SERVOTOUGH OxyExact 2200 Series

SERVICE MANUAL

Part Number: **02200002A**
Revision: **15**
Language: **UK English**

SERVOMEX.COM

SERVOMEX a spectris company

This page intentionally blank

Table of Contents

This page deliberately left blank

List of Figures

List of Tables

This page deliberately left blank

1 INTRODUCTION

1.1 Warnings, Cautions and Notes

This manual includes **WARNINGS**, **CAUTIONS** and **NOTES** which provide information relating to the following

WARNINGS

Hazards which could result in personal injury or death.

CAUTIONS

Hazards which could result in equipment or property damage.

NOTES

Alert the user to pertinent facts and conditions.

1.1.1 Service warnings

WARNING

Electrical safety

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

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

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

Gas hazards

The transmitter may contain toxic, corrosive, oxygen enriched, flammable or asphyxiant gases. It may be necessary to flush the analyser pipe work with a clean dry ‘safe’ gas (typically air) before commencing work.

Gas cylinders represent a danger to personnel due to their weight and the high pressure gas they contain. Gas cylinders must only be handled by competent personnel who are familiar with the hazards involved.

CAUTION

Explosion proof equipment

The area must be made safe and shown not to contain explosive or flammable gases before covers are opened or work done on the analyser system.

Any spare parts used must be as specified by Servomex. Replacement with non-approved parts will invalidate any safety certification.

1.2 Scope of this manual

This manual is intended for use by Servomex trained service personnel. The manual contains technical descriptions, fault diagnosis information, parts removal, refitting and test instructions associated with 2210/2220 series products.

Contacts for technical assistance and spares are given at the back of this manual.

Installation and operating instructions for the transmitter unit and control unit are given in the following manuals:

	English	French	German
Installation manual, Transmitter Unit model 2222 (High Temperature)	02222/005A	02222/015A	02222/025A
Installation manual, Transmitter Unit model 2223	02223/005A	02223/015A	02223/025A
Installation manual, Control Unit model 2210 (Zone 2/Div 2)	02210/005A	02210/015A	02210/025A
Installation manual, Control Unit model 2213 (Zone 1/Div 1)	02213/005A	02213/015A	02213/025A
Operations manual, model 2200 gas analyser system	02210/001A	02210/011A	02210/021A

A Certification supplement is available, in English only, (part number 02200008A).

This service manual (part number 02200002A) is only available in English.

About this manual

Ref:02200/002A/15, Order as part no. 02200002A

1.3 Service philosophy

> **WARNING**
>
> All servicing should be referred to qualified personnel.

Repairs to printed circuit boards are affected by module replacement. Component replacement is not recommended. The only exceptions to this are the mains fuses in the control unit and transmitter.

1.4 Overview of this manual

This manual is intended for operatives who are familiar with fault finding and servicing of instrumentation systems. This manual does not include all the information needed for a person unfamiliar with good instrumentation practice to safely and efficiently service the analyser system.

Section 2	Analyser system overview and paramagnetic measuring principle.
Section 3	Potential reasons for analyser instability and possible causes.
Section 4	Sample conditioning system maintenance; setting pressure, flow, sample and calibration gases.
Section 5	Description of the electronic system.
Section 6	Initial trouble shooting of the analyser system; calibration history and internal diagnostic features.
Section 7	Hardware diagnostics.
Section 8	Transmitter unit servicing; changing the measuring cell and associated items.
Section 9	Control unit servicing; installing option boards and servicing the power supply unit.
Section 10	Servicing check list.
Section 11	Recommended spare parts.

1.5 Tools required

A standard tool kit for maintenance of instrumentation systems is required. A voltmeter may be needed for some fault finding activities.

Metric sized threads are used throughout. Metric sized spanners, wrenches and Allen keys are required.

A means of supplying and controlling calibration gases.

Whilst the control unit menu tree is held in Appendix A, having access to a copy of the relevant installation manual and operators manual is recommended.

1.6 Shutdown procedure

The sample conditioning system and analyser should be flushed with clean, dry gas before disconnecting electrical power. This will reduce the possibility of condensation and subsequent corrosion of the measuring cell.

Any sources of possibly toxic or suffocating sample gases must be isolated.

Before servicing the analyser system all sources of electrical power, including those to relay contacts or other inputs/outputs, must be disconnected.

NOTE

When power is disconnected from a transmitter, all software parameters will be retained.

When power is disconnected from a control unit, all software parameters will be retained, however, the real time clock settings will only be retained for typically 14 days. If the clock settings are lost the ‘day/time not set’ status alarm will go active at the next power-up.

If option boards are removed from a control unit, and not replaced before power is re-applied, any configuration of the options will be deleted. Appendix B contains forms that may be used to document customer configuration of option boards prior to servicing the unit.

2 SYSTEM OVERVIEW

2.1 The 2200 analyser system

The Servomex 2200 system consists of a model 2210 or model 2213 Control Unit and one or more model 2222 and/or 2223 transmitter units. The units can be located on up to 1km of cable (total cable length).

The transmitters operate as 'stand alone' entities – they will continue to function even when power is removed from the control unit.

A single control unit can be connected to one or more transmitter units using a two-wire semi-duplex connection. The configurations possible are shown in Figure 1.

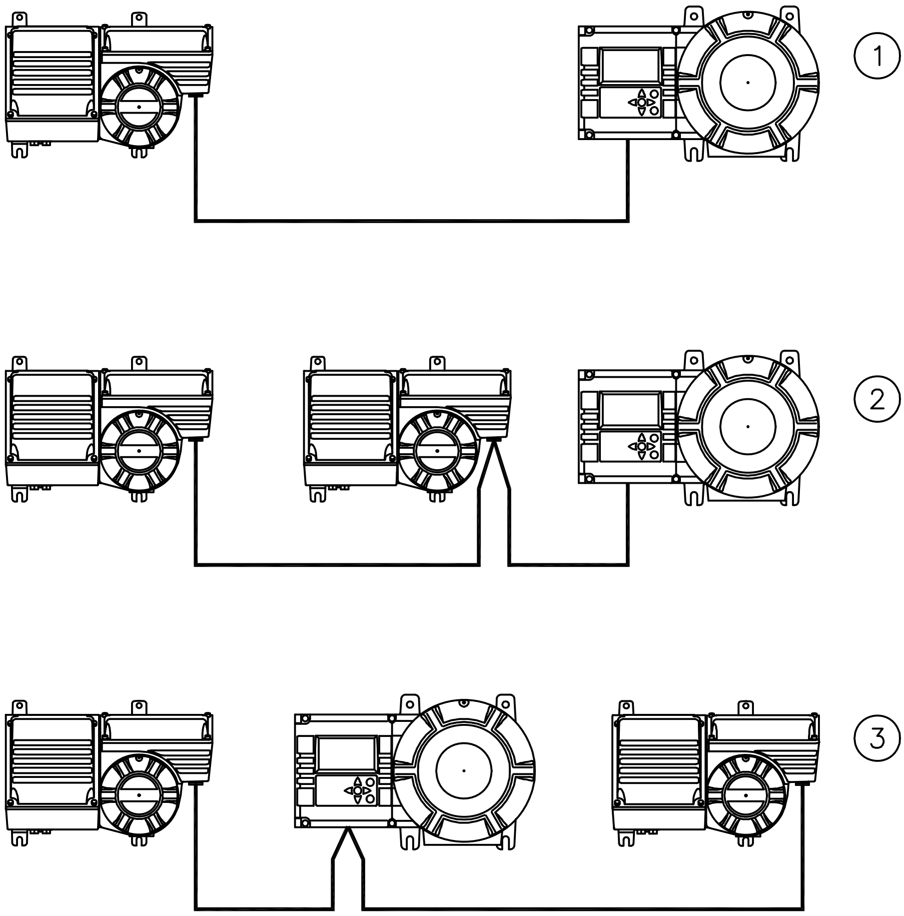


Figure 1 Analyser system configurations

Key to Figure 1

1 - Control unit connected to a single transmitter unit
2 - Multiple transmitter units with the control unit terminating the connecting cable
3 - Multiple transmitter units with the transmitter units terminating the connecting cable

Options enable the 2200 analyser system to be configured with a range of analog outputs representing primarily oxygen concentration for each sample point, from both the individual transmitter units and the control unit. These outputs are freely programmable to any span and offset.

Alarms include sample gas concentration and comprehensive diagnostics and status outputs. A digital output (MODBUS) is also available.

Comprehensive approvals for use in areas made hazardous by the presence of flammable gases enable the analyser system to be installed in refineries, petrochemicals works and similar plants. These approvals include use with flammable sample gases.

2.1.1 The control unit

The control unit is primarily the user interface, however, it also supports autocalibration when required.

Depending on options fitted the control unit provides the following connections:

- Two-wire communications to transmitters
- Digital communications port (MODBUS)
- 0/4-20mA output signals for gas concentration
- Relays for fault status, alarms or calibration
- Digital input signals for the status of associated external devices or initiating specific functions

The control unit requires connection to the electrical supply independent of a transmitter unit.

Control unit option cards:

The control unit may be supplied with either MODBUS® serial RS 485 or MODBUS® TCP Ethernet fitted . Other signal outputs and inputs are available using the following options:

Analog output board

- Two 0/4-20mA outputs
- Two low voltage relays with changeover contacts

Relay board

- Four relays with changeover contacts

Digital input board

- Eight digital inputs

Up to four boards in any combination can be fitted to the control unit.

All outputs and inputs are software configurable.

2.1.2 The transmitter unit

The transmitter unit contains the oxygen measuring cell in a temperature controlled enclosure and provides the following intrinsically safe connections:

one	0/4-20mA output signal for oxygen concentration
three	relays for fault status according to NAMUR recommendation NA64
two	0/4-20mA inputs for external signals such as sample pressure or cross-sensitivity correction
four	digital input signals for the status of associated external devices or initiating specific functions
two	connection pairs for external flow alarm devices

The transmitter requires connection to the electrical supply independent of a control unit.

The transmitter unit uses the Servomex paramagnetic torque balance measuring cell which provides fast, accurate measurements of oxygen. The measuring cell in the transmitter unit incorporates the many years of Servomex's experience in applying this technique on arduous applications.

2.1.3 Paramagnetic susceptibility of O_2

Oxygen is strongly attracted into a magnetic field whilst most others gases are slightly repelled. The paramagnetic susceptibility of gaseous oxygen is significantly greater than that of other common gases, for example on a scale of 0 to 100, where vacuum is 0 and pure oxygen is 100, nitrogen is -0.39 and carbon dioxide is -0.69.

This property is used in the Servomex measuring cell which is purely physical in measurement. As there are no chemicals, regular servicing or replacement are not required in normal use.

The measuring cell comprises a sample chamber in which two nitrogen filled glass spheres are mounted on a wire suspension. A mirror is mounted centrally on the suspension. Light is focussed onto the mirror and the reflected light is directed onto a pair of photocells.

The arrangement is shown in Figure 2.

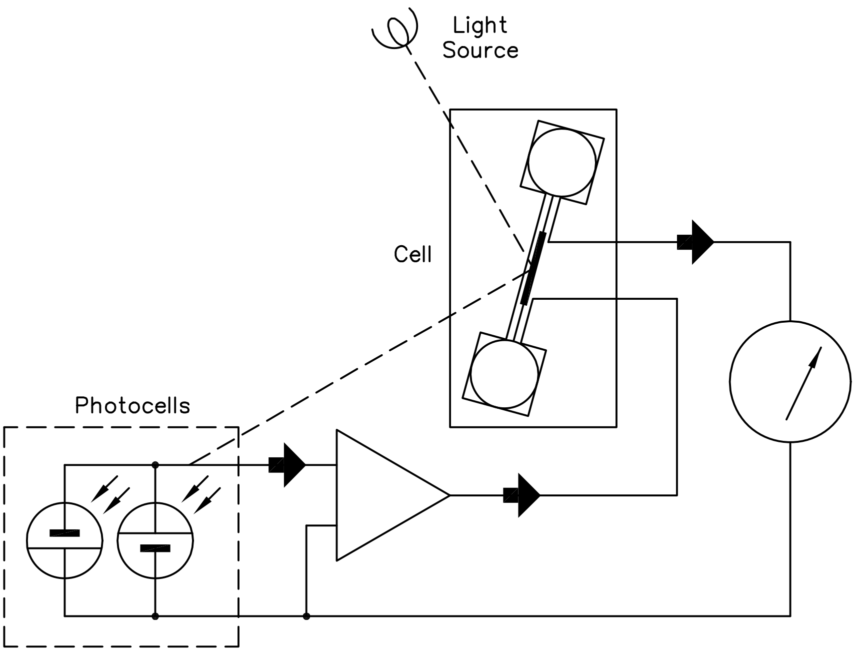


Figure 2 Measuring schematic

The measuring cell is sited in a focussed, non-linear, magnetic field. Any oxygen present will be attracted into the strongest part of the magnetic field. This displaces the nitrogen spheres and causes the suspension to rotate through a small angle.

The photocells (initially equally illuminated) will detect the movement and generate a signal difference as the photocells are now illuminated differently.

The signal generated by the photocells is passed to a feedback system. The feedback system generates a current that is sent through the wire suspension.

This causes a motor effect which returns the suspension to its original position.

The current flowing around the wire is directly proportional (i.e. inherently linear) to the concentration of oxygen within the gas mixture, and it is the feedback current that is the basis of the analyser oxygen reading.

3 FACTORS AFFECTING THE MEASUREMENT

NOTE

The paramagnetic measuring principle used in the transmitter is normally a very stable technique. It is also a highly sensitive measurement and may reveal errors in the complete measuring system **which are not faults in the gas analyser.**

This section provides some information on identifying and isolating the possible causes of errors and it is recommended that this section is read **before** performing any maintenance on the analyser system.

3.1 Factors that influence the paramagnetic technique

An understanding of the influence that various external factors can have on the measurement will enable the performance of the system to be reviewed.

3.1.1 Temperature effects

When gases are heated they expand. Fewer molecules occupy a given volume, so magnetic susceptibility changes with temperature. The analyser will actually give a lower reading when the measuring cell temperature is higher.

To minimise the effects of changes in ambient temperature, the measuring cell in the transmitter unit is controlled. In a type 2223 transmitter this is at a nominal 60°C, for the 2222 transmitter, the temperature may be factory set at temperatures up to 135°C.

The unit is designed to operate over a specified ambient temperature range. Ambient temperatures outside this range will impair the temperature control of the measuring cell and in extreme cases the control will not function.

Rapid changes in ambient temperatures may cause some instability before the temperature control can re-adjust. Such rapid changes may occur if the transmitter unit has been located close to sources of heat or cooling.

Note that the temperature of the transmitter unit may be different from the ambient air temperature due to incident sunlight or wind chill.

3.1.2 Pressure effects

When gases are compressed there are more molecules in a given volume.

The analyser will give a higher reading when the measuring cell pressure is higher. The reading is directly proportional to pressure.

In normal operation it is recommended that the measuring cell is vented to atmosphere. The pressure in the measuring cell will be atmospheric pressure.

