NOVATECH

OXYGEN ANALYSER
TRANSMITTER
MODEL 1532

CONTENTS

NOTE: This manual includes software modifications up to - Version 809, 7th September 1993.

All correspondence should be addressed to:

Technical Enquiries
Novatech Controls (Aust.) Pty Ltd
429 Graham Street
Port Melbourne — Phone: Melb 03 645 2377
Victoria 3207 — Phone: Outside Melb. 008 337 063
Australia. — Fax: 03 646 3027

USING THIS MANUAL

The Novatech 1532 Oxygen Transmitter has a variety of user-selectable functions.

They are simple to use because each selection is menu driven. For options you are not sure about; read the manual on that particular item.

Please read the safety information below and the 'Installation' section before connecting power to the analyser.

CAUTION
1

Combustion or atmosphere control systems can be dangerous. Burners must be mechanically set up so that in the worst case of equipment failure, the system cannot generate explosive atmospheres. This danger is normally avoided with flue gas trim systems by adjustment so that in the case of failure the appliance will not generate CO in excess of 400 ppm in the flue. The CO level in the flue should be measured with a separate CO instrument, normally an infrared or cell type.

CAUTION
2

The oxygen sensor may be heated to above 700°C and can be a source of ignition. Since raw fuel leaks can occur during burner shutdown, the analyser has an interlocking relay which removes power from the probe heater when the main fuel shut-off valve power is off. If this configuration does not suit or if it is possible for raw fuel to come into contact with a hot oxygen probe then the Model 1532 analyser with a heated probe may be unsuitable for your application.

An unheated probe can be utilised in such applications, however the oxygen readings are valid only above 650°C.

CAUTION
3

The reducing oxygen signal from the analyser and the associated alarm relay can be used as an explosive warning or trip. This measurement assumes complete combustion. If incomplete combustion is possible then this signal will read less reducing and should not be used as an alarm or trip. A true excess combustibles analyser, normally incorporating a catalyst and thermal conductivity bridge, would be more appropriate where incomplete combustion is possible.

Also read the probe electrical shock caution in Section 2.5 and the probe heater interlock caution in Section 6.5.

SPECIFICATIONS

1

1.1 MODEL 1532 OXYGEN ANALYSER

DESCRIPTION

The Novatech model 1532 oxygen analyser/transmitter provides in-situ measurement of oxygen in furnaces, kilns and boilers and in flue gases with temperatures from ambient up to 1400°C. The analyser provides local indication of oxygen plus thirteen other selectable variables.

Two linearised 4–20 mA output signals are provided. Alarms are displayed at the analyser and relay contacts activate remote alarm devices. The analyser, which is available for heated or unheated zirconia oxygen probes, provides automatic on-line gas calibration of the probe and filter purging, when used with the 1536 purge & calibration panel. The electronics self-calibrates all inputs every two seconds.

The 1532 has an internal keyboard for selecting the output range, thermocouple type, etc., as well as maintenance and commissioning functions. The instrument is microprocessor based and all adjustments are made using the internal keyboard.

- Used for air/fuel ratio combustion control
- Simple to install
- Linear output of % oxygen for recording or control
- Built in safety features
- 17 different alarm functions warn the operator of combustion, probe or analyser problems
- RS 232-C/RS 485 printer/computer interface
- Safety interlock relay for heated probe

SPECIFICATIONS

Inputs

- o Zirconia oxygen probe–heated or unheated.
- o Furnace, kiln or flue thermocouple, field selectable as type T, J, K, R, S, N. (optional).
- o Main flame established safety interlock (for heated probes only).
- o Ambient air sensor (optional).
- o Relative Humidity Sensor (optional).
- o Purge and Reference air flow switches.
- o Dual Fuel selector .

Outputs

- Two linearised 4–20 mA DC outputs (max. load 600 _).
- Common alarm relay.
- Probe not ready relay (under temperature).
- Auto cal/purge occurring relay (output is frozen when probe cal or purge is occurring).
- Alarm horn driver relay.

Computer

- RS 232-C or RS 485 for connection of a computer terminal or printer for diagnostics of the analyser, probe or combustion appliance.

Range of Output 1
Field selectable from the following:

Output Selection	Range
Linear	0–1% oxygen to 0–100 % oxygen
Log	0.1–20 % oxygen
Reducing	As described under Output 2 (see below)

Range of Output 2

Field selectable from the following:

Output	Zero Range	Span Range
Probe EMF	0–1100 mV in 100 mV steps	1000–1300 mV in 100 mV steps
Carbon Dioxide	0–10 %	2–20 %
Oxygen Deficiency	0–20% O_2 deficiency	0–100% O_2 excess
Efficiency	0 % Fixed	100 % Fixed
Stack Temperature	0–100°C in 1°C steps	100–1400°C in 100°C steps
Log Oxygen	0.1% O_2 Fixed	20% O_2 Fixed
Reducing Oxygen	10^{-1}–10^{-10} % oxygen in one decade steps, non-overlapping	10^{-1}–10^{-25} % oxygen in one decade steps. Min span two decades

Range of Indication, Upper Line

- Auto ranging from 10^{-25} to 100% 0_2

Indication Choice,Lower Line

Any or all of the following can be selected for lower line display:

Options:

- Date - time
- Run Hours since last service
- Date of last service
- Relative Humidity
- Probe Impedance
- Carbon Dioxide
- Oxygen Deficiency
- Probe EMF
- Efficiency
- Probe Temperature
- Stack Temperature
- Ambient Temperature
- Rear Head (Spare TC) Temperature

The oxygen deficiency output can be used in the same way as a combustibles analyser to signal the extent of reducing conditions of combustion processses.

Accuracy

- ±3% of actual measured oxygen value with a repeatability of ±0.5% of measured value.

Relay Contacts

- 4A 240 VAC, 2A 50 VDC

Ambient Temperature

- 0–50°C

Power Requirements

- 240 or 110V, 50/60 Hz, 150 VA (heated probe)
- 20 VA (unheated probe)

Weight
- Unheated probe analyser 8.5 kg
- Heated probe analyser 12.5 kg

Mounting

- Suitable for wall or surface mounting.

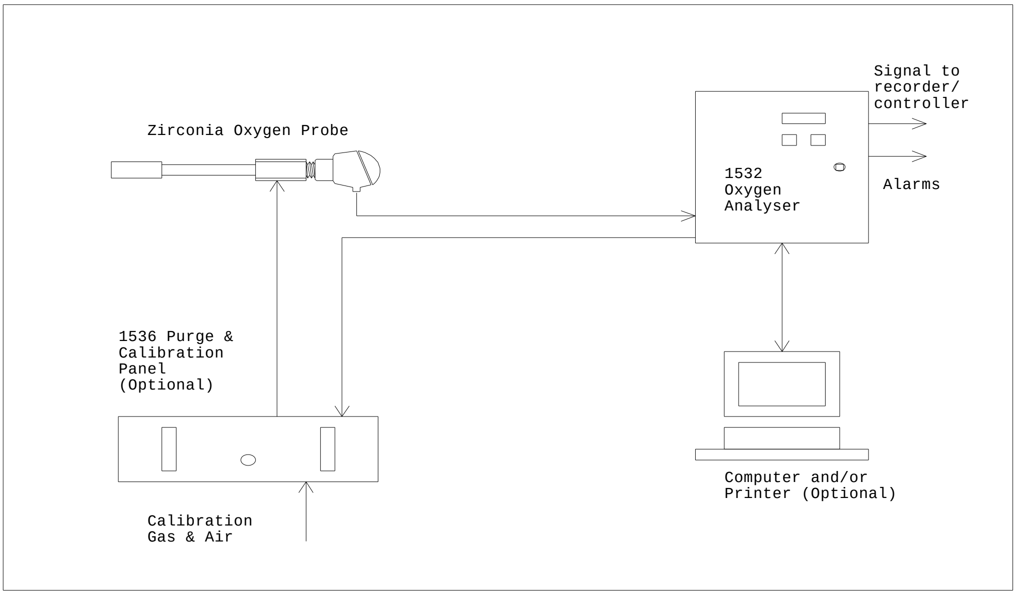


Figure 1.1 Probe and Analyser System

1.2 SERIES 1230 OXYGEN PROBES

FEATURES

- Fuel savings and pollution control in boilers, furnaces and kilns
- Low cost
- Simple to install

DESCRIPTION

Novatech series 1230 oxygen probes provide in-situ measurement of the oxygen level in boilers, kilns and furnaces. Series 1230 probes allow major fuel savings in combustion control applications. In atmosphere control of metal and ceramic heat treatment processes, series 1230 probes provide improved quality control. Ask for separate literature on this subject.

Novatech series 1230 oxygen probes employ state-of-the-art zirconia sensors and advanced materials, which provide the following benefits:

- Improved control due to fast response time–typically less than four seconds

- Cost-efficient design provides improved reliability

- Longer-life probe–greater resistance to corrosion from sulphur and zinc contaminants in flue gas

- Low-cost maintenance–simplified design allows easy refurbishment

- Reduced probe breakage–greater resistance to thermal shock during installation and start-up

Series 1230 probes are simple to install and maintain. All models provide direct measurement of oxygen level. On-line automatic calibration is available if required. Probes may be used with Novatech oxygen analysers and purge/cal panels and some model analysers from other manufacturers.

All Novatech oxygen probes are designed and manufactured to exacting standards of performance and reliability. Series 1230 probes are the result of extensive research and development by Novatech, industry and government agencies, including the CSIRO. Novatech Controls provides application and after-sales support for oxygen probes and ar

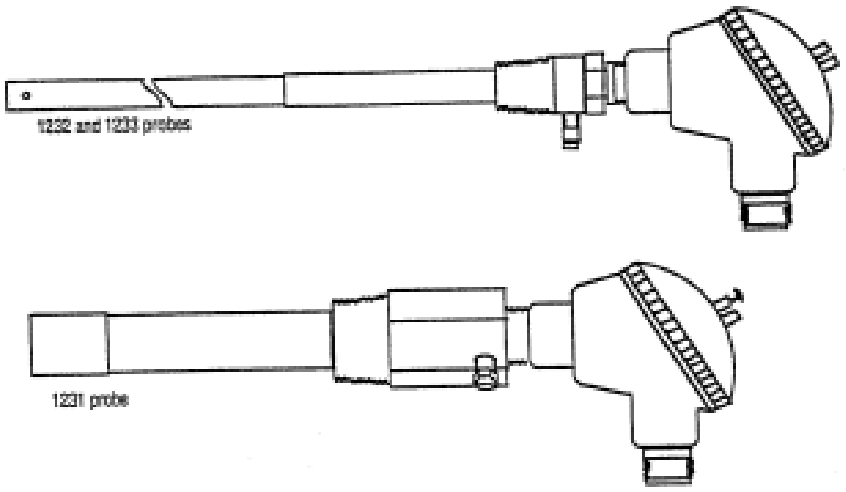


Figure 1.2 Oxygen Probes

ORDERING INFORMATION

Orders may be placed by submitting the following information (please number each item as below):

1. Combustion plant (e.g. boiler, furnace, kiln, etc.).

2. Type and size of plant.

3. Type of fuel(s).

4. Contaminants in gas being measured (e.g. sulphur, zinc, etc.) State percentage of contaminant if known.

5. Probe insertion length (from process end of mounting thread to probe sensing tip).

6. Probe cable (run distance between the probe and the analyser-maximum length 50metres.)

7. Lagging extension length, if required.

8. Mounting thread (process connection)—BSP or NPT (for size of thread refer to Specifications).

9. Operating temperature range—maximum and minimum temperatures for which probe readings are required.

10. If model 1232 probe, state preferred thermocouple type (Refer to Specifications).

11. If model 1231, state if separate flue gas thermocouple is required (refer to Note 3—Specifications).Also state preferred type: T, J, K, or N; insertion length; preferred thread—1/2" BSP or NPT; and length of lagging extension, if required.

12. If a 1231 probe longer than 1000 mm is required, specify flow guide tube type 1239 and required overall length. The oxygen probe fits into the flow guide tube. The probe sensing tip must be inside the flue wall 200 mm (8") or more.

13. Choose reference air kit or purge/cal panel.

Ask your local Novatech Distributor for assistance in ordering.

STANDARD PROBE 'U' LENGTHS

1231	**1232**	**1233**
250 mm (9.8")	300 mm (11.8")	457 mm (18")
500 mm (19.7")	500 mm (19.7")	609 mm (24")
750 mm (29.5")	750 mm (29.5")	914 mm (36")
1000 mm (39.4")	1000 mm (39.4")	1160 mm (45.8")
	1160 mm (45.8")	

Above 1000 mm use a Model 1239 Flow Guide Tube

Note:
Non standard sizes–within the range of standard lengths–can be specified on request.

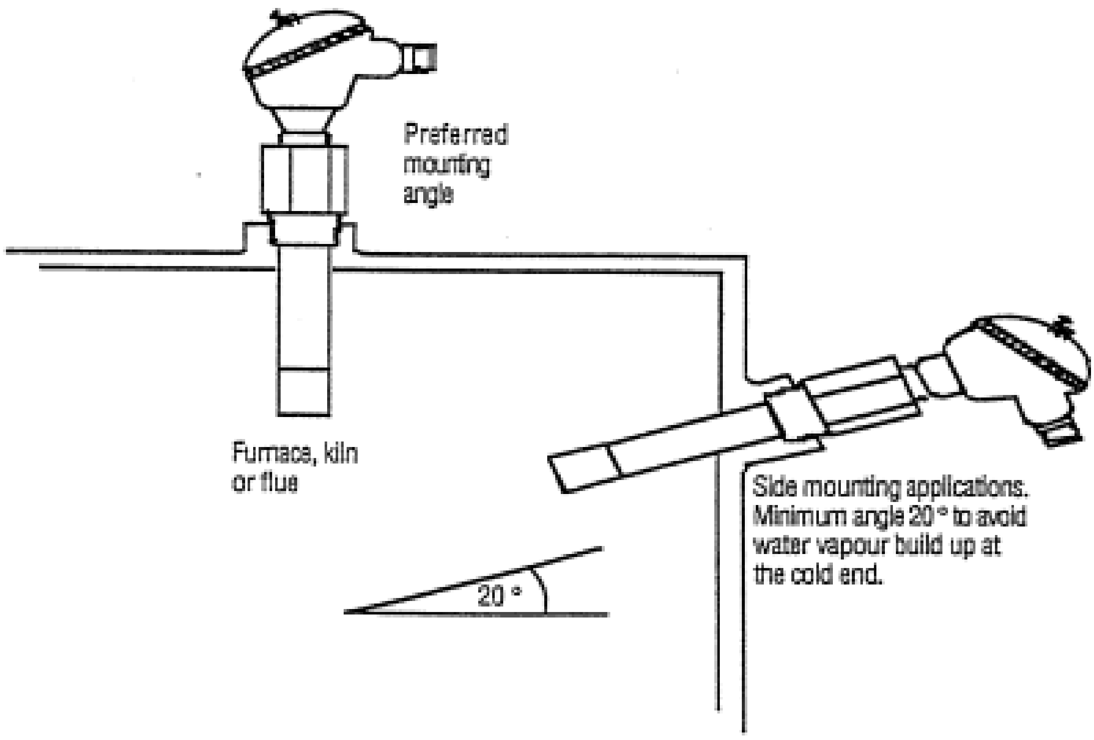


Figure 1.3 Probe Mounting

SPECIFICATIONS

MODEL	1231	1232	1233
Application	Combustion flue gases below 900°C (1830°F) refer to note 1	Combustion flue gases above 700°C (1290°F) with no contaminants. e.g. natural gas, light oils	Combustion flue gases above 700°C (1290°F) with contaminants such as zinc or sulphur.Refer note 2.
Temperature Range	0–900°C (32–1830°F)	700–1400°C (1290–2550°F)	700–1200°C (1290–2190°F)
Length	250–1000 mm (5.5–39 ")Above 1000 mm refer to Ordering info. 12	300–1160 mm (12–46 ")	300–1160 mm (12–46 ")
Process Connection	1 1/2" BSP or NPT	3/4" BSP or NPT	1" BSP or NPT
Heater	Yes	No	No
Flue Gas Thermocouple	Ordering info. 11 & note 3	R , integral	R, integral
Response Time	Typically less than 4 secs. See note 4.	Typically less than 1 sec. See note 4.	Typically less than 1 sec. See note 4.
Head Temperature	150°C (300°F) Max	150°C (300°F) Max	150°C (300°F)Max
Reference Gas	Ambient air 50 cc/min approx. Pump supplied with probe		
Reference Gas Alarm		Piston actuated flow switch	
Reference Air Connection	1/8" NPT female	Integral air line in probe cable. Barbed fitting to 3/16" ID PVC tube.	
Probe Cable	Supplied with connector to specified length - maximum 50 m (160 ft)		
Calibration Gas	1/8" NPT female	1/16" NPT female	1/16" NPT female
Weight	0.6 kg (1.35 lbs) plus 0.33 kg/ 100 mm (0.75 lbs/in)	0.4 kg (0.9 lbs) plus 0.1 kg/100 mm (0.6 lbs/in) length	

Probe M.T.B.F. Typically 1-2 years. -A low cost refurbishing service is available.

Notes:

(1) Care must be taken to avoid contact with explosive or inflammable gases with 1231 heated probes when hot. Novatech analysers have built in safety protection.

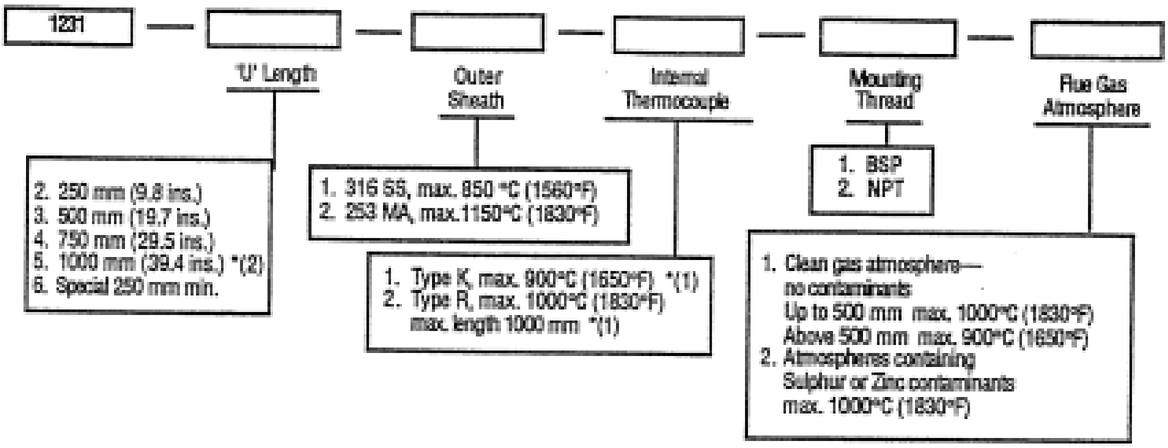
(2) Please contact factory for corrosives other than sulphur or zinc. We can provide test materials to try in your atmosphere.

(3) A separate flue gas thermocouple is required if an efficiency or oxygen deficiency display is needed from the analyser The probe thermocouple is used to control probe temperature.

(4) For normal probe. Typically 70 seconds for 500 mm (19.7") probe with 2000 mm (78.7") flow guide tube.

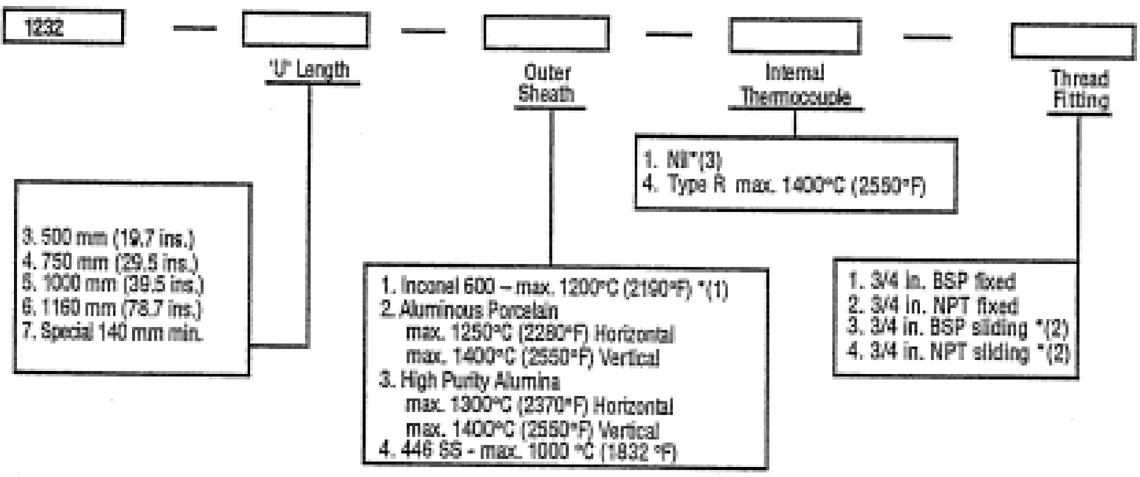
OXYGEN PROBE MODEL SELECTION GUIDE

Heated probe—temperature range 0–1000°C (32–1830°F)



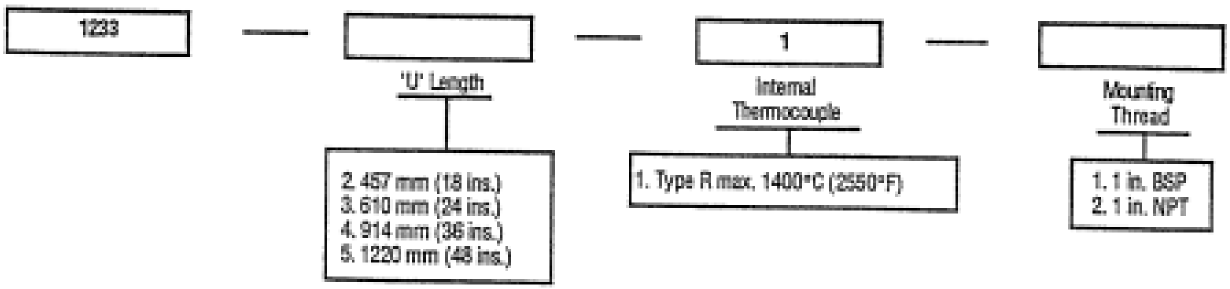
*Note: (1) A separate flue gas temperature thermocouple is required if calculation of the efficiency, excess fuel, CO_2, etc. are required.
(2) If probe longer than 1000 mm is required, use shorter 1231 probe with 1239 Flow Guide Tube.

Unheated probes for clean gases—temperature range 700–1400°C (1290–2550°F)



*Note: (1) Standard Carbon probe has Inconel sheath.
(2) Sliding compression fitting available for Inconel sheath only. If selected, deduct 50 mm (2 ins.) from available insertion length 'U'.
(3) For applications up to 1150°C (2100°F), it may be more economical to use a separate type 'K' or 'N' thermocouple than an internal 'R' thermocouple. It is important that a separate thermocouple senses the same temperature as the Oxygen probe tip.

Unheated probes for contaminated gases—temperature range 700–1200°C (1290–2190°F)



1.3 FLOW GUIDE TUBES

The maximum insertion length of Novatech oxygen probes is 1000 mm. Occasionally, for large flues, there is an advantage to have a longer insertion length to obtain a proper oxygen reading. In 99% of applications, 1000 mm is an adequate insertion length.

For longer insertion lengths a filtered flow guide tube is available. This tube diverts the flue gas stream from the point of sensing to a probe long enough to protrude through any flue lagging, typically 500–750 mm long.

Flow guide tubes are available in lengths from 1500–5000 mm. Longer flow guide tubes normally need supporting within the flue. The response time of flow guide tubes vary depending on the length and the amount of filter blockage. For a two metre tube it is typically 70 seconds. Particles blocking the filter can normally be removed by back-purging.

The weight of flow guide tubes is – 2000 mm: 10 kg, 5000 mm: 25 kg.

