SERVICE MANUAL
MANUAL

Model 9060
Zirconia Oxygen Analyser

9060/2006

CONTENTS

Note: This manual includes software modifications up to Version 2.25, October 2005

The product described in this manual and products for use with it, are subject to continuous developments and improvement. All information of a technical nature and particulars of the product and its use (including the information in this manual) are given by Teledyne Analytical Instruments in good faith. However, it is acknowledged that there may be errors or omissions in this manual. A list of details of any amendments or revisions to this manual can be obtained upon request from Teledyne Analytical Instruments Technical Enquires. Teledyne Analytical Instruments welcome comments and suggestions relating to the product and this manual.

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USING THIS MANUAL

The Teledyne 9060 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 transmitter.

CAUTION 1

The probe or sensor heater is supplied with mains voltage. This supply has electrical shock danger to maintenance personnel. Always isolate the transmitter before working with the probe or sensor, gas solenoids, or the transmitter.
The EARTH wire (green) from a heated probe or sensor must ALWAYS be connected to earth.

CAUTION 2

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 3

The oxygen sensor which is heated to over 700°C (1300°F) and is a source of ignition. Since raw fuel leaks can occur during burner shutdown, the transmitter has an interlocking relay that removes power from the probe or sensor 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 or sensor then the Model 9060 Analyser with a heated probe or sensor will not be safe in your application.
An unheated probe can be utilised in such applications, however the oxygen readings are valid only above 650°C (1200°F).

CAUTION 4

The reducing oxygen signal from the transmitter 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 transmitter, normally incorporating a catalyst or thermal conductivity bridge, would be more appropriate where incomplete combustion is possible.
Also read the probe or sensor electrical shock caution in Section 2.5 and the probe or sensor heater interlock caution in Section 3.6.

CAUTION 5

If an external pressure transducer is used to feed the process pressure to the transmitter for pressure compensation, it is essential that the pressure transducer is accurate and reliable. An incorrect reading of pressure will result in an incorrect reading of oxygen. It is therefore possible that an explosive level of fuel could be calculated in the transmitter as a safe mixture.

CAUTION 6

FIL-3 filter. If the optional FIL-3 has been fitted to the 1231 probe in this installation, please read the Important Notice in section 1.2.

SPECIFICATIONS

1

1.1 MODEL 9060 OXYGEN ANALYSER FOR TWO OXYGEN PROBES

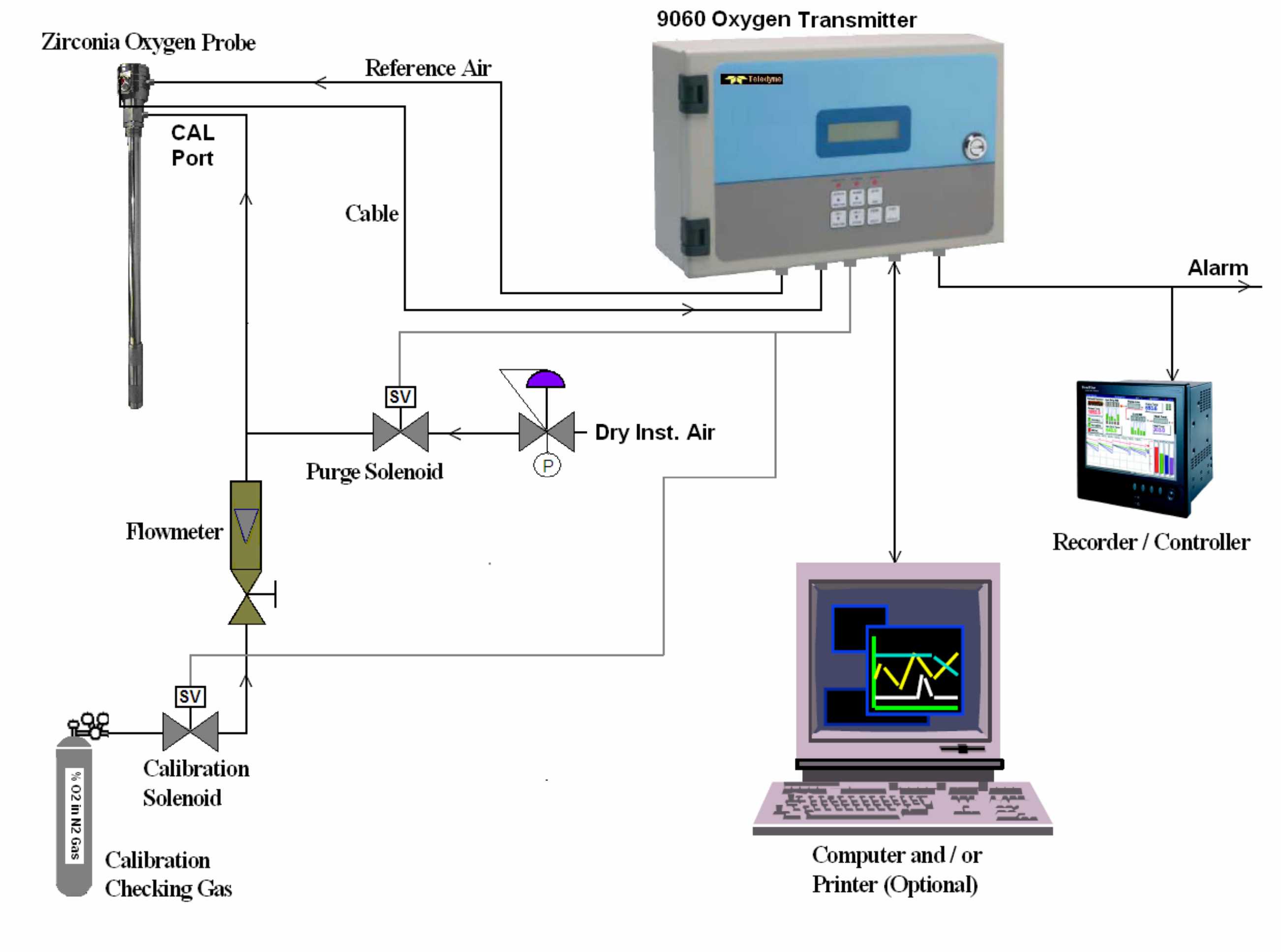
DESCRIPTION

The Teledyne Model 9060 oxygen analyser/ transmitter provides in-situ measurement for two oxygen probes in furnaces, kilns and boilers and flue gases with temperatures from ambient up to 1400°C (2550°F). The transmitter provides local indication of oxygen plus thirteen other selectable variables.

One or two probes or sensors in one process can be controlled from one transmitter providing an average and/or individual sensor signals. Two linearised and isolated 4 to 20 mA output signals are provided. Alarms are displayed at the transmitter and relay contacts activate remote alarm devices. The transmitter, which is available for heated or unheated zirconia oxygen probes, provides automatic on-line gas calibration check of the probe and filter purging. The electronics self-calibrates all inputs every minute.

The 9060 has a 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 keyboard.

- **Used for air / fuel ratio combustion control to provide fuel savings**
- **Used for product quality control in ceramic and metal processing industries**
- **Simple to install**
- **Linear output of % oxygen for recording or control**
- **Built in safety features**
- **26 different alarm conditions that warn the operator of combustion, probe, or transmitter problems**
- **Isolated RS 232-C printer/computer interface and an RS 485 MODBUS network interface**
- **Safety interlock relay for heated probes**



Oxygen Probe and Transmitter System

SPECIFICATIONS

Inputs

- Zirconia oxygen probe, heated or unheated
- Furnace, kiln or flue thermocouple, field selectable as type K or R.
- Main flame established safety interlock (for heated probes only)
- Purge pressure switch
- Dual Fuel selector
- Remote alarm accept

Outputs

- Two linearised 4 to 20 mA DC outputs, max. load 1000Ω
- Common alarm relay
- Three other alarm relays with selectable functions

Computer

- RS 232-C or RS 485 for connection of a computer terminal or printer for diagnostics of the transmitter, probe, sensor or combustion process. This connection is suitable for network connection to computers, DCSs or PLCs using MODBUS protocol.

Range of Output 1

Field selectable from the following:

Output Selection	*Range*
Linear, Probe 1	0 to 1% oxygen to 0 to 100 % oxygen
Linear, Probe 1 and 2 averaged (If 2 probes are used)	0 to 1% oxygen to 0 to 100 % oxygen
Log	0.1 to 20 % oxygen, fixed
Reducing	100 % to 10^{-4} oxygen, fixed
Reducing	10^{-1} to 10^{-25} % oxygen, fixed
Linear, probe 1, very low range	0 to 0.001% to 0 to 2.0 % oxygen (10ppm to 20,000ppm)

Range of Output 2

Field selectable from the following:

Output	*Zero Range*	*Span Range*
Sensor EMF	0 to 1100 mV in 100 mV steps	1000 to 1300 mV in 100 mV steps
Carbon Dioxide	0 to 10 %	2 to 20 %
Oxygen Deficiency	0 to 20% O_2 deficiency	0 to 100% O_2 excess
Aux Temperature	0 to 100°C (32 to 210°F) in 1 degree steps	100 to 1400°C (210 to 2550°F) in 100 degree steps
Log Oxygen	0.1% O_2 Fixed	20% O_2 Fixed
Reducing Oxygen	10^{+2} (100%) to 10^{-10} % oxygen in one decade steps, non-overlapping	10^{-3} to 10^{-30} % oxygen in one decade steps. Min span two decades.
Linear Oxygen, probe 2	0% oxygen, fixed	1 to 100%
Combustibles %, Probe 1	0% combustibles fixed	0.5 to 2.0 %
Linear, Probe 1 and 2 averaged (If 2 probes are used)	0% oxygen, fixed	1 to 100%

Range of Indication, Upper Line

- Auto ranging from 10^{-30} to 100% 0_2

Indication Choice, Lower Line

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

- Date - time
- Run Hours since last service
- Date of last service
- Probe 1 oxygen
- Probe 2 oxygen
- Probe 1 EMF
- Probe 2 EMF
- Probe 1 Temperature
- Auxiliary Temperature
- Probe 2 Temperature
- Probe 1 Impedance
- Probe 2 Impedance
- Ambient Temperature
- Ambient Relative Humidity
- Carbon Dioxide
- Combustibles
- Oxygen Deficiency

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

Accuracy

- ±1% of actual measured oxygen value with a repeatability of ±0.5% of measured value.

Relay Contacts

- 0.5A 24 VAC, 1A 36 VDC

Environmental Rating

- Operating Temperature: -25 to 55°C (-15 to 130°F)
- Relative Humidity: 5 to 95% (non-condensing)
- Vibration: 10 to 150Hz (2g peak)

Power Requirements

- 240 or 110V, 50/60 Hz, 105 VA (heated probe)
- 240 or 110V, 50/60 Hz, 5 VA (unheated probe)

Weight

- Transmitter, 3.75 kg (10 lbs.)

Dimensions

- 280mm (11”) W x 180mm (7”) H x 95mm (3.75”) D

Degree of Protection

- IP65 without reference air pump
- IP54 with reference air pump

Mounting

- Suitable for wall or surface mounting.

CALIBRATION PROCEDURES

2

2.1 GAS CALIBRATION CHECK FOR A MODEL 9060HEATED OXYGEN PROBE

Background

The sensor that is used in all Teledyne probes is extremely predictable, stable and reliable. For this reason, the calibration of a Teledyne oxygen system does not require the use of calibration gases.

However, all Teledyne oxygen probes have a built in gas connection that does allow the accuracy of the probe to be checked. This technical note describes the way to do this, and gives some typical results.

Dust filter

The 1231 oxygen probe can be supplied with or without a sintered dust filters. The filter not only stops dust build up in the probe when the probe is used in dusty processes, but also provides a partial gas barrier when a gas calibration check is being performed. This allows the process gas to be more easily kept away from the oxygen sensor during the gas calibration checking procedure.

Equipment required

- Certified gas supply bottle (generally between 2 and 8% oxygen in nitrogen)
- Pressure regulator
- Needle valve
- Flow meter (0.5 to 5 l/m)

The procedure

Gas calibration check while the probe is "in the process"

Setting the probe offset

1. Make sure that the reference air supply is connected to the probe and is operating normally (≈50 cc/m).
2. Set the **"Damping Factor"** on the analyser to 0 or **"No Damping"**
3. Set the lower line display to be showing the probe EMF (mV) and probe Impedance in **Set-up step 33**
4. Note the mV reading on the analyser
5. Connect a supply of clean fresh air ** to the "CAL" port of the probe from the regulator, needle valve and flow meter
6. Adjust the needle valve until about 0.5 l/m is flowing into the probe. If the connecting pipe is less than 5m, the mV reading should move towards 0mV within 5 seconds, and stabilize within 10 to 15 seconds. Note the mV reading.
7. As soon as the reading is stable and noted, change the flow rate to 1 l/m
8. Wait for a stable reading, and note the mV reading
9. Repeat this for flow rates of 2, 3, 4 and 5 l/m and then close the needle valve
10. Check the results, and pick the average mV reading, disregarding sudden variations at low and high flow levels
11. Enter this reading into the **"Probe Offset"** of the analyser

** If the air is from an instrument air supply or a gas bottle (compressed supply), add 0.4mV to the reading before entering it into "Probe Offset". This will compensate for the ambient humidity in the atmosphere.

If a diaphragm or aquarium pump is used to supply the CAL port, enter the mV reading as read from the lower line of the analyser. The analyser monitors and compensates for the ambient relative humidity.

Certified calibration gas check

12. Disconnect the air supply and connect the gas supply to the "CAL" port of the probe through the gas regulator, needle valve and the flow meter
13. Close the needle valve and set the gas regulator to about 50 kPa
14. Turn on the needle valve until about 0.5 l/m is flowing into the probe. The oxygen reading should move towards the certified oxygen concentration within <5 seconds, and stabilize within 10 to 15 seconds. Note the oxygen reading.
15. As soon as the reading is stable and noted, change the flow rate to 1 l/m
16. Wait for a stable reading, and note the oxygen reading
17. Repeat this for flow rates of 2, 3, 4 and 5 l/m and then close the needle valve

The oxygen readings should look like this –

Flow Rate(LPM)	Analyser Oxygen Reading(%)
0	3.5
0.5	4.6
1	4.9
2	5.0
3	5.0
4	5.0
5	5.2

Note:
The next time a gas calibration check is done, it will not be necessary to vary the flow rate, but simply use a flow rate in the centre of the 'flat' area of the curve.

Oxygen probe: Model 1231, without filters
Process oxygen reading: 3.5%
Certified calibration gas: 5.0 +/- 0.05%

If the oxygen probe has filters fitted, the results will be very similar except that the readings at the lower flow rates will be closer to the calibration gas level.

Gas calibration check while the probe is out of the process

The procedure for checking a probe that is out of the process is the same as checking it when it is in the process except that a small muffle of a high temperature insulating cloth (or a high temperature glove) should be placed loosely around the end of the probe in high wind conditions.

The reference air must also be still operating during the test.

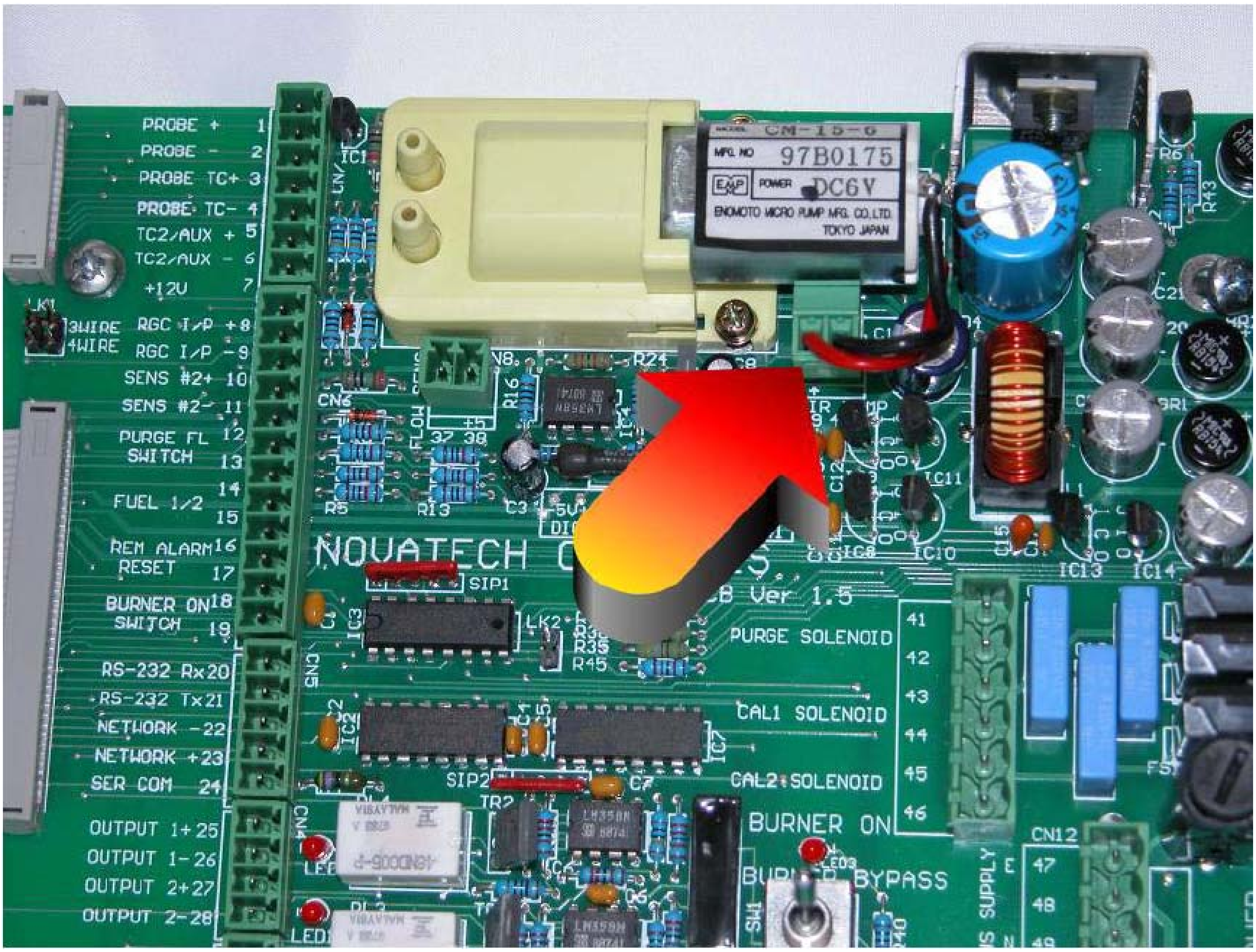
SERVICE NOTES & MAINTENANCE

3

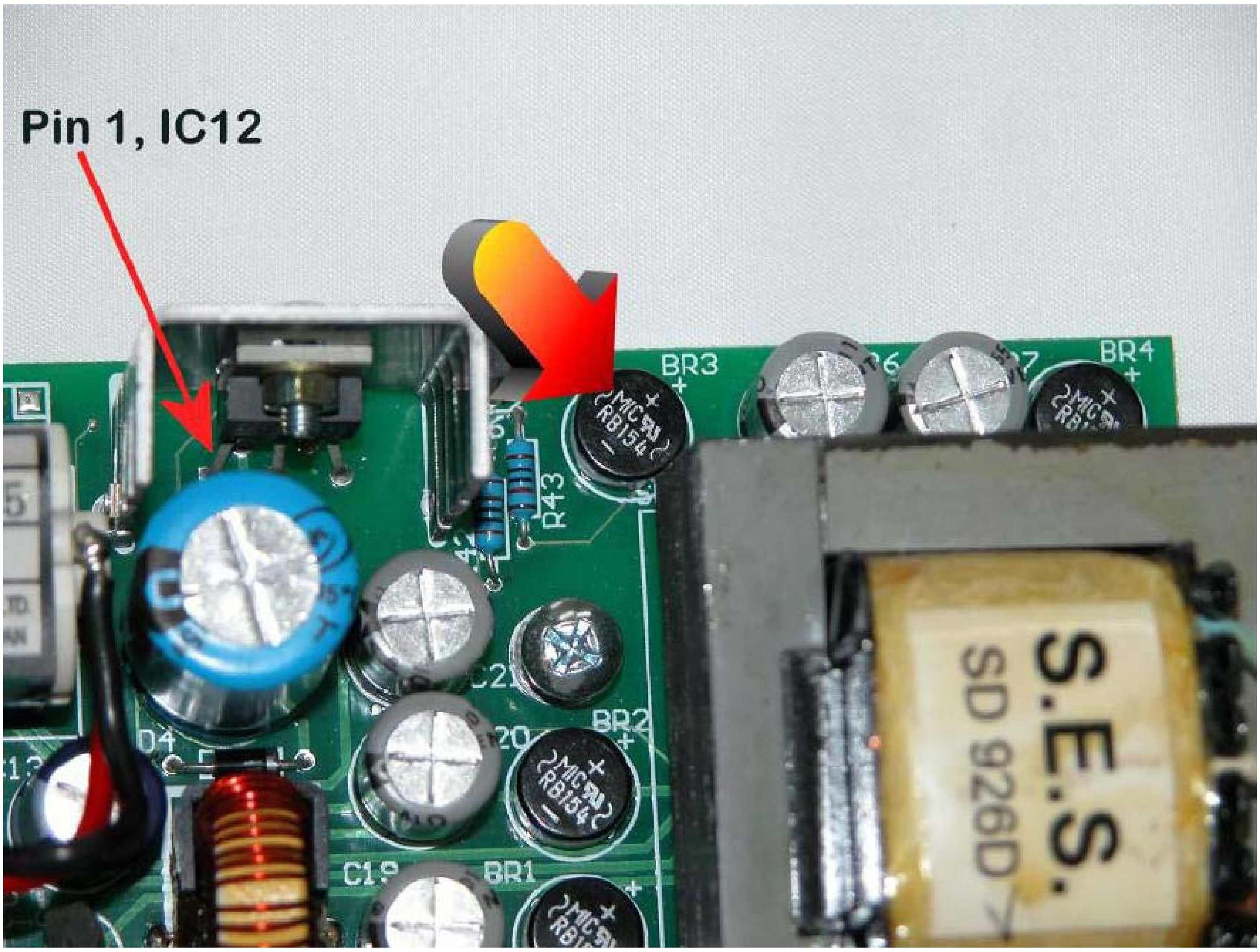
3.1 +5VDC RAIL ISSUE IN 9060 SERIES ANALYSERS

The +5V rail in a 9060 series analyser can cause the microprocessor to **"reset"** if the rail drops to 4.93V. This note lists the known common causes and cures for a poor quality 5V rail.

