to thermal shock.) The probe tube must be positioned so that the sensor head will be correctly orientated when it is fitted. See Figure 3.6.

4. Fit the gasket 'A' (3) and the sensor head to the vent flange making sure that the inlet port is aligned with the sample tube bore and that the central gasket holes align with the holes in the vent flange.

5. Secure the sensor head with four M10 nuts and washers.

Item	Description	Part number	Item	Description	Part Number
2	Probe tube		5	Sealing washer	2356-7562
	High temp alloy	00714944A-D	7	M10 stud	00022451B
	Ceramic, <1600C	00714909A-C	8	M10 nut	2247-8115
	Ceramic, <1800C	00714909D-F	9	M10 washer	2131-7462
3	Gasket 'A'	3931-6617	10	Vent plug	2348-8568
4	Gasket 'B'	3931-6491	11	Vent flange	00714433



PROBE TUBE INSERTION LENGTH	HIGH TEMP ALLOY	CERAMIC <1600C	CERAMIC <1800C
0.5 METRE	00714944A	00714909A	00714909D
1.0 METRE	00714944B	00714909B	00714909E
1.5 METRE	00714944C	00714909C	00714909F
2.0 METRE	00714944D	–	–
2.5 METRE	–	–	–
3.0 METRE	–	–	–

Figure 3.24 Installation of High Temperature Probe

3.9.5 High Temperature Probes with Stand-off See Figure 3.25.

1. Secure the stand-off (1) to the mounting flange using four M10 caphead bolts (6) and one of the gaskets 'B' (4). The stand-off must be used if the flue skin temperature is between 350°C and 500°C (662°F and 932°F).

2. Fit four studs (7) and the gasket 'B' to the stand-off.

3. Assemble the probe tube to the vent flange using the sealing washer (5).

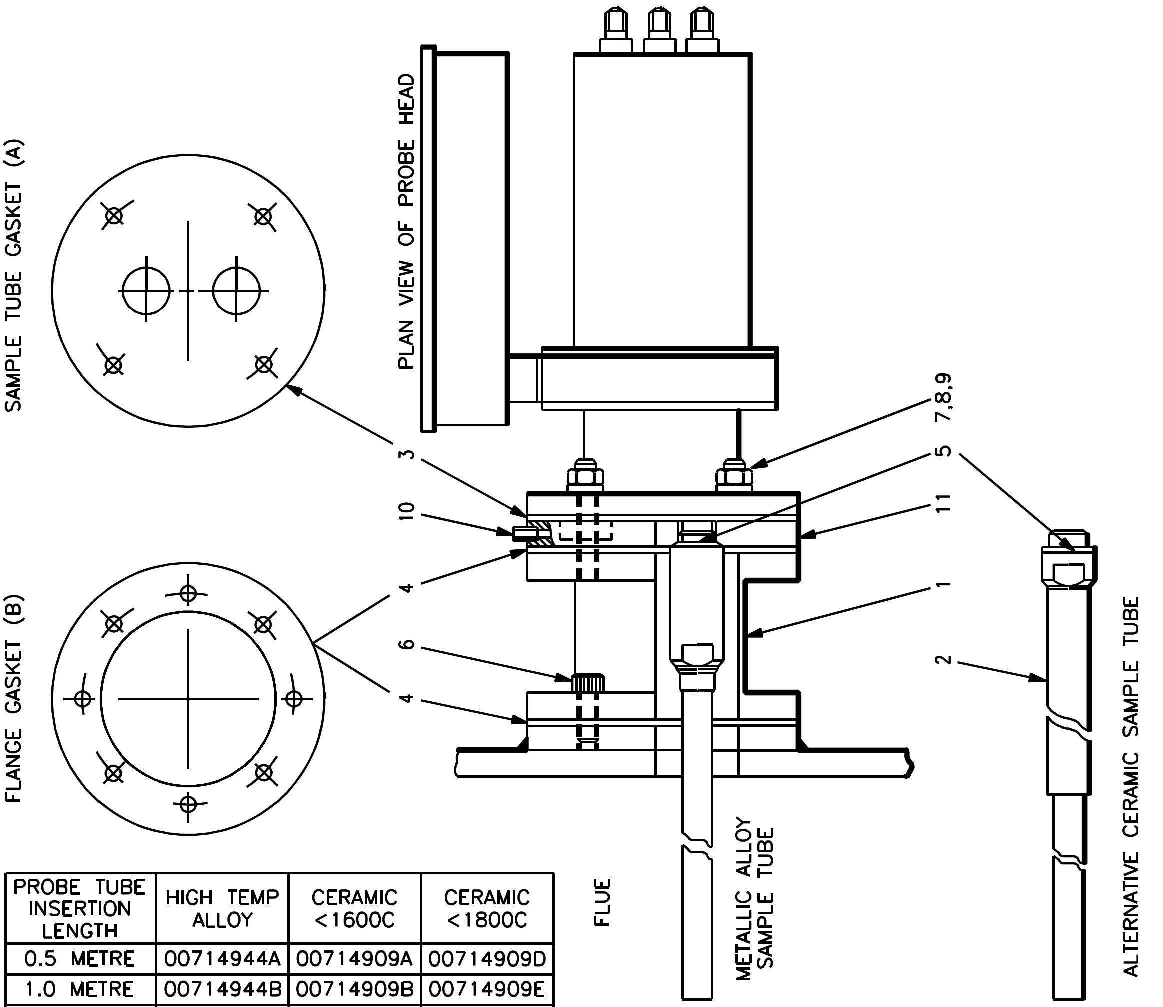
4. Insert the probe tube in to the flue and secure using four nuts only and the box spanner provided. (If a ceramic probe is being inserted in to a hot flue, this should be done slowly to avoid breaking the tube due to thermal shock.) The probe tube must be positioned so that the sensor head will be correctly orientated when it is fitted. See Figure 3.6.

5. Fit the gasket 'A' (3) and the sensor head to the vent flange making sure that the inlet port is aligned with the sample tube bore and that the central gasket holes align with the holes in the vent flange.

6. Secure the sensor head with four M10 nuts and washers.

Note: When the stand-off is used it must have insulation wrapped around the outside to prevent excessive heat loss.

Item	Description	Part number	Item	Description	Part Number
1	Stand-off assembly	00714920A	5	Sealing washer	2356-7562
2	Probe tube		7	M10 stud	00022451B
	High temp alloy	00714944A-D	8	M10 nut	2247-8115
	Ceramic, <1600C	00714909A-C	9	M10 washer	2131-7462
	Ceramic, <1800C	00714909D-F	10	Vent plug	2348-8568
3	Gasket 'A'	3931-6617	11	Vent flange	00714433
4	Gasket 'B'	3931-6491			



PROBE TUBE INSERTION LENGTH	HIGH TEMP ALLOY	CERAMIC <1600C	CERAMIC <1800C
0.5 METRE	00714944A	00714909A	00714909D
1.0 METRE	00714944B	00714909B	00714909E
1.5 METRE	00714944C	00714909C	00714909F
2.0 METRE	00714944D	–	–
2.5 METRE	–	–	–
3.0 METRE	–	–	–

Figure 3.25 Installation of High Temperature Probe with Stand-off

3.10 CALIBRATING GASES

The following calibration gases must be available:

Oxygen Sensor:

Air point: Clean, dry air, free of combustibles. Plant compressed air may be used providing it is clean and free of water and oil vapour.

End point: 0.3% O_2 in N_2, nominal, is recommended (can be in the range 0.25 to 2.5% O_2). The oxygen content of this gas must be known accurately, preferably with a certificate of analysis.

Combustible Sensor:

Zero gas: As for Air Point above.

Span gas: 1% CO in air, is recommended. The CO content must be known accurately, preferably with a certificate of analysis.

3.11 CALIBRATION GAS CONNECTIONS

In many cases it may be convenient to install a permanent connection to the calibration port of the sensor head so that bottles of calibration gas can be located convenient to the operator or control unit.

Arrangements should include installation of a flowmeter and flow control so that calibrating gases can be set to a flow rate of 600ml/min (± 100ml/min).

Note that the calibrating gas supply must be fitted with an isolating valve to seal the calibration port on the sensor head when it is not being calibrated.

The calibration gas connection will normally be under a slight vacuum. Any pipework must be checked for leaks. Leaks will lead to air ingress which will cause erroneous operation of the analyser.

3.12 COMMISSIONING PROCEDURE

This commissioning procedure describes how to check the installation and initial powering-up of the analyser. Operation of the analyser is described in Section 4. Before the analyser is connected to the electrical supply the following checks should be done.

1. Ensure that the inter-connection wiring between the control unit and sensor head is correct. Check it against the relevant Cable Schedules (Appendix 1-3).

2. Check the voltage links in the control unit and sensor head and that all other links are correct.

3. Set the aspirator air pressure to the value shown on the label in the terminal box of the sensor head.

4 Check that the calibration port is sealed to prevent air ingress. If an isolating valve is fitted it should be closed.

5. Check that the correct electrical supply fuse (F2) in the control unit has been fitted. See 3.4.4.

3.12.1 Initial Start-up

When the electrical supply is switched on, the display will indicate 'RESTART' shortly before displaying the message 'PROBE 713/4' which identifies the type of sensor head fitted. After 2.5 seconds 'WARMING UP' is displayed. The keypad becomes active at the same time as the message changes.

The diagnostic routines within the analyser do not commence until the zirconia cell temperature comes under control or 3 minutes have elapsed since the 'RESTART' message. The 'WARMING UP' message will then be replaced by the oxygen reading unless the keypad is in use. The display may flash for a few seconds until the cell reaches its correct temperature. If this flashing continues there is a fault. See Section 5.

A further 40 minutes is required for the sensor head to reach its operating temperature. During this time the sensor head temperature diagnostics are suppressed. The oxygen display is interrupted every 8 seconds by the 'WARMING UP' message. After 40 minutes the full diagnostic routine is initiated.

Note : 1. The analyser should be allowed to stabilise for several hours (eg overnight) before calibration.

2. It is recommended that calibrating gases should be passed through the sensor head to confirm correct operation of the analyser. The sensor head can then be connected to the flue.

3.13 SHUT DOWN PROCEDURE

The sensor head should never be left unpowered on a flue which is being used. This can result in corrosion damage to the sensor head.

If the process is out of service for only a short time it is recommended that the analyser is left powered. It does not matter if aspirator air is flowing or not.

If the analyser has to be switched off on a flue which is being used and is to be left for more than, say, 1-2 weeks then it is recommended that the sensor head is removed from the flue. Alternatively, a flow of dry air can be connected to the calibration port. This will prevent corrosive gases from entering the sensor head.

NOTES

SECTION 4 : OPERATION

LIST OF CONTENTS

SECTION **PAGE**

4.1 GENERAL 4.3

4.2 USE OF KEYPAD 4.4

4.2.1 General 4.4

4.3 ANALYSER OPERATION VIA THE KEYPAD 4.8

4.3.1 Normal Function 4.8
4.3.2 Protected Functions 4.8
4.3.3 Restart 4.9
4.3.4 Timeout 4.9

4.4 DISPLAY MODES 4.10

4.4.1 Single Measurement 4.10
4.4.2 Dual Display of Oxygen Level with Combustibles, Temperature and Efficiency 4.11

4.5 PROTECTED FUNCTIONS - ENTRY AND EXIT 4.12

4.5.1 Password Entry 4.12
4.5.2 Exit from a Parameter or Calibrate Routine 4.14

4.6 SETTING-UP ANALYSER AND OUTPUTS 4.15

4.6.1 Flow Alarm Trip Level Parameter 4.15
4.6.2 Oxygen Output (non-isolated) 4.16
4.6.3 Combustibles Output 4.18
4.6.4 Oxygen Output (isolated) and Alarms 4.20
4.6.5 Temperature and Efficiency Parameters 4.23

4.7 CALIBRATION 4.26

4.7.1 Frequency of Calibration 4.26
4.7.2 Flow Sensor Calibration Procedure 4.26
4.7.3 Oxygen Sensor Air Point Calibration Procedure 4.27
4.7.4 Oxygen Sensor End Point Calibration Procedure 4.29
4.7.5 Combustibles Sensor Zero Calibration Procedure 4.31
4.7.6 Combustibles Sensor Span Calibration Procedure 4.33

CONTENTS (continued)

SECTION **PAGE**

4.8 CHANGING THE PASSWORD 4.35

4.9 ALARMS AND FAULTS 4.36

4.9.1 Displaying Alarms and Faults 4.36
4.9.1.1 Alarm displays 4.37

ILLUSTRATIONS

FIGURE **PAGE**

4.1A Key functions 4.4
4.1B Key functions 4.5

4.2 Keypad function overview 4.6-4.7

4.3 Keypad layout 4.8

SECTION 4 : OPERATION

4.1 GENERAL

See Section 3.12 for commissioning procedure.

Once powered up the analyser should be operated continuously. If it has to be switched off see Section 3.13.

The display will show the oxygen reading unless the keypad is in use, in which case the parameters requested are displayed. The display will 'time-out' to the oxygen reading within 1 minute of the last key-stroke (9 minutes during calibration sequences).

Fitting a combustibles and/or temperature and efficiency card allows the display of oxygen reading and one other parameter simultaneously. This is achieved by pressing the appropriate key twice. This 'split' display is continuous until a key is pressed when the parameter corresponding to that key is displayed alone.

The analyser can be requested, via the keypad, to display messages to aid fault diagnosis.

Note: All instruments are despatched with the password set to: 000

If a new password is assigned make a note of it and store in a safe place. If it is lost, contact Servomex.

4.2 USE OF KEYPAD

4.2.1 General

The keypad (refer to Figure 4.3) is colour coded and annotated to simplify operation.

KEY COLOUR	TYPE OF FUNCTION
Orange	Measurement
Grey	Calibration, Parameter, Status
Yellow	Not Used

All the keys are auto-repeating. If a key is pressed for longer than one second, additional strokes will be registered at a rate of 10 strokes per second.

The Key Functions table, Figure 4.1A and 4.1B, lists the function of the keys, both in 'Normal' (unprotected) and 'Protected' operation.

KEY FUNCTIONS		
KEY	**NORMAL OPERATION**	**PROTECTED OPERATION**
Oxygen	Displays measured oxygen level	Oxygen functions
Combust	Displays measured combustibles level	Combustibles function
Efficiency	Displays efficiency	Efficiency functions
Flue Temp / Flow	Displays flue gas temperature	Flow functions
Calibrate	Accesses calibration routines	Accesses calibration routines
Parameter	Accesses parameter routines	Accesses parameter routines
Normal	Resets display to show oxygen	First press will exit from the current activity Second press returns the instrument to normal operation and saves new data
⬆	Invalid key	Change a value

Figure 4.1A

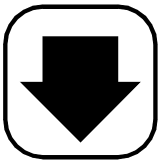
KEY FUNCTIONS		
KEY	**NORMAL OPERATION**	**PROTECTED OPERATION**
	Invalid key	Change a value
Set Point	Not Used	Not Used
Neutral	Not Used	Not Used
Automatic	Not Used	Not Used
Manual / Special	Not Used	Not Used
Continue	Press to move onto another function in a particular sequence	Press to move on to another function in a particular sequence
Status & Alarms	Press to provide indications of the fault and alarm status of the instrument	Calibration mode : Invalid key Parameter mode : Password change routine
Enter	Invalid key	Commands the instrument to accept the last keypad entry

Figure 4.1B

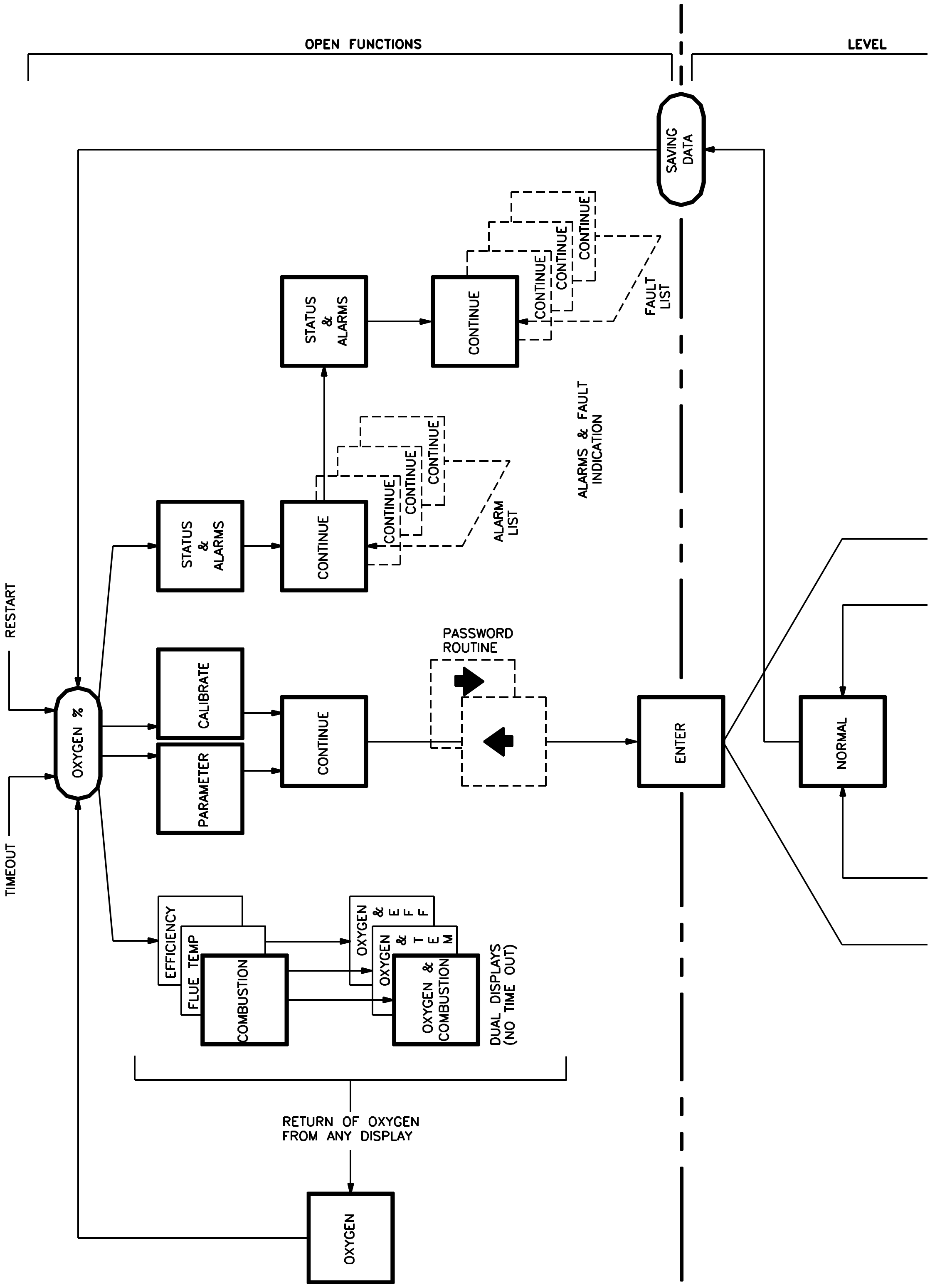


Figure 4.2 Keypad Function Overview

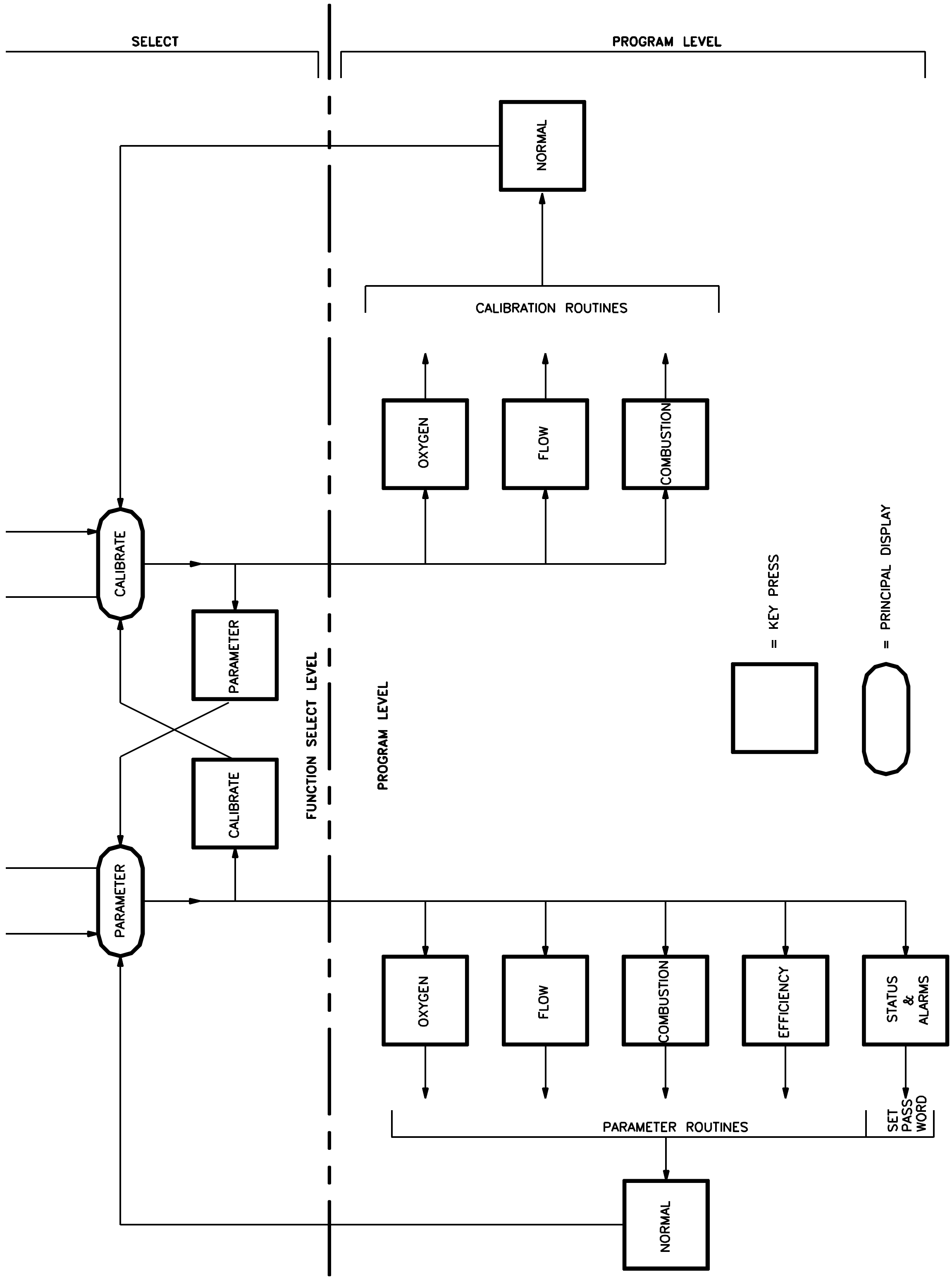


Figure 4.2 Keypad Function Overview

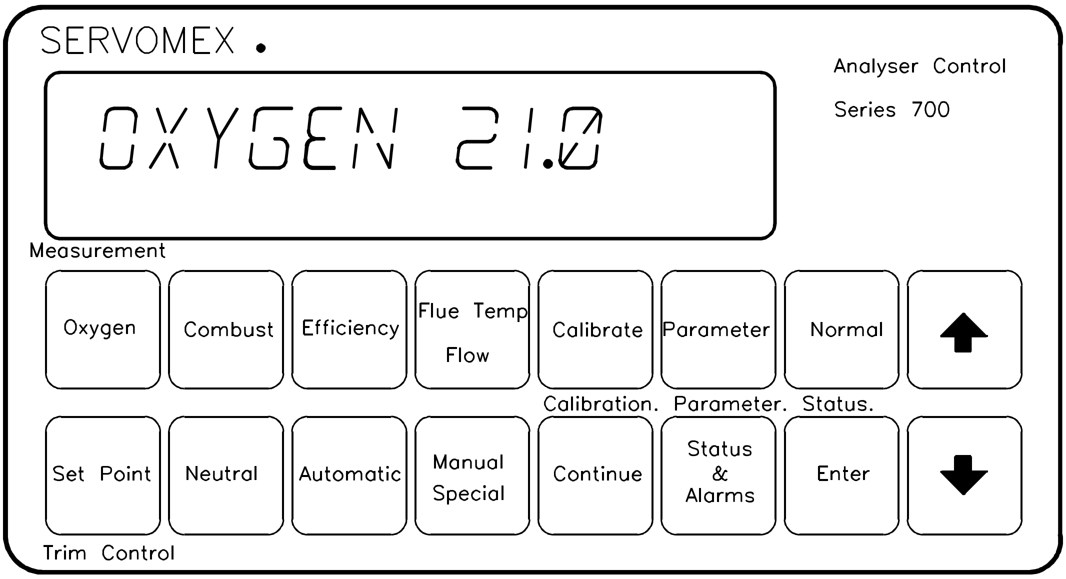


Figure 4.3 Keypad Layout

4.3 ANALYSER OPERATION VIA THE KEYPAD

Figure 4.2 shows in overview how the keypad command system is structured. Only principal displays are shown but the keypress sequences demonstrate how to move around the system, displaying the measurements, interrogating system alarms and faults and entering the password protected parameter and calibration routines.

4.3.1 Normal Functions

Normal functions do not require a password to access them. At this level the user can select the measured values to be displayed and interrogate the system alarm and fault conditions. Oxygen % display can be restored from any display by pressing the 'Oxygen' key. Dual measurement displays will not 'Time Out' but any other display will automatically revert to 'Oxygen %' 1 minute after the last keypress. Alterations to the analyser memory cannot be made at this level.

4.3.2 Protected Functions

Access to protected functions is via the user selected password. The following are then possible:

a) Exit from Protected Functions and return to Oxygen % by pressing 'Normal'.

b) Switch between 'Parameter' and 'Calibrate' modes.

c) Having selected required mode, proceed to the individual parameter or calibrate routine by pressing appropriate key.

Having selected a particular routine refer to the relevant step by step instructions following for details and explanations. The user may 'step through' these routines using the 'Continue' key to read present data without making alterations.

If the analyser is calibrated or functions are changed the new data is not saved until the analyser is returned to the oxygen display by pressing 'Normal' twice. The message 'Saving Data' will appear briefly.

4.3.3 Restart

This is the microprocessor initialisation procedure. It occurs:

a) After Power Up or Power Fail.

b) If main board reset button is pressed.

c) If the processor 'Watchdog' circuit detects a processor malfunction.

After a 'Restart' Oxygen % will be displayed, warnings being given should the displayed value be in any doubt, eg 'Warming Up' message or a 'Fault' indicated by flashing display.

4.3.4 Timeout

The analyser will 'Timeout' from any keypad operating sequence and return to the Oxygen display 1 minute after the last key press. With two exceptions:

a) It is possible to have a continuous simultaneous display of oxygen and either combustibles, temperature or efficiency (depending on options fitted).

b) At points in the calibration routines, 'Timeout' is extended to 9 minutes (Flow: 3 minutes) allowing time for gas connection and sensor output stabilisation.

Any timeout period can be restarted by a key press, preferably using a key not relevant at that point in sequence eg an 'Invalid Key' operation. (See note below).

Any data changes in the Parameter or Calibration routines that have not been saved will be lost on a 'Timeout' or 'Restart' and will have to be re-entered. The original data will be retained.

Note: If extensive data changes in various routines are anticipated, it may save time to set any existing password to '000' before starting. It is then a rapid procedure to 'Save Data' between routines. This will minimise any loss of new data through an inadvertent Timeout or power fail. Re-enter password on completion of changes.

If an incorrect key is pressed then one of the following displays occurs briefly before the analyser reverts to the step in the sequence that was wrong.

a) 'NOT FITTED': The relevant option is not fitted.

b) 'INVALID KEY': The last key pressed has no useful function at this time.

4.4 DISPLAY MODES

As standard the analyser indicates oxygen. Depending on options fitted it is also possible to display combustibles, flue temperature or efficiency, either alone or combined with the oxygen display.

4.4.1 Single Measurement

DESCRIPTION	KEY	DISPLAY	MEANING
Request the analyser to display the oxygen measurement	Oxygen	OXYGEN NN.N	NN.N is the % oxygen measurement displayed over the range 0.1 to 21.0%.
Request the analyser to display the combustibles measurement	Combust	CO N.NNN or CO OVER	N.NNN is the % combustibles indication over the range 0.000 to 5.000. Current combustibles indication is over 5.000%
Request the analyser to display the efficiency measurement	Combust	EF.NN FUEL or OUT OF RANGE	NN is efficiency in the range 0 to 99% FUEL can be either coal, oil or gas as selected in parameter routine. Oxygen level not within the range 1 to 15% O_2 or Flue gas temperature less than or equal to air temperature. or Flue temperature greater than 700 C (1292 F).
Request analyser to display flue gas temperature	Flue Temp Flow	TEMP.NNNN C or TEMP.NNNN F	NNNN is the flue temperature in C or F (Selected by a link on the card) Range: 0 to 1000 C or: 32 to 1832 F

4.4.2 Dual Display of Oxygen Level with Combustibles, Temperature or Efficiency

This function is only available when the combustibles and/or temperature and efficiency options are fitted and it enables the operator to observe two measurements simultaneously. Dual displays do not time out to 'OXYGEN' display. On any `RESTART' the dual display will revert to `OXYGEN' display.

4.4.2.1 Oxygen and Combustibles Dual Display

DESCRIPTION	KEY	DISPLAY	MEANING
From display of typically :		OXYGEN 21.0	Current oxygen level
To select oxygen and combustibles display.	Combust	CO 0.000	Current combustibles indication.
To obtain the dual display press the `Combust' key again.	Combust	21.0 C 0.000 or 21.0 C OVER	21.0 is the current oxygen level.C 0.000 is the current combustibles level. 21.0 is the current oxygen level. The current combustibles level is over 5.000%
To return to the normal display press:	Oxygen	OXYGEN 21.0	

4.4.2.2 Oxygen and Temperature Dual Display

From a display of typically :		OXYGEN 21.0	Current oxygen level.
To select oxygen and flue temperature display.	Flue Temp / Flow	TEMP.NNNNC	Current flue temperature reading NNNN.C
To obtain dual display press the `Flue Temp' key again.	Flue Temp / Flow	21.0 T.NNNNC	21.0 is the current oxygen level. T.NNNNC is the current flue temperature in C. (or F).
To return to normal display press :	Oxygen	OXYGEN 21.0	

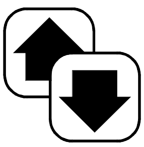
4.4.2.3 Oxygen and Efficiency Dual Display

DESCRIPTION	KEY	DISPLAY	MEANING
From a display of typically :		OXYGEN XY.Z	XY.Z is current oxygen level.
To select oxygen and efficiency display.	Efficiency	EF.NN GAS or OUT OF RANGE	Current efficiency reading NN%. The fuel is gas. See Section 4.4.1.
To obtain dual display press the function key again.	Efficiency	XY.Z.EF.MM	XY.Z is current oxygen level. EF.MM is the calculated combustion efficiency in %.
To return to normal display press :	Oxygen	OXYGEN XY.Z	

4.5 PROTECTED FUNCTIONS

This section describes password entry to protected functions, and exit procedure for saving data after changes to parameters have been made.