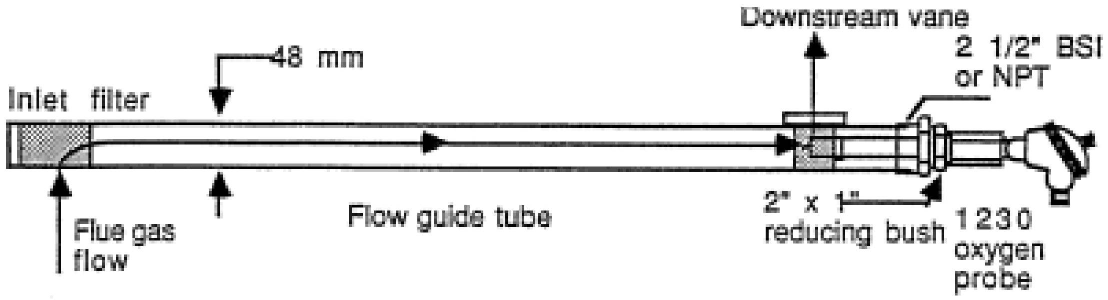
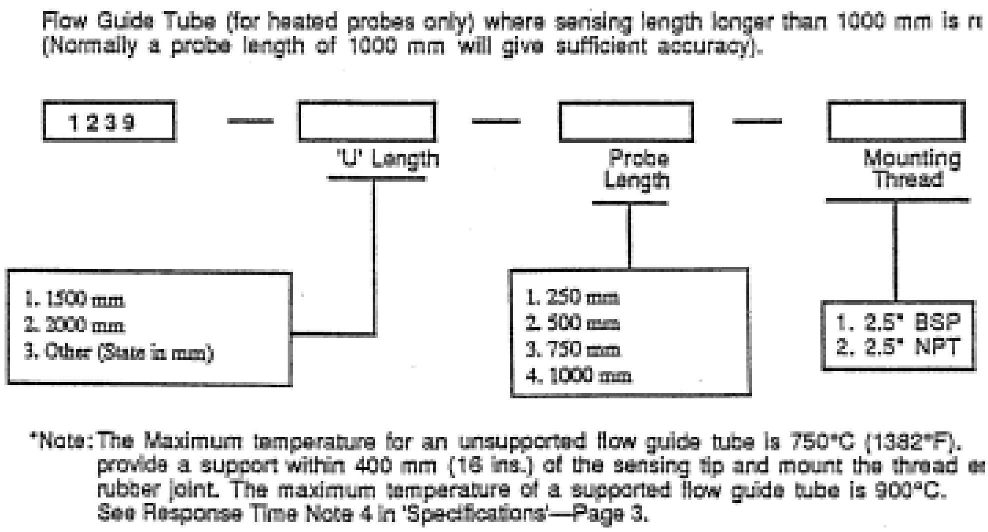


Figure 1.4 Flow Guide Tube

FLOW GUIDE TUBE SELECTION GUIDE



1.4 MODEL 1536 PURGE/CALIBRATION PANELS

Due to the absolute measurement characteristics of zirconia sensors and the self calibration features of Novatech analysers, probe calibration checks with calibrated gas are not normally required. In some installations however, automatic gas calibration checks are required by Environmental Protection Authorities and by production engineering management in Power Stations, Oil Refineries and similar large end users.

Novatech purge/calibration panels provide a ready method of connecting on-line calibration gases, and have a probe zero off-set check facility. They provide on-line automatic checking of probe and analyser calibration, as well as a probe purge facility and a reference air facility.

The absolute characteristics of zirconia sensors require only one calibration gas to properly check the probe's performance. Where required however, purge/cal panels are available to handle two calibration gases.

Dirty flue gas applications often require the back purge facility to keep a probe filter free from blockage. (In these applications, it is more reliable to install probes pointing vertically downwards with no filter). The purge and cal solenoid valves can be operated manually or automatically from a 1532 series transmitter or a 1533 trim monitor or controller.

Each panel is supplied with:

- A reference air flow meter/regulator
- A reference air flow switch
- A hand valve for zero off-set calibration
- A calibration gas flow meter/regulator
- A 24 VAC solenoid valve for each calibration gas

Panels with filter purge include:

- A 24 VAC purge solenoid valve
- A purge flow switch to test for filter blockage.

The customer should supply:

- Span gas cylinder(s), typically 2 % oxygen in nitrogen or a similar percentage of 0_2 close to the normal level in the gas stream being measured, to ensure fast recovery.

- A 100 kPa (15 P.S.I.) clean and dry instrument air supply when filter purging is required. If purging is not required and instrument air is not available, an electric pump should be used for reference air and zero off-set calibration air.

PURGE/CAL PANEL MODEL SELECTIONS

Model Number	No of Span Gases	Filter Purge	For Class 1 Hazardous Area
1536–1	1	No	No
1536–2	2	No	No
1536–3	1	Yes	No
1536–5	1	No	Yes
1536–6	2	No	Yes
1536–7	1	Yes	Yes

1.5 SPECIFICATIONS – AMBIENT HUMIDITY PROBE

(Required only if improved accuracy is required on efficiency or oxygen deficiency outputs)

Model	CH15
Humidity Range	0 –100 % RH
Temperature	–20 – +90 ° C
Output	0 –1 VDC , linearly proportional to 0 –100 % RH

1.6 SPECIFICATIONS – REFERENCE AIR & FILTER PURGE FLOW SWITCHES

Model –	Reference Air	LPH–125–0 *
	Filter Purge	LPH–125–7 *
Range –	Reference Air	50 c.c./minute
	Filter Purge	2500 c.c./minute
Dimensions	50 mm high by 14 mm wide	
Type		Magnetic piston & reed switch, 1 AMP.
Mounting		Vertical only

* Suffix ‘A’ denotes acrylic body with flying leads. (Not suitable for outdoor installation) e.g. LPH–125-0A
Suffix ‘B’ denotes brass body with conduit thread entry for leads. Suitable for outdoor installation.

2 DESCRIPTION

DESCRIPTION

2.1 THE ZIRCONIA SENSOR

The analyser input is provided from a solid electrolyte oxygen probe which contains a zirconia element and thermocouple. The probe is designed to be inserted into the boiler or furnace exit gas flue. Sampling lines and filters are not required. A reference air supply or pump is required for probes with insertion length 250 mm and above. The probe sensing end construction is shown in Figure 2.1.

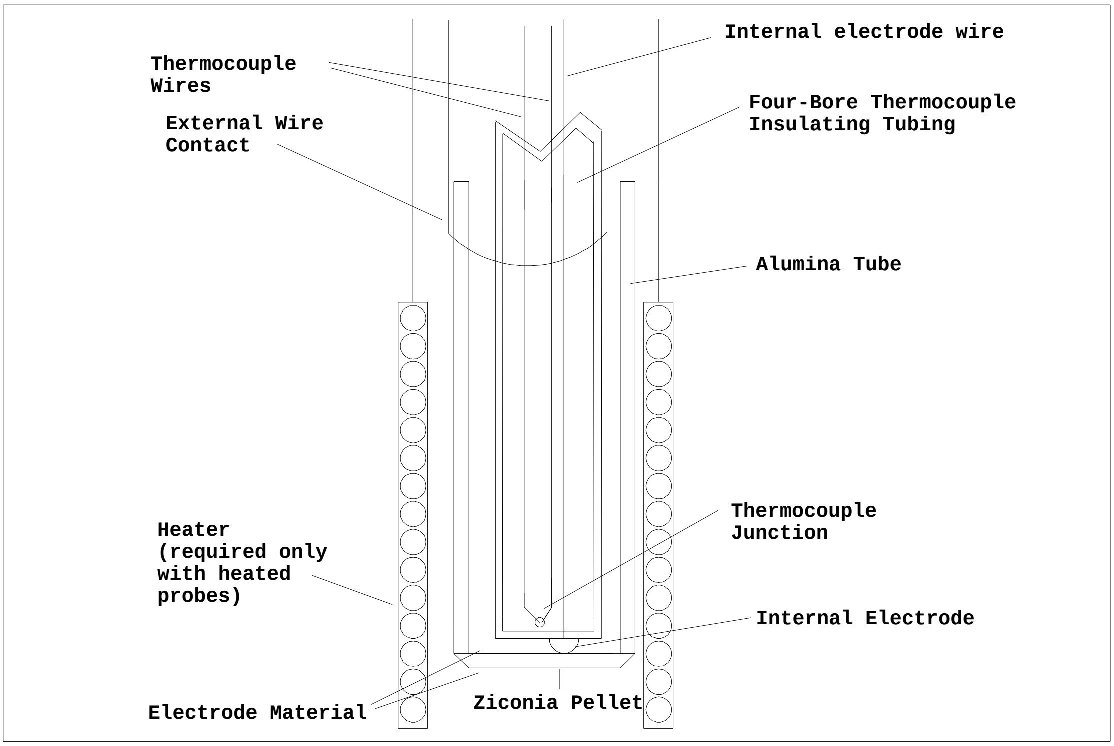


Figure 2.1 Schematic View of a Sensor Assembly

The heater control is a time proportioning temperature controller and triac so that the thermocouple junction is controlled to approximately 720°C. Probes operating in a combustion environment above 700°C do not require a heater.

When exposed to different oxygen partial pressures at the outside and inside of the sensor, an EMF (E) is developed which obeys the Nernst equation:

$$E \text{ (millivolts)} = \frac{RT}{4F} \log_e \frac{(PO_2) \text{ INSIDE}}{(PO_2) \text{ OUTSIDE}}$$

Where T is the temperature (K) at the pellet (> 650°C), R is the gas constant, F is the Faraday constant and (PO_2) INSIDE and (PO_2) OUTSIDE are the oxygen partial pressures at the inner and outer electrodes, respectively, with the higher oxygen partial pressure electrode being positive.

If dry air at atmospheric pressure, (21 % oxygen) is used as a reference gas at the inner electrode, the following equations are obtained:

$$E \text{ (millivolts)} = 2.154 \times 10^{-2}\, T \log_e \frac{0.21}{(PO_2) \text{ OUTSIDE}}$$

Transposing this equation

$$(\%O_2) \text{ OUTSIDE (ATM)} = 0.21 \text{ EXP } \frac{-46.421E}{T}$$

The 1532 transmitter solves this equation which is valid above 650°C. The probe heater, or the process maintains the sensor temperature at this level.

2.2 THE OXYGEN PROBE

The probe assembly provides a means of exposing the sensor to the atmosphere to be measured with sensor, thermocouple and heater wires connected via a weatherproof plug to the analyser lead. Reference air is fed via the plug for unheated probes and via a separate gas thread connection for heated probes.

Connections are provided for an in-situ gas calibration check. A cleaning purge of air can be admitted via the cal. gas entry. The outer sheath can be metal or ceramic, depending on the application.

In-situ zirconia oxygen probes will give a lower oxygen reading than a sampled gas measurement on a chromatograph or paramagnetic analyser because the flue gas contains a significant level of water vapour and a sampling system removes the water vapour through condensation. The oxygen content then appears as a higher percentage of the remaining gas. For example:

If the gas contained five parts oxygen and fifteen parts moisture, removing the moisture would leave the oxygen at 5.88%. This phenonema will depend on the fuel and the completeness of combustion. They are common to all zirconia oxygen sensors.

Probes of 1000 mm normally have sufficient length for any installation. Customers requiring probes longer than 1000 mm are supplied with a flow guide tube which uses the flue velocity to pull flue gas through a filter at the sensing tip and exhaust it near the flue wall.

2.3 THE ANALYSER

The 1532 analyser is a transmitter with two 4–20 mA. outputs. One output is % oxygen with selectable span (Refer to Set-up Steps 4 and 5 in Section 5.5).
The second output can be selected as oxygen deficiency, efficiency, flue temperature, reducing oxygen, percent carbon dioxide, probe EMF or a logarithmic oxygen range. Four alarm relays are provided. Refer to the specifications section for more details.

The 1532 analyser is designed to operate with either a heated or unheated, zirconia probe. The analyser maintains the temperature of heated probes at 720°C. If the flue gas temperature is above 730°C, the probe heater cuts out completely and the process provides probe heating. The analyser solves the Nernst equation and will provide accurate oxygen measurements up to 1500°C (2730°F), although most probes are suitable only to 1400°C (2250°F) and some are limited to 900°C (1650°F).

A block diagram of the analyser is shown in Figure 2.2 and details on its functions are given in the remainder of this section.

2.4 ALARMS

Refer to OPERATOR FUNCTIONS Section for details on alarm functions.

2.5 HEATER SUPPLY

CAUTION

The probe heater is supplied with 110 VAC at 1 A (cold). This supply has electrical shock danger to maintenance personnel. Always isolate the analyser before working with the probe. For maximum safety the heater supply is transformer isolated.

2.6 APPLICATIONS WHERE SENSING POINT IS NOT AT ATMOSPHERIC PRESSURE

To apply the 1532 analyser to processes which have pressure at the point of measurement significantly above or below atmospheric pressure, then a compensation must be applied. (Refer to Set-up Steps 11 and 12 in Section 5.5).

2.7 PROBE IMPEDANCE

The probe impedance is a basic measurement of the reliability of the oxygen reading. A probe with a high impedance reading will eventually produce erroneous signals. The analyser checks the probe impedance once per minute and if the impedance is above the maximum level for a specific temperature then the impedance alarm will be activated. Typical probe impedance is 800 –2000 _ at 720 ° C.

2.8 AUTO CALIBRATION - ELECTRONICS

The analyser input section is self calibrating. There are no adjustments. The analog to digital converter input stages are checked against a precision reference source and calibrated once every three seconds. Should the input electronics drift slightly then the drift will be automatically compensated for within the microprocessor. If a large error occurs due to an electronic fault then an 'A/D CAL ERROR' alarm will occur.

A one-off calibration procedure of the precision reference sources should never need to be repeated for the instrument life unless the instrument undergoes a 'COLD START' (Refer to Section 3.17). If there is any doubt about the accuracy of the instrument readings, then refer to Maintenance Section 6.5, items 6, 7, 8 and 9 for a full description of this simple calibration procedure.

The digital to analog converters or output section of the analyser are tested for accuracy every three seconds and if they are found to have an error then a 'D/A CAL ERROR' alarm will occur. The D/A sections are recalibrated in one second by pressing the 'AUTO CAL' button on the technicians keyboard.

All output signals will drop to 0 mA. for the one second period. It is suggested that a D/A recalibration be performed after the instrument has stabilized, approximately 30 minutes after first switching on and after Maintenance Section 6.5, items 6, 7, 8 and 9 have been completed, and then annually. If a 'D/A CAL ERROR' alarm occurs during normal operation, then a hardware fault should be suspected.

2.9 AUTO CALIBRATION CHECKING– PROBE

On-line automatic gas calibration is not normally required. Where it is required however, the probe can be checked for accuracy in-situ and on-line. Solenoid valves can admit up to two calibrated gas mixtures into the probe via solenoid valves under microprocessor control on a timed basis. For details on installation refer Section 3.11. For details on setting up this facility refer to Set-up steps 33 to 45 in Section 5.5.

During probe auto calibration checking, the analyser output will freeze and remain frozen for a further adjustable period, allowing the probe time to recover and continue reading the flue gas oxygen level.

Calibration gases may be manually admitted by pressing the 'CAL' buttons on the keyboard while in 'RUN' mode. The analyser output is frozen during the pressing of these buttons and immediately becomes active when the button is released.

2.10 AUTO PURGE

In oil and coal fired plant, it is possible for the probe sensing filter to become blocked. An automatic purge cycle can be set up so that a blast of air, maximum 100 kPa., will automatically back-flush the probe filter on a timed basis. Refer to Set-up steps 28 to 32 in Section 5.5.

A purge flow switch will sense that there is sufficient flow to clear the filter during the purge cycle, otherwise a ‘FILTER BLOCKED’ alarm will occur.
The probe can be manually purged from the keyboard while in ‘RUN’ mode. The analyser output is not frozen during or after the pressing of this button.

2.11 RS 485 –RS 232C PORTS

The serial port is for connecting a printer, a data logger, or any computer with an RS485 –232-C port. It can be used to monitor the transmitter and process by logging the values of functions selected in step 46 of the Set-up menu in Section 5.5.

The log period may be selected in step 47 for 1–2000 minutes, and the baud rate may be set up in step 48.

Alarms, including the time they occured, will be transmitted to the printer and computer whenever they are first initiated, accepted and cleared.

The protocol for the serial port is eight data bits, one stop bit, no parity.

2.12 OTHER INPUTS -HUMIDITY, AMBIENT TEMPERATURE & FLUE TEMPERATURE

Applications requiring high accuracy for the display of oxygen deficiency or combustion efficiency can have the relative humidity of the combustion air included in the calculation.

This requires the connection of a CH15 sensor/transmitter with a range of 0 –100 % RH. and output of 0 –1 volt.

A flue thermocouple and ambient temperature sensor should also be connected when efficiency display is required.

2.13 WATCHDOG TIMER

The watchdog timer is started if the microprocessor fails to pulse it within any three second period, (i.e. fails to run its normal program).

The microprocessor will then be repeatedly reset until normal operation is resumed. Reset cycles are displayed by the RESET light on the internal keyboard. A steady ‘ON’ light indicates normal operation.

If the program has not resumed normal operation after three attempts to reset, the common alarm relay will be activated.

2.14 BACK-UP BATTERY

The transmitter’s RAM and real-time clock are backed up by a lithium battery in the event of power failure. All set-up and maintenance variables are saved and the clock is kept running for approximately ten years with the power off. The average life of the battery with the power on is 38 years

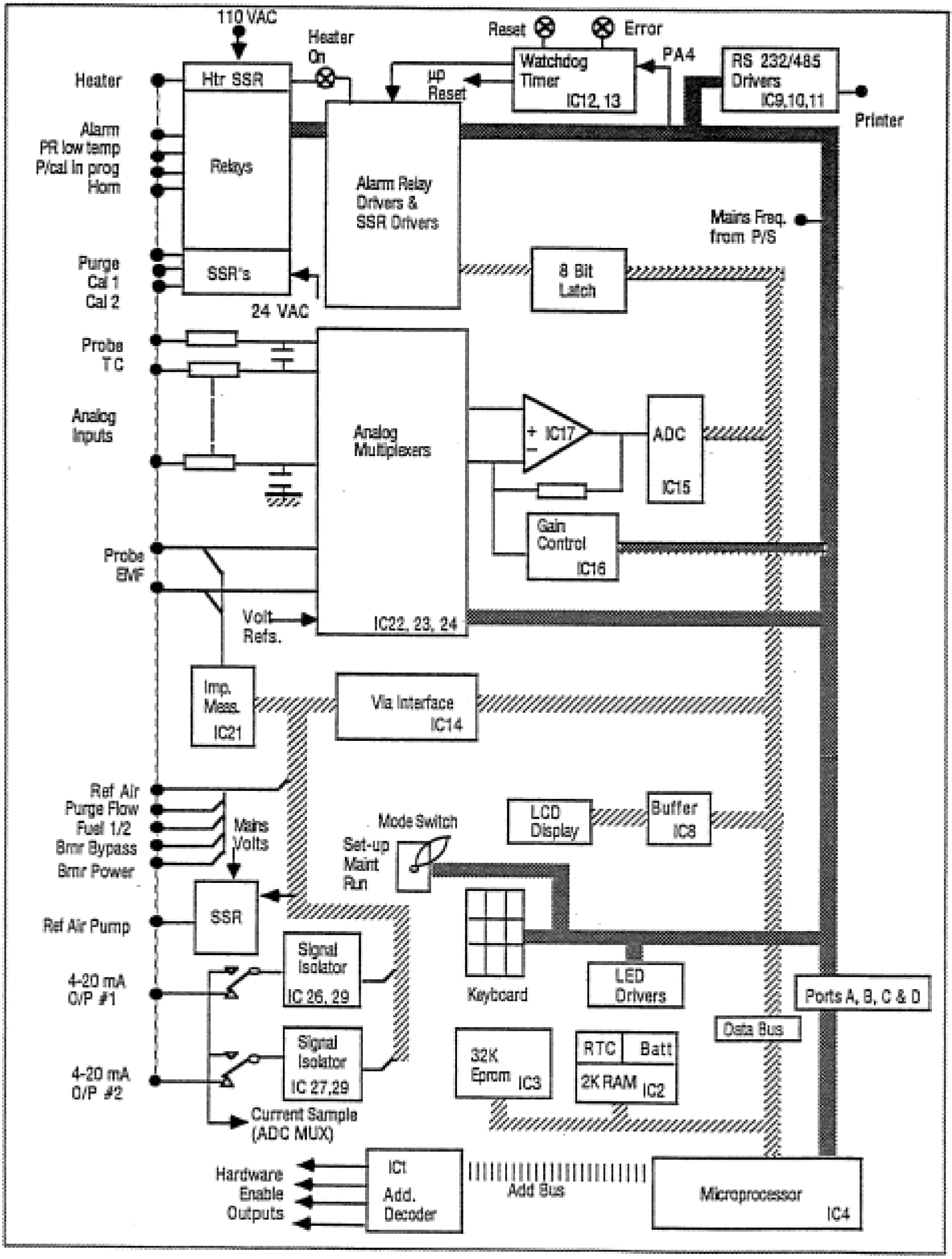


Figure 2.2 1532 Analyser Block Diagram

INSTALLATION & COMMISSIONING

3

INSTALLATION

3.1 MOUNTING THE ANALYSER

Surface mount the transmitter case on to a flat surface or bracket, using the four holes provided. Refer to Figure 3.1. If the hole layout provided is not suitable then the circuit boards may be removed and additional holes drilled in the rear of the case. Mounting screws should not come into contact with the printed circuit boards. All wiring should comply with local electrical codes. The lead between the probe and transmitter should be ordered with the probe. It has an integral weatherproof connector to plug into the probe head.

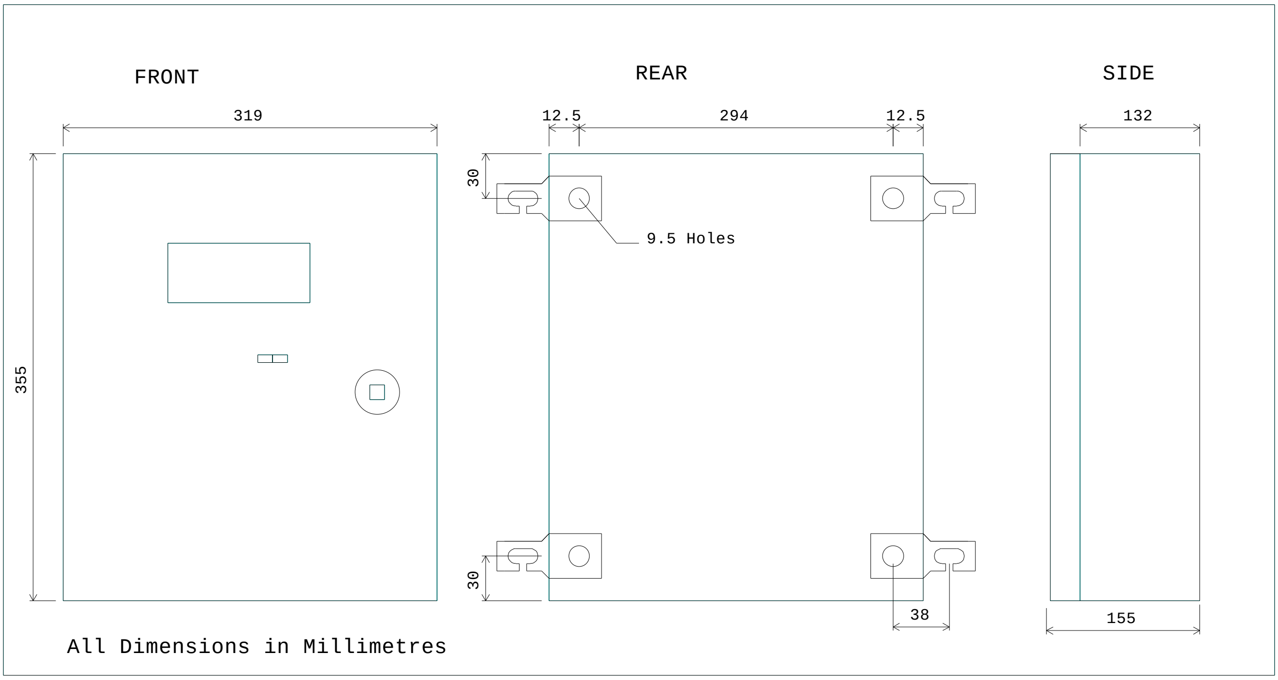


Figure 3.1 Case Mounting Dimensions

3.2 HEATER INTERLOCK RELAYS

CAUTION

Explosion protection for heated probes is achieved by switching the power to the probe heater off whenever the main fuel valve is closed.

The principle of safety is that if the main fuel valve is open then main flame has been established. With this primary source of ignition on, the probe heater can be safely switched on. The most dangerous situation is if fuel leaks into the combustion appliance when the fuel valve is closed. When power is removed from the main fuel valve the heater should also be switched off.

