Novatech CONTROLS PTY. LTD.

Oxygen / Carbon Dioxide Analyser / Transmitter

Model 1637

August 2007

Getting Going Fast……

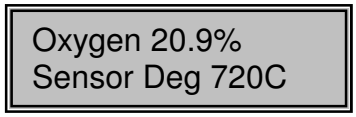
How to get your 1637 analyser working for you with the minimum of fuss…..

1. Plug the power lead into the analyser and into the power point.

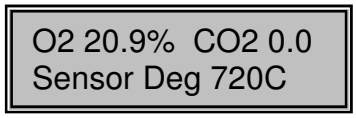
2. Turn on the power at the power point and the analyser.

3. Screw the sample pipe onto the 1/8" Swagelok tube connector, on the right hand side of the analyser.

4. Wait approximately 10 minutes for the oxygen sensor to get above 700°C.



The display will look like this if the analyser is oxygen only.

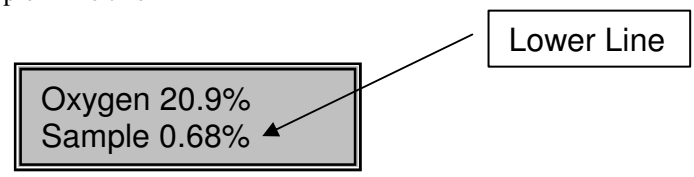


The display will look like this if the analyser is set-up for oxygen and carbon dioxide.

The 1637 analyser is now reading oxygen (and carbon dioxide if installed).

5. Insert the hypodermic through a septum into a food pack to get a gas reading. Leave the hypodermic in the pack for 4 to 6 seconds, or until the head space is nearly all pumped out. Don't suck in the food product.
(See question #1, in Frequently Asked Questions on the next page)

6. If you want to display the minimum oxygen, press the DISPLAY button until the lower line of the display reads "Sample" like this-



Some of the menu items that ***may*** have to be set the ***first time*** the analyser is used…..

1. Select the "Sample mode" (Set-up #31).

Continuous.	When the process gas is available continuously. Eg Gas supply monitoring.
Display Sample.	When sampling a gas from a food pack.
Fast Sample	When sampling a gas from a food pack with very small head space. (<50cc)

2. Select the "Display Mode" (Set-up #32)

Oxygen %	The oxygen will be displayed as a percentage down to 0.1%, then ppm down to 0.1ppm.
Oxygen PPM	The oxygen will always be displayed as parts per million.
O2/CO2 % only	The same as 'Oxygen %' with carbon dioxide also displayed.
O2/CO2 %/PPM	The same as 'Oxygen PPM' with carbon dioxide also displayed.

3. Select the alarm levels, if either the alarm light on the front panel of the analyser or a relay contact is required if the oxygen / carbon dioxide is high / low.

High Oxygen	Set-up #44
Low Oxygen	Set-up #46
Very Low Oxygen	Set-up #48
High Carbon Dioxide	Set-up #50
Low Carbon Dioxide	Set-up #52

4. Select the output range for one or both output channels. ie To allow the oxygen or carbon dioxide to be transmitted to another instrument. To use the outputs, "Not Used" must NOT be selected in set-up 14.

Channel 1, Set-up #25 to #27

eg	Oxygen	0.1 to 100.0%
	Low Oxygen	10 to 10,000 PPM

Channel 2, Set-up #28 to #30

eg Sample Oxygen
Low Oxygen
Carbon dioxide

Frequently Asked Questions……..

1. *How do I insert the hypodermic needle into the food pack?*

Cut a 1.5 cm length of the septum strip. Peal the backing tape off. Squeeze the food pack to get the gas into one place. Press the septum piece firmly onto the plastic wrapping film. Insert the hypodermic needle into the headspace through the septum without touching the food product.
Leave the needle in the food pack until the pack has nearly collapsed, or at least 4 seconds for an oxygen measurement, and 6 seconds for an oxygen and carbon dioxide measurement.
The septum strip will self-seal and can be re-used several times.