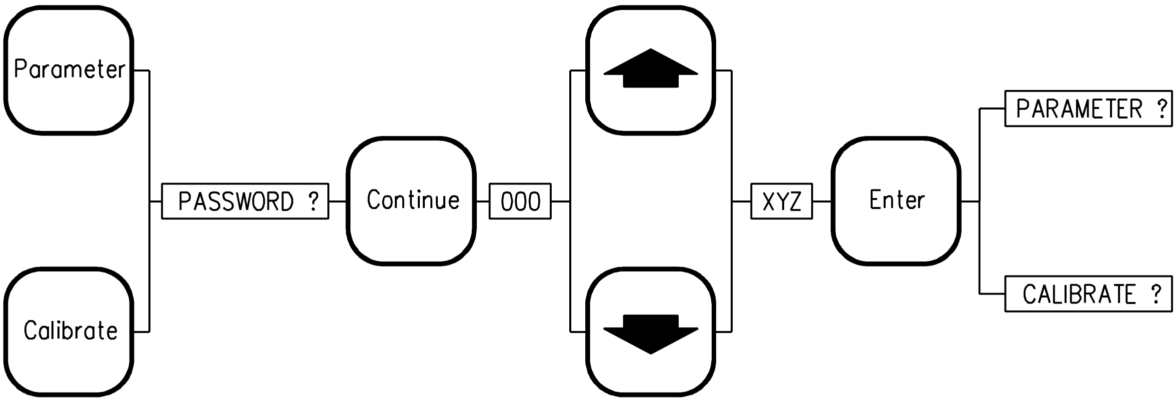
4.5.1 Password Entry

DESCRIPTION	KEY	DISPLAY	MEANING
Select and access required password protected functions	Parameter or Calibrate	PASSWORD ?	Prompt to enter password.
	Continue	000	Number which the operator must make equal to the password. If the pass word is `000' press `Enter'.
Continuously depressing these keys will cause an accelerating display change.		NNN	NNN is the password.

DESCRIPTION	KEY	DISPLAY	MEANING
Command the analyser to accept the password.	Enter	WRONG or PARAMETER ? or CALIBRATE ?	Indicates that the entered password was wrong. Displayed for 2.5 seconds before reverting to oxygen reading. Check password and then recommence the entry routine. Parameter access selected, password correct, proceed to parameter sections of this manual. Calibration access selected, password correct, proceed to calibration section of this manual.
Once password has been entered the operator can switch between calibrate and parameter functions by pressing the appropriate keys.			

4.5.1.1 Memory Aid to Password Sequence

As a memory aid the password sequence is shown in brief form at the start of any section where it is necessary to enter protected functions:



Where XYZ is the correct password.

4.5.2 Exit From a Parameter or Calibrate Routine

Note: This key sequence is shown in summary at the end of each protected routine.

DESCRIPTION	KEY	DISPLAY	MEANING
Last step in present routine.			Routine complete. Display has returned to start of loop. If satisfied that all settings in this loop are as required, press `Normal' (Use `Continue' key to review list).
Exit from this routine. (Any routine can be left at any point by pressing Normal key).	Normal	PARAMETER ? or CALIBRATE ?	If leaving a Parameter routine. If leaving a calibration routine. Prompt to change other parameters or perform other calibrations if required. **Note :** If a `Powerfail', `Reset' or inadvertent `Time Out' occur during subsequent routines, before the next `Saving Data' operation the new data in this routine will be lost along with any `unsaved' new data from previous routines. (The original data will be retained).  Press `Normal' to save data.
Command the analyser to store new data in this routine. (Will also store any unstored data from any previous routine).	Normal	SAVING DATA then OXYGEN NN.N	If the `Enter' key has been used in previous routine(s) the message `Saving Data' will be displayed briefly as analyser stores new information. Display reverts to current oxygen measurement.

4.5.2.1 Saving Data

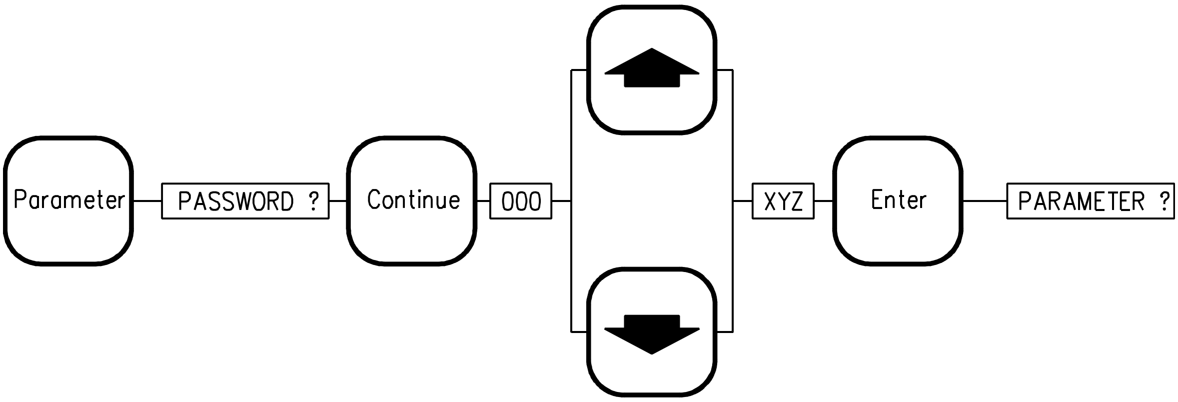
If during a series of data entries a 'Timeout' occurs, all data that has not been 'Saved' (transferred into permanent memory) will be lost and have to be re-entered. To minimise this risk, at the end of each entry section, it is advisable to 'save' data. This procedure is described in section 4.5.2, that is the 'Normal-Normal' key sequence. To proceed with further data entry, a re-entry via the password sequence will have to be carried out.

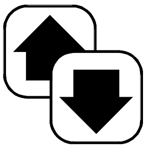
4.6 SETTING-UP ANALYSER AND OUTPUTS

4.6.1 Flow Alarm Trip Level Parameter

The flow alarm trip level can be set to trip either at zero flow (<10%) or at low flow (approximately 20% of nominal full flow).

Enter password for parameter functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Command the analyser to display the flow parameters.	Flue Temp / Flow	F.TRIP ZERO or F.TRIP LOW	Trip level is at zero flow. Trip level is at 20% of flow.
Select the required trip level. Either zero or low flow.		F.TRIP ZERO or F.TRIP LOW	
Command the analyser to accept the new information and move onto the next function.	Enter	NEW F.TRIP 0 or NEW F.TRIP LO	Trip level is now set to zero. Trip level is now set at 20% of flow.

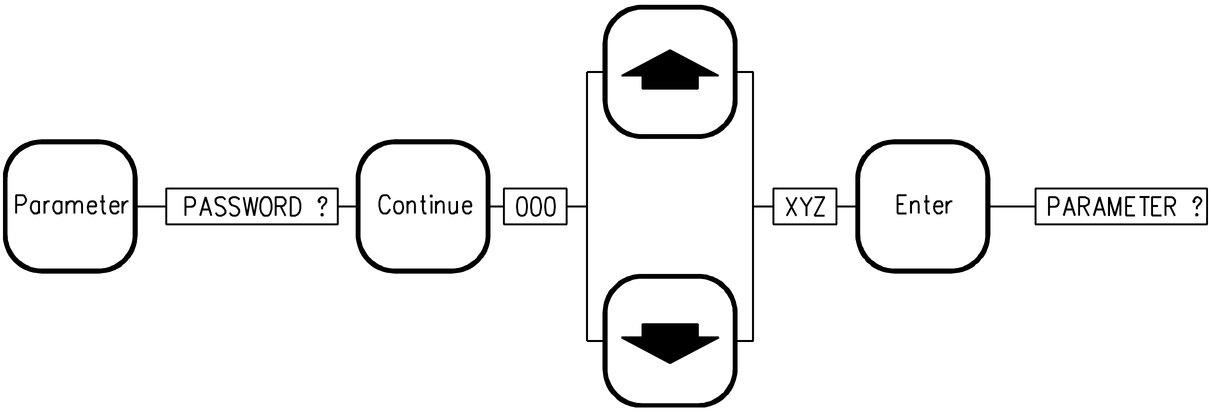
DESCRIPTION	KEY	DISPLAY	MEANING
Exit from this routine.	Normal	PARAMETER ?	
Command analyser to store data.	Normal	PARAMETER then OXYGEN NN.N	Data stored in permanent memory.

4.6.2 Oxygen Output (non-isolated)

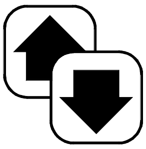
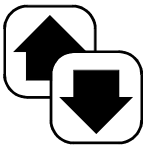
Note: 1. If the isolated oxygen output and alarm card is fitted (00722911) then its output may be set differently to the standard, mainboard, non-isolated output. See Section 4.6.4 for setting the isolated output.

2. If the isolated oxygen and combustibles card (00722921) is fitted then the oxygen output is the same as the standard mainboard, non-isolated output and there is only one parameter setting routine for both outputs.

Enter password for parameter functions.



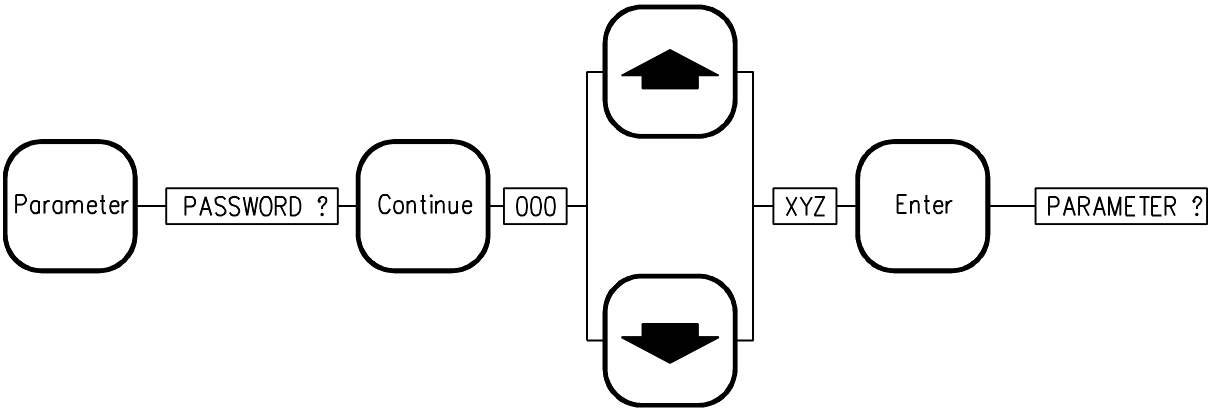
DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Command the analyser to display the oxygen parameters.	Oxygen	OX.RANGE NN	Where NN is the analogue output range in % oxygen.

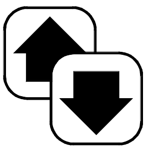
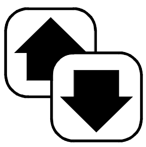
DESCRIPTION	KEY	DISPLAY	MEANING
Select the required oxygen output range. 2.5, 5, 10 or 25%O_2		OX.RANGE MM	Where MM is the new output range.
Command the analyser to accept the information and move onto the next function.	Enter	OX.ZERO LIVE or OX.ZERO TRUE	Analogue output for oxygen is 4 to 20 mA and 2 to 10V (TB2). Analogue output for oxygen is 0 to 20 mA and 0 to 10V (TB2).
Select live or true zero for the oxygen analogue output.		OX.ZERO LIVE or OX.ZERO TRUE	
Command the analyser to accept the information and move onto the next function.	Enter	OX.RANGE NN	Returned to the first parameter i.e. oxygen output range.
Exit from this routine.	Normal	PARAMETER ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

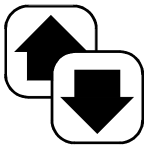
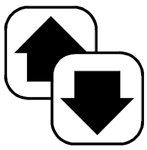
4.6.3 Combustibles Output

Note : If the isolated oxygen and combustibles card (00722921) is fitted then the oxygen output is the same as the standard mainboard, non-isolated output and there is only one parameter setting routine for both outputs.

Enter password for parameter functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Command the analyser to display the combustibles parameters.	Combust	CO.AL.X.XX or CO.AL.OFF	Where X.XX is the current set point of the combustibles alarm in % CO. If the alarm is set to above 4.99% the display will read `OFF'. Combustibles alarm inoperative.
Select the alarm level required.		CO.AL.N.NN	Where N.NN is the new setting of the alarm level. N.NN will indicate OFF if the alarm is set to above 4.99%. Alarm is then inoperative.
Command the analyser to accept the information and move onto the next function.	Enter	CO.RANGE Y.YY	Where Y.YY is the analogue output range in % combustibles.
Select the required combustibles output range (0.25, 0.5, 1.00 or 5.00% FSD).		CO.RANGEM.MM	Where M.MM is the new output range.

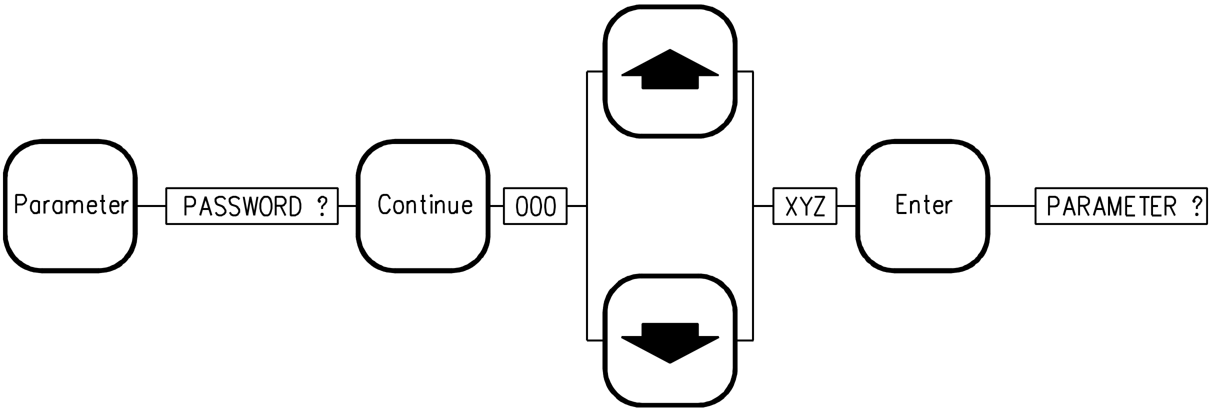
DESCRIPTION	KEY	DISPLAY	MEANING
Command the analyser to accept the information and move onto the next function.	Enter	CO.ZERO LIVE or CO.ZERO TRUE	Analogue output for combustibles is 4 to 20 mA and 2 to 10V (TB50). Analogue output for combustibles is 0 to 20mA and 0 to 10V (TB50).
Select live or true zero for the combustibles analogue output.		CO.ZERO LIVE or CO.ZERO TRUE	
Command the analyser to accept the information and move onto the next function.	Enter	SENS CONST.Z	Where Z is the present combustibles sensor constant.
Set the sensor constant to the number marked on the printed circuit board inside of the sensor head terminal box.		SENS CONST.B	Where B is the correct sensor constant.
Command the analyser to accept the information and move on to the next function.	Enter	CO.AL.X.XX	Returned to the first parameter i.e. combustibles alarm level.
Exit from this routine	Normal	PARAMETER ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory

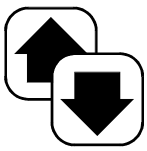
4.6.4 Oxygen Output (isolated) and Alarms

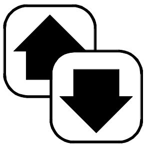
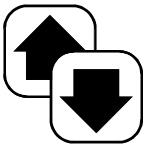
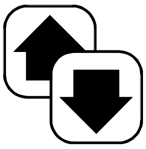
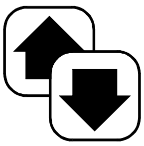
Note: 1. This section also includes information on setting the standard, main board, non-isolated oxygen output.

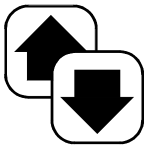
2. If the isolated oxygen output and alarm card is fitted (00722911) then its output may be set differently to the standard, mainboard, non-isolated output.

Enter password for parameter functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Command the analyser to display the oxygen parameters.	Oxygen	OX.AL.L.XX.X or OX.AL.L.OFF	Where XX.X is the current set point of the low oxygen alarm in % O_2. If the alarm is set below 0.1 % O_2 the display will read OFF. Oxygen low alarm is inoperative.
Select the required low alarm level.		OX.AL.L.YY.Y	Where YY.Y is the new setting of the low alarm level. YY.Y will indicate OFF if the alarm is set to below 0.1% O_2. Low alarm is then inoperative.
Command the analyser to accept the information and move onto the next function.	Enter	OX.AL.H.XX.X or OX.AL.H.OFF	Where XX.X is the current set point of the high oxygen alarm in % O_2. If the level is set to above 24.9% O_2 the display will read OFF. Oxygen high alarm is inoperative.

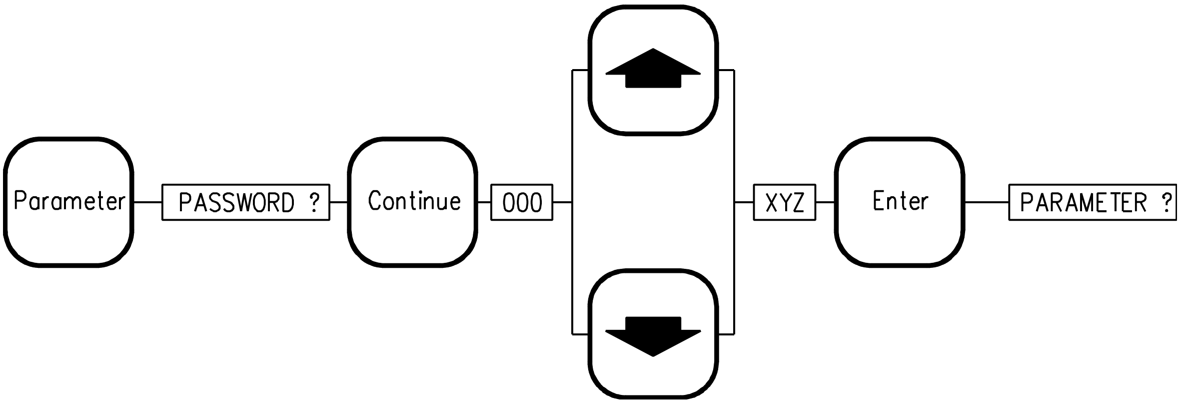
DESCRIPTION	KEY	DISPLAY	MEANING
Select the required high alarm level.		OX.AL.H.YY.Y	Where YY.Y is the new setting of the high alarm, YY.Y will indicate OFF if the alarm is set to above 24.9% O_2. Oxygen high alarm is then inoperative.
Command the analyser to accept the information and move on to the next function.	Enter	I.OX.RANGE XX	Where XX is the isolated analogue output range information in % oxygen.
Select the required isolated oxygen output range. (2.5, 5, 10 or 25% O_2 FSD).		I.OX.RANGE YY	Where YY is the new isolated output range.
Command the analyser to accept the information and move onto the next function.	Enter	I.OX.ZERO LIVE or I.OX.ZERO TRUE	Isolated analogue output for oxygen is 2 to 10V and 4 to 20 mA (TB 11). Isolated analogue output for oxygen is 0 to 10V and 0 to 20 mA (TB 11).
Select live or true zero for the oxygen isolated analogue output.		I.OX.ZERO LIVE or I.OX.ZERO TRUE	
Command the analyser to accept the information and move onto the next function. (Setting the non-isolated oxygen output).	Enter	OX.RANGE XX	Where XX is the non-isolated analogue output range in % oxygen. **Note :** It can be set to a range different from the isolated output range if required.
Select the required non-isolated oxygen output range. (2.5, 5, 10 or 25% FSD).		OX.RANGE YY	Where YY is the new non-isolated analogue output range.

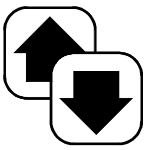
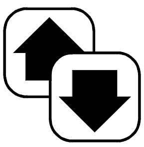
DESCRIPTION	KEY	DISPLAY	MEANING
Command the analyser to accept this information and move onto the next function.	Enter	OX.ZERO LIVE or OX.ZERO TRUE	Standard non-isolated output is 2 to 10V and 4 to 20 mA (TB2). Standard non-isolated output is 0 to 10V and 0 to 20mA (TB2).
Select live or true zero for the non-isolated analogue output.		OX.ZERO LIVE or OX.ZERO TRUE	Non-isolated analogue output for oxygen is 2 to 10V and 4 to 20mA. This need not be the same as the isolated signal. Non-isolated analogue output for oxygen is 0 to 10V and 0 to 20mA. This need not be the same as the isolated signal.
Command the analyser to accept this information and move onto the next function.	Enter	OX.AL.L.XX.X	Returned to the first parameter i.e. low oxygen alarm level.
Exit from this routine.	Normal	PARAMETER ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

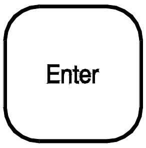
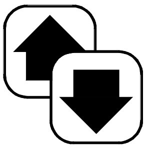
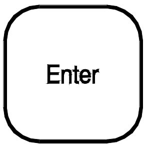
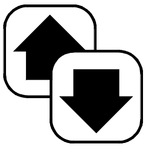
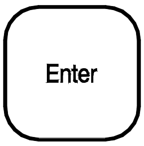
4.6.5 Temperature and Efficiency Parameters

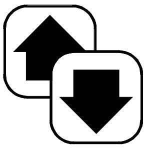
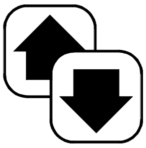
Note: To change temperature reading from centigrade to fahrenheit make link LK1 (wire wrap plug adjacent to IC6) on temperature and efficiency option printed circuit board (00722914). Then press reset button on main board.

Enter password for parameter functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Command the analyser to display the temperature and efficiency parameters	Efficiency	FUEL NNNN	NNNN is the current setting of the fuel. (GAS, OIL or COAL).
Select the required fuel, i.e. gas, oil or coal.		FUEL MMMM	Where MMMM is the new fuel used in the efficiency calculation.
Command the analyser to accept the information and move onto the next function.	Enter	EF.ZERO LIVE or EF.ZERO TRUE	Analogue output for efficiency is 4 to 20mA and 2 to 10V. (TB41). Analogue output for efficiency is 0 to 20mA and 0 to 10V, (TB41).
Select live or true zero for the efficiency analogue output.		EF.ZERO LIVE or EF.ZERO TRUE	

DESCRIPTION	KEY	DISPLAY	MEANING
Command the analyser to accept the information and move onto the next function.		FT.ZERO LIVE or FT.ZERO TRUE	Analogue output for flue temperature is 4 to 20 mA and 2 to 10V. (TB41). Analogue output for flue temperature is 0 to 20 mA and 0 to 10V. (TB41).
Select live or true zero for the flue temperature.		FT.ZERO LIVE or FT.ZERO TRUE	
Command the analyser to accept the information and move onto the next function.		F.T.RANGE 500 or F.T.RANGE 1000 or F.T.RANGE 2000	Analogue output range for flue temperature is 0 to 500 C. Analogue output range for flue temperature is 0 to 1000 C or 0 to 1000 F. Analogue output range for flue temperature is 0 to 2000 F. (Limits at 1832 F).
Select the required flue temperature output range.		F.T.RANGE 500 or F.T.RANGE 1000 or F.T.RANGE 2000	
Command the analyser to accept the information and move onto the next function.		F.T.ALARM NNN or F.T.ALARM OFF	Where NNN is the current set point of the flue temperature alarm scaled either in C or F. If the alarm is set above 999 C or 1830 F it is inoperative. Flue temperature alarm inoperative.

DESCRIPTION	KEY	DISPLAY	MEANING
Select the required alarm level.		F.T.ALARM MMM	Where MMM is the new setting of the alarm level. MMM will indicate OFF if the alarm is set above 999 C or 1830 F.
Command the analyser to accept the information and move onto the next function.	Enter	AIR TEMP.NNN or T.C.TEMP.NNN	Where NNN is the air temperature used in the efficiency calculation when an inlet thermocouple is not fitted. The available range for this setting is -20 to +150 C or 0 to 300 F. Where NNN is the air temperature measured by the inlet thermocouple. Range -20 to +150 C (-4 to 302 F) This is a measured parameter and cannot be changed via the key pad. Press `Continue' key to move onto next function.
If an inlet thermocouple is not fitted, select the required air temperature (-20 to +150C, -4 to +302F)		AIR TEMP.MMM	Where MMM is the new setting for the air temperature.
Command the analyser to accept the information and move onto the next function.	Enter	FUEL NNNN	Returned to the first parameter i.e. fuel selection.
Exit from this routine.	Normal	PARAMETER ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

4.7 CALIBRATION

Calibration gases are specified in Section 3.10

Details of calibration gas connections, flow rates etc. are given in Section 3.11.

If the combustibles is fitted and the combustibles sensor and or the combustibles card have been changed then the combustibles board must be adjusted and the correct sensor constant entered prior to combustibles calibration. Refer to section 5.2.2.6.

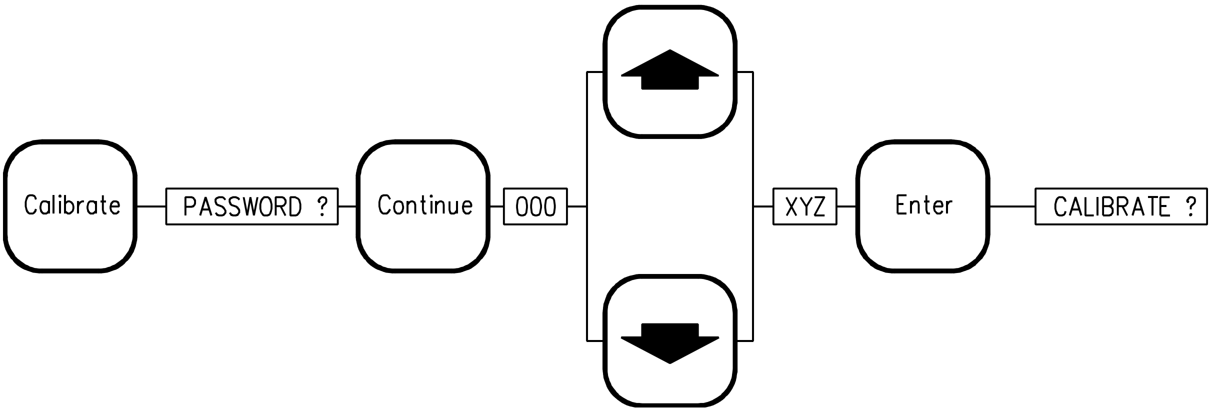
4.7.1 Frequency of Calibration

The frequency of calibration will depend upon the use to which the analyser is being put and the reliance being placed upon it. The following is suggested which can be modified as a result of operating experience.

Weekly:	Combustibles zero	3 monthly:	Oxygen air point Oxygen end point Combustibles span Flow sensor

4.7.2 Flow Sensor Calibration Procedure

Enter password for calibration functions.



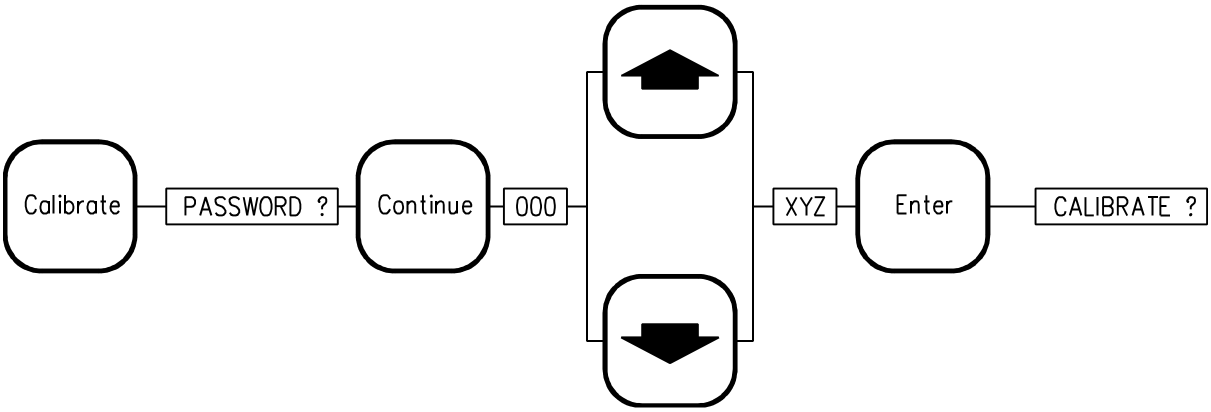
DESCRIPTION	KEY	DISPLAY	MEANING
		CALIBRATE ?	Calibrate functions have been selected.
Select flow calibration. The analyser will time out three minutes after this key is pressed unless another key is pressed.	Flue Temp Flow	ZERO FLOW ZERO FLOW*	Switch off the aspirator air supply. Allow two minutes for the flow sensor output to settle. An asterisk will show on the display after two minutes indicating that the instrument will time out after another minute.

DESCRIPTION	KEY	DISPLAY	MEANING
Command the analyser to calibrate the flow zero point. The analyser will time out after three minutes unless another key is pressed.	Enter	FLOW 0 SET or CAL.ERROR	Flow zero point has been correctly set. Sensor not settled (output of flow sensor changed significantly during the calculation). Displayed for 2.5 seconds before reverting to display ZERO FLOW.
Exit from this routine.	Normal	CALIBRATE ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

Note : Turn on aspirator air supply once flow sensor calibration is completed.

4.7.3 Oxygen Sensor Air Point Calibration Procedure

Enter password for calibration functions.



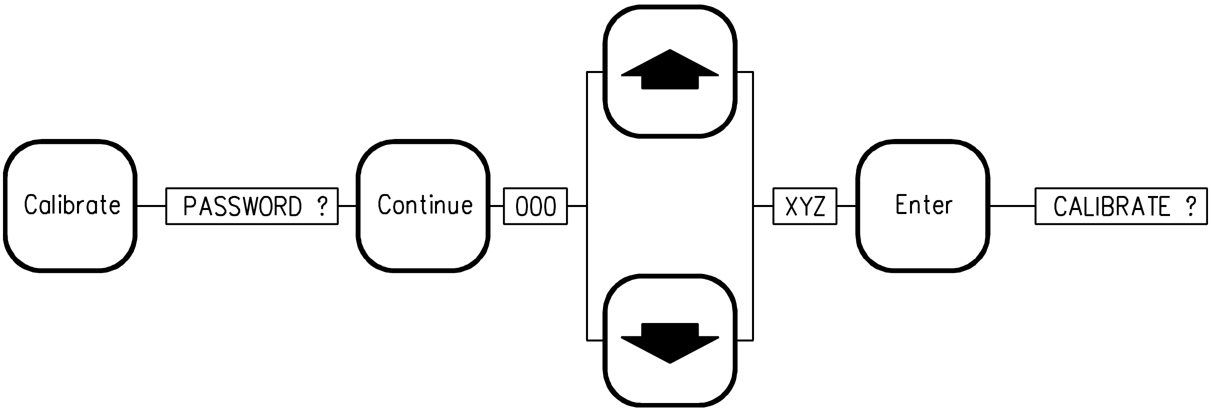
DESCRIPTION	KEY	DISPLAY	MEANING
		CALIBRATE ?	Calibrate functions have been selected.
Select oxygen sensor calibration.	Oxygen	CAL.PT.AIR	If only end point calibration is required press `Continue' to jump to start of end point calibration routine.

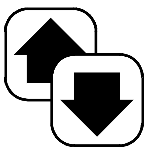
Select air as the calibration point.	Enter	CAL.GAS.AIR	Air point calibration has been selected.
Press `Continue' then connect a supply of calibration air to the calibration inlet of the sensor head at a flow rate of 600 ml/min.	Continue	AA.AA 20.95 AA.AA 20.95*	Where AA.AA is the measured oxygen level calculated using existing data. 20.95 is the air calibration point. Providing stability is achieved within 9 minutes, calibration can be completed. After 8 minutes, an asterix will show on the display indicating that the analyser will time out after a further minute.
When the display is stable, command the analyser to recalculate and update the calibration data such that the measured oxygen level AA.AA equals the air calibration point (20.95). Then move onto the next function.	Enter	CAL.PT.N.NN or CAL.ERROR or CAL.FAIL	Air point calibration has been successful. Prompt to continue onto end point calibration where N.NN is the end point calibration point. Indicates that the cell output changed during the calculation. Wait for stability and press `Enter' again. The cell output is outside its tolerance limits. See Section 5.2.2.3. CAL.ERROR and CAL.FAIL messages are displayed for 2.5 seconds before the display reverts to AA.AA 20.95.
Exit from this routine.	Normal	CALIBRATE ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

Note : Disconnect calibration air from the analyser and seal calibration port.

4.7.4 Oxygen Sensor End Point Calibration Procedure

Enter password for calibration functions.