To achieve this protection, connect the main fuel valve power to the ‘BURNER ON I/P’ terminals and check that relay RL7 coil is compatible with the voltage connected e.g. 110 or 240 VAC.For Installation where there is no risk of explosion, connect a constant mains supply to terminals number 39 & 40. Refer to Figure 3.2.

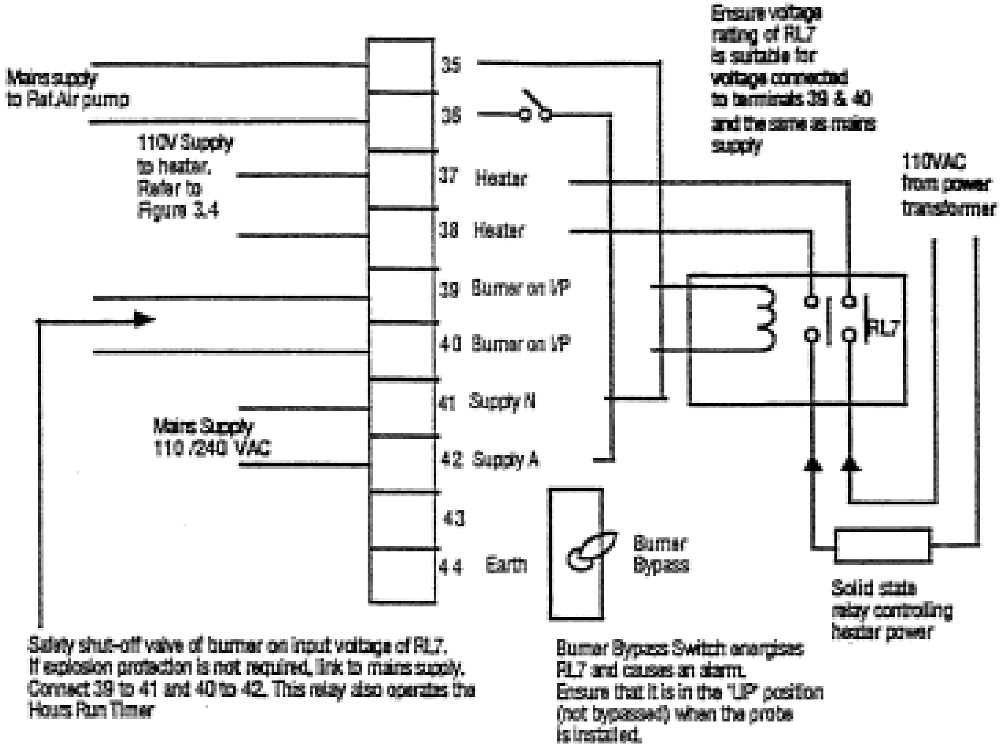


Figure 3.2 Heater Supply Interlock Connection For Heated Probes

3.3 EARTH, SHIELD & POWER CONNECTIONS

All external earthing should be shielded. The printed circuit boards are fully floating above earth. All earth and shield connections should be connected to the earth terminal number 44. The mains earth should be connected to a sound electrical earth.Do not connect shields at the field end. Simply clip off and insulate. An extra terminal strip may be required to connect all shields together. This should be supplied by the installer. Before connection of mains power check that the correct solder links are installed as shown in Figure 3.3.

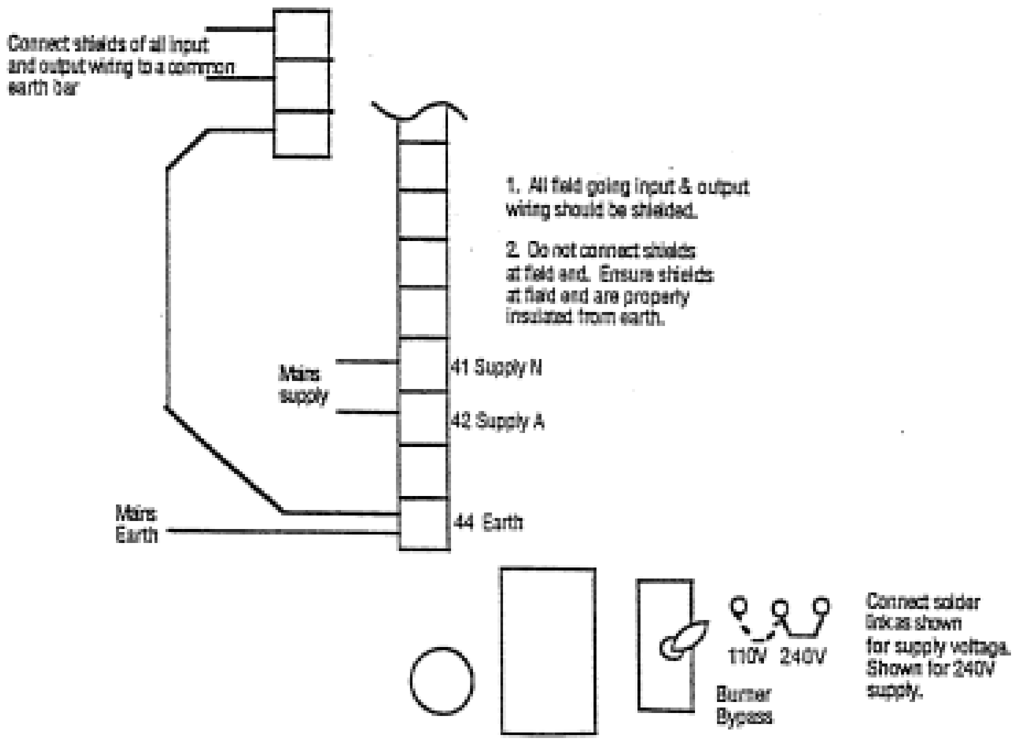


Figure 3.3 Earth, Shield and Power Connections

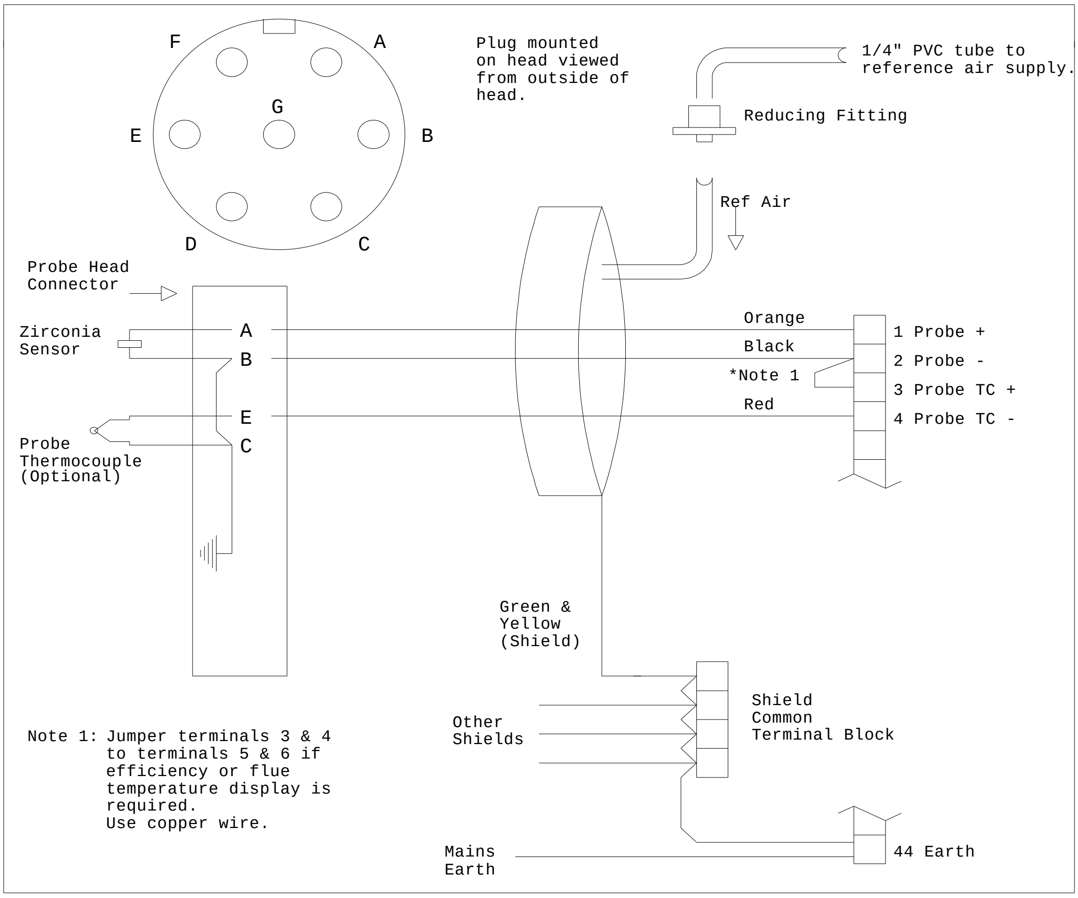


Figure 3.4a Connection of Probe Cable for Unheated Probes Models 1232 and 1233.

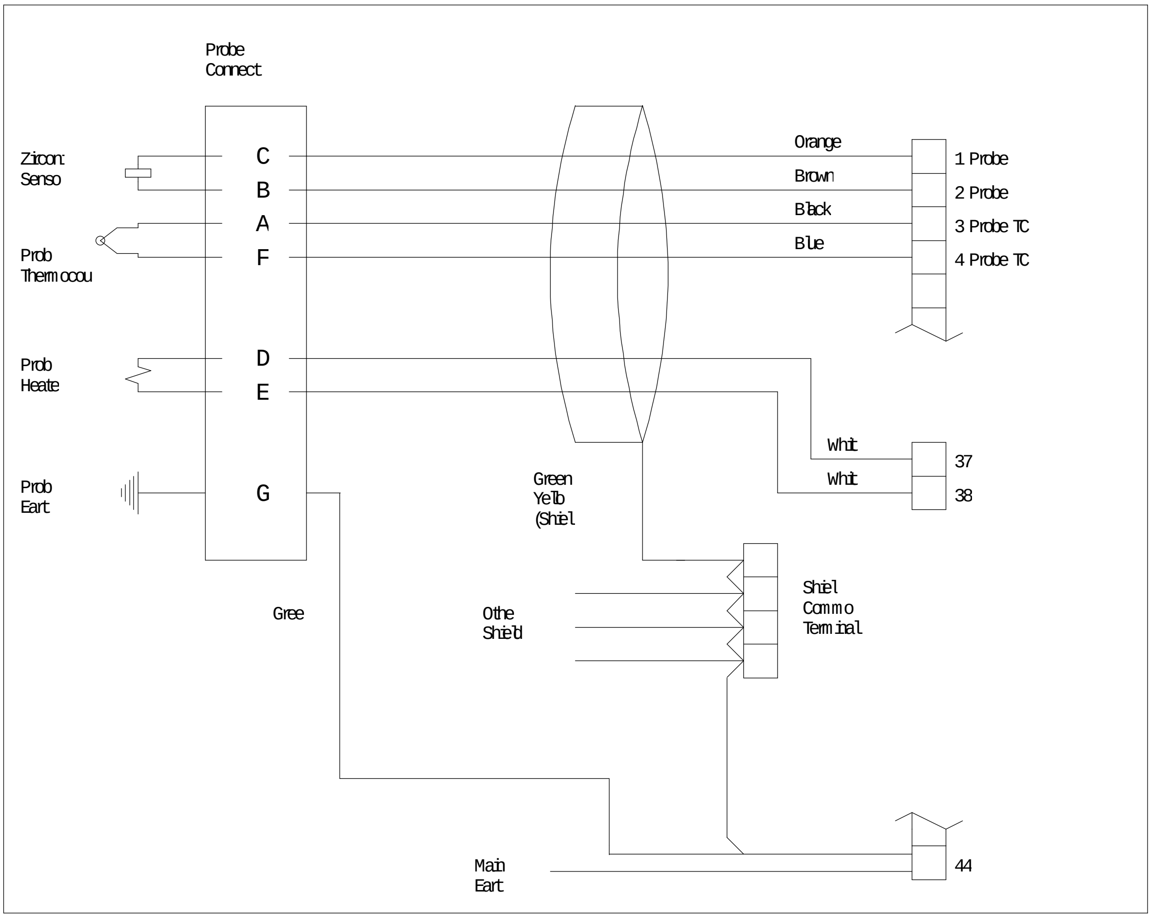


Figure 3.4b Connection of Probe Cable for Heated Probes Model 1231.

3.4 CONNECTING THE PROBE CABLE

Connect the probe lead supplied as shown in Figures 3.4a and 3.4b. Unheated probe leads have integral reference air tube. An adaptor has been supplied to connect this tube to quarter inch flexible PVC tubing, from the air pump or reference air supply.

3.5 CONNECTING THE FLUE THERMOCOUPLE

For heated probes the flue thermocouple must be a separate TC with the junction isolated from earth, mounted near to and upstream of the oxygen probe. It can be any one of types T, J, K, R, S or N. It is optional.
If efficiency, oxygen deficiency, flue temperature display or transmitted signals are not required, then a flue TC is not necessary.
For unheated probes the probe TC can also serve as a flue TC. For this option, jumper in copper wire from terminal 3 and 4 to terminals 5 and 6 respectively. Remove link LK2 when connecting in this way.

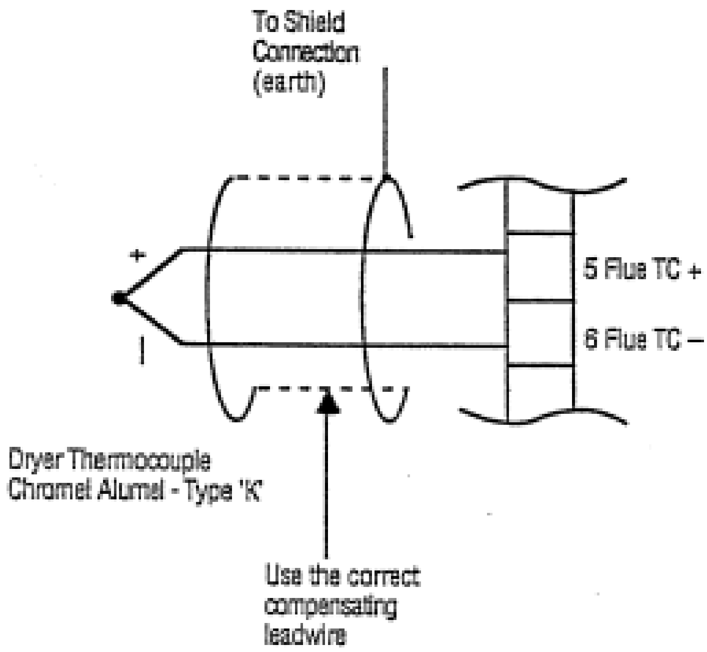


Figure 3.5 FlueThermocouple Connection

3.6 CONNECTING THE RELATIVE HUMIDITY SENSOR

Refer to Section 2.12 for details on this optional input. Mount the relative humidity sensor in a position to sense air with equivalent RH to combustion air. For connection details refer Figure 3.6.

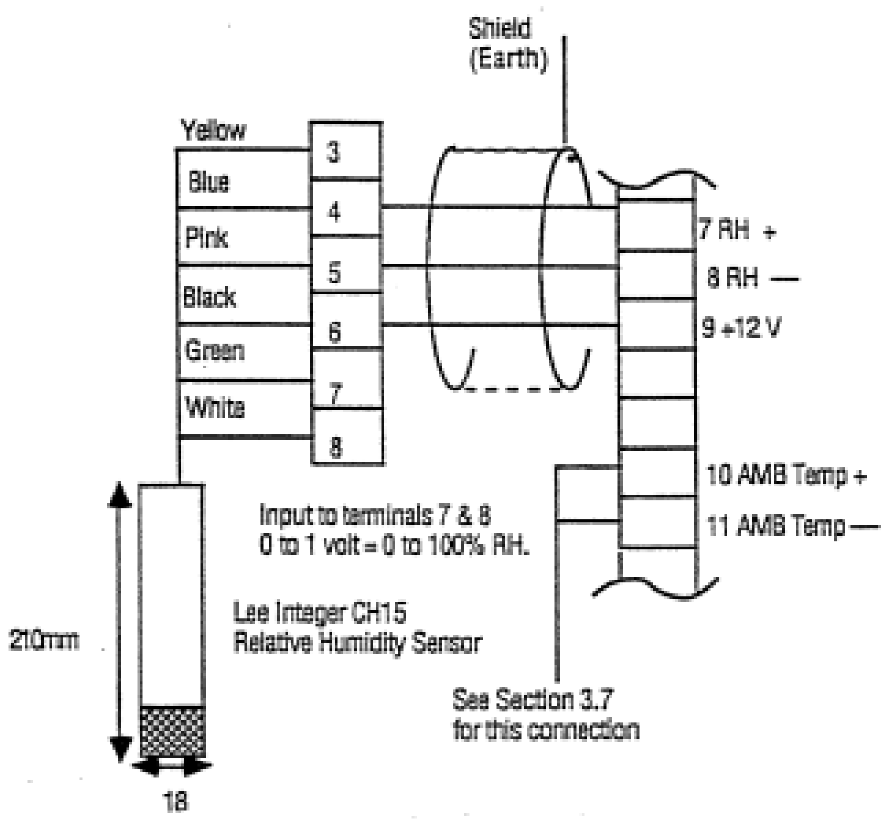


Figure 3.6 Connections for Relative Humidity Sensor

3.7 CONNECTING THE AMBIENT TEMPERATURE SENSOR

This input is only required if an efficiency display is required. Mount the ambient temperature sensor enclosure in a position to sense air temperature equal to combustion air. The sensor may be supplied within the relative humidity sensing enclosure or separately if no RH sensor is required. Refer to Figure 3.7 for connection details.

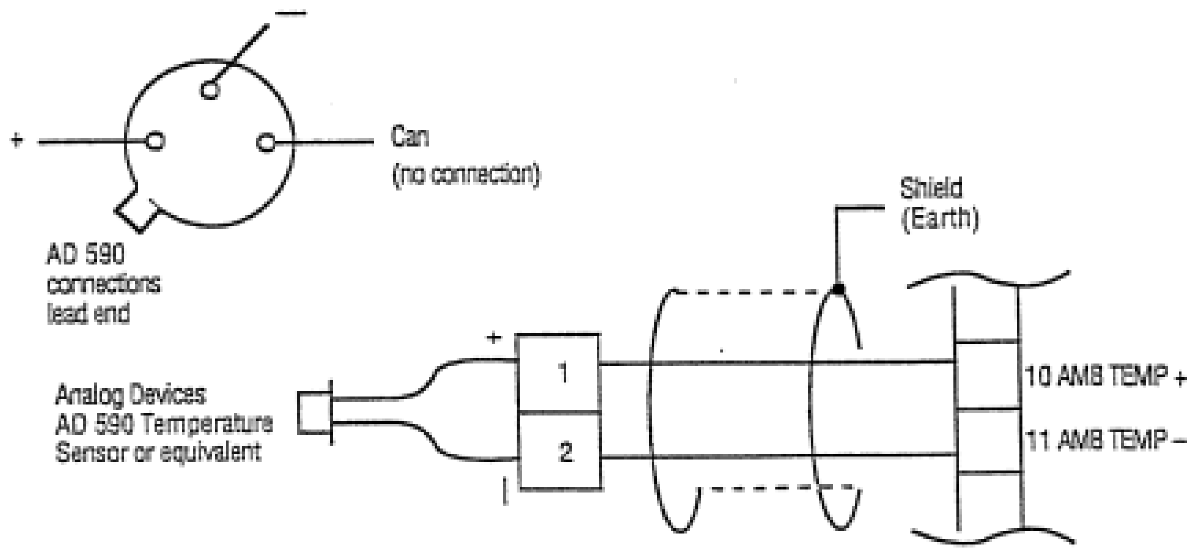


Figure 3.7 Connection of Ambient Temperature Sensor

3.8 CONNECTING THE OUTPUT CHANNELS

The two 4–20 mA DC output channels are capable of driving into a 600 _ load. Refer to Figure 3.8.

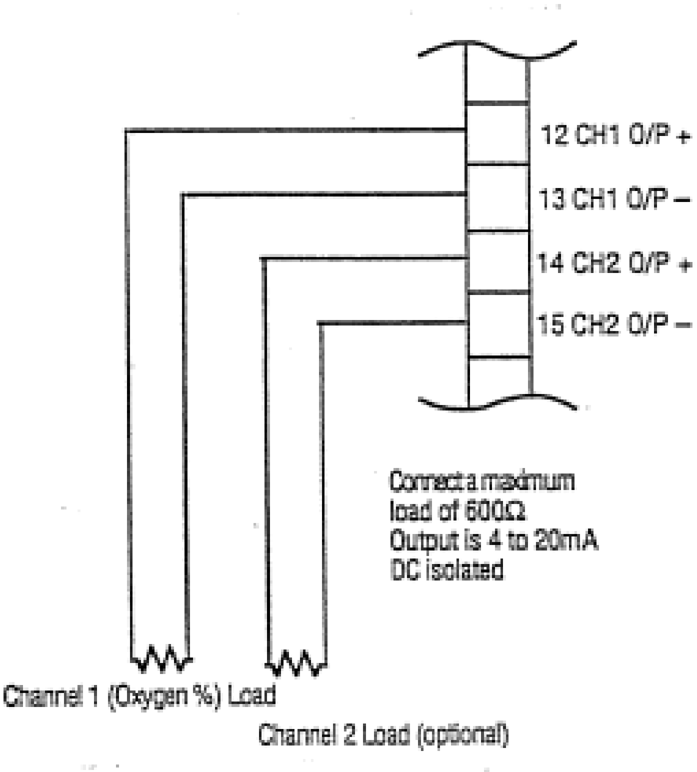


Figure 3.8 Connections for Transmitter Output Channels.

3.9 CONNECTING THE ALARMS

The alarm relay functions are described in detail in Sections 4.2 and 4.3. Each relay, except for the horn relay, has normally closed contacts. The contacts will open in alarm condition. The horn relay has normally open contacts. All systems should have the alarm relay RL5 connected to Terminals 26 and 27, and the probe low temperature relay RL3 connected. The probe calibration and horn relays are optional. Alarm wiring should be shielded.

3.10 CONNECTING THE HORN RELAY

The horn relay operates as a true alarm system and can be connected directly to a horn. The horn relay is latching and can be reset by pressing the alarm button. Refer to Figure 3.9.

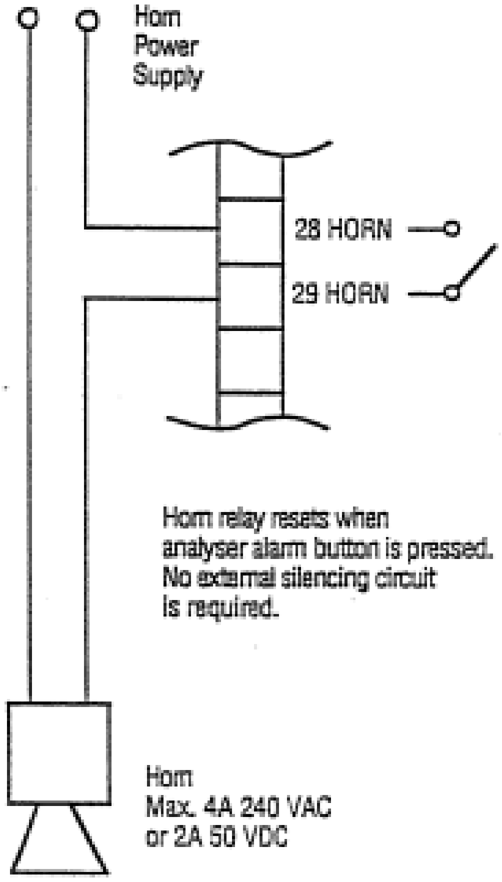


Figure 3.9 Connections for Alarm Horn

3.11 CONNECTING THE AUTOMATIC PURGE AND CALIBRATION SYSTEM

The on-line auto purge and calibration system is optional. For details on its operation refer to Sections 1.1, 2.9 and 2.10. Typical connection details are shown in Figures 3.10 (a) and (b).

After installation the purge/cal system should be tested thoroughly for leaks. Any leaks can cause significant errors if the flue is at negative pressure. If the flue is at positive pressure, an outward leak can cause corrosion in the purge/cal system piping and fittings.