2. *How often do I have to calibrate the analyser?*

Oxygen – Once per year.
The 1637 uses the extremely stable zirconia oxygen sensor technology. In addition, the analyser automatically corrects for any drift in the analyser.
Carbon dioxide – Every 6 months, or for critical applications every 2 - 3 months.
The carbon dioxide sensor uses a specifically designed infra red source to increase the signal strength and reduce the effect of sensor drift. However optical measurements are not absolute measurements like the zirconia oxygen sensor, so occasional checks on a calibration gas will confirm the accuracy.

3. *Why are there 3 sample modes, and which one should I use?*

The 1637 analyser can read and display the current level of oxygen and carbon dioxide,
or
It can pick the minimum / maximum oxygen and the maximum carbon dioxide.
Use 'Continuous' mode if the analyser is to read a continuous supply of gas, such as monitoring a gas blanket over milk powder.
Use either 'Display Sample' or 'Fast Sample' if the gas to be tested is in a food pack. The size of the pack will determine which of these two modes to use. Use Fast Sample if the package has less than 50cc head space. The Display Sample mode has the added advantage of displaying the oxygen and carbon dioxide levels as they change through the testing process.

4. *Why does the back of the cabinet get so warm?*

The zirconia oxygen sensor runs at about 720°C. The small furnace is mounted in the vented section at the back of the cabinet.

5. *When should I replace the small disc filter on the hypodermic needle?*

It will depend on the application, but you will know that the filter is blocked when the response time is much quicker when the filter is removed. The filters are much cheaper than the oxygen sensor. Keep spares handy.

CONTENTS

1. SPECIFICATIONS
2. DESCRIPTION
3. INSTALLATION & COMMISSIONING
4. OPERATORS FUNCTIONS - ALARMS
5. SETTING UP THE ANALYSER
6. MAINTENANCE

APPENDIX

1. OXYGEN SENSOR EMF TABLES
2. LOGARITHMIC OXYGEN SCALE
3. SAMPLE LOG PRINT OUT
4. CIRCUIT SCHEMATICS

Note: This manual includes software modifications up to Version 7.98, July 20th , 2006

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USING THIS MANUAL

The Novatech 1637 Trace Oxygen Analyser 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

The oxygen sensor heater is supplied with mains voltage. This supply has electrical shock danger to maintenance personnel. Always isolate the analyser before working with the oxygen sensor.

The oxygen sensor must ***ALWAYS*** be connected to EARTH.

CAUTION 2

The oxygen sensor which is heated to 720°C (1320°F) in this instrument can be a source of ignition in applications where fuel gases or very high oxygen percentages (above 50%) are present. For these applications, it will be necessary to provide a sampling line made of flame proof material, with adequate flashback arresters. If this configuration does not suit or if it is possible for raw fuel to come into contact with a hot oxygen sensor then the Model 1637 analyser with a heated sensor may be unsuitable for your application.

SPECIFICATIONS

1

1.1 MODEL 1637 OXYGEN ANALYSER DESCRIPTION
1.2 DETAILED SPECIFICATIONS
1.3 ORDERING INFORMATION
1.4 MODEL SELECTION GUIDE

SPECIFICATIONS

1.1 MODEL 1637 OXYGEN ANALYSER DESCRIPTION

The Novatech model 1637 oxygen/carbon dioxide analyser/transmitter provides an integrated instrument for measurement of oxygen and carbon dioxide for food packaging and gas monitoring. The analyser provides local indication of oxygen/carbon dioxide, plus eight other selectable variables, including minimum sample hold level.

Two linearised 4–20 mA output signals are provided. Alarms are displayed at the analyser and relay contacts activate remote alarm devices every minute.

The 1637 has a keyboard for selecting the output range, display options, alarm levels, etc. The instrument is microprocessor based and all adjustments are made using the keyboard.