Atmospheric pressure varies according to meteorological conditions. The range depends upon geographical location but in temperate regions is generally between 950 and 1040mBar (at sea level). A change in atmospheric pressure of 10mBar will change the oxygen reading by approximately 1% (of reading).

Pressure compensation or regular ‘span’ calibration will remove this effect.

If the measuring cell is not vented directly to atmosphere but to a vent header, the pressure in the measuring cell may vary due to external factors, i.e. changes in vent header pressure will change the pressure in the measuring cell.

> **NOTE**
>
> Significant pressure changes will also affect a nitrogen ‘zero’ point.

3.1.3 Pressure compensation

The 2223 transmitter may be fitted with pressure compensation which monitors the pressure in the measuring cell and corrects the oxygen reading. This is usually only required for applications requiring high accuracy and stability when measuring higher concentrations.

> **NOTE**
>
> Internal pressure compensation should be calibrated on a gas equivalent to the typical sample concentration.

3.1.4 Gas flow rate

The flow rate of the sample gas through the measuring cell usually only has a small effect on the reading. However, it may lead to a variation in the back-pressure on the cell.

Any vent pipework should be of adequate dimensions to ensure that there is a minimum back-pressure on the measuring cell.

The flow rate through the cell should be kept constant, and the flow rate for the calibrating gases should be the same as the flow rate for the sample gas.

> **NOTE**
>
> Different gases have different viscosities and densities. This may affect flowmeter readings and the flow effect of the measuring cell.

3.1.5 Effect of background gases

A variation in background gas concentration of the sample gas can affect the oxygen reading; see Appendix A in the operator manual.

3.1.6 The use of sample pumps

The measuring cell has an inherently fast response time. A pump may produce pressure pulses which may be detected as a change in oxygen value. In extreme cases this may cause instability.

Any pumps should be installed correctly and be of adequate size, with pressure and flow control. If pressure pulsing is suspected the installation of a ballast volume (accumulator) should be considered.

A pump or other means of drawing the sample gas through the measuring cell should not preferably be placed after the cell. This may result in an unpredictable pressure in the measuring cell.

3.2 Investigating analog output trends

A significant level of investigation may be conducted by reviewing the analog output from a functioning analyser. The following subsections detail a number of output trends and potential causes.

During the warm-up period some change in the output is both normal and expected. The analyser system should not be calibrated or used for making measurements until the measuring cell has stabilised at operating temperature. This can take up to 12 hours.

It is assumed the analyser has been calibrated under stable conditions – i.e. the measuring cell is at operating temperature and the sample flowrate and pressure are controlled.

Note: In the figures below the effects are exaggerated for clarity.

3.2.1 Noise

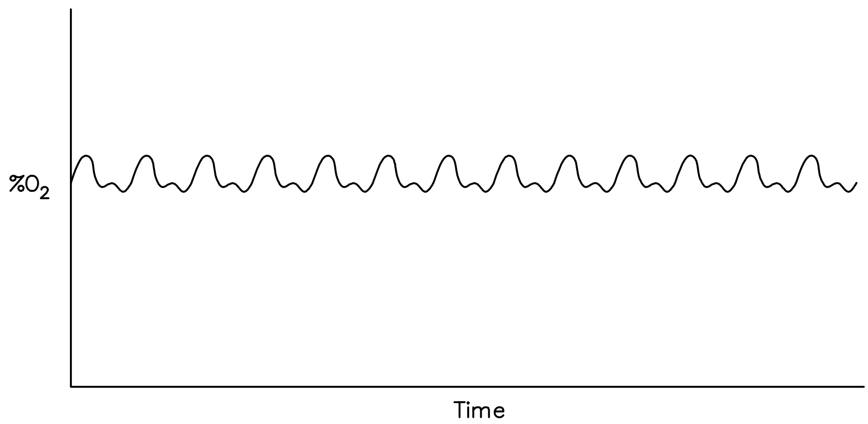


Figure 3 Analog output noise

Analog output is characterised by a noisy signal, but the average value is constant. Frequency and amplitude is variable. Such a signal may be the result of sample flow and/or pressure fluctuations.

Recommendation – Turn the sample gas off. If the noise is no longer present investigate the sample system.

The unit may also run on calibration gases under controlled conditions, with no pumps or vent restrictions. Noise whilst operating on zero gas implies degradation of the measuring cell or components of the optical feedback circuit.

If there is no noise whilst operating on the zero gas, the problem is unlikely to be inside the transmitter.

3.2.2 Spikes

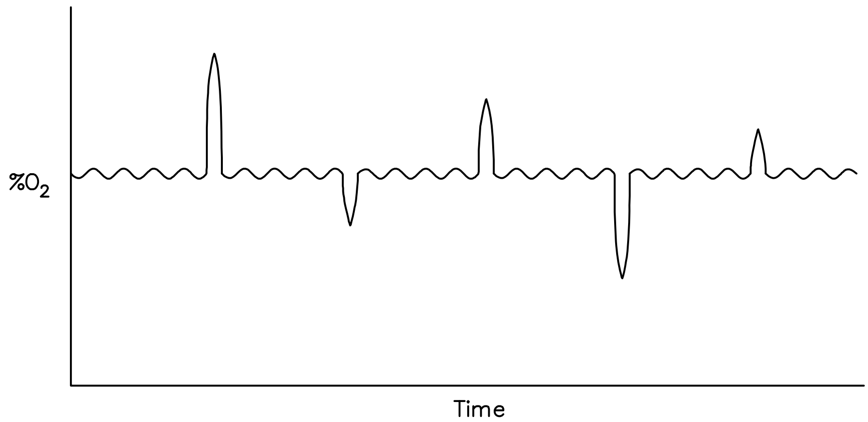


Figure 4 Analog output spikes

A spike is typified by a momentary excursion (either positive or negative) after which the reading returns to baseline.

If frequent and the spike exists for a few seconds it may be a real change in the sample gas. Pressure pulses for example may lead to the above effect.

If infrequent and the spike exists for less than a second the most likely cause historically has been due to electrical interference (EMC) on the installation – not just the cable connecting the analog output to the recording device. The installation EMC protection should be investigated.

The 2200 allows analog outputs to be taken from both the transmitter and the control unit – if acceptable (check hazardous area implications) it may be possible to compare outputs from either end of the system.

3.2.3 Ambient effects

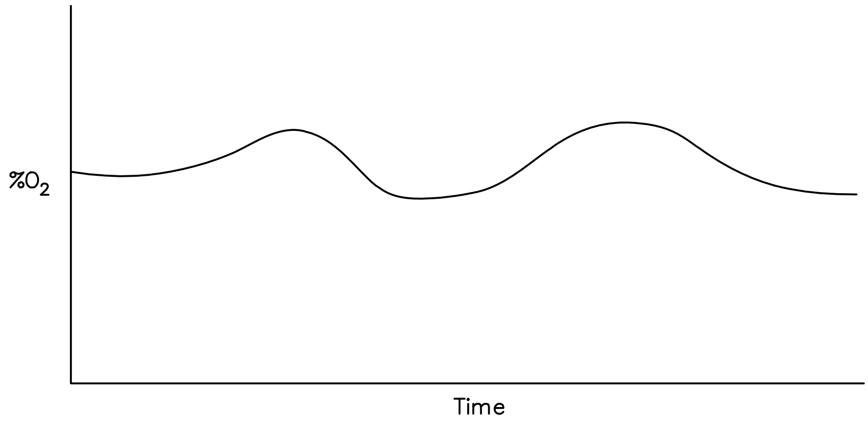


Figure 5 Analog output ambient effects

This variation occurs over a significant time interval of possibly several days. The average value remains constant. This is generally not an analyser fault, but may be due to cyclic changes in sample gas (i.e. the process), atmospheric pressure or ambient temperature.

3.2.4 Drift

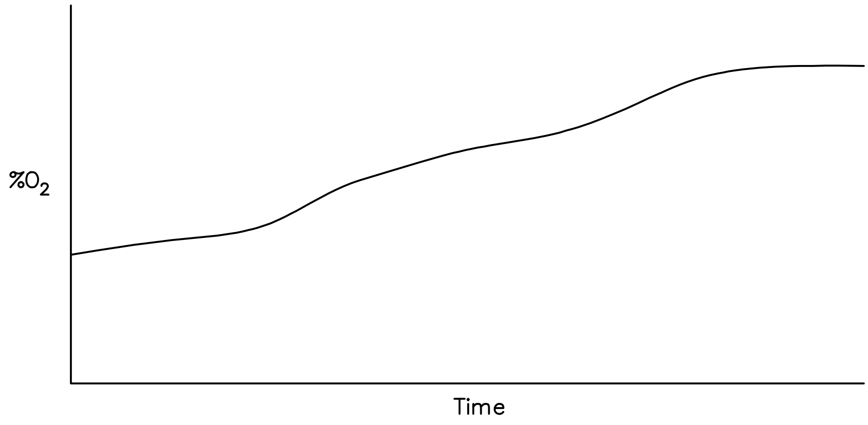


Figure 6 Analog output drift

Drift is often seen with a new analyser system, or after a new component is fitted. The rate of drift when measured over days, usually becomes less and eventually negligible. Drift may be positive (as shown) or negative.

If drift does not become negligible, it may indicate a potential problem with the measuring cell, for example due to degradation because of inadequate sample conditioning.

3.3 The implications of calibration gas tolerances on performance

The Servomex Paramagnetic Torque Balance measuring technique is inherently linear. As with any straight line graph, the best ‘fit’ results are obtained when the end points are far apart – since the effects of errors in the actual end points (in this case due to gas tolerances) is reduced. This is shown pictorially in Figure 7.

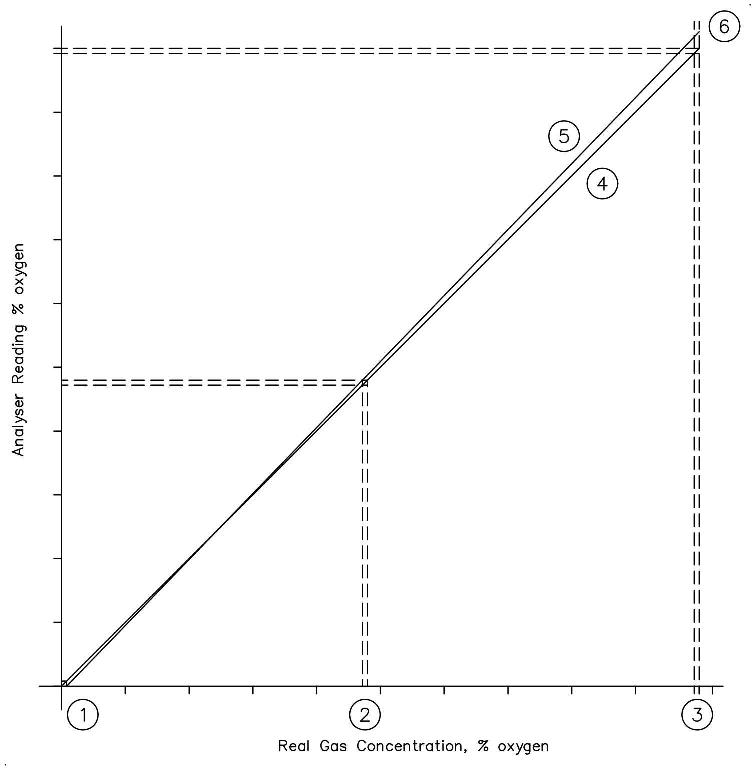


Figure 7 The effects of calibration gas tolerances

Key to Figure 7

1 - Low calibration gas target and tolerance band
2 - Mid range ‘high’ calibration gas target and tolerance band
3 - Full scale ‘high’ calibration gas target and tolerance band
4 - Ideal calibration characteristic
5 - Calibration characteristic based on mid range point
6 - Calibration error at full scale

Whilst simplistic, in this example, the error at full scale is actually outside the tolerance band.

Best accuracy is obtained with widely spaced calibration gases, one of which should be near zero.

4 THE SAMPLE CONDITIONING SYSTEM

Many analyser system problems can be traced to an inadequate sample conditioning system.

4.1 General guidance

The sample gas for the analyser must be:

Free of dust and particulate matter.

Free of condensate (both water and organics).

At the correct flow rate.

At the correct pressure.

Sample conditioning systems vary in design but in general the following will be needed:

A sampling point.

A filter, this may be in the process duct or external to it and may be heated.

A pump, if the process gas is at an inadequate pressure to pass it through the sample conditioning system.

A means for removing possible condensate. This can be an electrical chiller.

Pressure and flow controls.

Means for introducing calibrating gases.

A bypass to improve response time.

A vent for the sample gas.

In the case of a ‘high temperature’ system, the conditioning system may be heated to maintain the sample gas above a ‘dewpoint temperature’.

Figure 8 shows the essential components for a sample conditioning system. This diagram is included for illustrative purposes only and does not show all the components which may be necessary for a specific application.

Clean, dry gases may not require the filtering and condensate removal. Process gases which may have high dust loading or corrosive constituents may require more sample preparation.

> **NOTE**
>
> It is good practice for all sample pipework to be installed so that it drains down to any condensate removal device, with the transmitter unit mounted above the condensate removal device. If condensates may be present there should be no loops where condensate may collect.

It is advised that an inspection of the sample conditioning system should be done if the analyser system appears not to be performing to requirements. It is not possible to give detailed guidance as sample conditioning systems vary in design, however, the following are an indication of the points to be checked.