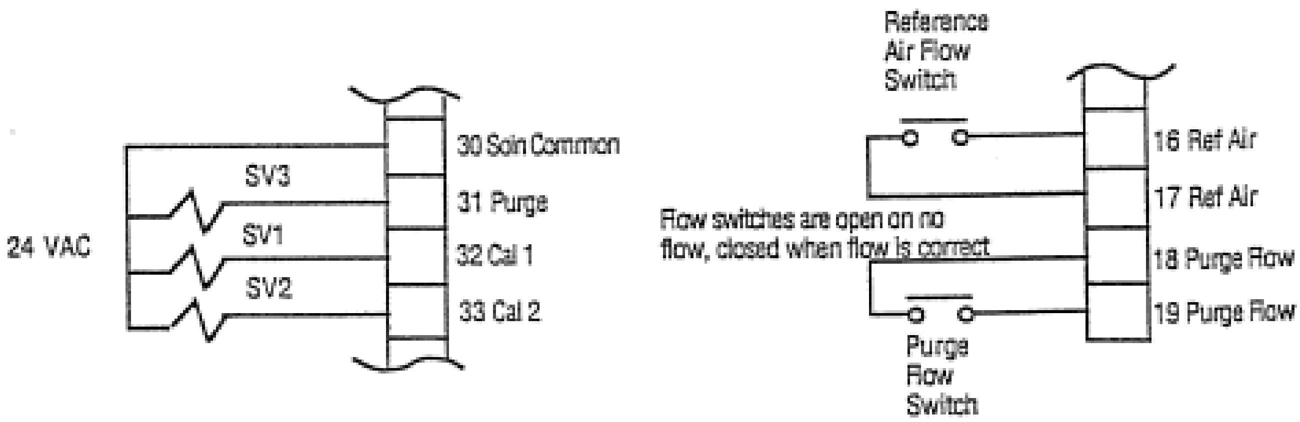


Figure 3.10a Automatic Purge & Calibration System Wiring Schematic

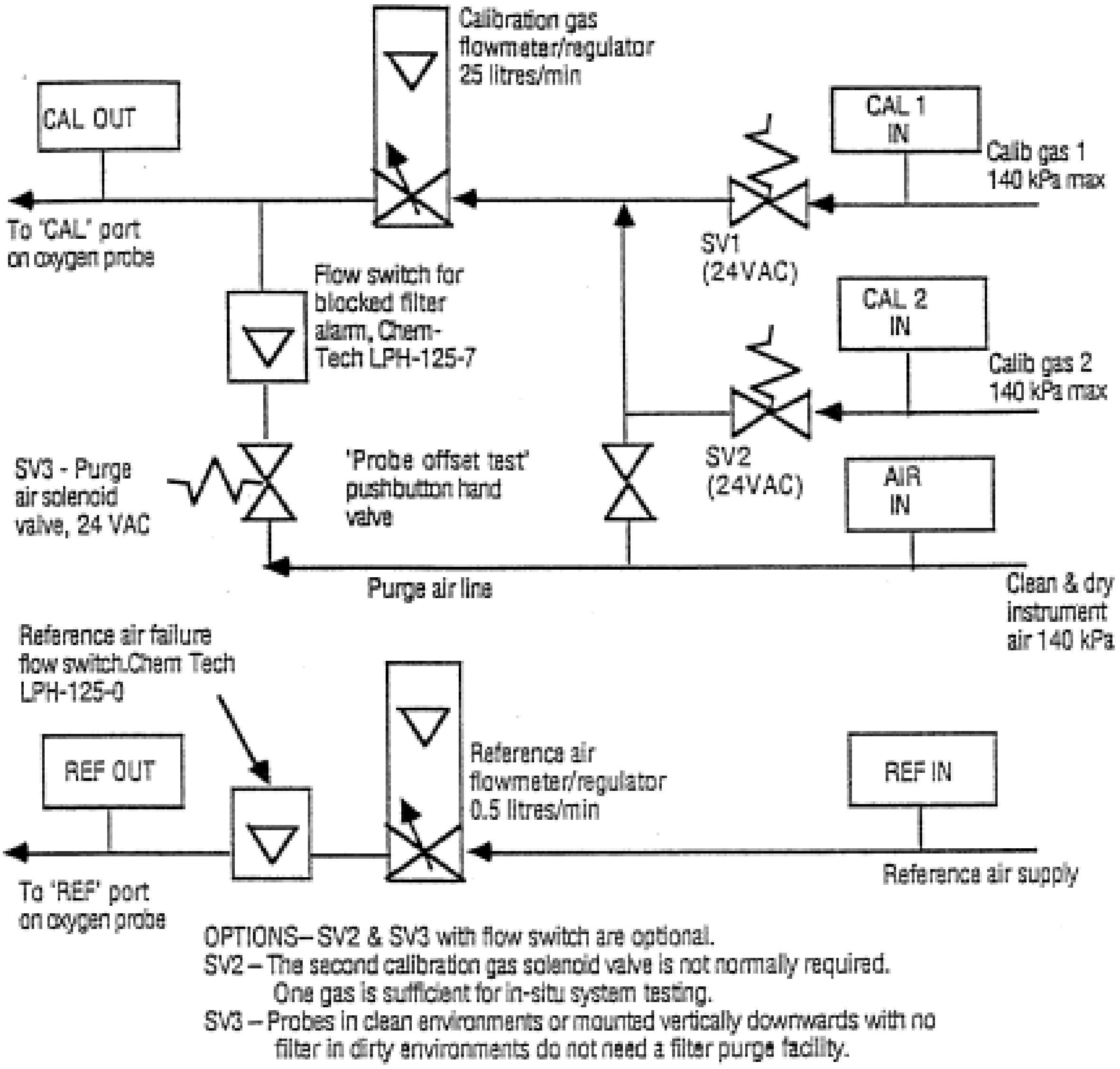


Figure 3.10b Automatic Purge & Calibration System Piping Schematic

3.12 CONNECTING REFERENCE AIR

Reference air must be clean and dry. If there is any doubt about plant instrument air quality, it is better to use a separate diaphragm pump. Connect as shown in Figure 3.11.

A reference air flow switch is required. Connection details are shown in Figure 3.11b. The flow switch causes an alarm if the reference air flow is insufficient. Failure of reference air can cause indeterminate errors which may result in a dangerous combustion situation.

Reference air flow should be regulated to 200–500 ml/min to provide a flow of 20.9% oxygen air. As a guide, if the end of the air supply tube is held 20 mm under water, then you should see several bubbles per second. The flow should be sufficient to actuate the reference air flow switch.

Cooling effect errors will occur if the reference air flow is too high. This can be checked by turning the flow on and off while reducing the flow until NO difference in oxygen reading is noticed between flow and no-flow.

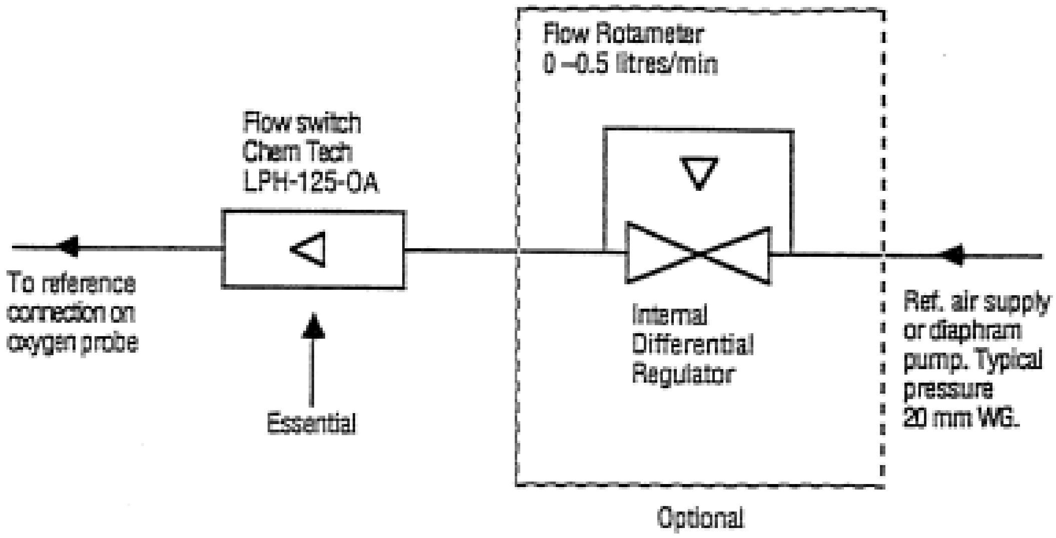


Figure 3.11 Reference Air Connection

3.13 CONNECTING THE DUAL FUEL INPUT

If efficiency display is required and the appliance is capable of firing more than one fuel, then an external contact must be connected for the analyser to determine which fuel is being burnt. See Figure 3.12 for details.

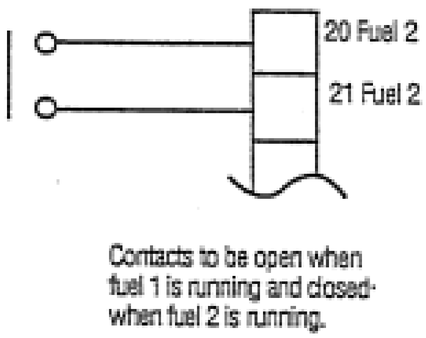


Figure 3.12 Fuel Selector Input Contacts Connections

3.14 CONNECTING THE PRINTER

The RS 485–232-C port is available at the connector on the lower right hand side of the main circuit board.

A printer with a serial port, or a data logger, or a computer terminal may be connected to the port.

Data is logged out of the port as arranged in Set-up steps 46 and 47. Refer to Section 2.11 for the baud rate selectable in set up step 48..

Connection details are shown in Figure 3.13. Note: For the RS 485–232-C port to work as an RS 232-C port, there must be no other connection from the external device back to the transmitter, (including an earth return).

The RS-232 protocol for the serial port is eight data bits, one stop bit, no parity.

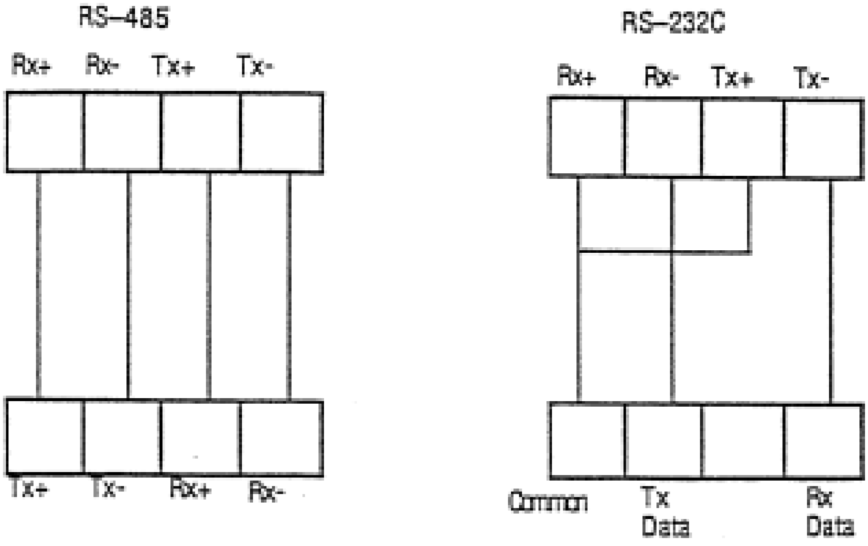


Figure 3.13 Serial Port Connections

3.15 INSTALLING THE OXYGEN PROBE

Weld a BSP or NPT socket to the flue in a suitable position for flue gas sensing. For the correct size of socket refer to probe data in Section 1. The closer to the source of combustion the smaller will be sensing lag time, allowing better control. Also, the efficiency calculation requires the probe to be as close to the final heat exchange as possible.

The probe has a typical response time of less than four seconds, so most of the delay time is normally the transit time of the gas from the point of combustion to the point of sensing.

It is necessary to angle the probe downwards at about 30° minimum angle from horizontal, to avoid water vapour building up in the probe housing. The sensing tip should be lower than the head.

If a flow guide tube is used (heated probes only), it is important that the fin be pointing directly downstream. If the exact flow direction is not known, use a wind vane which can be made from a piece of wire and flat metal. If the flow guide tube is installed facing the wrong direction for any period, the suction filter may block with flue gas dust particles.

The maximum temperature for an unsupported flow guide tube is 750°C (1382°F). Above this temperature, provide a support and flanged flexible rubber joint as shown in Figure 3.14. The maximum temperature of a supported flow guide tube is 900°C.

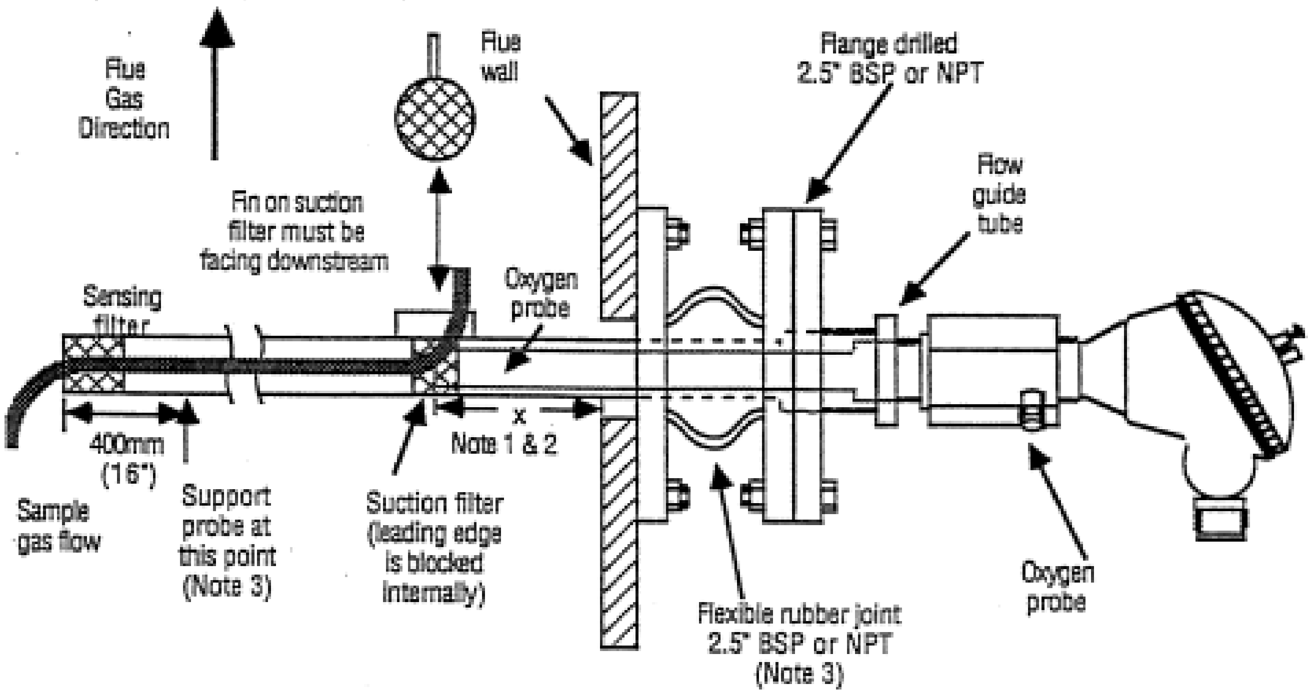
If installing a probe into a hot environment, slide the probe in slowly to avoid thermal shock to the internal ceramic parts. If the flue gas is 1000°C, it should take approximately ten minutes to install a 500 mm. probe, moving it in about 20 mm. steps.

CAUTION

It is important that there is no air in leakage upstream of the oxygen sensing point, otherwise there will be a high oxygen reading.

If the probe is to be installed on a bend in the flue, it is best located on the outer circumference of the bend to avoid dead pockets of flue gas flow. While the standard 1231 probe with a ‘U’ length of 250 mm. will suit most low temperature flue applications, it is occasionally necessary to have a longer probe with the sensing tip in the center of the flue gas stream.

Although it is rare, occasionally a probe may sense oxygen vastly differently from the average reading in the flue gas. If it occurs, then the probe should be moved, or a longer probe installed. This phenomena is normally caused by stratification of the flue gas.



NOTES: 1. Oxygen probe must reach suction filter when fully screwed in.

2. Distance 'x' must be 200 mm (8") or longer.

3. Flow guide tubes operating below 750 °C do not require support or a flexible rubber joint

Figure 3.14 Mounting of Flow Guide Tube

3.16 INSTALLING THE FLUE THERMOCOUPLE

Weld a 1/2 inch BSP mounting socket to the flue within about 300 mm, and upstream of the oxygen probe. The thermocouple should be of similar length to the oxygen probe to prevent flue temperature distribution errors.

3.17 CONNECTING POWER - COLD START

Before commissioning the probe or transmitter, read the two Caution paragraphs at the front of this manual.

Check that the mains supply voltage link is in the correct place for the supply voltage. To locate this link refer to Section 3.3

It is recommended that, prior to commissioning, a 'COLD START' be performed. This resets all 'Set-up' and 'Maintenance' mode entries to their normal default values. 'COLD START' will show on the display for a second prior to a microprocessor initialising sequence, which takes about seven seconds.

After a 'COLD START', it is necessary to set all new variables in 'MAINTENANCE' and 'SET-UP' modes, including calibration voltages and time and date.

To perform a 'COLD START', apply power to the transmitter while at the same time holding down one of the nine internal keyboard buttons.

A 'WARM START', which is performed by applying power without holding down an internal keyboard button, will retain all data previously entered in Maintenance and Set-up modes.

3.18 REFERENCE AIR FLOW SWITCH

If the oxygen probe is longer than 250 mm, ensure that reference air is flowing and that the reference air flow switch is closed by pressing the alarm button to ensure a 'REF AIR FAIL' alarm is not occurring.

If the probe is 250 mm long ensure that there is a jumper between terminals 16 and 17.

3.19 COMMISSIONING - MAINTENANCE MODE

Switch the mode switch to 'MAINT'. Enter the date and time. If the analyser has performed a 'COLD START', then the reference voltage calibration will have to be performed. If a 'COLD START' has been performed or a new probe installed, then the probe offset will need to be set. Refer to Section 6 for full details on calibration.

3.20 COMMISSIONING - SET-UP MODE

Switch the mode switch to 'SET UP' and enter all set up functions as listed in Section 5.

3.21 RUN MODE

Switch the mode switch to 'RUN'. The upper line of the display will now read '% OXYGEN' if the probe temperature is above 650 °C. The probe temperature can be checked on the lower line of the display. Refer to Section 3.6 for calibration of the D/A section of the analyser.

3.22 HEATER BY-PASS SWITCH

Heated probes should have their heater supply interlocked with RL7. If the combustion appliance is not running then power will not be supplied to the heater.
To commission an oxygen probe when the main burner is turned off, switch power off the analyser, remove the probe from the mounting point and connect the lead with the probe laying on a metal or ceramic surface external to the flue, and capable of withstanding 720 °C.

Re-apply power to the analyser, press the burner by-pass switch into the ‘DOWN’ position. This will apply power to the probe heater even when the plant is not running. The probe offset can now be set and calibration checked with appropriate calibration gases (typically 2% oxygen in nitrogen).

Ensure that the burner by-pass switch and the power are turned off before the probe is re-installed. An alarm will occur if the burner by-pass switch is turned on (down) during normal operation.

3.23 CHECKING THE ALARMS

If any alarms are present the alarm LED should be lit, either flashing or steady. To interpret the alarms, press the alarm button until all alarm functions have been displayed. Rectify the cause of each alarm until no further alarms appear on the display. For details on the operation of the alarm button and the alarm functions refer to Section 4.

3.24 PROBE CALIBRATION

The zirconia sensor in the probe provides an absolute measurement of oxygen partial pressure. There are no calibration adjustments, apart from ‘PROBE OFFSET’, for the probe. The probe EMF is either correct or the probe is faulty.
To check that the probe is functioning correctly, firstly check that the high probe impedance alarm is not activated. The display would show ‘SENSOR FAIL’. The actual impedance can be displayed on the lower line. It should be less than 2000 _.

Once it has been established that the probe impedance is normal, the probe offset may be tested and set Refer to Section 5.5. A small flow of air must be admitted to both the ‘REF’ and ‘CAL’ ports when testing probe offset. Gas calibration tests can then be carried out. Refer to Section 3.26.

3.25 FILTER PURGE SET-UP PROCEDURE

Before setting up probe calibration gases, the filter purge should be set up. If filter purge is not installed, proceed to the calibration gas set-up described in the following paragraph.

Set up the probe outside the flue so that the filter can be viewed whilst running purge air, (controlled from the ‘PURGE’ button on the analyser when in ‘RUN’ mode). Gradually adjust the purge air supply regulator, increasing the pressure until sufficient flow is obtained to clear the filter.

This is best checked with a dirty filter after a period of operation, by withdrawing the probe from service and watching any build up on the filter being blown off at the set pressure. Normally 30 kPa (5 psi) is adequate but the air pressure may be set as high as 100 kPa (15 psi). With filter purge set up, the air pressure has been determined and the calibration gas system can be set to an equal pressure.

3.26 CALIBRATION GAS SET-UP PROCEDURE

If the installation has a filter purge facility, set this up first. Refer to the previous paragraph. Press the zero offset valve to obtain a reasonable flow through the calibration gas flow meter. Leave the pressure set on the air regulator for filter purge and adjust the flow on the rotameter flow regulator. The flow requirements vary depending upon the length of the probe and whether or not the probe has a filter. Required flows normally range from 5 –20 1itres per minute.

Probes without filters will require a higher flow to achieve an accurate calibration gas reading and sometimes may not exactly read the calibration gas due to equilabration of the calibration gas with the process gas near the sensor. So long as the reading is reasonably close, accuracy is guaranteed, because the sensor is an absolute device. With the probe removed from service, a filter can be temporarily held over the sensing end of the probe to obtain an accurate check of oxygen readings. It is mainly for probes with no filters that acceptable accuracies can be entered in Set-up mode. Too high a flow will cause cooling of the sensor, creating errors.

With heated probes that have no filter, a compromise flow rate may be required. For this reason an acceptable accuracy level can be set in the instrument to avoid nuisance ‘GAS CAL ERROR’ alarms. Once this flow has been set, the calibration gas solenoids should be manually operated from the instrument keyboard by pressing the ‘CAL 1’ or ‘CAL 2’ button whilst in ‘RUN’ mode. The calibration gas cylinder pressure should be gradually increased to achieve exactly the same flow reading on the flow metre as the zero offset flow, without adjusting the rotameter flow regulator. Calibration gas flow(s) and the zero offset flow should be identical. Some adjustments may be required to obtain satisfactory results with calibration gas flows.

The maximum pressure on the calibration gas cylinders is 100 kPa (15 psi). 30 kPa (5 psi) is sufficient, particularly when no purge option is installed. Use a calibration gas close to the normal operating oxygen level to avoid a long recovery time.

3.27 DUST IN THE FLUE GAS

For unheated probes with no filter, entrained solids or dust in the flue gas does not present a problem unless the dust, when settled, is not porous. Allow the dust in the process to build up on the probe. It will form a porous layer slowing the response time. To avoid mechanical abrasion of the electrode material pack ‘SAFFIL’ or equivalent alumina based ceramic fibre in the sensing holes to protect the electrode. Do not use silica based ceramic fibres such as ‘KAOWOOL’, which can attack the electrode at high temperatures. Once the dust has built up the response time of the probe will be slower.

For heated probes the preferred method of mounting for dust laden applications is facing vertically downwards with the filter removed. With no filter, some errors in gas calibration can occur when the gas sample has an oxygen content significantly different from that of the flue gas. Allow for this when setting auto-calibration tolerances in the Set-up mode.

Probes can also be mounted horizontally with no filter with some dusts. An occasional automatic back purge is helpful in this case.

Normally heated probes are supplied with filters for dusty applications or with flow guide tubes with filters. The probe response line should be tested when the probe is first installed, and then regularly until it remains constant for a significant period. Filter purging should be set up on the time periods determined by these tests. To test the probe response time, use a stop watch to obtain the time for a probe to achieve a 63 % change from one reading to another. If a probe filter blocks completely in a short period of time, then there is no option but to use the probe without the filter. A trial probe with filter is available to test whether filter blockage is likely to occur.