- Used for continuous gas sampling, food pack testing
- Simple to use
- Sensitive down to 0.1 ppm oxygen resolution
- Displays 0.1% carbon dioxide resolution
- Automatic minimum/maximum sample detection, display and output to printer and 4–20 mA signals
- Automatic calibration of oxygen and carbon dioxide offset
- Linear output of % oxygen and carbon dioxide for recording or control
- Built in safety features
- 16 different alarm functions warn the operator of gas composition, sensor or analyser problems
- RS 232C / RS 485 printer / computer interface

1.2 DETAILED SPECIFICATIONS

Measuring Range
- 1 ppm to 100% oxygen, 100ppm minimum range (0.1ppm resolution)
- 0 to 100% carbon dioxide, 20% minimum range

Response Time
- Less than 4 seconds with a gas flow of 100cc per minute (0.21cfh), oxygen
- Less than 8 seconds with a gas flow of 100cc per minute (0.21cfh), carbon dioxide

Accuracy
- ±1% of actual measured oxygen value with a repeatability of ±0.5% of measured value.
- Carbon dioxide ±3%

Warm Up Time
- Fifteen minutes approximately for optimum accuracy. Useful readings are possible within 10 minutes after switching the instrument on.

Outputs
- Two isolated linearised 4-20mAor 0-20mA DC outputs into 1000Ω load (max).
- RS232 / 485 computer / printer interface for peak oxygen value report and alarm functions.
- One common alarm relay for self diagnostic alarms
- One user selectable alarm relays for gas related alarm levels, 'Sensor low temperature' and 'Calibration in progress'.

Power Requirement
- 240/110 VAC, 50/60 Hz, 115W

Gas Connection
- 1/8'' Swagelok tube connector

Flow Rate
- 100 - 300 cc per minute (0.21 – 0.64cfm), governed by internal pump

Environmental Rating
- Operating Temperature: 0 – 50°C (32 - 120°F) or 0 – 45°C (32 - 110°F) with CO_2 option
- Relative Humidity: 5 – 95% non-condensing
- 5 – 95%

Weight
- 6 kg (13 lbs.)

Dimensions
- 265mm (W) x 150mm (H) x 350mm (D). (10.5" x 6" x 13.75")

Range of Output 1
- Field selectable from the following:

Output Selection	*Range*
Linear oxygen	0 – 0.1% oxygen to 0 – 100.0% oxygen
	0 – 1000ppm oxygen to 0 – 1,000,000ppm oxygen
Low Range Linear oxygen	0 – 0.001% oxygen to 0 – 1.0% oxygen
	0 – 10ppm oxygen to 0 – 10,000ppm oxygen

Range of Output 2
- Field selectable from the following:

Output Selection	*Zero Range*	*Span Range*	
• Carbon Dioxide,	0 – 90%	10 – 100%	Min span 10%
• Reducing Oxygen	10^{-1} – 10^{-10} %	10^{-1} – 10^{-30} %	Min span
	In one decade steps.		three decades
• Oxygen sensor EMF	0 – 1100mV	1000 – 1300mV	
	In 100mV steps	In 100mV steps	
• Sample Oxygen	0 – 0.1%	0.01 – 20%	Min Span 0.01%
	0 – 1000ppm	100 – 20,000ppm	Min span 100 ppm
• Low oxygen	0 – 99.9%	0.1 – 100% oxygen	Min span 0.1%
	0 - 999,000ppm	1,000 - 1,000,000ppm	Min span 1,000ppm
• Logarithmic Oxygen	0.1% O_2 Fixed	20% O_2 Fixed	

Range of Indication, Upper Line
- Oxygen selectable either % O_2 or ppm, and carbon dioxide
- Oxygen, auto ranging from 0.1ppm to 100% O_2 (always ppm below 0.1% oxygen if selected as % O_2 in set-up #32)
- Carbon dioxide, 0.1 to 100.0%

Indication Choice, Lower Line
Any or all of the following can be selected for lower line display:
Options:

- Oxygen Sensor EMF
- Oxygen Sensor Temperature
- Oxygen Sensor Impedance
- Sample Oxygen / Carbon Dioxide
- Ambient Temperature
- Balance gas (Remaining gas after the O_2 and CO_2 have been subtracted)
- Date - time
- Run Hours since last service
- Date of last service

Relay Contacts

- 0.5A 24 VAC, 1A 36 VDC

Mounting

- Desktop. Also available as a surface mount analyser with an external oxygen sensor.