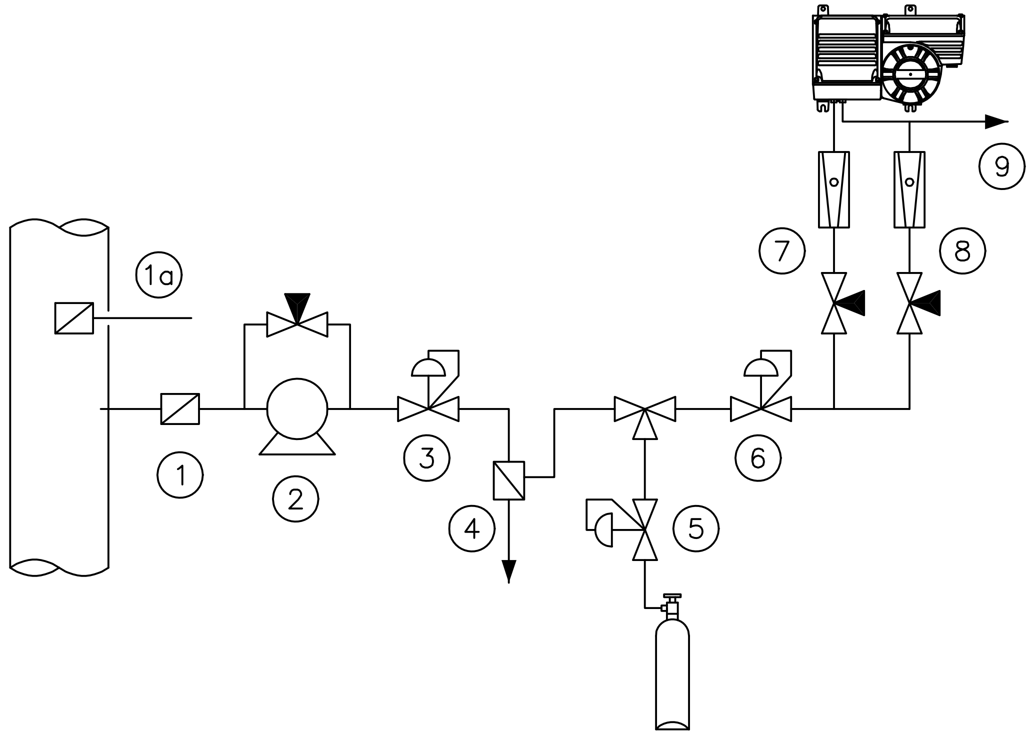


Figure 8 Typical sample system components

The key to Figure 8 is held in Table 1, along with fault diagnosis details:

Table 1 Sample system components (See Figure 8)

Item	Description	Possible fault	Action
1	Sample probe with external filter	Blocking of filter Failure of any heating resulting in corrosion Indicated by low flow	Check filter and clean or replace as required Check heater and control
1a	Sample probe with insitu filter	Blocking of filter, indicated by low flow	Check filter Check action of any ‘blow back’ cleaning process

Table 1	Sample system components (See Figure 8)		
Item	**Description**	**Possible fault**	**Action**
2	Pump with bypass control (may not be required)	Pump failure, resulting in no or low flow Note presence of bypass loop to prevent the pump operating against a dead head	Check operation of pump Adjust bypass loop flow for most efficient operation
3	Primary pressure control	Failure of pressure regulator Incorrect pressure setting Indicated by high or low flow	Check correct operation
4	Condensate removal (chiller) with condensate drain	Details of condensate removal vary widely Permeation dryers require regular replacement	Check correct operation
5	Calibration gases with control valves and regulators	Empty cylinders Incorrect gas concentration	Check
6	Secondary pressure regulation	Failure of pressure regulator Incorrect pressure setting Indicated by high or low flow	Check correct operation Sample gas and calibration gases should be delivered to the transmitter unit at the same pressure
7	'Sample' flow control / flowmeter	Incorrect settings Indicated by long response times May be full of condensate	Adjust sample flow rate Check previous system components
8	'Bypass' flow control / flowmeter	Incorrect settings Indicated by long response times	Adjust bypass flow rate to optimise response time against gas usage
9	Sample vent	Incorrect flow rate Incorrect reading due to back pressure	Check vent is free of obstruction and is of adequate size for length and flow rate
-	Sample Heating	Heating not operating (blown controller) or set to incorrect temperature	Check for operation at an appropriate set point

4.2 Condensates

Condensed liquids must not be allowed to enter the measuring cell. Condensation in the cell will cause false readings and may permanently damage the cell. Often condensate can be seen in the sight glasses of flowmeters. If present the cell must be examined.

4.3 Test and calibration gas requirements

The transmitter requires two calibration gases with known oxygen concentrations.

4.3.1 Low calibration gas

For most applications this is nitrogen.

4.3.2 High calibration gas

It is recommended that this gas is at least 5% oxygen greater than the low concentration gas.

This will be typically air, 20.95% oxygen, or pure oxygen.

NOTE

Ambient air contains water vapour which has the effect of reducing the oxygen content compared to a dry gas. If ambient air is used it should either be passed through a dryer, or through the complete sampling system to ensure that the moisture content is the same as the sample gas.

A molecular sieve dryer may significantly alter the oxygen content of the gas.

Consideration of the sample gas dew-point may demand that sample gas is not passed through the transmitter unit until warm-up is completed. This prevents the possibility of condensation in the measuring cell which may result in damage.

4.4 Setting calibration and sample gas flow rates

> **CAUTION**
>
> All gas cylinders and gas sources must be fitted with pressure and flow controllers to ensure that the maximum flow and pressure requirements of the measuring cell are not exceeded.
>
> Damage to the cell can result if the gas pressure and flow rates are exceeded.

Apply the low calibration gas and set the pressure and flow controls so that the flow through the measuring cell is <250ml/min (or, in certain versions of the 2223 type transmitter only, <1.0l/min for the high flow rate option). A lower flow rate will increase the response time.

Apply the sample gas and set the relevant pressure and flow controls so that the flow rate is the same as the calibration gas flow rate.

This page deliberately left blank

5 DESCRIPTION OF THE ELECTRONICS

As previously stated, it is not possible to repair any of the circuit boards inside either the transmitter or associated control unit. The following block diagrams are only intended to facilitate fault finding down to board replacement level.

Figure 9 provides details of the control unit.

Power is connected to the *Power Supply* board located at the right hand end of the card frame. This creates regulated supplies on the *Backplane,* from which all other circuit boards derive power.

The *Display* and *Display Adaptor* are located in the door assembly and are connected to the *Interfaces* board located in the left hand end of the card frame. The interfaces board also accommodates connection to transmitters (an intermediary terminal block is used in the 2213 Control Unit). **These connections are intrinsically safe in all control units.**

The *Processor* is located in the next slot along from the left hand end.

The four remaining card frame positions can accommodate any combination of option boards. Once configured, option boards should not be relocated.

Figure 10 provides details of the transmitter.

Power is connected to the *Heater/Supply* board located at the front of the flameproof enclosure. This creates regulated supplies to the *Barrier* board located in the rear of the flameproof enclosure. An intrinsically safe connection is made, via a flameproof feedthrough to the *Signal Processing* board located in the top enclosure.

Connections to the measuring sensor/s and control units are made in the top enclosure.

Figure 11 provides further details of the functions conducted by the transmitter signal processing board.

NOTE

Boards must not be removed from a powered unit.

If control unit option boards are not replaced before power is re-applied, any configuration of the options will be deleted.

The following figures include manufacturing reference number information. Part numbers for **correct spares items** are listed at the back of this manual.

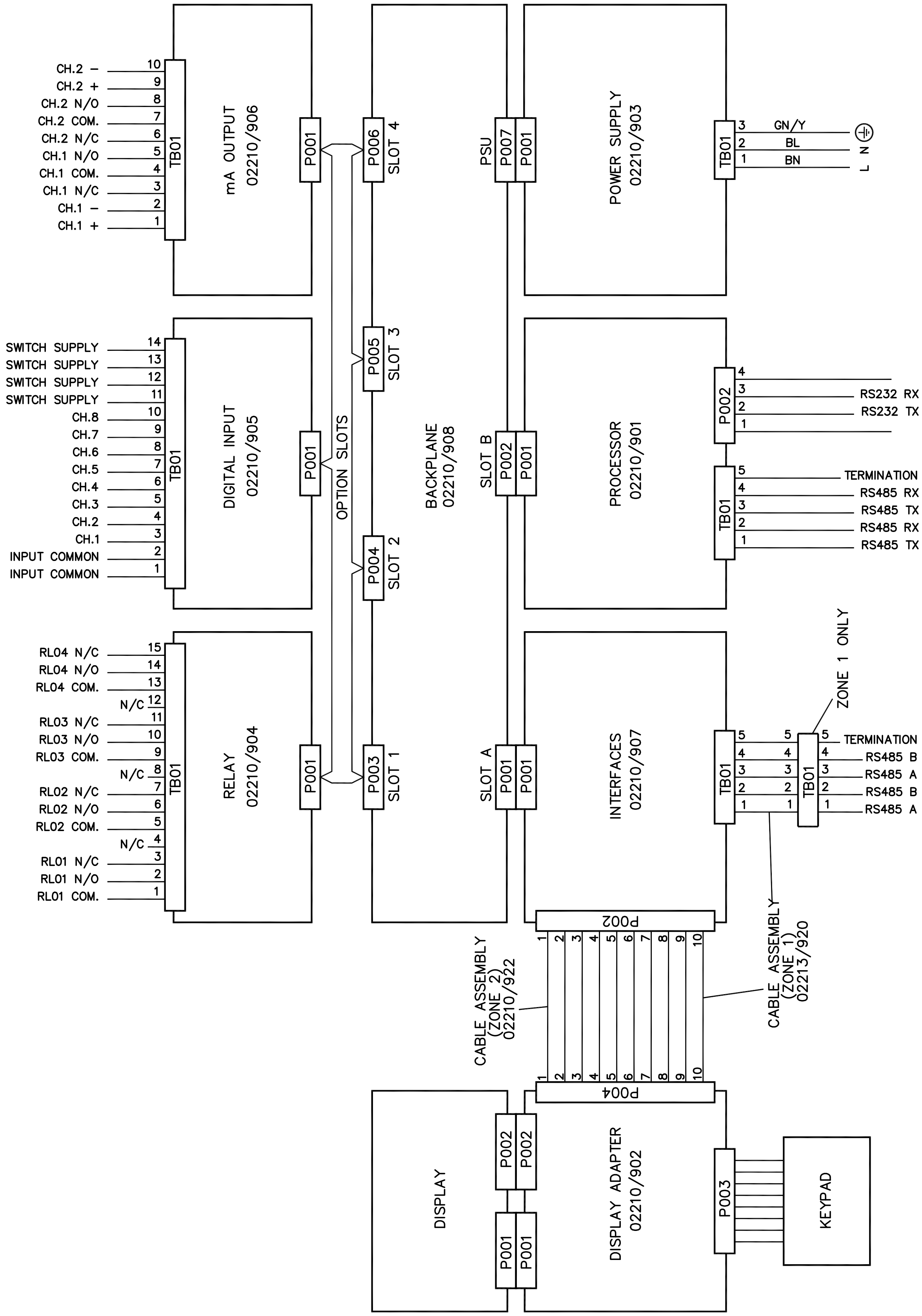


Figure 9 Control unit block diagram (Previous Processor)

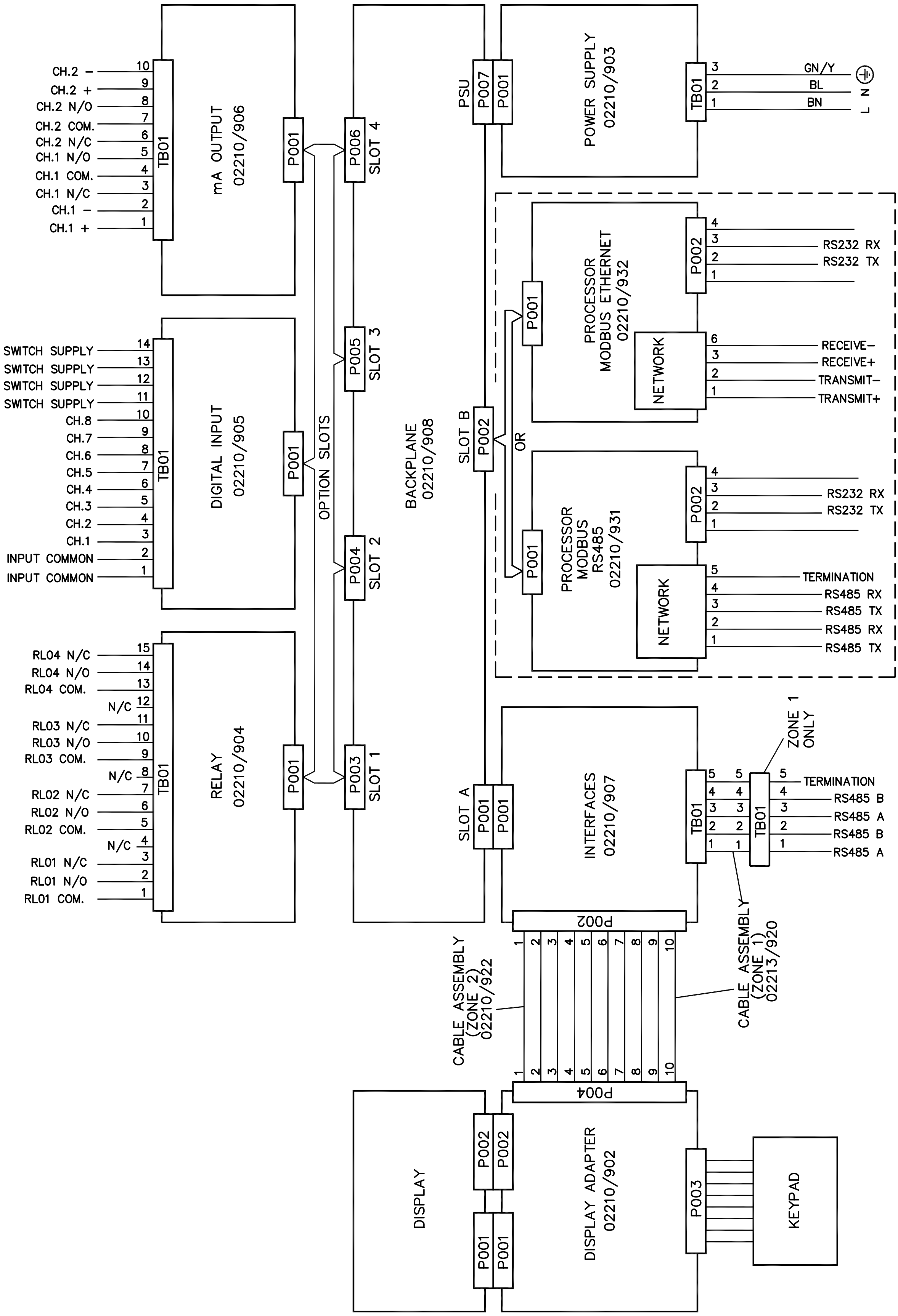


Figure 9a Control unit block diagram (Current Processor)