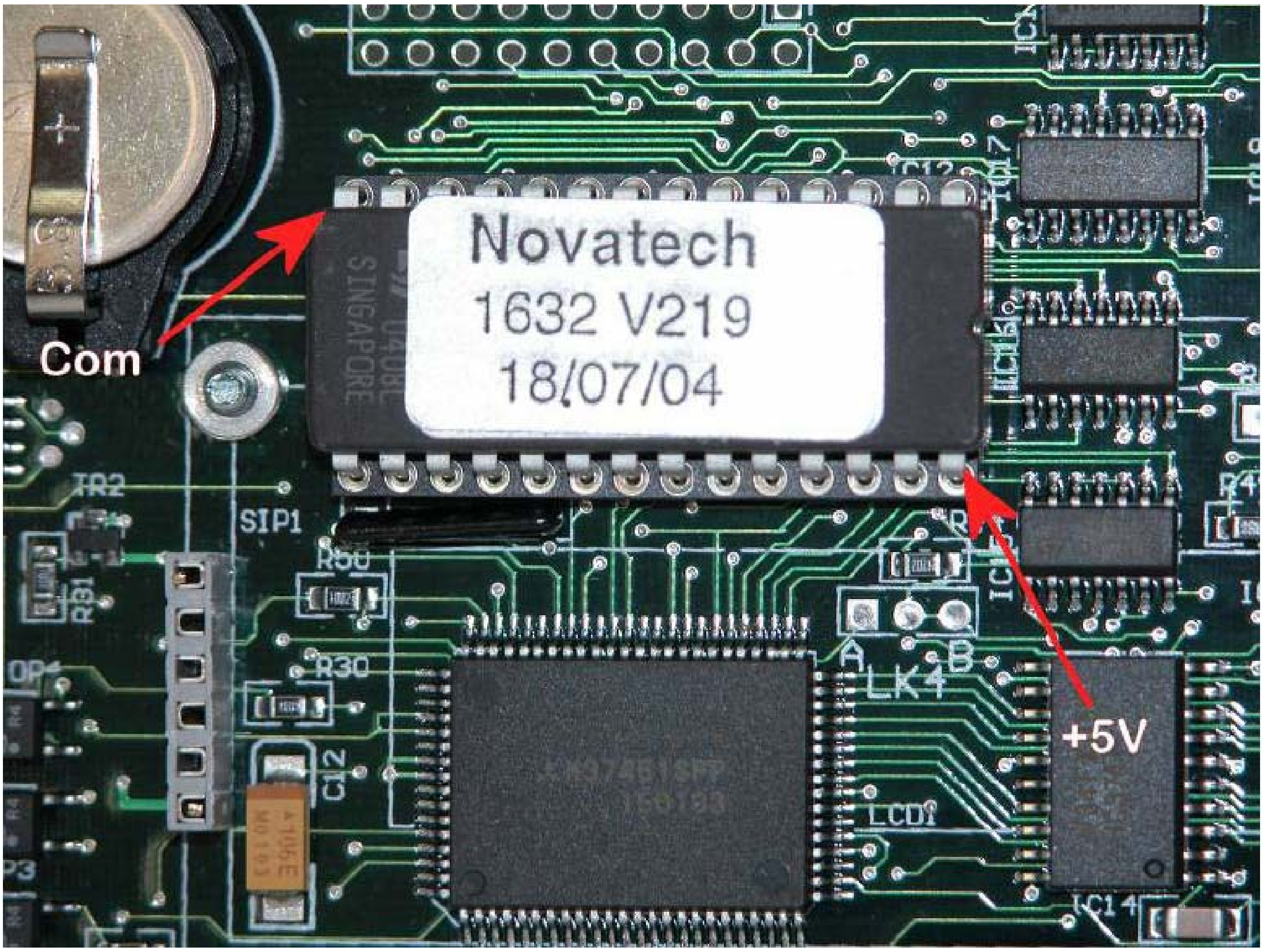
3.1.1 The CM-15 reference air pump is worn and is drawing a higher than normal current from the 5V rail. This normally results in the analyser constantly resetting it self when the pump is turned on at the end of the start-up sequence. If this stops when the pump cable is unplugged then the pump requires replacement.



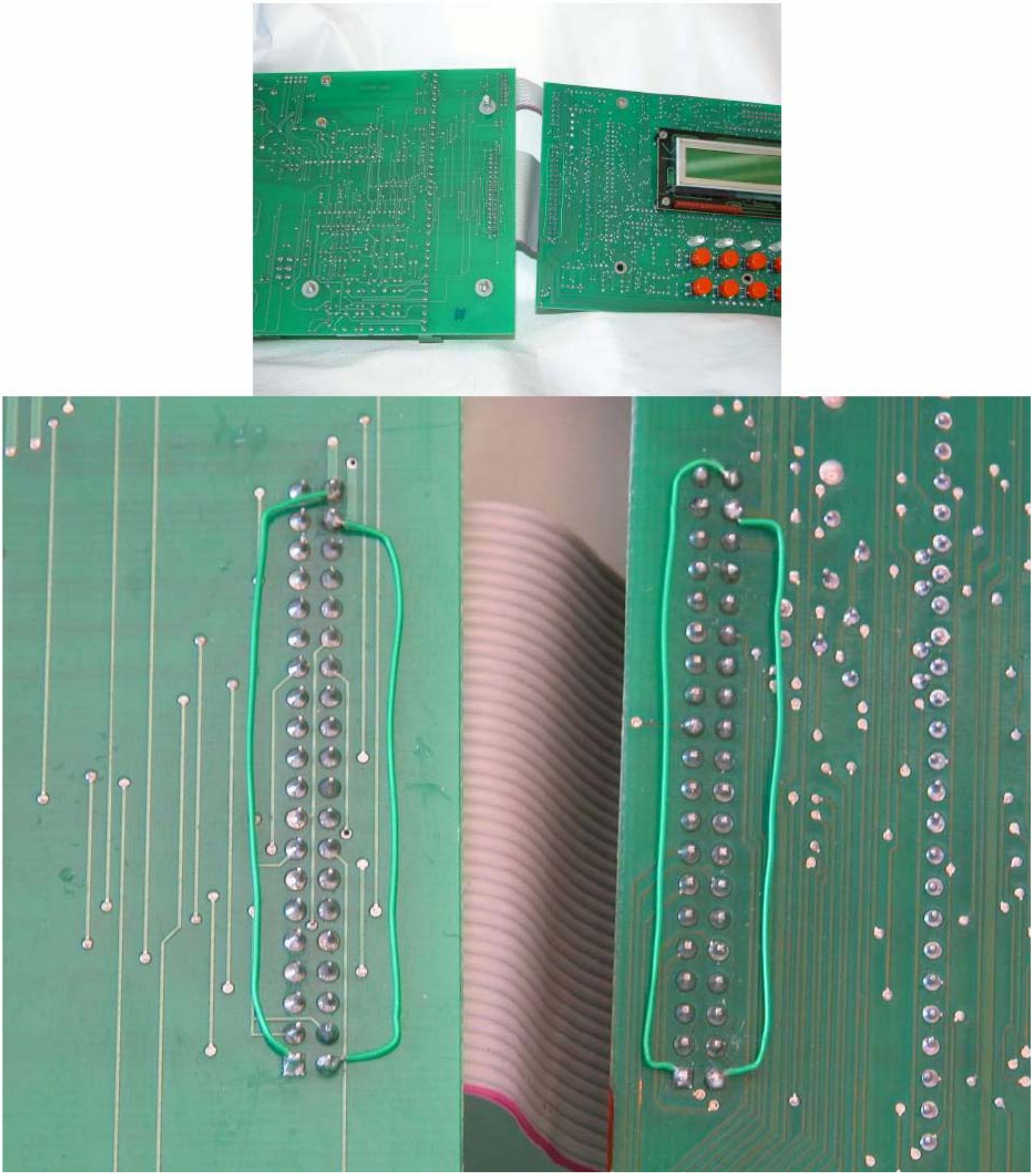
3.1.2 The bridge rectifier, BR3, has an open circuit diode reducing the available power from the 5V rail. This can be confirmed measuring the pre-regulated DC voltage on pin 1 of IC12, this should be between 14 & 18VDC, or by using a CRO. Replace BR3 and make sure the component is installed so there is at least 3mm between the component and the circuit board. This helps the component to dissipate heat.



3.1.3 On analysers with version 1.6 or earlier 1630-2 boards, the 40-way ribbon cable is worn or damaged. Measure the 5V rail on the 1630-2 PSU board and then on the 1630-1 board. If the value measured on the 1630-1 board is less than the value measured on the 1630-2 then the ribbon cable is causing excessive voltage drop.

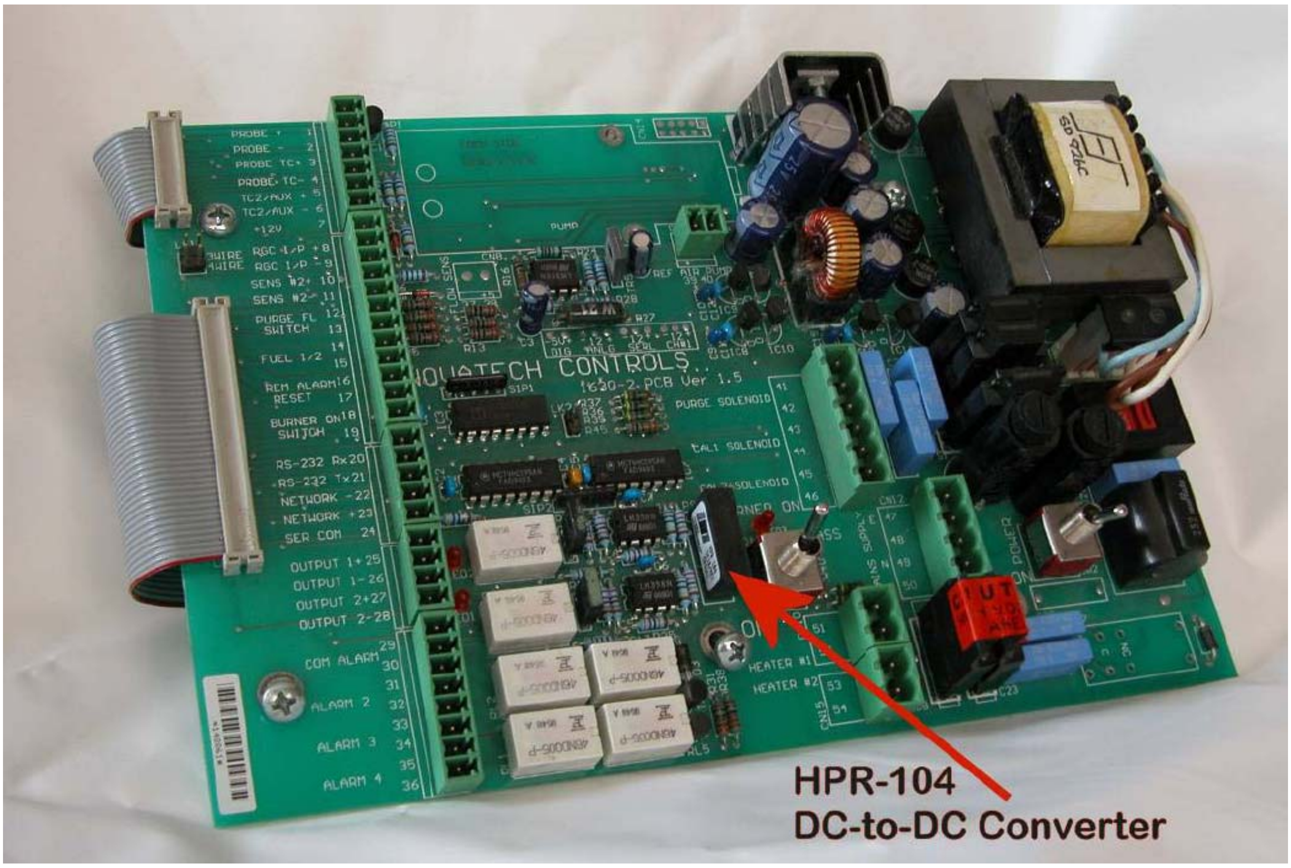


There are spare conductors in the ribbon cable that can be utilized for the 5V rail and the common of the power supply. Solder two jumpers to each of the headers as shown below.



3.1.4 The DC-to-DC converter, PS1, that powers the output 4-20mA channel 2, can be damaged if a power supply is connected in an attempt to loop power the output circuit. The isolated 4-20mA outputs are active outputs on the 9060 series of analysers. When the DC-to-DC converter is damaged due to loop powering it will overload the +5V rail causing the component to rise in temperature.

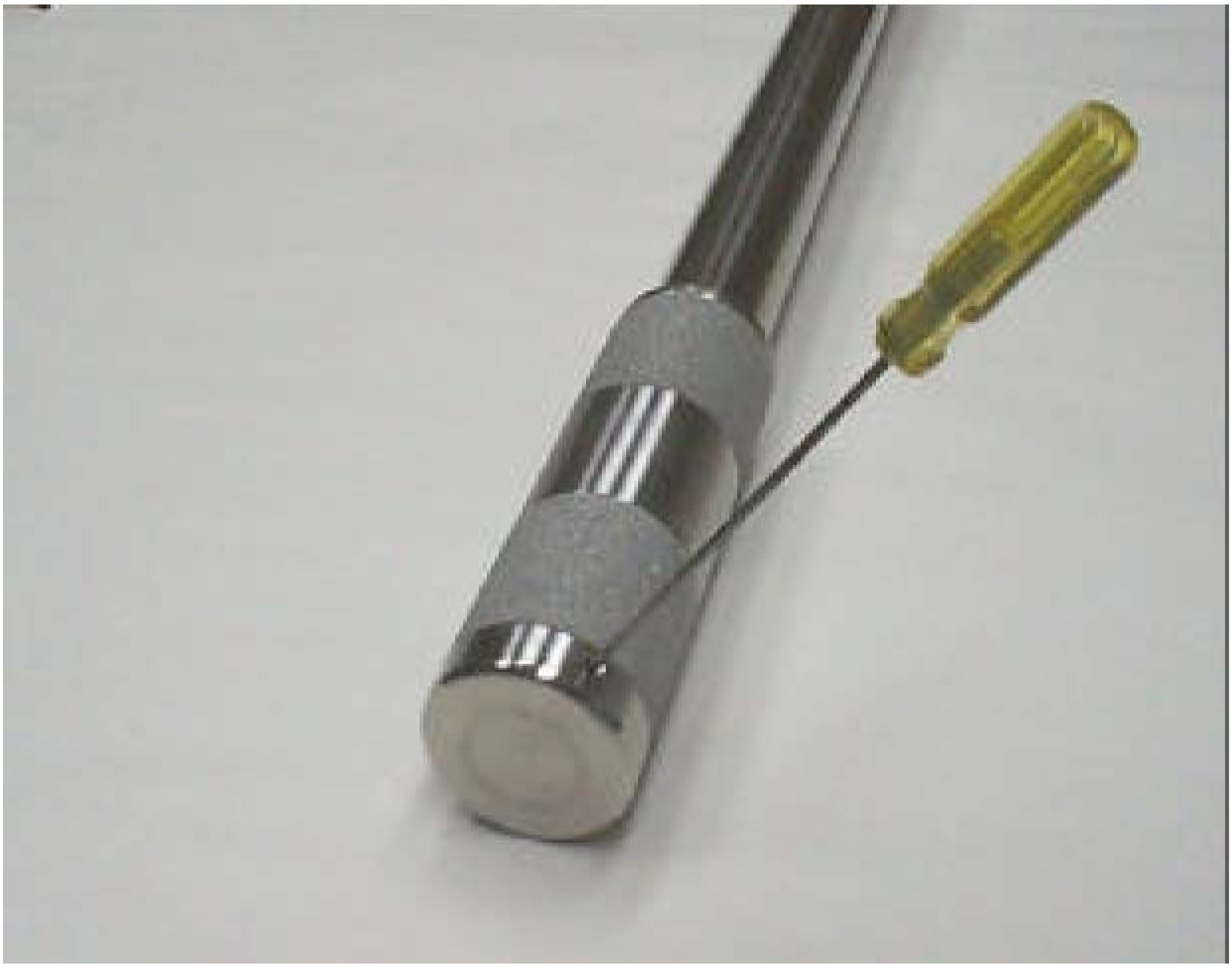
Replace the DC-to-DC converter, PS1, with an HPR-104 (5V to +/-12V).



3.2 FILTER REPLACEMENT PROCEDURE ON 9060 OXYGEN PROBES

PROCEDURE

3.2.1 To dismantle the filter assembly, loosen the two 4mm grub screws on the end cap.



3.2.2 Slide the end cap, filters and spacer from the probe.

3.2.3 Use clean compressed air to dislodge any particulate that may have accumulated inside the filter assembly. If particulate build up is excessive then consider using the 15 micron filters. The finer filters will considerably dampen the response time of the probe.

3.2.4 Clean the steel surfaces of the filter retainer, spacer and filter collar, especially where the filters make contact with the retainer, spacer and collar.

3.2.5 Reassemble the filter assembly. The grub screws on the filter retainer should engage the grub screw locking holes at the end of the outer sheath.

3.3 DISASSEMBLY, SERVICE & ASSEMBLY OF HEATED OXYGEN PROBE

INTRODUCTION

The 9060 Heated oxygen probe is made up of 5 major parts: –

1. Alumina four-bore assembly and compression spring

2. Zirconia sensor, alumina tube, sensor gland and compression spring

3. Heater, inner sheath and gland assembly

4. Filter, outer sheath & nipple assembly

5. Termination Head & circuit board

This service note describes how to disassemble, inspect, repair or replace components, and reassemble the oxygen probe.

3.3.1. TOOLS REQUIRED

To carry out these procedures, the following tools are necessary: -

1. · vice with an 80mm opening, and soft jaws
2. · 7/16” x 1/2” AF open end spanner
3. · 7 mm open end spanner
4. · 7 mm nut driver
5. · 6.5 mm x 1.5 mm flat bladed screwdriver
6. · 2.5 mm x 1.0 mm flat bladed screwdriver
7. · 2 mm Allen key
8. · 100 mm long nosed pliers

3.3.2. TESTING

It is recommended that before the probe is disassembled, it should be tested in a workshop.
For the probe to be tested completely –

1. Power must be applied to the heater and controlled to maintain about 720°C at the sensor.

   Expected result-
   The "SENSOR TEMP" should rise to 720°C ± 15°C within 15 minutes.
   The display of "SENSOR TEMP" should fluctuate less than 2°C.

2. A certified gas connected to the "CAL" port of the probe (2 liters per minute), and the sensor EMF / Oxygen measured.

   Expected result-
   The oxygen reading from the probe should agree with the gas bottle's certified value.

3. The impedance of the sensor measured.

   Expected result-
   The impedance of the zirconia sensor as read on the analyser should be less than 7kW when the sensor is 720°C ±15°C.

   The easiest way to do these tests is to use a Teledyne oxygen analyser. This provides all the facilities to do a complete electrical test of the probe.