3.28 STRATIFICATION

If the analyser and probe have been fully tested and the oxygen readings in the flue gas are incorrect, gas stratification may be occurring. The phenomena cannot be anticipated for any particular installation. Generally, large flues have oxygen differences of approximately one percent across the flue. Occasionally an oxygen error of several percent may occur in a flue of any size. This problem is normally solved by moving the probe to a new location.

OPERATOR FUNCTIONS

4

OPERATOR FUNCTIONS (RUN MODE)

4.1 DISPLAY BUTTON

The upper line on the display will always read % oxygen. The following are available for display on the lower line.

1. DATE –TIME
2. RUN HOURS SINCE LAST SERVICE
3. DATE OF LAST SERVICE
4. RELATIVE HUMIDITY (If RH sensor is connected)
5. PROBE IMPEDANCE, a measure of integrity of the sensor's electrode, the part of the probe that normally wears out first.
6. % CARBON DIOXIDE, dry. Calculated from the oxygen reading. Assumes complete combustion.
7. % CO IN CO_2 (for reducing conditions calibration purposes).
8. OXYGEN DEFICIENCY
9. PROBE EMF (millivolts)
10. % EFFICIENCY
11. PROBE TEMPERATURE
12. FLUE TEMPERATURE
13. AMBIENT TEMPERATURE
14. The lower line may be set to be ‘BLANK’
    Any number of these variables can be displayed sequentially by pressing the ‘DISPLAY’ button. Items can be selected for display or deleted in Set-up step 10 on the technicians keyboard.In addition to the above lower line displays, the analyser will automatically display:
15. PROBE UNDERTEMP, when the probe is below 650°C
16. PROBE CALIBRATION, occurring for Cal Gas 1 or 2
17. PROBE PURGE occurring

NOTE:

The run time will be the period of time the fuel valve contract is closed (i.e. main fuel valve open). If no explosion protection is required, a permanent bridge between the fuel valve terminals to mains power will register run time whenever the analyser is powered.

This timer can be used as a probe replacement and/or boiler service schedule aid. The start time is reset by changing the ‘SERVICE DAY’ in Maintenance mode on the technicians keyboard.

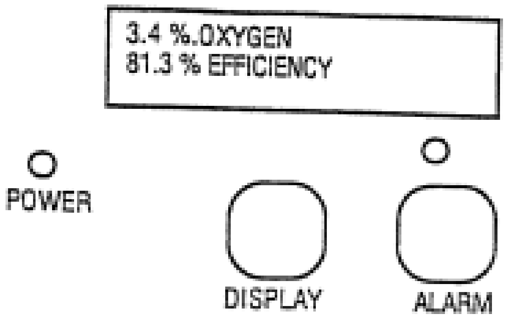


Figure 4.1 Operator's Panel

4.2 ALARM BUTTON

Repeatedly pressing the operators ‘ALARM’ button will produce alarm displays in sequence on the lower line of the LCD display. If an alarm has cleared prior to pressing the ‘ALARM’ button, it will not re-appear on a second run through the alarms. Active alarms which have been previously displayed will have ‘ACC’ (accepted), displayed alongside. New alarms will not have ‘ACC’ displayed until a second press of the ‘ALARM’ button. After the last active alarm is indicated, the lower line of the display will return to the last displayed lower line variable.

The alarm ‘LED’ will flash on alarm. Pressing the ‘ALARM’ button will cause the LED to go steady if any alarms are still active, or extinguish if there are no active alarms. The horn relay will operate when an alarm occurs. Pressing ‘ALARM’ will mute the horn relay which will re-initiate on any new alarms.

4.3 ALARM SCHEDULE

4.3.1 SUMMARY OF ALARMS

ALARM	DESCRIPTION
‘SENSOR FAIL’	Oxygen cell or electrode failure (high impedance); (inhibited under 650°C).
‘PROBE HEATER FAILURE’	In the first 20 minutes of power being applied to the heater after being switched on, this alarm will not occur, but a ‘PROBE UNDER–TEMPERATURE’ display will occur and relay RL8 will be activated. Refer to Section 6.13.
‘PROBE TC O/C’	Probe thermocouple is open circuit. The heater in heated probes will switch off.
‘REF AIR FAIL’	Low reference air flow to probe.
‘FLOW SWITCH’	The reference air flow switch has failed. This is tested by automatically switching off the reference air pump once every ten minutes for three seconds to check the operation of the flow switch.
‘A/D CAL ERROR’	The analog to digital converter has been found to fall outside the normal calibration specifications. This is an electronic fault.
‘D/A CAL ERROR’	The digital to analog and voltage isolator circuit has been found to fall outside the normal calibration specifications. This check is only performed when the ‘AUTO CAL’ button is pressed. Refer to Section 6.6.

ALARM	DESCRIPTION
'FILTER BLOCKED'	Blocked probe filter, low purge flow. This test is only performed when automatic purging of the probe is requested. Refer to step 29 in the set-up menu Section 5.5.
'GAS-1 CAL ERROR'	Probe does not correctly calibrate to calibration gas1.
'GAS-2 CAL ERROR'	Probe does not correctly calibrate to calibration gas2.
'HEATER BY-PASS'	The safety interlock relay has been bypassed by turning on the 'BURNER BY-PASS' switch on the terminal printed circuit board. Refer to Section 3.2 and 3.22
'WATCHDOG TIMER'	Software error. This alarm will not appear on the display. The 'ERROR' LED on the front door will illuminate.

4.3.2 SUMMARY OF ALARM RELAYS

ALARM	RELAY	FUNCTION	LATCHING	NOTES
'PROBE LOW TEMP'	RL3	Probe reading is invalid (under 650 ° C)	No	If the probe heater has been on for more than 20 minutes and thetemperature is less than 650°C a heater fail alarm will occur
'CAL IN PROG'	RL4	Probe calibration /purge check in progress	No	
'ALARM'	RL5	Alarm condition present	No	
'HORN'	RL6	Horn Driver	Yes	Press the 'ALARM' button twice for any one alarm to reset the horn relay.

NOTE:

The 'Probe Not Ready' relay is used with unheated probes to indicate oxygen reading is invalid (the probe is below 650°C), in case the process temperature falls below this level. For heated probes this relay will be energised while the probe is heating up from ambient.

4.4 POWER LAMP

Illuminates when power is connected to the analyser.

4.5 ERROR LAMP

If the microprocessor's software fails, then the 'ERROR' LED will be lit and the common alarm relay activated.

SETTING UP THE ANALYSER

5

SECTION
NUMBER

SET-UP MODE SUMMARY

5.1 SET-UP MODE FUNCTIONS

1. Sensor Type
2. Probe Thermocouple Type
3. Flue Thermocouple Type
4. Transmitter Output Channel 1
5. Transmitter Span Channel 1
6. Transmitter Output Channel 2
7. Transmitter Zero Channel 2
8. Transmitter Span Channel 2
9. Centigrade/Fahrenheit Selection
10. Lower Line Display Functions
11. Flue Pressure mm/inches/kilopascals
12. Flue Pressure Value

Set-up steps 13 to 27 will be skipped automatically if efficiency or oxygen deficiency are not selected in steps 6, 10 or 46.

13. Single or Dual Fuel
14. Type of Fuel #1
15. Fuel #1 'A' Value
16. Fuel #1 'H' Value
17. Fuel #1 'O' Value
18. Fuel #1 'N' Value
19. Fuel #1 'S' Value
20. Fuel #1 'M' Value

Set-up steps 21 to 27 will be skipped automatically if 'Single Fuel' is selected in set-up step 13.

21. Type of Fuel #2
22. Fuel #2 'A' Value
23. Fuel #2 'H' Value
24. Fuel #2 'O' Value
25. Fuel #2 'N' Value
26. Fuel #2 'S' Value
27. Fuel #2 'M' Value
28. Purge/Cal Time
29. Automatic Purge

Set-up steps 30 to 32 will be skipped automatically if 'No' is selected in set-up step 29.

30. Time Between Purges
31. Purge Duration
32. Purge Freeze Time
33. Number of Cal Gases

Set-up steps 34 to 45 may be skipped automatically, depending on the selection in set up step 33.

34. Oxygen Content of Cal Gas 1
35. Maximum Acceptable Positive Error Gas 1
36. Maximum Acceptable Negative Error Gas 1
37 Period Between Gas 1 Autocals
38. Duration of Autocal Gas 1
39. Freeze Time Gas 1
40. Oxygen Content Of Cal Gas 2
41. Maximum Acceptable Positive Error Gas 2
42. Maximum Acceptable Negative Error Gas 2
43. Period Between Gas 2 Autocals
44. Duration of Autocal Gas 2
45. Freeze Time Gas 2
46. Data to Print
47. Print Log Period
48. Printer Baud Rate
49. Relative Humidity Sensor Connected
50. Switched Reference Air Supply
51. Damping Factor

5.2 SET-UP/MAINTENANCE/RUN SWITCH

For the 'Set-up' mode keyboard to operate, move the toggle switch to 'SET-UP'. The outputs will be frozen when in set-up mode.

If purges or auto-calibration occur while the mode switch is in 'SET-UP' mode, they will be delayed until the mode switch is returned to 'RUN'.

To cancel a purge or calibration cycle, press 'ENTER' while in 'RUN' mode.

5.3 FUNCTION SELECT

When the 'SET-UP/MAINTENANCE/RUN' switch is moved to 'SET-UP', the display will automatically read the last set-up function selected.

To select other functions, operate the 'FUNCTION _' button to increment to the next function, or 'FUNCTION —' to decrement to the previous function.

5.4 ENTER OPTION OR VALUE

A. Options.

To step through the available options for each function press the 'OPTION _' or 'OPTION —' buttons.

When the required option is selected press the 'ENTER' button. An asterisk will then appear alongside the option selected. When stepping through the set-up functions, the display will always first indicate the last options entered. The 'Lower Line Select' and 'Data To Print' functions 10 and 46 are multiple options. One or more options may be selected for these functions.

B Values

To set a value for a particular function press the 'OPTION _' button to increase the value and the 'OPTION —' button to decrease the value. A momentary press will change the value one digit. Holding the button will change the value more quickly. Once the correct option or value is displayed it can be entered into the analyser's memory by pressing the 'ENTER' button. When a value has been entered an asterisk will appear at the R.H.S. of the lower line.

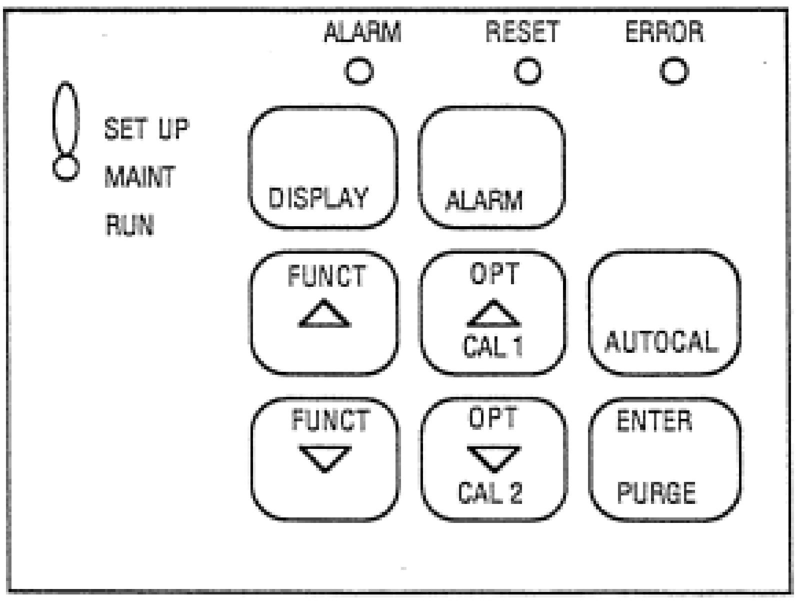


Figure 5.1 Internal Technicians Keyboard

5.5 SET-UP FUNCTION DETAILS

1. SENSOR TYPE

Options

Model No.	Enter the probe in use
1. 1231	Heated Probe
2. 1232	Unheated Probe
3. 1233	Unheated Probe for high sulphur applications (cermet sheath)

2. PROBE THERMOCOUPLE TYPE

The probe can have either a type K, R, or N thermocouple as a sensor temperature detector.

Options

1. K	Check in the manual Section 1
2. R	for the probe model number.
3. N	Enter the correct TC type.

3. FLUE THERMOCOUPLE TYPE

Select the flue thermocouple type.

Options

1. T
2. J
3. K
4. R
5. S
6. N
7. Nil

NOTE

For heated probes the flue thermocouple is a separate sensor from the oxygen probe and should be mounted near to and upstream from the probe. It is optional. If no thermocouple is required, select option 'NIL'. In this case efficiency and flue temperature readouts will not be operable.

With an unheated probe, the thermocouple within the probe may be used to sense flue temperature. In this case connect Terminals 3 and 4 to Terminals 5 and 6 with copper wire.

---

4. TRANSMITTER OUTPUT CHANNEL 1

Select the type of output required from Channel 1. Linear is the most common output required. The logarithmic output is often used where analog indicators give an exploded view of the oxygen range near stoichiometry. You can draw your own scale using data in Appendix 3.

Options:

1. Linear
2. Logarithmic
3. Reducing

The reducing output is for special applications requiring extreme reducing conditions e.g. ceramic surface treatment. Linear output spans are adjustable in Set-up step 5. The logarithmic output is fixed at 0.1 to 20 % oxygen and the reducing output is fired at 10^{-1} to 10^{-25} % oxygen. If either of the latter two are selected, then set-up 5 will be skipped.

5. TRANSMITTER SPAN CHANNEL 1

Applicable only to linear outputs. Select transmitter span for output Channel 1. For combustion applications, typical Linear spans are 0 to 10 % or 0 to 15 % oxygen.

6. TRANSMITTER OUTPUT CHANNEL 2

Select transmitter output for output Channel 2.

Options:
1.Probe EMF (0 –1300 millivots)
2. % carbon dioxide dry
3. Oxygen deficiency
4. % efficiency
5. Flue temperature ° C
6. 0.1 –20 % oxygen logarithmic
7. 1 x 10^{-1}– 10^{-25} % oxygen (for reducing conditions)

7. TRANSMITTER ZERO CHANNEL 2

The output zero and span of Channel 2 is set in set-up steps 7 and 8. Range limits are shown below.

8. TRANSMITTER SPAN CHANNEL 2

OUTPUT	ZERO RANGE	SPAN RANGE
PROBE EMF	0 –1100 mV in 100 mV steps	100 –1300 mV in 100 mV steps
CARBON DIOXIDE	0 –10 %	2 –20 %
OXYGEN DEFICIENCY (see Note 3)	0 –20 % oxygen deficiency	0 –100% oxygen excess
EFFICIENCY	0 % fixed	100 % fixed
FLUE TEMPERATURE	0 –100 °C in 1 ° C steps	100 –1400 ° C in 100 ° C steps
LOG OXYGEN (see Note 1)	0.1 % oxygen fixed	20 % oxygen fixed
REDUCING OXYGEN (see Note 2)	10^{-1} –10^{-10} % oxygen in one decade steps, non overlapping	10^{-1} –10^{-25} % oxygen in one decade steps. Min span two decades

NOTE

1: For log oxygen scale details, Refer to Appendix 3.
2: Note that the reducing oxygen span is shown on the display as the exponent only. -1 represents 10^{-1} % oxygen.
3: The oxygen deficiency output can be used in the same way as a combustibles analyser to signal the extent of reducing conditions. As an example, if the oxygen deficiency is 3 %, then the burner would need 3 % oxygen to bring it back to stoichiometry.

9. CENTIGRADE/FAHRENHEIT SELECTION

Select whether displays and outputs are to be in °Celsius or Fahrenheit
Options:
1. Celsius (centigrade)
2. Fahrenheit

10. LOWER LINE DISPLAY FUNCTIONS

In the run mode the upper line on the LCD display will always read % oxygen. The lower line can be set to read one or more of the following. Select as many as are required to be displayed by pressing the ‘ENTER’ button. Those selected will have an asterisk displayed alongside.
Options:
1. Date – time
2. Run hours since last service
3. Date of last service
4. Relative humidity
5. Probe impedance
6. Carbon dioxide
7. % CO in CO_2 (see Note 2)
8. Oxygen deficiency (see Note 3)
9. Probe EMF
10. Efficiency (see Note 1)
11. Probe temperature
12. Flue temperature (see Note 1)
13. Ambient temperature

If no lower line options are required then do not enter any. If options already selected are required to be deleted, select the required option and press the ‘ENTER’ button. The asterisk will be removed.

NOTE

1: A flue thermocouple or unheated probe TC, jumpered on Terminals 3 and 4 to Terminals 5 and 6. (Refer Section 3.5) must be fitted to obtain a proper reading on 9 or 11. Sensors must be connected to obtain a proper reading on 4, and 12.

2: The % CO in CO_2 display is used to test probe calibration with calibrated gases in reducing conditions. For example, 10 % CO in CO_2 = 5 % oxygen deficiency; 5% CO in CO_2 = 2.5 % oxygen deficiency.

3: The oxygen deficiency display will read ‘EXCESS’ when the combustion contains excess air.

11. FLUE PRESSURE

Enter flue pressure, e.g. 3 mm W.G.
Options:
MM W.G.
Kilopascals
Inches W.G.

12. FLUE PRESSURE VALUE

Enter flue pressure e.g. 3 mm W.G.
Limits :
-200 –+200 mm W.G.
-9 –+9 inches W.G.
-200 –+200 kpa.

13. SINGLE OR DUAL FUEL

Enter single or dual fuel (for the efficiency calculation). This step and steps 14 to 27 will be skipped if efficiency is not selected in Set-up steps 6, 10 or 46 for display or output on the printer port.

Options:
Single/Dual

14. TYPE OF FUEL NUMBER 1

Select fuel type #1. If the fuel constants in Appendix 1 are not correct for your fuel, they can be altered and entered. Two special fuel options are available if the required fuel designation is not on the list in Appendix 1.

15. FUEL NUMBER 1 ‘A’ VALUE

Enter the correct value of ‘A’ (Refer notes in Appendix 1).

16. FUEL NUMBER 1 ‘H’ VALUE

Enter the correct value of ‘H’ (Refer notes in Appendix 1).

17. FUEL NUMBER 1 ‘O’ VALUE

Enter the correct value of ‘O’ (Refer notes in Appendix 1.

18. FUEL NUMBER 1 ‘N’ VALUE

Enter the correct value of ‘N’ (Refer notes in Appendix 1).

19. FUEL NUMBER 1 ‘S’ VALUE

Enter the correct value of ‘S’ (Refer notes in Appendix 1).

20. FUEL NUMBER 1 ‘M’ VALUE

Enter the correct value of ‘M’ (Refer notes in Appendix 1).

For single fuel applications the next set-up stepwill be 28, for dual fuel the next step is 21

21. TYPE OF FUEL NUMBER 2

Select fuel type 2. If the fuel constants in Options Appendix 1 are not correct for your fuel they can be modified as in set-up step 14. Refer Appendix 1

22. FUEL NUMBER 2 ‘A’ VALUE

Enter the correct value of ‘A’ (Refer notes in Appendix 1).

23. FUEL NUMBER 2 ‘H’ VALUE

Enter the correct value of ‘H’ (Refer notes in Appendix 1).

24. FUEL NUMBER 2 ‘O’ VALUE

Enter the correct value of ‘O’ (Refer notes in Appendix 1).

25. FUEL NUMBER 2 ‘N’ VALUE

Enter the correct value of ‘N’ (Refer notes in Appendix 1).

26. FUEL NUMBER 2 ‘S’ VALUE

Enter the correct value of ‘S’ (Refer notes in Appendix 1).

27. FUEL NUMBER 2 ‘M’ VALUE

Enter the correct value of ‘M’ (Refer notes in Appendix 1).

28. PURGE/CAL TIME

Set the purge time to occur at the correct time-of-day. If purging is not required but on-line auto gas calibration is required, enter a time-of-day value suitable for the auto calibrations. Cal Gas 1 will be tested ten minutes after the purge/cal time and Cal Gas 2, 20 minutes after. If neither purge nor auto calibration is required, ignore the time setting.

Range:
0 –23 hours in one hour steps.

29. AUTOMATIC PURGE

For oil and coal fired plant, sensor filters are necessary and should be back-purged with sufficient frequency to avoid blocked filters. The output will be frozen during purging. If no purge is required, set-up steps 30, 31 and 32 will be skipped.

Options:
Yes
No

30. TIME BETWEEN PURGES

Set the time between purges e.g. a two hourly purge or a 100 hourly purge.

Range:
1 –199 hours

31. PURGE DURATION

Set up purge duration to a number between three and ten seconds. The filter is actually purged in less than one second, but three seconds are required for the purge flow switch to check that the filter is not blocked.

Range:
0 –10 seconds

32. PURGE FREEZE TIME

After the purge period the transmitter output will remain fixed (frozen) for an adjustable period to allow the probe reading to return to the correct process level and avoid output ‘bumps’. The freeze period time required will depend on the probe response time and thus its design, and whether it has a filter or not.
To determine the required freeze time, manually perform a purge while the plant is in operation and note the time required for the reading to return to the correct process level within approximately 0.5 % oxygen.

Range:
100 –1000 seconds in ten second steps

33. NUMBER OF CAL GASES

Select the number of cal gases 0, 1 or 2. For example, one may be air (20.9 % oxygen) and the other 2 % oxygen

Options:
No Cal Gas
Single Cal Gas
Dual Cal Gas
During the timed calibration periods the transmitter outputs will be frozen and the analyser will alarm if readings are not within the accuracy limits sets in set-up steps 34 and 35. If autocal is not required enter ‘NO CAL GAS’ and the transmitter will step to set-up 46.

34. OXYGEN CONTENT OF CAL GAS 1

Enter value of Cal Gas 1 (to one decimal point).

Range:
0.0 –20.9 % oxygen

35. MAXIMUM ACCEPTABLE POSITIVE ERROR GAS 1

Set the maximum positive error above which the ‘AUTOCAL ERROR HIGH’ alarm will be initiated after the timed period set in set-up step 38.

Range:
0.1 –3.0 % oxygen

36. MAXIMUM ACCEPTABLE NEGATIVE ERROR GAS 1

Set the maximum negative error below which the ‘AUTOCAL ERROR LOW’ alarm will be initiated after the timed period set in set-up step 38.

Range:
0.1 –3.0 % oxygen

37. PERIOD BETWEEN GAS 1 AUTOCALS

Set the number of hours between autocal Gas 1. A typical time would be 24 to 168 hours. (Daily of weekly).

Range:
1 to 1999 hours

38. DURATION OF AUTOCAL GAS 1

Set the number of seconds that the autocal gas solenoid will be open. At the end of this period, if the oxygen level measured is not within the limits set for Cal Gas 1, an ‘AUTOCAL ERROR’ will initiate. To determine the minimum time required for a particular length or design of probe to settle, manually admit cal gas while observing the oxygen reading in ‘RUN’ mode. Typical minimum times vary from 15 seconds to 90 seconds, depending on the probe length and gas plumbing arrangement.

Range:
0 –90 seconds

39. FREEZE TIME GAS 1

After the Cal Gas 1 period, the transmitter output will remain fixed, (frozen) for an adjustable period to allow the probe reading to return to the correct process level and avoid output 'bumps'. The freeze period time required will depend on the probe response time, and thus its design and whether or not it has a filter.

Range:
10 –100 seconds in ten second steps

To determine the required freeze time, manually perform a calibration with Gas 1 while the plant is in operation and note the time required for the reading to return to the correct process level within approximately 0.5 % oxygen.

40 TO 45

Enter the same requirements for Cal Gas 2 as per set-up steps 34 to 39 for Cal Gas 1. Cal Gas 2 could typically be 2 % oxygen in nitrogen.

46. DATA TO PRINT

Any or all of the following values may be printed on a printer or computer connected to port 2. They may be selected or de-selected using the 'ENTER' buttons as in set-up step 10. The log period follows in set-up steps 47-48. A sample of a print-out from port 2 is contained in Appendix 4. RS–232C protocol is :

Data word length	Eight bits
Stop bits	One
Parity	None

Options :
1. Oxygen %
2. Date –Time
3. Run Hours Since Last Service
4. Date of Last Service
5. Relative Humidity
6. Probe Impedance
7. Carbon Dioxide
8. Burner Deficiency
9. Probe EMF
10. Oxygen Efficiency
11. Probe Temperature
12. Flue Temperature
13. Ambient Temperature

47 PRINT LOG PERIOD

Select the time interval between data printouts on the printer.