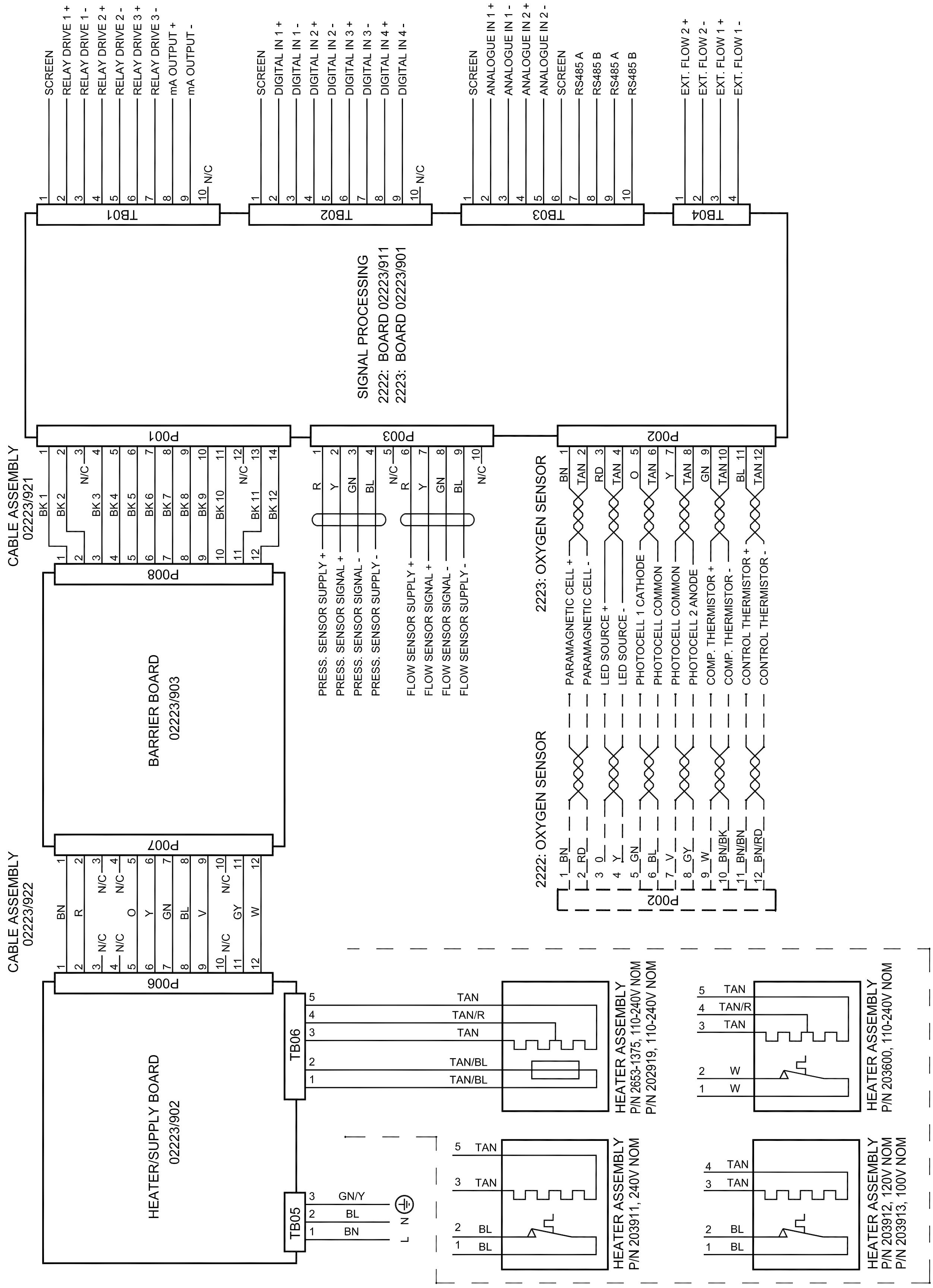


Figure 10 Transmitter unit block diagram

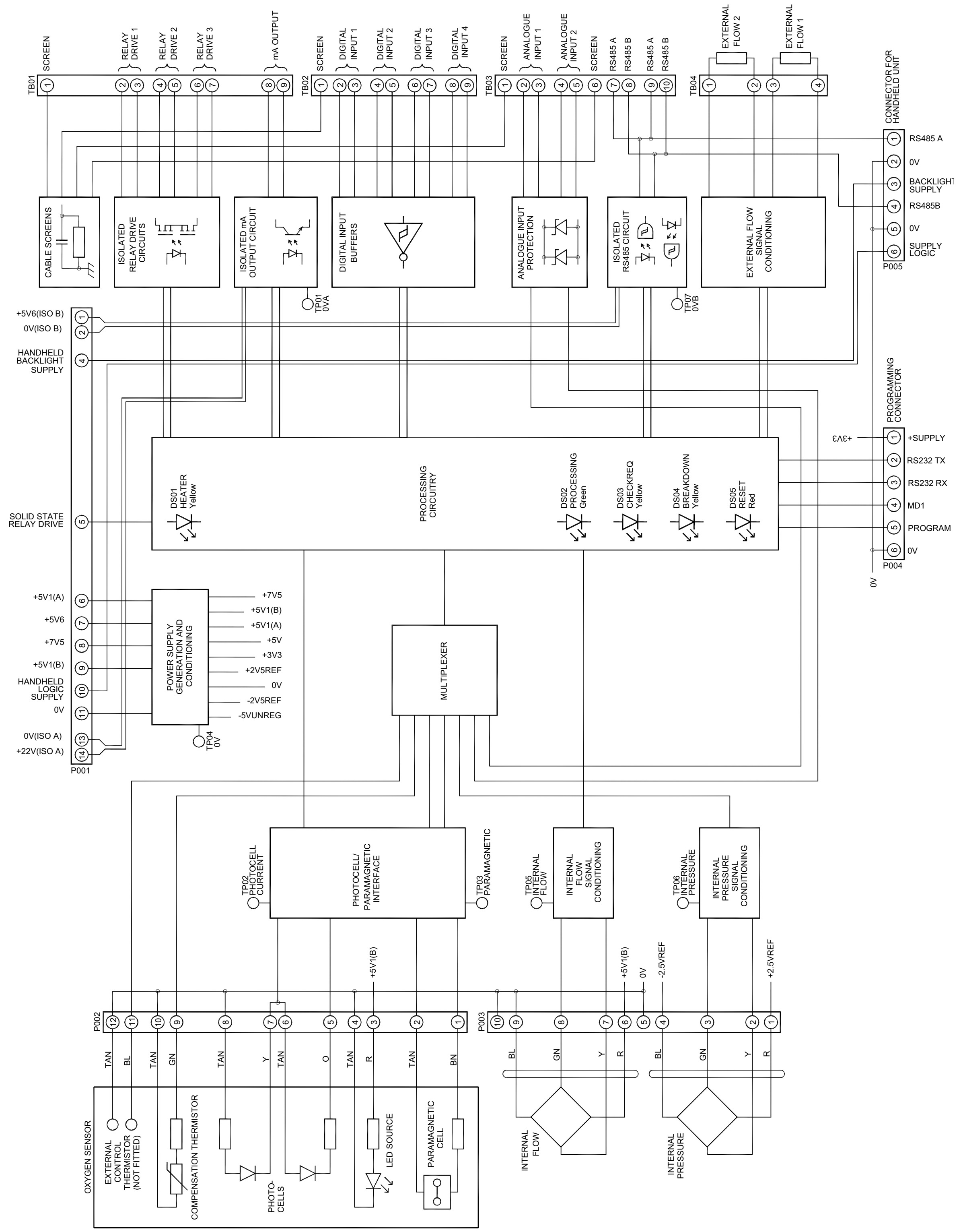


Figure 11 Signal processing block diagram

This page deliberately left blank

6 INITIAL TROUBLESHOOTING

If operational, the current status and status history screens for both the transmitter and control unit should be reviewed. This *may* lead the user directly to the source of the problem.

6.1 Initial power-up

Electrical power is supplied separately to the transmitter unit and control unit. Ensure that both units are connected and powered.

Upon initial power-up of a 2200 analyser system, and after a minute from switch on, the control unit display shows:

Display	Description
No display (Look also for backlight)	Check electrical supply to control unit. Check internal fuse. Check PSU.
`Transmitter Not Responding`	No response from transmitter unit. Check cable continuity. Check electrical power to transmitter unit. Check internal fuse. Check PSU.
`No Transmitters Registered`	It is required to register at least one transmitter unit to proceed. See the operations manual.
XXXXXX % O_2	A transmitter unit is registered, but is disabled. It must be enabled to proceed. See the operations manual.

6.2 Failure to calibrate

Ensure that gas pressure and flow settings are correct.

Check that the correct gas actually reaches the transmitter (view transmitter service diagnostics screen to check for changes in oxygen concentration).

Check all settings associated with calibration targets and tolerances.

There is an optional sintered filter in the inlet assembly of the transmitter unit. Poor flow may be due to blocking of this filter. This indicates inadequate sample conditioning. See Section 8 for replacement of filter.

Note that a failed calibration will raise the 'MAINTENANCE' status at both the transmitter and associated control unit. This will lead to an entry in the status history. It will not, however, create an entry in the calibration history.

6.2.1 Calibration history

The calibration history records all successful oxygen measurement checks and calibrations. This includes those that occur during autocalibration. The history may be reviewed to determine analyser stability over a long period of time.

6.3 Internal diagnostic checks

Information regarding the 'health' of the oxygen measurement may be gained by viewing the internal diagnostics, however, before viewing this information, an understanding of the measurement chain is recommended. This is shown in Figure 12.

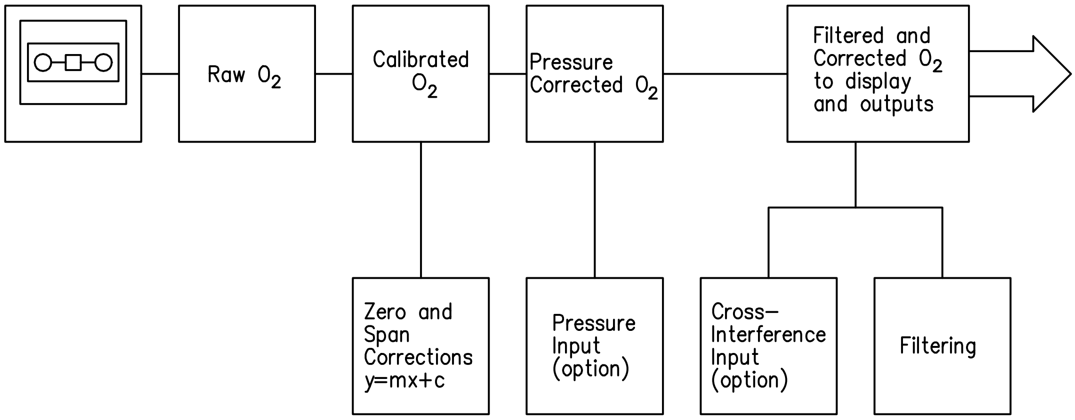


Figure 12 Measurement chain

i.e.: the measuring cell output is termed 'raw oxygen'.

'calibrated oxygen' is raw oxygen with calibration constants applied

etc.…

> **NOTE**
>
> The oxygen value on the display and at all analog outputs has been subjected to calibration, and, if configured; pressure correction, cross interference compensation and filtering.

6.3.1 Transmitter unit diagnostics

Transmitter unit diagnostics is accessed under the relevant transmitter, service menu.

In the following form, the value for the voltages are dependent on the oxygen concentration. A difference of 20% oxygen should produce a change of *nominally* 0.2V. The user may use calibration gases to confirm the analyser is responding to gas changes.

Parameter	Typical value	Diagnostic	Action
`Raw Oxygen Reading`	-0.3V to 2.0V	Proportional to oxygen content.	Check that the readings change by approximately 0.2V for 20% oxygen – **these will not be identical.**
`Feedback Voltage`			
`Calibrated Oxygen`	20.950% (Air point)	Value after calibration has been applied.	Check that the reading tracks calibration gas targets when appropriate gas is applied.
`Pressure Corrected O2`	20.950%	Value after pressure compensation.	Errors usually mean the oxygen measurement has not been calibrated after re-calibration of the pressure sensor.
`Filtered Oxygen`	20.950%	Value after cross-interference correction and filtering.	Errors usually mean the cross interferent signal is out of limits or incorrectly configured. Check user filter if this signal *only* is responding very slowly.
`Gain`	50 to 200	The gain and zero offset figures that convert raw oxygen to calibrated oxygen.	Check calibration at atmospheric pressure if these are outside typical limits.
`Zero Offset`	-0.3V to +0.3V		
`Photocell Current`	0.5µA to 15µA	≤0.2µA gives a fault status signal.	Check measurement optics.
`Cell temperature`	"set point" 2223: 60°C 2222: factory set up to 135°C	Between ambient and set point Value less than ambient or > set point	System is warming up. Heater failure. Failure of temperature sensor.
`Oven Temperature`			

Fault and Maintenance messages will indicate if any of the above parameters are outside of normal limits, and may imply degradation of components within the measurement optics (as shown in Figure 2). This will result in a decrease in performance of the measuring system, which may be shown as:

Excessive noise or drift:

Oxygen value is either upscale or downscale **(and fails to calibrate).**

The most likely causes are:

Contamination of the window or mirror in the measuring cell.

Failure of the suspension of the dumbbell, due to corrosion.

However, ageing of the light source and or photocells should not be ruled out.

Examining the cell will usually reveal contamination, however, the cell is probably satisfactory if:

The dumbbell oscillates **gently.**

The window is clean and the mirror is bright.

The electrical resistance of the coil is measured across the pins of the cell is nominally 50Ω.

Contamination of the measuring cell is due to poor sample conditioning. This **must** be rectified before the cell is replaced.

6.4 Output signal diagnostics

Ensure that the outputs are setup correctly. For lack of output signals for both the transmitter unit and control unit check the following:

6.4.1 mA output and status/alarm relay output checking

It is assumed that the ‘symptom’ is that the relevant output does not respond.

Reason	**Action**
Output is not allocated	Allocate output to a function.
Output is not enabled	Enable output.
Incorrect settings	Check all user settings.

The output signals for relays and analog outputs have internal test functions and diagnostics to aid fault finding.

The transmitter unit signal processing circuits are integral with the main board. If the parameters are setup correctly and the system fails in diagnostic tests the main board should be replaced; see Section 8.

The control unit signal processing circuits are option boards. These can be replaced separately; see Section 9.

6.5 Internal diagnostic messages

The control unit may display a number of diagnostics messages. Aside from routine information, the following table lists such messages and possible causes.

6.5.1 Messages associated with the transmitter

Such messages will usually be preceded with “T01”, “T02”, etc where 1, 2 etc is the address of the transmitter at fault.

Message	Implication
`Pressure Low/High Check/Fault`	Internal pressure sensor operating outside limits or faulty.
`Warmup Time Exceeded`	Check transmitter is heating up. (Note, the 2222 may take a significantly long time to warm up)
`Feedback Check/Fault`	Oxygen sensor contamination.
`Photocell Check/Fault`	
`Flow Sensor Fault`	Internal/external flow sensor defective.
`Software Processing Fail`	Signal processing board faulty (check status history for ‘watchdog fault’).
`NV/Ram Fail`	
`Internal/External ADC Fail`	
`Program Integrity Fail`	

6.5.2 Messages associated with the control unit

Such messages will usually be preceded with “C” to imply control.

Message	Implication
`Communications Failure`	Processing board faulty.
`Ethernet Failure`	Processing board faulty (02210932 only)
`Option Card Reset n`	If problem persists, faulty option card.
`Option Reset Override n`	
`Display Card Reset`	If problem persists, faulty display/display adaptor or interfaces board.
`Display Reset Override`	
`Software Processing Fail`	Processing board faulty (check status history for ‘watchdog fault’).
`NV/Ram Fail`	
`Program Integrity Fail`	

This page deliberately left blank

7 HARDWARE DIAGNOSTICS

WARNING

The control unit and transmitter include circuits which are intrinsically safe.

The connection *between* the transmitter and control unit is intrinsically safe. **This must be considered when servicing one end of the system.**

Diagnostic servicing may require removal of flameproof covers whilst electrical power is still applied to a unit. The explosion proof enclosure must not be opened in an area which is not safe. **Hazardous area implications must be considered before servicing.**

7.1 Transmitter unit hardware diagnostics

The Transmitter Unit is essentially an aluminium enclosure finished with a protective epoxy powder paint. All weatherproof seals are viton or silicone rubber.

The unit comprises three separate compartments.

Lower Right: An explosion proof enclosure for the power supply and intrinsic safety components that supply electrical power to the rest of the unit. Connection to the electrical power supply is made inside this enclosure.