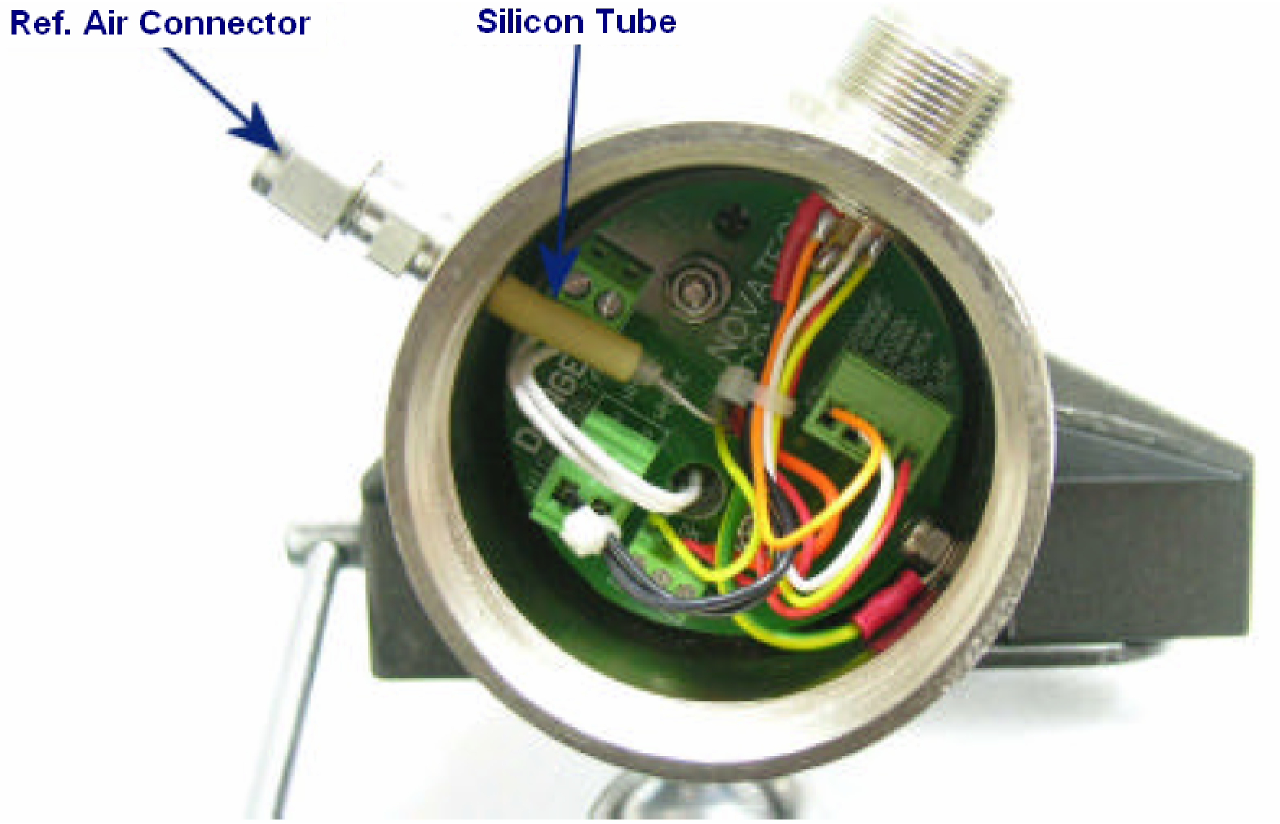
   Alternatively, a common temperature controller and a 110VAC transformer could be used to control the temperature. A digital multimeter and the oxygen / EMF tables could be used to determine the oxygen level. This does not give you the impedance of the sensor.

3.3.3. DISASSEMBLY PROCEDURE

WARNING:
The probe must NOT be disassembled while connected to an analyser. The heater terminals in the probe could have the 110 / 240 VAC mains voltages present.

3.3.3.1 Hold probe vertically and securely by the hexagonal body in a vice with the probe connector at the rear.

3.3.3.2 Open the probe's screwed head cover by turning the cap anti-clockwise.

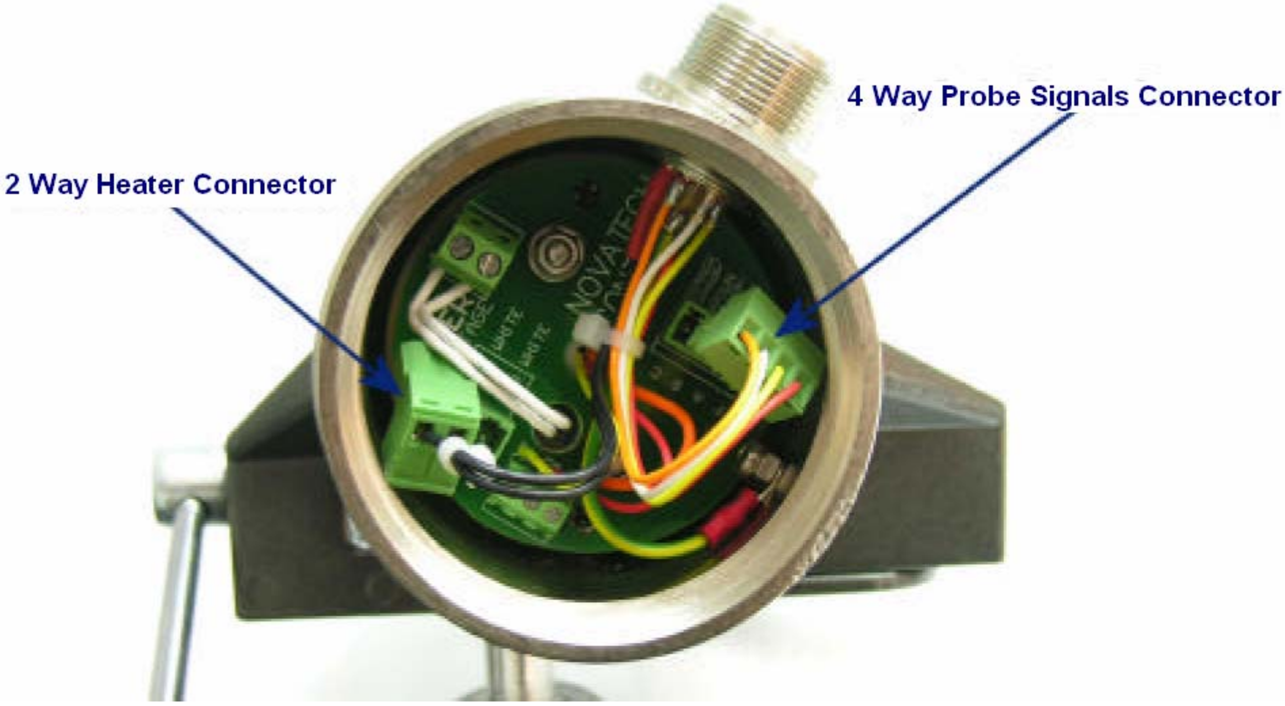


3.3.3.3 Hold the reference air hypodermic silicon tube while unscrewing the reference air male tube connector from the head to avoid twisting the silicon tube.

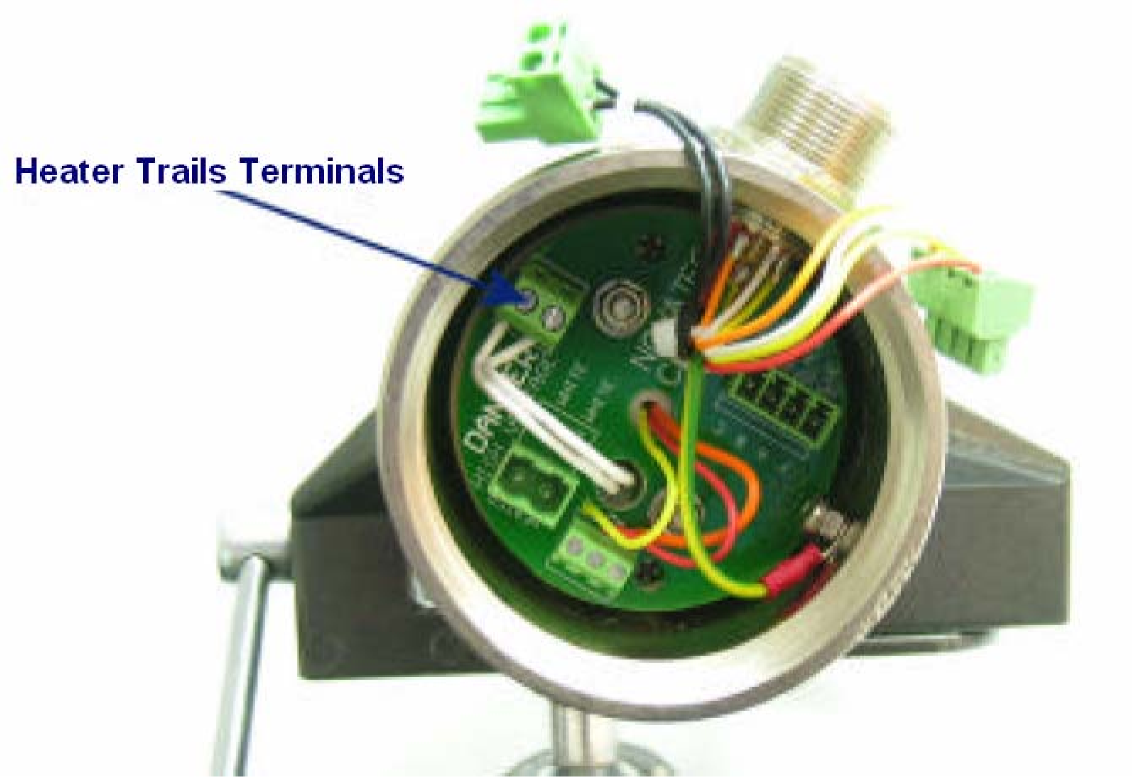
3.3.3.4 When the reference air male connector is unscrewed from the head gently remove it from the silicon tube.

3.3.3.5 Remove the reference air hypodermic by lifting straight up. Do not bend. Sharp bends could cause a blockage in the tube.

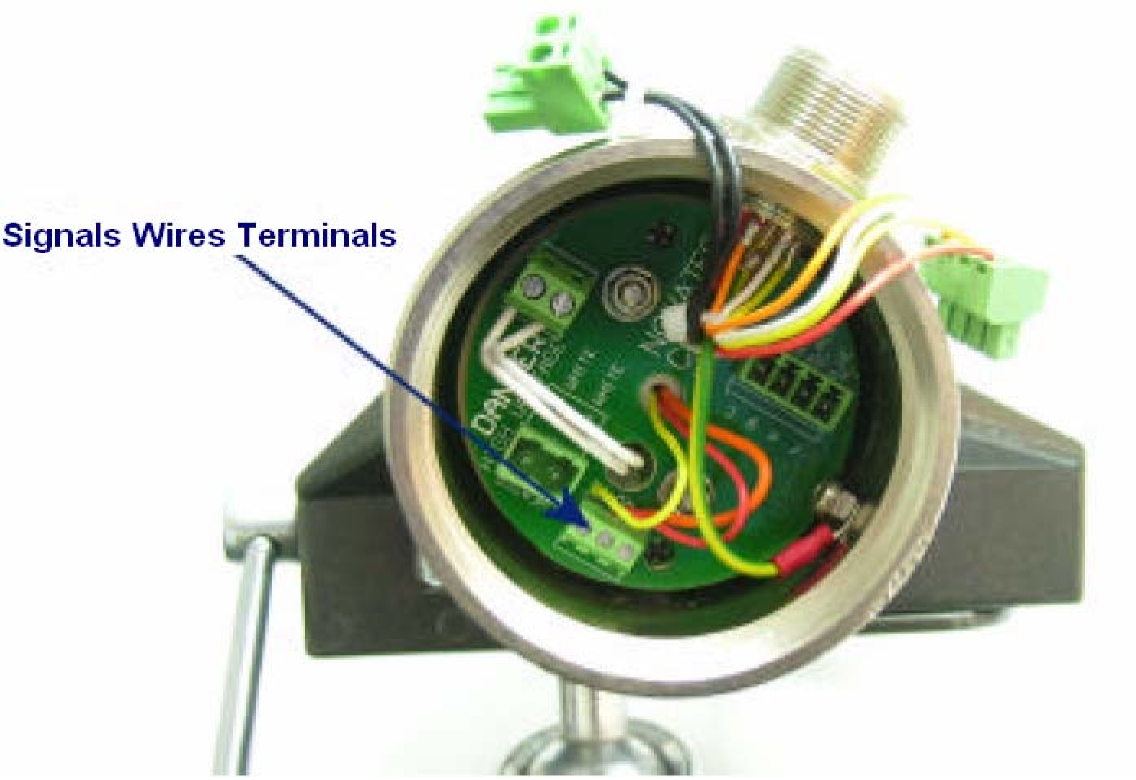
3.3.3.6 From the circuit board, lift out the two-way heater wire connector and the 4-way O2 +ve, O2 –ve, T/C +ve and T/C -ve connector. Both connectors can be folded back outside the head for clearance.



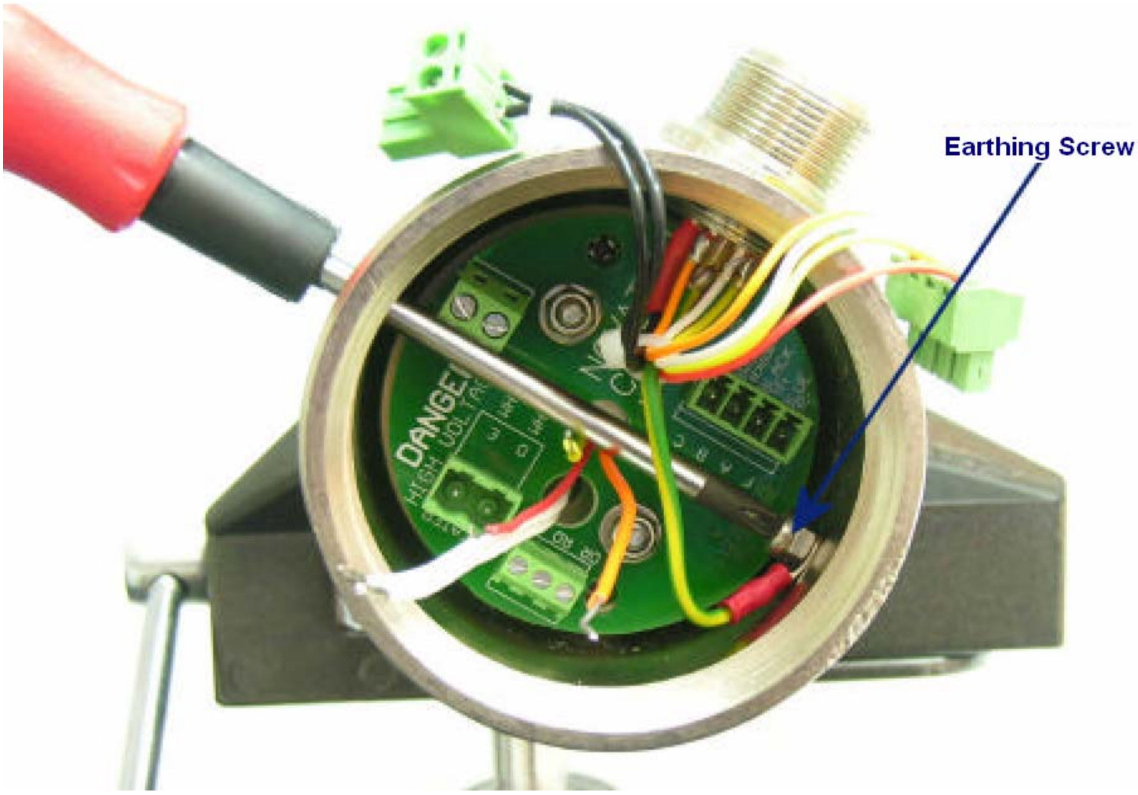
3.3.3.7 Remove the heater tail wires from the two way terminal by loosening the two screws.



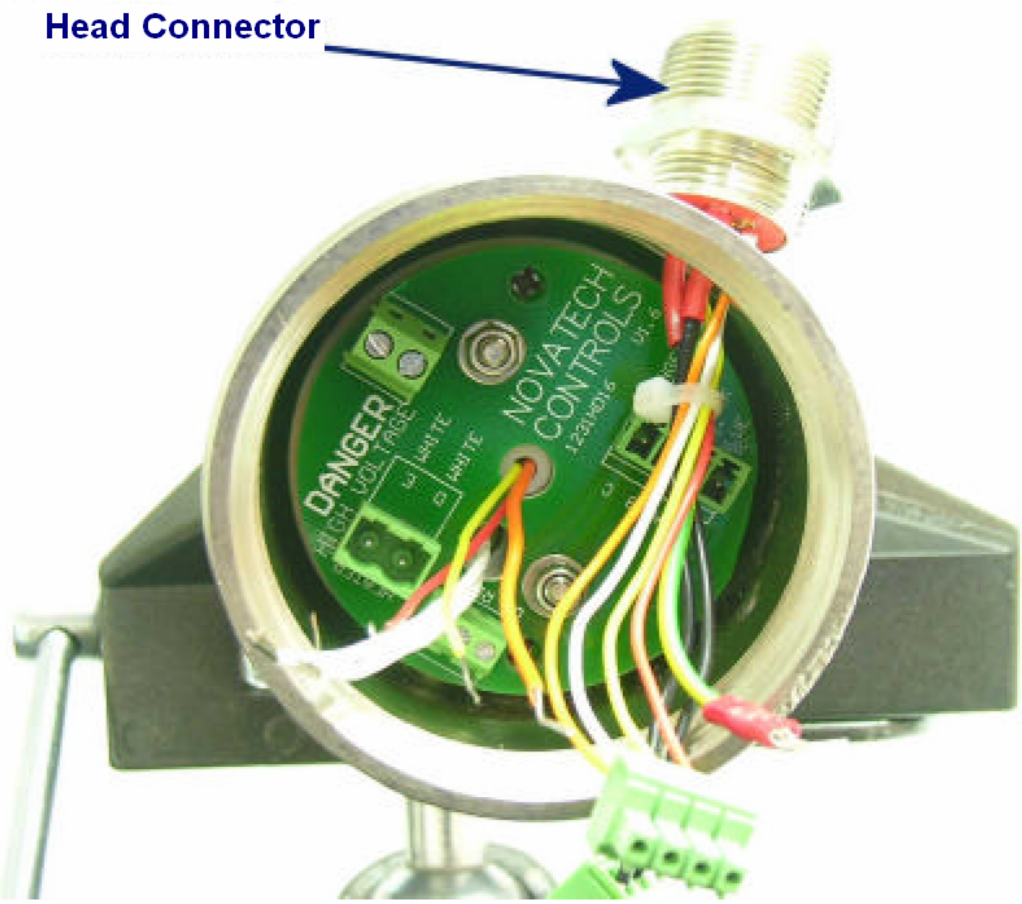
3.3.3.8 Remove the O2 +ve, T/C+ve and T/C-ve wires from the three way terminal by loosening the three screws.



3.3.3.9 Remove the earth lead wire. Access the M4 screw through the reference air male connector port.

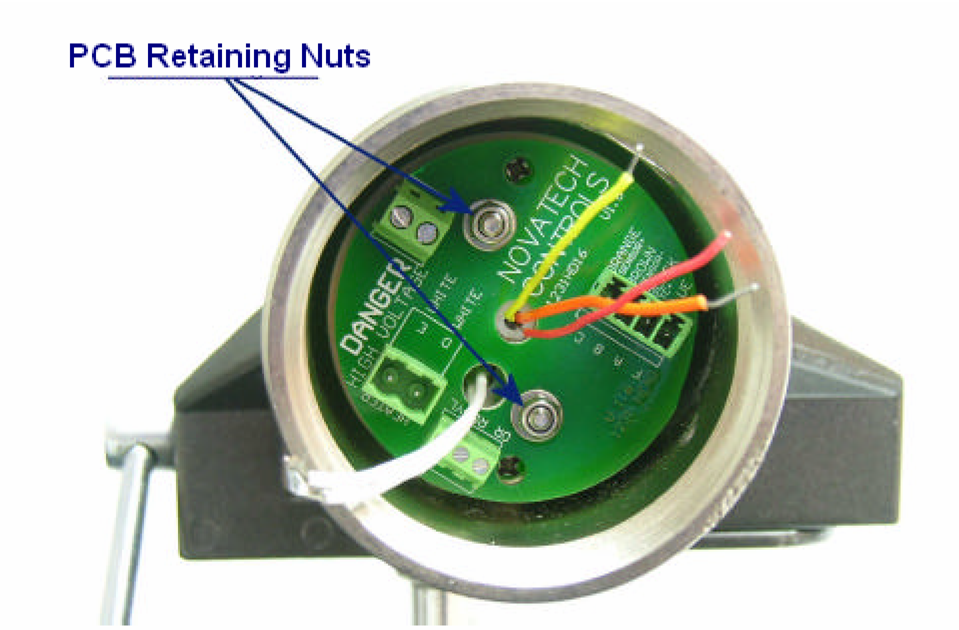


3.3.3.10 If installed, remove the weatherproof plug (head connector) by unscrewing (anti-clockwise). Avoid twisting the wires while unscrewing the connector.



WARNING:
The circuit board is held down against spring pressure by the two retaining nuts (M4 Nylock). Release the circuit board evenly upwards to avoid damage to the ceramic four-bore tube. The ceramic tube is brittle and easily broken with sideways movement.