Range:
1 –2000 minutes

48. PRINTER BAUD RATE

Select the correct BAUD rate for data to be transmitted out of the port to the printer.

Options:
300
1200
2400
4800
9600

49. RELATIVE HUMIDITY SENSOR CONNECTED

For improved accuracy in the calculation of efficiency of the burner, the air inlet relative humidity may be measured and included in the calculation. Provision has been made on Terminals 7 and 8 for a 0 –+1 volt signal, proportional to 0 –100 % RH.

If an RH sensor is not available, the option ‘SENSOR NOT CONNECTED’ may be used to set a constant RH input of 50 %.

Options:
1. Sensor Connected
2. Sensor Not Connected.

50. SWITCHED REFERENCE AIR SUPPLY

It is recommended that the reference air supply for the oxygen probe is supplied to the probe through a flow sensor (See Section 3.12, Connecting Reference Air). The pump that supplies the reference air supplied by Novatech Controls can be installed inside the 1532 transmitter. The power lead of the pump is connected to terminals 35 and 36 (See Figure 2.3) The flow switch contacts are connected to terminals 16 and 17 (See Figure 3.10a).

The flow switch would be on all the time, with the possibility that the float in the sensor may stick. To exercise the switch and to actually check its reaction to a break in reference air flow, the power to terminals 35 and 36 (Reference air pump), is interrupted for about three seconds every five minutes.

If a plant air supply is being used, a mains voltage solenoid valve may be used to switch the reference air supply off. Connect the coil of the solenoid to terminals 35 and 26 (Reference air pump). If a switched reference air supply is not being used, select ‘NO’ to inhibit the ‘FLOW SWITCH’ alarm.

Options
1. YES
2. NO.

51. DAMPING FACTOR

Each time a new reading is read from the oxygen probe, the new reading is averaged with the last readings taken, before the new average is either displayed on the LCD, or sent to the 4–20 mA output.

The number of readings that are averaged together is adjustable by the user in this function.

A value of five for example, means that the new reading from the probe, and the previous four readings are averaged together before being displayed.

A value of one entered here will mean that every new reading from the probe will be sent to the display unaltered.

Range
1–20

MAINTENANCE

6

SECTION
NUMBER

TRANSMITTER MAINTENANCE

6.1 MAINTENANCE MODE SUMMARY

1. ENTER DATE, YEAR
2. ENTER DATE, MONTH
3. ENTER DATE, DAY
4. ENTER TIME, HOURS
5. ENTER TIME, MINUTES
6. SET 20MV REFERENCE (TEST POINT 4)
7. SET 70MV REFERENCE (TEST POINT 3)
8. SET 1200MV REFERENCE (TEST POINT 2)
9. SET 2500MV REFERENCE (TEST POINT 1)
10. SET PROBE OFFSET (PROBE CALIBRATION)
11. 4-20mA OUTPUT CALIBRATION CHANNEL #1
12. 4-20mA OUTPUT CALIBRATION CHANNEL #2
13. ENTER SERVICE YEAR
14. ENTER SERVICE MONTH
15. ENTER SERVICE DAY

6.2 SET-UP/MAINTENANCE/RUN/SWITCH

For the 'MAINTENANCE ' mode on the keyboard to operate, move the toggle switch to 'MAINT'. The outputs will be frozen when in 'MAINTENANCE' mode.

If purges or auto calibration occur while the mode switch is in 'MAINT', they will be delayed until the mode switch is returned to 'RUN'.

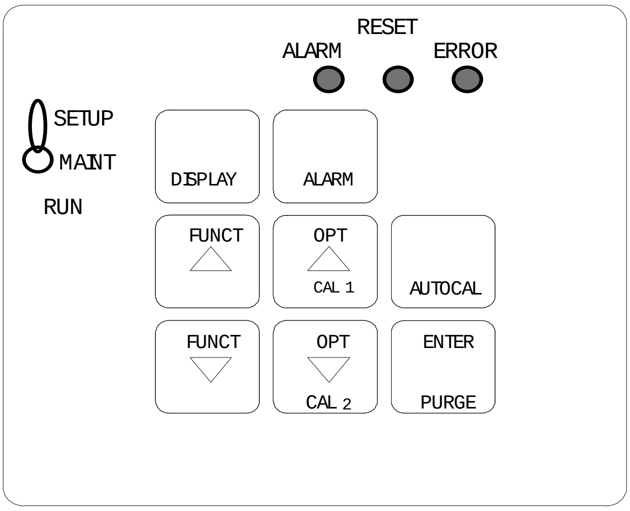


Figure 6.1 Internal Technicians Keyboard

6.3 FUNCTION SWITCH

When the ‘SET–UP/MAINTENANCE/RUN SWITCH’ is moved to ‘MAINT’, the display will automatically read the last ‘MAINTENANCE’ function selected. To select other functions, operate the ‘FUNCTION _’ button to increment to the next function or the ‘FUNCTION —’ to decrement to the previous function.

6.4 ENTER VALUES

To set a value for a particular function press the ‘OPTION _’ button to increase the value, and the ‘OPTION —’ button to decrease the value. A momentary press will change the value one digit. Holding the button will change the value more quickly. Once the correct option or value is displayed it can be entered into the analyser's memory by pressing the ‘ENTER’ button. When a value has been accepted an asterisk will appear at the R.H.S. of the lower line (except for calendar date and time values).

6.5 MAINTENANCE FUNCTIONS DETAIL

1. ENTER DATE DD/MM/YR
Enter year e.g. 04-08-93 =4th August, 1993.

2. ENTER DATE
Enter month.

3. ENTER DAY
Enter day.

4. ENTER HOURS
Enter hours e.g. 22:04 = 10.04 pm.

5. ENTER TIME
Enter minutes.

6. SET 20 mV REF.
Enter the 20 mV reference voltage to calibrate the transmitter.

7. SET 70 mV REF.
Enter the 70 mV reference voltage.

8. SET 1200 mV REF
Enter the 1200 mV reference voltage.

9. SET 2500 mV REF
Enter the 2500 mV reference voltage.

Functions 6 to 9 are used to calibrate the A/D of the instrument. This should be done 30 minutes or more after the instrument has been on, approximately once every year. The calibration constants are retained in battery backed memory unless a ‘COLD START’ is performed. Refer to Section 3.17.
Connect a 3 1/2 digit multimeter negative lead to the terminal marked ‘COMMON’ to the left of the internal keyboard. Measure the four test point voltages on the test pins marked 1 to 4 below the common test pin with the positive lead. Refer to Figure 6.2 These voltages should be approximately:

1) 2481 mV
2) 1159 mV
3) 66.6 mV
4) 18.8 mV

Enter the measured values in functions 6 to 9. Whenever new values are entered the D/A section should be recalibrated, Refer to Section 6.6.

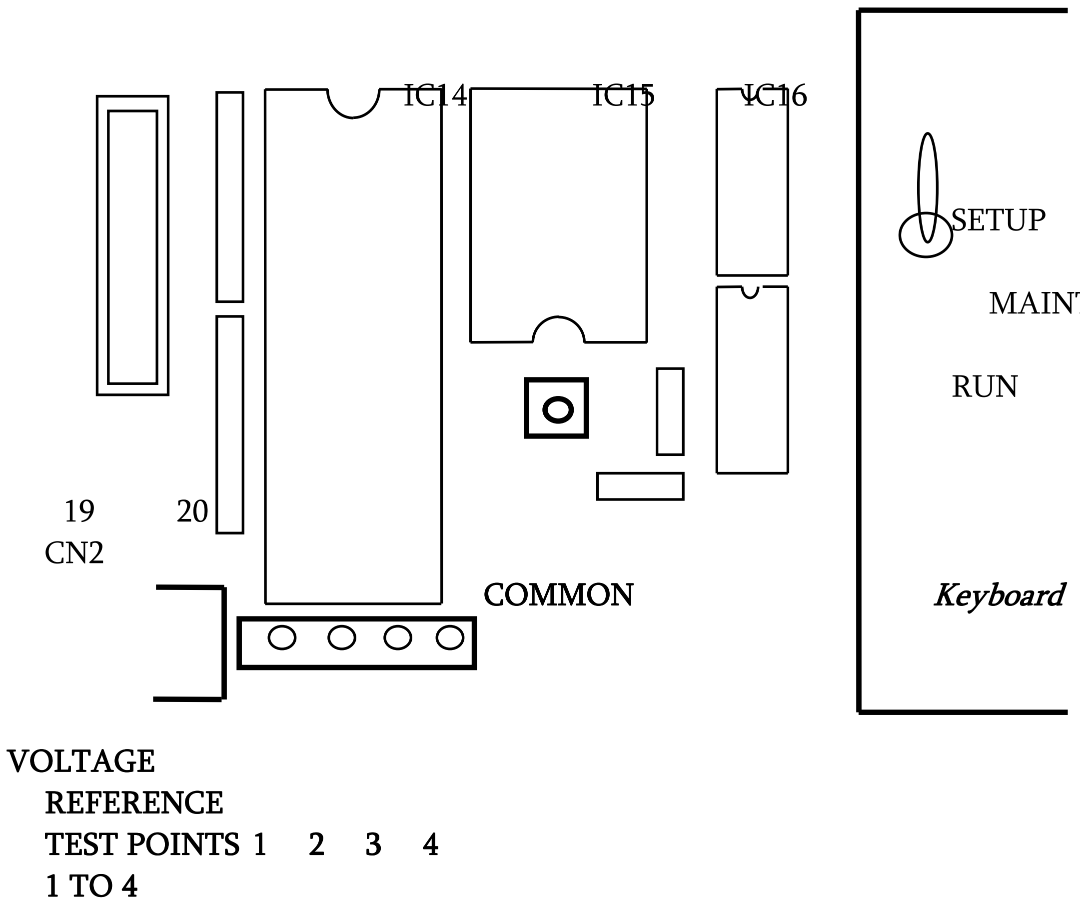


Figure 6.2 Location of Calibration Test Points

10. SET PROBE OFFSET
A new EMF offset must be entered whenever a new oxygen probe is installed to calibrate for any offset an individual probe may have. Each probe will have an offset value noted on a removeable tag. Enter the ‘PROBE OFFSET’ value with opposite polarity, e.g. if offset value is -1.2 mV. enter 1.2 mV. The typical maximum is 2mV.

To check a probe offset on site, the probe must be sensing air with reference air connected (if longer than 140 mm) and allowed to settle at the probe operating temperature for 30 minutes. Read the offset in ‘RUN’ mode in millivolts on the lower line. Offset errors can occur if the sensor does not have some air passing over it. A gentle flow of air in the calibration port can be provided by a reference air pump or similar.

For heated probes, if the combustion appliance is not operational and the probe heater is interlocked with the ‘FUEL ON’ signal, the ‘HEATER LOCKOUT BYPASS’ switch should be set to ‘BYPASS’ to power the probe heater after removing the probe from the flue.

CAUTION DANGER

Return the ‘HEATER LOCKOUT BYPASS’ switch to normal before installing the probe in the flue.

For unheated probes, the probe sensing tip must be raised to at least 700°C with a portable furnace. (Available as an accessory).

Determine the probe offset in ‘RUN’ mode. Select ‘PROBE EMF’ on the lower line. With probe in air, stabilized at temperature for 30 minutes, read the ‘PROBE EMF’. Switch back to ‘MAINTENANCE’ mode and enter ‘PROBE OFFSET’ of equal value and opposite polarity. e.g.,if ’PROBE OFFSET’ was 0.8 mV. enter -0.8 mV.

When reading the EMF offset the flue pressure compensation must be set. If the probe has been removed from the flue, set the flue pressure compensation to 0 in set-up step 12.

11. SET CALIBRATION FACTOR FOR 4–20 CHANNEL #1

The calibration of the 4–20 mA outputs is done by reading back the output into the input and calibrating this against a known standard. The standard however, may vary from analyser to analyser. To allow for this a trim factor has been provided to set the calibration of each channel for your particular analyser. These two values should only have to be entered once for the life of the instrument, then the only calibration of the outputs should be to press the 'AUTOCAL' button every six months.

To determine the factors, generate a full scale value to be sent to the output. eg. For Channel #1, if set up steps 5 and 6 were set for a full scale output of 10% oxygen, then generate input signals until the top line of the display reads 10% oxygen. This is best done with the use of a Novatech probe simulator test box, but can also be achieved with a millivolt generator.

Read the output of channel #1 with a three and a half digit multimeter.
i.e. The output should be 20mA.
If your meter reads 19.65mA.
20.00 – 19.65 = 0.35
(0.35/19.65 *100% = 1.78% error.

Enter the value of 101.8 into 'MAINT' step 11, 4–20 mA #1 CAL, and press 'AUTOCAL' after returning to the RUN mode.

NOTE

The accuracy of the output channels without trimming these factors is generally within 2% after using the ' AUTOCAL' procedure. In most cases the instrument can be used without this further trimming of the calibration.

12. SET CALIBRATION FACTOR FOR 4–20 CHANNEL #2

Follow the procedure set in step 11 for Channel #2.
(It is convenient to use set up step 6 set to PROBE EMF, 0-100 mV to set and test the calibration of channel #2.)

13. ENTER SERVICE YEAR

For a new 'DATE OF LAST SERVICE', enter the service 'YEAR'. This can represent the last time the probe was serviced or the last time the boiler was serviced. It is recommended that probes be refurbished every two years

14. ENTER SERVICE MONTH

Enter the current 'MONTH'.

15 ENTER SERVICE DAY

End the current 'DAY' of the month. Altering these values will reset the 'RUN TIME'.

6.6 D/A CALIBRATION

If a 'COLD START' is performed (Section 3.17), then the D/A section of the analyser will be automatically calibrated after a thirty second delay. The D/A section should be manually re-calibrated after the instrument has been switched on for 30 minutes and stabilised. This is achieved by pressing the 'AUTO CAL' button. This button should be pressed annually, or if the reference voltages are altered in 'MAINT'. Refer to Section 6.5, items 6,7,8 or 9 to re-calibrate the D/A converter and isolated output section. An 'AUTO CAL' will be performed for one second after pressing the button. The transmitter outputs will fall to 0 mA. for this one second period.

If a 'D/A CAL' error occurs during normal operation, then a hardware fault should be suspected.

6.7 BACK-UP BATTERY REPLACEMENT

The back-up battery is contained within the module, plugged into socket IC2. It is rated for an average service life of 38 years with power on, and for ten years with the power off. The battery is not re-chargeable and should be replaced every three years with stored transmitters with power off or every ten years with transmitters which have had the power on.
After replacing the battery, re-enter all maintenance and set-up mode functions.

6.8 ELECTRONIC REPAIRS

Electronic schematics are included in Appendix 5. A competent electronic technician could perform troubleshooting with these schematics, aided by the analyser self-diagnostic alarms.

It is recommended that service be performed on a change-over circuit board basis. A fast turn-around or replacement service is available from Novatech or accredited service agents.

Other service aids, including a firmware package and input simulator are also available from Novatech.

PROBE MAINTENANCE

6.9 TEST EQUIPMENT REQUIRED

All measurements are simplified if an analyser is connected to the probe. Readings can then be easily taken of probe impedance, EMF, temperature and percent oxygen. The analyser also provides proper heater control for heated probes.

The following tests are described using readily available workshop equipment where an analyser is not available. If an analyser is available the same test procedures will apply. First check all alarms on the analyser, allowing time for the probe to heat up after switch on.

An instrument to measure probe EMF and temperature is required. A 3 1/2 or 4 1/2 digit multimeter will perform both measurements.

A separate temperature indicator to suit the probe thermocouple type is also useful, although not necessary.

A reference air pump is required and a cylinder of calibration gas e.g. 2 % oxygen in nitrogen. The cylinder should have a pressure and flow regulator. Both of these are inexpensive devices available from gas supply companies. The calibration gas should be chromatograph tested to an accuracy of 0.1 % oxygen.

UNHEATED PROBES

A small test furnace capable of raising the probe tip temperature to 720 °C is required. The furnace should have a uniform temperature for about 50 mm either side of the sensor tip.

HEATED PROBES

If a 1532 analyser is available at the test location then no other equipment will be required. If not, then a controllable power source for the heater is required. A Variac (variable transformer), set to approximately 100 volts will regulate the probe temperature to 720 °C approximately.

6.10 TESTING A PROBE

With the probe tip heated to approximately 720 °C, either from a small test furnace or its own internal heater, connect a digital multimeter to the probe electrode conductors. Connect the multimeter positive to the internal electrode conductor. Connect reference air to probes longer than 140 mm and apply a gentle purge of air to the probe calibration port. Reference air flow should be the smallest flow available (less than 50 cc per minute). The multimeter should read zero millivolts ± two millivolts. If not, then there is a problem with the probe electrodes and the sensor needs refurbishing. Normally a faulty probe electrode is indicated with a high source impedance.

To test the source impedance, set the multimeter to read ohms and take a measurement, within a couple of seconds, of the probe impendance. Reverse the multimeter and repeat the reading. Take the average of the two readings for an approximate measurement of impedance. If the impedance is above 2000 _, then the electrode needs refurbishing. The probe must be at 720 °C or above for this measurement.

The reason that impedance measurements need to be performed quickly, is that the zirconia sensor polarises with the DC voltage from the multimeter across it. Where a probe electrode requires refurbishing it is suggested that they should be returned to Novatech or an accredited service organisation.

If the probe tests reveal less than 2 mV. offset and a good impedance reading, the next step is to apply a calibration gas. The calibration gas should be inserted in the calibration port. With the calibration gas flowing, the probe should develop an EMF according to the tables in Appendix 2. If the EMF reading is low then there may be insufficient calibration gas flow. Increase the calibration gas until the reading is correct. An excessive calibration gas flow will cause cooling on one surface of the sensor, giving temperature differential errors on the sensor.

If the calibration gas flow is high and it is left to flow on a probe at a high temperature for more than about 15 seconds, the ceramic parts of the sensor and probe sheath can be cooled to the point where, when the flow is removed, they can break due to thermal shock.

If the flow is kept on for a long time it should be reduced slowly to allow the ceramic surfaces to heat at a rate of not more than 50 °C per minute. ie. To remove a flow which has been running for some time on a probe at 1100 °C, the time taken should be about 22 minutes.

The sensor accuracy should be within 0.5 mV. with the same offset which was measured with air on both sides of the sensor. If the probe EMF is not within this tolerance, then it will require the electrodes to be refurbished.

As an alternative, using the reference air port, the calibration gas can be inserted into the inside of the sensor. This requires a lower flow rate, and thus lower usage of calibration gas. The flow rate should be similar to that of the reference air, which should be removed for internal calibration. The probe EMF reading will be identical but negative in polarity. A small flow of air should be flowing over the outside of the sensor, when testing in this way.

Occasionally, a sensor can develop offset with a polluted electrode caused by contaminants in the flue gas stream. In this case, the old electrode material must be completely cleaned off before re-applying the fresh electrode material. Again, return the probe or sensor to Novatech or an accredited service organisation.

6.11 SENSOR IMPEDANCE

If the sensor impedance is found to be high in the test described in Section 6.10 it is occasionally necessary to cause a small movement of the inner electrode conductor to re-establish contact. This is achieved by gently pulling the four bore ceramic tube against its spring loading for approximately 1 mm and releasing. This procedure is normally only required with a probe which has been sitting cold for many months.

With some probes it is possible to view the sensor electrode material from outside the outer sheath. The electrode material should be either grey or green and should fully cover the end of the sensor. If any cream coloured ceramic material is visible at the sensor end, then the electrode has been degraded and will require refurbishment.

6.12 PROBE THERMOCOUPLE

Although some unheated probes are specified without a thermocouple, most probes, both heated and unheated, have an integral thermocouple which is fitted in to the four bore insulator. The analyser has an alarm function which will advise the operator of an open circuit probe thermocouple, however bench testing can be performed by simply measuring the thermocouple continuity. If the thermocouple requires replacement, care should be taken not to physically damage the inner electrode material during removal and replacement of the thermocouple and insulator.

6.13 HEATER FAILURE

For heated probes, a heater failure will cause a ‘PROBE UNDER TEMPERATURE’ or ‘HEATER FAILURE’ alarm. Heaters can be tested from the probe head with a continuity test.

The heater impedance should be approximately 100 _. Should the heater be open circuit, contact Novatech or an accredited service agent.

6.14 FILTER BLOCKAGE

For oxygen probes or flow guide tubes with filters in installations with entrained solids in the flue gas, it is sometimes necessary to replace the filter. Filters are normally cleared with back purging. However fine fly-ash, or other particles can ultimately completely block a filter necessitating filter replacement. A new probe filter can be fitted by Novatech or an accredited service agent. Flow guide tube filters are field replaceable.

6.15 PACKING

To return a probe for refurbishment to our factory, please ensure that it is properly packed. We recommend a cardboard box which is normally dropped with less force than a heavy wooden box. Use polystyrene beads for internal packing and some cardboard to inhibit end travel of the probe.

Due to the delicate ceramic inner components of the probe, probes improperly packed are normally broken by the time they arrive at our factory.

Refurbishment is normally an inexpensive operation that can be made expensive with improper packing.

APPENDICES

1. CONSTITUENT VALUES FOR VARIOUS FUELS
2. PROBE EMF TABLES
3. % OXYGEN SCALE – LOGARITHMIC
4. SAMPLE LOG PRINT OUT
5. CIRCUIT SCHEMATICS

APPENDIX 1

CONSTITUENT VALUES FOR FUELS

If the analyser is set up to have readout or output of efficiency, then the fuel constituents must be entered. The analyser has preselected values for typical fuels and these may be sufficiently accurate for your purposes. If not, any or all of the variables can be modified and entered in set-up steps 15 to 20 and 22 to 27. (Refer to Section 5.5). Your fuel supplier or chemist should be able to give you all these values.

A is the heat of combustion of the fuel per gram atom of contained carbon.

H is the H/C atom ratio in the fuel.

O is the O/C atom ratio in the fuel.

N is the N/C atom ratio in the fuel.

S is the S/C atom ratio in the fuel.

M is the ratio of H_20 molecules to C atoms in the fuel

FUEL	A	H	O	N	S	M
Blast furnace gas	50.55	0.08	1.30	3.08	b	a
Coke oven gas	256.88	5.60	0.25	0.23	b	a
Producer gas	101.98	1.18	1.02	2.90	b	a
Natural gas	209.90	3.86	0	0.10	0	0
Propane, natural	176.40	2.69	0	0	0	0
Butane, refinery	166.10	2.34	0	0	0	0
Methanol	172.59	3.97	1.00	—	—	—
Gasoline, motor	157.58	2.01	0	0	0	0
No 1 Distillate oil	149.65	1.83	0	—	0	—
No 2 Distillate oil	145.18	1.71	—	—	0	—
No 4 Fuel oil	145.54	1.60	—	—	0.01	0
No 5 Residual oil	142.25	1.44	—	0	0	0
No 6 Residual oil	136.52	1.25	0.01	0	0	0
Wood,non-resinous	110.91	2.26	1.07	0	0	c
Coal, bituminous	116.88	0.74	0.05	0	0	0.03
Coal, anthracite	104.98	0.35	0.05	0	0.01	0.04
Coke	99.63	0.11	0.01	0.01	0	0.01

a. The moisture level varies depending on the process details.
The calculated values assume M = O.

b. The sulphur level varies depending on the process details.
The calculated values assume S = O.

c. Variable.

Values calculated from the North American Combustion Handbook, Tables 2.1a and 2.1b.

APPENDIX 2

PROBE EMF TABLES

ZIRCONIA OXYGEN PROBE OUTPUT (mV)
PROBE TYPE 1231

% OXYGEN	mV at 720ºC
20.0	0.99
19.5	1.53
19.0	2.09
18.5	2.66
18.0	3.25
17.0	4.47
16.5	5.11
16.0	5.77
15.5	6.45
15.0	7.15
14.5	7.87
14.0	8.62
13.5	9.40
12.5	11.05
12.0	11.92
11.5	12.83
11.0	13.78
10.5	14.78
10.0	15.82
9.5	16.92
9.0	18.08
8.5	19.30
8.0	20.60
7.5	21.98
7.0	23.45
6.5	25.04
6.0	26.75
5.5	28.61
5.0	30.65
4.5	32.90
4.0	35.42
3.5	38.28
3.0	41.58
2.5	45.48
2.0	50.25
1.5	56.41
1.0	65.08
0.5	79.91
0.2	99.51
‘K’ TC mV	**29.965**

These tables are based on the Nernst equation:
Probe e.m.f. = 0.02154 x T x 1n x 21% oxygen, where T = ºK (ºC + 273).