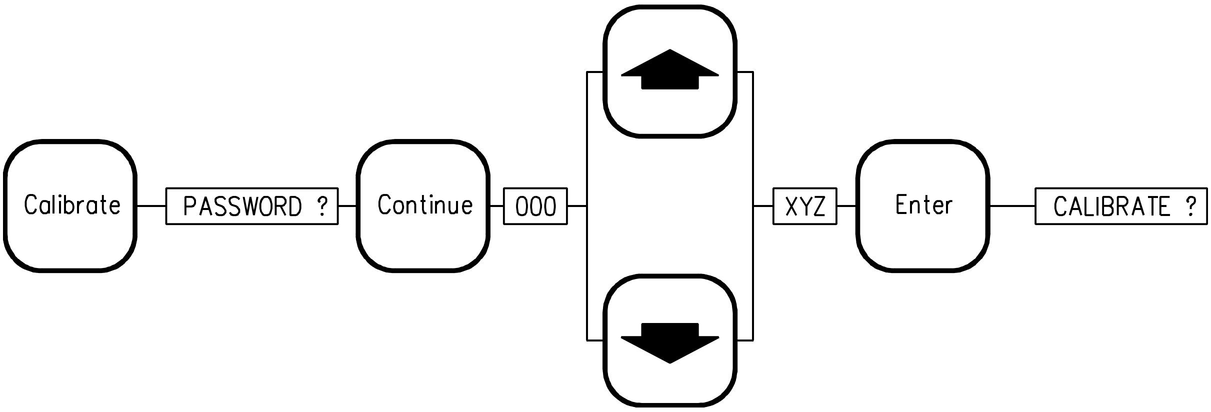
DESCRIPTION	KEY	DISPLAY	MEANING
		CALIBRATE ?	Calibration functions have been selected.
Select oxygen sensor calibration.	Oxygen	CAL.PT.AIR	Air point calibration has already been performed so continue onto end point calibration.
Select end point calibration.	Continue	CAL.PT.N.NN	Where N.NN is the calibration point which was used during the last calibration.
Set end point calibration point to the certified analysis of the gas mixture. Range 0.25 to 2.50% O_2.		CAL.PT.M.MM	M.MM is the new end point calibration point.
Command the analyser to accept this information and move onto the next function.	Enter	CAL.GAS.M.MM	Where M.MM is the new concentration in % oxygen of the end point calibration gas.

DESCRIPTION	KEY	DISPLAY	MEANING
Press `Continue' then connect a supply of end point calibration gas to the calibration inlet at a flow rate of 600 ml/min.	Continue	BB.BB.M.MM BB.BB.M.MM*	Where BB.BB is the measured oxygen level calculated using existing data. Providing stability is achieved within 9 minutes calibration can be completed. After 8 minutes, an asterix will show on the display indicating that the analyser will time out after a further minute.
When the display is stable, command the analyser to recalculate and update the calibration data such that the measured oxygen level BB.BB equals the end point calibration gas M.MM Then move onto the next function.	Enter	CAL.PT.AIR or CAL.ERROR or CAL.FAIL	End point calibration has been successful. Prompt to continue onto air point calibration if required. Indicates that the cell output changed during the calculation. Wait for stability and press `Enter' again. The cell output is outside its tolerance limits. See Section 5.2.2.3. CAL.ERROR and CAL.FAIL messages are displayed for 2.5 seconds before the display reverts to BB.BB M.MM.
Exit from this routine.	Normal	CALIBRATE ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

Note : Disconnect calibration gas from the analyser and seal calibration port.

4.7.5 Combustible Sensor Zero Calibration Procedure

Enter password for calibration functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		CALIBRATE ?	Calibration functions have been selected.
Select combustibles sensor calibration.	Combust	CO.ZERO ?	If only span calibration is required press `Continue' to jump to start of span calibration routine.
Select zero combustibles gas as calibration point.	Enter	CAL.GAS ZERO	Zero combustibles calibration gas has been selected.
Press `Continue' then connect combustibles zero gas to the calibration inlet of the sensor head at a flow rate of 600 ml/min.	Continue	A.AAA 0.000 A.AAA 0.000*	Where A.AAA is the current combustibles level. 0.000 is the zero combustibles point. Negative values of combustibles are shown as 0.000. The zero calibration procedure should be completed even if the display indicates 0.000. Providing stability is achieved within 8 minutes , calibration can be completed. After 8 minutes an asterix will show on the display indicating that the analyser will time out after a further minute.

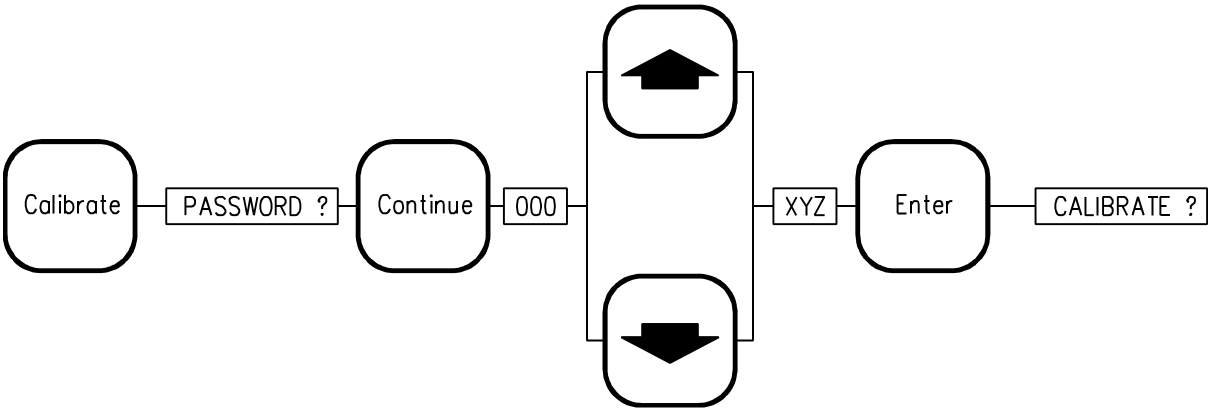
DESCRIPTION	KEY	DISPLAY	MEANING
When the display is stable command the analyser to recalculate and update the calibration data such that the measured combustibles level equals the zero combustibles point (0.000). Then move onto the next function.	Enter	ZERO CAL OK or CAL.ERROR or CAL.FAIL then CO.SPAN ? N.NN	The zero point calibration has been successful. Indicates that the sensor output changed during the calculation. Wait for stability and press \`Enter' again.  The sensor output is outside its tolerance limits. See section 5.2.2.7.  \`CAL.ERROR' and \`CAL.FAIL' messages are displayed for 2.5 seconds before the display reverts to A.AAA 0.000. Prompt to continue onto the span calibration. Where N.NN is the span calibration point.
Exit from this routine.	Normal	CALIBRATE ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

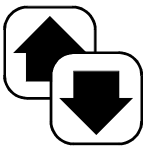
Note : Disconnect calibration gas from the analyser and seal calibration port.

4.7.6 Combustibles Sensor Span Calibration Procedure

Note : Combustibles sensor zero calibration must be performed before span calibration.

Enter password for calibration functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		CALIBRATE ?	Calibration functions have been selected.
Select combustibles sensor calibration.	Combust	CO ZERO ?	Zero calibration has already been performed so continue onto span calibration.
Select span point calibration.	Continue	CO.SPAN ? N.NN	Where N.NN is the calibration point which was used during the last span calibration.
Select the span gas calibration point to the certified analysis of the gas mixture, range 0.2 to 5.00%.		CO.SPAN M.MM	Where M.MM is the new span calibration point.
Command the analyser to accept this information and move onto the next function.	Enter	CAL.GAS.SPAN	Span point selected.

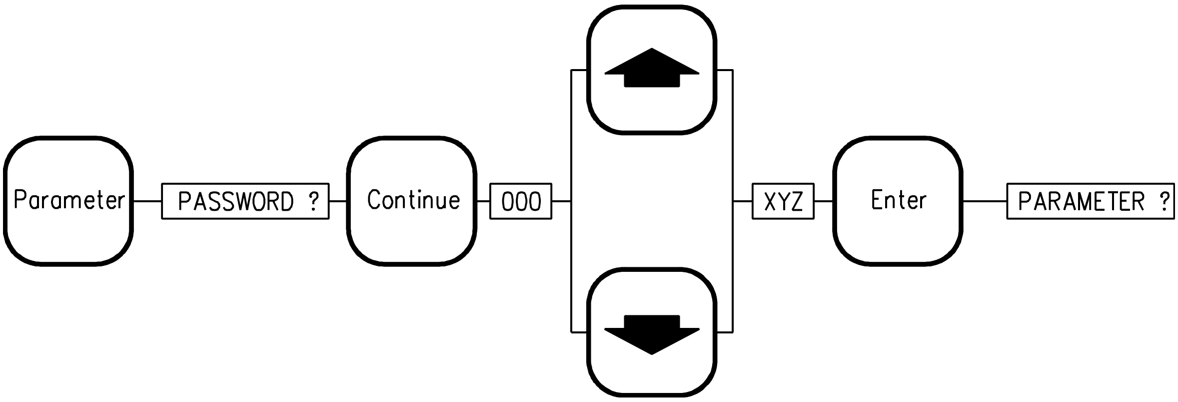
DESCRIPTION	KEY	DISPLAY	MEANING
Press `Continue'. Then connect combustibles span gas to the calibration inlet at a flow rate of 600 ml/min.	Continue	A.AAA M.MMM A.AAA M.MMM*	Where A.AAA is the measured combustibles level calculated using existing data. Providing stability is achieved within 9 minutes, calibration can be completed. After 8 minutes an asterix will show on the display indicating that the analyser will time out in a further minute.
When the display is stable, command the analyser to recalculate and update the calibration data such that the measured combustibles level A.AAA equals the span calibration gas level M.MMM. Then move onto the next function.	Enter	SPAN CAL.OK then CO.ZERO ? or CAL ERROR or CAL FAIL	The span point calibration has been successful. Prompt to repeat zero calibration if desired. Indicates that the sensor output changed during calculation. Wait for stability and press `Enter' again. The sensor output is outside its tolerance limits. See Section 5.2.2.7. CAL ERROR and CAL FAIL messages are displayed for 2.5 seconds before the display reverts to A.AAA M.MMM.
Exit from this routine.	Normal	CALIBRATE ?	
Command analyser to store new data.	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

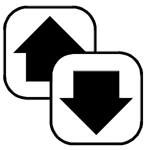
Note : Disconnect calibration gas from the analyser and seal calibration port.

4.8 CHANGING THE PASSWORD

Note: The password to the protected functions is factory set to: 000

Enter password for parameter functions.



DESCRIPTION	KEY	DISPLAY	MEANING
		PARAMETER ?	Parameter functions have been selected.
Select the password routine.	Status & Alarms	PASS.CHANGE ?	Password routine selected.
	Continue	PPP	Where PPP is the existing password number.
Select the required password number.		NNN	Where NNN is the new password number.
Command the analyser to accept the information and move to the next function.	Enter	NEW PASS=NNN	Where NNN is the new password number. The display will time out and the new number will be erased if the `Normal' key is not pressed within one minute.

DESCRIPTION	KEY	DISPLAY	MEANING
Exit from this routine.	Normal	PARAMETER ?	
Command analyser to store new data	Normal	SAVING DATA then OXYGEN NN.N	Data stored in permanent memory.

4.9 ALARMS AND FAULTS

An alarm or fault condition is indicated by a flashing display.

Alarms are user defined and relate to process variables. Faults are malfunctions of the analyser that may result in measurement errors.

When there is a major analyser failure the display will show 'SYS FAIL N' (N = 1 to 9). See Section 5.2.1 for further information.

4.9.1 Displaying Alarms and Faults

DESCRIPTION	KEY	DISPLAY	MEANING
From flashing display press :	Status & Alarms	ALARM N,N,N... or FAULT N,N,N...	Alarms or faults are present. N is the position of the card which has generated the alarm or fault.
Identify alarms or faults.	Continue	DDDD....	Where DDDD.... is the alarm or fault display.
Press as many times as necessary to identify all alarms or faults.	Continue		See section 4.9.1.1 for list of alarms and section 5.2.2 for list of faults.

DESCRIPTION	KEY	DISPLAY	MEANING
Press if alarms are present to identify any faults.	Status & Alarms	FAULT N,N,N...	Faults are present N is the position of the card which has generated the fault.
	Continue	DDDD....	Where DDDD.... is the fault display.
Press as many times as necessary to identify any faults.	Continue		
	Oxygen	OXYGEN NN.N	Return to oxygen display.

4.9.1.1 Alarm Messages

Flashing Display	**Description**
OXYGEN LOW	The oxygen content is below the low oxygen alarm level.
OXYGEN HIGH	The oxygen content is above the high oxygen alarm level.
COMB. HIGH	The combustibles content is above the combustibles alarm level.
FLUE TEMP HI	The flue temperature is above the flue temperature alarm level.

SECTION 5 : MAINTENANCE

CONTENTS

SECTION **PAGE**

5.1 GENERAL 5.3

5.1.1 Repair Equipment and Tools 5.4

5.2 FAULT DIAGNOSIS 5.5

5.2.1 Shutdown faults 5.5
5.2.2 Self Diagnostic Faults 5.6
5.2.2.1 CELL TEMP HI or CELL TEMP LO 5.10
5.2.2.2 OX. RANGE ERROR 5.11
5.2.2.3 CAL.FAIL 5.12
5.2.2.4 CAL.ERROR 5.12
5.2.2.5 CO.SENS FLT 5.14
5.2.2.6 Combustibles board (00722925) Set Up Procedure 5.16
5.2.2.7 CAL.FAIL 5.17
5.2.2.8 CAL.ERROR 5.17
5.2.2.9 OVEN TEMP LO 5.17
5.2.2.10 T.SENSOR FAIL 5.18
5.2.2.11 FLOW FAILURE 5.18
5.2.2.12 FLUE T.C.FAIL 5.20
5.2.2.13 DATA CORRUPT 5.20

5.3 REPAIR OF THE CONTROL UNIT 5.21

5.3.1 Removal of Option Boards 5.21
5.3.2 Removal of the Interface Adaptor Board 5.22
5.3.3 Removal of the Main PCB Assembly 5.22
5.3.4 Removal of the Display Board 5.22

5.4 REPAIR OF THE SENSOR HEAD 5.23

5.4.1 Removal of Sensor Head Covers 5.23
5.4.2 Removal of the Internal Filter 5.26
5.4.3 Removal of the Complete Combustibles Sensor (if fitted) 5.26
5.4.4 Removal of the Combustibles Sensor Parts 5.26
5.4.5 Removal of the Oxygen Sensor 5.27
5.4.6 Removal of the Flow Sensor 5.28
5.4.7 Removal of Flame Traps 5.28
5.4.8 Removal of Cartridge Heaters 5.28
5.4.9 Removal of Thermocouple Reference Assembly and Thermistor 5.29
5.4.10 Removal of Thermostats 5.29
5.4.11 Removal of the Solenoid Valve 5.29
5.4.12 Removal of the Aspirator Assembly 5.30

CONTENTS (continued)

SECTION		PAGE
5.5	**MAINTENANCE OF THE SAMPLE PROBE**	5.30
5.5.1	Cleaning the Probe Tube	5.30
5.5.2	Replacement of the Probe Tube	5.31
5.5.3	Maintenance of the Probe Filter	5.31
5.6	**RETRO-FITTING OF THE COMBUSTIBLES SENSOR KIT (00714998)**	5.32
5.7	**SERVICING OF AIR FILTER/REGULATOR UNIT**	5.33

LIST OF ILLUSTRATIONS

FIGURE		PAGE
5.1	Location of Fuses and Indicators	5.8-5.9
5.2	Cell Output	5.13
5.3	Exploded View - Sensor Head	5.24-5.25

SECTION 5 : MAINTENANCE

5.1 GENERAL

Repair of the analyser should be done by qualified personnel who are familiar with good workshop practice and the requirements for repairing certified equipment.

WARNING

The electrical power in this equipment is at a voltage high enough to endanger life.

Before carrying out maintenance or repair, persons concerned must ensure that the equipment is disconnected from the electrical power supply and tests made to verify that the isolation is complete.

Also ensure that power is disconnected from external circuits connected to the analyser, eg., alarms.

When the supply is not disconnected, functional testing, maintenance and repair of the electrical units is to be undertaken only by persons fully aware of the danger involved and who have taken adequate precautions.

Removing the sensor head cover will expose heated parts. Ensure that the internal temperature has dropped to a safe level before working on them.

Ensure that only fuses of the specified current and type are used.

HAZARDOUS AREA

If the analyser is installed on a hazardous application the area must be made safe and shown not to contain explosive or flammable gases before covers are opened or work done on the equipment.

CAUTION

To maintain the analyser's performance only spares of suitable quality should be used to repair this analyser. These should be obtained from Servomex, its associated companies or local agents

The circuit boards in the control unit are tested using specialised test equipment. Faulty boards should be replaced and returned to Servomex for repair, thus no circuit diagrams are included in this manual to enable board repair at component level.

Only standard tools are required to dismantle the analyser and replace the various component parts. These are listed in Section 5.1.1.

The fault diagnosis section (Section 5.2) is intended to provide a fault resolution down to the level of the sub-assemblies given in the Recommended Spares List (Section 7).

5.1.1 Repair Equipment And Tools

The following equipment and tools should be available to personnel responsible for maintenance and repair of the analyser.

Description	Quantity	For use on :-
Open-ended spanners :		
7mm AF	1	M4 nuts
8mm (5/16 inch) AF	1	Flametrap bodies
10mm AF	1	M6 bolts
7/16 inch AF	2	1/8 inch couplings
13mm AF	1	1/4 inch union nuts
9/16 inch AF	1	1/4 inch couplings, calibration port nuts
11/16 inch AF	1	Oxygen sensor coupling nuts
1 inch AF	1	Fitting high temp. probes
16mm (5/8 inch) AF	1	Oxygen sensor body
17mm AF	1	M10 mounting bolts
Screwdrivers :		
Pozidrive No.2	1	Terminal box cover
Small flat blade (1/8"; 3mm)	1	Terminals
M3 nut runner	1	Option board
M6 nut runner	1	Sensor head cover
Others :		
Hexagon key 5mm AF	1	Filter assembly screws
Box spanner 9/16 AF	1	Aspirator assembly
*Box spanner 17mm AF	1	Recessed mounting bolts
*(Supplied in mounting kits)		
Digital multimeter with a resolution of 0.1mV.		
For calibration gases see Section 3.10.		

5.2 FAULT DIAGNOSIS

In the event of analyser failure, faults can be traced by the interpretation of the fault indications on the control unit display.

The analyser has two levels of fault indication: one level is to aid fault finding via a self diagnostic display, the other level (∗SYS FAIL N∗) is to protect and shutdown the analyser if a severe problem occurs.

If a shut down fault occurs the analyser display will show *SYS FAIL N* where N is from 1 to 9. If a self diagnostic fault occurs the display will flash. See Section 4.9 for details of interrogating the display.

5.2.1 Shutdown Faults

When a major fault occurs, the instrument will shut down to a safe condition. In this case the display will show:

∗SYS. FAIL N∗

where 'N' is a number which indicates the cause of the shutdown as shown in the following table.

A manual restart can be attempted by pressing the 'RESET' button on the main board inside the analyser. Refer to figure 5.1.

Fault Display	Description
∗SYS. FAIL 1∗	Addresses of the RAM chips are not unique. PCB faults such as shorted or broken tracks will cause this. The RAM chips themselves may be faulty or incorrectly seated. (IC7 and IC9 on the main PCB).
∗SYS. FAIL 2∗	The ROM checksum does not match. ROM chip failure or PCB faults as in '∗SYS. FAIL 1∗' above. (IC3 on main PCB).
∗SYS. FAIL 3∗	The EEPROM checksum does not match. EEPROM chip failure or PCB faults as in '∗SYS. FAIL 1∗'.(IC5 on main PCB).
∗SYS. FAIL 4∗	Cell temperature below limit for more than 30 min. Refer to section 5.2.2.1.
∗SYS. FAIL 5∗	Cell temperature above limit for more than 30 min. Refer to section 5.2.2.1.
∗SYS. FAIL 6∗	Oven temperature below limit for more than 30 min. Refer to section 5.2.2.9.
∗SYS. FAIL 7∗	Oven temperature above limit for more than 30 min. Refer to section 5.2.2.9.

SYS. FAIL 8	The oxygen cell was grossly over temperature or thermocouple circuit failure. Refer to section 5.2.2.1.
SYS. FAIL 9	The thermocouple has been incorrectly cabled. Refer to section 5.2.2.1.

'*SYS. FAIL 2*' or '*SYS. FAIL 3*' may also arise from electromagnetic interference due to poor screening or inadequate cabling. In the event of such fault indications the cabling should be checked thoroughly to ensure that it complies with the cabling instructions and schedules.

It must be emphasised that an instrument which is displaying '*SYS. FAIL 1*', '*SYS. FAIL 2*' or '*SYS. FAIL 3*' may be in such a condition that the diagnostic information could be misleading.

5.2.2 Self Diagnostic Faults

This section describes the self diagnostic faults together with their associated major analyser components. Lists of voltages, resistances and notes are given so that appropriate checks and actions can be taken in response to the various self diagnostic fault displays. These checks should be done using a digital multimeter or similar device. For each check two points are given to measure between. Where appropriate the first is the low voltage side and the second the high voltage side. e.g. for oxygen cell output : Test points are TB2: 1,2

Which means, check between Terminal block 2 terminal 1 (low side) and terminal block 2 terminal 2 (high side).

Figure 5.1 shows the location of test points, fuses and indicators etc.

Self diagnostic faults are indicated by a flashing display or fault contact if this option is fitted. The actual fault is displayed by using the status and alarm and continue keys as described in Section 4.9.

Faults are signalled by the basic analyser or the option boards with a message of the form 'FAULT N' where 'N' indicates the position of the option board which has generated the fault. The option positions viewed from the front of the analyser are:

Top deck: 1 - 3 - 5
Lower deck: 2 - 4 - 6

These numbers are printed on the interface board. Fault 0 means that the fault lies in the basic analyser on the main board. Refer to figure 3.2.

Self Diagnostic Fault List (not including data link option)

Flashing Display	Description
WARMING UP	The analyser has been started up within the last 40 minutes.
CELL TEMP HIGH	Zirconia cell temperature is more than 32C above the control temperature setpoint.
CELL TEMP LO	Zirconia cell temperature is more than 32C below the control temperature setpoint.
OX.RANGE ERR	The output from the zirconia cell is outside of its tolerance limits.
CO.SENS FLT	Combustibles heated body is over or under temperature by 5C. Combustibles sensors are open or short circuit.
CO.WARM UP	As in CO. SENS. FLT above but analyser has been started up or reset within the last 60 minutes
T.SENSOR FAIL	The thermistor used in the sample block temperature control is out of specification.
OVEN TEMP.HI	The Sensor Head sample block is 10C above its control temperature.
OVEN TEMP.LO	The Sensor Head sample block is 20C below its control temperature.
FLOW FAILURE	The sample flowrate has fallen below the level determined by the flow trip level parameter.
FLUE T.C.FAIL	Flue thermocouple used with temperature and efficiency option is open circuit.
DATA CORRUPT	Permanent memory data has been corrupted. This means that calibration and parameter data are suspect.

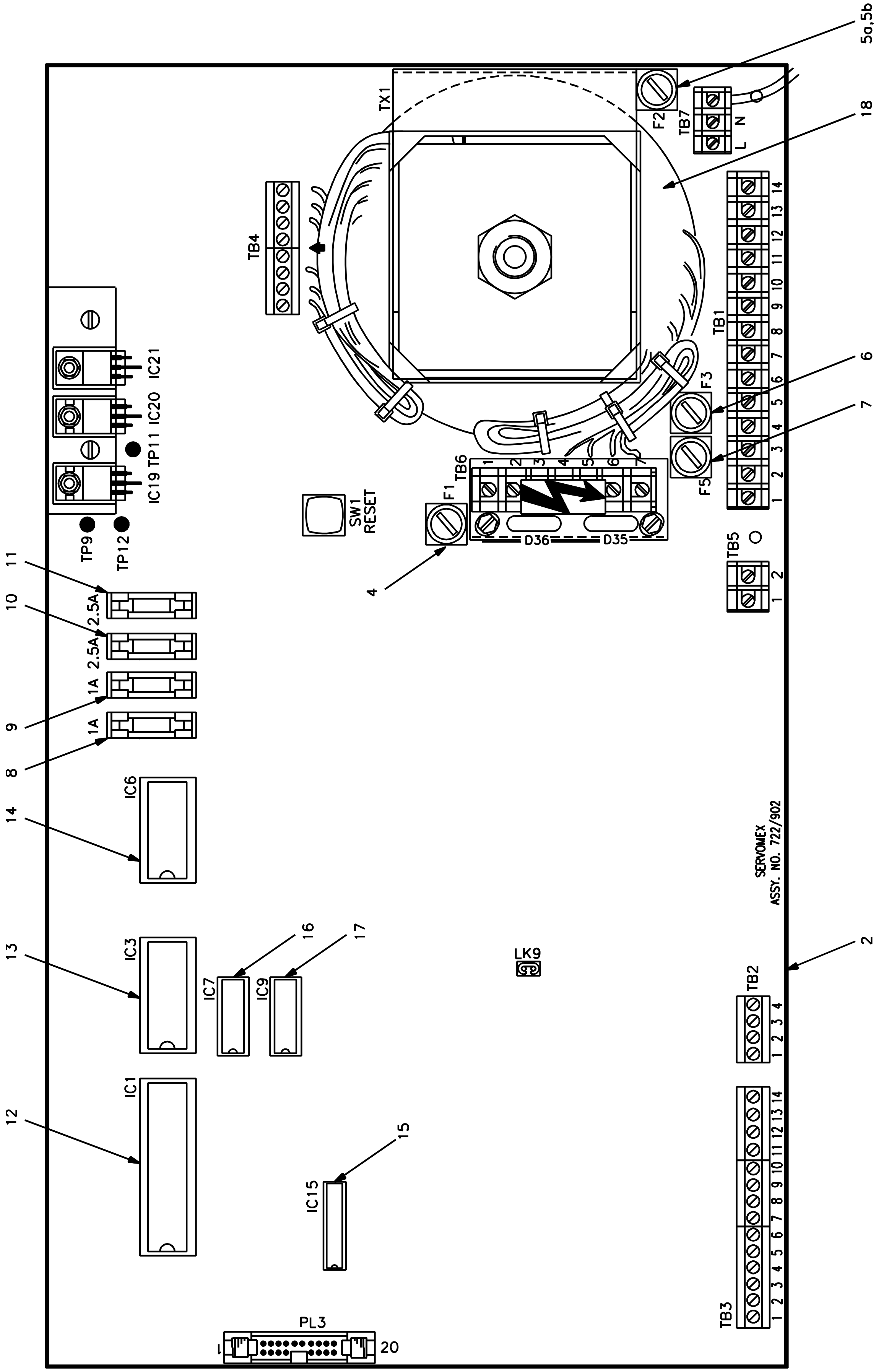


Figure 5.1a   Location of Components On Main Board

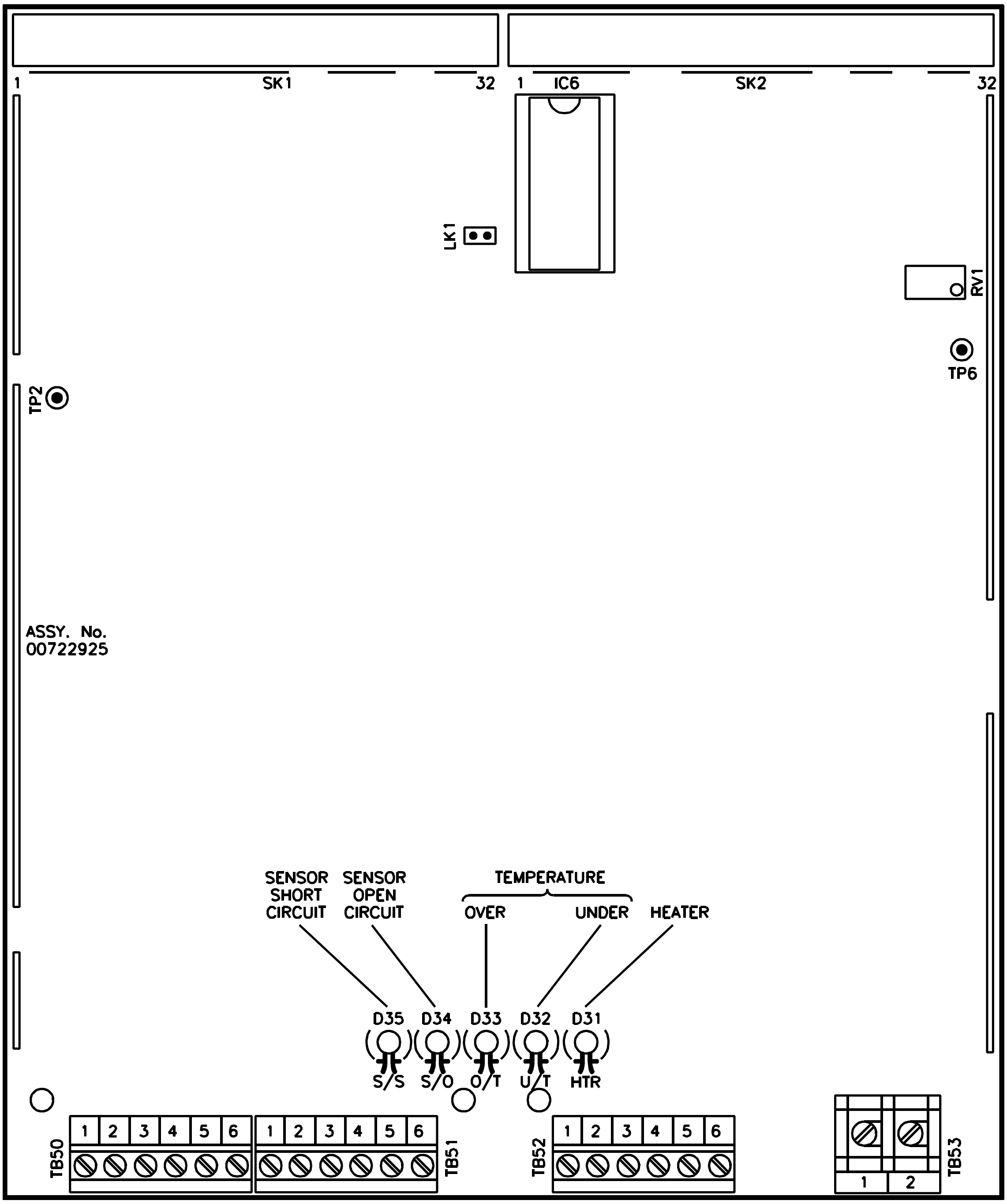


Figure 5.1b Location of components on Combustibles board

5.2.2.1 CELL TEMP HI or CELL TEMP LO

CELL TEMP HI or CELL TEMP LO occur when the zirconia cell temperature is more than ±32C from its set point.

Note: 1. If there are problems with the sample block temperature control this will also affect the zirconia cell temperature. Thus any such problems must be cured first.

2. The cold junction assembly is mounted in the sample block close to the thermistor and therefore is also at 200 C in normal operation. It is wired in series with the cell thermocouple, (refer to appendix 1 wiring diagram) and provides the cold junction reference for the oxygen cell temperature measurement.

Check: 1. Check all cabling between controller and sensor head.

2. Check that link LK9 on the main circuit board is fitted.

3. Check that there is an external link between TB3, 9 and 10 on the main circuit board.

Sensor Head Terminals	Function Description	Normal Reading
TB2: 4,3	Oxygen cell thermocouple and cold junction circuit output d.c. voltage.	22mV ±1mV
TB2: 4,3	Oxygen cell thermocouple and cold junction circuit resistance at 20 C.	23 to 39 ohms
TB6: 1,2	Oxygen cell thermocouple only d.c. voltage.	29mV ±1mV
TB6: 1,2	Oxygen cell thermocouple only typical resistance at 20 C.	18 ohms
TB1: 5,6	Oxygen cell heater circuit resistance at 20 C.	6.7 to 8.3 ohms
TB1: 5,6	Typical oxygen cell heater circuit a.c. voltage.	8 to 11 volts peak
TB1: 5,6	As above but with cell heater disconnected or open circuit.	30 volts (approx.)