Access to this enclosure is by **releasing the locking screw** in the explosion proof cover and unscrewing it anti (counter)-clockwise.

Upper Right: An enclosure for the signal processing electronics and all user connections. The electronics are intrinsically safe. Access to this enclosure is by removing the 4 screws securing the cover.

Left: A second enclosure containing the measuring cell and pressure transducer (option). Gas connections are made to this enclosure.

All diagnostics LED's and function switches are on the signal processing board.

Remove the cover of the upper electronics enclosure, it is not necessary to remove the internal metallic cover to perform diagnostics checks.

Figure 13 shows the location of switches, test points and LED's that are referred to during fault diagnosis (test point access is accommodated on connectors).

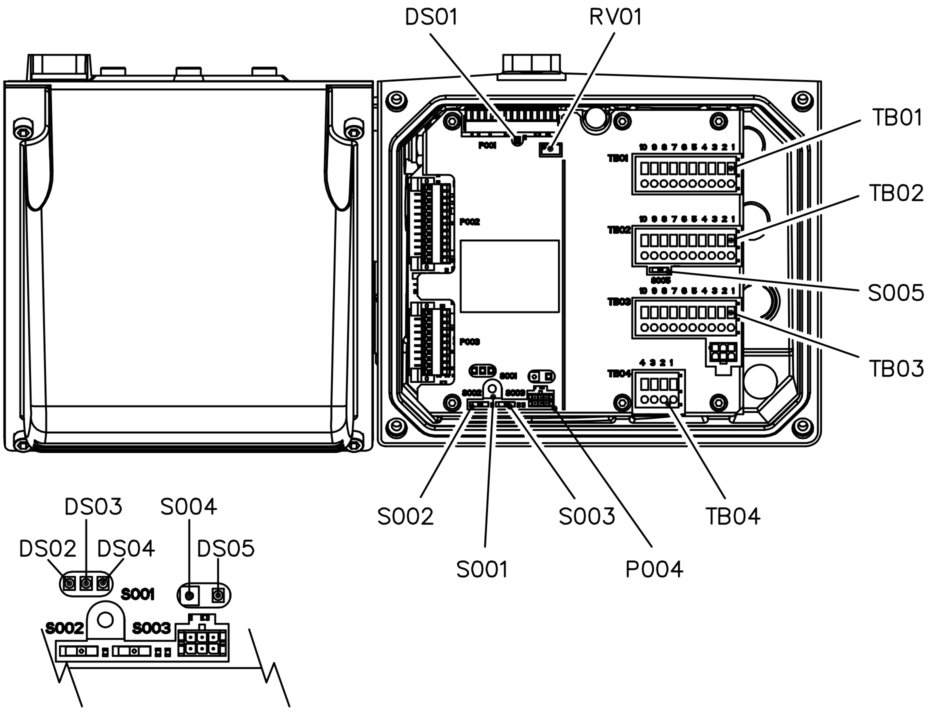
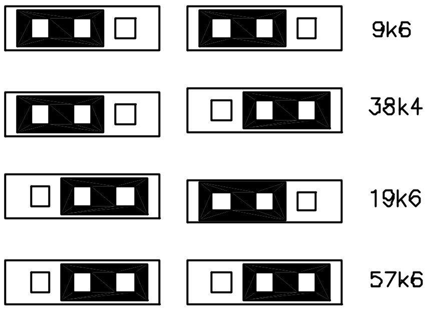
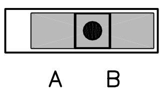
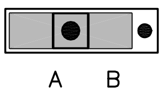


Figure 13 Transmitter diagnostics and switches

The key to Figure 13 is held in Table 2, along with fault diagnosis details.

Table 2 Transmitter diagnostics and switches (See Figure 13)

Ident.	Description	Function
DS01	Heater LED	Flashes in normal operation, when it is lit the heater is on
DS02	System OK LED	Flashes in normal operation to indicate system software is running
DS03	Maintenance Required LED	Not usually lit – indicates Maintenance required status
DS04	Fault LED	Not usually lit – indicates Fault status
DS05	Reset LED	Not usually lit, will flash on when the reset button is pressed
RV01	MA Output adjust	Adjust the span of the analog output
P001	Power supply TB	Checking the supply voltages
P002	Connections to oxygen sensor	Checking the basic oxygen measurement signals

Table 2	Transmitter diagnostics and switches (See Figure 13)	
Ident.	**Description**	**Function**
P003	Connections to internal pressure and/or flow sensors	Checking the basic pressure and/or flow signals
P004	Computer connection	Used to facilitate software upgrades
TB01 TB02 TB03 TB04	Terminals for customer connections	Refer to installation manual
S001	Address switch, set during installation	Switch position: 0 Not used N/A 1 Factory default for 1 transmitter T01 2 Set for transmitter no. 2 if fitted T02 3 Set for transmitter no. 3 if fitted T03 4 Set for transmitter no. 4 if fitted T04 5 Set for transmitter no. 5 if fitted T05 6 Set for transmitter no. 6 if fitted T06 7 to F Not used N/A
S002 S003	Transmitter baud rate setting, factory set to 57k6, changing this setting will disable communication (Early transmitters used slide switches, which operated with ‘reverse polarity’)	
S004	Processor reset	Resets the microprocessor, this function does not delete user configuration settings
S005	Termination switch, set during installation	 ‘mid point’ multiple unit connections  ‘end’; single unit connection

7.1.1 Low voltage power supply checking

Low voltage electrical supplies are available on P001. Pin 1 is the right hand end, pin 14 is the left hand end.

Pin	Function	Value
14	Isolated supply for analog output +ve	+22Vdc (-4V, +1,2V) with respect to pin 13
13	Isolated supply for analog output -ve	0Vdc with respect to pin 14. Isolated from earth (ground)
12	no connection	N/A
11	0V (earth/ground)	Common to instrument chassis
10	Logic supply to handheld unit	+7.2Vdc (-2.1V, +0.3V) with respect to pin 11
9	Stabilised supply to measuring cell and flow sensor	+5.1Vdc (-0.7V, +0.3V) with respect to pin 11
8	Supply to signal processing electronics	+7.5Vdc (-0.9, +0.4V) with respect to pin 11
7	Supply to signal processing electronics	+4.23Vdc to +4.53Vdc with respect to pin 11
6	Supply to opto-coupler isolators	+5.1Vdc (-0.7, +0.3V) with respect pin 11
5	Logic drive to heater control	Operation should track the heater LED
4	Handheld backlight supply	4.7Vdc (-1,7V, +0.3V)
3	no connection	N/A
2	Isolated supply for digital outputs -ve	0Vdc isolated from earth (ground)
1	Isolated supply for digital outputs +ve	+5.6Vdc (-0.2V, +0.9V) with respect to pin 2

If the supply voltages are incorrect the power supply assembly should be replaced. If the voltages are still incorrect the barrier board assembly should be replaced; see Section 8. Neither of these assemblies are user serviceable.

7.1.2 Cell electrical continuity

The electrical continuity of the cell can be checked without removing the cell. This is recommended if values obtained in Section 6.3.1 are incorrect.

1. Remove plug-in connector P002.
2. Measure the electrical resistance between pin 1 and pin 2 on the plug which should be nominally 68Ω. A high resistance will indicate a faulty coil and the cell must be replaced.
3. Replace the plug-in connector.

7.1.3 Flow alarm/internal pressure compensation (options)

The internal flow alarm operates on the thermal conductivity principle. It is optimised for gases which have a thermal conductivity and viscosity similar to nitrogen.

It is not suitable for gases which have thermal conductivity or viscosity substantially different to nitrogen.

The first diagnostic check is to confirm performance using air or nitrogen.

NOTE

The internal diagnostics screen (Section 6.3.1) will include information regarding 'raw' and calibrated flow and/or internal pressure signals if either of these options are installed.

Electrical supplies may be checked on P003. pin 10 is at the top.

Pin	Function	Value
6	supply for pressure transducer +ve	+5.1Vdc with respect to pin 5
5	supply for pressure transducer -ve	0Vdc with respect to ground
4	supply for flow sensor -ve	-5Vdc with respect to pin 1
1	supply for flow sensor +ve	+2.5Vdc with respect to ground

7.2 Control unit hardware diagnostics

The control unit is essentially an aluminium enclosure finished with a protective epoxy powder paint. A glass window facilitates viewing the integral display and the user interface is via a polyester keypad. All weatherproof seals are silicone rubber. The internal electronics are of modular form and fit into seven positions within a card frame.

The display and keypad are mounted on the rear side of a door.

The 2210 control unit is a single enclosure, access to the electronics is made by removing the four screws securing the cover and opening the hinged door.

The 2213 control unit comprises two separate compartments.

Right: An explosion proof enclosure for the card frame assembly, access to the electronics is made by **releasing the locking screw** in the explosion proof cover and unscrewing it anti (counter)-clockwise.

Left: A weatherproof enclosure housing the display, access is made by removing the four screws securing the cover and opening the hinged door.

NOTE

The only internal diagnostic information available is the LED on the front of the processor board. This flashes in normal operation. Fault finding is by assembly replacement.

7.2.1 Display contrast adjustment

The control unit display contrast may be adjusted if necessary. The adjustment trim pot is accessed through the metal cover on the rear of the hinged door, via a small hole in the side furthest away from the hinge.

7.2.2 Analog output adjustment

If fitted, the analog output channels include a span adjustment potentiometer. Access is through the appropriate hole in the card front, labelled CH1 and CH2.

8 TRANSMITTER UNIT SERVICING

8.1 Servicing the transducer assembly

The measuring cell can be replaced. Servicing of the other components is by replacement of the transducer assembly. A replacement transducer assembly includes a measuring cell

.

CAUTION

Do not operate the transmitter with the sample cover removed. The 'T' rating of the transmitter is limited by a thermal fuse embedded within the cartridge heater. Operation of the unit without the sample cover fitted may lead to temperatures which will impair the life of the fuse.

Hot surfaces. The transducer assembly operates at temperatures at or above 60°C (128°F). It is recommended that the unit is allowed to cool to room temperature before servicing. This may be 'quickened' by removing the cover from the left hand enclosure once the heater has been 'disabled' (see operations manual) or power has been disconnected.

NOTE

The thermal control algorithm in the type 2223 has been designed to give optimum control at the set point and to protect the thermal fuse/thermostat embedded in the heater. This has been achieved at the expense of a fast warm-up characteristic under certain conditions. However:

A 2223 transmitter which has been allowed to cool to ambient temperature **throughout** will warm up generally within an hour.

A 2223 transmitter in which temperatures **have not** been allowed to equalise may take significantly longer to reach temperature **(a number of hours is not abnormal).**

A 2222 transmitter typically takes six hours to warm up from ambient, however, this depends on the actual set point.

If a 2222 transmitter has experienced a short power interrupt, it may be necessary to switch off power for 1 hour before re-applying power.

Isolate the transmitter unit from electrical power and sample gas.

Remove the cover of the transducer/sample enclosure (the left hand compartment) by removing the 4 screws and loosing EMC earth strap connections where fitted...

NOTE

Due to the strong magnetic field around the transducer assembly it is advisable to remove wristwatches.

The internal arrangements are shown in Figures 14 and 15

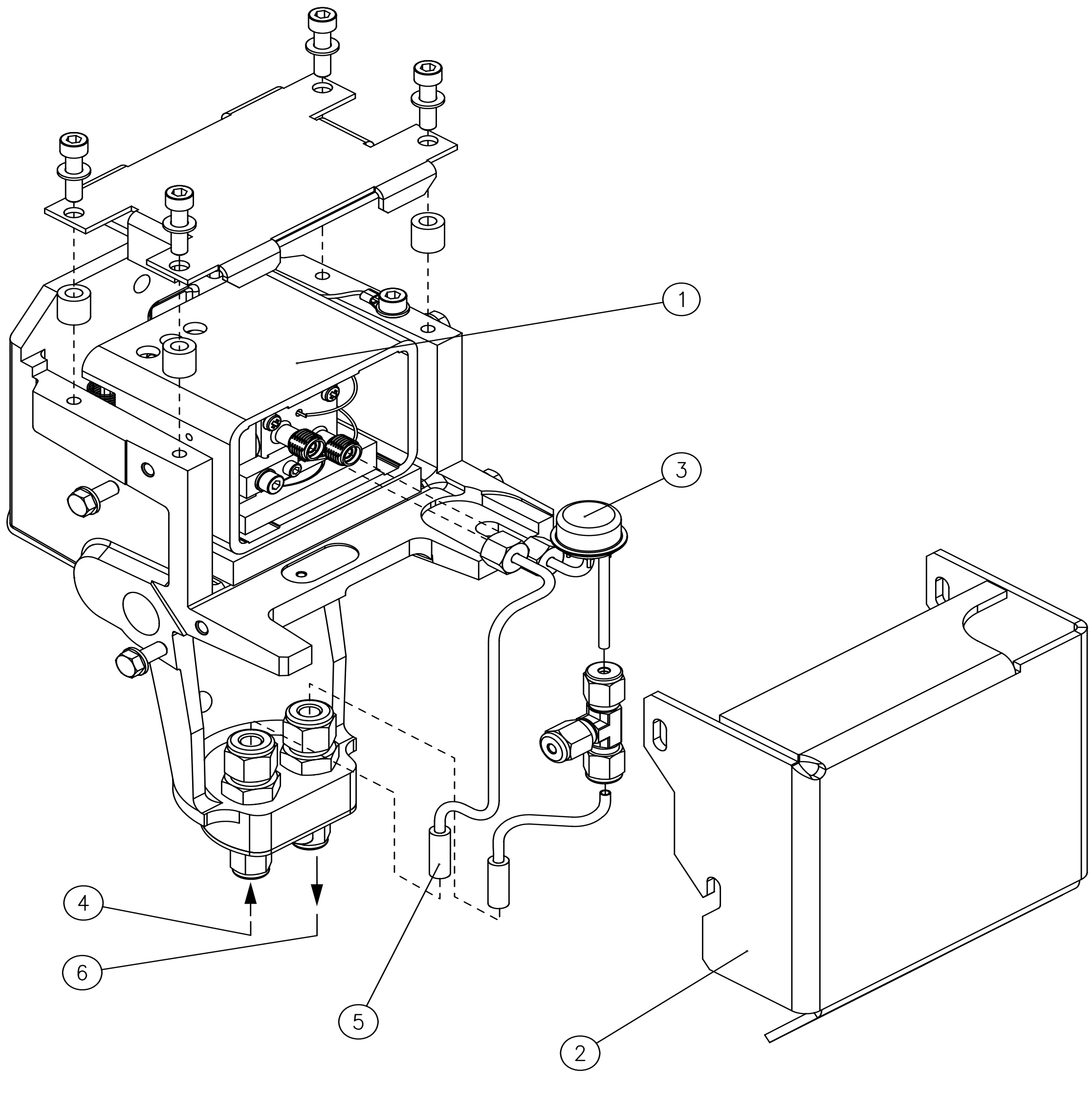


Figure 14 2222 Transducer/sample compartment

Key to Figure 14

1 - Oxygen sensor assembly
2 - Thermal cover
3 - Flow sensor (option)
4 - Sample gas inlet
5 - Cell inlet tube
6 - Sample gas outlet