3.3.3.11 Removed both circuit board retaining nuts.



3.33.12 Lift the circuit board over the heater, O2 +ve, T/C +ve and T/C -ve wires.

3.33.13 Gently lift the ceramic four-bore straight up (avoid bending) until clear of the probe body.

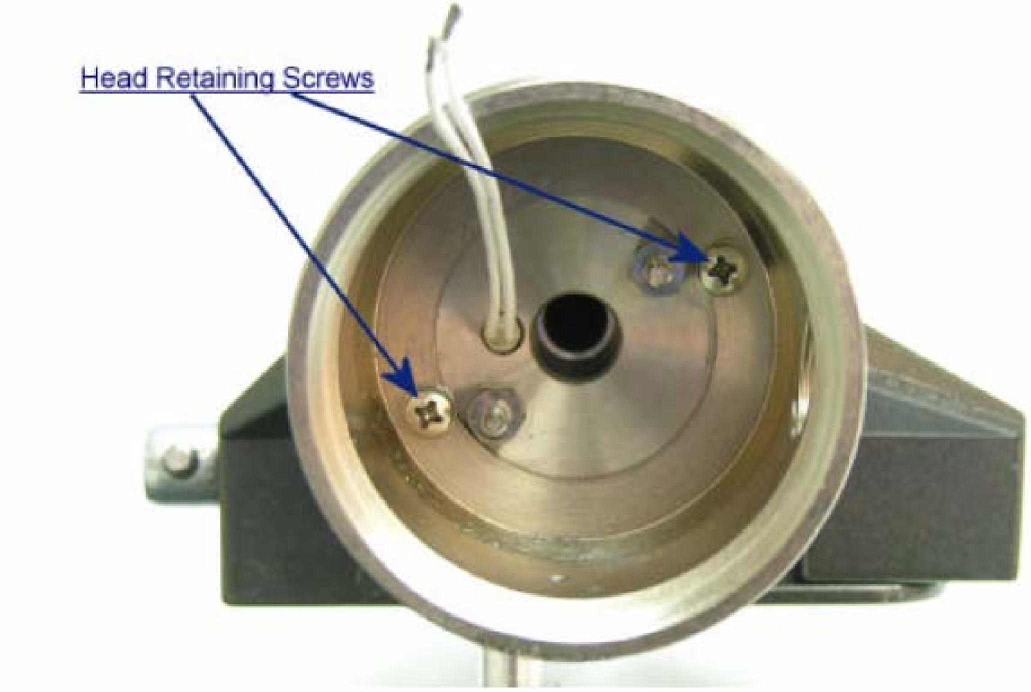
3.3.3.14 Set aside the four-bore in a safe place to avoid damage and contamination.

3.3.3.15 Remove the sensor compression spring by gently working it from the sensor gland.

3.3.3.16 Remove the sensor by holding the sensor gland with pliers and gently lifting it straight up (avoid bending) until clear of the probe body. Resistance will be felt removing the sensor due to the sensor gland o-ring seal. The sensor must not be forced, as it is brittle and easily broken.

3.3.3.17 Set aside the sensor in a safe place to avoid damage and contamination.

3.3.3.18 Remove the probe head from the probe body by unscrewing the two retaining screws.



3.3.3.19 Lift the inner sheath straight up and out of the outer sheath. Resistance will be felt removing the inner sheath due to the o-ring seal inside the hexagonal nipple. Once the o-ring is clear of the hexagonal nipple, care must be taken removing the inner sheath. It must not be forced, but gently worked until clear of the outer sheath.

3.3.3.20 Set aside the inner sheath in a safe place. The heater insulation must be protected from damage and contamination.

The probe is now disassembled to the major subassemblies.

3.3.4.0 INSPECTION

3.3.4.1 Outer Sheath

Check for corrosion inside and outside especially near the hex nipple. This is where the condensation of process gasses will cause the worst corrosion.

3.3.4.2 Inner Sheath / Heater

Check the heater continuity (approx. 110W).

Check the heater insulation resistance (greater than 10MW).

Check for signs of corrosion along the heater sheath.

Check the o-ring for damage or wear.

Check the tubular heater insulation for damage and degradation.

3.3.4.3 Zirconia Sensor and Alumina tube

Inspect the oxygen sensor for physical damage and loss of electrode paste.
Check the o-rings for damage or wear.

If the sensor is to be replaced use a flat faced drill (8mm) to remove any scale from the sensor seat to ensure a good electrical contact between the sensor and seat (O2 –ve).

3.3.4.4 Thermocouple 4-bore

Inspect the 4-bore for physical damage. Check the thermocouple and O2 +ve conductor for continuity, and brittleness or oxidation of the wires.

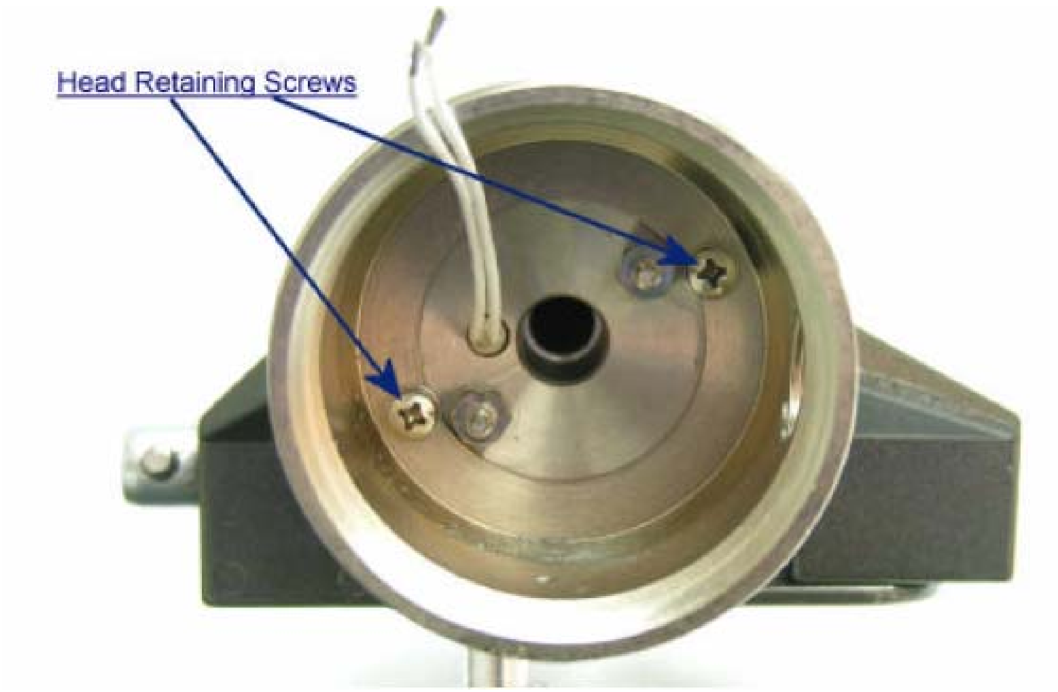
3.3.4.5 Head Assembly

Check the reference air hypodermic for blockages.

3.3.5.0 RE-ASSEMBLY

3.3.5.1 Wipe a small amount of o-ring grease (such as Molykote FS3451) around the o-ring on the gland body. Push the inner sheath straight into the outer sheath aligning the holes in the inner sheath assembly with the threaded holes in the outer sheath's hexagonal nipple. Resistance will be felt replacing the inner sheath due to the o-ring seal inside the hexagonal nipple. Care must be taken replacing the inner sheath to prevent damaging the heater insulation and o-ring. It must not be forced, but gently worked into position.

3.3.5.2 Align the reference air male connector port in the head opposite the 1/8" NPT calibration port on the inner sheath assembly; screw the probe head to the probe body with the two retaining screws.



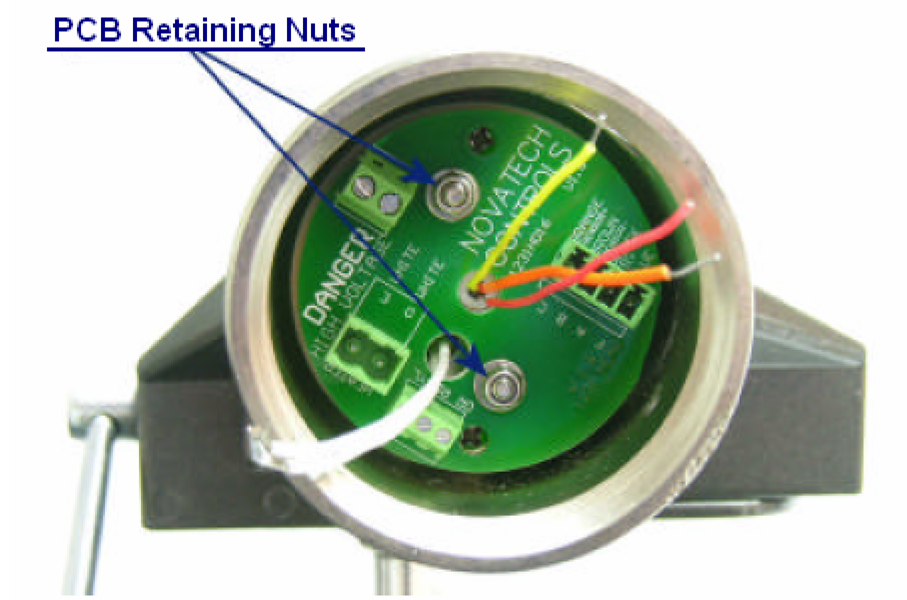
3.3.5.3 Wipe a small amount of o-ring grease (such as Molykote FS3451) around the top of the sensor and outer o-ring on the sensor gland. Carefully insert the sensor into the inner sheath. **Do not allow the tip of the sensor to contact the o-ring grease or the sensor will become contaminated**. Use long nosed pliers to work the sensor gland and o-ring into the seal, do not use excessive force as this could damage the sensor.

3.3.5.4 Replace the sensor compression spring onto the sensor gland.

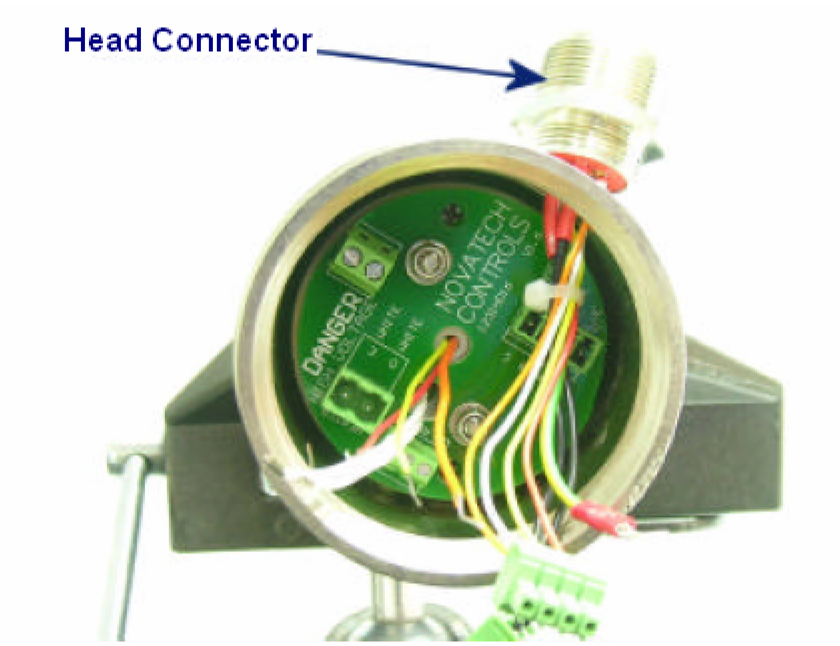
3.3.5.5 Carefully insert the four-bore assembly into the sensor.

3.3.5.6 Feed the four-bore wires through the circuit board centre hole and the heater wires through the hole adjacent to the three-way connector. Install the reference air hypodermic into the four-bore insulator. While pushing the circuit board into position take extreme care lining up the four-bore spring and sensor compression spring to avoid breaking the four-bore insulator.

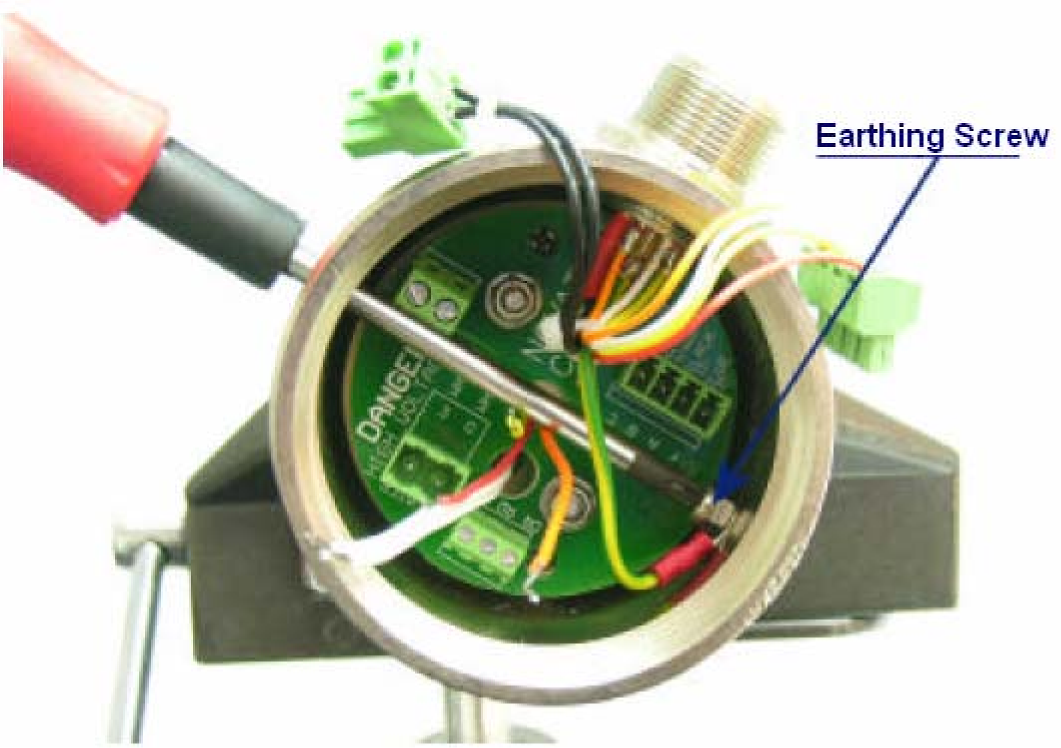
3.3.5.7 Replace both circuit board retaining nuts and flat washers.



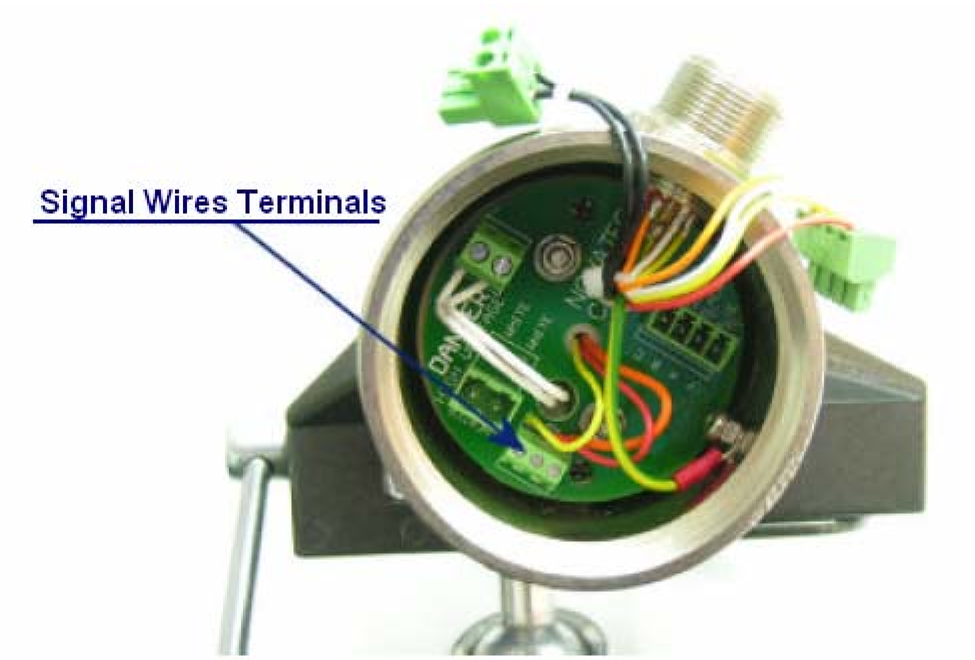
3.3.5.8 Replace the weatherproof plug (head connector). Avoid twisting the wires while screwing in the connector.



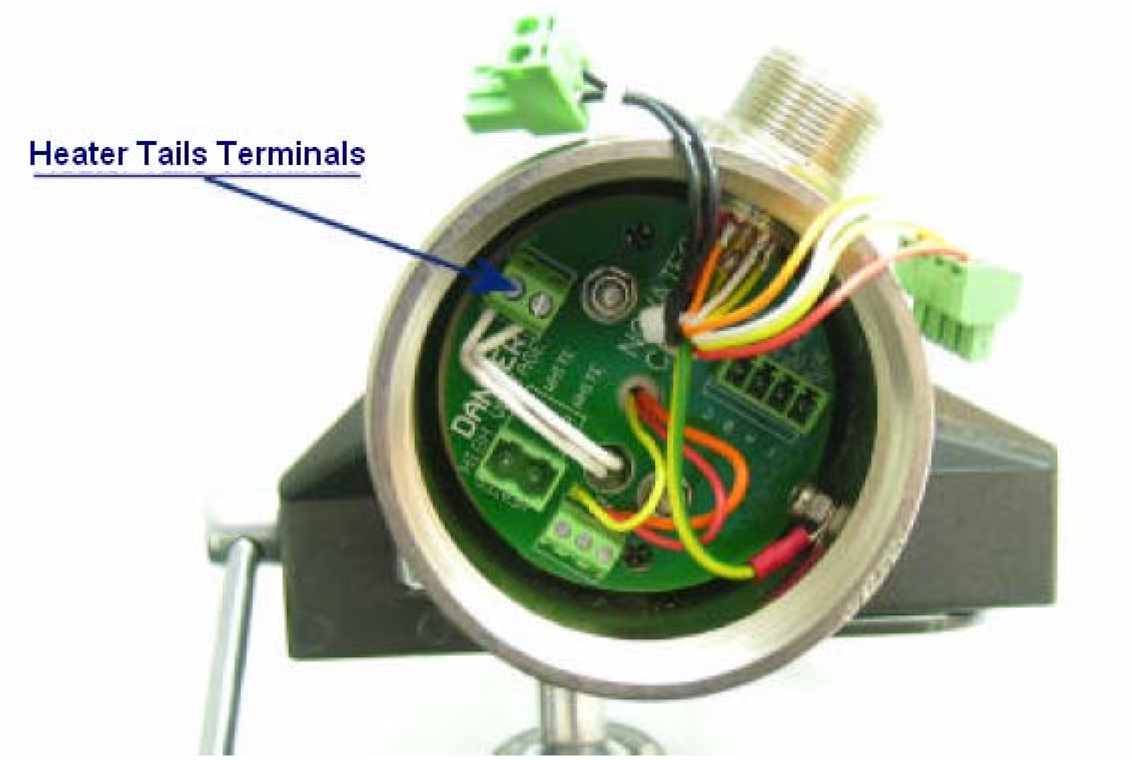
3.3.5.9 Pass a Philips head screwdriver through the reference air male connector port and attaché the earth lead wire to the opposite side of the head with the M4 screw. Tighten securely.



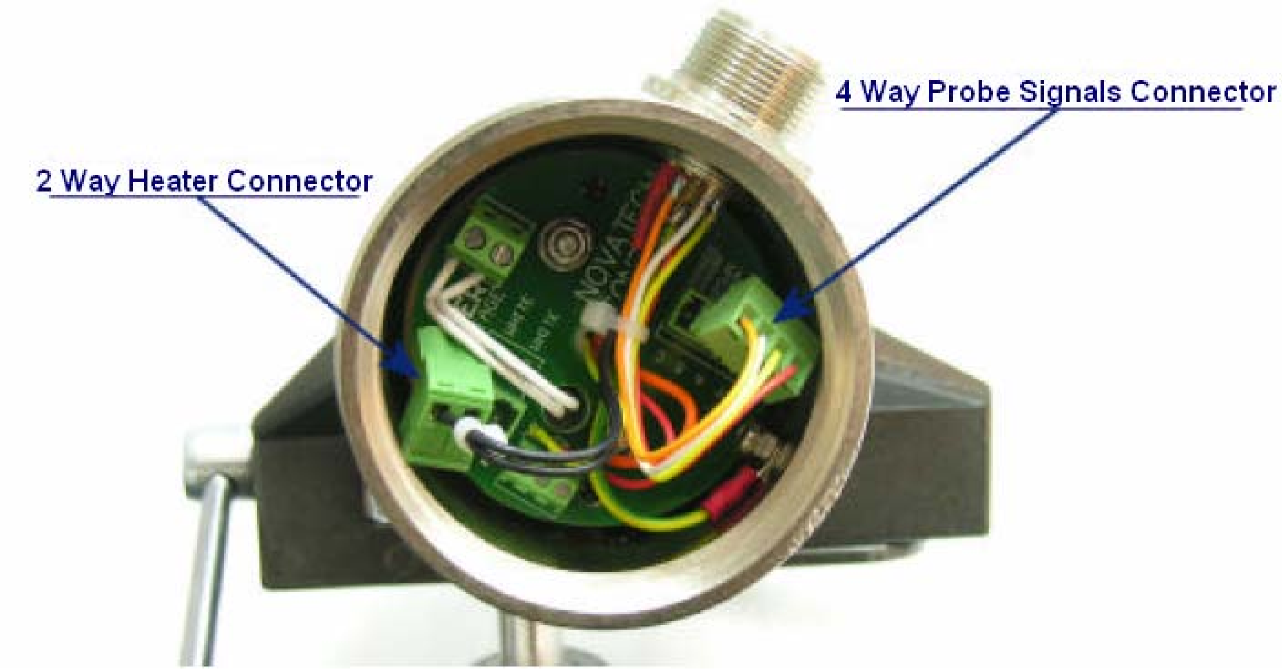
3.3.5.10 Replace the O2 +ve (orange), T/C +ve (yellow) and T/C –ve (red) into the three way terminal block. The terminals are marked “O”, “R”, and “Y”.