Control Unit Terminals	Function Description	Normal Reading
TB5: 1, TB4: 8	Oxygen cell heater fuse F1 (2.5A).	< 1 ohm

5.2.2.2 OX. RANGE ERROR

OX. RANGE ERROR occurs when the signal from the zirconia cell is outside the range -8 to +156mV (equivalent to 30% to 0.014% O_2).

Note: 1. The zirconia cell operates at 725°C. If there are a high level of combustibles in the sample gas then these will burn at the cell, consuming oxygen, and giving a low reading. In these circumstances it is possible that OX RANGE ERROR may occur. This is not an analyser fault but a process problem. Prolonged operation under these conditions may have an adverse effect on the oxygen cell. In these circumstances contact Servomex.

Check: 1. Check all cabling between controller and sensor head.

2. Check that the aspirator air supply is oil free.

3. Check that there are no leaks in the sensor head pipework or the calibration gas system.

4. Check that the concentration of the calibration gas is the same as the concentration entered in the calibration routine.

Sensor Head Terminals	Function Description	Normal Reading
TB2: 1,2	Oxygen cell output voltage with air as sample gas.	0 ±4mV
TB2: 1,2	Oxygen cell output voltage with 0.30% oxygen in nitrogen calibration gas. For other calibration gases calculate output from equation given in section 5.2.2.2.2.	87 -93mV

5.2.2.2.1 Cell Offset Voltage

The output of the zirconia measuring cell can be measured directly across TB2: 1, 2 in the sensor head or TB3: 4, 5 in the control unit.

With the sensor head powered and operating normally and with clean dry air as the calibrating gas, the cell offset should be less than 4mV. If it is greater than this it may be due to the presence of high levels of combustibles in the sample gas. Leave the cell with air flowing through it for several hours. If the offset voltage remains greater than 4mV then the cell should be changed. See Section 5.4.5.

5.2.2.2.2 Cell Output Voltage

The cell output voltage, at a cell temperature of 725C, can be calculated from:

$$E = 21.50 \ \ln \frac{(20.95)}{P} \ mV$$

where P is the percentage oxygen concentration. This equation assumes an offset of zero. Any offset observed at the air point should be added or subtracted according to its polarity.

Figure 5.2 shows the cell output and its acceptable limits. Further information on the operation of the cell is given in Section 6.

5.2.2.3 CAL.FAIL

The CAL.FAIL display occurs within the sensor calibration routine, refer to section 4.7, and in the case of the oxygen sensor indicates that with air as calibrating gas the output from the cell was greater than ±8mV or with end point calibrating gas the cell output was not within ±20% of the expected output. refer to figure 5.2 and to section 5.2.2.2 for details of voltages, test terminals and checks. After doing this if the problem still exists the cell must be changed.

5.2.2.4 CAL.ERROR

The CAL.ERROR display occurs within the sensor calibration routine, refer to section 4.7, and indicates that during the sensor calibration procedure the output from the sensor was changing. Perform the following checks and calibrate again.

Check: 1. Check all signal cabling and earths to ensure that the shielding is correct.

2. Check that the calibration gas flow is 600ml/min and wait for the sensor to stabilize.

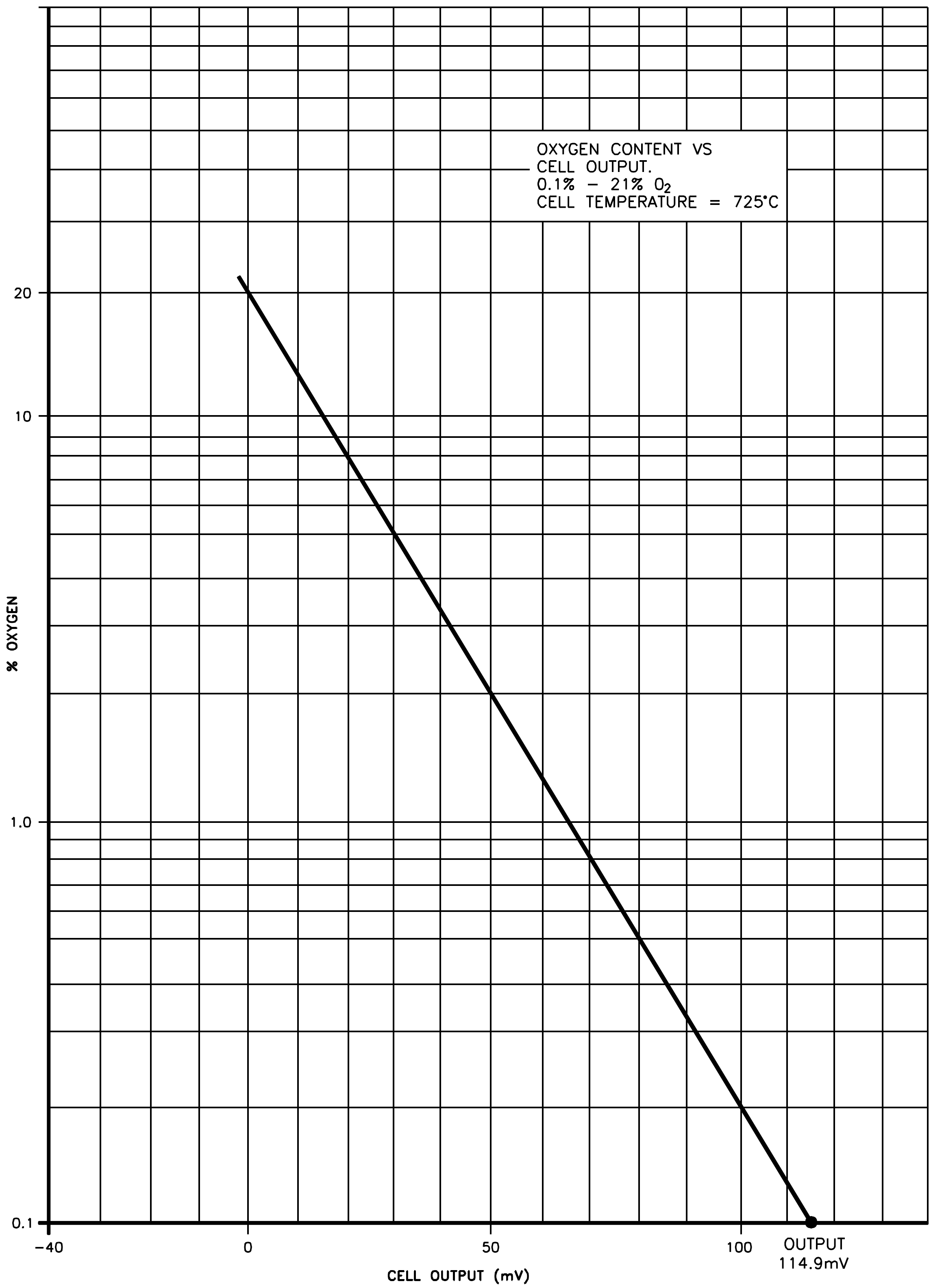


Figure 5.2 Cell Output

5.2.2.5 CO. SENS FLT

The combustibles sensor consists of two pellistors in a heated body. A detailed description of its operation is given in Section 6.

On the combustibles board (00722925) there are four diagnostic indicators which identify the specific fault (see Figure 5.1b).

These indicators are for:

Combustibles sensor short circuit	S/S	(pcb ident)
Combustibles sensor open circuit	S/O	(pcb ident)
Combustibles temperature high	O/T	(pcb ident)
Combustibles temperature low	U/T	(pcb ident)

The combustibles sensor takes approximately 60 minutes to warm up during which time the "CO WARM UP" message will be displayed as a fault status. Any combustible fault indicators should be ignored during this warm up period.

5.2.2.5.1 Combustibles temperature high or low indicators on

These indicators show if the combustibles body is ±5 C from its set point.

Note: When the green indicator on the 00722925 combustibles board is on, it indicates that power is being passed to the combustibles heater. After warm up this will flash slowly with typically the on time being equal to the off time.

Check: Check cabling between sensor head and control unit is correct and to specification.

Sensor Head Terminals	Function Description	Normal Reading
TB1: 1,4	Combustibles sensor heater circuit resistance.	2160 to 2510 ohms
TB1: 1,4	Combustibles sensor heater circuit a.c. voltage	Pulsed supply voltage 110 or 240V a.c. nominal
TB2: 10,11	Platinum resistance temperature sensor (ground).	< 0.5 ohms
TB2: 11,12	Platinum resistance temperature sensor (output) at 20 C	108 ohms typical
TB2: 11,12	Platinum resistance temperature sensor circuit d.c. voltage at 200 C.	0.65V typical
TB4: 9,10	Combustibles heater over temperature thermostat. Opens at 240 C.	< 1 ohms

Control Unit Terminals	Function Description	Normal Reading
TB1: 3,7	Combustibles sensor heater fuse F5 (500mA)	< 2 ohms

5.2.2.5.2 Sensor short circuit indicator on and/or sensor open circuit indicator on

These indicators show if a problem exists with the combustibles sensors.

Note: 1. There is a test point TP6, on the 00722925 combustibles board, which can be used to measure analogue voltages under various conditions.

2. When the voltage on TP6 exceeds 10 volts then the circuit gain is automatically divided by 3. Thus when this occurs, any further increase in combustibles level will result in an increase in TP6 voltage by approximately 0.8V per 1% increase in combustibles.

Check: 1. Check that cabling between the control unit and sensor head is correct and to specification and that all earths (grounds) are properly connected.

2. Check that there is no dampness in the sensor head terminal box.

Sensor Head Terminals	Function Description	Normal Reading
TB2: 13,14	Resistance of compensator tails	< 0.5 ohms
TB2: 15,16	Resistance of detector tails	< 0.5 ohms
TB2: 13,17	Resistance of compensator element	1 - 2 ohms
TB2: 16,18	Resistance of detector element.	1 - 2 ohms
TB2: 10,13& TB2: 10,14	Typical compensator d.c. voltages.	4.8V
TB2: 10,15& TB2: 10,16	Typical detector d.c. voltages.	4.8V
TB2: 10,17& TB2: 10,18	Typical combustibles sensor d.c. supply voltage.	5.5V

Combustibles board	Test Condition	Normal Reading
TP2, TP6	No combustibles in sample, with RV1 and sensor constant adjusted correctly. See section 5.2.2.6.	3V
TP2, TP6	1% CO in sample plus oxygen. (See note 2).	5V approx.

5.2.2.6 Combustibles Board (00722925) Set Up Procedure

This board is factory set. However if the combustibles sensor and or the combustibles board are changed then the following procedure must be carried out:-

1. Set the combustibles sensor constant to 3. Refer to section 4.6.3.

2. Connect a supply of calibration air to the calibration inlet of the sensor head at a flow rate of 600ml/min and allow sensor to stabilize.

3. Adjust potentiometer RV1 on the combustibles board so that the voltage between TP6 and TP2 (0V) is 3V. If this is not possible change the sensor constant and try again. Repeat until the correct voltage can be obtained.

4. Perform combustibles zero calibration. Refer to section 4.7.4.

5. Perform combustibles span calibration. Refer to section 4.7.5.

6. Connect a supply of oxygen sensor end point calibration gas, typically 0.3% oxygen in nitrogen, to the calibration inlet of the sensor head at a flow rate of 600ml/min and allow combustibles sensor to stabilize.

7. Adjust potentiometer RV1 on the combustibles board so that the combustibles display reads 0.050 (500 ppm).

8. Connect a supply of calibration air to the calibration inlet of the sensor head at a flow rate of 600ml/min and allow sensor to stabilize. Note the displayed combustibles reading.

9. If the combustibles display is more than 0.060 then set the sensor constant to a lower value. Refer to section 4.6.3.

10. If the combustibles display is less than 0.040 then set the sensor constant to a higher value. Refer to section 4.6.3.

11. Repeat steps 6 to 10 until the combustibles display change between using low oxygen gas and air is a minimum. Typically should be less than 0.006 (60 ppm).

12. Perform normal combustibles zero and span calibration referring to section 4.7.4.

Note : The aforementioned procedure is only required when a new combustibles board and or sensor are fitted.

5.2.2.7 CAL.FAIL

The CAL.FAIL display only occurs within the sensor calibration routine, refer to section 4.7.

In the case of the combustibles sensor this indicates that with air as calibrating gas the voltage between TP6 and TP2 on the combustibles board is not between 0 and 5 volts.

Similarly the CAL.FAIL display will also occur when using 1% carbon monoxide in air as a calibrating gas if the voltage between TP6 and TP2 on the combustibles card is not between 1 and 5 volts greater than the voltage measured at the same point using air as calibrating gas.

5.2.2.8 CAL.ERROR

This display may also occur within the combustibles sensor calibration routine. See Section 5.2.2.4.

Check: 1. Check all signal cabling and earths to ensure that the shielding is correct.

2. Check that the calibration gas flow is 600ml/min and wait for the sensor to stabilize.

5.2.2.9 OVEN TEMP LO or OVEN TEMP HI

This display will occur if the sample block temperature is +10 C or -20 C from its set point.

Note: 1. Indicator D31 (see Fig 5.1b) indicates when power is being switched to the sample block heater. When the analyser is powered up from cold, this will be on continuously. After warm-up it will then flash at a rate determined by the amount of power required to maintain the temperature at its control point.

2. The sample block thermostat with yellow leads is wired in series with the heaters and prevents damage occurring due to faulty components or wiring.

Check: Check cabling is correct between sensor head and control unit.

Sensor Head Terminals	Function Description	Normal Reading
TB1 : 1,3	Sample block heater circuit resistance.	172 - 201 ohms
TB1 : 1,3	Sample block heater circuit a.c. voltage	Pulsed supply voltage 110 or 240V a.c. nominal
TB4 : 3,4	Sample block heater over temperature thermostat (opens at 240C)	<1 ohm

5.2.2.10 T. SENSOR FAIL

This display shows if the temperature sensor used to control the sample block temperature is faulty. This sensor is a thermistor with a resistance between 287 and 4300 ohms, depending on its temperature.

Note: The thermistor controls the block temperature at 200C.

Check: Check cabling is correct between sensor head and control unit.

Sensor Head Terminals	Function Description	Normal Reading
TB2 : 6,5	Sample block temperature sensor (thermistor) at 20C.	300-400K ohms
TB2 : 6,5	Sample block temperature sensor (thermistor) at 200C.	1.1K ohms typical
TB2 : 6,5	Thermistor circuit d.c. voltage.	0.7V typical

5.2.2.11 FLOW FAILURE

This display indicates that the sample flow has fallen below the set trip level.

Note: 1. FLOW FAILURE can be caused by:-

a. Failure of the aspirator air or blockage of the aspirator jet.
b. Blocking of the external filter (if fitted) or probe tube.
c. Blocking of the internal filter.
d. Failure of the flow alarm.

2. The aspirator air solenoid valve will remain shut for approximately 1 hour after switch on from cold.

Check: 1. Check cabling between sensor head and control unit.

2. Check that the flow trip parameter is set to the most suitable for the application. On most 700B applications we recommend setting this to F. TRIP ZERO. Refer to section 4.6.1.

3. Check that the aspirator air solenoid valve has opened.

4. Check the flow sensor calibration. Refer to section 4.7.2.

5. Check that the aspirator air pressure is set to the correct value, as shown on the label below the circuit board in the sensor head terminal box, and that there is an air flow of approximately 1.5 litres/min. If not, remove and clean the aspirator jet, see figure 5.3.

6. Check that with the aspirator air correctly set, as above, that there is a sample inlet flow of approximately 300 ml/min. If not, check for a blockage in the sample system. Investigate external and internal filter, inlet probe tubes, internal pipework, flametraps and finally the sample block.

7. Pass air and then end point calibration gas through the calibration port of the sensor head. If the analyser responds normally (response time of 5-10 secs) and/or the flow failure alarm disappears then it is probable that the external filter or probe tube is blocked. If the analyser does not respond normally it is possible that the internal filter, aspirator or pipework of the sensor head are blocked. Refer to section 5.4.

8. Pass air through the calibration port so that the analyser reads 21%. Stop the air so that the analyser is sampling flue gas. If the analyser does not respond normally then this will confirm blockage of the external filter or probe tube. Refer to section 5.5.

9. The internal filter and aspirator jet are checked by removal. Sensor head pipework and flame traps are checked by dismantling. Refer to section 5.4.

10. The flow sensor and aspirator air solenoid valve are checked in the following tests :-

Sensor Head Terminals	Function Description	Normal Reading
TB2 : 7,8	Negative half flow sensor circuit resistance.	26 to 28 ohms
TB2 : 8,9	Positive half flow sensor circuit resistance.	26 to 28 ohms
TB2 : 7,6	Flow sensor negative supply d.c. voltage.	15.0V approx.
TB2 : 8,6	Flow sensor centre tap (output terminal) d.c. voltage.	8.5V approx.
TB2 : 9,6	Flow sensor positive supply d.c. voltage.	2.5V approx.
TB3 : 1,2	Aspirator air solenoid valve resistance	800 - 900 ohms
TB4 : 1,2	Aspirator air solenoid valve thermostat resistance (Closes at 185^{o}C). **Remove Power Before Measuring.**	<1 ohm
TB1 : 1,2	Aspirator air solenoid valve a.c. supply voltage.	120V ac typical

Control unit Terminals	Function Description	Normal Reading
TB1 : 12,5	Aspirator air solenoid fuse F3 (500mA).	<2 ohms

Control unit Test points	Function Description	Normal Reading
TP4, TP1 (Main board)	Aspirator air turned off, no sample flow.	20 - 30mV typical*
TP4, TP1	Aspirator air on and set to pressure written on the sensor head printed circuit board. Wait two minutes to stabilise.	30 - 40mV typical*

* When the aspirator air off voltage is subtracted from the aspirator air on voltage. the result should be approximately +10mV.

5.2.2.12 FLUE T.C. FAIL

This display indicates that the flue gas thermocouple used with the temperature and efficiency option if faulty.

Note: This is a type K thermocouple. The result of the second test below will depend on flue temperature. Consult standard tables for other temperatures.

Check: Check cabling is correct between thermocouple and control unit. This must be screened compensating cable.

Temp & Efficiency board terminals	Function Description	Normal Reading
TB40 : 1,2	Flue temperature thermocouple resistance at 20C.	<20 ohms
TB40 : 1,2	Flue temperature thermocouple output d.c. output voltage at 200C.	8 mV approx.

5.2.2.13 DATA CORRUPT

The analyser has a self check system for determining the validity of the data stored in memory. If the analyser detects any illogical changes to the data in memory it will display the 'DATA CORRUPT' diagnostic.

Note: 1. This may be caused by a large transient on the electrical supply, e.g. changing supplies from electricity authority supplies to a local generator, lightning strike, welding close to the analyser or removing fuses from within the analyser with the power still on.

2. The 'DATA CORRUPT' fault is cleared by entering the Parameter or Calibrate mode and pressing the 'Enter' key. Check, and correct as necessary, all set-up values and re-calibrate the analyser.

3. If the problem persists and all external causes have been eliminated then it is possible that there is a fault on the analyser main board. It is recommended that the main board is changed. The analyser will need to be recalibrated and set up.

Check: 1. The usual cause of data corruption is electrical interference from outside the analyser. Check all cable screens are present and bonded to the earth (ground) point in the control unit.

2. Check that all covers are on and doors closed. Check that the system and local earths are well made and of low resistance.

5.3 REPAIR OF THE CONTROL UNIT

The repair of printed circuit boards at component level is not recommended and it is normal to trace faults on these boards by substitution. This section covers the removal of these boards so that any faulty ones can be replaced and returned to Servomex for repair. Refer to figure 3.2 for identification and relationship of parts.

WARNING

Disconnect electrical power from the analyser before working on the control unit.

Also ensure that power is disconnected from external circuits connected to the analyser, e.g.alarms.

5.3.1 Removal of Option Boards

The software instructions for a given option board installed in a given position are peculiar to that board/position combination. Therefore, if a board is moved to another position, its parameters and calibration data will have to be reset.

If the power supply is switched off, the software will retain the preset values of the parameters and calibrations

1. Open the control unit door

2. Remove any wire connections to the terminal block on the board.

3. Undo the nuts securing the board in position. Remove and retain these nuts and washers. If two layers of option boards are fitted and the lower one is to be removed also, remove and retain the spacers.

4. Lift up the bottom of the option board until it just clears the thread of the spacers and then pull it downwards carefully. The option board should then come free.

5. Do not move the board from side to side extensively to remove it as this may damage the connector on the interface adaptor board.

6. Refit in the reverse order to above - **Note - Ensure that option cards 00722925 (combustibles) and 00722911 (isolated O_2 output) are not fitted above one another.**

5.3.2 Removal of the Interface Adaptor Board

1. Remove any option boards fitted as described in Section 5.3.1.

2. Remove the six screws and washers that secure the interface adaptor board to the chassis.

3. Pull the board forwards carefully to release it from the mother board connector.

4. Refit in the reverse order to the above.

5.3.3 Removal of the Main PCB Assembly

1. Remove any option boards that may be fitted as described in Section 5.3.1.

2. Remove the interface adaptor board as described in Section 5.3.2.

3. Disconnect the wires from TB1, TB3, TB5 and TB7 on the board and TB2, when used.

4. Disconnect the display board ribbon cable plug from the main board by releasing its two catches and pulling the plug gently.

5. Undo the 16 M3 nuts, one 1/4 inch BSP nut on the transformer and the two pan head screws at the top right. The board may now be removed carefully.

6. Refit in the reverse order to the above. Refer to the interconnection drawings and cable schedules when reconnecting the wires, Appendix 1,2,3. It is important to refit the two pan head screws at top right as these secure heat sinks to the DC power regulator.

5.3.4 Removal of the Display Board

1. Disconnect the multiway keypad connector from the display board.

2. Disconnect the ribbon cable from the main PCB assembly board by releasing the two catches and pulling the plug gently.

   Note: It may be necessary to remove option boards to allow this plug to be disconnected.

3. Undo the six M3 screws securing the display board to the front door.

4. The display board can now be removed.

5. Refit in the reverse order to the above.

5.4 REPAIR OF THE SENSOR HEAD

This section covers removal and replacement of the major components in the sensor head. Refer to Figure 5.3 for identification and relationship of all parts.

It is recommended that anti-seize compound is used on certain gas connectors. This is detailed in the appropriate places below.

When undoing or replacing any pipework fittings always use two adjacent spanners to break or seal a particular union. Support the 'fixed' part and rotate the union nuts. The pipework alone is not strong enough to withstand the torque needed to make or break the union seals. This is especially important with the oxygen cell.

Two types of 1/8 inch coupling nuts are used in the sensor head. One is 'Metric' which has a groove in the body. The other is 'Imperial' which has no groove. Ensure that the correct type is used by referring to Figure 5.3.

5.4.1 Removal of Sensor Head Covers

1. Remove the blanking nut (51).

2. Remove the air supply tube (24).

3. Remove any connection to the auxiliary air and/or the purge outlet ports.

4. Loosen the three sealing nuts (31) on the calibration, auxiliary air and aspirator inlets.

5. Undo the four screws (41) holding the cover to the back of the mounting flange.

6. Slide off the cover (18) with the thermal insulation (76) and gasket (83). Take care not to damage the insulation.

7. Remove the screws (45) securing the terminal box cover.

8. Remove the cover from the terminal box.

9. Reassemble in reverse order using the tapered orange plugs supplied in the accessories bag to seal up the inlet port pipework to ensure that no parts of the thermal insulation get into the pipes.

   Note:

   If desired, the sensor head cover may be completely separated by undoing the earth strap. If this is done it must be reconnected when the cover is replaced.

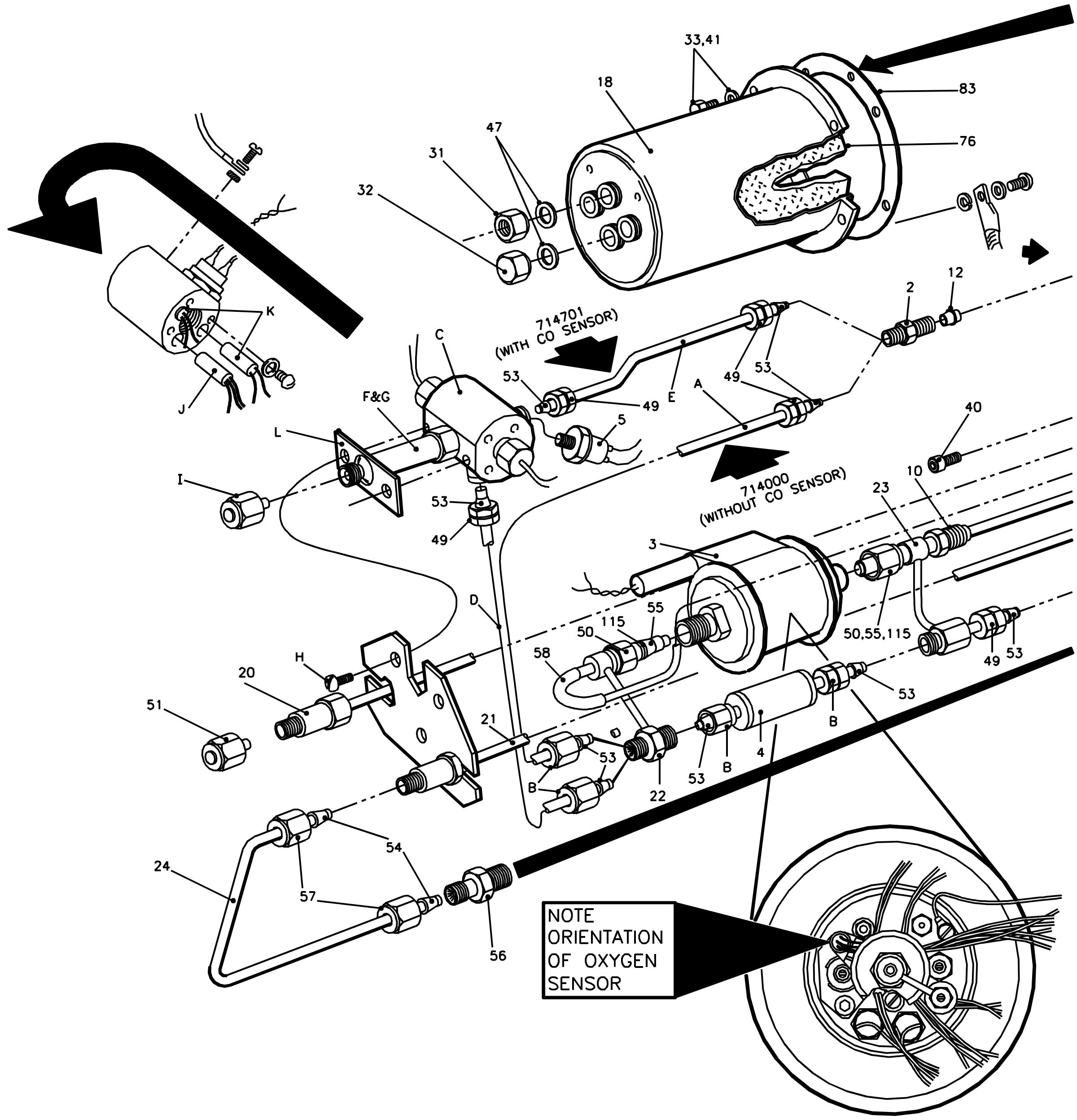


Figure 5.3 Exploded view - sensor head

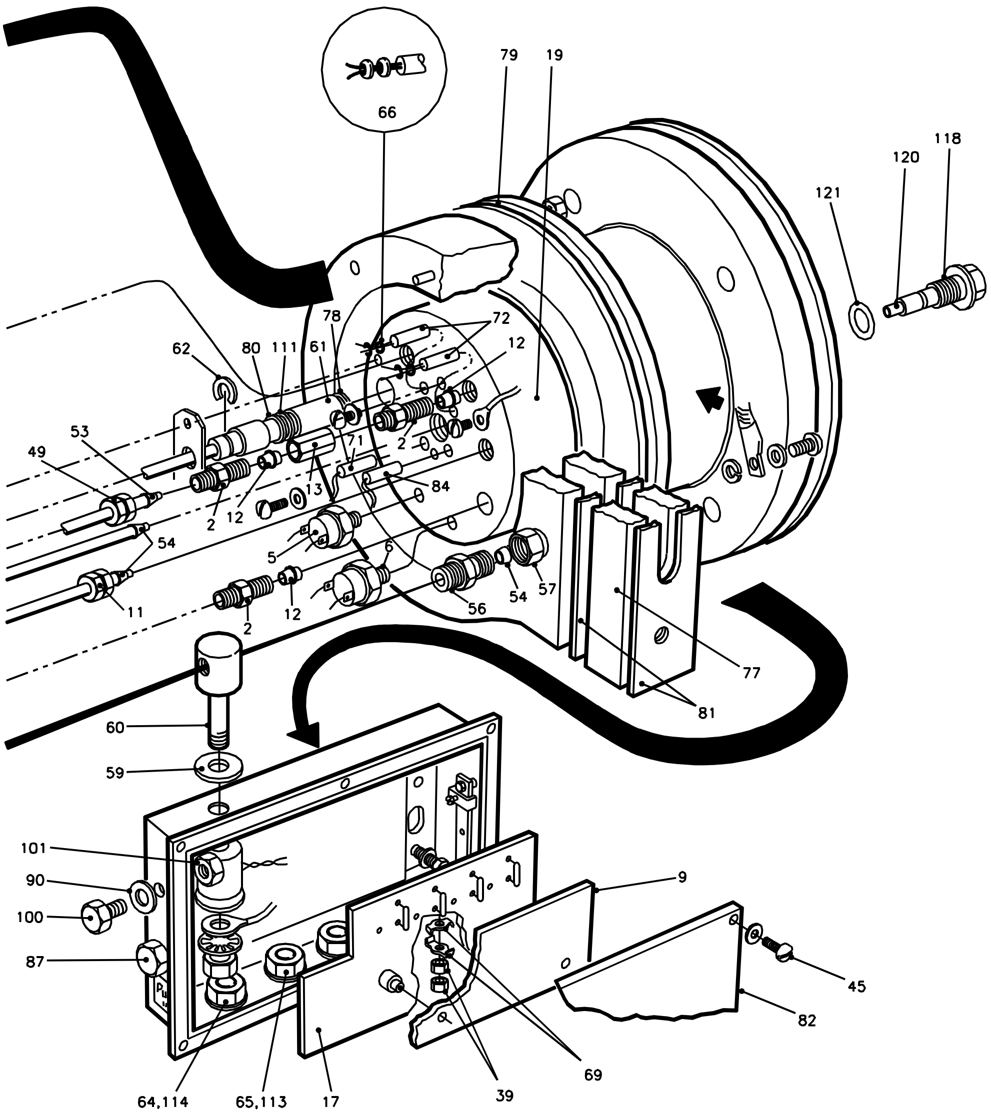


Figure 5.3 Exploded view - sensor head

5.4.2 Removal of the Internal Filter

1. Remove the calibration pipe and filter assembly (20) by undoing and removing the two M6 socket cap screws (40)

2. Note the type and position of the three gaskets associated with the filter (61). One (78) is located at the bottom of the filter hole in the sample block. The other two are located between the filter and calibration pipe (80 & 111)

3. Unscrew the filter from the calibration pipe.

4. Reassemble in reverse order using new gaskets.

5.4.3 Removal of the Complete Combustibles Sensor (if fitted)

1. Undo the four coupling nuts on the pipes (D) and (E).

2. Remove the screws (H) and insulating plate (L).

3. Undo the wiring wraps from the pipework.

4. Withdraw the complete sensor (C, F, G, J, K,) upwards and lay to one side.

5. If it is required to remove the sensor completely, proceed as follows:

6. Disconnect the wiring from TB4 and TB5, see Appendix 2.

7. Re-assemble in the reverse order using a draw wire to pull the sensor leads into the terminal box.

   Note: If it is required to remove the oxygen sensor or the flow sensor, it is not necessary to disconnect the combustibles sensor wiring.