ZIRCONIA OXYGEN PROBE OUTPUT (mV), PROBE TYPE 1232

				TEMPERATURE					
% O2	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**
20	0.917	1.023	1.128	1.233	1.338	1.443	1.548	1.653	1.758
19.5	1.394	1.553	1.713	1.872	2.032	2.192	2.351	2.511	2.671
19	1.882	2.098	2.313	2.529	2.744	2.960	3.175	3.391	3.607
18.5	2.383	2.657	2.930	3.203	3.476	3.749	4.022	4.295	4.568
18	2.899	3.231	3.563	3.895	4.227	4.559	4.891	5.223	5.555
17.5	3.428	3.821	4.214	4.607	4.999	5.392	5.795	6.177	6.570
17	3.974	4.429	4.884	5.339	5.794	6.249	6.705	7.160	7.615
16.5	4.535	5.054	5.574	6.093	6.613	7.132	7.652	8.171	8.691
16	5.114	5.699	6.285	6.871	7.457	8.042	8.628	9.214	9.800
15.5	5.711	6.365	7.019	7.673	8.327	8.981	9.635	10.289	10.944
15	6.327	7.052	7.777	8.501	9.226	9.951	10.676	11.400	12.125
14.5	6.965	7.762	8.560	9.358	10.156	10.954	11.751	12.549	13.347
14	7.625	8.498	9.371	10.245	11.118	11.991	12.865	13.738	14.612
13.5	8.308	9.260	10.212	11.164	12.115	13.067	14.019	14.970	15.922
13	9.018	10.051	11.084	12.117	13.150	14.183	15.216	16.249	17.282
12.5	9.756	10.873	11.991	13.108	14.226	15.343	16.461	17.578	18.695
12	10.523	11.729	12.934	14.139	15.345	16.550	17.756	18.961	20.167
11.5	11.324	12.621	13.918	15.215	16.512	17.809	19.106	20.403	21.700
11	12.159	13.552	14.945	16.338	17.731	19.124	20.516	21.909	23.302
10.5	13.034	14.527	16.020	17.513	19.006	20.499	21.992	23.486	24.979
10	13.952	15.550	17.148	18.746	20.344	21.942	23.540	25.139	26.737
9.5	14.916	16.625	18.333	20.042	21.751	23.459	25.168	26.877	28.585
9	15.933	17.758	19.583	21.408	23.233	25.058	26.883	28.709	30.534
8.5	17.008	18.956	20.904	22.852	24.801	26.749	28.697	30.645	32.593
8	18.148	20.227	22.305	24.384	26.463	28.542	30.620	32.669	34.778
7.5	19.361	21.579	23.797	26.015	28.223	30.450	32.668	34.886	37.104
7	20.659	23.025	25.392	27.758	30.124	32.491	34.857	37.224	39.590
6.5	22.052	24.578	27.104	29.630	32.156	34.683	37.209	39.735	42.261
6	23.557	26.256	28.954	31.653	34.351	37.050	39.748	42.447	45.145
5.5	25.194	28.080	30.965	33.851	36.737	39.623	42.509	45.395	48.281
5	26.986	30.077	33.168	36.259	39.351	42.442	45.533	48.624	51.715
4.5	28.967	32.285	35.603	38.922	42.240	45.558	48.876	52.194	55.512
4	31.182	34.754	38.326	41.897	45.469	49.041	52.613	56.185	59.757
3.5	33.693	37.552	41.412	45.271	49.131	52.990	56.850	60.709	64.569
3	36.592	40.783	44.975	49.166	53.358	57.549	61.741	65.932	70.124
2.5	40.020	44.604	49.189	53.773	58.357	62.941	67.525	72.110	76.694
2	44.216	49.281	54.346	59.411	64.476	69.541	74.605	79.670	84.735
1.5	49.626	55.310	60.995	66.680	72.364	78.049	83.733	89.418	95.102
1	57.250	63.808	70.366	76.924	83.482	90.040	96.598	103.156	109.714
0.5	70.285	78.336	86.387	94.438	102.488	110.539	118.590	126.641	134.692
0.2	87.515	97.540	107.564	117.589	127.614	137.638	147.663	157.687	167.712
TC mV									
‘R’	5.582	6.741	7.949	9.203	10.503	11.846	13.224	14.624	16.035
‘K’	24.902	29.128	33.277	37.325	41.269	45.108	48.828	–	–
‘N’	20.609	24.526	28.456	32.370	36.248	40.076	43.836	47.502	–

These tables are based on the Nernst equation:
Probe e.m.f.= 0.02154 x T x 1n x 21/% oxygen
Where T = ° K (° C + 273)

ZIRCONIA OXYGEN PROBE OUTPUT (mV), PROBE TYPE 1233

	TEMPERATURE								
% O2	**600**	**700**	**800**	**900**	**1000**	**1100**	**1200**	**1300**	**1400**
20	-14.310	-15.346	-19.380	-22.511	-25.760	-29.120	-32.570	-36.077	-39.612
19.5	-13.008	-15.776	-18.795	-21.872	-25.066	-28.371	-31.767	-35.219	-38.699
19	-12.520	-15.294	-18.195	-21.215	-24.354	-27.603	-30.943	-34.339	-37.763
18.5	-12.019	-14.735	-17.578	-20.541	-23.622	-26.814	-30.096	-33.435	-36.802
18	-11.503	-14.161	-16.945	-19.849	-22.871	-26.004	-29.227	-32.507	-35.815
17.5	-10.974	-13.571	-16.294	-19.137	-22.099	-25.171	-28.323	-31.553	-34.800
17	-10.428	-12.963	-15.624	-18.345	-21.304	-24.314	-27.403	-30.570	-33.755
16.5	-9.867	-12.338	-14.934	-17.651	-20.485	-23.431	-26.466	-29.559	-32.679
16	-9.288	-11.693	-14.223	-16.873	-19.641	-22.521	-25.490	-28.516	-31.570
15.5	-8.691	-11.027	-13.489	-16.071	-18.771	-21.582	-24.483	-27.441	-30.426
15	-8.075	-10.340	-12.731	-15.243	-17.872	-20.612	-23.442	-26.330	-29.245
14.5	-7.437	-9.630	-11.948	-14.386	-16.942	-19.609	-22.367	-25.181	-28.023
14	-6.777	-8.894	-11.137	-13.499	-15.980	-18.572	-21.253	-23.992	-26.758
13.5	-6.094	-8.132	-10.296	-12.580	-14.983	-17.496	-20.099	-22.760	-25.448
13	-5.384	-7.341	-9.424	-11.627	-13.948	-16.380	-18.902	-21.481	-24.088
12.5	-4.646	-6.519	-8.517	-10.636	-12.872	-15.220	-17.657	-20.152	-22.675
12	-3.879	-5.663	-7.574	-9.605	-11.753	-14.013	-16.362	-18.769	-21.203
11.5	-3.078	-4.771	-6.590	-8.529	-10.586	-12.754	-15.012	-17.327	-19.670
11	-2.243	-3.840	-5.563	-7.406	-9.367	-11.439	-13.602	-15.821	-18.068
10.5	-1.368	-2.865	-4.488	-6.231	-8.092	-10.064	-12.126	-14.244	-16.391
10	-0.450	-1.842	-3.360	-4.998	-6.754	-8.621	-10.578	-12.591	-14.633
9.5	0.514	-0.767	-2.175	-3.702	-5.347	-7.104	-8.950	-10.853	-12.785
9	1.531	0.366	-0.925	-2.336	-3.865	-5.505	-7.235	-9.021	-10.836
8.5	2.606	1.564	0.396	-0.892	-2.297	-3.814	-5.421	-7.085	-8.777
8	3.746	2.835	1.797	0.640	-0.635	-2.021	-3.498	-5.061	-6.592
7.5	4.959	4.187	3.289	2.271	1.135	-0.113	-1.450	-2.844	-4.266
7	6.257	5.633	4.884	4.014	3.026	1.928	0.739	-0.506	-1.780
6.5	7.650	7.186	6.596	5.888	5.058	4.120	3.091	2.005	0.891
6	9.155	8.864	8.446	7.909	7.253	6.487	5.630	4.717	3.775
5.5	10.792	10.688	10.457	10.107	9.639	9.060	8.391	7.665	6.911
5	12.584	12.685	12.660	12.515	12.253	11.879	11.415	10.894	10.345
4.5	14.565	14.893	15.095	15.178	15.142	14.995	14.758	14.464	14.142
4	16.780	17.362	17.818	18.153	18.371	18.478	18.495	18.455	18.387
3.5	19.291	20.160	20.904	21.527	22.033	22.427	22.732	22.979	23.199
3	22.190	23.391	24.467	25.422	26.260	26.986	27.623	28.202	28.754
2.5	25.618	27.212	28.681	29.989	31.259	32.378	33.407	34.380	35.324
2	29.814	31.889	33.838	35.667	37.378	38.978	40.487	41.940	43.365
1.5	35.224	37.918	40.487	42.936	45.266	47.486	49.615	51.688	55.732
1	42.848	46.416	49.858	53.180	56.384	59.477	62.480	65.426	68.344
0.5	55.883	60.944	65.879	70.694	75.390	79.976	84.472	88.911	93.322
0.2	73.113	80.148	87.056	93.845	100.516	107.075	113.545	119.957	126.342
TC mV									
‘R’ x 2.58	5.582	6.741	7.949	9.203	10.503	11.846	13.224	14.624	16.035

1233 Probes use the same Nernst equation as 1232 probes, minus 2.58 x TC e.m.f. (mV).

APPENDIX 3

% OXYGEN SCALE – LOGARITHMIC

% OXYGEN	% FULL SCALE
0.1	0
0.15	7.66
0.2	13.1
0.3	20.7
0.4	26.2
0.6	33.8
0.8	39.2
1	43.5
1.5	51.1
2	56.5
3	64.2
4	69.6
6	77.3
8	82.7
10	86.9
12	90.8
14	93.3
16	95.8
18	98
20	100

APPENDIX 4

SAMPLE LOG PRINT OUT

12.07: 12/02/93

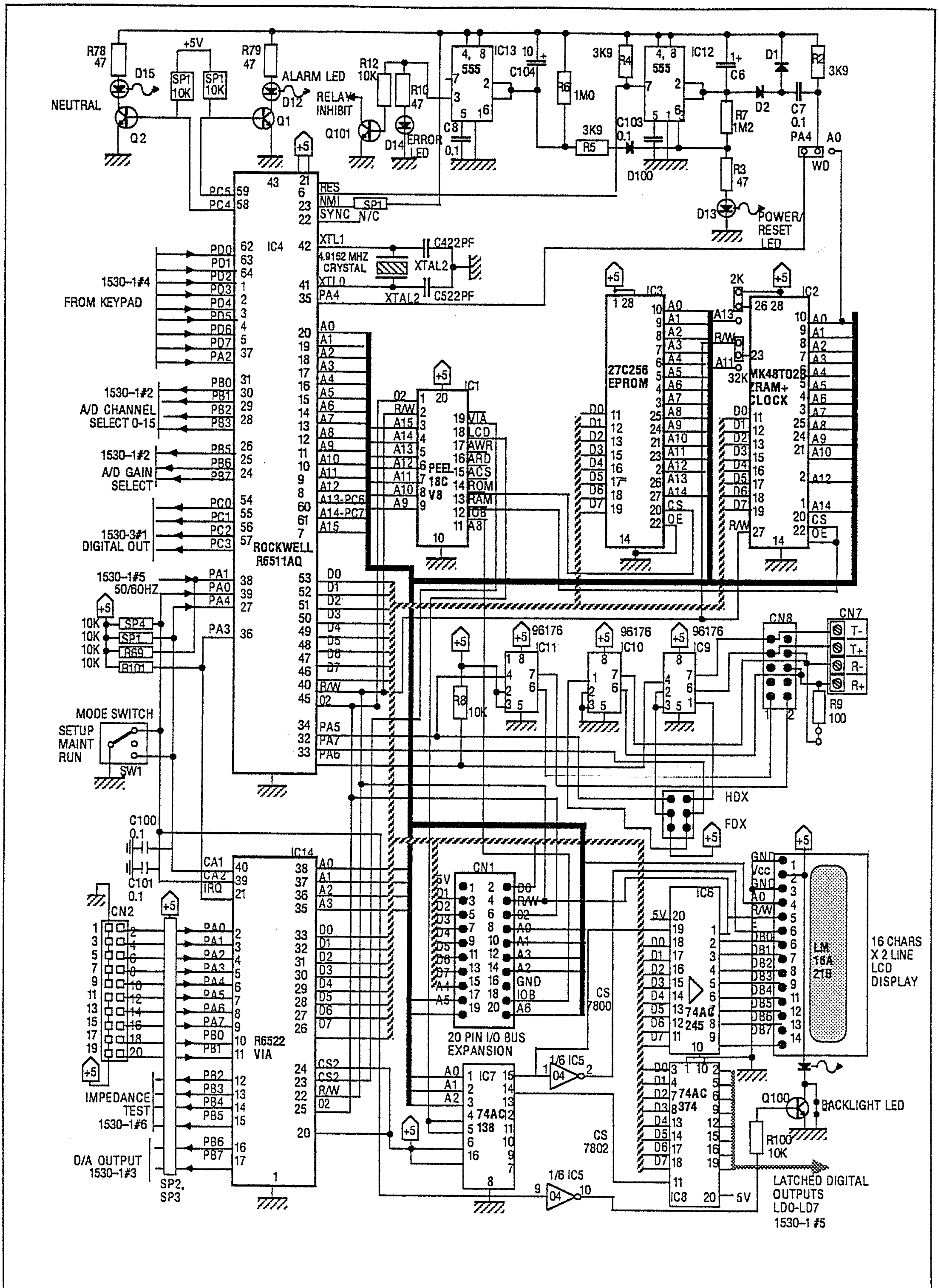
OXYGEN% 1.13
EFFIC'NCY 0%
O2 EXCESS
EMF mV 61.8
OFFSET 0.0
PRB TEMP 720 C
FLUE TEMP 488 C
AMBNT TEMP 25 C
PROBE IMP 1.0K
CO/CO2 0%
HUMIDITY 50.0%
RUN TIME 1435:21
SRVCD 6/02/93

PURGE 1433 MINS, GAS 1 CAL 3 MINS, PRINT LOG 13 MINS,

12:06:55 28/02/93 REF AIR FAIL SELF CLEARED
12:06:29 28/02/93 HTR BYPASS ACCEPTED
12:07:43 28/02/93 REF AIR FAIL
12:07:46 28/02/93 REF AIR FAIL SELF CLEARED

APPENDIX 5

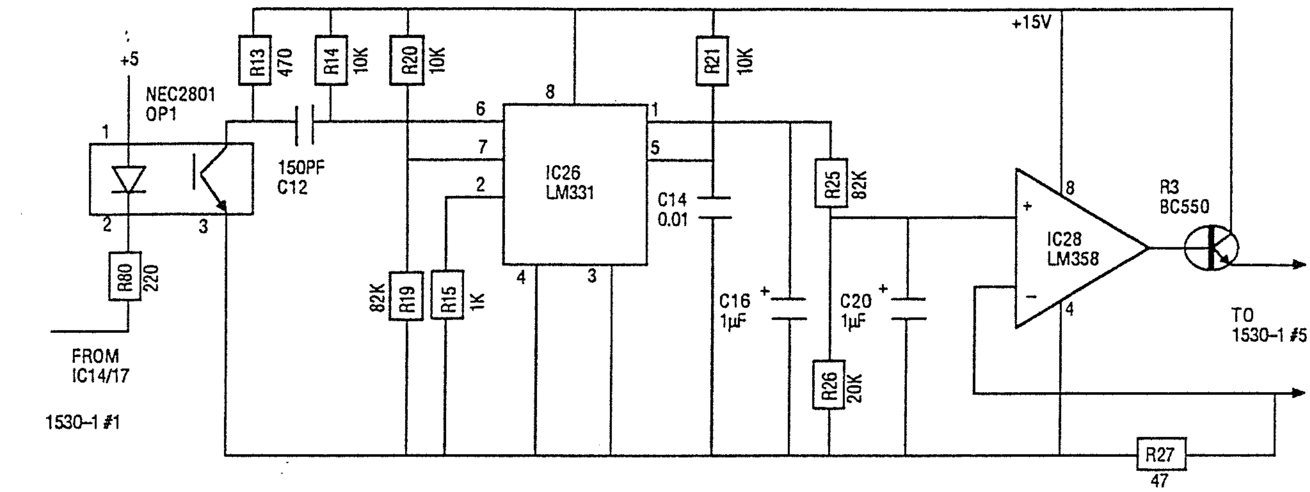
CIRCUIT SCHEMATICS

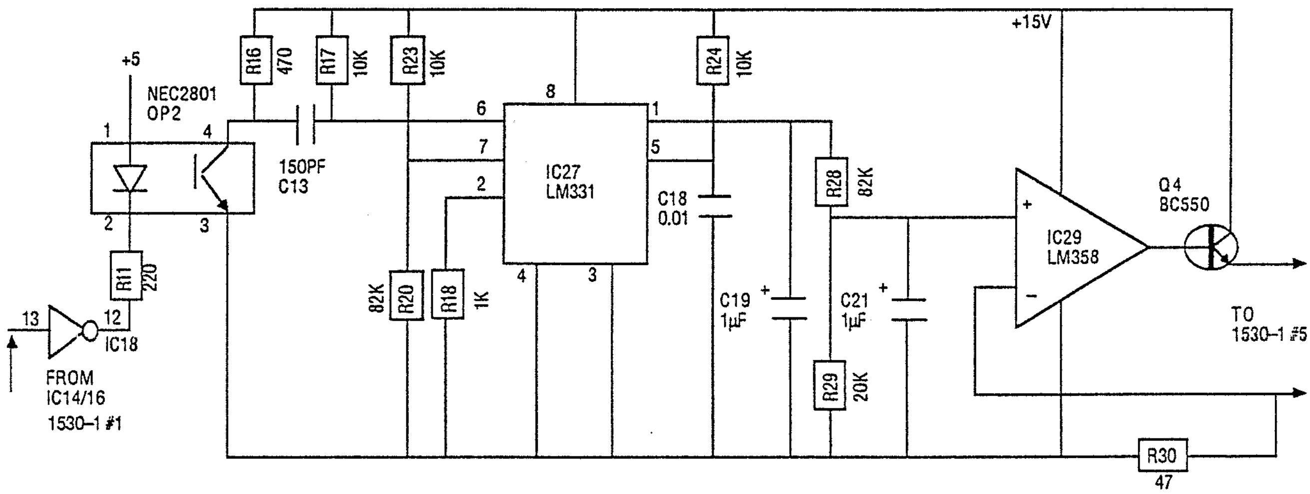


NOVATECH CONTROLS

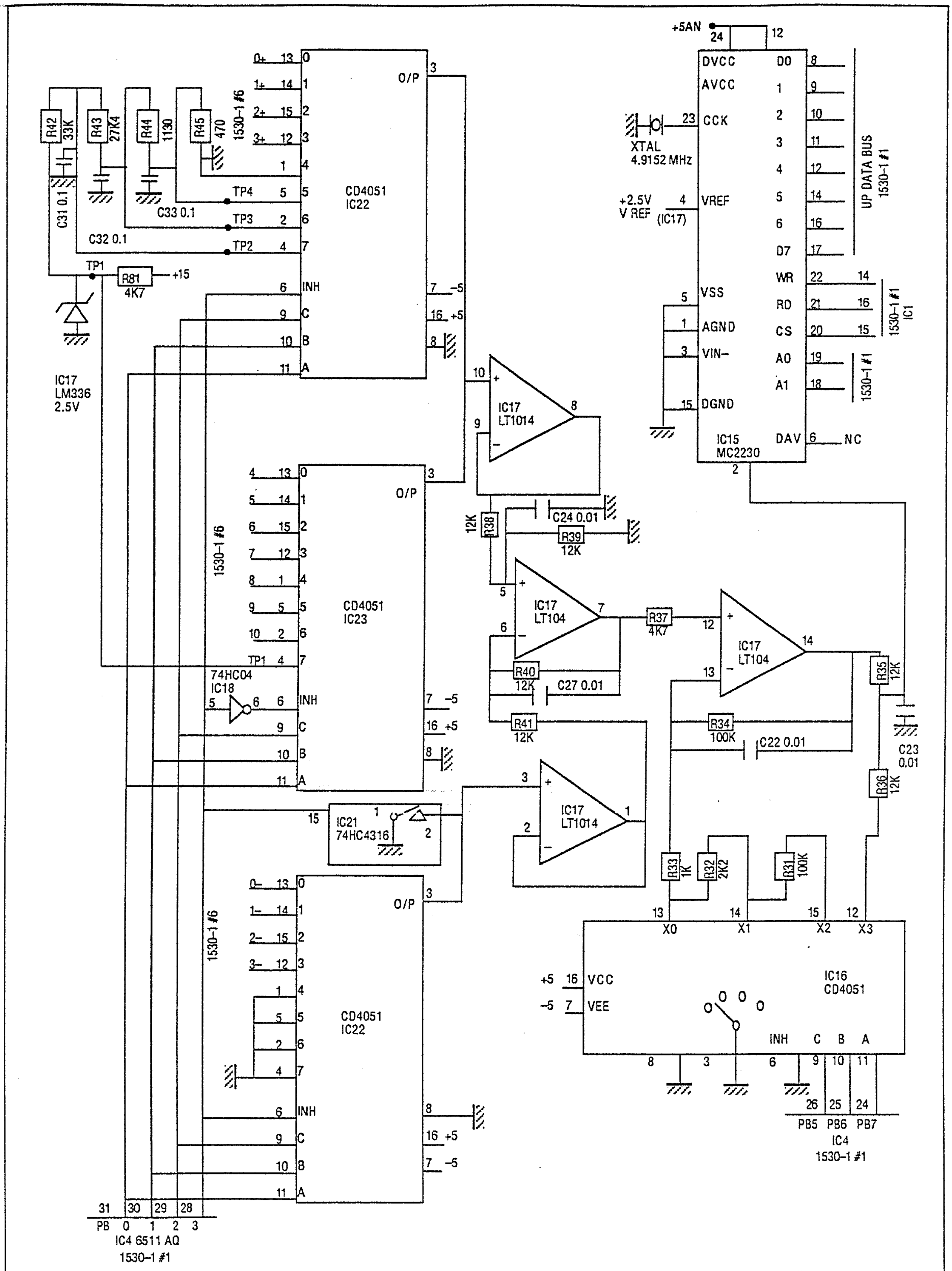
1530-1 #1 CPU, WATCHDOG TIMER DISPLAY VIA RS232/485, EPROM, RAM RTC, LATCH

F.CHAPMAN MARCH 1991





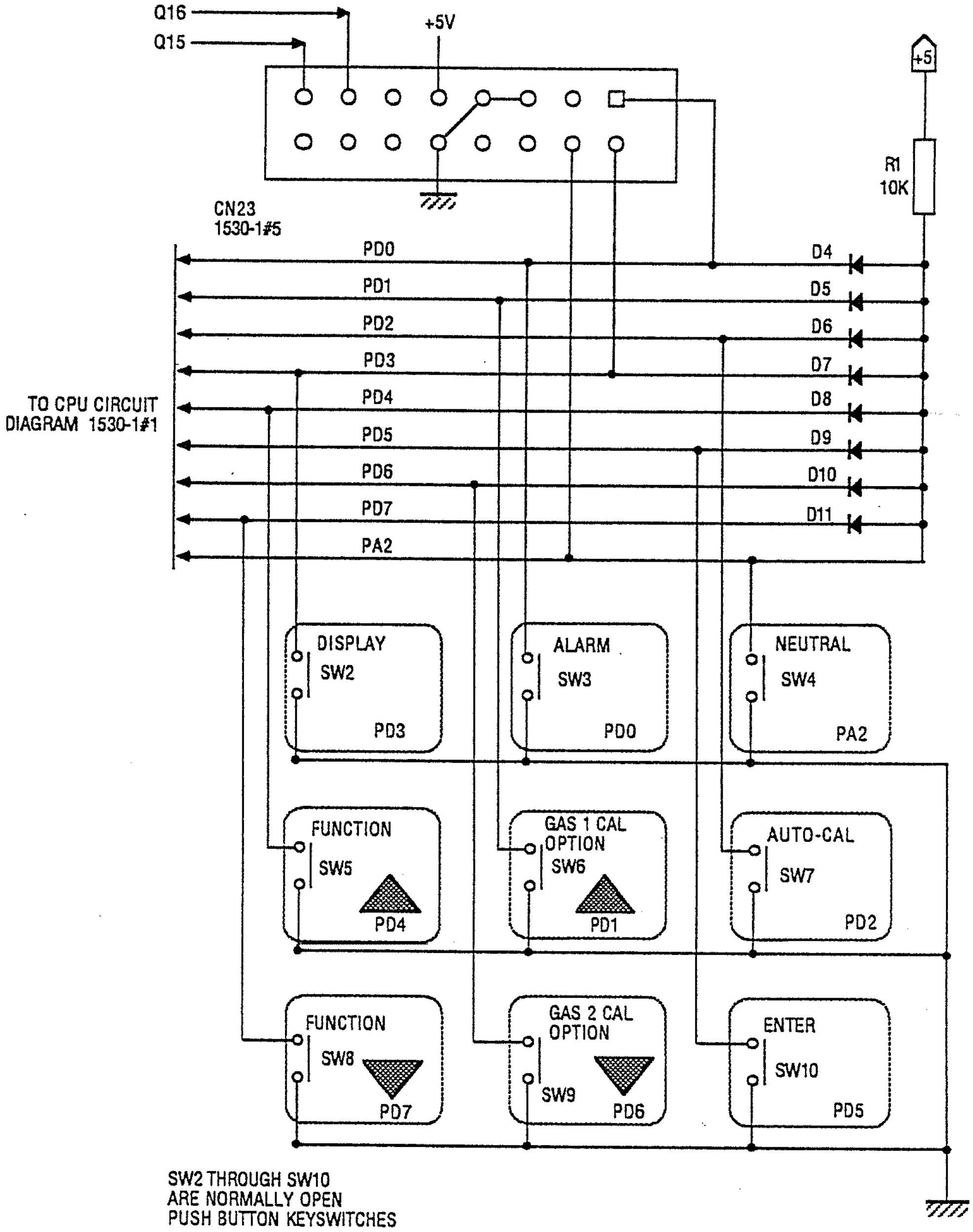
NOVATECH CONTROLS	1530-1 (V1.4) #3 4-20 MA OUTPUT ISOLATORS
	F.CHAPMAN MARCH 1991