1.3 ORDERING INFORMATION

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

1. State if carbon dioxide measurement is required.
2. Minimum and maximum expected oxygen in sample (particularly the minimum value)
3. Other gas constituents (Any combustibles will consume oxygen as they are burnt on the surface of the sensor)
4. If the gas is under pressure or if the gas must be extracted to the 1637 analyser.
5. Gas connection required (1/8'' Swagelok is standard)
6. Supply voltage (240 or 110 VAC)
7. If auto / manual on-line oxygen gas calibration checking is required.
8. If surface mounting of the instrument is required or if free standing on rubber feet is preferred.

Ask your local Novatech Distributor for assistance in ordering

1.4 MODEL SELECTION GUIDE

There are three models
available within the 1637 range.

1637-1	Oxygen sensor only, with pump.
1637-2	Oxygen sensor only, no pump.
1637-5	Oxygen sensor and carbon dioxide sensor, with pump.

DESCRIPTION

2

SECTION
NUMBER

2.1 THE ZIRCONIA SENSOR
2.2 THE OXYGEN SENSOR ASSEMBLY
2.3 THE CARBON DIOXIDE SENSOR ASSEMBLY
2.4 THE ANALYSER
2.5 ALARMS
2.6 HEATER SUPPLY FOR THE OXYGEN SENSOR
2.7 THE OXYGEN SENSOR IMPEDANCE
2.8 AUTO CALIBRATION—ELECTRONICS
2.9 AUTO CALIBRATION CHECKING—OXYGEN SENSOR
2.10 AUTO CALIBRATION CHECKING—CARBON DIOXIDE SENSOR
2.11 RS 485 / 232C PORTS
2.12 AMBIENT TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS
2.13 WATCHDOG TIMER
2.14 BACK UP BATTERY

DESCRIPTION

2.1 THE ZIRCONIA SENSOR

The oxygen analyser input is provided from a solid electrolyte oxygen sensor which contains a zirconia element and thermocouple. The sensor is designed to have a small sample of the unknown gas passed into the inside of the sensor tube, and air (20.95% oxygen) around the outside. A heater is mounted around the sensor to keep the sensor hot. The sensor construction is shown in Figure 2.1.