5.4.4 Removal of the Combustibles Sensor Parts

1. Carry out steps 1 - 4 in Section 5.4.3

2. Undo the screws and washers retaining the two cartridge heaters (J) and temperature sensor (K) in the combustibles body

3. If required remove any of these parts by disconnecting the wiring from TB4 and TB5 as appropriate (see Appendix 2)

4. Unscrew the thermostat (5) from the combustibles body and if required remove by disconnecting the wiring from TB4 (see Appendix 2)

5. Undo the auxiliary air inlet port assembly (F) and (G) from the combustibles body.

6. Disconnect the combustibles detector and compensator wiring from TB5 (see Appendix 2). The combustibles sensor and body (C) can now be removed.

7. Re-assemble in the reverse order using a draw wire to pull the sensor leads into the terminal box.

5.4.5 Removal of the Oxygen Sensor

CAUTION

When undoing or retightening the pipe work associated with the oxygen cell, always use two spanners and take care not to twist the cell otherwise it may be damaged.

1. If a combustibles sensor is fitted carry out steps 1 to 4 in Section 5.4.3, otherwise remove the by-pass tube (A).

2. Remove the calibration pipe and filter assembly (20) by undoing and removing the two M6 socket cap screws (40).

3. Remove the cell inlet pipe assembly (22) by undoing the coupling nuts on the flametrap (2), on the flow sensor (4) and on the oxygen cell (3). Release this cell nut by using an 11/16 inch AF spanner on the nut (50) and a 16mm AF spanner on the adjacent flats on the oxygen cell so as not to twist it. When this cell connection is stuck, keep undoing the cell nut as above and use the jacking shoulder to pull the stuck ferrules from the cell. Ensure that all associated pipework coupling nuts have been fully undone prior to doing this.

4. Disconnect the cell wires from the terminal blocks TB5 and TB6 and withdraw the wires, (see Appendix 1). Note the oxygen cell orientation.

5. Release the oxygen cell from the reference air assembly (23) using 11/16 inch and 16mm AF spanners as above. Do not twist the cell.

6. Re-assemble in the reverse order using a draw wire to pull the sensor leads into the terminal box, ensuring that no wiring touches the sensor body.

Note:

1. If during disassembly it was necessary to prise apart the oxygen cell sample fitting to release the coupling then the 3/8 OD ferrules may have been pulled forward. They must be repositioned before reassembly or the other cell inlet pipe fittings will not engage. The gap between the shoulder and cell nut (50) should be 2.5 mm (0.1 in) when the nut is held against the ferrules.

5.4.6 Removal of the Flow Sensor

1. Carry out steps 1 to 3 of Section 5.4.3.

2. Undo the 1/8 OD flow sensor coupling to oxygen cell reference assembly (23).

3. Disconnect the flow sensor wires from terminal block TB5 (see Appendix 1)

4. Withdraw the flow sensor.

5. Re-assemble in the reverse order using a draw wire to pull the sensor leads into the terminal box. When reassembling the wires must exit towards the sample block.

Note:

The flow alarm is not reversible.

5.4.7 Removal of Flame Traps

1. Carry out steps in Section 5.4.3, 5.4.5, and 5.4.6 to remove sensors.

2. Remove the flame traps (2) and associated double ended ferrules (12) by unscrewing the flame traps from the sample block.

3. Re-assemble in reverse order.

Note:

When new flame traps are fitted, apply release compound (117) sparingly to the thread entering the sample block - DO NOT ALLOW THE COMPOUND TO ENTER THE PIPEWORK.

5.4.8 Removal of Cartridge Heaters

1. The cartridge heaters (72) may be removed without disassembly of any other parts.

2. Remove the cartridge heater locking screw and washer.

3. Ease the two insulation beads (66) down the cartridge heater wires and remove the heater from the block by gently pulling on it's leads.

4. Disconnect the cartridge heater wiring from TB4 (see Appendix 2).

5. Re-assemble in reverse order using the insulation beads removed from the old heater.

Note:

1. If both heaters have been disconnected, when re-assembling, check carefully which leads belong to which heater before reconnecting to TB4 in accordance to the wiring diagram (See Appendix 1).

2. The sample block is maintained at 200°C by two cartridge heaters, each rated at 120 volts 150 watt. For continuity checking each heater has a resistance of 95 ohms nominal.

5.4.9 Removal of Thermocouple Reference Assembly and Thermistor

1. The thermocouple reference assembly (84) and thermistor (71) may be removed without disassembling any other parts.

2. Remove the common locking screw and washer

3. Disconnect the appropriate wires from TB5. (See Appendix 1). The thermocouple reference assembly has blue and brown leads. The thermistor has green leads.

4. Remove the components from the block by gently pulling on their leads.

5. Refit in the reverse order to the above.

5.4.10 Removal of Thermostats

1. The under temperature thermostat (6) and over temperature thermostat (5) may be removed without disassembling any other parts.

2. Disconnect the appropriate wires from TB4. (See Appendix 2). The under temperature thermostat has violet wires, the over temperature thermostat has yellow wires.

3. Withdraw the wires and unscrew the thermostat from the sample block.

4. Re-assemble in reverse order taking care not to over tighten the thermostat.

5.4.11 Removal of the Solenoid Valve

1. Disconnect the solenoid valve leads from TB3. (See Appendix 1)

2. Disconnect the air supply tube (24) and the aspirator air supply connected to the solenoid valve.

3. Remove the solenoid valve by undoing the retaining nuts, washers and earth lead.

4. If it is required to replace the valve, remove the tube to thread adaptors (56) and fit them to the new valve.

5. Re-assemble in the reverse order.

5.4.12 Removal of the Aspirator Assembly

1. Remove the aspirator jet (120) from the front face of the sample block by undoing the aspirator screw (118).

2. Clean or replace the complete jet and screw assembly as required. (See note 2 below).

3. Prior to reassembly press the aspirator jet into the aspirator screw using a vice. Take care not to damage the jet and ensure that it is pressed fully in so that its shoulder touches the aspirator screw.

4. Re-assemble in reverse order noting the position of the 'O' ring (121)

5. A new `O' ring (121) must be fitted.

Note:

1. If a new aspirator screw is used, apply release compound (117) sparingly to the thread entering the sample block - DO NOT ALLOW THE COMPOUND TO ENTER THE PIPEWORK.

2. The aspirator jet is not removable from the aspirator screw and they have to be replaced as a complete assembly.

5.5 MAINTENANCE OF THE SAMPLE PROBE

5.5.1 Cleaning the Probe Tube

If sample probe blockage is suspected then this can be investigated without removing the sensor head from its mounting flange by doing the following:

1. Remove the blanking nut from the calibration port.

2. Push a suitable rod approximately 1mm in diameter into this port. There should be no obstructions until the external probe filter is met (if fitted).

3. If blockages are encountered then it may be possible to clear them in the short term by using the rod to push the obstruction out or into the external filter. See Note below.

4. Remember to replace the calibration port blanking nut

Probe tube blockages do not occur in correctly applied and installed analysers. If this problem is occurring, then the root problem must be found and will be due to one of the following.

1. Dust entering the probe tube from the process. This will only occur if the external filter is damaged or a filter is not fitted. Check this filter or consult Servomex about fitting one.

2. Corrosion blockages are due to the process sample falling below its dew-point temperature and condensing. This will only occur if the sensor head has not been correctly installed. Ensure that there are no cold spots along the length of the inlet tube. These may be due to mounting the sensor head on a stand-off. Move the sensor head closer to the process and/or ensure that hot sample gas can flow around the inlet tube. If a flange stand off has to be used, the distance from the flange to the wall must be kept to a minimum. We advise 50mm maximum. Additionally the whole assembly must be well insulated.

   Note:

   It is recommended that whenever corrosion blockages have occurred in the inlet tube that the tube is replaced after the root cause has been resolved, even if the blockage has been dislodged in the short term, by rodding out as described earlier.

5.5.2 Replacement of the Probe Tube

1. Connect an air supply to the calibration gas port and back flush the probe tube.

2. Turn off the electrical supply to the analyser and allow the sensor head to cool.

3. Refer to Section 3.9 and carry out the sensor head mounting operations in reverse order.

4. Remove the old probe tube, fit the new one and then proceed as if fitting a new sensor head.

5.5.3 Maintenance of the Probe Filter

When a probe filter is fitted it is recommended that it is checked annually.

1. Remove the probe tube as in Section 5.5.2.

2. Inspect the filter for damage.

3. Check the filter is not excessively blocked. This may be done by applying a suction to one end of the probe tube and ensuring that a gas flow exists through the filter. See note
4. Referring to section 3.10, remove the filter from the probe tube.

5. Clean the filter in a suitable solvent or fit a new one.

6. Reassemble in reverse order.

Note:

The gas flow through the filter and pressure drop will vary according to the type of filter used. Hence this blockage test is best done by comparison with a new one of the same type.

5.6 RETRO-FITTING COMBUSTIBLES SENSOR KIT (00714998)

(See Figure 5.3).

1. Turn off the electrical supply to the analyser and allow the sensor head to cool.

2. Remove and discard the auxiliary air blanking nut (32) from the sensor head cover (18) and remove the cover. Refer to section 5.4.1.

3. Remove and discard the combustibles sensor blanking tube (A).

4. Strip one end of the green PTFE wire, supplied and crimp on the M4 tag. Secure the crimp tag and wire to the combustibles sensor body (C) using the M4 washer and screw provided into the tapped hole along side the over temperature thermostat (5). Ensure that there is good electrical contact.

5. Assemble, finger tight only, the detector outlet tube (D), inlet tube (E) and combustibles sensor assembly (C,J,K,5) using the nuts and ferrules provided.

6. Position the insulating gasket (L) over the combustibles sensor auxiliary air inlet port (F,G).

7. Locate the inlet tube (E) into the flame trap (2) and swing the combustibles sensor into position ensuring that the insulating gasket is correctly located between the sensor body and the top plate of the inlet air port assembly (21).

8. At the same time locate the outlet tube (D) between the sensor outlet port and tube assembly (22).

9. Secure the sensor using the M4x6 screws making sure that the existing wires run between the detector outlet tube (D) and the top plate of the inlet air port assembly.

10. Tighten all unions finger tight plus 1/2 to 1 turn and check all joints are leak tight.

11. Use a draw wire to pull the new wires from the combustibles sensor into the terminal box and secure the wires to the calibration port assembly tube (20) using the PTFE spiral wrap provided.

12. Make connections as shown in Appendix 2, making sure that no wires touch the oxygen cell.

13. Fit the interface board 00722901 in the control unit. Refer to section 3.2.2.

14. Fit the combustibles board 00722925 to the interface board in the control unit. Refer to section 3.2.3.

15. Connect a cable with 5 twisted pairs as specified in Appendix 2 between the sensor head and control unit.

16. Switch on the analyser and allow it to warm up and stabilize.

17. Set up the combustibles board, 00722925 referring to section 5.2.2.6.

18. Referring to section 4.7, calibrate the oxygen and combustibles sensors.

19. Set in the combustibles parameter as required referring to section 4.6.3.

5.7 SERVICING OF AIR FILTER/REGULATOR UNIT

At monthly intervals, check all filter bowls and filters. Clean or replace and drain as necessary. See Figures 3.19, 3.20 and 3.21.

NOTES

SECTION 6 : FUNCTIONAL DESCRIPTION AND SPECIFICATION

CONTENTS

SECTION			PAGE
6.1	**SENSOR HEAD AND CONTROL UNIT**		6.3
	6.1.1	Introduction	6.3
	6.1.2	Specification	6.3
	6.1.2.1	Indication	6.3
	6.1.2.2	Outputs	6.3
	6.1.2.3	External Services Required	6.3
	6.1.2.4	Accuracy (Typical)	6.4
	6.1.2.5	Alarms	6.5
	6.1.2.6	Environmental	6.5
	6.1.2.7	Physical Characteristics	6.5
	6.1.2.8	External Dimensions	6.6
	6.1.2.9	Materials of Construction	6.6
	6.1.2.10	Gas Connections	6.6
6.2	**PROBES/RESPONSE TIMES**		6.9
	6.2.1	Introduction	6.9
	6.2.2	Response Times	6.10
6.3	**PRINCIPLES OF OPERATION**		6.11
	6.3.1	Oxygen Sensor	6.11
	6.3.2	Flow Sensor	6.12
	6.3.3	Combustibles Sensor	6.12
6.4	**ISOLATED OUTPUT AND ALARM CARD (00722911)**		6.15
	6.4.1	Description	6.15
	6.4.2	Specification	6.15
	6.4.2.1	Voltage Output (oxygen)	6.15
	6.4.2.2	Current Output (oxygen)	6.15
	6.4.2.3	Alarms	6.15
	6.4.2.4	5V Output	6.16
6.5	**DUAL ISOLATED CURRENT OUTPUT MODULE (00722921)**		6.16
	6.5.1	Description	6.16
	6.5.2	Specification	6.16
	6.5.2.1	Current Output	6.16
	6.5.2.2	Measurement Range	6.16

6.6 TEMPERATURE AND EFFICIENCY CARD (00722914) 6.16

6.6.1 Description 6.16
6.6.2 Functional Description 6.17
6.6.3 Specification 6.17
6.6.3.1 Inputs 6.17
6.6.3.2 Current Output (Efficiency) 6.18
6.6.3.3 Voltage Output (Efficiency) 6.18
6.6.3.4 Current Output (Temperature) 6.18
6.6.3.5 Voltage Output (Temperature) 6.19
6.6.3.6 Alarm 6.19
6.6.3.7 5V Voltage 6.19

6.7 DATA COMMUNICATIONS CARD (00722913) 6.19

6.7.1 Description 6.19
6.7.2 Location and Function of Dipswitches 6.20
6.7.3 Protocol Setting 6.21
6.7.4 Specification 6.21
6.7.5 Operation - Option A 6.22
6.7.5.1 Option A 6.22
6.7.5.2 Echo Facility 6.23
6.7.5.3 On/Off Facility 6.23
6.7.5.4 Messages 6.23
6.7.6 Operation - Options B & C 6.23
6.7.6.1 Options B & C 6.23
6.7.6.2 Data Transmission Format 6.24
6.7.6.3 Fault and Alarm Messages 6.27
6.7.7 Self Testing Facility 6.28

LIST OF ILLUSTRATIONS

FIGURE **PAGE**

6.1 Control Unit Dimensions 6.7
6.2 Sensor Head Dimensions 6.8
6.3 Zirconia Oxygen Sensor 6.11
6.4 Relationship Between the Flue Gas Components,
Combustion Efficiency and Fuel/Air Ratio 6.14
6.5 Location and Function of Dipswitches 6.20

SECTION 6: FUNCTIONAL DESCRIPTION AND SPECIFICATION

6.1 SENSOR HEAD AND CONTROL UNIT

6.1.1 INTRODUCTION

Functional description information for both the Sensor Head and Control Unit may be found in Section 2 of this manual.

6.1.2 SPECIFICATIONS

6.1.2.1 Indication

12 character alphanumeric vacuum fluorescent display.

6.1.2.2 Outputs

Oxygen Output:

Non-isolated:	0-10V and 0-20mA or 2-10V and 4-20mA (user selectable)
Output ranges:	2.5%; 5%; 10%; 25% (selectable)

NOTE: Display and output limit at 21% O_2

Combustible Output (when specified):

Non-isolated:	0-10V and 0-20mA or 2-10V and 4-20mA (user selectable)
Output ranges:	0.25%; 0.50%; 1%; 5%

Load Resistance:

Voltage outputs:	2 kohms (minimum)
Current outputs:	500 ohms (maximum)

6.1.2.3 External Services Required

Electrical supply:

The equipment will operate from 110Vac, 120Vac, 220Vac, 230Vac and 240Vac and is suitable for 50/60Hz supplies. The supply should be stable to ±10% of nominal and must be free from transients.

The power requirement of the equipment fitted with all options is 450VA on start-up and, typically, 250VA after warm-up.

Air supply: Clean dry air, free of combustibles. Plant compressed air may be used providing it is clean and free of water and oil vapour.

Supply pressure (if Servomex regulators are used): 0.6 to 10 barg (10 to 150 psig)

Consumption: Less than 2.5 litres/min at N.T.P. For regulation specification at Sensor Head, refer to Section 2.4 (Air Regulator Units).

6.1.2.4 Accuracy (typical)

Under constant conditions and directly after span and air point calibration, the following accuracy will be achieved:

Oxygen Output:	±0.1% oxygen up to 10% oxygen ±2.5% of reading between 10% and 21% oxygen
Combustibles output:	±5% of range selected on factory calibration gases

NOTE: Accuracy is defined as the net effect of non-repeatability and non-linearity.

The combustibles detector will respond to most combustible gases and is operated to give a minimum sensitivity to methane.

By optimising its response to CO, the detector is ideal for indicating the breakthrough of CO at the onset of poor combustion conditions.

The display has a resolution of 0.1% oxygen and 0.001% CO.

Effect of ambient temperature:

Sensor Head temperature (with Control Unit at constant temperature)

Oxygen output:	0.13% of reading/10°C
Combustibles output:	8ppm/°C at 1.0% CO

Control Unit temperature (with Sensor Head at constant temperature):

Oxygen output (-10 to +55°C) :	<-0.001% O_2/°C at 21% O_2
Combustibles output (+25 to +55°C) :	<0.002%/°C at 1% CO

Effect of Barometric and Flue Pressure:

Negligible effect on oxygen reading due to barometric and flue pressure variations.

Effect of Supply Voltage Variations:

Oxygen:	0.05% oxygen maximum change for ±10% change in supply voltage
Combustibles:	60ppm CO maximum change for ±10% change in supply voltage

(The above apply to long term changes. After a step change (-10% to +10%) a small variation in the oxygen reading may be observed which will settle out within approximately 1 minute.)

Effect of Radio Frequency Interference:

When the instrument is subjected to the levels of interference set out in the relevant EMC immunity test schedule, the performance is as follows:

O_2 reading accuracy - local display and signal output: ±0.1%O_2 or 10% of reading.
Temperature reading accuracy (if applicable) - local display and signal output: +20°C/-10°C

6.1.2.5 Alarms

All system faults and alarms cause the display to flash and can be interrogated via the key pad (see Operating Instructions).

Oxygen alarm and system fault outputs are available via the isolated oxygen output and alarm module (refer to Section 6.4).

The combustibles level alarm is available on the combustibles version of the 700B as follows:

Range: 0-4.99% CO + OFF (0.01% steps)

Output: (Non-isolated)	Type:	Open drain transistor	
	Logic:	Transistor does not conduct in the alarm state	
	Rating:	I(max):	225mA
		V(max):	24V
		Dissipation(max):	600mW

Polarity: Externally applied voltage must be DC and positive with respect to 0 volts

A +5 volt supply is available from the card to drive an external relay, max current: 100mA

6.1.2.6 Environmental

Ambient temperature (Sensor Head):	-20°C to 80°C
Ambient temperature (Control Unit):	0°C to +55°C
Relative humidity:	0-95% non-condensing
Maximum Flue Skin Temperature:	350°C 500°C with stand-off Above 500°C consult Servomex
Maximum Process Pressure:	±1200mm H_2O vent to flue only (outside this range or for vent to atmosphere refer to Servomex)

6.1.2.7 Physical Characteristics

Sensor Head Classification:	IP55 Safe area installation only unless purged by suitable system
Control Unit Classification:	IP54 Safe area installation only unless purged by suitable system.

6.1.2.8 External Dimensions

See outline dimensional drawings :		Figures :	6.1 Control Unit 6.2 Sensor Head
Weight:	Sensor Head Unit:	9.0kg (20 lb) excluding probe tube	
	Control Unit:	11.5kg (25.31 lb)	

6.1.2.9 Materials of Construction

Sensor Head:

Terminal Box:	Zinc coated mild steel with epoxy powder paint finish
Heated Unit:	Zinc chromated mild steel with heat resistant paint finish, aluminium reinforced calcium silicate, 303 and 316 stainless steels.
Sample Wetted Parts:	303 and 316 stainless steels, platinum, stabilised zirconia, Nilo 475, alumina, PTFE, sealing glass.

Control Unit: Mild steel coated with epoxy powder paint.

6.1.2.10 Gas Connections

Sensor Head :

Aspirator air	1/4 inch OD compression	
Calibration gas	1/4 inch OD compression	
Auxiliary air	1/8 inch OD compression	
Purge gas	Purge in:	Hole (17mm dia) to take M16 external
	Purge sense:	Hole (13mm dia) to take 1/4 inch BSP external
	Purge out:	3/8 BSP external
Sample gas entry	1/4 inch NPTF	

Control unit :

Purge gas	3 holes, 18mm dia

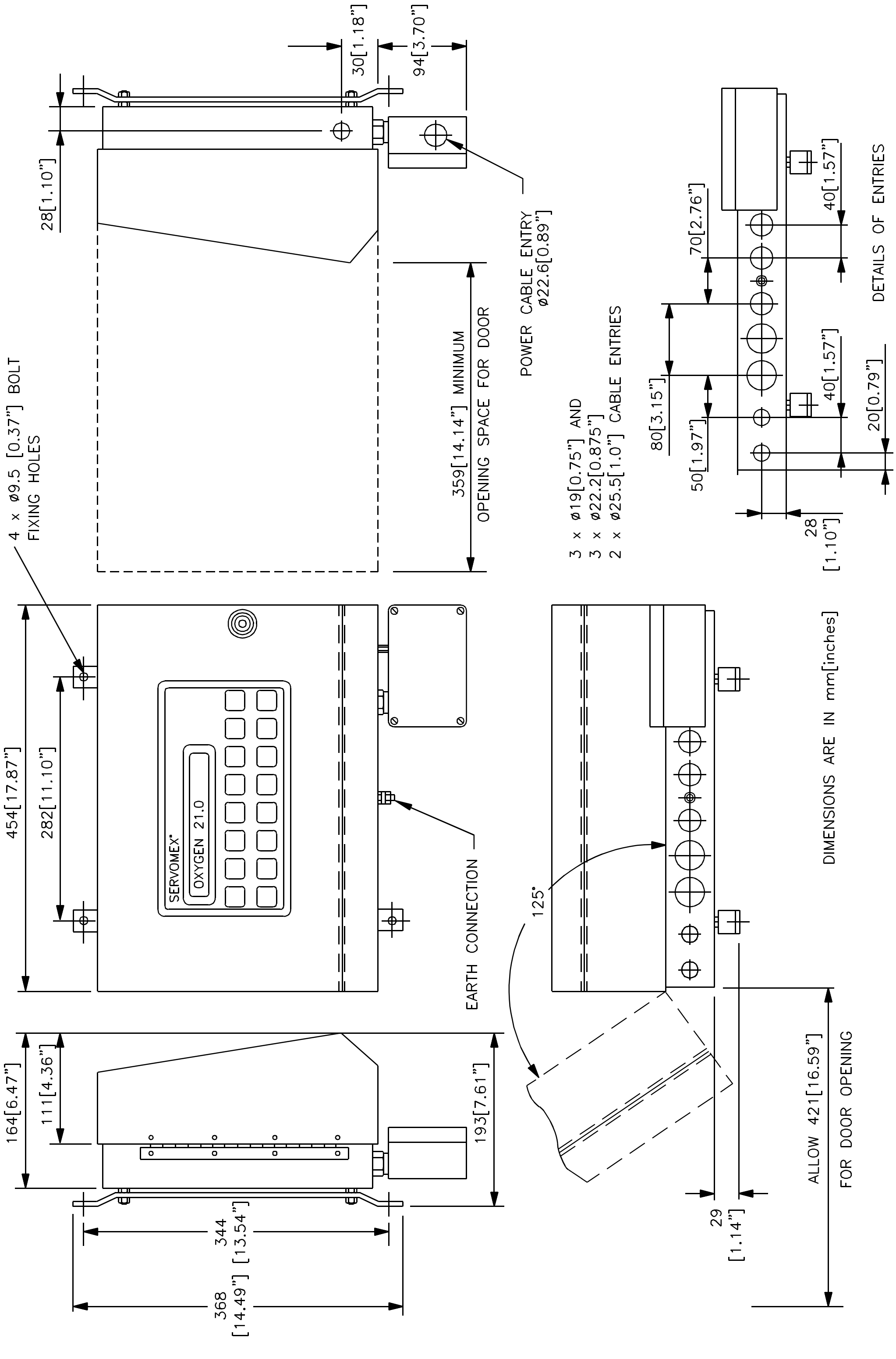


Figure 6.1 Control Unit Dimensions

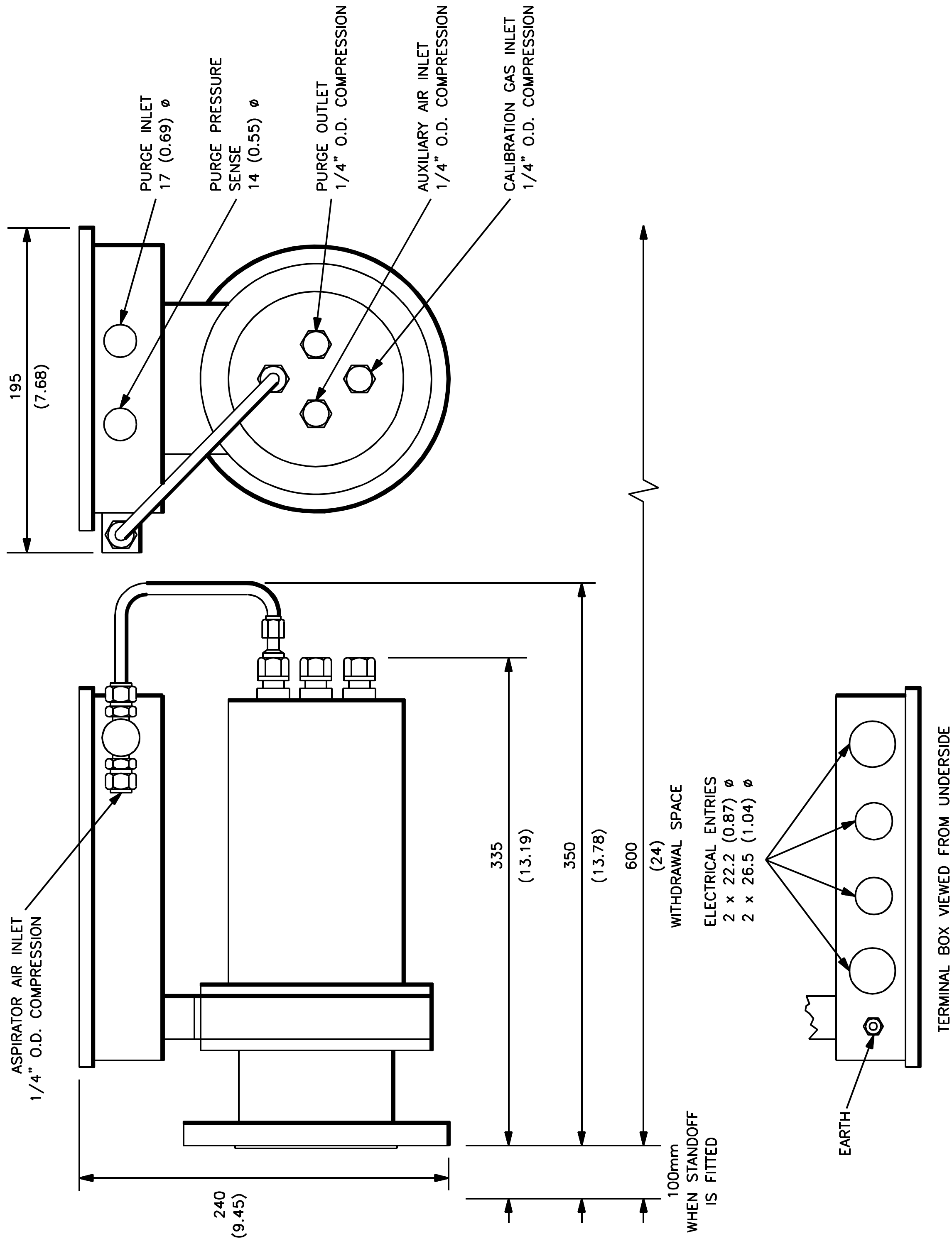


Figure 6.2 Sensor Head Dimensions

6.2 PROBES/RESPONSE TIMES

6.2.1 INTRODUCTION

Response time depends upon probe type and length.

There are essentially 5 categories of probe:

< 500°C, Filter probes, unsupported
< 500°C, Filter probes, supported
< 1000°C, High temperature alloy probes
< 1600°C, Ceramic probes
< 1800°C, Ceramic probes

All data given in this Section refers to the Vent to Flue Options and are typical times only.

The response times given in Table 2 are for an average temperature of the sample gas in the probe of 200°C.

Table 1 shows approximate speed of response correction factors for higher sample gas temperatures.

<u>Table 1</u>

Flue Temp °C	Sample Average Temp°C	Factor
20	20	x1.61
200	200	x1.00
300	250	x0.90
400	300	x0.83
500	350	x0.76
600	400	x0.70
700	450	x0.65
800	500	x0.61
1000	600	x0.52
1200	700	x0.49

Flue Temp °C	Sample Average Temp°C	Factor
1400	800	x0.44
1600	900	x0.40
1800	1000	x0.37
1800	1100	x0.34
1800	1200	x0.32
1800	1300	x0.30
1800	1400	x0.28
1800	1500	x0.26
1800	1600	x0.25

Flue temperature °C: This is the most simple correction and is adequate for most purposes. It assumes a linear temperature gradient along the probe tube from the flue gas temperature at the probe tip to 200°C at the entry to analyser.

Sample average temperature: If the average temperature of the sample gas in the probe tube can be established or estimated by measuring temperature profile along the tube, use column 2 to find the appropriate correction factor.

6.2.2 RESPONSE TIMES

Table 2

Probe Type	Description	DV lag sec	T63% sec	T90% sec
<500°C Filtered Probes, unsupported	0.5m long, ¼" OD tube, large filter	2.6	6.4	10.4
	1m long, ¼OD tube, large filter	3.0	6.8	10.8
<500°C Filtered Probes, supported	0.5m supported	2.6	6.4	0.4
	1.0m supported	3.0	6.8	10.8
	1.5m supported	3.4	7.3	11.2
	2.0m supported	3.8	7.7	11.6
	2.5m supported	4.2	8.1	12.0
	3.0m supported	4.6	8.5	12.5
<1000°C High Temperature Alloy Probes	0.5m Haynes probe	7.5	10.6	12.2
	1.0m Haynes probe	13.8	14.7	19.6
	1.5m Haynes probe	19.9	24.7	26.6
	2.0m Haynes probe	26.0	30.9	32.8
<1600°C Ceramic Probe	0.5m Ceramic	9.6	14.1	16.0
	1.0m Ceramic	20.5	26.5	28.8
	1.5m Ceramic	26.3	32.4	34.9
<1800°C Ceramic Probe	0.5m Ceramic	9.6	14.1	16.0
	1.0m Ceramic	20.5	26.5	28.8
	1.5m Ceramic	26.3	32.4	34.9

6.3 PRINCIPLES OF OPERATION

6.3.1 OXYGEN SENSOR

The Servomex (R) zirconia sensor (Figure 6.3) is manufactured using yttria stabilised zirconia. When this material is heated to a temperature above 600°C it will conduct oxygen ions. The oxygen ion conductivity increases exponentially with temperature. The sensor consists of a disc of yttria stabilised zirconia mounted in a tube of the same material. The faces of the disc are coated with platinum and the assembly is mounted in a small temperature controlled tubular oven.

When the two sides of the disc are exposed to gases containing oxygen, a concentration cell is formed and an electrical output proportional to the logarithm of the ratio of the oxygen concentrations on each side of the disc is obtained. (When the concentration is the same on both sides of the disc the logarithm of the ratio is 0.)

The fact that the oxygen content of air is very constant at 20.95% makes it convenient to use air as the reference gas which is applied to one side of the disc while the sample is applied to the other side.