3.3.5.11 Replace the heater wires into the two-way terminal block. These leads are not polarized.

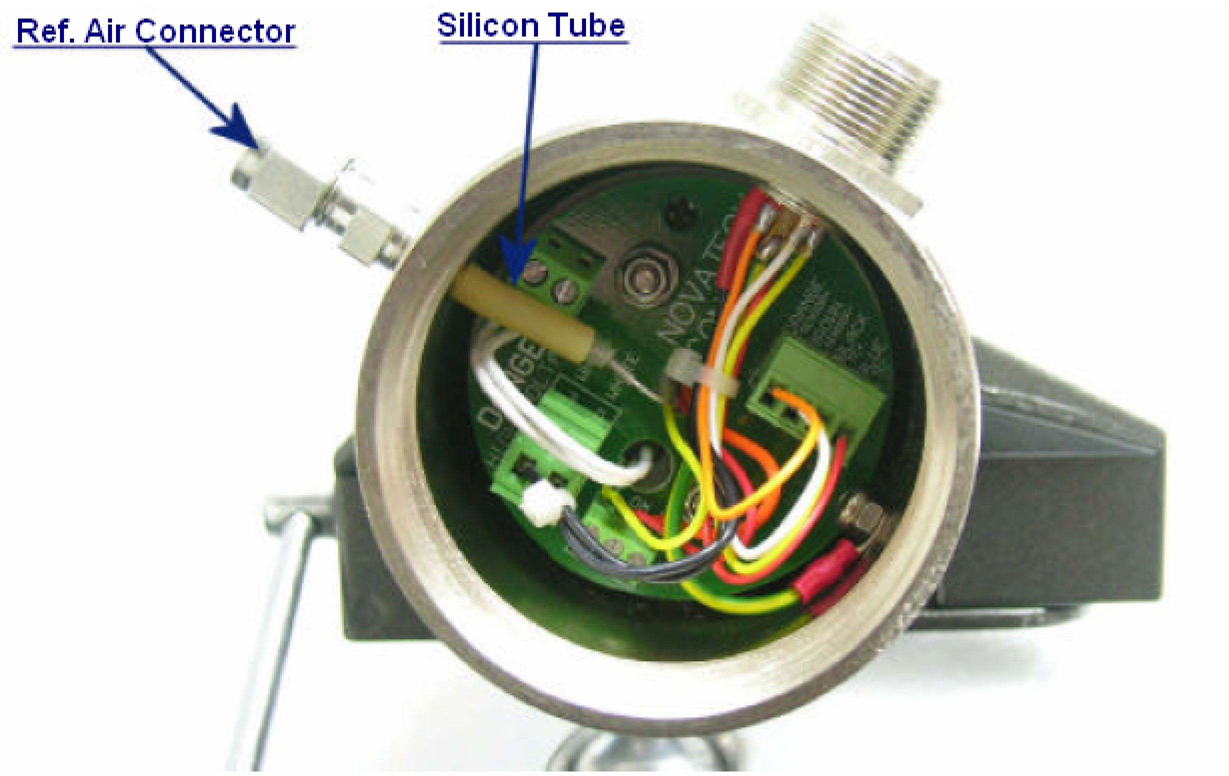


3.3.5.12 Plug in the two wire heater connector and four way sensor / T/C connector.



3.3.5.13 Before screwing the reference air male connector into the head be sure the hypodermic is inserted into the barb's hole. Tighten the male connector and then slide the silicon sleeve over the barb connector to form a seal.

3.3.5.14 Install the screw top lid and tighten using the castellated slots on the lid. The probe can now be tested as in section 2.0

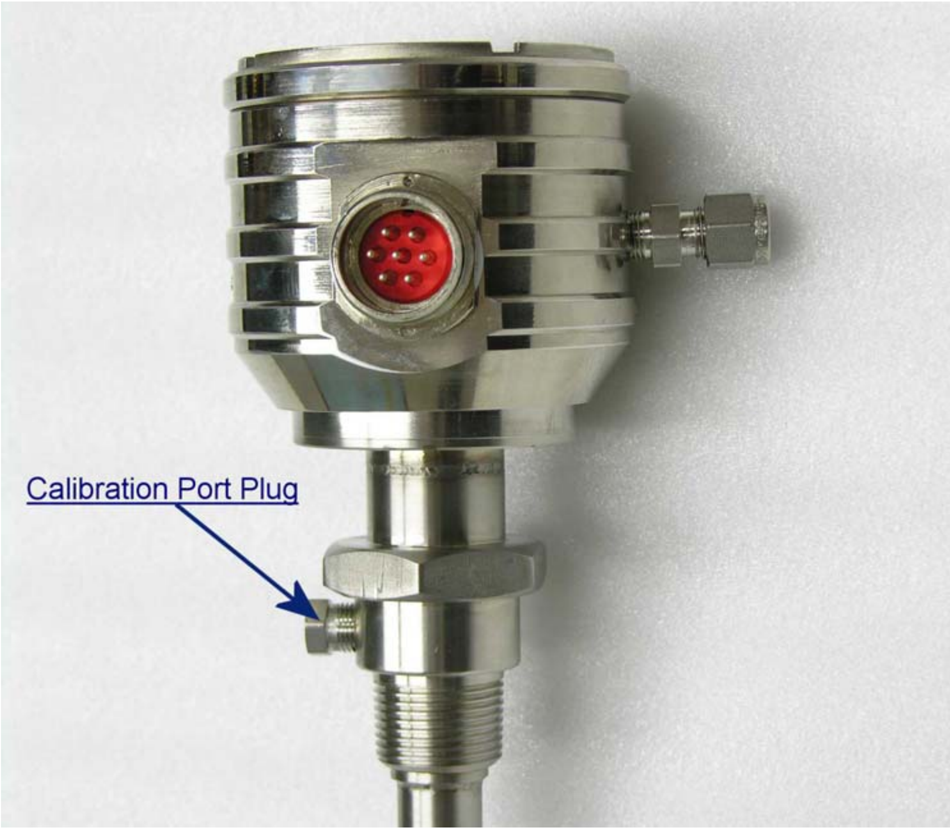


3.4 DISASSEMBLY & SERVICE OF UN-HEATED OXYGEN PROBE

3.4.1 9060 500mm 253MA Oxygen Probe

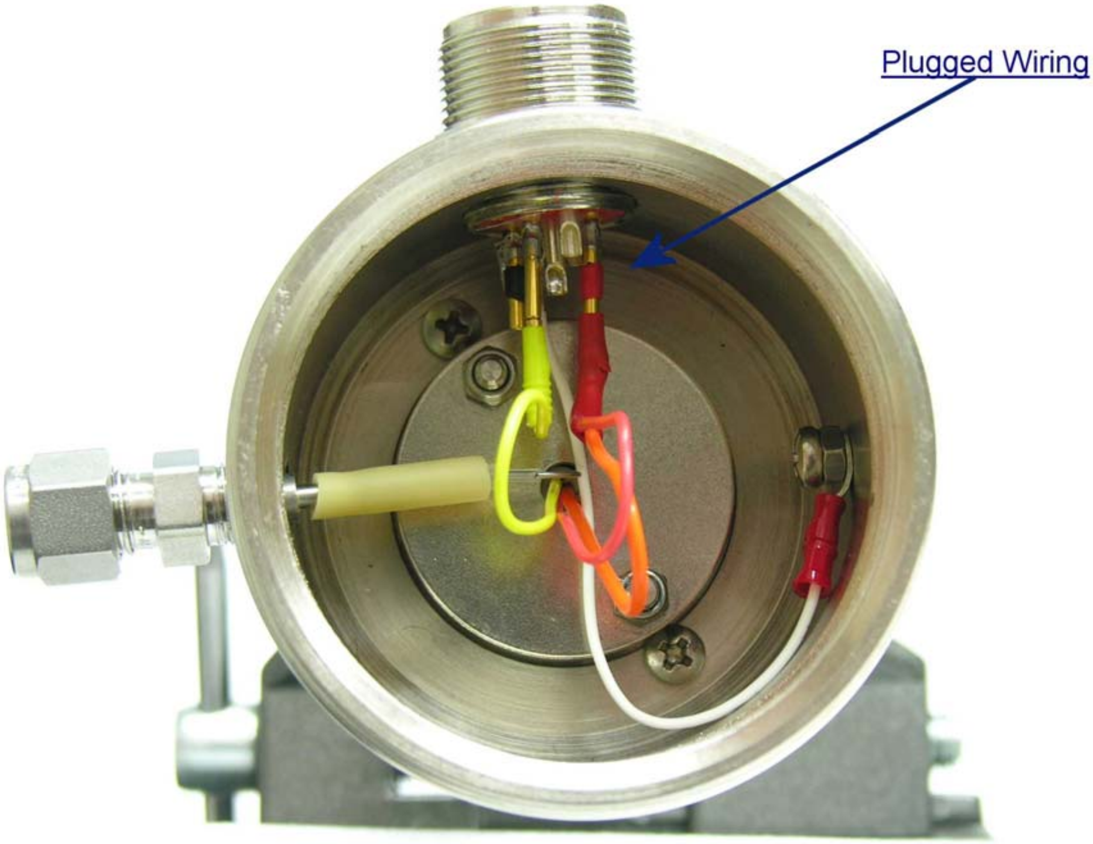
3.4.1 DISASSEMBLY PROCEDURE

3.4.1.1 Remove the calibration port fitting. This could be 1/8" NPT plug or male connector if purge air or calibration gas is used.

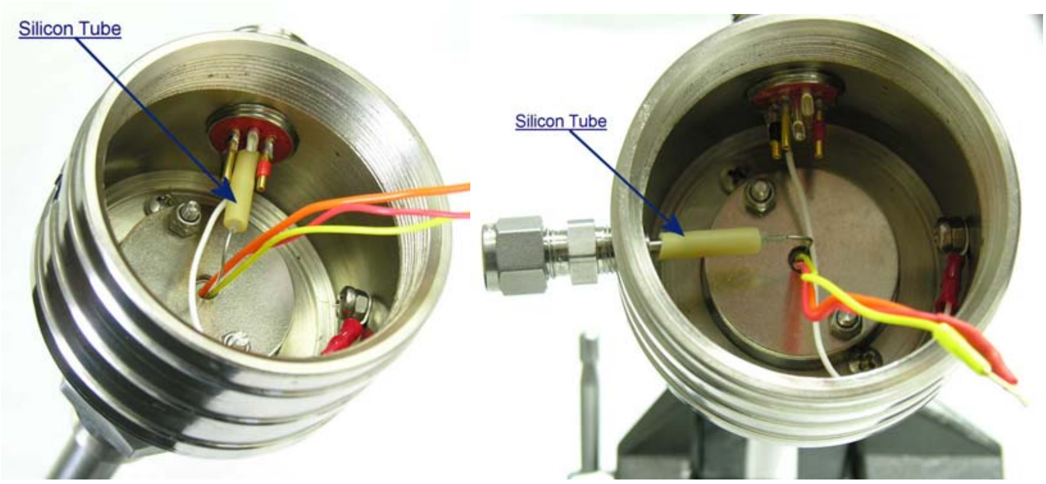


3.4.1.2 Remove the castellated lid on the probe head. Use the shank of a suitable spanner or a square cross-section bar

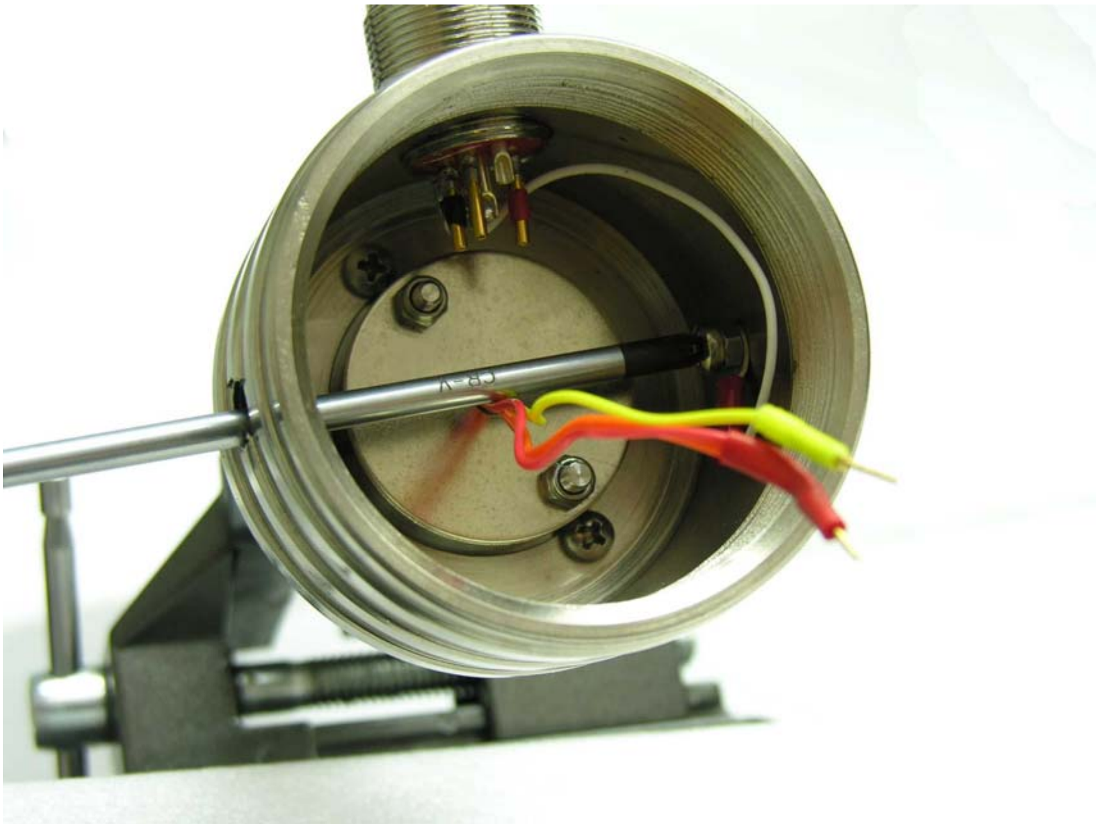
3.4.1.3 Unplug the wiring from the head connector. These are the probe positive, thermocouple positive and thermocouple negative. The thermocouple is optional in the 1232 probe.



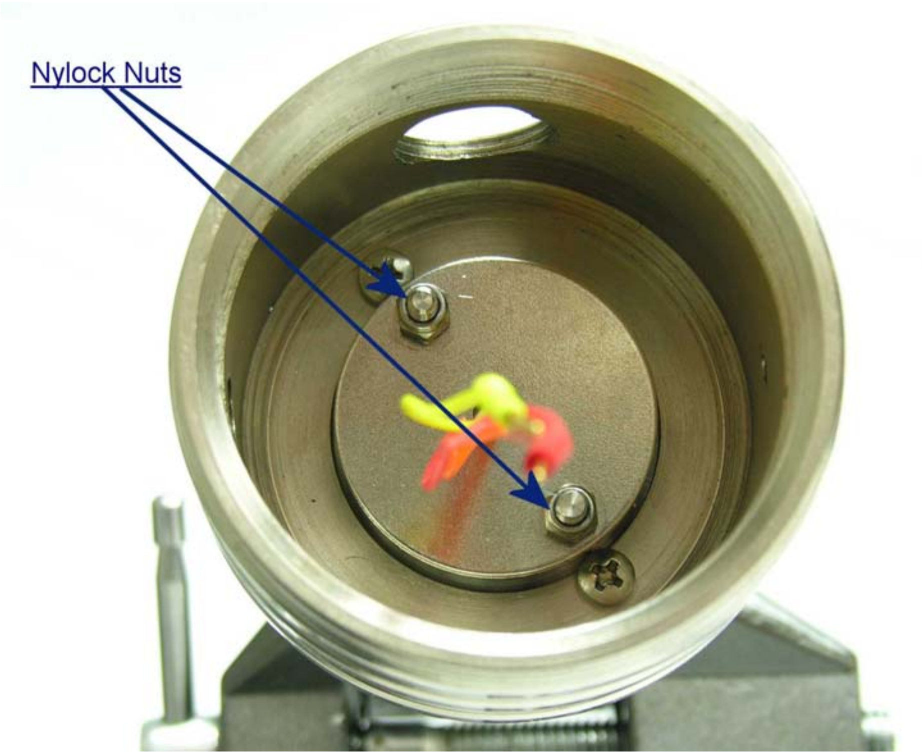
3.4.1.4 Remove the silicon tube from the hypodermic that runs through the head connector or from the barb on the external reference air connector. (Gently work the silicon tube to get this off)



3.4.1.5 Remove the earthed wire inside the head (O_2 –ve) and remove the head connector.

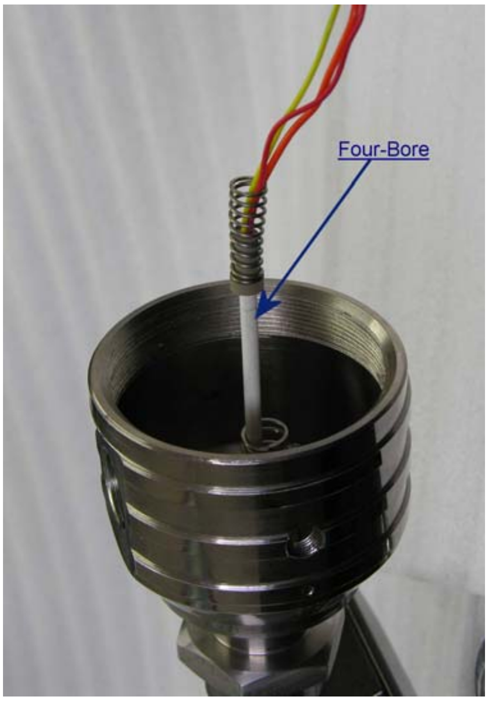


3.4.1.6 Evenly remove the two Nylok nuts holding down the compression plate. This will remove the spring loading on the four-bore insulator and the sensor.

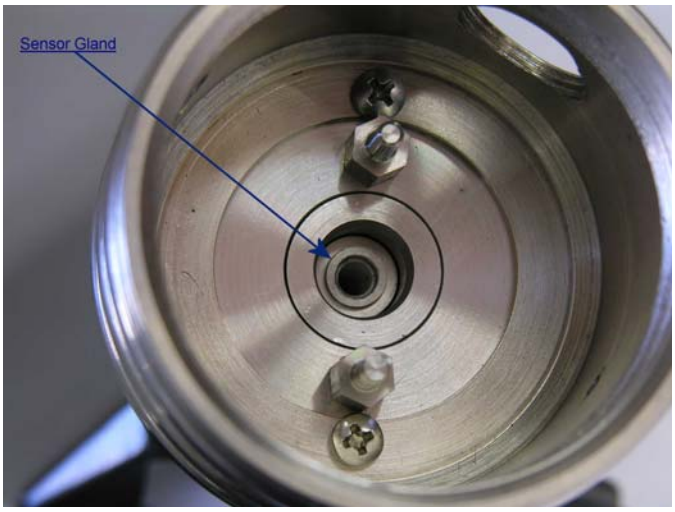


3.4.1.7 Carefully remove the four-bore insulator containing the thermocouple and probe positive conductor.
a) Inspect for damage to the ceramic insulator.
b) Check the conductors for damage or oxidation.

3.4.1.8 Remove the sensor compression spring from the gland on top of the sensor.



3.4.1.9 Using long nose pliers, carefully remove the sensor gland and the sensor from the probe sheath.
a) Inspect for damage
b) Check the state of the sensor's catalytic electrode material



Reverse this procedure for reassembly.

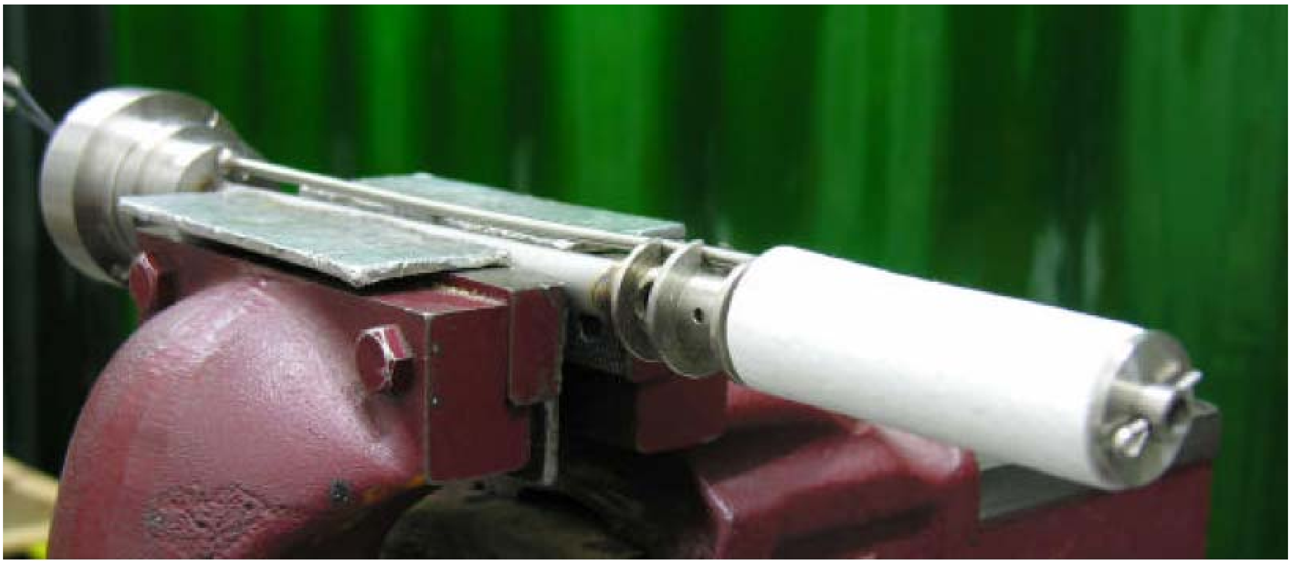
Note: Wipe a small amount of o-ring grease (such as Molykote FS3451) around the top of the sensor and outer o-ring on the sensor gland before re-installing the sensor and gland.