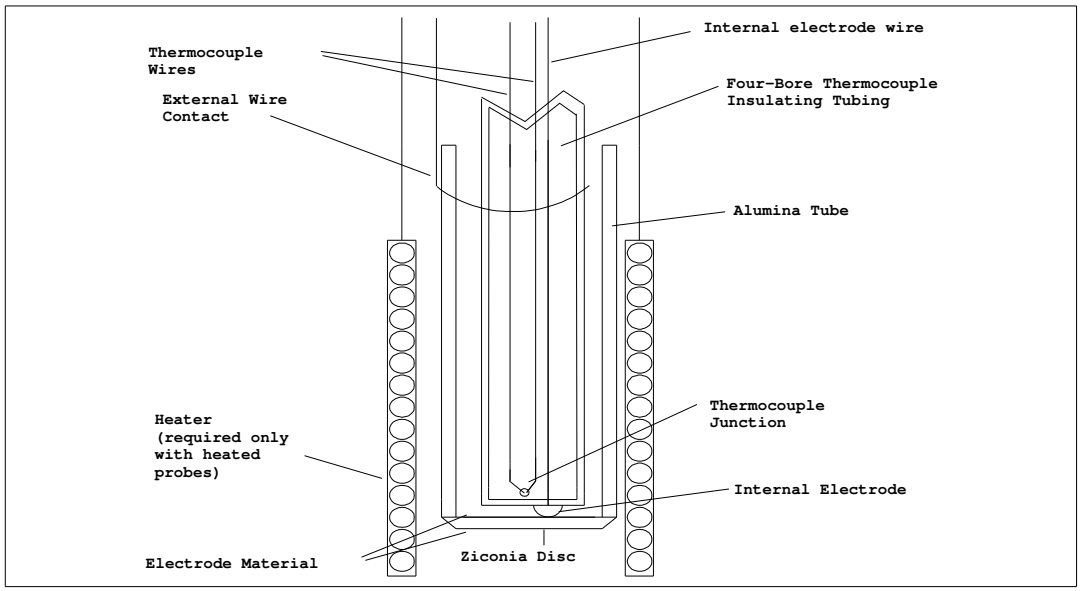


Fig 2.1 Schematic View of a Sensor Assembly

The heater control is a time proportioning temperature controller and triac so that the thermocouple junction is controlled to between 720°C (1320°F) and 720°C.

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:

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

Where T is the temperature (K) at the zirconia disc (>650°C (>1200°F)), 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 1637 transmitter solves this equation which is valid above 650°C (1200°F). The oxygen sensor heater maintains the sensor temperature at this level.

2.2 THE OXYGEN SENSOR ASSEMBLY

The oxygen sensor assembly provides a means of exposing the zirconia sensor to the atmosphere to be measured on the inside of the sensor, and maintain air as a reference gas on the outside of the sensor. A small volume, (from as little as 150cc/min (20scfm)) of the gas to be sampled is either pumped through the assembly at a known rate by the internal pump. The gas flow rate may also be monitored by a flow rate switch, which will cause an alarm if the rate falls below 120cc/min (15scfm).

The sensor assembly also provides the means of maintaining the temperature of the sensor at 720°C (1320°F) by surrounding the sensor tube with a heater element, and measuring the temperature of the zirconia disc with a thermocouple inside the sensor. (See Figure 2.1)

2.3 THE CARBON DIOXIDE SENSOR ASSEMBLY

The carbon dioxide sensor assembly is mounted on a circuit board in the 1637 cabinet. The CO_2 sensor PCB has a separate microprocessor to control the operation of the CO_2 cell, maintain calibration and provide a linear output to the main 1637 PCB. It has been designed to read carbon dioxide concentrations within the temperature range of 5 to 45°C (40°F to 110°F), with ambient humidity not exceeding 85% RH. A state of the art temperature compensated sensor is employed to maintain accuracy and reduce the need for calibration. The range of the CO_2 sensor PCB is 0 to 100%. The 4-20 (0-20) mA output can be scaled to cover other ranges with a minimum span of 10% carbon dioxide.

The principle of operation is that of absorption of the specially designed infra red light source which is passed through an analysis cell and a thin film filter into a solid state detector. The filter is selective and passes radiation only in the carbon dioxide absorption wave band. The detector output is amplified and, with no carbon dioxide present in the cell, is balanced against a reference voltage to give a zero output voltage.

Absorption of infra red radiation by the gas in the cell reduces the detector signal, leading to a positive voltage appearing at the sensor output. The gain of the amplifier is adjusted automatically, and the signal is digitally processed. The carbon dioxide level is transferred to the main 1637 microprocessor via a digital link. Span and zero calibration can be done from the keyboard of the 1637.
The response from the CO_2 cell is non-linear with respect to carbon dioxide percentage, but is linearised within the microprocessor on the CO_2 PCB.

Calibrate to ZERO & SPAN once every two months for best performance.

2.4 THE ANALYSER

The 1637 oxygen analyser is a microprocessor based, auto–calibrating instrument with a liquid crystal display, two 4 – 20 or 0 – 20mA output signals, a printer / computer port and four alarm relays with a total of 24 alarm functions.