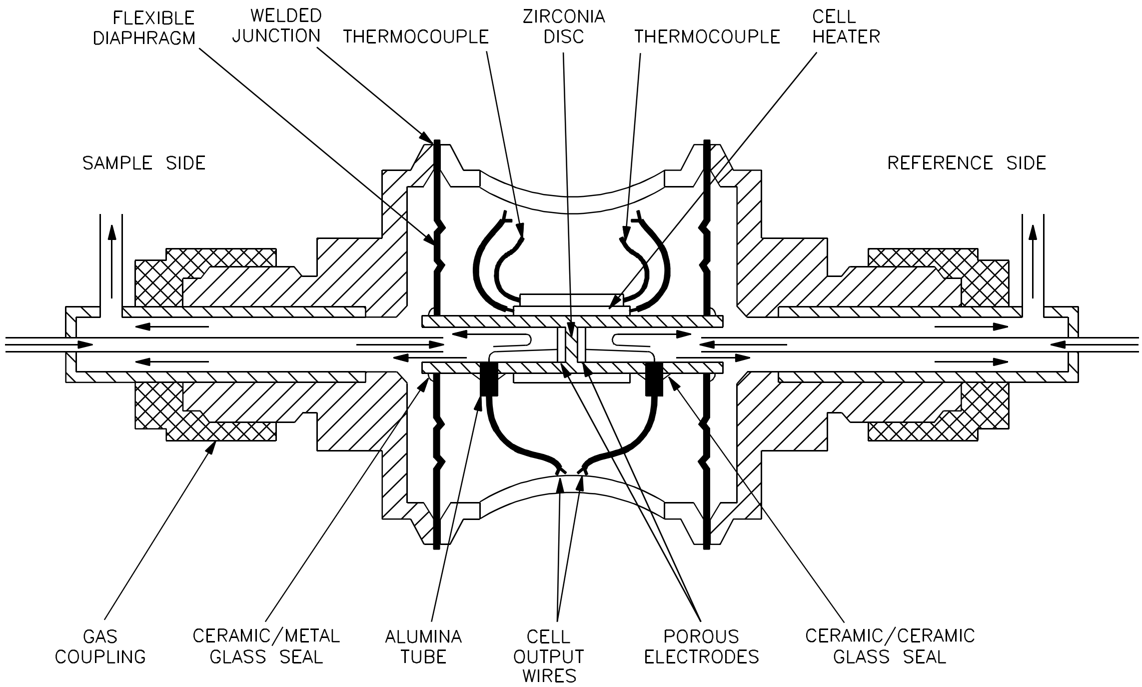


Figure 6.3 Servomex Zirconia Oxygen Sensor

The output of the cell is given by the Nernst equation:

$$E = \frac{RT}{nF} \ln \frac{(20.95)}{(P)} \; mV$$

where 20.95 and P are the oxygen contents of air and the sample respectively (%).

For the nominal cell temperature of 725°C: (RT/nF) = 21.50mV

Hence the cell output is given by: E = 21.50ln(20.95/P)mV.

6.3.2 FLOW SENSOR

The flow sensor utilises a non-invasive method of flow detection. The only material which comes into contact with the sample is 316 stainless steel.

The sample gas flows through a stainless steel tube around which an insulated platinum wire coil is wound uniformly along its length. This coil is centre tapped so that it may be operated in a bridge circuit. A current is passed through the coil which heats the tube and raises its temperature to about 100°C above ambient. As the sample gas flows through the tube, the first half is cooled with respect to the second half. This reduces the resistance of the first coil, unbalancing the bridge and giving rise to an output.

The simple operating principle and straight forward electronic control lead to trouble free performance. Further, the small variation in sensitivity between sensors avoids the need for span calibration when the device is used as a flow alarm. The micro-processor signals an alarm when the output from the sensor falls below a preset level (corresponding to about 10% of the nominal flow rate) or to zero (indicating complete loss of sample flow). The trip levels can be selected from the analyser keyboard.

6.3.3 COMBUSTIBLES SENSOR

The combustibles sensor is a constant temperature catalytic (CTC) device and acts by burning any combustible gases present in the sample on the surface of a catalytic bead. The sensor comprises a matched pair of beads, one of which displays catalytic activity while the other is passivated.

The active unit consists of an alumina bead, coated with a catalyst, formed over a fine platinum wire and suspended by wires between rigid legs in a protective can. A current passed through the wire core raises the temperature of the bead to a level where combustible gases are oxidised by the catalyst coating on the surface of the bead. This reaction raises the temperature of the bead further and causes the resistance of the platinum to change. Measurement of this change results in a signal proportional to the concentration of the combustible gases in the sample.

An active and a passive device are used together to minimise the effects of ambient temperature variations. They are carefully matched in their thermal properties and are mounted close together. Only one, the active device (detector), is treated with catalyst. The other is passivated to suppress any reaction. (This enables the two to be easily distinguished visually as the detector bead appears black while the other is white.) As the two beads are mounted close together they experience the same variations in ambient conditions and as oxidation does not occur on the passive bead the presence of combustible gas is indicated by a difference in temperature between the two beads. This can be measured by comparing the resistances of the coils or the currents passing through them.

A feedback system is used in the 700 series combustibles monitor to obtain a more stable measurement than is otherwise possible.

The principle is to maintain the same voltage drop across both devices by adjusting the current in the detector whilst holding that in the inactive bead constant. The output signal is the difference between these two currents, both of which are measured as the voltage drop across a precision resistor connected in series with the appropriate device. These resistors are located on the combustibles module in the Control Unit.

The point of ideal combustion is always related to a level of excess oxygen in the flue (see Figure 6.4). The oxygen and combustibles version of the zirconia analyser is designed to identify this point and will do this accurately without a supplementary air supply. However, for circumstances where it is desirable to measure combustible gas in sub-stoichiometric (reducing) conditions an auxiliary air supply port is available.

It must be noted that the analyser is designed as a device for maximising combustion efficiency and NOT as a primary safety device used to detect hazardous conditions.

The combustibles sensor, which is normally calibrated for CO, is cross sensitive to hydrogen and hydrocarbons (except methane). This cross sensitivity is an advantage for the purpose for which the sensor was designed but makes the concept of absolute accuracy difficult to define. In terms of combustion efficiency there is normally a sharp change from the combustibles background level on reaching the point of ideal combustion. The combustibles sensor will identify this point and should therefore be considered as a combustibles breakthrough indicator rather than an absolute measurement

Other gases and vapours in the sample gas may give the combustibles detector a positive offset. However, as this effect is fairly constant over the range of concentrations normally found in flue gas samples, it does not detract from the use of the detector as a combustibles breakthrough indicator.

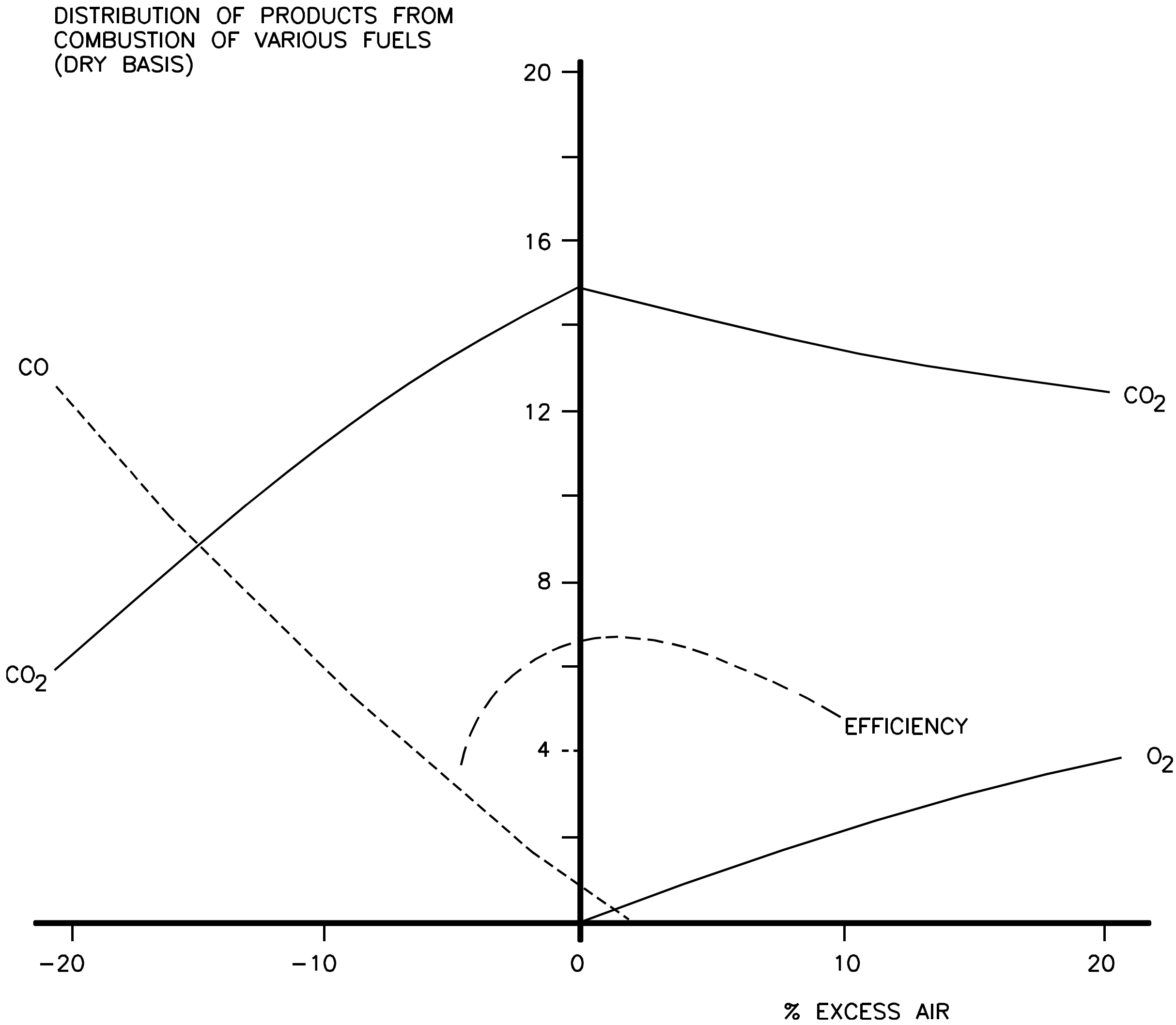


Figure 6.4 Relationship between Flue Gas Components, Combustion Efficiency and Fuel/Air Ratio

6.4 ISOLATED OUTPUT AND ALARM CARD (00722911)

6.4.1 DESCRIPTION

This option card provides isolated current and voltage analogue outputs for the oxygen signal and relay contacts for general alarm. Non-isolated outputs are also provided for oxygen high, oxygen low and instrument failure alarms. The card can be fitted in any of the option positions on the interface adaptor card.

6.4.2 SPECIFICATION

6.4.2.1 Voltage Output (Oxygen)

Output:	0 to 10V or 2 to 10V (keypad selected)
Output impedance:	Less than 1 ohm
Maximum output:	5mA at 10V
Short circuit protection:	Output is limited to a safe value of approximately 5mA
Isolation:	500V RMS between output and ground
Accuracy:	±0.3% FSD
Linearity:	±0.1% of reading
Temperature co-efficient:	Zero -0.002% FSD/°C
	Span -0.002% FSD/°C
Noise:	Less than 10mV peak to peak

6.4.2.2 Current Output (Oxygen)

Output:	0 to 20mA or 4 to 20mA (keypad selected)
Output load:	0 to 500 ohm
Maximum output current:	20mA
Isolation:	500V RMS between output and ground
Accuracy:	±0.3% FSD
Linearity:	±0.1% of reading
Temperature co-efficient:	Zero -0.002% FSD/°C
	Span - 0.002% FSD/°C
Noise:	Less than 20mV peak to peak

Note: It is the users' responsibility to ensure that the current loop is adequately grounded and cannot exceed a potential of 50V peak with respect to the analyser ground.

6.4.2.3 Alarms

Non Isolated	Functions:	Instrument failure, oxygen high and low alarm
	Output:	Open collector darlington, live when there is no alarm
	Maximum voltage:	24V
	Maximum current:	500mA
Isolated	Function:	General alarm
	Output:	Relay contacts, closed if there is no alarm
	Contact rating:	20W, 50V, 1.5A DC

6.4.2.4 5V Output - for operation of alarms

Maximum current: 100 mA

NOTE: The current and voltage outputs are not isolated from each other.

6.5 DUAL ISOLATED CURRENT OUTPUT MODULE (00722921)

6.5.1 Description

This option card provides isolated current output for the oxygen and combustibles signals. These outputs can be selected via the keypad and this card may be fitted in any of the option position on the interface adaptor card.

6.5.2 Specification

6.5.2.1 Current output

Output:	0-20mA or 4-20mA (user selectable as for non-isolated output)
Maximum output load:	1 kohm
Isolation:	500V (RMS)
Accuracy:	Typically within 0.02mA over the temperature range of 0-55°C, load variation 0-1 kohm and supply variation ±10%

Note: It is the users' responsibility to ensure that the current loop is adequately grounded and cannot exceed a potential of 50V peak with respect to the analyser ground.

6.5.2.2 Measurement range

As for non-isolated outputs
ie. 2.5; 5; 10; 25% Oxygen
0.25; 0.5; 1.0; 5% Combustibles

Note: The dual isolated output card, output current ranges and measurement ranges (FSD) are automatically set the same as the non-isolated oxygen and combustibles outputs.

6.6 TEMPERATURE AND EFFICIENCY CARD (00722914)

6.6.1 DESCRIPTION

This option card provides output of flue gas temperature and combustion efficiency both on the display and as an analogue output. The temperature may be calibrated in degrees Centigrade or Fahrenheit. A flue temperature high alarm is also provided.

6.6.2 FUNCTIONAL DESCRIPTION

This card accepts an input from the thermocouple which is placed in the flue gas stream.

An optional inlet thermocouple may be fitted to measure the air temperature to the burner. If this thermocouple is not fitted, the equation used for calculating efficiency will use a value for air temperature entered via the keypad.

The combustion efficiency is calculated according to the Siegert equation:

$$Efficiency\ (\%) = 100 - \frac{K_1\ \Delta T}{(21.00 - \%O_2)} - K_2\ (K_3 - T + \Delta T)$$

where: K_1 and K_2 are fuel constants
K_3 is 1171.4
ΔT is the difference between ambient and flue gas temperature (°C)
T is the ambient temperature (°C)

A choice of 3 pairs of constants is selected via the keypad, depending on the fuel used.

	Coal	Gas	Oil
K_1	0.70	0.62	0.71
K_2 (x 1000)	4.07	8.27	5.13

This calculation is only performed if the following conditions are satisfied:

1. Oxygen level is within the range of 1 to 15% O_2
2. Difference between flue and air inlet temperatures is positive
3. Flue temperature is less than 700°C (1292°F)

If the measurements are outside these limits, the message "OUT OF RANGE" will be displayed.

6.6.3 SPECIFICATION

6.6.3.1 Inputs

Flue temperature:	Type K thermocouple:	BS4937 Part 4 (Part No 00715994)
Air inlet temperature (optional):	Type K thermocouple:	BS4937 Part 4 (Part No 00725994)

Measurement Range

Flue temperature:	0-1000°C with 1°C resolution or 32-1832°F with 1°F resolution

Note: Accuracy is limited by thermocouple calibration

Air Inlet Temperature -20°C to 150°C with 1°C resolution
or -4°F to 302°F with 1°F resolution

Accuracy of Temperature Reading

The flue temperature input accuracy has been optimised for a type K thermocouple in the range of 160°C to 250°C to obtain ±2°C accuracy. The range of readings extends from 0°C to 1000°C. Linearity errors will increase to a maximum of ±6°C at the extremes of the range. Users must ensure that the thermocouple installed is capable of withstanding the process temperature.

All thermocouples are subject to a temperature tolerance. The thermocouple error is in addition to the linearity errors described above.

6.6.3.2 Current Output (Efficiency)

Output:	0 to 20mA or 4 to 20mA (keypad selected)
Range:	0 to 100%
Output Load:	0 to 500 ohm
Maximum Output Current:	20mA
Accuracy:	±0.5% of FSD in addition to calculation accuracy

6.6.3.3 Voltage Output (Efficiency)

Output:	0 to 10V or 2 to 10V (keypad selected)
Range:	0 to 100%
Output Impedance:	Less than 1 ohm
Maximum Output:	5mA at 10V
Short Circuit Protection:	Output is limited to a safe value of approximately 5mA
Accuracy:	±0.5% of FSD in addition to calculation accuracy

6.6.3.4 Current Output (Flue Gas Temperature)

Output:	0 to 20mA or 4 to 20mA (keypad selected)
Range:	0 to 500°C or 0 to 1000°C (Centigrade calibrated) 0 to 1000°F or 0 to 2000°F (Fahrenheit calibrated)
Output Load:	0 to 500 ohm
Maximum Output Current:	20mA
Accuracy:	±0.5% of FSD in addition to measurement accuracy

6.6.3.5 Voltage Output (Flue Gas Temperature)

Output:	0 to 10V or 2 to 10V (keypad selected)
Range:	0 to 500°C or 0 to 1000°C (Centigrade calibrated)
	0 to 1000°F or 0 to 2000°F (Fahrenheit calibrated)
Output Impedance:	Less than 1 ohm
Maximum Output:	5mA at 10V
Short Circuit Protection:	Output is limited to a safe value of approximately 5mA
Accuracy:	±0.5% of FSD in addition to measurement accuracy

6.6.3.6 Alarm

Function:	Flue temperature high
Setting:	User adjustable
Output:	Open collector, open circuit in alarm condition
Maximum Voltage:	24V
Maximum Current:	225mA

6.6.3.7 5V Voltage - for Operation of Alarms

Maximum Current:	100mA

6.7 DATA COMMUNICATIONS CARD (00722913)

6.7.1 DESCRIPTION

The datalink option can be fitted to enable two way communication between the analyser and a computer or terminal. Communication is via ASCII code over a full duplex link with a choice of data formats at a transmission rate of between 300 and 19200 baud.

Three types of isolated output are available; 20mA current loop, RS232C and RS423.

The format for communication, ie number of bits, parity and number of stop bits, is selected via dipswitches 3, 4 and 5 on the board. (See Figure 6.5).

6.7.2 LOCATION AND FUNCTION OF DIPSWITCHES

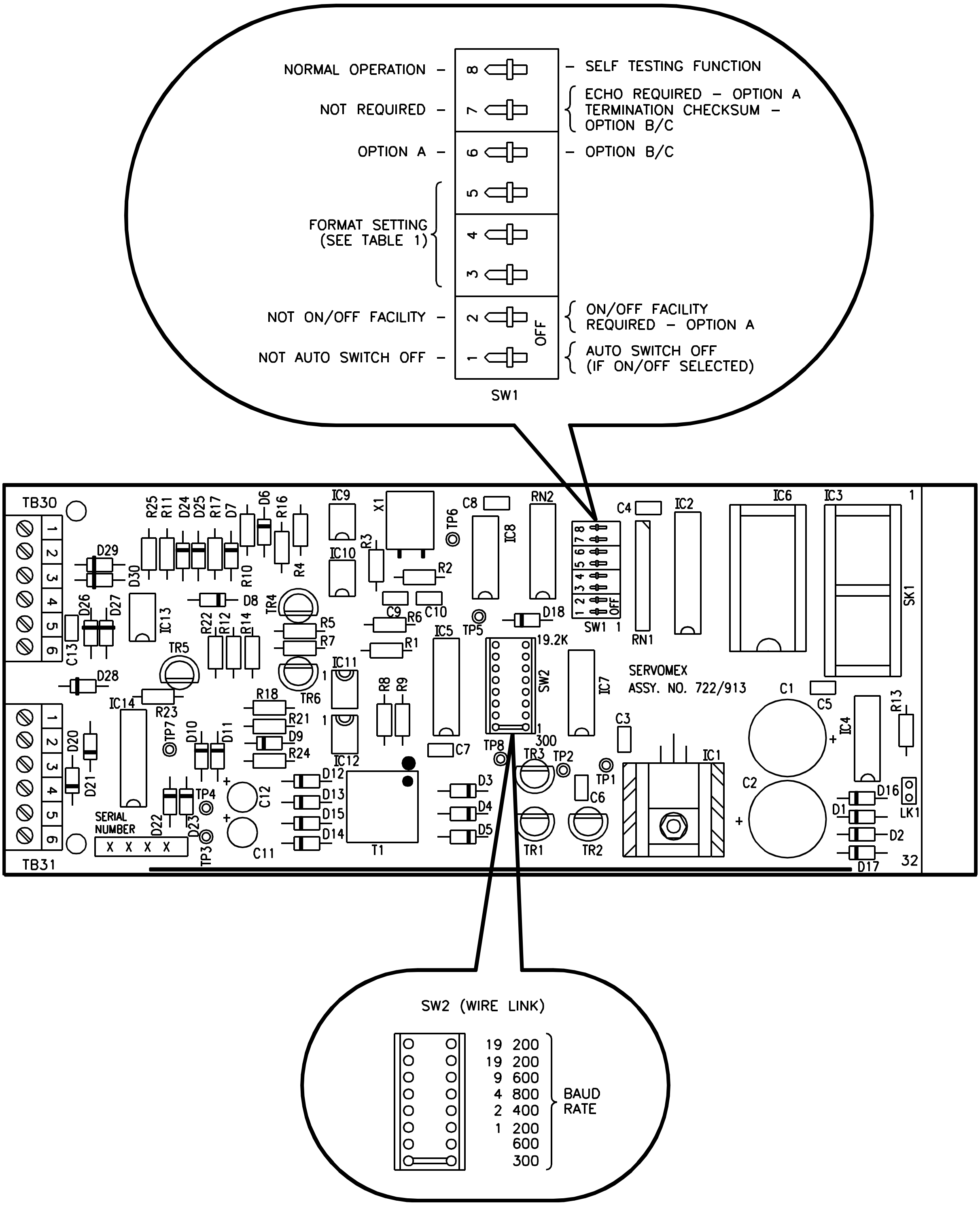


Figure 6.5 Location and Function of Dipswitches

Table 1 Setting the Format

Position of switches SW5	SW4	SW3	No of bits	Parity	No of stop bits
ON	ON	ON	7	EVEN	2
ON	ON	OFF	7	ODD	2
ON	OFF	ON	7	EVEN	1
ON	OFF	OFF	7	ODD	1
OFF	ON	ON	8	NONE	2
OFF	ON	OFF	8	NONE	1
OFF	OFF	ON	8	EVEN	1
OFF	OFF	OFF	8	ODD	1

6.7.3 PROTOCOL SETTING

There are two ways in which the datalink can be used:

i) To connect to a remote dumb terminal acting as a parallel keypad and display (option A). Set dipswitch 6 to option A.

ii) To connect to a computer to enable the computer to obtain information from the analyser (options B and C). Set dipswitch 6 to option B/C.

Option A - Allows a dumb terminal (or a computer configured as a dumb terminal), to be used in parallel to the keypad and display. All operations normally performed via the keypad can also be performed from the terminal.

Option B - Information is sent in a set format when a request is received. Data values can only be viewed, not changed.

Option C - This option is intended for use by a customer's energy management system and is, in general, similar to option B.

6.7.4 SPECIFICATION

Outputs: RS232C
RS423
Current loop (passive when transmitting, active when receiving)

Baud rate: 300, 600, 1200, 2400, 4800, 9600 or 19200
Selectable by links on the datalink card

Transmission distance:	RS232C and RS423 -	up to 500 metres at baud rates between 300 and 4800
	Current loop -	up to 500 metres at baud rates between 300 and 9600

6.7.5 OPERATION - OPTION A

6.7.5.1 Option A

Enables a dumb terminal, or a computer emulating a dumb terminal, to behave as a remote parallel keypad and display. The analyser can be operated as normal from the front panel keypad/display. The dumb terminal keys that represent keys on the analyser are listed in Table 2. Note the use of the upper case characters for transmission to the analyser. The response lower case characters, or upper case characters not listed in Table 2 will be "INVALID KEY".

Table 2 ASCII Equivalents of Keys

Control Unit Key	ASCII Character
Oxygen	O
Combustibles	C
Efficiency	E
Flue Temp/Flow	F
Calibrate	*
Parameter	P

Control Unit Key	ASCII Character
Normal	Q
(Raise) (Lower)	R L
Continue	T
Status and Alarms	D
Enter	Carriage Return

The analyser will transmit alphabetic characters in upper case if there are any faults or alarms otherwise they will be in lower case.

A line feed will be transmitted if the analyser goes from normal operation to an alarm or fault condition, or vice versa. Hence an alarm or fault condition will produce a line printed in upper case on the dumb terminal display.

6.7.5.2 Echo Facility

The analyser may be set to echo received characters. This facility enables the control unit to retransmit the received ASCII command at the end of the data stream, ie. on receipt of an ASCII command from the dumb terminal the control unit echoes the character along with a line feed and then sends the requested data.

6.7.5.3 On/Off Facility

If required, the serial link can be switched on and off by commands from the dumb terminal. This feature is selected by dipswitch 2 on the board. The link is switched on when a "9" is transmitted from the dumb terminal and off when a "O" is transmitted. When switching on the analyser the serial link will be in the off state if the on/off facility is selected.

If the on/off facility is selected the link can be made to switch itself off if there is no transmission from the dumb terminal for 90 seconds. This feature is selected by dipswitch 1 on the board.

6.7.5.4 Messages

This facility is normally used by Servomex engineers when carrying out remote servicing. It allows defined messages to be displayed on the control unit by transmission of a single character from the dumb terminal. the message will revert to the oxygen display after 10 minutes. Any invalid character entered will cause the display to show "INVALID KEY" for 2.5 seconds before reverting to the normal display.

The characters required to produce messages are:-

Character	Message
Z	"ATTENTION"
Then 1	"TEL 0892 652181"
2	"FINISHED"
3	"TALK TO ENG"

N.B. Since the software was written, the Servomex telephone number has been changed to: 01892 652181

6.7.6 OPERATION - OPTIONS B AND C

6.7.6.1 Options B and C

Options B and C enable information to be obtained from the analyser in a format more suitable for use by a computer. Information is requested by transmission of a single character to the analyser. No further requests should be transmitted until a response has been received.

Transmission of the response from the analyser should commence within 11 ms. If user adjustable parameter settings are requested as in Option B this figure extends to 1.5 seconds. It is anticipated that Option C will normally be used.

If Option B is required, make Link 1 on the datalink board. If Option C is required leave Link 1 open.

NOTE: Characters are not transmitted from the analyser in a continuous train. There may be a gap of up to 10 ms between characters.

Worst case times for transmission of requested information are as follows:

Option B -	5 seconds
Option C -	500 ms

This assumes a transmission rate of 300 baud and the use of a checksum.
If parameters are requested for an option which is not fitted then the response will be to transmit "*". If information is not available because the analyser is in a parameter change or calibration routine then the response will be to transmit "$".

6.7.6.2 Data Transmission Format

All messages in Option B and C begin with a "start of text" (STX) header and end with "end of text" (ETX).

If required a single byte checksum may also be transmitted following the main part of the message. The checksum is formed by adding all characters in the message including STX and ETX. The checksum is terminated with an "end of text" (EOT) character. This checksum is selected by dipswitch 7 on the board.

STX Data ETX Checksum EOT

Table 3 ASCII Commands for Option B

ASCII Command	Data Required	Format
v	Oxygen Combustibles Temperature of flue % Efficiency	Oooooo Cccccc Tttttt Eeeeee %O_2 %CO ^{o}C or ^{o}F %Eff (as set on PCB)
f	Fault status for mainboard and six option cards	FOff 1ff 2ff 3ff 4ff 5ff 6ff Mainboard Option cards. Number indicates position in control unit. ff - Two hexadecimal digits representing fault byte. (See Section 6.7.6.3)
a	Alarm status for mainboard and six option cards	AOaa 1aa 2aa 3aa 4aa 5aa 6aa Mainboard Option cards. Number indicates position in control unit. aa - Two hexadecimal digits representing alarm byte. (See Section 6.7.6.3)
o	Options fitted (in slot number order)	O###### * = No option fitted or, # = Option identifier, # Option fitted 1 Analogue output and alarm 3 Data Communications 4 Temperature and efficiency 5 Combustibles 7 Multiple analogue output
t	Time since last restart	Tddd hhh mmm sss days hours minutes seconds

ASCII Command	Data Requested	Format
z	Oxygen cell temperature in ^{o}C	Z ttttt - temp in ^{o}C
b	Oven temperature	B 11111 - temp (no units)
1	Oxygen sensor zero calibration point	z xxxxx - Zero point calibration point (O_2)
2	Oxygen sensor span calibration point	s xxxxx - Span calibration point (O_2)
3	Flow sensor zero calibration point	f xxxxx - Zero calibration point (flow sensor) * - If no flow sensor fitted
4	Combustibles sensor zero calibration point	q xxxxx - Zero calibration point (CO) * - If no combustibles sensor fitted
5	Combustibles sensor span calibration point	r xxxxx - Span calibration point (CO) * - If no combustibles sensor fitted
C	Combustibles parameters	xxxxx xxxxx xxxxx etc until all parameters have been listed
E	Efficiency parameters	xxxxx xxxxx xxxxx etc until all parameters have been listed
F	Flow parameters	xxxxx xxxxx xxxxx etc until all parameters have been listed
O	Oxygen parameters (Number of parameters listed increase if analogue output and alarm card is fitted)	xxxxx xxxxx xxxxx etc until all parameters have been listed

6.7.6.3 Interpretation of Fault and Alarm Messages

The interpretation of the fault and alarm messages depends on knowing which option card is fitted in each option location. By entering the ASCII code "o" this information will be given. Each option card has its own set of faults and alarm messages which are interpreted as follows:

Table 4 Fault Messages

Card Generating the fault	Fault Condition	Fault Message (in hexadecimal)
Temperature and efficiency	Flue thermocouple fail	01
Combustibles	Sensor fault	02
Main board	Data corrupt O_2 range error Oven temp sens fail Flow failure Oven temp high Oven temp low Cell temp high Cell temp low	80 40 20 10 08 04 02 01

Table 5 Alarm Messages

Card Generating the alarm	Alarm Condition	Alarm Message (in hexadecimal)
Temp & efficiency	Flue temp high	01
Combustibles	Combustibles high	01
Analogue output & alarms	Oxygen high alarm Oxygen low alarm	04 02

Table 6 ASCII Commands for Option C

ASCII Code	Data Requested	Format
O	Measured oxygen level	00021.0
T	Flue temp	%001000 (in ^{o}C or ^{o}F depending on setting of link on T&E card)
I	Air inlet temp	I000020
E	Efficiency	E000075
C	Measured combustibles	C04.800
D	Alarm/fault status	D0000AF (alarms & faults) D0000A0 (alarms) D00000F (faults) D000000 (no alarms, no faults)

6.7.7 SELF-TESTING FACILITY

The RS232C, RS423 and current loop can be tested by connecting the respective receive and transmit terminals together. Make the appropriate connections with the electrical supply disconnected. Set dipswitch 8 to the self test position. Reconnect electrical supply and observe the front panel display. This will indicate either data link "D/L PASS" or "D/L FAIL".