3.5 HEATER REMOVAL PROCEDURE ON 9060 OXYGEN PROBE (NEW VERSION- AFTER JAN 2007 ONWARDS)

Procedure

Refer to service note “3.3, Disassembly, Repair” for instructions to dismantle the probe to its basic components.

3.5.1 Secure the inner sheath in a vice.



3.5.2 Remove the split-pin.

3.5.3 Remove the heater insulation retainer.

3.5.4 Remove the heater insulation.

3.5.5 Gently twist the heater to and fro while sliding it off the sheath.

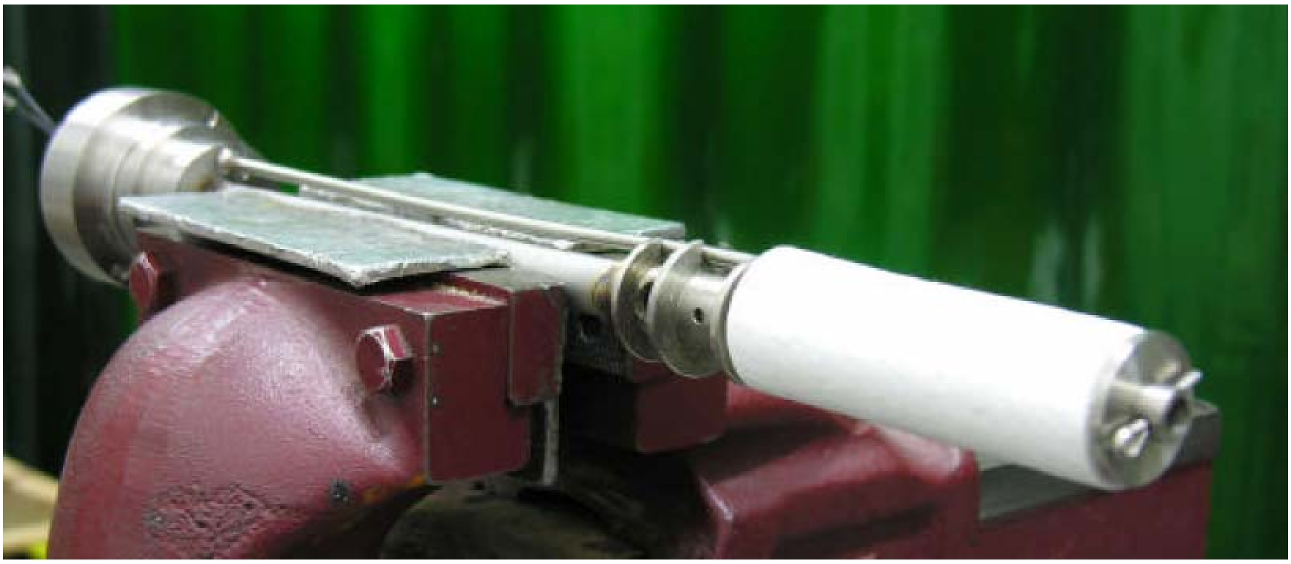
3.5.6 Re-installation is simply a reversal of this procedure.

3.6 HEATER REMOVAL PROCEDURE ON 9060 OXYGEN PROBE (OLD VERSION- BEFORE JAN 2007)

Procedure

Refer to service note “3.3, Disassembly, Repair” for instructions to dismantle the probe to its basic components.

3.6.1 Secure the inner sheath in a vice.



3.6.2 Use a 3/8” drill to break the weld on the heater insulation retainer.

3.6.3 Use multi-grips to remove the heater insulation retainer.

3.6.4 Remove the heater insulation.

3.6.5 Gently twist the heater to and fro while sliding it off the sheath.

3.6.6 Re-installation is simply a reversal of this procedure.

FREQUENTLY ASKED QUESTIONS

4

4.1 Question: "Sometimes I see a symbol (*) and (+) on the LCD of the O2 analyser, what does it mean?"

Answer:
Four symbols periodically flash on the right hand side of the display during normal operation, each indicates that a specific function is currently being performed by the analyser.

+ = Checking for timed events (30-second interval). Purge and calibration sequences, updates run-time, checks that the BBRAM is okay, reads the ambient RH, updates the O2 value of the reference air with respect to the RH value.

***** = The heartbeat means the software is running correctly (1.5- second interval).

= Auto-calibration of the analyser's electronics with respect to the four reference voltages (60-second interval).

Z = Sensor Impedance Check (24-hour interval when the impedance is normal, at 11:30pm; 60-second interval when the impedance is high).

4.2 Question: "How do I set my 9060 oxygen analyser to transmit 0-21% linear oxygen from probe 1 on channel 1 and from probe 2 on channel 2?"

Answer:
1) First, make sure that two probes have been selected in set-up step 1.

2) Enter the set-up mode and go to set-up step 26, "Chan1 Scale". Using the "OPTION" up or down buttons, select "Linear Sensor1" and push "ENTER".

3) Go to set-up step 27 "Chan1 Span" and push the "OPTION" up or down buttons until the lower line reads "20.9" and push "ENTER". Channel 1 has now been scaled.

4) Go to set-up step 28, "Chan2 Output" and use the "OPTION" up or down buttons to select "Linear Sensor2" and push "ENTER".

5) Go to set-up step 29, "Chan2 Zero", and push the "OPTION" up or down buttons until the lower line reads, "Zero 0" and push "ENTER".

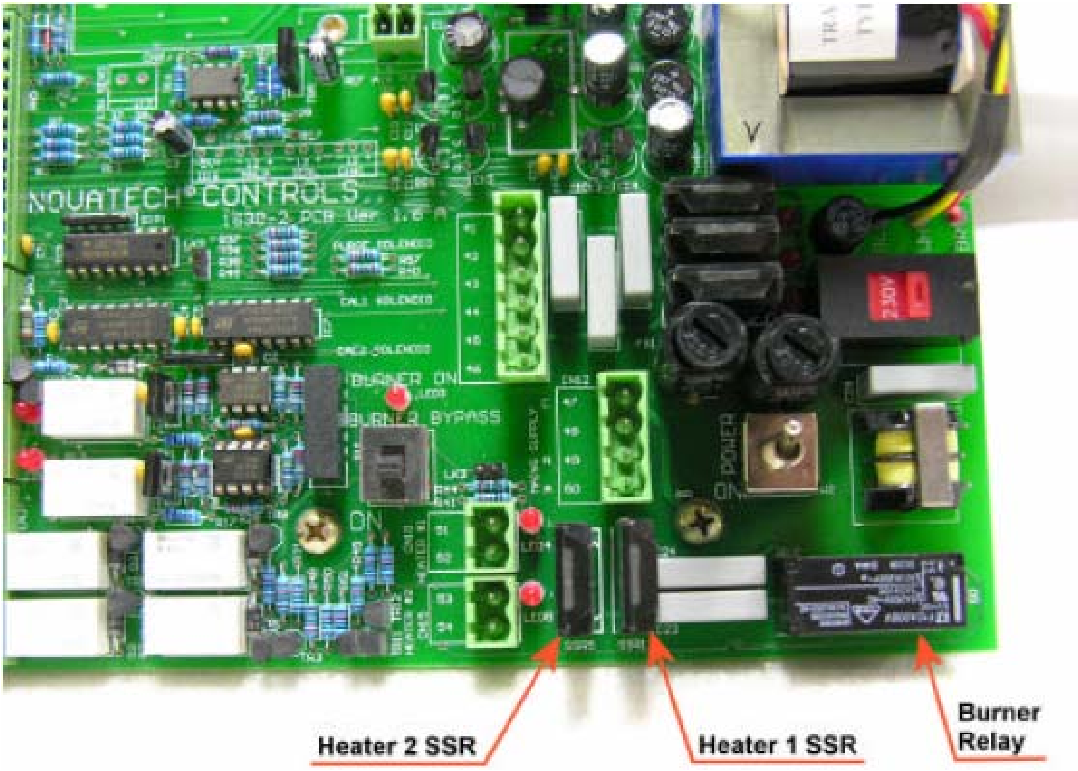
6) Go to set-up step 30, "Chan2 Span", and push the "OPTION" up or down buttons until the lower line reads "Span = 21" and push "ENTER". Channel 2 has now been scaled.

4.3 Question: "What does the "Htr SSR Fail" alarm mean?"

Answer:
The power to the heater in a 9060H probe is powered through a solid state relay (SSR). SSR1 controls heater 1 and SSR5 controls heater 2. The electromechanical relay RL7 (Burner on Relay) switches the active and neutral lines to both SSRs and is used to disable power to the sensors' heaters if: -

1) The terminals 18 and 19 (Burner On Switch) are open circuit

2) The probe or sensor temperature is greater than 735°C.



The most common mode of failure for a solid state relay is a short circuit. This will result in 100% power applied to the probe or sensor's heater that will destroy the heater due to excessive temperature.

The 9060H Control unit turns off the electromechanical burner relay when the sensor temperature reaches 735°C. If the temperature is caused by the process then heater power is not required; if the temperature is caused by a "shorted" SSR then heater power is not desired. The electromechanical burner relay is turned off.

When the probe or sensor temperature drops below 735°C the electromechanical burner relay is re-energised. If the SSR is shorted and the process temperature is above 715°C then the shorted SSR is not a threat to the heater because the heater will be powered for a relatively short time before it reaches 735°C again. If the process is considerably lower than 715°C then the 100% power applied to the heater will be significantly longer and detrimental to the heater before the temperature reaches 735°C again. If the temperature cycles between 735°C and 715°C three times then the instrument raises the "Htr SSR Fail" alarm and shuts power off to the heaters until a "warm start" is initiated (power off then back on).

The number of cycles that will cause the alarm is selectable in the Extended Menu set-up under "SSR fail Alrm". The alarm can be disabled if "Disabled" is selected for this menu item.

4.4 Question: "What is Control of 1234 OR Extractive type Oxygen Sensor?"

Answer:
The temperature of the 1234 oxygen sensor must be maintained between 650 and 800°C. The recommended running temperature is 720°C.

The temperature should be stable to within 10°C per minute.

Control of the temperature can be achieved with proportional and integral action, with a time proportioning cycle of 2.5 seconds.

The proportional band should be set to 15% (150°C proportional range).
The integral action should be set to 200 seconds

NOTE:
If running the 1234 oxygen sensor from 240VAC allow only a 25% duty cycle.
If running the 1234 oxygen sensor from 110VAC a 100% duty cycle is allowed.
The heater will get to 720°C within 10 minutes if the voltage and the duty cycle are correct.
The heater inside the 1234 oxygen sensor is rated at 240VAC, but DO NOT apply 240VAC to the heater for more than a few seconds.

Output: EMF = 2.154 x 10-2 x T x loge (0.2095/oxygen level of the sample)
T = Temperature in °K

4.5 Question: "How long will the CM-15 reference air pump last?"

Answer:
The life of a CM-15 pump can vary greatly from site to site. If the analyser is located in an air conditioned control room then several years would be the expected life, if it were located in a hot and dirty heat treat shop then the life could be as short as six months.
There are three factors that reduce the life of the CM-15 pump.

1). Operating ambient temperature. As this increases the pump life decreases. If the internal temperature exceed 35°C the analyser will turn off the backlight display and cycle the pump on and off to assist reducing the temperature and extending the life of the pump.

2). Particulate loading of the air being pumped. This is mainly a problem on heat treatment sites; the grit in these places gets lodged in the diaphragm increasing the load on the pump. The analysers are fitted with a filter on the reference air inlet to the analyser to extend the pump's life.

3). The amount of restriction in the reference air line to the probe. The greater the restriction the greater the load is on the pump's phosphor bronze bearings.
The normal flow range from a CM-15 pump connected to an oxygen probe is 100 to 120 cc per minute. The zirconia sensor will work properly with a reference air flow rate as low as 10 cc per minute.

The common mode of failure for the CM-15 is a worn phosphor bronze bearing eventually causing the motor to "pole out" thereby greatly increasing the current drain. The 9060 analyser monitors the current consumption of the pump and will raise a "Reference Air Fail" alarm if the current consumption exceeds a set level (250mA). The alarm is also raised if the current falls below a set level (15mA) if the pump goes open circuit or is unplugged.

4.6 "What is the Zirconia Probe Life Expectancy?"

Answer:

Introduction
The deterioration of a zirconia oxygen probe is of interest to maintenance engineers trying to maintain instrumental reliability, and project planners budgeting for maintenance expenses. Unfortunately, the degradation does not follow a predictable formula.

Background
Zirconium oxygen probes are the most common method of controlling combustion and heat treatment processes. Teledyne Analytical Instruments have thousands of systems installed in power stations, petrochemical plants, heat treatment hardening furnaces and annealing furnaces, and a variety of incinerators, cement plants and drying ovens. All of these processes have different requirements, and pose different conditions to the components of the probe exposed to the process.

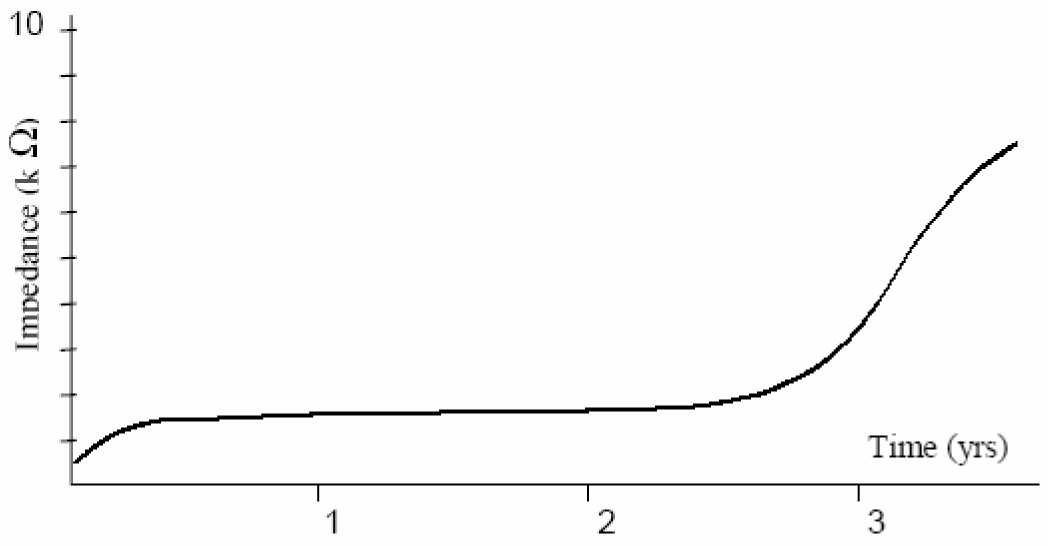
Failure modes
The useful life of the probe is limited by the first component of the probe to fail. The failure may be a slow deterioration or a sudden change of the working condition of one of the vital components.
Components that may have a sudden failure are:
• The heater in heated probes (open circuit or short circuit to ground)
• The thermocouple (cracking thermal junction causing an open circuit)
• Outer metal sheathing (breakage through corrosion or abrasion, or chemical attack)
• The ceramic components of the probe (physical or thermal shock)

Components that will slowly deteriorate are:
• The electrode coating of the zirconia sensor
• The thermocouple (oxidation, grain growth)
• The internal electrode conductor (oxidation, grain growth)

Out of all of these component failures, only the zirconia electrode material loss can be measured in an attempt to determine the remaining life of the probe. Unfortunately, this failure can only be predicted with the experience of the process it is being used.

The Teledyne Analytical Instruments analysers measure the impedance of the zirconia sensor automatically. Without interfering with the process measurement, the analyser allows an operator to read the impedance measurement and will automatically raise an alarm if the impedance is high enough to require attention.

Oxygen Sensor Impedance



Typical deterioration rate of a Teledyne Zirconia sensor

There is not a definite impedance at which a sensor can be said to have failed. As the electrode deteriorates, the impedance will rise. However the sensor oxygen reading is not affected by the loss of electrode material over a wide range if impedances (up to tens of kΩ). In fact, if the temperature of the sensor is over 850°C the sensor will read the correct oxygen concentration without any electrode material as long as there is no other deterioration of the electrode connections. The response time will usually increase as the electrode ages.

The above graph shows how sensor impedance will typically vary with use.

The sensor impedance is the sum of the electrode impedance and the electrolyte impedance. The electrode impedance is the part that will increase as the probe ages. Complicating the interpretation of the sensor impedance measurement is that the electrolyte impedance will be markedly lower at higher sensor temperatures. This is taken into account in the determination of the alarm status of the Teledyne Analytical Instruments analysers.

As an indication of probe life, the Teledyne Analytical Instruments analyser will raise a "Sensor Fail" alarm when the sensor is over 9kΩ when the sensor temperature is 720°C.

Summary

An oxygen probe will fail through a number of failure modes, only one of which has a measurable quantity related to the potential failure. Although most probes are taken out of service because the sensor electrode has deteriorated, the impedance changes must be taken as a series of readings over a period of several weeks. The best indication of an impending probe failure is in a series of impedance readings showing a definite and rapid increase.

4.7 "What is Oxygen Deficiency Scale?"

Answer:
The negative oxygen deficiency scale of the Teledyne Analytical Instruments 9060 oxygen analyser is a measure of the amount of oxygen that would be required to bring the combustion back to the perfect balance.

As a result of the burning of the fuel and air in the boiler there is a mixture of gasses. These gasses are mainly –

- Carbon dioxide
- Carbon monoxide
- Oxygen
- Water vapour
- Hydrogen

When a boiler is **FUEL RICH** there is a balance established between all of these gasses that is dependent on the temperature and the air / fuel ratio before the combustion.

In these conditions the free oxygen will be very small (less than **0.000,000,001 %**).
A zirconia sensor can measure down to less than
0.000,000,000,000,000,000,000,000,000,001 %.

If the oxygen, and the temperature of the oxygen sensor are measured, the percentage of oxygen required to bring the combustion back to the perfect balance can be calculated.

This can be very useful in the operation of a power station boiler because it gives the operator a way of recording both –

1. The oxygen level when the boiler is under normal **AIR EXCESS** conditions

2. How far and for how long the boiler was in **FUEL RICH**.

Both of these scales are transmitted on one 4-20 mA output channel.

The normal scale will be from –5% (oxygen deficiency) to 10% (air excess), but both ends of the scale can be set in the field.

4.8 "Can you provide some tips on In-Site type Applications?"

Answer:
For flue gas applications: -

Location
On coal-fired boilers the best mounting position for a 1231 probe is vertically downwards. The probe can be used without filters but the purge facility should still be utilized.

Locate the probe where the process temperature is between 300°C and 700°C. Below 200°C the inner sheath, outer sheath and heater can be corroded by concentrated acids condensing on the S/S and inconel. Above 800°C, the heavy metals and many compounds are hostile to the electrode material used on the surface of the zirconia sensor. Silica will also attack the grain boundary layer of the sensor.

The probe should be located at least five flue / duct diameters downstream of any bends and three diameters upstream of any bends.

Gas Velocity
The gas velocity passing the end of the probe should be greater than 5 meters per second. Low gas velocities result in slow refresh times of the process gas around the sensor causing a gradual depletion of the oxygen reading; any hydrocarbons in the gas will accelerate the oxygen depletion rate at the sensor's surface.

Dust
If the particulate loading is less than 500 mg/Nm3 then filters are not required. Use the sintered filters for particulate loadings in the range of 0.5 to 10 g/Nm3. 30 micron filters are used on most applications but 15 micron filters are available if required. Remember that the response time to changes in oxygen levels dramatically increase with the finer pored filters.

For dust levels up to 200 g/m3 on coal fired boilers the fly-ash can be abrasive. A protection shield may be required to prevent the probe from being prematurely destroyed.

In higher dust levels than 200 g/m3 do not use filters but the probe must be mounted vertically downwards and purged frequently.

Process Pressure
Teledyne Analytical Instruments in-situ oxygen probes can operate over the process pressure range of -60kPa to 250kPa. The analyser can compensate for a fixed process pressure or accept an analogue input signal from a pressure transducer for varying process pressures.

Probe Length
The insertion depth required is dictated by the size of the flue or duct and the velocity of the process gas. The probe should protrude almost halfway across small diameter flues and about 750mm into large ducts. Higher flue gas flow rates reduce the depth of tramp air ingression at the boundary of the duct and can therefore use a shorter probe.

In high temperature processes with high velocities the appropriate insertion depth can be determined by inserting an inconel (or 253MA) tube into the gas stream longer than the estimated (or guessed) insertion depth. Leave the tube in the process for a week and then remove it. The affect of heat and available oxygen will discolor the sheath proportional to the amount of heat and oxygen. The correct insertion depth is the length required to reach the point where the discoloration or oxidation of the tube is uniform.

4.9 "What to do if the oxygen reading does not match the certified gas %?"