The display will read in either % oxygen or ppm, as selected in set–up function 27. It is capable of calculating the oxygen volume from less than 0.1ppm to 100%. The top line of the LCD is used to display the oxygen and the carbon dioxide content.

The lower line is used to display nine other variables such as sensor temperature, sensor impedance, date / time etc. The lower line is also used to display alarm messages such as sensor 'OXYGEN NOT READY' and 'A/D CAL ERROR', 'HIGH O2' etc.

Many of the functions are user variable (such as 4 – 20mA output channel ranging), and are changed using a menu system from the keyboard. Even the one–time calibration is performed using the keypad. (See Section 2.8). The changes are then all stored in a battery-backed RAM module.

2.5 ALARMS

Refer to OPERATOR FUNCTIONS Section 4 for details on alarm functions.

2.6 HEATER SUPPLY FOR THE OXYGEN SENSOR

CAUTION

The oxygen sensor heater is supplied with mains voltage. This supply has electrical shock danger to maintenance personnel. Always isolate the analyser before working with the oxygen sensor.

The sensor assembly must ***always*** be connected to earth.

The heater is supplied from the mains power directly, and the temperature is controlled initially at 720°C (1320°F) after turn on.

2.7 THE OXYGEN SENSOR IMPEDANCE

The oxygen sensor impedance is a basic measurement of the reliability of the oxygen reading. An oxygen sensor with a high impedance reading will eventually produce erroneous signals. The analyser checks the oxygen sensor impedance every 60 minutes and if the impedance is above the maximum level for a specific temperature then the impedance alarm will be activated. Typical oxygen sensor impedance is 1 KΩ to 8 KΩ at 720°C (1320°F).

Impedance can also be calculated any time by pressing the 'Auto Cal' button when in 'RUN' mode. A 'Z' will be seen on the top RH side of the display while the analyser is measuring the sensor impedance.

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 'ADC CAL FAIL' 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 has been repaired. For a description of the calibration procedure, refer to 'Set-up Function Details', Section 5.5, items 6, 7 8 and 9.

The digital to analog converters or output section of the analyser are tested for accuracy when the 'AUTOCAL' button is pressed, and when the analyser goes through the start up procedure. If the output calibration factors are found to have changed more than expected, the 'DAC Warning' alarm will occur. If either output has a fault, the 'DAC CAL FAIL' alarm will occur. The D/A sections are re-calibrated by pressing the 'AUTO CAL' button on the keyboard while in 'SET-UP' mode. Each of the output channels have three menu items which provide manual calibration (set-up 16 to 21). If 'Manual' is selected in set-up 16 or 19, the 'AUTO CAL' will be skipped and the manual calibration factors will be retained. If 'Not Used' is selected in set-up14, the 'DAC CAL FAIL' alarm is inhibited. See section 5.5 set-up 16, and section 6.3 for more details.

All output signals will drop to 0 mA for one second period. It is suggested that a D/A re-calibration be performed after the instrument has stabilised, approximately 30 minutes after first switching on and after Setting Up The Analyser Section 5.5, items 6, 7, 8 and 9 have been completed, and then annually.

2.9 AUTO CALIBRATION CHECKING - OXYGEN SENSOR

The calibration of the oxygen sensor is done automatically at the 20.9% (zero sensor mV), and can be checked with the on-line automatic gas calibration using a span gas.

Air, 20.9%. While the analyser is not doing a process gas measurement (the sample inlet pipe is sucking in air), the analyser can automatically trim the calibration to read 20.9% oxygen. For more details see the set-up section 5.5, number 10 & 11.

Span gas. On-line automatic gas calibration checking is not normally required, particularly if a gas sampling is being used. Where it is required however, when continuous gas monitoring is being used, the sensor can be checked for accuracy on-line. A solenoid valve can admit calibrated gas mixtures into the oxygen sensor via the solenoid valve under microprocessor control on a timed basis. For details refer to Section 3.6, (Using the Automatic Oxygen Check System). For details on setting up this facility, refer to set-up steps 35 to 42 in Section 5.5.