NOVATECH CONTROLS

1530-1 (V1.5) #2 ANALOG INPUT MUX, ADC

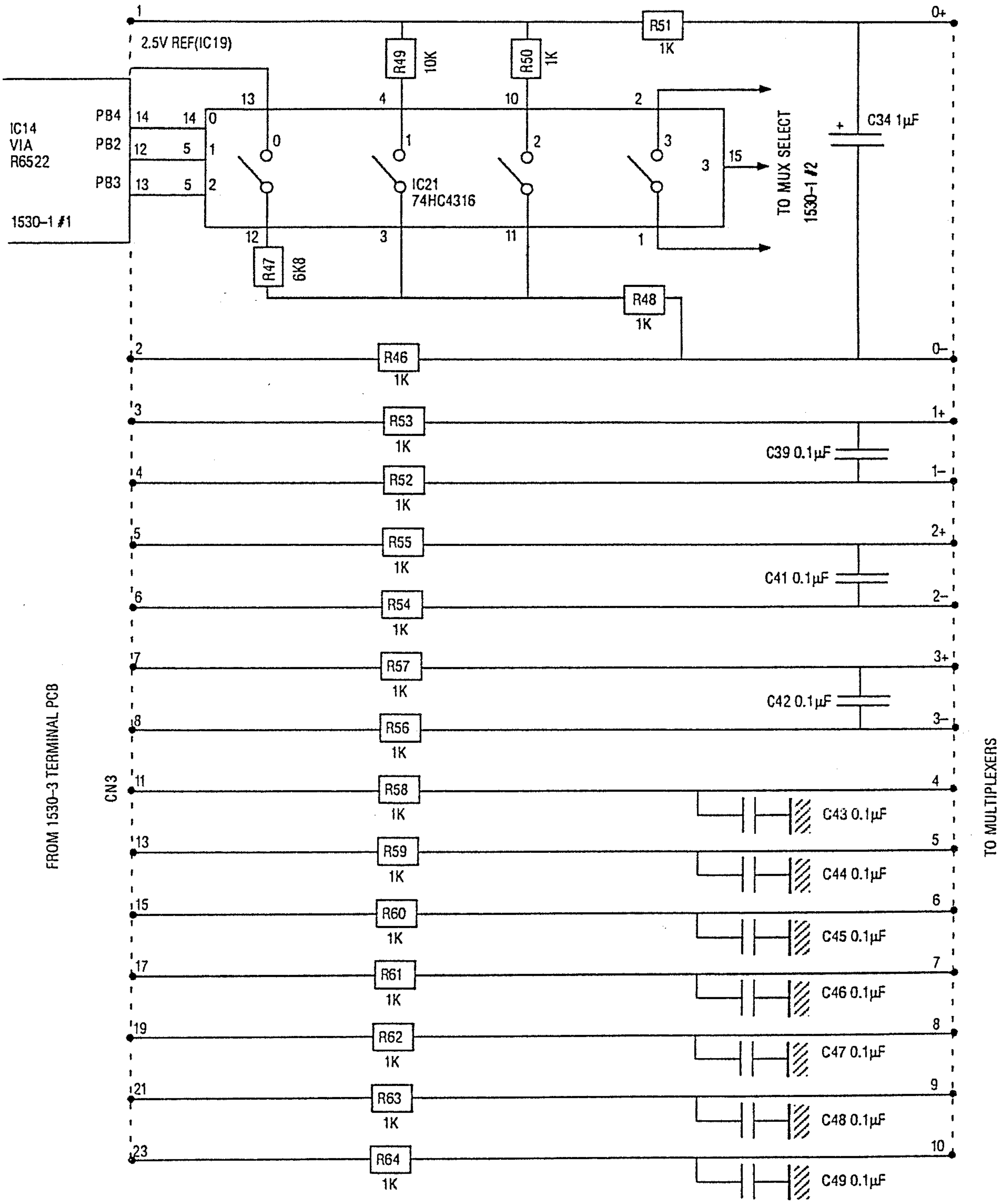
F.CHAPMAN MARCH 1991



SW2 THROUGH SW10
ARE NORMALLY OPEN
PUSH BUTTON KEYSWITCHES

NOTES:-
The software programs PA2 as a negative edge triggered Interrupt line, thus any keypress will pull PA2 low and generate an Interrupt.
If a keypress is detected and PD0-7 reads $FF, then PA2 key is pressed.

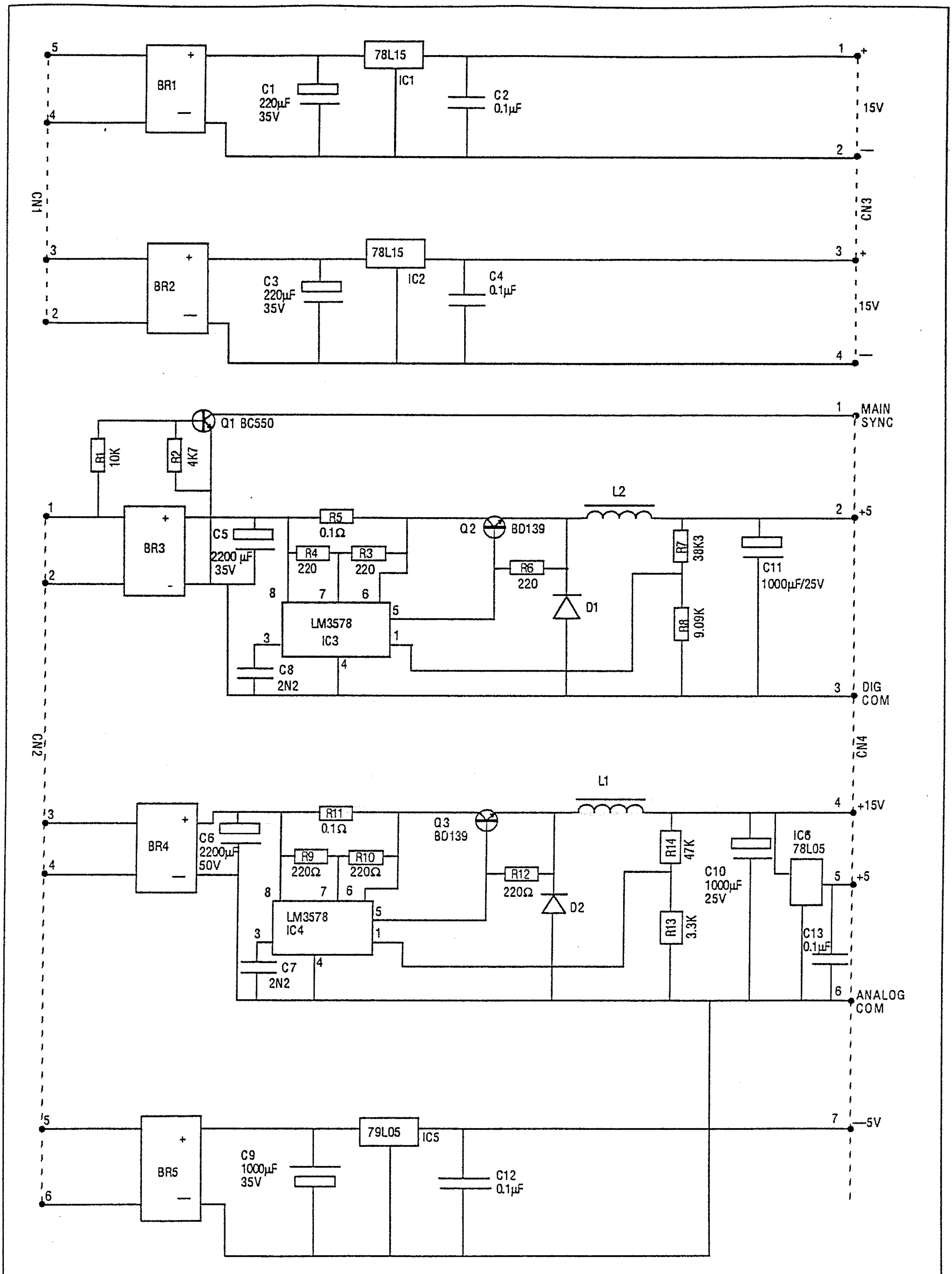
NOVATECH CONTROLS	1530-1 #4 Keypad
	Fraser Chapman September 1991



NOVATECH CONTROLS

1530-1 #6 INPUT FILTERS IMPEDANCE MEASUREMENT

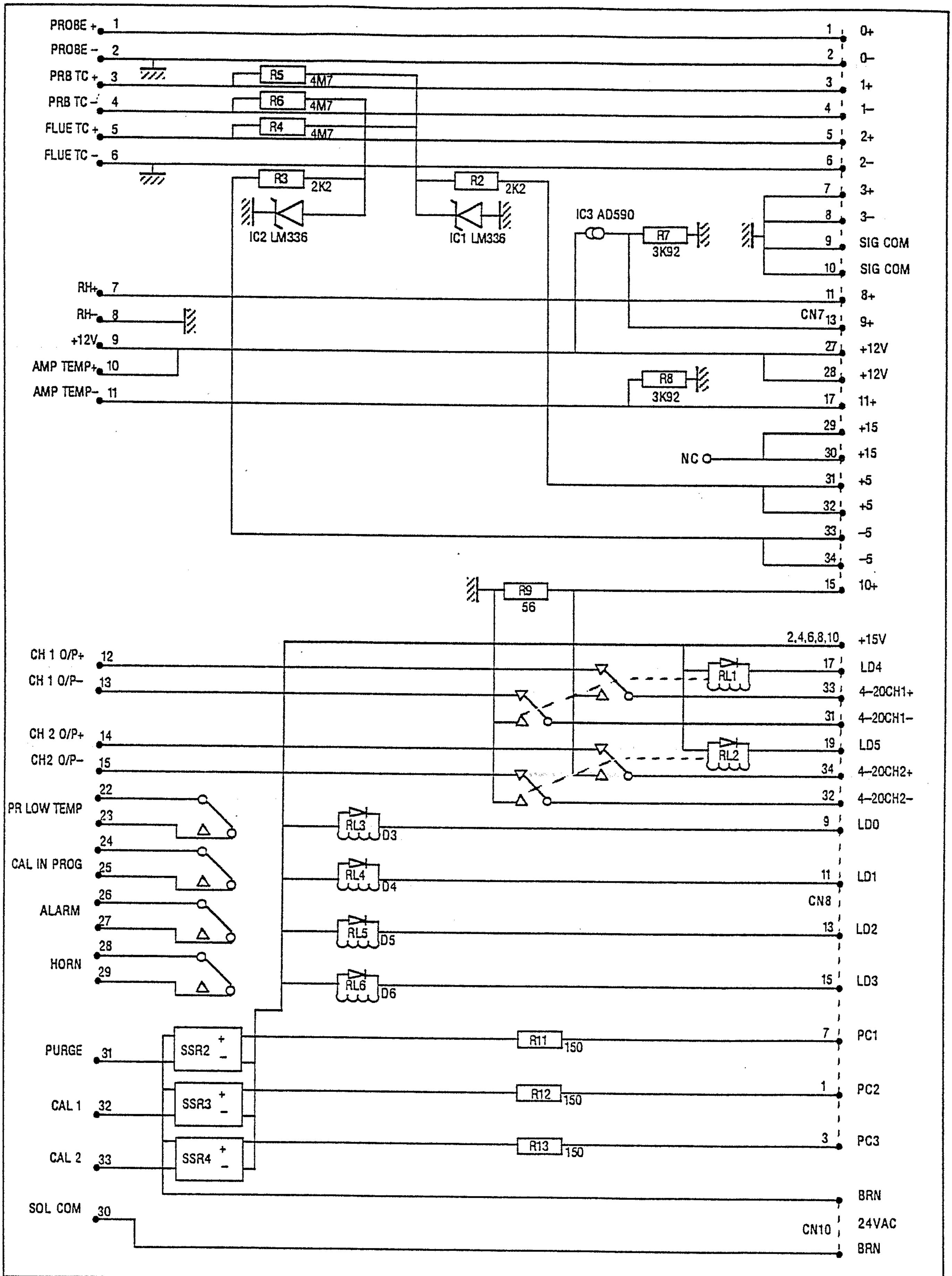
F.CHAPMAN MARCH 1991



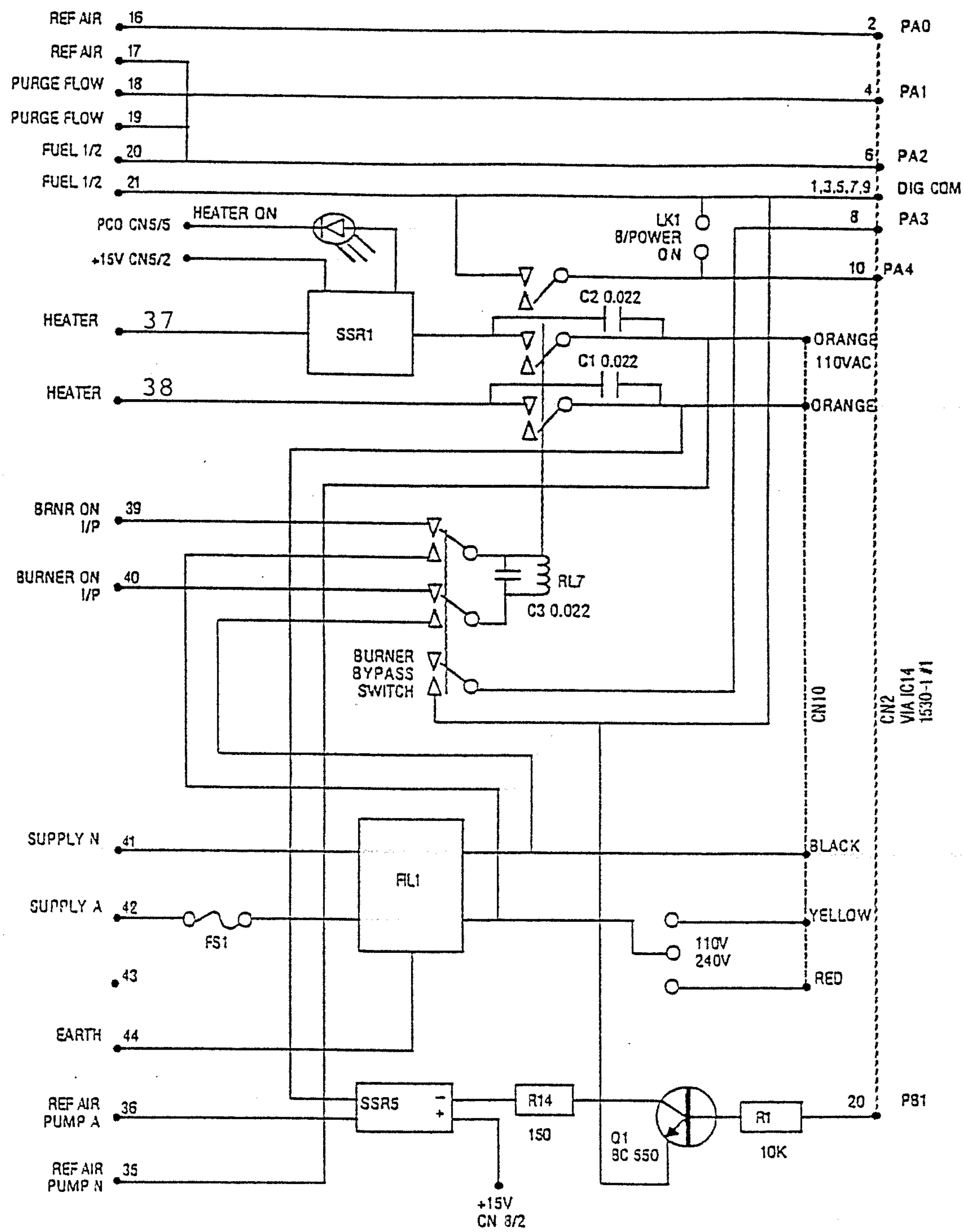
NOVATECH CONTROLS

1530-2 (V 2.0) POWER SUPPLY

FRASER CHAPMAN MARCH 1991



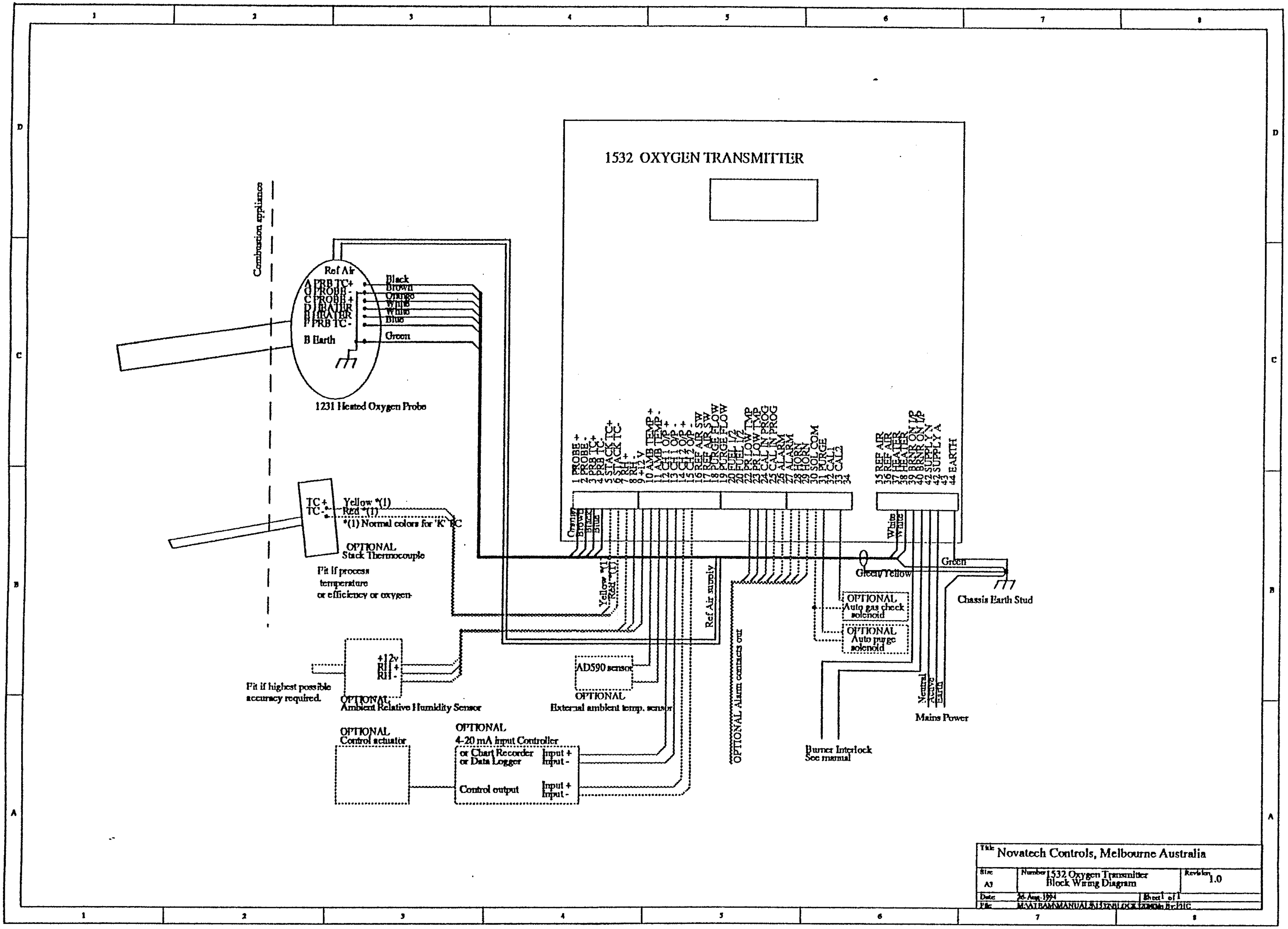
NOVATECH CONTROLS	1530-3 (V2.0) #1 TERMINAL PCB
	FRASER CHAPMAN 6/2/92



NOVATECH CONTROLS

1530-3 (V2.0) #2 TERMINAL PCB

FRASER CHAPMAN MARCH 1991


1532 OXYGEN TRANSMITTER
1 PROBE +
2 PROBE -
3 PRB TC+
4 PRB TC-
5 STACK TC+
6 STACK TC-
7 RH +
8 RH -
9 +12 V
10 AMB TEMP +
11 AMB TEMP -
12 CH1 O/P +
13 CH1 O/P -
14 CH2 O/P +
15 CH2 O/P -
16 REF AIR SW
17 REF AIR SW
18 PURGE FLOW
19 PURGE FLOW
20 FUEL 1/2
21 FUEL 1/2
22 PR LOW TMP
23 PR LOW TMP
24 CAL IN PROG
25 CAL IN PROG
26 ALARM
27 ALARM
28 HORN
29 HORN
30 SOL COM
31 PURGE
32 CAL1
33 CAL2
34
35 REF AIR
36 REF AIR
37 HEATER
38 HEATER
39 BRNR ON I/P
40 BRNR ON I/P
41 SUPPLY N
42 SUPPLY A
43
44 EARTH
Combustion appliance
Ref Air
A PRB TC+
G PROBE -
C PROBE +
D HEATER
E HEATER
F PRB TC-
B Earth
Black
Brown
Orange
White
White
Blue
Green
1231 Heated Oxygen Probe
TC+
TC-
Yellow *(1)
Red *(1)
*(1) Normal colors for 'K' TC
OPTIONAL
Stack Thermocouple
Fit if process temperature or efficiency or oxygen
Orange
Brown
Black
Blue
Yellow *(1)
Red *(1)
Ref Air supply
OPTIONAL Alarm contacts out
White
White
Green
Green/Yellow
Chassis Earth Stud
OPTIONAL
Auto gas check solenoid
OPTIONAL
Auto purge solenoid
Burner Interlock
See manual
Neutral
Active
Earth
Mains Power
+12v
RH +
RH -
Fit if highest possible accuracy required.
OPTIONAL
Ambient Relative Humidity Sensor
AD590 sensor
OPTIONAL
External ambient temp. sensor
OPTIONAL
Control actuator
OPTIONAL
4-20 mA input Controller
or Chart Recorder
or Data Logger
Input +
Input -
Control output
Input +
Input -
Title Novatech Controls, Melbourne Australia
Size A3
Number 1532 Oxygen Transmitter Block Wiring Diagram
Revision 1.0
Date 26-Aug-1994
Sheet 1 of 1