Answer:

1. Check the setting of the reference voltages in the analyser
2. Check that the calibration gas pipe work connections are not leaking
3. Confirm that the readings were taken within 1 minute, especially at high flow rates
4. Confirm the accuracy of the gas bottle

READING LOW

If the probe appears to be reading low this can be caused by a build up of hydrocarbons at the sensor running at 720°C and consuming the oxygen that should be measured due to combustion. A solution to this is to pump air into the calibration port to accelerate the burning process to consume and eliminate the hydrocarbons.

Having an excessive flow of reference air can also cause a low reading; this causes a cooling affect on the zirconia sensor. Reference airflow should be approximately 50cc/min.

READING HIGH

If the probe appears to be reading high then the reference air should be checked, remove the cap on the probe and pull the hypodermic from the four bore insulator, place the hypodermic in a glass of water to observe air flow.

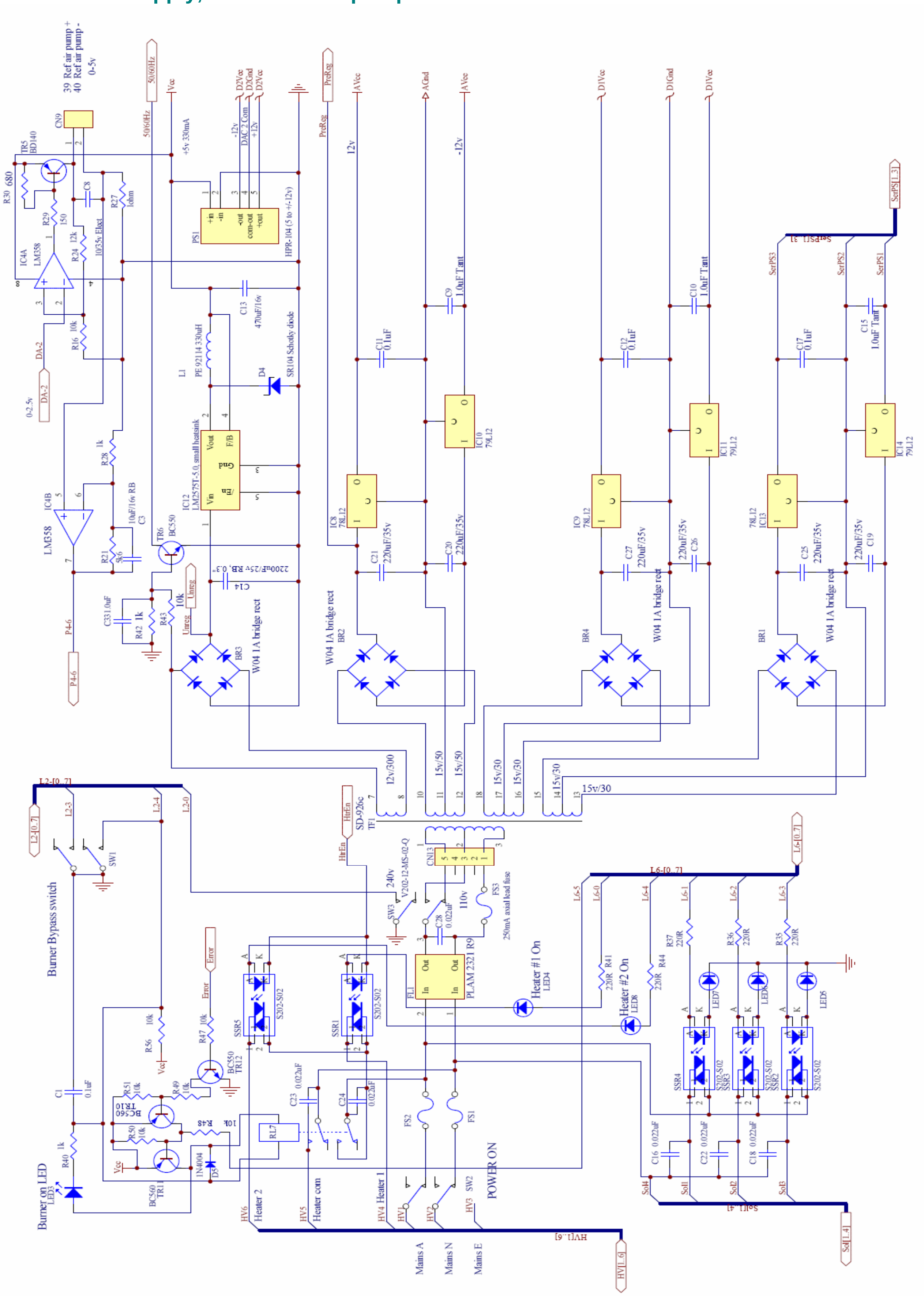
If the process operates under a negative pressure then check that the 1/8-inch plug screwed into the calibration port on the probe is not leaking.

If the problem persists then replace or return the probe to Teledyne Analytical Instruments.

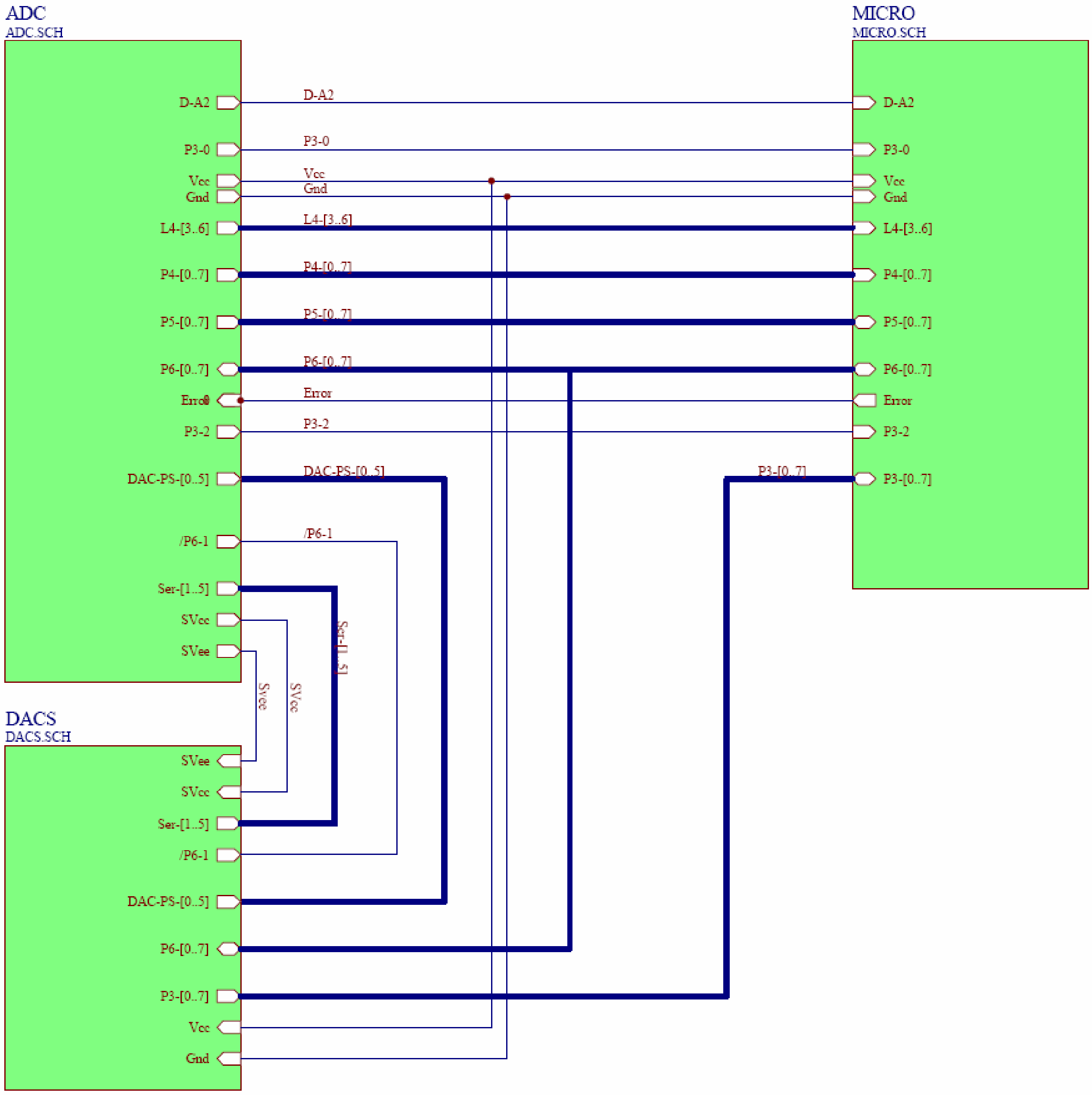
Schematics

5

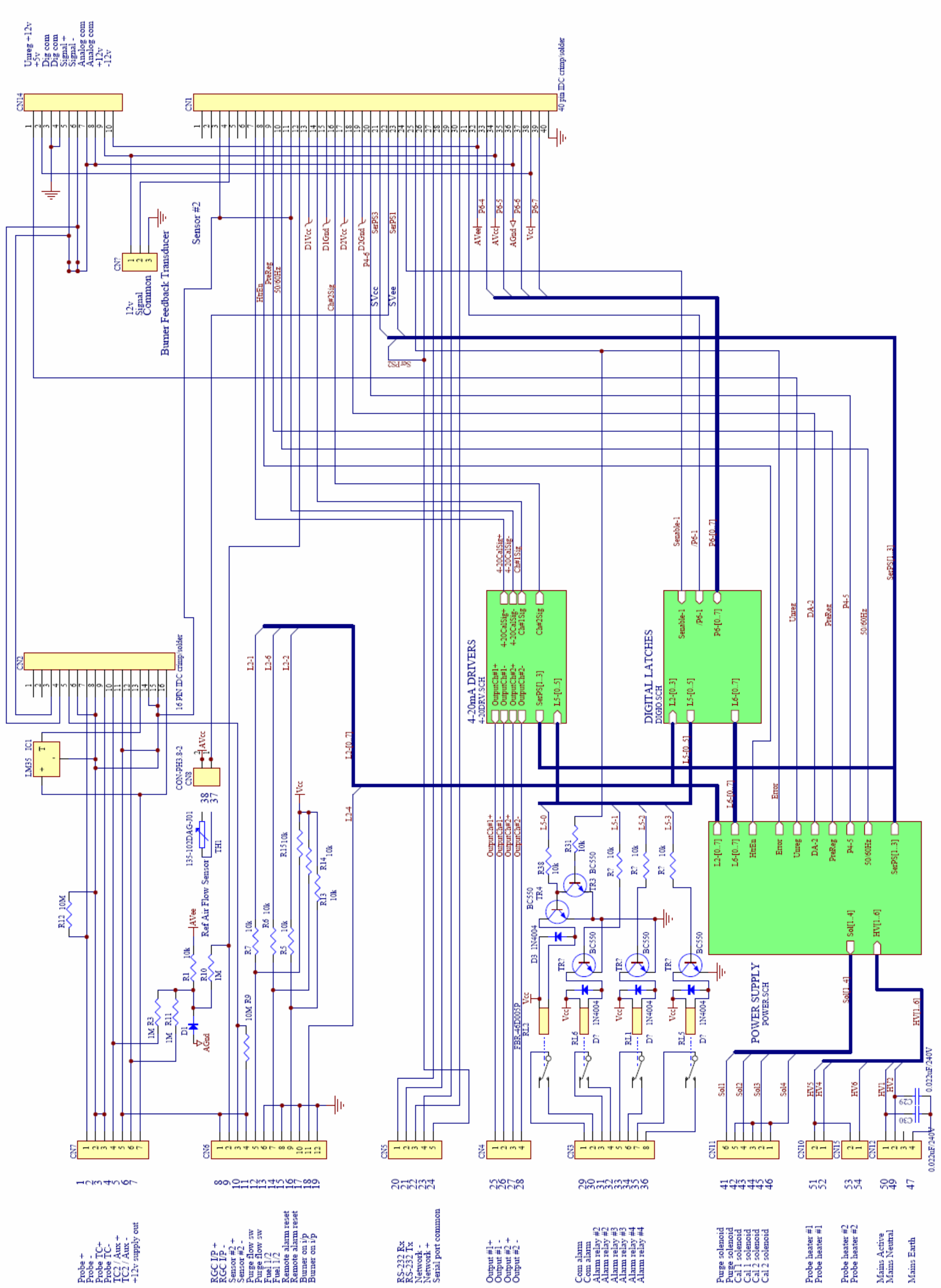
5.1 Power Supply, Reference air pump



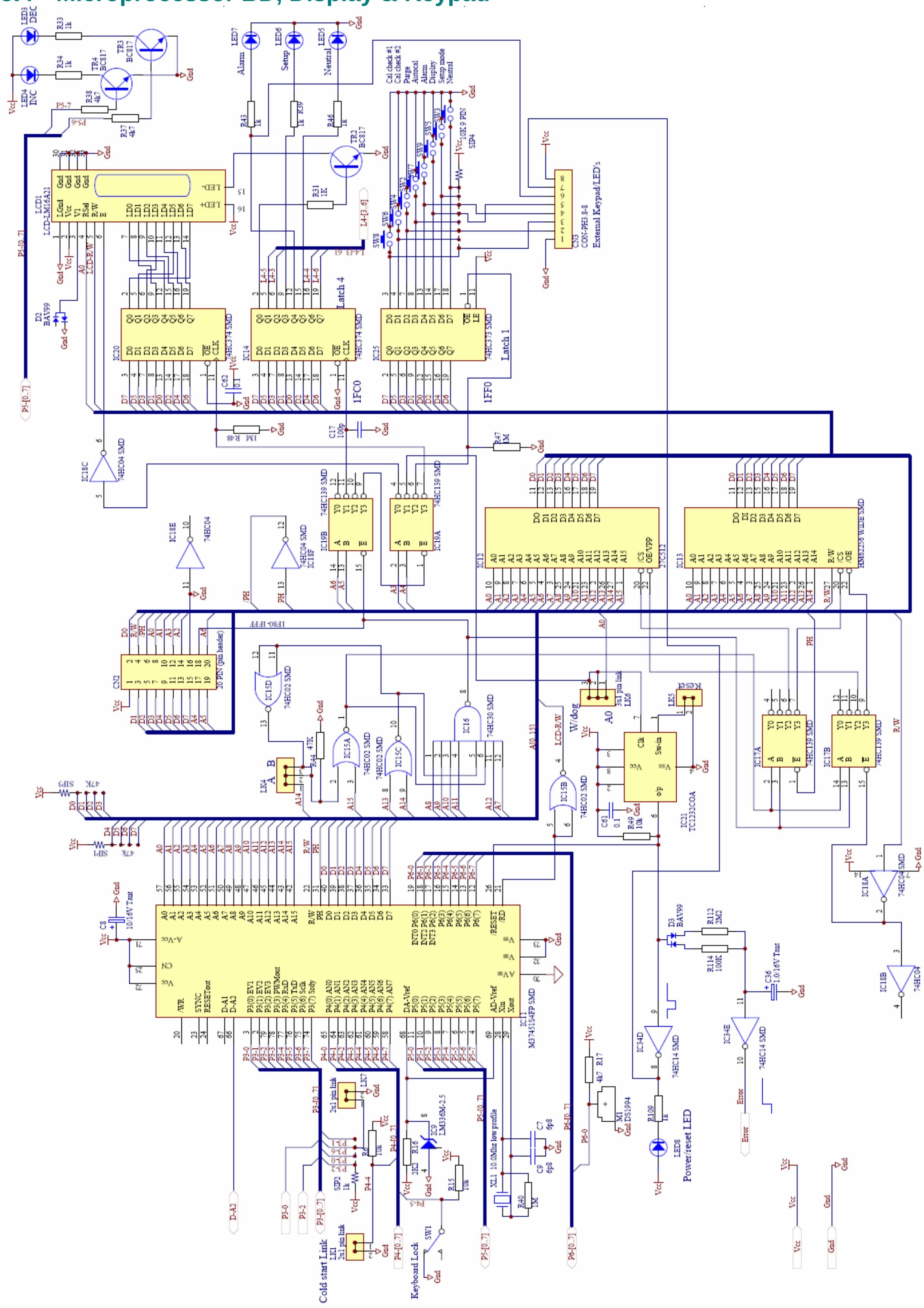
5.2 Main Board Block Diagram



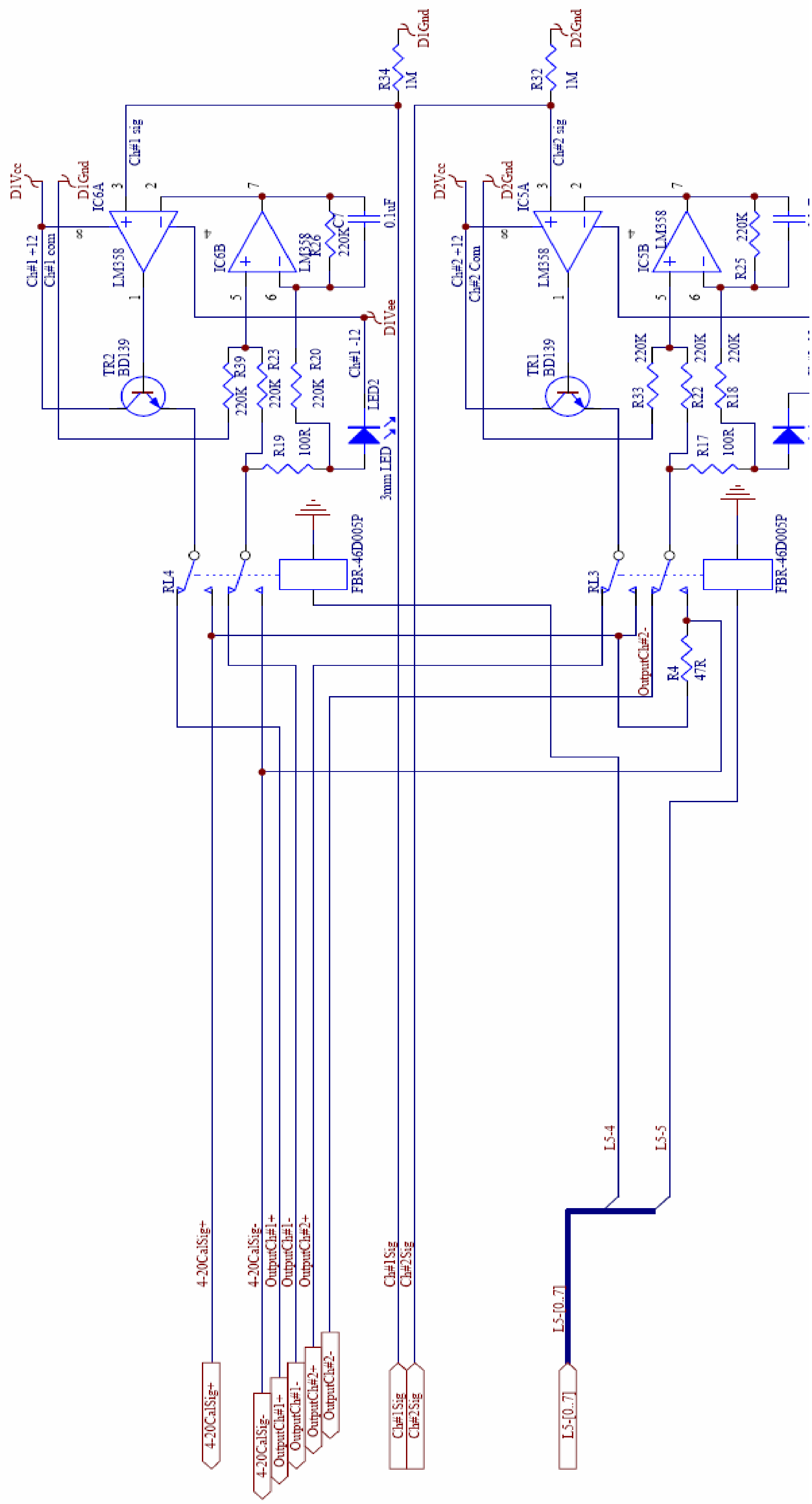
5.3 Main Board Terminal Allocation Block Diagram