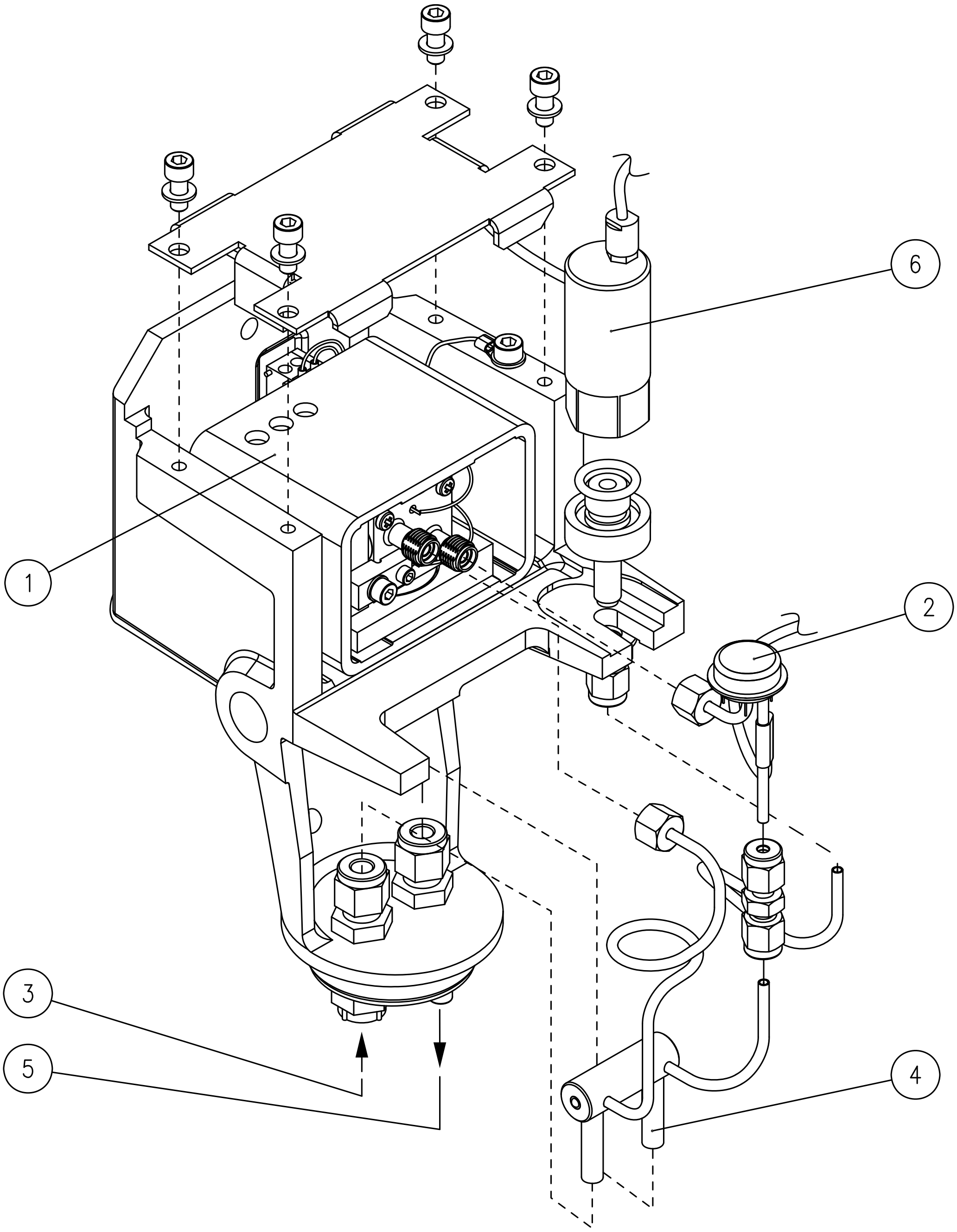


Figure 15 2223 Transducer/sample compartment

Key to Figure 15

1 - Oxygen sensor assembly
2 - Flow sensor (option)
3 - Sample gas inlet
4 - Fast response bypass (option)
5 - Sample gas outlet
6 - Pressure sensor (option)

8.1.1 Removal of the oxygen sensor (transducer)

1. Options that may be fitted are pressure sensor and flow sensor. Dismantling details are included for these where required.
2. 2222 only - loosen/undoe the four fixing screws and remove the thermal cover.
3. Undo the two sample connection nuts on the rear of the cell.
4. If a pressure sensor is fitted undo the nut on the pipe connection to the pressure sensor. Slacken the holding nut for the pressure sensor to allow the pipework to move.
5. 2222 only - remove the two lower sections of insulation to access the sample gas inlet/outlet connections in the base of the unit.
6. Undo the sample gas inlet and outlet nuts in the base of the enclosure. Remove the pipework. Please note the sintered filter (optional) in the inlet (left hand) connection.
7. To remove the electrical lead:

   Note the position of the wires on connector P002.

   Remove wires from connector P002 (2222 only - feed connection to pin 5 carefully out through the ferrite).

   Loosen gland nut .

   Remove sealing gland.

   Remove connecting wires through gland hole into the transducer enclosure.
8. Remove the 4 screws holding the transducer clamping plate and remove the plate. 2222 only - remove the four spacers under the clamping plate.
9. Remove the transducer assembly.
10. If required, replace the cell as described earlier.

NOTE

There are no serviceable components of the transducer assembly.

Dismantling the transducer assembly will permanently damage the assembly.

8.1.2 Replacement of the transducer assembly

1. Replace the transducer assembly and clamping plate etc.
2. Re-install the electrical connections:
3. There must be a minimum of 10mm of lead through visible in the electronics enclosure; see Figure 17.

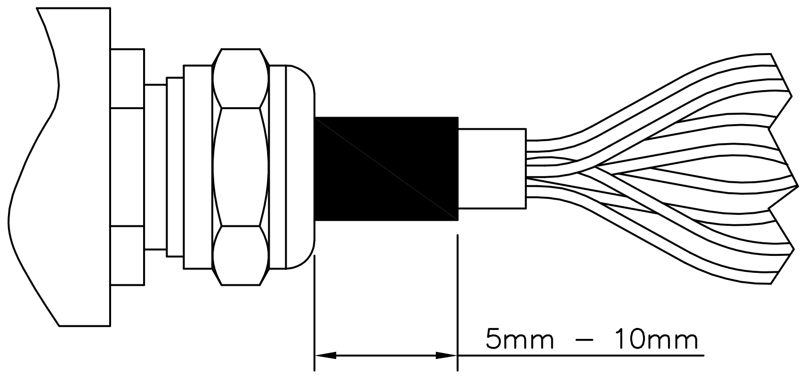


Figure 16 Cable details

4. Fit sealing gland.
5. Secure gland nut.
6. Remake electrical connection to plug P002. Ensure correct locations of wires.

	Pin number	Color: 2222 transmitter	Color: 2223 transmitter	
Top	12	Brown/Red	Tan	Twisted pair
	11	Brown/Brown	Blue	
	10	Brown/Black	Tan	Twisted pair
	9	White	Green	
	8	Grey	Tan	Twisted pair
	7	Violet	Yellow	
	6	Blue	Tan	Twisted pair
	5	Green	Orange	
	4	Yellow	Tan	Twisted pair
	3	Orange	Red	
	2	Red	Tan	Twisted pair
Bottom	1	Brown	Brown	

7. Replace connector P002 (2222 only - refit ferrite to pin 5 connection)
8. Fit new ‘O’ rings at the cell connection.

   The ‘O’ rings supplied with the type 325 cell are Viton (black). PTFE (white) ‘O’ rings are supplied with the type 357 cell.
9. Reconnect pipework.
10. Locate the pipework in the sample gas in and out connectors. Leave the unions loose.
11. Locate the pipework in the cell in and out connectors. Leave the unions loose.
12. Slacken the nut holding the pressure sensor in place and locate the pipework in the pressure sensor.
13. Tighten the unions and tighten the nut securing the pressure sensor.
14. Leak test; see Section 8.6
15. Replace enclosure cover.
16. Perform a check calibration.

NOTE

Re-enable the heater if it has been disabled.

The zero point calibration of a new transducer may require coarse adjustment outside of normal limits. This is achieved by setting the software tolerance to maximum (10%) and by performing a number of calibrations whilst moving the calibration target iteratively from the ‘as fitted’ value to the real gas value.

Once completed targets and tolerances should be returned to normal values.

A final calibration should be conducted once the unit has warmed up.

8.2 Replacement of filter

A filter is incorporated in the inlet (left hand side) connector. This filter is for the protection of the measuring cell; adequate filtering of the sample gas is required. The cause of particulate matter reaching the transmitter unit must be rectified.

Low flow rate (long response time) may be due to the blocking of this filter.

To replace the filter:

1. Options that may be fitted are pressure sensor and flow sensor. Dismantling details are included for these where required.
2. Undo the two sample connection nuts on the rear of the cell.
3. If a pressure sensor is fitted undo the nut on the pipe connection to the pressure sensor. Slacken the holding nut for the pressure sensor to allow the pipework to move.
4. Undo the sample gas inlet and outlet nuts in the base of the enclosure. Remove the pipework.

5. Remove the filter from the inlet (left hand) connector.
6. Replace filter, ensure the ‘O’ ring is in place.
7. Reconnect pipework.
8. Locate the pipework in the sample gas in and out connectors. Leave the unions loose.
9. Locate the pipework in the cell in and out connectors. Leave the unions loose.
10. Slacken the nut holding the pressure sensor in place and locate the pipework in the pressure sensor.
11. Tighten the unions and tighten the nut securing the pressure sensor.
12. Leak test; see Section 8.6.
13. Replace enclosure cover.
14. Perform a check calibration.

NOTE

Re-enable the heater if is has been disabled.
A final calibration should be conducted once the unit has warmed up.

8.3 Replacement of flow sensor and pressure sensor

1. Remove flow sensor or pressure sensor from sample pipework.
2. To remove the electrical lead:

    Note the position of the wires on connector P003.
    Remove wires from connector P003.
    Loosen gland nut.
    Remove sealing gland.
3. Remove connecting wires through gland hole into the transducer enclosure.
4. Replacement is a reverse of the removal procedure.
5. Remake electrical connection to plug P003.

	Pin number	Color	
Top	10	No Connection	Flow sensor
	9	Blue	
	8	Grey-green	
	7	Yellow	
	6	Red	
	5	No Connection	Pressure sensor
	4	Green	
	3	Red	
	2	Black	
Bottom	1	White	

NOTE

If only one sensor is fitted the blanking plug in the rubber gland **must** be in place.

8.4 Replacement of the microprocessor board

Remove the cover of the electronics enclosure.

There are no user serviceable items on the microprocessor board. Servicing is by replacement.

1. Note all user connections to terminal blocks TB01 to TB04.
2. Note user setting for address switch S001.
3. Note user settings for links S002 and S003.
4. Remove user connections from TB01 to TB05.
5. Remove any connections to P004 and P005.
6. Remove plug-in connectors P001 to P003.
7. Remove the 6 off screws securing the covering plate and remove.
8. Remove the 6 off pillars securing the board.
9. Set switch S001 and links S002 and S003 on the replacement board to correspond with the original.
10. Replacement is the reverse of the removal procedure. Ensure user connections are correctly made.
11. Replace cover.
12. Replace enclosure cover.
13. Re-configure as required. Perform a calibration.

8.4.1 Setting of 4-20mA output span

The 20mA setting of the 4 – 20mA output is factory set. The zero point is fixed in hardware, however, the span may be checked and adjusted as required with RV01. Connect a dc mA meter between TB01 – 8 and TB01 – 9.

Any current output can be set using the output test function, refer to the operations manual.

1. Set up the output test function via the control unit (this condition will last for five minutes unless the relevant form is quit).
2. Adjust RV1 so that meter indicates the test current value.

8.5 Servicing the power supply unit and heaters

Remove the cover of the explosion proof enclosure by slackening (but not removing) the locking screw and undoing the cover by rotating it anti-clockwise. Take care not to damage the threads.

The power supply consists of 2 assemblies – a heater/supply board and a barrier board for intrinsically safe power supplies for the electronics and transducer assemblies.

The heater/supply assembly and barrier board assembly are not user serviceable. Service is by replacement.

Contact Servomex if the electrical supply voltage requires to be changed.

8.5.1 Fuse

The fuse is located in the holder on the front of the heater/power supply board.

Electrical supply – Fuse F001, 1.6A

8.5.2 Heater diagnostics

The heater assembly incorporates a thermal fuse or thermostat to protect against over-temperature.

However, before checking the heater element ensure that fuses are intact.

To check heaters:503-554Ω

1. Remove wires from connector TB006.
2. Check resistance below, refer also to Figure 18

	Heater part number				
	2653-1375	202919 203600	203911	203912	203913
Resistance between each tan and the central tan/red wire	347-384Ω	306-337Ω	503-554Ω	155-171Ω	104-115Ω

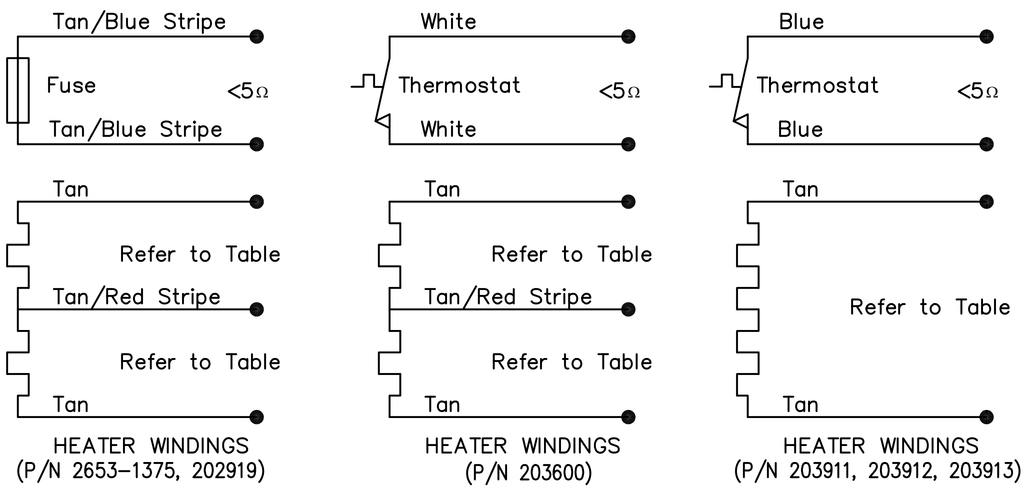


Figure 17 Heater continuity

3. Failure requires replacement of the complete heater element.

> **WARNING**
>
> The cartridge heater governs the T rating of the transmitter. It is an integral part of the safety of the product and the key certification related item. If a replacement is to be fitted ensure that the correct Servomex spare has been selected.