SECTION 7 : RECOMMENDED SPARES AND PARTS LIST

CONTENTS

SECTION **PAGE**

7.1 RECOMMENDED SPARES 7.3

7.1.1 General 7.3
7.1.2 Control Unit 7.3
7.1.3 Sensor Head 7.6
7.1.4 Sample Probes 7.7

7.2 PARTS LIST 7.10

7.2.1 Control Unit 7.10
7.2.2 Sensor Head 7.11
7.2.3 Sample Probes 7.13

LIST OF ILLUSTRATIONS

FIGURE **PAGE**

7.1 Component Location - Control Unit 7.2
7.2 Sensor Head - Exploded View 7.4-7.5
7.3 Unsupported Filter Probe 7.7
7.4 Supported Filter Probe 7.8
7.5 High Temperature Probes 7.9

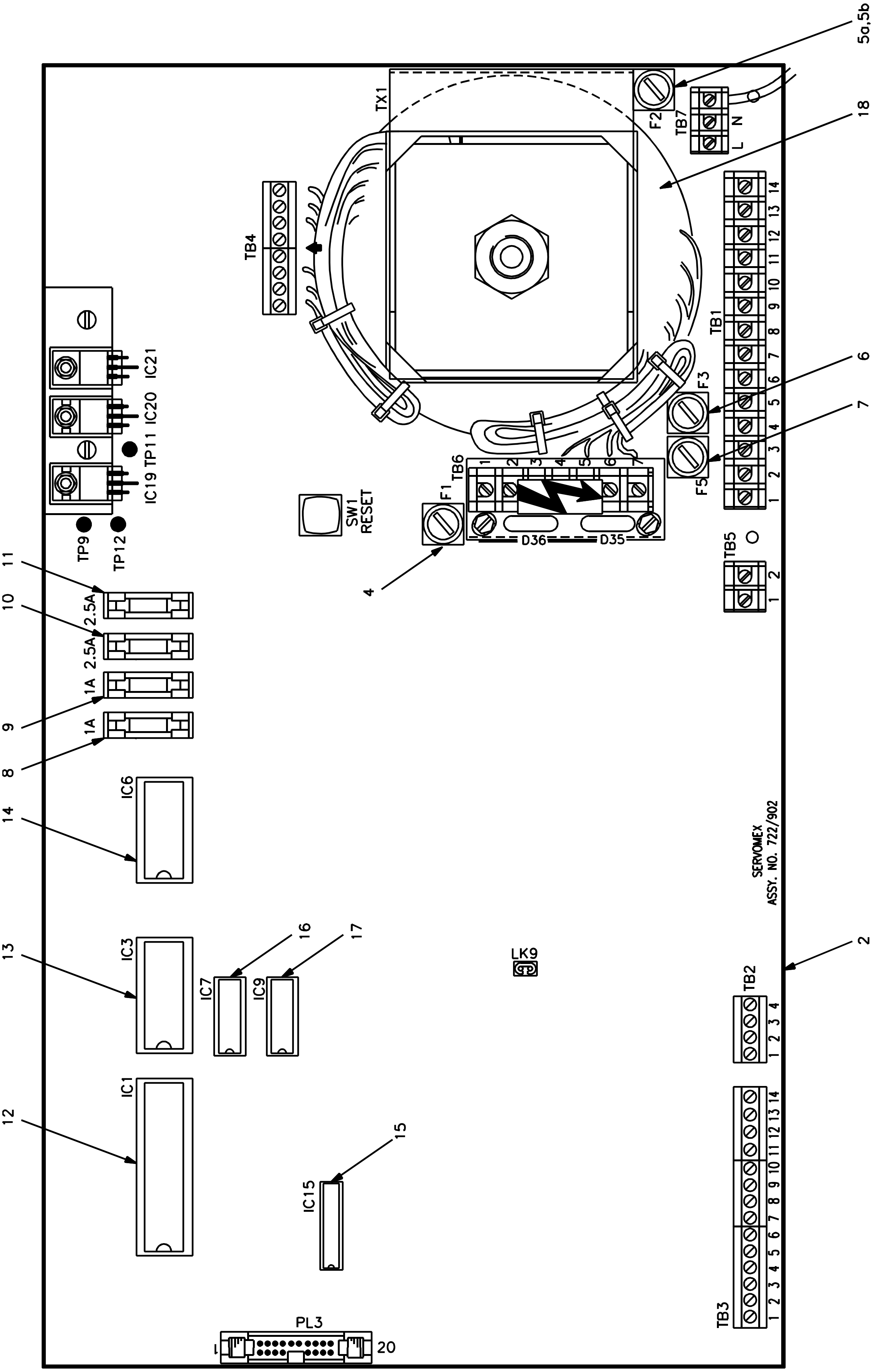


Figure 7.1 Component Location - Control Unit

SECTION 7 : RECOMMENDED SPARES AND PARTS LIST

7.1 RECOMMENDED SPARES

7.1.1 General

The quantities given in the following recommended spares list are based on experience and our normal service support. If the analyser is being used where minimal down-time is required then the quantities must be adjusted accordingly.

7.1.2 Control Unit

Refer to figure 7.1

Item Number	Description			No. of Analysers 1-3	4-9	10 +	Part Number
-	*Interface Adaptor Card			0	0	1	S0722901
2	Main Microprocessor Card			0	0	1	S0722902
-	Display Card			0	0	1	00722903
-	*Isolated Output and Alarm Card			0	0	1	00722911
-	*Data Link Card			0	0	1	S0722913
-	*Temperature and Efficiency Card			0	1	1	00722914
-	*Combustibles Card			0	1	1	S0722925
-	*Isolated Oxygen and Combustibles Card			0	1	1	00722921
4	Cell Heater Fuse	2.5A QAHB	F1	2	5	5	2531-2298
5a	240V A.C. Supply Fuse	1.6A TLHBC	F2	2	5	5	2531-2647
5b	110V A.C. Supply Fuse	3.15A TLHBC	F2	2	5	5	2531-2678
6	Solenoid Supply Fuse	500mA QAMB	F3	2	5	5	2531-2212
7	Combustibles Heater Fuse	500mA TLHBC	F5	2	5	5	2531-2591
8	Internal Supply Fuse	1A QAHBC	F6	2	5	5	2531-2243
9	Internal Supply Fuse	1A QAHBC	F7	2	5	5	2531-2243
10	Internal Supply Fuse	2.5A QAHBC	F8	2	5	5	2531-2298
11	Internal Supply Fuse	2.5A QAHBC	F9	2	5	5	2531-2298
-	Door Key			1	1	2	2531-2798

* - Only required if these options are fitted.

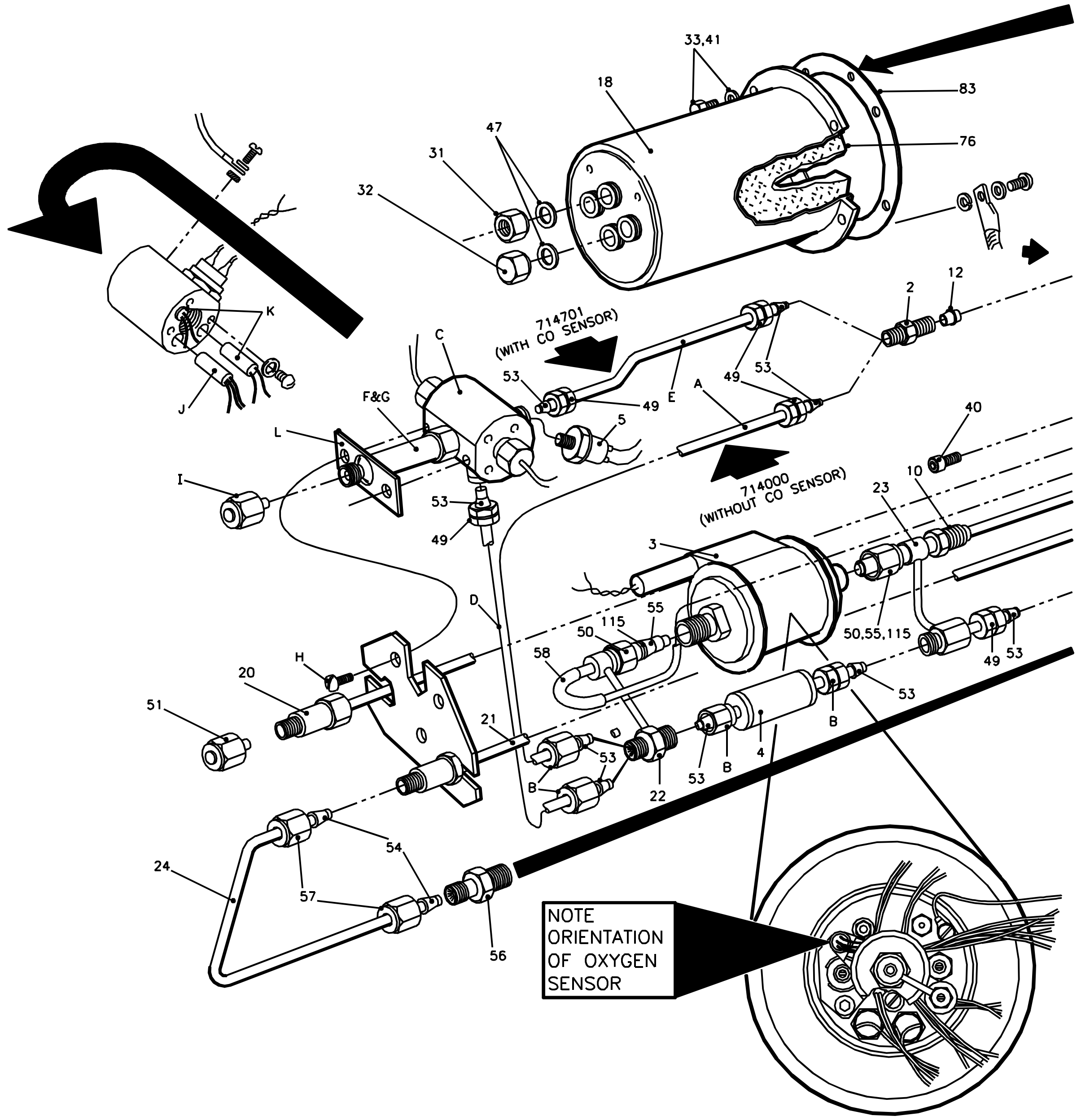


Figure 7.2 Sensor Head - Exploded View

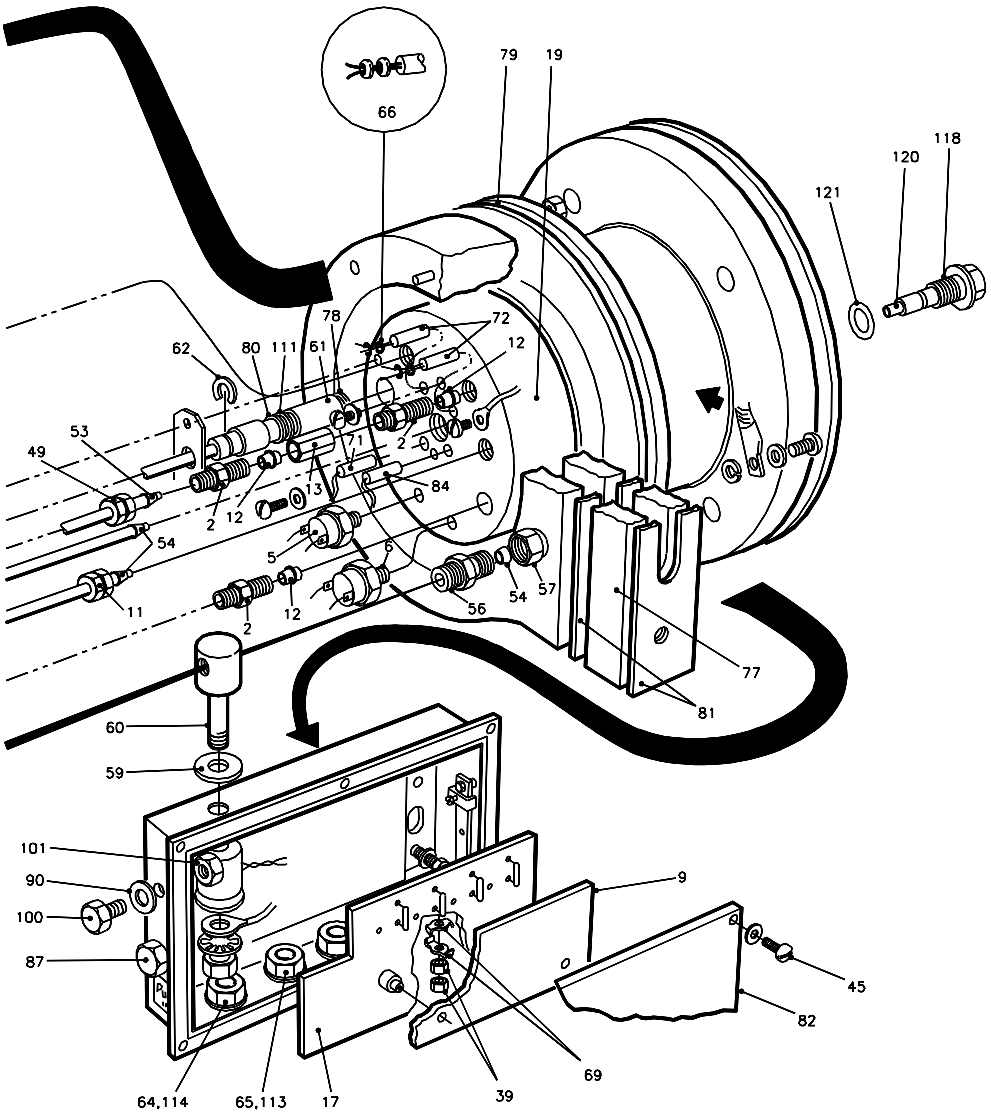


Figure 7.2 Sensor Head - Exploded View

7.1.3 Sensor Head

Refer to figure 7.2

Item Number	Description	No. of Analysers 1-3	4-9	10 +	Part Number
3	Zirconia Oxygen Sensor	1	1	2	00703000
C*	Combustibles Sensor and Housing Assembly (Heaters and Temperature Sensors are not included)	1	1	2	00706701
4	Flow Sensor (See Note)	0	1	1	00705000
2	Flame Trap	0	1	2	00022907
72	Cartridge Heaters, Sample Block	2	2	4	2653-1159
J*	Cartridge Heaters, Combustibles Block	2	2	4	2653-1344
71	Thermistor (Green Leads)	1	1	2	2651-7124
K*	Platinum Resistor	1	1	2	2653-4165
5*	Thermostat-Combustibles	0	1	1	00711909
5	Thermostat-Sample Block, Over Temperature (Yellow Leads)	0	1	1	00711909
6	Thermostat-Sample Block, Under Temperature (Violet Leads)	0	1	1	00711925
84	Thermocouple Reference Assembly	1	1	2	3989-0016
61	Filter Sample Block	1	2	4	2377-3646
78	Gasket - Filter Lower End	2	4	8	3931-7090
80	Gasket - Filter Top End, Fibre	2	4	8	3931-6718
111	Gasket - Filter Top End PTFE	2	4	8	3931-7083
118	Aspirator Screw	1	1	2	00714553
120	Aspirator Jet	1	1	2	00715415
121	'O' Ring	1	1	2	2323-6019
N/A	Zirconia Cell Reference Tube Parts Kit	0	1	2	S0714906

* - Only required if these options are fitted.

Note : When ordering the 00705000 flow sensor as a spare, new ferrules will be required for connecting it to the pipework. This assumes that the existing compression nuts will be cut from the old flow sensor. Thus additional parts required are 2 off 1/8 OD ferrules Part Number 2354-8929.

Similarly it must be remembered that when ordering spare pipework etc. that appropriate ferrules must be ordered to make connection to the existing pipework.

7.1.4 Sample Probes

The following recommended spares are for standard probes only. If a special probe has been supplied please refer to manual addendum or consult Servomex.

7.1.4.1 Unsupported Filter Probe, Stainless Steel, Upto 500°C

Refer to figure 7.3

Item Number	Description		No. of Analysers 1-3	4-9	10 +	Part Number
1	Filter		1	1	2	2377-6777
9	Filter Nut		1	1	2	00022471
10	Ferrule 1/4" O.D. for Probe Tube		1	1	2	2354-8936
4	Probe Tube :	0.5 MR	1	1	2	00714480A
		1.0 MR	1	1	2	00714480B
8	Probe Tube Coupling		1	1	2	2354-2060
6	Gasket 'B'		2	4	6	3931-6491

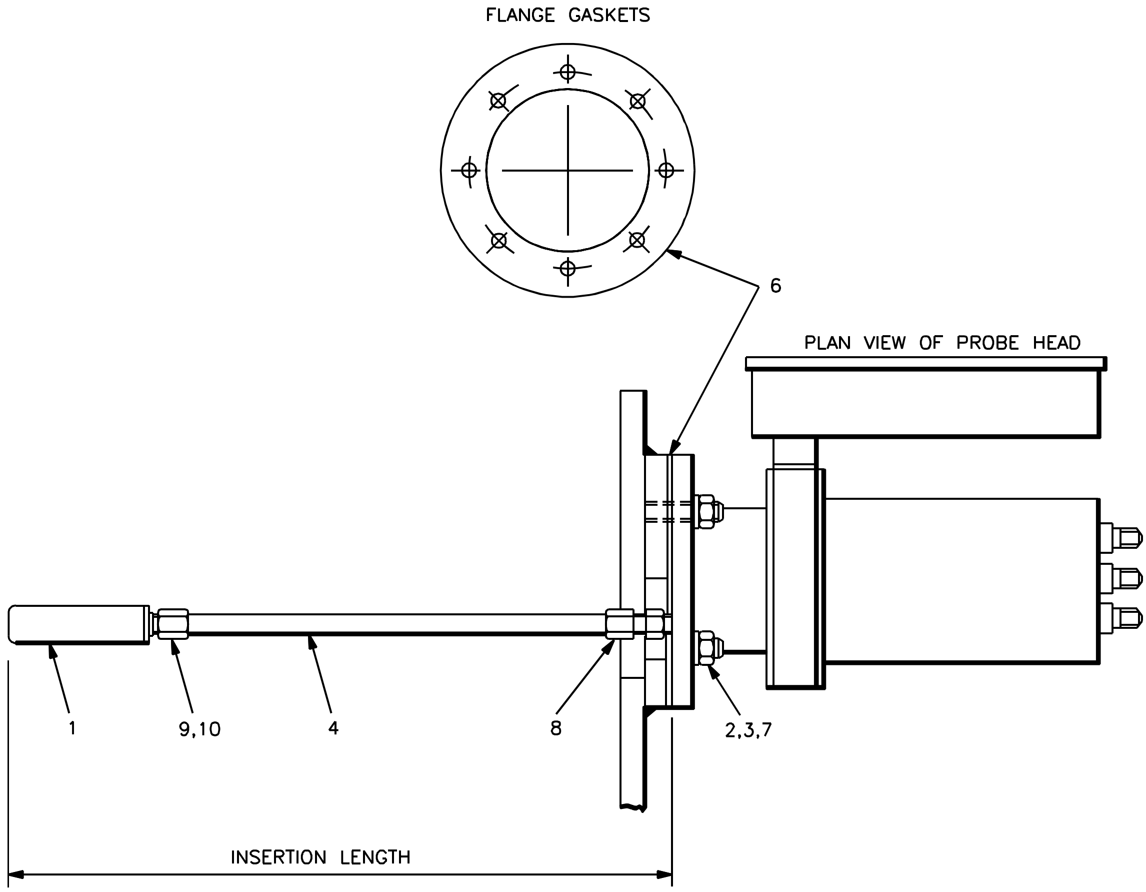


Figure 7.3 Unsupported Filter Probe

7.1.4.2 Supported Filter Probe Stainless Steel Upto 500°C

Refer to Figure 7.4

Item Number	Description	No. of Analysers 1-3	4-9	10 +	Part Number
11	Filter	1	1	2	2377-6777
6	Filter Nut	1	1	2	00022471
12	Ferrule 1/4" O.D. for Probe Tube	1	1	2	2354-8936
4	Probe Tube for				
	Insertion Lengths of : 0.5 MR	1	1	2	00714480A
	1.0 MR	1	1	2	00714480B
	1.5 MR	1	1	2	00714480C
	2.0 MR	1	1	2	00714480D
	2.5 MR	1	1	2	00714480E
	3.0 MR	1	1	2	00714480F
13	Probe Tube Coupling	1	1	2	2354-2060
8	Gasket 'A'	2	4	6	3931-6617
9	Gasket 'B'	2	4	6	3931-6491

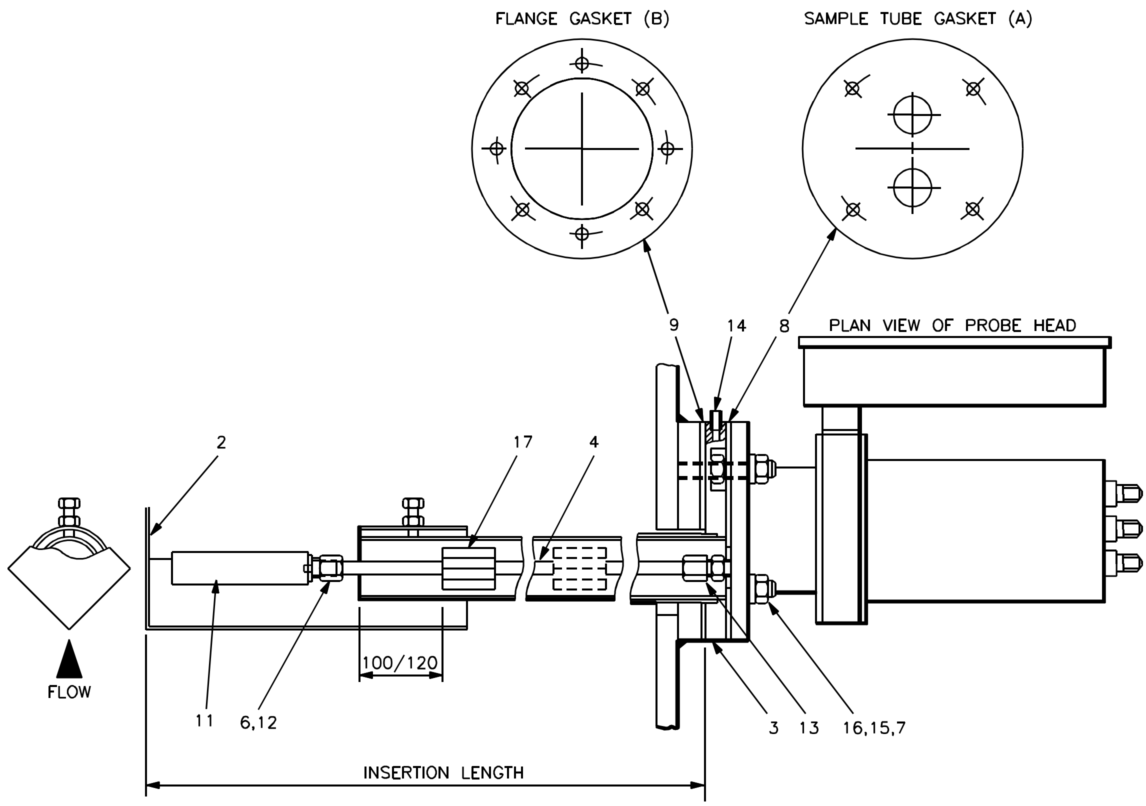


Figure 7.4 Supported Filter Probe

7.1.4.3 High Temperature Probes upto 1800°C

Refer to figure 7.5

Item Number	Description		No. of Analysers 1-3	4-9	10+	Part Number
2	Probe < 1000°C Alloy	0.5 MR	1	1	2	00714944A
		1.0 MR	1	1	2	00714944B
		1.5 MR	1	1	2	00714944C
		2.0 MR	1	1	2	00714944D
2	Probe < 1600°C Ceramic	0.5 MR	1	1	2	00714909A
		1.0 MR	1	1	2	00714909B
		1.5 MR	1	1	2	00714909C
2	Probe < 1800°C Ceramic	0.5 MR	1	1	2	00714909D
		1.0 MR	1	1	2	00714909E
		1.5 MR	1	1	2	00714909F
3	Gasket 'A'		2	4	6	3931-6617
4	Gasket 'B'		2	4	6	3931-6491
5	Sealing Washer		1	2	4	2356-7562

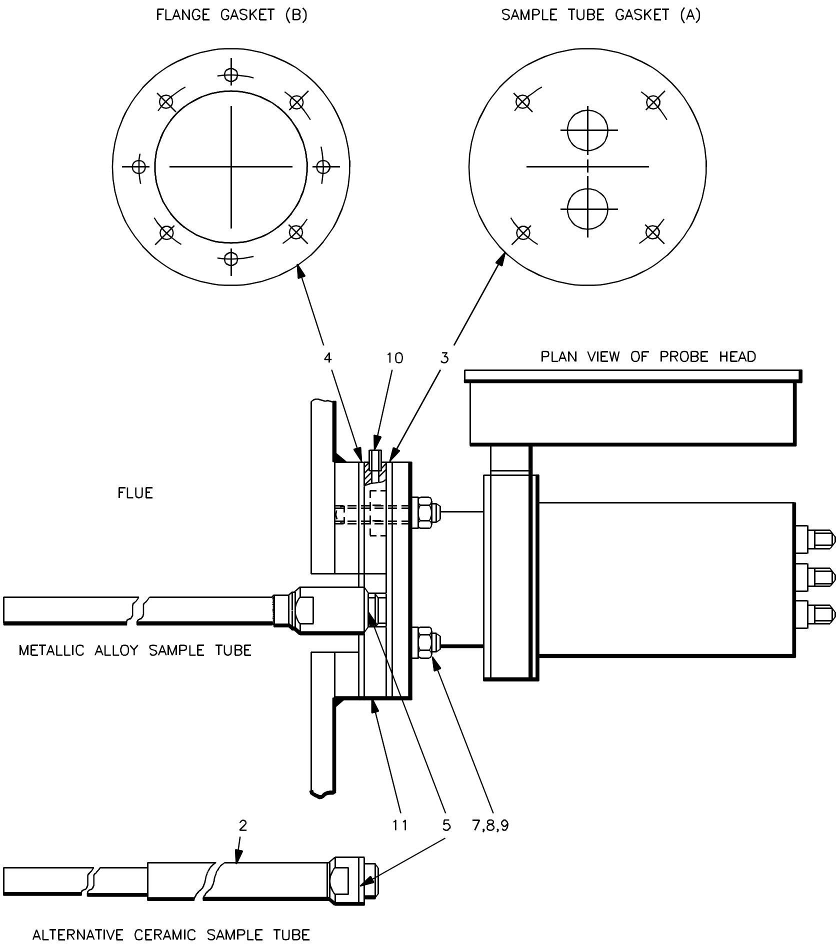


Figure 7.5 High Temperature Probes

7.2 Parts List

7.2.1 Control Unit

Refer to Figure 7.1

Item Number	Description			Part Number
-	*Interface Adaptor Card			S0722901
2	Main Microprocessor Card			S0722902
-	Display Card			00722903
-	*Isolated Output and Alarm Card			00722911
-	*Data Link Card			S0722913
-	*Temperature and Efficiency Card			00722914
-	*Combustibles Card			S0722925
-	*Isolated Oxygen and Combustibles Card			00722921
4	Cell Heater Fuse	2.5A QAHB	F1	2531-2298
5a	240V A.C. Supply Fuse	1.6A TLHBC	F2	2531-2647
5b	110V A.C. Supply Fuse	3.15A TLHBC	F2	2531-2678
6	Solenoid Supply Fuse	500mA QAMB	F3	2531-2212
7	Combustibles Heater Fuse	500mA TLHBC	F5	2531-2591
8	Internal Supply Fuse	1A QAHBC	F6	2531-2243
9	Internal Supply Fuse	1A QAHBC	F7	2531-2243
10	Internal Supply Fuse	2.5A QAHBC	F8	2531-2298
11	Internal Supply Fuse	2.5A QAHBC	F9	2531-2298
12	IC1 - 6802P			2897-5614
13	IC3 - Firmware			00722652F
14	IC6 - 74LS138			2897-8815
15	IC15 - AD581/LH00870			2896-2955
16	IC7 - 2114/314			2898-1024
17	IC9 - 2114/314			2898-1024
18	Transformer			4961-1010
-	Door Key			2531-2798

* - Optional assemblies

7.2.2 Sensor Head

Refer to figure 7.2

Item Number	Description	Part Number
2	Flame Trap	00022907
3	Zirconia O_2 Cell	00703000
4	Flow Sensor	00705000
5	Thermostat Assembly, Over Temp, N/C	00711909
6	Thermostat Assembly, N/O <185^oC	00711925
9	Cover, Terminals	00714528
10	Union Screw (M14 x 1.25)	00714425
11	Union Screw (M12 x 1.25)	00714426
12	Olive, double ended, $^1/_8$"	00714427
13	Connector, In Line	00714428
17	Interconnection PCB	00714901A
18	Cover Assembly	00714932
19	Chest Assembly	00714903
20	Cal Port Assembly	00714930
21	Port Assembly	00714931
22	Tube Assembly, Sample In/Out Cell	00714943
23	Tube Assembly, Ref In/Out tube	00714917
24	Tube, Air Supply	00714500
30	Cable Wrap, Spiral, PTFE	2511-8591
31	Nut, Union, Captive Seal $^1/_2$"	00022413
32	Nut, Blanking, Captive Seal $^1/_2$"	00022414
33	Washer M6	2131-7431
39	Nut M5	2247-8083
40	Screw M6 x 12mm Hex Socket	2259-3724
41	Bolt M6 x 20 Hexagon	2252-3765
45	Screw M5 x 10mm Panhead	2278-3303
47	Seal $^1/_2$" square section	2321-7010
49	Nut, Compression Fitting	00022432
50	Nut Union $^3/_8$"	2354-8051
51	Plug Male $^1/_4$" OD	2354-8448
53	Ferrule $^1/_8$"	2354-8929
54	Ferrule $^1/_4$"	2354-8936
55	Ferrule, Front $^3/_8$"	2344-8254
56	Adaptor $^1/_4$ O.D.x $^1/_8$ APIM	2354-2053
57	Nut, union $^1/_4$"	2354-8044
58	Sleeving, PTFE	1837-6344
59	Gasket solenoid seal	3931-6693
60	Solenoid valve 120V 50/60Hz	2372-8026
61	Filter 15<25 uM	2377-3646
62	Circlip, External	2443-1659
64	Blanking plug+nut+washer M25	2512-8477

Item Number	Description	Part Number
65	Blanking plug+nut+washer M20Insulator,	2512-8484
66	Ceramic bead spacer	2513-8137
69	Washer, cable clamping M4	2515-8324
71	Thermistor	2651-7124
72	Cartridge heater 120V, 150W	2653-1159
76	Insulation liner, cover	3912-7024
77	Insulation, terminal box	3921-7426
78	Gasket PTFE 9.5mm ID	3931-7090
79	Gasket (134OD 90 ID)	3931-6578
80	Gasket (21 OD 13.5ID)	3931-6718
81	Gasket (100 X 25.4)	3931-6592
82	Gasket Terminal Box	3931-6701
83	Gasket (134 OD 103 ID)	3931-6624
84	Thermocouple assembly	3989-0016
87	Blanking plug+nut+washer M16	2512-8491
90	Washer Sealing	2321-8020
100	Plug $^1/_4$ BSPPM	2356-1083
101	Locknut	2356-8820
111	Gasket, PTFE	3931-7083
112	Anti Seize Compound - Polybutylcuprysil	1761-3211
113	Gasket 20 ID	3931-7519
114	Gasket 25 ID	3931-7526
115	Ferrule, Rear, $^3/_8$"	2344-8355
117	Anti Seize Compound - Silver Goop	1765-8032
118	Aspirator Screw	00714553
120	Aspirator Jet	00715415
121	'O'Ring	2323-6019
A**	Tube CO Sensor Blanking	00714463
B*	Nut Union, $^1/_8$"	2354-8099
C*	Combustibles Sensor (VQ11)	00706701
D*	Tube, outlet, detector, $^1/_8$" OD	00714423
E*	Tube, inlet, detector, $^1/_8$" OD	00714424
F*	Tube, restrictor, $^1/_8$ " OD X 64L	00714437
G*	Inlet port, auxiliary air	00714524
H*	Screw M4 x 8 Panhead	2268-2488
I*	Plug male $^1/_8$" OD	2354-8424
J*	Heater, cartridge 120V 12W	2653-1344
K*	Sensor, temperature	2653-4165
L*	Gasket, Insulating	3931-6686

* - Oxygen and combustibles version only

** - Oxygen only version

7.2.3 Sample Probes

Parts list information for standard probes may be found in section 3.9 of this manual.

For information on special probes, please refer to the manual addendum or consult Servomex.