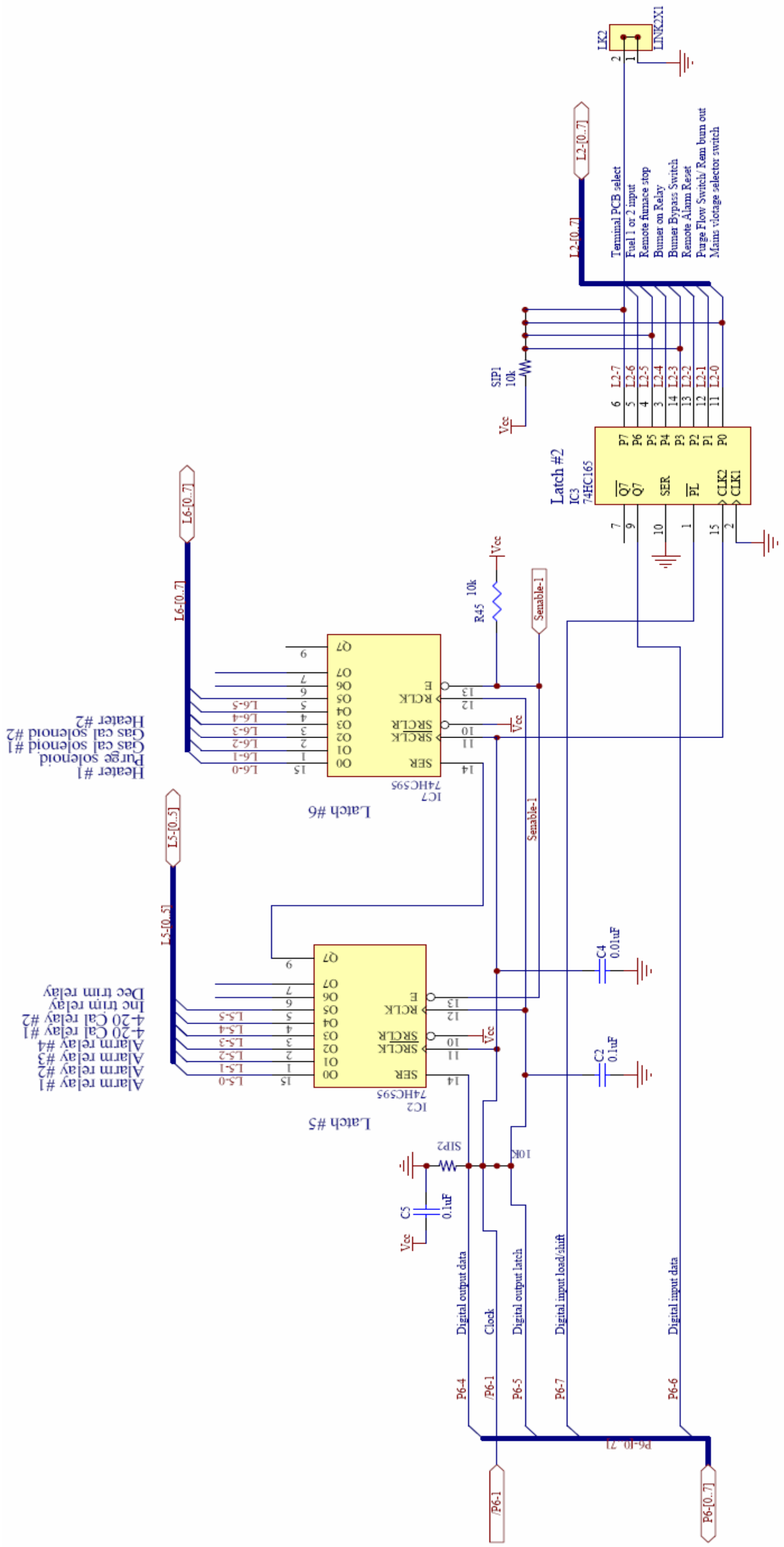
5.4 Microprocessor BD, Display & Keypad



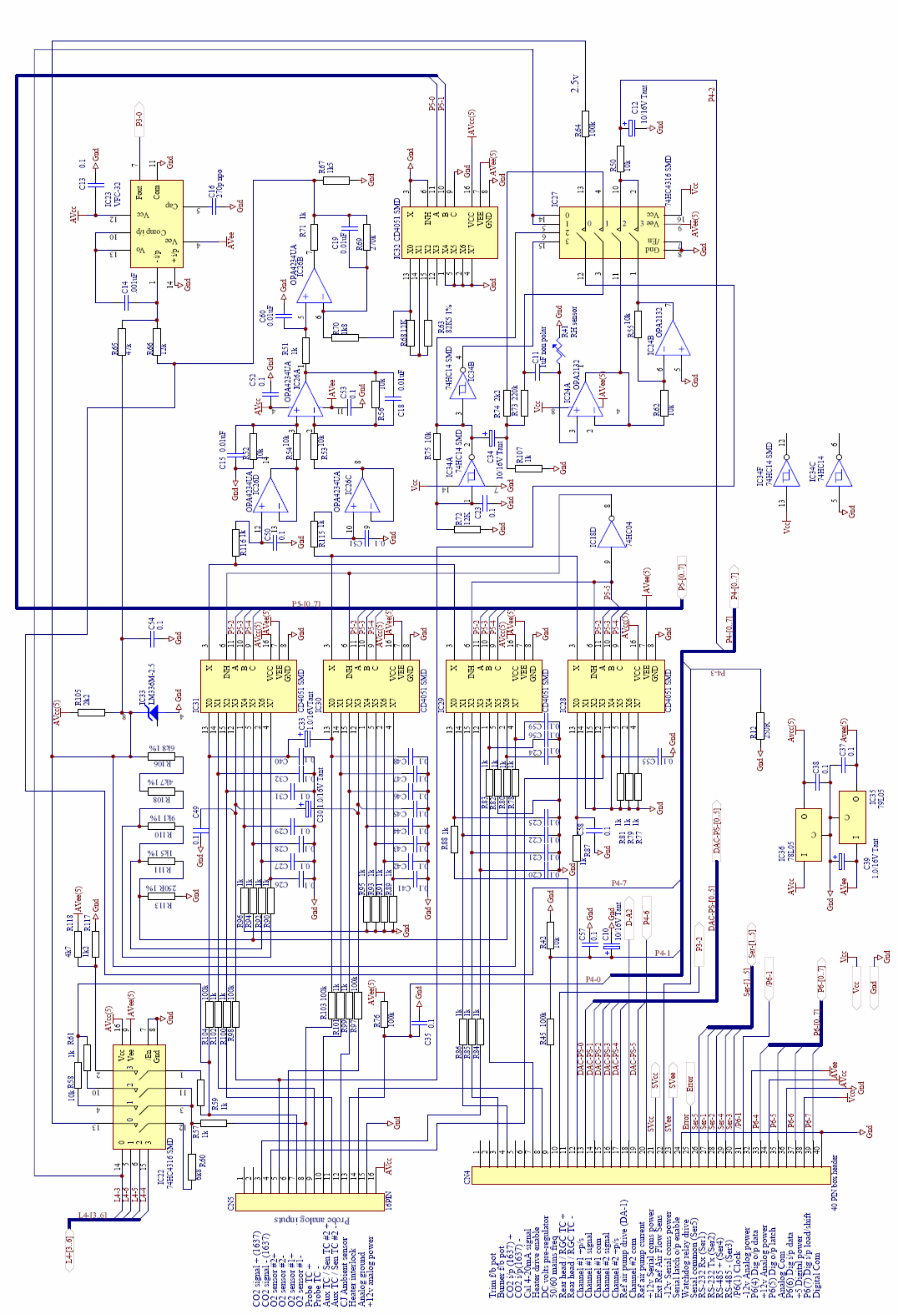
5.5 4-20 mA Output Drivers



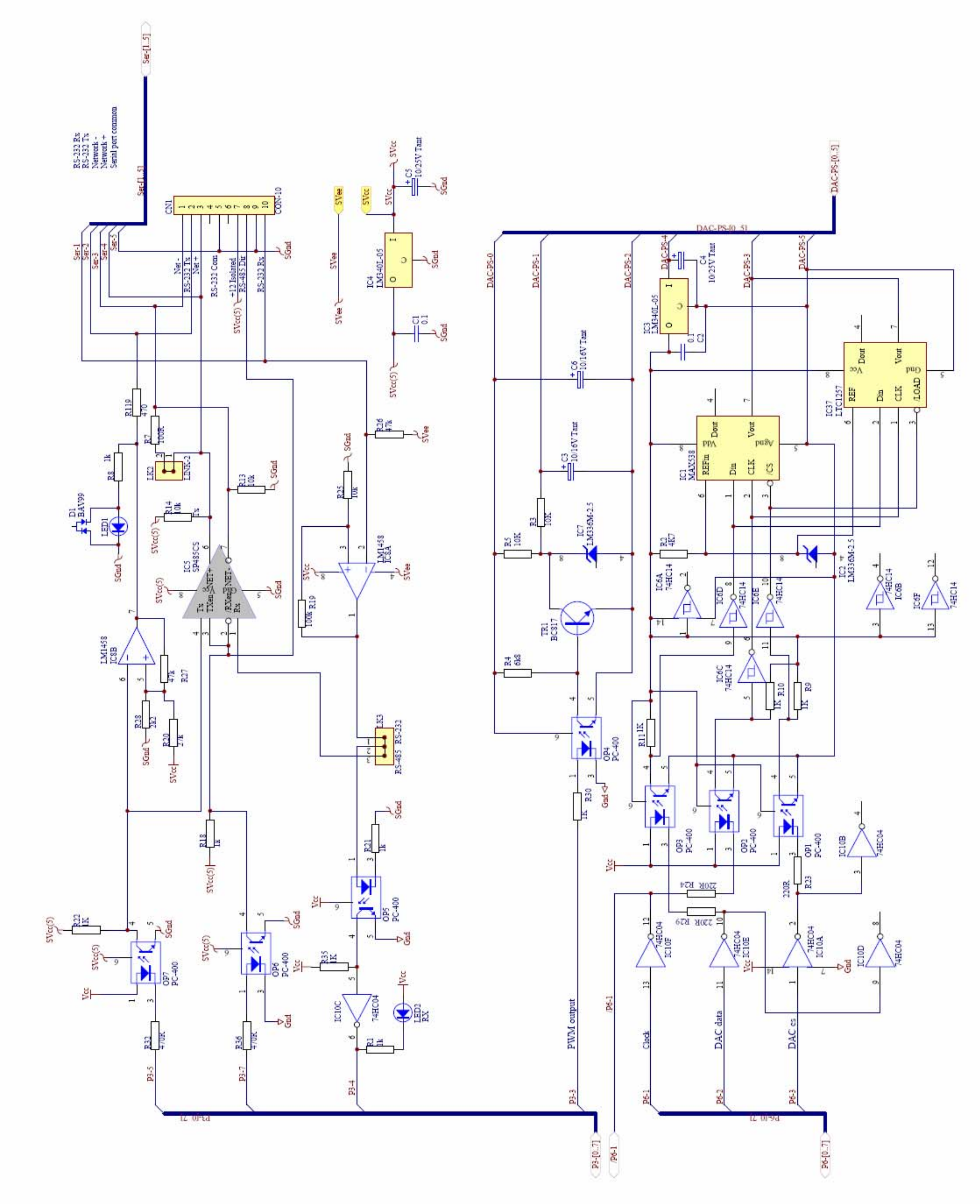
5.6 Digital Input/Output



5.7 Input MUX's, ADC & RH sensor

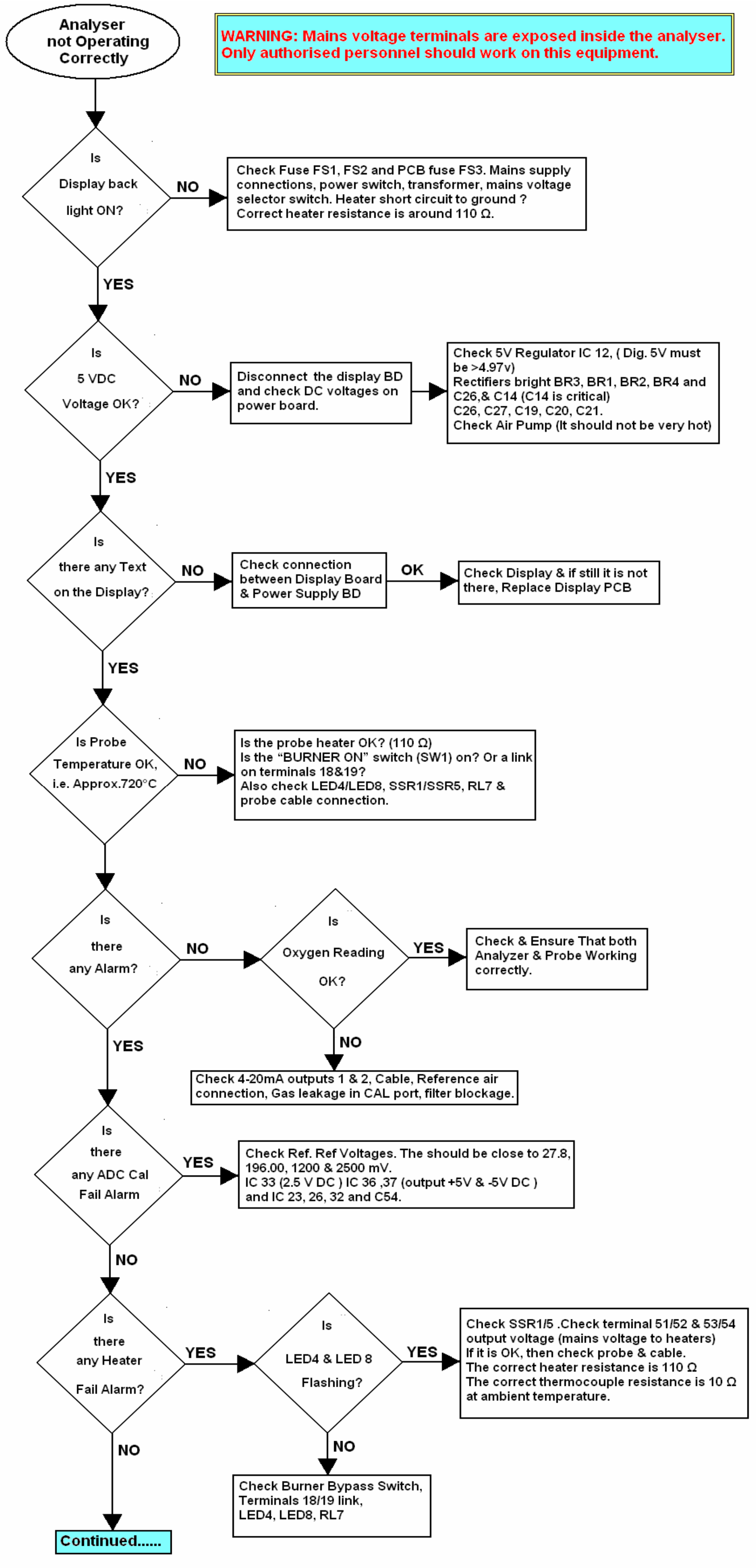


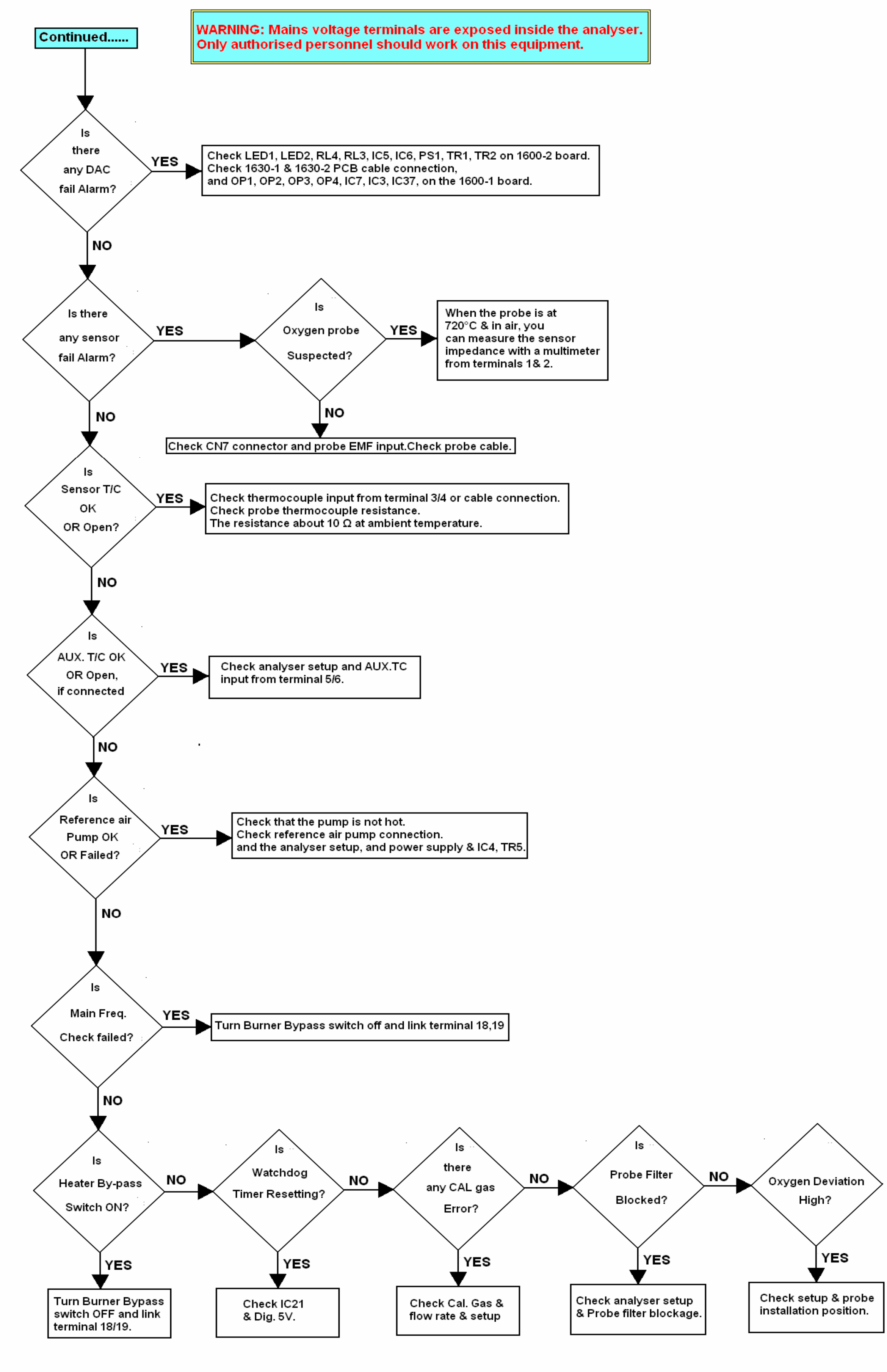
5.8 Serial Interface & D/A Converters



TROUBLE SHOOTING

6


Analyser not Operating Correctly
WARNING: Mains voltage terminals are exposed inside the analyser. Only authorised personnel should work on this equipment.
Is Display back light ON?
NO
Check Fuse FS1, FS2 and PCB fuse FS3. Mains supply connections, power switch, transformer, mains voltage selector switch. Heater short circuit to ground ? Correct heater resistance is around 110 Ω.
YES
Is 5 VDC Voltage OK?
NO
Disconnect the display BD and check DC voltages on power board.
Check 5V Regulator IC 12, (Dig. 5V must be >4.97v) Rectifiers bright BR3, BR1, BR2, BR4 and C26,& C14 (C14 is critical) C26, C27, C19, C20, C21. Check Air Pump (It should not be very hot)
YES
Is there any Text on the Display?
NO
Check connection between Display Board & Power Supply BD
OK
Check Display & if still it is not there, Replace Display PCB
YES
Is Probe Temperature OK, i.e. Approx.720°C
NO
Is the probe heater OK? (110 Ω) Is the "BURNER ON" switch (SW1) on? Or a link on terminals 18&19? Also check LED4/LED8, SSR1/SSR5, RL7 & probe cable connection.
Is there any Alarm?
NO
Is Oxygen Reading OK?
YES
Check & Ensure That both Analyzer & Probe Working correctly.
NO
Check 4-20mA outputs 1 & 2, Cable, Reference air connection, Gas leakage in CAL port, filter blockage.
YES
Is there any ADC Cal Fail Alarm
YES
Check Ref. Ref Voltages. The should be close to 27.8, 196.00, 1200 & 2500 mV. IC 33 (2.5 V DC) IC 36 ,37 (output +5V & -5V DC) and IC 23, 26, 32 and C54.
NO
Is there any Heater Fail Alarm?
YES
Is LED4 & LED 8 Flashing?
YES
Check SSR1/5 .Check terminal 51/52 & 53/54 output voltage (mains voltage to heaters) If it is OK, then check probe & cable. The correct heater resistance is 110 Ω The correct thermocouple resistance is 10 Ω at ambient temperature.
NO
Check Burner Bypass Switch, Terminals 18/19 link, LED4, LED8, RL7
NO
Continued......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WARNING: Mains voltage terminals are exposed inside the analyser. Only authorised personnel should work on this equipment.
Is there any DAC fail Alarm?
YES
Check LED1, LED2, RL4, RL3, IC5, IC6, PS1, TR1, TR2 on 1600-2 board. Check 1630-1 & 1630-2 PCB cable connection, and OP1, OP2, OP3, OP4, IC7, IC3, IC37, on the 1600-1 board.
NO
Is there any sensor fail Alarm?
YES
Is Oxygen probe Suspected?
YES
When the probe is at 720°C & in air, you can measure the sensor impedance with a multimeter from terminals 1& 2.
NO
Check CN7 connector and probe EMF input.Check probe cable.
NO
Is Sensor T/C OK OR Open?
YES
Check thermocouple input from terminal 3/4 or cable connection. Check probe thermocouple resistance. The resistance about 10 Ω at ambient temperature.
NO
Is AUX. T/C OK OR Open, if connected
YES
Check analyser setup and AUX.TC input from terminal 5/6.
NO
Is Reference air Pump OK OR Failed?
YES
Check that the pump is not hot. Check reference air pump connection. and the analyser setup, and power supply & IC4, TR5.
NO
Is Main Freq. Check failed?
YES
Turn Burner Bypass switch off and link terminal 18,19
NO
Is Heater By-pass Switch ON?
YES
Turn Burner Bypass switch OFF and link terminal 18/19.
NO
Is Watchdog Timer Resetting?
YES
Check IC21 & Dig. 5V.
NO
Is there any CAL gas Error?
YES
Check Cal. Gas & flow rate & setup
NO
Is Probe Filter Blocked?
YES
Check analyser setup & Probe filter blockage.
NO
Oxygen Deviation High?
YES
Check setup & probe installation position.