4. Reconnect wires to TB006 as below:

	Pin no.	P/N 2653-1375 202919	P/N 203600	P/N 203911	P/N 203912 203913
Left hand end	1	Tan/blue trace	White	Blue	Blue
	2	Tan/blue trace	White	Blue	Blue
	3	Tan	Tan	Tan	Tan
	4	Tan/red trace	Tan/red trace	none	Tan
Right hand end	5	Tan	Tan	Tan	none

8.5.3 Replacement of heater

1. Remove the wires from TB006.
2. Remove the spring clip retaining the heater.
3. Withdraw the heater element.
4. Replacement is the reverse of the above procedure. Ensure the plastic tubing spacer is fully inserted.
5. Refit the spring clip.
6. Reconnect wires to TB006.

8.5.4 Replacement of power supply assembly

1. Remove connections for electrical supply.
2. Remove connections to TB006 for heater.
3. Remove 4 × hex head screws holding assembly in place.
4. Lift out assembly, remove connector P006.
5. Installation is the reverse of the removal procedure.

8.5.5 Replacement of barrier board assembly

1. Remove power supply assembly as in Section 8.5.4.

   Note: It is not necessary to disconnect wires.
2. Remove connectors PL3 and PL4.
3. Remove 4 × hex head screws holding assembly in place.
4. Installation is the reverse of the removal procedure.

After servicing replace the explosion proof cover. Tighten the locking screw. Recalibrate.

8.6 Leak test

It is recommended that the complete gas system is leak tested.

1. Common the ‘Sample In’ and ‘Sample Out’ gas connections and connect a water manometer to the junction.
2. Pressurize the sample system to 500mm water gauge and measure the rate of pressure loss on the manometer. (For a typical 5mm ID manometer, this should be less than 1mm water in a two minute period.)
3. If the leak rate is excessive, check analyser pipework for leaks using a solution of neutral wetting agent.
4. Rectify leaks and re-check.

NOTE

When pressurising the system, ensure that the sample gas inlet and outlet are coupled together and raise the pressure slowly to prevent potential damage to the measuring cell.

When trying to find a leak using a wetting agent, do not apply excessive pressure to the system – if the leak is ‘big’ the measuring cell will be subjected to a gas flow dependant on the leak rate.

This page deliberately left blank

9 CONTROL UNIT SERVICING

9.1 Control unit layouts

The model 2210 (Zone 2/Div 2) and model 2213 (Zone 1/Div 1) differ mechanically but have common electronics assemblies.

The display, display adaptor and keypad are mounted behind the metal cover on the hinged lid. Other boards are located as shown in Figures 19 and 20.

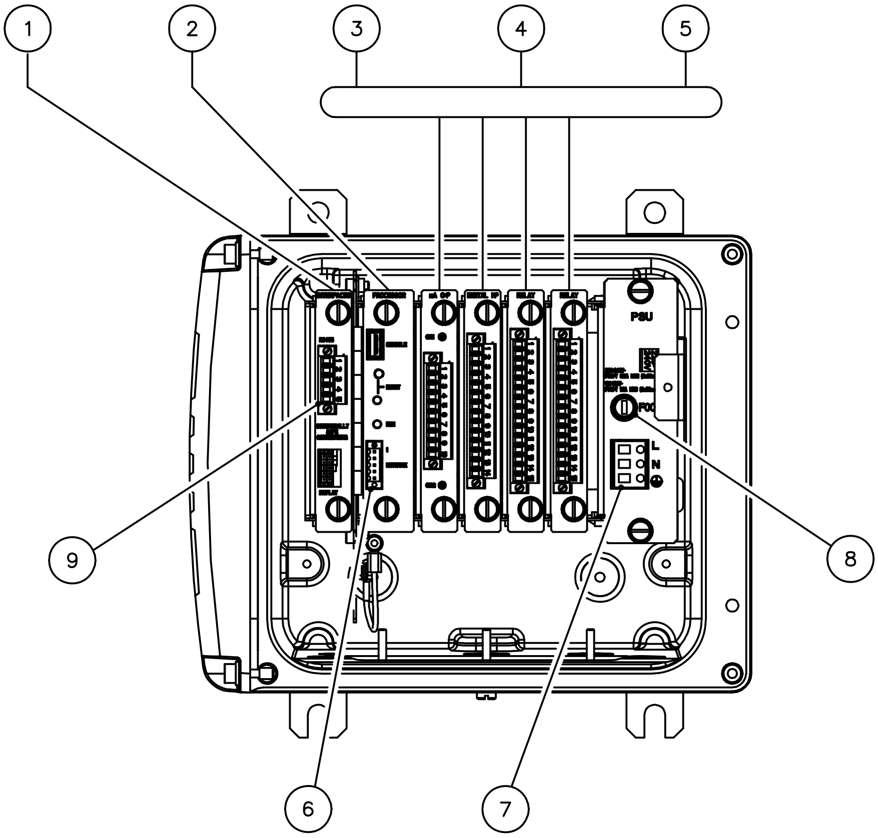


Figure 18 Model 2210 Control Unit (Zone 2, Div 2) layout

Key to Figure 19

1 - Interfaces board
2 - Processor board
3 - Option board – analog output
4 - Option board – digital input
5 - Option board – relay
6 - Network connector (MODBUS RS485 or Ethernet)
7 - Power supply terminals
8 - Mains fuse
9 - Transmitter connection block

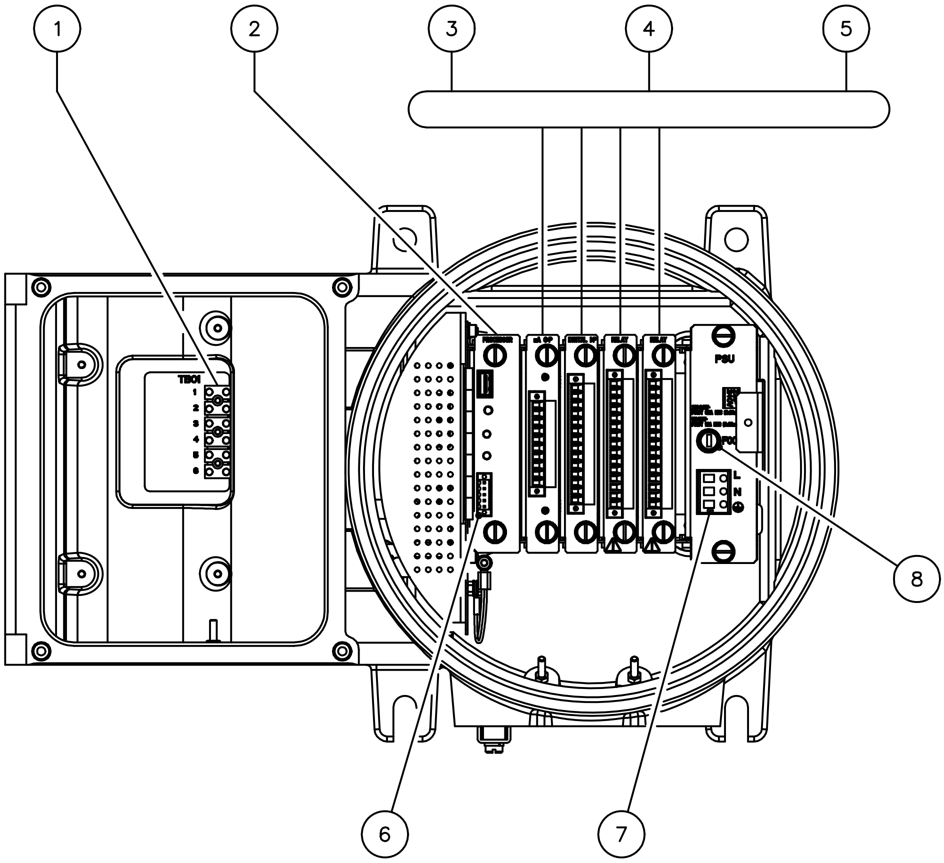


Figure 19 Model 2213 Control Unit (Zone 1, Div 1) layout

Key to Figure 20

1 - Transmitter connection block
2 - Processor board
3 - Option board – analog output
4 - Option board – digital input
5 - Option board – relay
6 - Network connector (MODBUS RS485 or Ethernet)
7 - Power supply terminals
8 - Mains fuse

9.2 Replacement of electrical assemblies

Isolate the control unit from electrical power.

> **WARNING**
>
> Reminder – the connection *between* the transmitter and control unit is intrinsically safe.

Model 2210

Access is by undoing the 4 screws on the front cover and opening the door. Release the single screw securing the inner door.

Model 2213

Access to the main compartment is by releasing the locking screw of the explosion-proof cover and unscrewing it anti (counter)-clockwise. Release the single screw securing the inner door.

9.2.1 Signal boards, option boards and power supply

Any option board may be fitted in any of the positions 1 to 4, and more than one board of the same type can be fitted to provide multiple outputs.

> **NOTE**
>
> An option board must be replaced in the slot from which it was removed.
>
> **If option boards are removed from a control unit, and not replaced before power is re-applied any configuration of the options will be deleted.**
>
> **Appendix B contains forms that may be used to document customer configuration of option boards prior to servicing the unit.**

1. Please note the position of boards and electrical connectors. Boards and connectors **must** be reinstalled in the original positions.
2. Release the securing screws for the assembly.
3. Install replacement assembly.
4. Make electrical connections.
5. Adjust mA output if required (see Section 9.3).

> **CAUTION**
>
> The power supply must be configured for use at the operational voltage. This involves checking that the correct fuse is installed and that the appropriate voltage selection 'header' is fitted.

9.2.2 Replacement of display adaptor assembly

The display adaptor is mounted on the rear of the hinged door; see Figure 21.

1. Remove the connecting earth cable from the door assembly.
2. Remove the 5 screws securing the covering plate.
3. Remove the ribbon cable to the keyboard.
4. Remove the 4 screws securing the display adaptor assembly and remove the board. **Lift the board off squarely to avoid damaging connection pins.**
5. Remove the cable to the Interfaces board.
6. Installation is the reverse of the removal procedure.

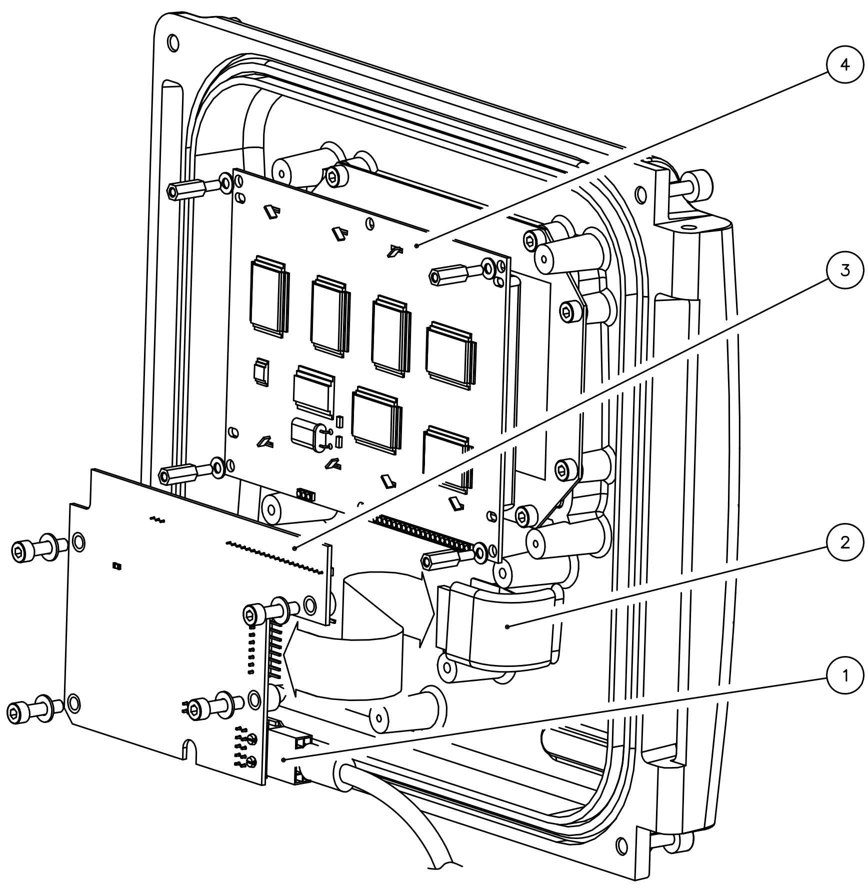


Figure 20 Display location

Key to Figure 21

1 - Cable to interfaces board
2 - Ribbon cable to keypad
3 - Display adaptor board
4 - Display module

9.2.3 Replacement of display module

The display module is mounted on the rear of the hinged door; see Figure 20.

1. Remove the connecting earth cable from the door assembly.
2. Remove the 5 screws securing the covering plate.
3. Remove the ribbon cable to the keyboard.
4. Remove the 4 screws securing the display adaptor assembly and remove the board. **Lift the board of squarely to avoid damaging connection pins.**
5. Remove the 4 screws securing the display module and remove the display assembly.
6. Installation is the reverse of the removal procedure.

9.2.4 Replacement of keypad

The keypad is an integral part of the front door and is supplied as a sub-assembly. The display and all fixtures and fittings should be removed prior to fitting a new door.

1. Remove the hinge pins (the door may be removed once the upper pin is unscrewed).
2. Fit the new door. Please note the washer located on lower hinge pin.
3. Transfer fixtures and fittings from old door assembly.

9.3 Setting of 4-20mA output

The 20mA settings of the 4 – 20mA output are factory set. The zero point is fixed in hardware, however, the span may be checked and adjusted as required using the appropriate trim pots.

Access is through the appropriate hole in the card front, labelled CH1 and CH2.

Any current output can be set using the output test function; see the operations manual.

1. Set up the output test function via the control unit (this condition will last for five minutes unless the relevant form is quit).
2. Adjust CH1 or CH2 as appropriate so that meter indicates the test current value.

This page deliberately left blank

10 SERVICE CHECK LIST

Following completion of any servicing check:

Item	Checked
The unit is correctly earthed/grounded	
Connection is made to control unit	
Connection is made to analog output (as required)	
Connection is made to analog inputs (as required)	
Connection is made to alarm relays (as required)	
Connection is made to digital inputs (as required)	
Sockets are secured to their relevant boards	
All wiring terminations are tightened	
Screws in unused terminals are tightened	
Cable glands are secured and made weather-tight	
Cables are dressed neatly within the enclosures	
Inner door is secured	
Hazardous area safety requirements are complied with	
External electrical connections are labelled	
Covers are secured and weatherproof	
Sample gas system is leak free	
Reprogrammed as required	

This page deliberately left blank

11 SPARE PARTS

Parts used for routine maintenance are listed in the relevant installation manual. This section includes part numbers for those items that may be used during field service.

The replacement of items not listed will usually require the unit to be serviced at the Servomex factory.

11.1 Recommended spare parts

The stock of spare parts required depends upon:

1. the reliance placed upon the analyser system
2. the number of similar units on the system
3. the locality/availability of a Servomex stockist

However, it is recommended that a number of power supply fuses are readily available and that an appropriate spare measuring cell is stocked for the transmitter to facilitate changeover should the sample system malfunction.