NOTES

Appendices

Appendix 1 . . . . Interconnections - Oxygen Only

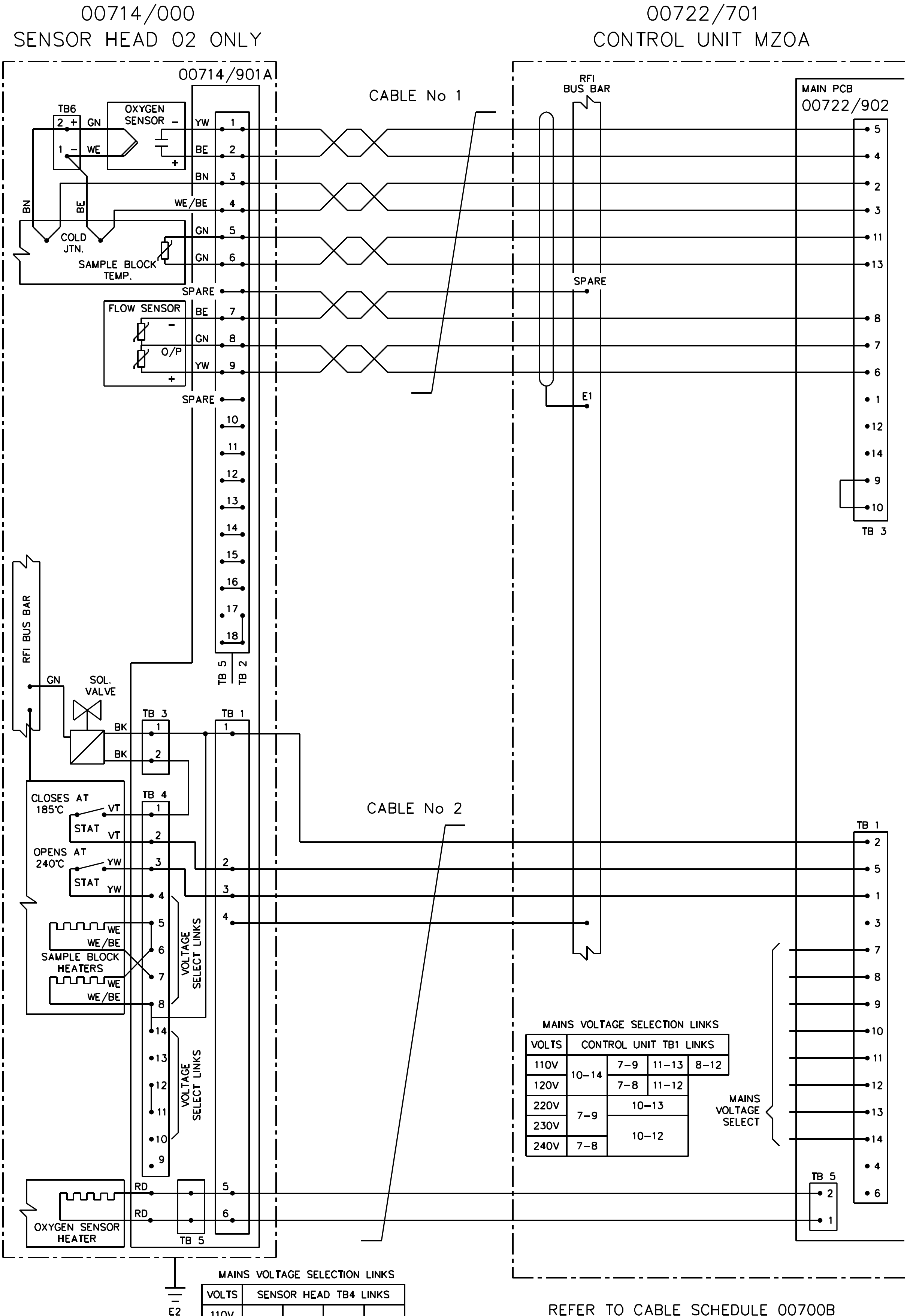
Appendix 2 . . . . Interconnections - Oxygen and Combustibles

Appendix 3 . . . . Cable Schedules

Appendix 4 . . . . Purge Details

NOTES

Appendix 1 Interconnections - Oxygen Only



MAINS VOLTAGE SELECTION LINKS

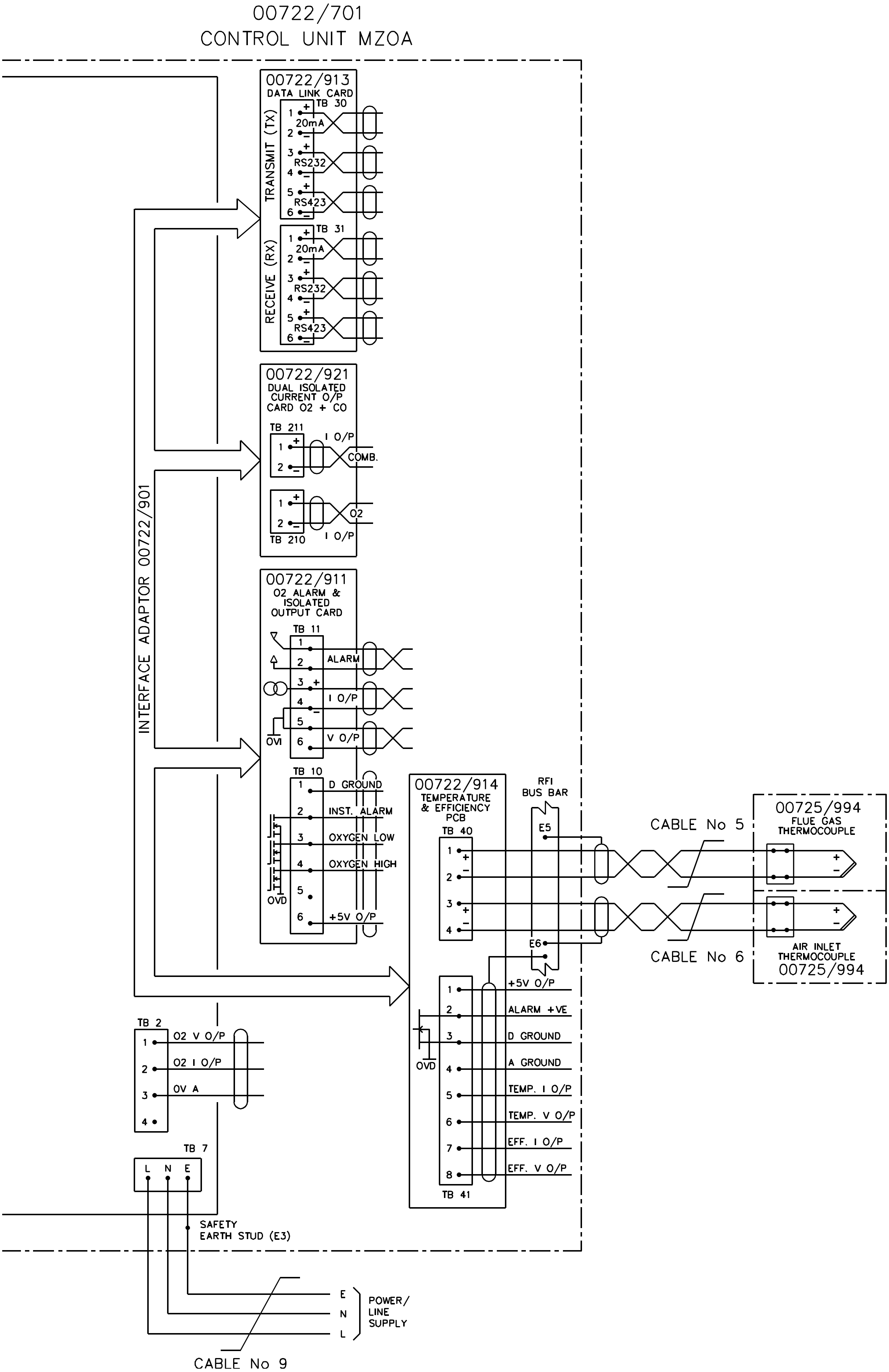
VOLTS	CONTROL UNIT TB1 LINKS			
110V	10–14	7–9	11–13	8–12
120V		7–8	11–12	
220V	7–9	10–13		
230V		10–12		
240V	7–8			

MAINS VOLTAGE SELECTION LINKS

VOLTS	SENSOR HEAD TB4 LINKS			
110V	4–5	7–8	10–11	13–14
120V				
220V	4–7		10–13	
230V				
240V				

REFER TO CABLE SCHEDULE 00700B

Derived from Drawing No 00700/121B Sheet 1



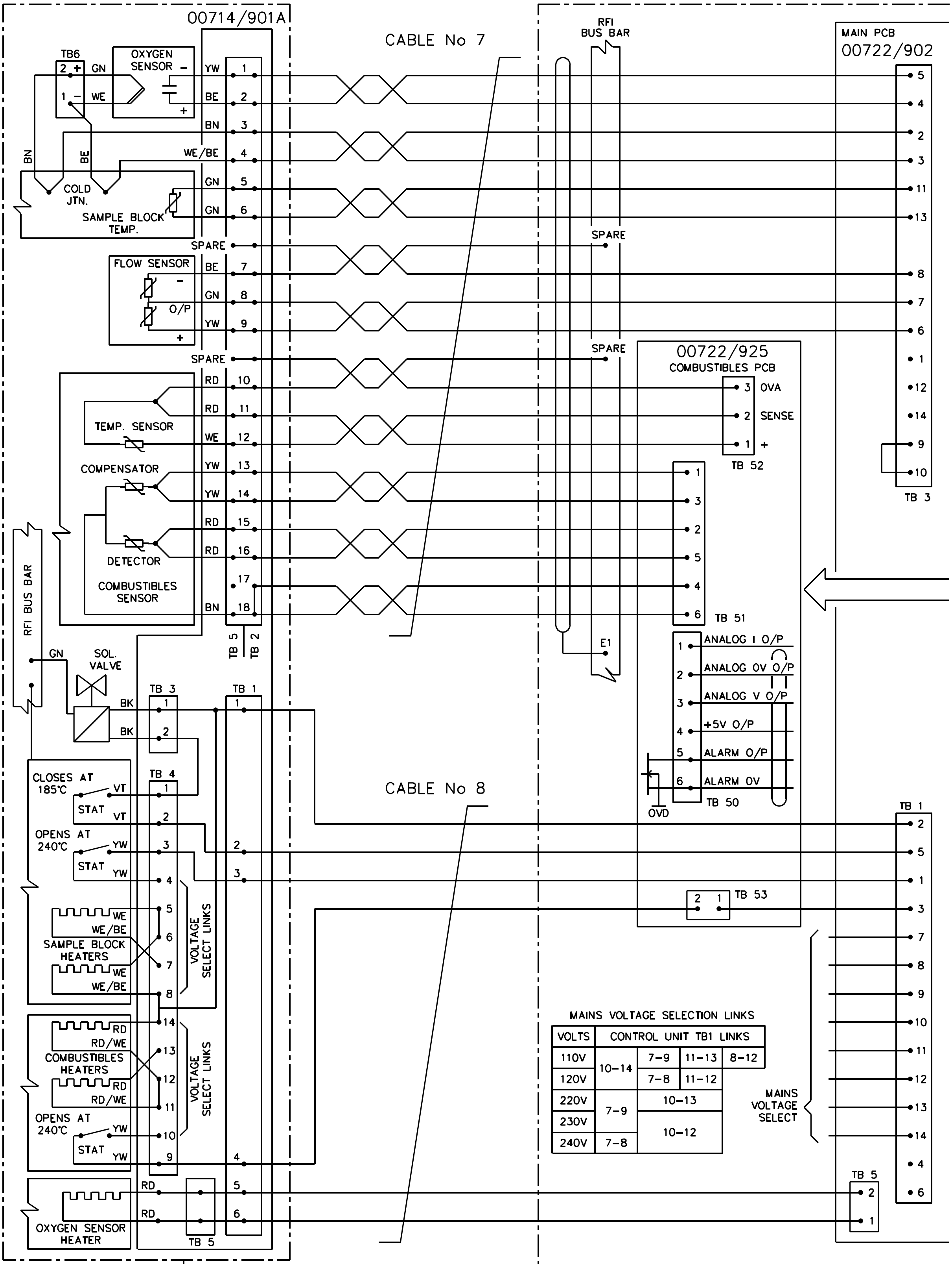
00722/701
CONTROL UNIT MZOA
00722/913
DATA LINK CARD
TB 30
TRANSMIT (TX)
20mA
RS232
RS423
TB 31
RECEIVE (RX)
20mA
RS232
RS423
INTERFACE ADAPTOR 00722/901
00722/921
DUAL ISOLATED
CURRENT O/P
CARD O2 + CO
TB 211
I O/P
COMB.
O2
TB 210
I O/P
00722/911
O2 ALARM &
ISOLATED
OUTPUT CARD
TB 11
ALARM
I O/P
V O/P
OVI
TB 10
D GROUND
INST. ALARM
OXYGEN LOW
OXYGEN HIGH
+5V O/P
OVD
00722/914
TEMPERATURE
& EFFICIENCY
PCB
TB 40
RFI
BUS BAR
E5
E6
CABLE No 5
CABLE No 6
00725/994
FLUE GAS
THERMOCOUPLE
AIR INLET
THERMOCOUPLE
00725/994
+5V O/P
ALARM +VE
D GROUND
A GROUND
TEMP. I O/P
TEMP. V O/P
EFF. I O/P
EFF. V O/P
OVD
TB 41
TB 2
O2 V O/P
O2 I O/P
OV A
TB 7
L N E
SAFETY
EARTH STUD (E3)
E
N
L
POWER/
LINE
SUPPLY
CABLE No 9

NOTES

Appendix 2 Interconnections - Oxygen and Combustibles

00714/701
SENSOR HEAD 02 & CO

00722/701
CONTROL UNIT MZOA



MAINS VOLTAGE SELECTION LINKS

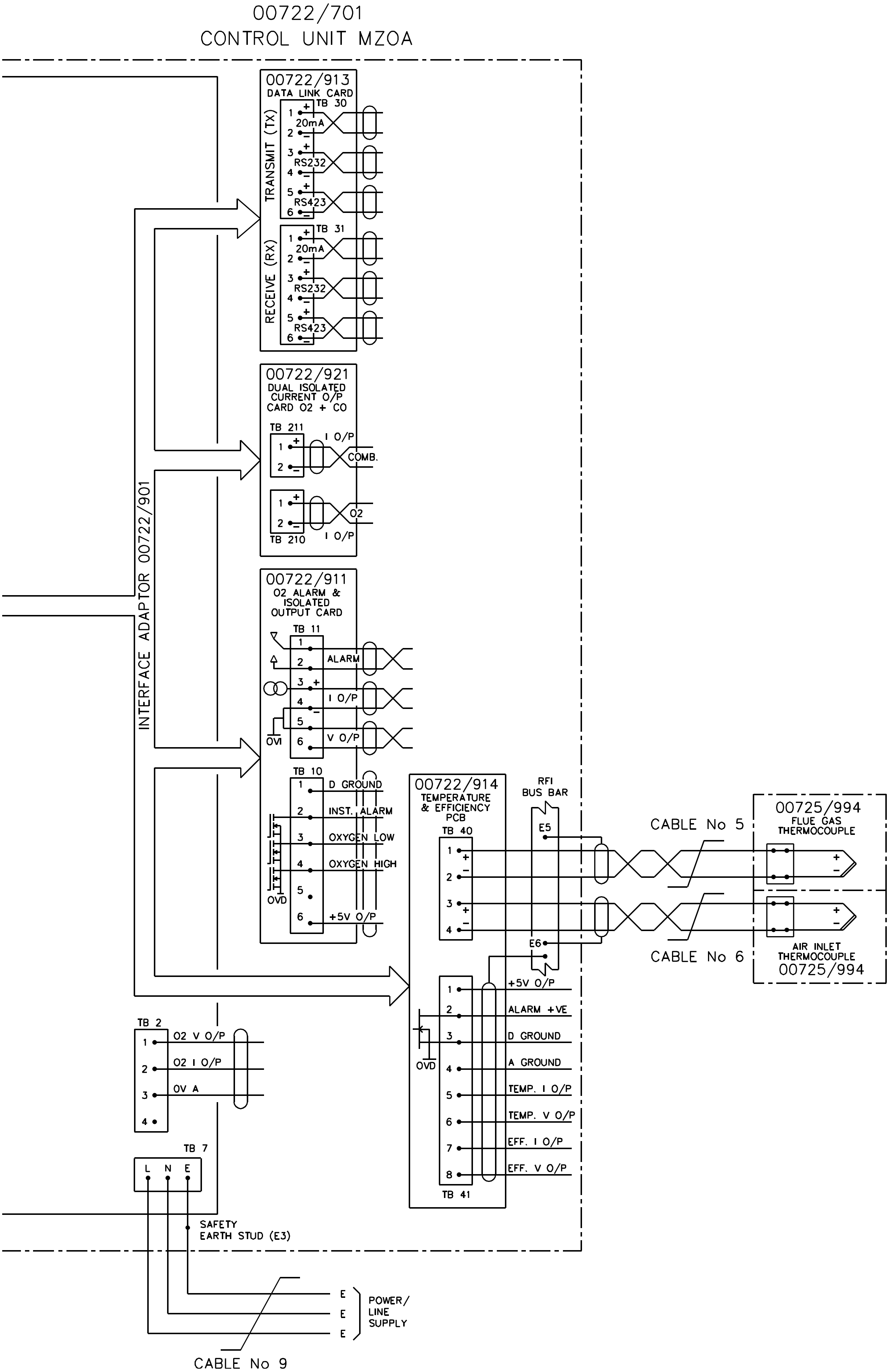
VOLTS	CONTROL UNIT TB1 LINKS			
110V	10–14	7–9	11–13	8–12
120V		7–8	11–12	
220V	7–9	10–13		
230V		10–12		
240V	7–8			

MAINS VOLTAGE SELECTION LINKS

VOLTS	SENSOR HEAD TB4 LINKS			
110V	4–5	7–8	10–11	13–14
120V				
220V	4–7		10–13	
230V				
240V				

REFER TO CABLE SCHEDULE 00700B

Derived from Drawing No 00700/121B Sheet 2


00722/701
CONTROL UNIT MZOA
00722/913
DATA LINK CARD
TB 30
TRANSMIT (TX)
20mA
RS232
RS423
TB 31
RECEIVE (RX)
20mA
RS232
RS423
00722/921
DUAL ISOLATED
CURRENT O/P
CARD O2 + CO
TB 211
I O/P
COMB.
O2
TB 210
I O/P
00722/911
O2 ALARM &
ISOLATED
OUTPUT CARD
TB 11
ALARM
I O/P
V O/P
OVI
TB 10
D GROUND
INST. ALARM
OXYGEN LOW
OXYGEN HIGH
+5V O/P
OVD
INTERFACE ADAPTOR 00722/901
00722/914
TEMPERATURE
& EFFICIENCY
PCB
TB 40
RFI
BUS BAR
E5
E6
CABLE No 5
00725/994
FLUE GAS
THERMOCOUPLE
CABLE No 6
AIR INLET
THERMOCOUPLE
00725/994
+5V O/P
ALARM +VE
D GROUND
A GROUND
TEMP. I O/P
TEMP. V O/P
EFF. I O/P
EFF. V O/P
TB 41
OVD
TB 2
O2 V O/P
O2 I O/P
OV A
TB 7
L N E
SAFETY
EARTH STUD (E3)
POWER/
LINE
SUPPLY
CABLE No 9

NOTES

Appendix 3 Cable Schedules

	CABLE SCHEDULE	SHEET 1 OF 8

Type 00700B Cabling for 714 Sensor Head to 722 Controller O_2 only and O_2 + CO

This Schedule is to be used as an installation and check document and should be witnessed by engineer(s) responsible.
Performance may be degraded if installation practice varies from this schedule.
Refer to Servomex for particular enquiries.

INSTALLATION SUPPLY VOLTAGE___________ VOLTS_______ Hz
1) CHECK THAT INSTRUMENT(S) VOLTAGE TAPPINGS ARE CORRECT
2) CHECK THAT INSTRUMENT(S) ARE FITTED WITH CORRECT FUSES

TOTAL NUMBER OF CABLES = 7

DESCRIPTION	CABLE NO	SHEET NO	INSTALLED	CHECKED
Signals O_2 Only	1	3		
AC Service O_2 Only	2	4		
Temp T/C Flue Gas	5	5		
Temp T/C Inlet	6	5		
Signals O_2 + CO	7	6		
AC Service O_2 + CO	8	7		
AC Mains Supply	9	8		

TOTAL NUMBER OF EARTHS/SCREENS = 5

EARTH NO	SHEET NO	INSTALLED	CHECKED
E1	3, 6		
E2	4, 7		
E3	8		
E5	5		
E6	5		

EACH CORE SHOULD BE UNIQUELY IDENTIFIED, EITHER BY COLOUR OR BY NUMBER FERRULE. THIS IDENT TO BE ENTERED IN APPROPRIATE BOX IN SCHEDULE

98P060	6/98	All	M.L.	RAH	RAH						
Change Note No	Date	Sheets Affected	Chg. by	Ckd.	Appd	Change Note No	Date	Sheets Affected	Chg. by	Ckd.	Appd

Drawn M.L.	Date 06/98	Checked RAH	Approved RAH
SERVOMEX	No CS 00700B	Issue 6	Sheet 1

Notes:

1) Sleeve the screen drain wire and connect to RFI Earth Bus Bar in 00722 Controller. Cut back and insulate free end of screen.

2) The remote keypad adaptor card should be installed in slot PL1 of the interface adaptor card. Use upper slot PL2 when other options are fitted. This alleviates the possibility of the interconnecting cable chafing against the underside of another option card.

3) The flying lead from remote interface PCB 00725918 TB82-13 is to be connected to the RFI Bus Bar in the 00722 Controller.

4) Connect "Spare" signal conductors into terminals TB2 spare in the 714 Sensor Head.

5) Connect "Spare" conductors into RFI Bus Bar in 00722 Controller.

6) Both 714 Sensor Head and 00722 Controller are provided with safety earth studs which require local earth bonding.

7) Cut back and insulate free end of screen.

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 05/93	Date 20.08.98	Date 20.08.98		Sheet 2

SERVOMEX	CABLE SCHEDULE	Sheet 3 of 8
CABLE DESCRIPTION	Cable Function	Cable No 1

No of Cores	10	Conductor Insulation	PVC	Signals for O_2 only Sensor Head Nominal O/D - 13mm Cable Glands 2 off 2512-1647
Twisted Pairs	5	Outer Sheath	PVC	
Indiv. Screen	N	Special Cable See Note on Sheet 2	___	
O/All Screen	Y			Maximum Loop Resistance 36 ohms

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
0.5 (16/0.2)	529	1566-8633

TERMINATION 'A' 00714 Sensor Head PCB 00714901A	Conductor	Ident	TERMINATION 'B' 722 Controller PCB 00722902
TB2-1	1	TWISTED PAIR	TB3-5
TB2-2	2		TB3-4
TB2-3	3	TWISTED PAIR	TB3-2
TB2-4	4		TB3-3
TB2-5	5	TWISTED PAIR	TB3-11
TB2-6	6		TB3-13
TB2-7	7	TWISTED PAIR	TB3-8
TB2-SPARE See Note 4	8		EARTH BUS BAR See Note 5
TB2-8	9	TWISTED PAIR	TB3-7
TB2-9	10		TB3-6
NONE See Note 1 Sheet 2	11	SCREEN "E1"	RFI BUS BAR See Note 1
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 06/98	Date 20.08.98	Date 20.08.98		Sheet 3

SERVOMEX	CABLE SCHEDULE	Sheet 4 of 8

CABLE DESCRIPTION				Cable Function	Cable No 2
No of Cores	6	Conductor Insulation	PVC	AC Service for O_2 Only Sensor Head	

<table>
<tr><td>Twisted Pairs</td><td>---</td><td>Outer Sheath</td><td>PVC</td><td colspan="2"></td></tr>
<tr><td>Indiv. Screen</td><td>N</td><td rowspan="2">Special Cable
See Note on Sheet 2</td><td rowspan="2">___</td><td colspan="2"></td></tr>
<tr><td>O/All Screen</td><td>N</td><td colspan="2">Maximum Loop Resistance <4 ohms</td></tr>
</table>

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
1.0 (32/0.2)	112	1566-8431
1.5 (30/0.25)	176	1566-8448
2.5 (50/0.25)	285	1566-8455

TERMINATION 'A' 714 Sensor Head PCB 00714901A	Conductor	Ident	TERMINATION 'B' 722 Controller PCB 00722902
TB1-1	1		TB1-2
TB1-2	2		TB1-5
TB1-3	3		TB1-1
TB1-4	4		RFI BUS BAR See Note 5
TB1-5	5		TB5-2
TB1-6	6		TB5-1
EXTERNAL SAFETY EARTH STUD	7	"E2" See Note 6	
	8		
	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		

<table>
<tr><td>Drawn M.L.</td><td>Checked RAH</td><td>Approved RAH</td><td rowspan="2">No CS 00700B</td><td>Issue 6</td></tr>
<tr><td>Date 06/98</td><td>Date 20.08.98</td><td>Date 20.08.98</td><td>Sheet 4</td></tr>
</table>

SERVOMEX	CABLE SCHEDULE	Sheet 5 of 8

CABLE DESCRIPTION				Cable Function	Cable No 5 & 6
No of Cores	2	Conductor Insulation	PVC	Temperature and Efficiency Thermocouple Cables	
Twisted Pairs	1	Outer Sheath	PVC		
Indiv. Screen	N	Special Cable See Note on Sheet 2	---		
O/All Screen	Y			Maximum Loop Resistance --- ohms	

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
0.8 (1/0.8)	N/A	1582-0998

TERMINATION 'A' Temperature & Efficiency PCB 00722914 - TB40	CABLE 5 Flue Gas Thermocouple Conductor	Ident	TERMINATION 'B' Flue Gas Thermocouple 00725994
TB40-1-BROWN	1	T/C CABLE	BROWN
TB40-2-BLUE	2	T/C CABLE	BLUE
RFI BUS BAR See Note 1 Sheet 2	3	SCREEN "E5"	NONE, See Note 1 Sheet 2
	4		
	5		
	6		
	7		
	8		
	9		
	10		

TERMINATION 'A' Temperature & Efficiency PCB 00722914 - TB40	CABLE 6 Air Inlet Thermocouple Conductor	Ident	TERMINATION 'B' Inlet Thermocouple (if fitted) 00725994
TB40-3-BROWN	1	T/C CABLE	BROWN
TB40-4-BLUE	2	T/C CABLE	BLUE
RFI BUS BAR See Note 1 Sheet 2	3	SCREEN "E6"	NONE, See Note 1 Sheet 2
	4		
	5		
	6		
	7		
	8		
	9		
	10		

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 06/98	Date 20.08.98	Date 20.08.98		Sheet 5

SERVOMEX	CABLE SCHEDULE	Sheet 6 of 8

CABLE DESCRIPTION				Cable Function	Cable No 7
No of Cores	20	Conductor Insulation	PVC	Signal Cable for O_2 + CO Sensor Head	
Twisted Pairs	10	Outer Sheath	PVC		
Indiv. Screen	N	Special Cable See Note on Sheet 2	___		
O/All Screen	Y			Maximum Loop Resistance <6.0 ohms	

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
0.5 (16/0.2)	100	1566-8657
1.0	200	----
1.5	300	----

TERMINATION 'A' 714 Sensor Head PCB 00714901A	Conductor	Ident	TERMINATION 'B' 722 Controller
TB2-1	1	TWISTED PAIR	PCB 00722902 TB3-5
TB2-2	2		PCB 00722902 TB3-4
TB2-3	3	TWISTED PAIR	PCB 00722902 TB3-2
TB2-4	4		PCB 00722902 TB3-3
TB2-5	5	TWISTED PAIR	PCB 00722902 TB3-11
TB2-6	6		PCB 00722902 TB3-13
TB2-7	7	TWISTED PAIR	PCB 00722902 TB3-8
SPARE See Note 4	8		RFI BUS BAR See Note 5
TB2-8	9	TWISTED PAIR	PCB 00722902 TB3-7
TB2-9	10		PCB 00722902 TB3-6
TB2-10	11	TWISTED PAIR	PCB 00722925 TB52-3
SPARE See Note 4	12		RFI BUS BAR See Note 5
TB2-11	13	TWISTED PAIR	PCB 00722925 TB52-2
TB2-12	14		PCB 00722925 TB52-1
TB2-13	15	TWISTED PAIR	PCB 00722925 TB51-1
TB2-14	16		PCB 00722925 TB51-3
TB2-15	17	TWISTED PAIR	PCB 00722925 TB51-2
TB2-16	18		PCB 00722925 TB51-5
TB2-17	19	TWISTED PAIR	PCB 00722925 TB51-4
TB2-18	20		PCB 00722925 TB51-6
NONE See Note 1 Sheet 2	21	SCREEN "E1"	RFI EARTH BUS BAR
	22		See Note 1 Sheet 2
	23		
	24		

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 06/98	Date 20.08.98	Date 20.08.98		Sheet 6

SERVOMEX	CABLE SCHEDULE	Sheet 7 of 8

CABLE DESCRIPTION				Cable Function	Cable No 8
No of Cores	6	Conductor Insulation	PVC	AC Service for O_2 + CO Sensor Head	
Twisted Pairs	---	Outer Sheath	PVC		
Indiv. Screen	N	Special Cable See Note on Sheet 2	___		
O/All Screen	N			Maximum Loop Resistance <4 ohms	

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
1.0 (32/0.2)	112	1566-8431
1.5	176	---
2.5	285	---

TERMINATION 'A' 714 Sensor Head PCB 00714901A	Conductor	Ident	TERMINATION 'B' 722 Controller
TB1-1	1		PCB 00722902 TB1-2
TB1-2	2		PCB 00722902 TB1-5
TB1-3	3		PCB 00722902 TB1-1
TB1-4	4		PCB 00722925 TB53-2
TB1-5	5		PCB 00722902 TB5-2
TB1-6	6		PCB 00922902 TB5-1
EXTERNAL SAFETY EARTH STUD	7	"E2" SEE NOTE 6	
	8		
	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 06/98	Date 20.08.98	Date 20.08.98		Sheet 7

SERVOMEX	CABLE SCHEDULE	Sheet 8 of 8

CABLE DESCRIPTION				Cable Function	Cable No 9
No of Cores	3	Conductor Insulation	PVC	AC Mains Supply Nominal O/D 6.5mm Cable Glands 2 off 2512-1685	
Twisted Pairs	---	Outer Sheath	PVC		
Indiv. Screen	N	Special Cable See Note on Sheet 2	___		
O/All Screen	N			Maximum Loop Resistance --- ohms	

Conductor Cross Section (mm^2)	Maximum Separation (metres)	Servomex Part Number
1.0 (32/0.2)	23 @ 110 VAC	1566-8215
1.0 (32/0.2)	55 @ 240 VAC	1566-8215

TERMINATION 'A' AC Mains Supply	Conductor	Ident	TERMINATION 'B' 722 Controller PCB 00722902
LIVE	1		TB7-"L"
NEUTRAL	2		TB7-"N"
EARTH	3	"E3"	SAFETY EARTH STUD
	4		See Note 6
	5		
	6		
	7		
	8		
	9		
	10		
	11		
	12		
	13		
	14		
	15		
	16		
	17		
	18		
	19		
	20		
	21		
	22		
	23		
	24		

Drawn M.L.	Checked RAH	Approved RAH	No CS 00700B	Issue 6
Date 06/98	Date 20.08.98	Date 20.08.98		Sheet 8

NOTES

Appendix 4 Purge Details

CONTENTS

Section **Page**

A4.1 General A4.2

A4.2 Requirements A4.2

Appendix 4 : Sensor Head Purge Systems

A4.1 General

The sensor head must be purged to meet hazardous area requirements.

A4.2 Requirements

The 700B series sensor heads have a purge inlet, purge outlet and a pressure sense port (see figure 6.2). The pressure sense port is a requirement for sensing the over pressure when using a pneumatic purge control unit.

When Servomex have not supplied the protection system, it is the users responsibility to install a suitable purge system to meet local and national regulations. These may require certification/approval.

The following information is provided as a guide to enable such a system to be designed :

General Data	700B
Sensor head internal volume	$4dm^3$
Minimum pressure	100Pa
Maximum pressure	5kPa
Purge gas	Air or any inert gas
Initial purge gas (5 volumes)	$20dm^3$
Leakage compensation flow rate	200ml/min (max)

The T rating is governed by the hottest exposed surface under worst case conditions (ie. hottest flue skin and hottest ambient) and has to be established with the temperature controller working on the overtemperature thermostat.

Flame traps must be fitted to any port that needs to be opened, or is open, under normal operation ie. the calibration port. Air supply ports need not be protected as they are permanently connected, however, high integrity piping and couplings should be employed.

Warnings

1. **Equipment must not be opened in the presence of an explosive atmosphere**

2. **Air supply couplings must not be removed in the presence of an explosive atmosphere as there is danger of ignition via the flue.**