11.2 Model 2210 Control Unit

Item Description	Part Number
Fuse F001 110v, nominal, operation T, 1A, 250V, HRC, 20mm	2531-2630
Fuse F001 240v, nominal, operation T, 500mA, 250V, HRC, 20mm	2531-2616
Power supply module (see voltage setting links below)	S2210903A
100-110V nominal voltage selector link	02210920A
220-240V nominal voltage selector link	02210920B
Display adaptor board	02210902
Display module	S2210921A
Interfaces board	02210907
Processor board with MODBUS RS485	S2210931
Processor board with MODBUS Ethernet	S2210932
Relay board	02210904
Analog output board	02210906
Digital input board	02210905
Door assembly for ATEX certified product	S2210981ATEX
Door assembly for CSA certified product	S2210981CSA
Door assembly for FM certified product	S2210981FM
Manuals	See section 1.2

11.3 Model 2213 Control Unit

Item Description	Part Number
Fuse F001 110V, nominal, operation T, 1A, 250V, HRC, 20mm	2531-2630
Fuse F001 240V, nominal, operation T, 500mA, 250V, HRC, 20mm	2531-2616
Power supply module, see voltage setting links, below	S2210903A
100-110V nominal voltage selector link	02210920A
220-240V nominal voltage selector link	02210920B
Display adaptor board	02210902
Display module	S2210921A
Interfaces board	02210907
Processor board with MODBUS RS485	S2210931
Processor board with MODBUS Ethernet	S2210932
Relay board	02210904
Analog output board	02210906
Digital input board	02210905
Door assembly	02213981
Manuals	See section 1.2

11.4 Model 2222 Transmitter Unit

Item Description	Part Number
Oxygen sensor assembly, with 357 cell	S1157000
Inlet filter, stainless steel	2377-3862
Viton ‘O’ ring for stainless steel inlet filter	2323-7803
Fuse 1.6A, 250V	2531-2267
Flow sensor - stainless steel compatible	S1760000
Cartridge heater <110C version, 100-240V nom.	203600
Cartridge heater <135C version, 220-240V nom,	203911
Cartridge heater <135C version, 110-120V nom.	203912
Cartridge heater <135C version, 100V nom.	203913
Barrier board	02223903
Heater/supply board (see voltage setting links below)	S2223902A
100-110V nominal voltage selector link	02223920A
220-240V nominal voltage selector link	02223920B
100V nominal voltage selector link	02223920C
120V nominal voltage selector link	02223920D
Signal processing board for 110°C version	S2223911A
Signal processing board for 135°C version	S2223911B

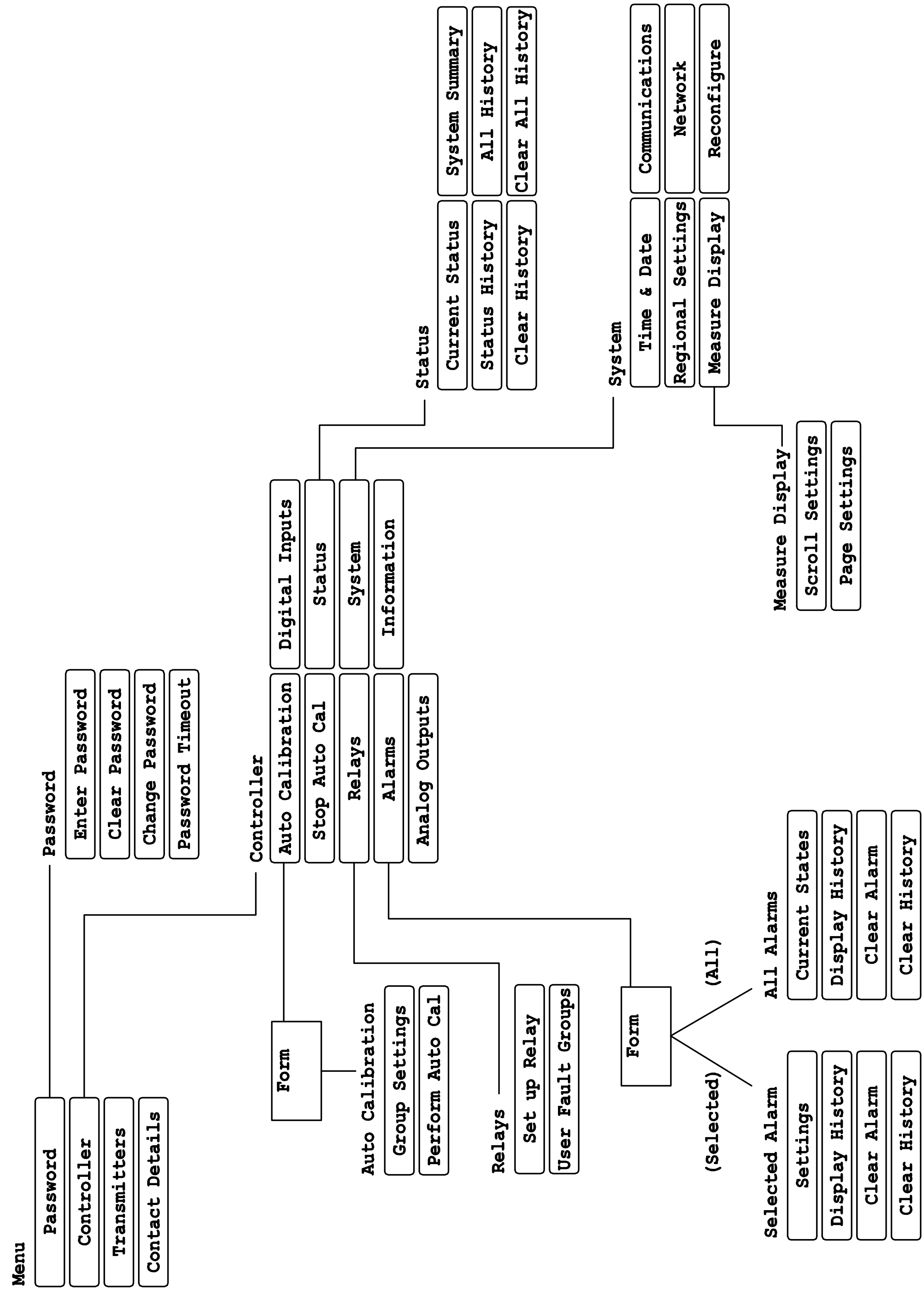
11.5 Model 2223 Transmitter Unit

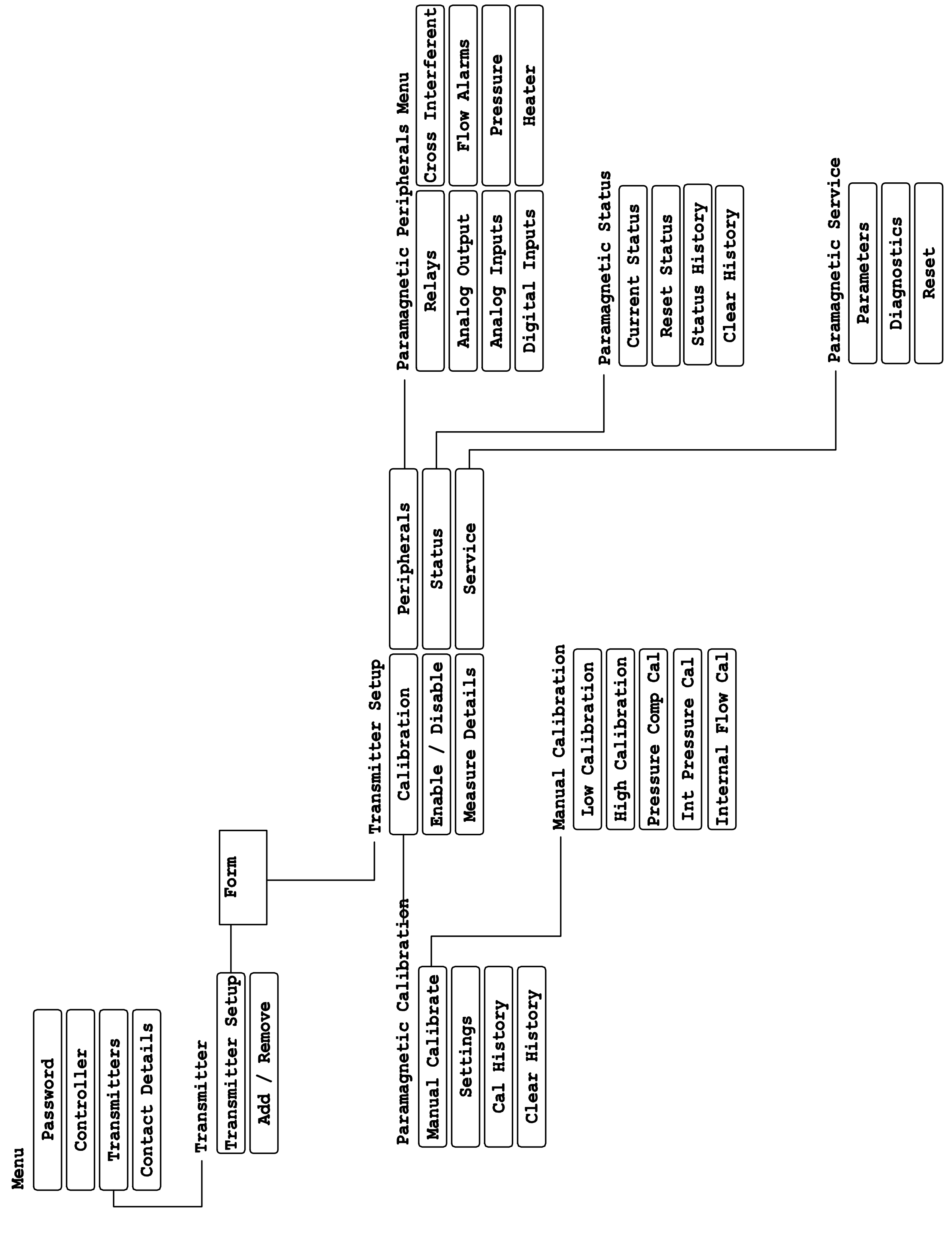
Item Description	Part Number
Oxygen sensor assembly, with 325 cell	01160000
Oxygen sensor assembly, with 357 cell	01160702
Inlet filter, stainless steel	2377-3862
Viton ‘O’ ring for stainless steel inlet filter	2323-7803
Inlet filter, hastelloy	2377-3879
Chemraz ‘O’ ring for hastelloy inlet filter	2323-7928
Fuse 1.6A, 250V	2531-2267
Pressure sensor	S2223924
Flow sensor - stainless steel compatible	S1760000
Flow sensor - hastelloy compatible	S1760H000
Cartridge heater	2653-1375
Barrier board	02223903
Heater/supply board (see voltage setting links below)	S2223902A
100-110V nominal voltage selector link	02223920A
220-240V nominal voltage selector link	02223920B
Signal processing board	02223901
Signal processing board (TIIS TC21163)	02223931

This page deliberately left blank

Appendix A User Menu Tree

(continued overleaf)





Menu
Password
Controller
Transmitters
Contact Details
Transmitter
Transmitter Setup
Add / Remove
Form
Transmitter Setup
Calibration
Enable / Disable
Measure Details
Peripherals
Status
Service
Paramagnetic Calibration
Manual Calibrate
Settings
Cal History
Clear History
Manual Calibration
Low Calibration
High Calibration
Pressure Comp Cal
Int Pressure Cal
Internal Flow Cal
Paramagnetic Peripherals Menu
Relays
Analog Output
Analog Inputs
Digital Inputs
Cross Interferent
Flow Alarms
Pressure
Heater
Paramagnetic Status
Current Status
Reset Status
Status History
Clear History
Paramagnetic Service
Parameters
Diagnostics
Reset

Analog Output / Settings

	Output ____ . 1	Output _____ . 2
Analog Output Enabled		
Current Measurement		
New Measurement	N/A	N/A
Change Measurement	N/A	N/A
Output Current Range		
Output Range		
Underrange Current		
Jam		
On Service In Progress		
AutoRange Change At		
AutoRange Hysteresis		
AutoRange Change When		
Primary Output Range Settings		
Measurement 1		
Measurement 2		
Secondary Output Range Settings		
Measurement 1		
Measurement 2		
OK	N/A	N/A
Cancel	N/A	N/A
Current Output	N/A	N/A
Analog Output Test	N/A	N/A
Output Test Current		
Test Analog Output	N/A	N/A
Stop Analog Output Test	N/A	

Analog Output / Settings

	Output ____ . 1	Output _____ . 2
Analog Output Enabled		
Current Measurement		
New Measurement	N/A	N/A
Change Measurement	N/A	N/A
Output Current Range		
Output Range		
Underrange Current		
Jam		
On Service In Progress		
AutoRange Change At		
AutoRange Hysteresis		
AutoRange Change When		
Primary Output Range Settings		
Measurement 1		
Measurement 2		
Secondary Output Range Settings		
Measurement 1		
Measurement 2		
OK	N/A	N/A
Cancel	N/A	N/A
Current Output	N/A	N/A
Analog Output Test	N/A	N/A
Output Test Current		
Test Analog Output	N/A	N/A
Stop Analog Output Test	N/A	

Relay Settings

	Relay _____ . _____	Relay _____ . _____
Uass'd Add Remove	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

	Relay _____ . _____	Relay _____ . _____
Uass'd Add Remove	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

Relay Settings

	Relay _____ . _____	Relay _____ . _____
Uass'd **Add** **Remove**	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

	Relay _____ . _____	Relay _____ . _____
Uass'd **Add** **Remove**	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

Relay Settings

	Relay _____ . _____	Relay _____ . _____
Uass'd Add Remove	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

	Relay _____ . _____	Relay _____ . _____
Uass'd Add Remove	N/A	N/A
Assigned		
Inactive		
OK	N/A	N/A
Cancel	N/A	N/A
Current State	N/A	N/A
Relay Test	N/A	N/A
Energise Relay		
De-Energise Relay		
Stop Relay Test	N/A	N/A

Digital Input Settings

Input:	_____ . 1	_____ . 2	_____ . 3	_____ . 4
Input Enabled				
Unass'd	N/A	N/A	N/A	N/A
Add	N/A	N/A	N/A	N/A
Remove	N/A	N/A	N/A	N/A
Assigned				
Active State				
OK	N/A	N/A	N/A	N/A
Cancel	N/A	N/A	N/A	N/A
Current State				

Input:	_____ . 5	_____ . 6	_____ . 7	_____ . 8
Input Enabled				
Unass'd	N/A	N/A	N/A	N/A
Add	N/A	N/A	N/A	N/A
Remove	N/A	N/A	N/A	N/A
Assigned				
Active State				
OK	N/A	N/A	N/A	N/A
Cancel	N/A	N/A	N/A	N/A
Current State				

Input:	____ . ____	____ . ____	____ . ____	____ . ____
Input Enabled				
Unass'd	N/A	N/A	N/A	N/A
Add	N/A	N/A	N/A	N/A
Remove	N/A	N/A	N/A	N/A
Assigned				
Active State				
OK	N/A	N/A	N/A	N/A
Cancel	N/A	N/A	N/A	N/A
Current State				