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

Calibration check 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. If calibration gas checking is enabled in the Set-up menu for either gas, an automatic gas cycle can be started by pressing the 'CAL' buttons in RUN mode. The cycle can be terminated by pressing any other button.

When using automatic calibration checking, it is important that the flow rate of both the sample gas and the calibration gas be approximately the same. To achieve this, the sample gas should not be driven directly into the analyser, but should use a bypass pipe (ie. A 'T' pipe on the inlet to the analyser) that the analyser can suck a sample of the calibration gas from.

2.10 AUTO CALIBRATION CHECKING - CARBON DIOXIDE SENSOR

Integrated into the 1637 analyser is a self checking and calibrating system for the CO_2 cell.

For best results when calibrating the CO_2 board for either span or zero, please observe the following guidelines.
Connect the zero or span gas to the inlet and allow the gas to flow for about 30 seconds before initiating a calibration sequence from the 1637 keyboard.
Use the hypodermic needle to sample the calibration gas from a plastic pipe to maintain the normal use flow conditions.
If a span and zero calibration is to be carried out, always start with the zero calibration first.

The zero calibration takes longer than the span calibration. The maximum time involved with a zero calibration is around 50 seconds, and for a span calibration the time is around 30 seconds.
If a calibration has been unsuccessful due to an interrupted gas flow, contaminated calibration gas, or excessive temperature (ie: >50°C {>120°F}), re-initiate the calibration from the 1637 keyboard.
Do not under any circumstances tamper with or open the CO_2 analysis chamber. Doing so will void the manufacturers warranty. There are no user serviceable parts inside, and any tampering will drastically reduce it's performance and lifetime. Any Analysis chamber sent back for repair which has been tampered with will have to be replaced.
If the carbon dioxide module fails, it should be sent back to the manufacturer for repair, and factory re-calibration.

In addition, there is an automatic process that uses the oxygen signal to enable an offset for the CO_2 cell to be read and saved. This system ensures that the CO_2 cell will always read zero when air is flowing in the cell.

2.11 RS 485 AND RS 232C PORT

The serial port is for connecting a printer, a data logger, or any computer with an RS 485 / 232-C port. It can be used to monitor the transmitter and process by logging the values of functions selected in step 58 of the set-up menu in Section 5.5.

The log period may be selected in step 20 for 1 to 2000 minutes for the printer mode or 5 to 1200 seconds for the data log mode. The baud rate may be set up in step 51.

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

Alarms, including the time they occurred, will be transmitted to the printer and computer whenever they are first initiated, accepted and cleared (in the printer mode only).

If 'Fast Sample or 'Display Sample' is selected in set-up step 31, each time a new minimum rate of oxygen is detected, this value plus date/time, will also be printed (in the printer mode only).

NOTE: The RS232 port is not available in the model 1637-5 (With carbon dioxide installed).

2.12 AMBIENT TEMPERATURE AND RELATIVE HUMIDITY MEASUREMENTS

Ambient temperature and relative humidity are measured within the analyser to improve the accuracy of the oxygen readings.
All zirconia oxygen analysers should use the relative humidity measurement in the oxygen calculation because the oxygen content in the ambient is not always 20.95%, especially in hot and humid conditions.
The ambient temperature reading can be displayed on the lower line of the LCD (see set-up step 34).

2.13 WATCHDOG TIMER

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

The microprocessor will then be repeatedly reset until normal operation is resumed. Reset cycles are displayed by the 'POWER' light above the keyboard on the front panel. A steady 'ON' light indicates normal operation. If the program has not resumed normal operation after two attempts to reset, the common alarm relay will be activated. If a successful reset is achieved, the alarm will be cancelled and the analyser will continue to run normally.

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 variables are saved and the clock is kept running for approximately ten years with the power off. The battery module should be replaced every 8 years. (It is the battery shaped device clipped in a socket labelled M1)

INSTALLATION & COMMISSIONING 3

SECTION NUMBER

INSTALLATION

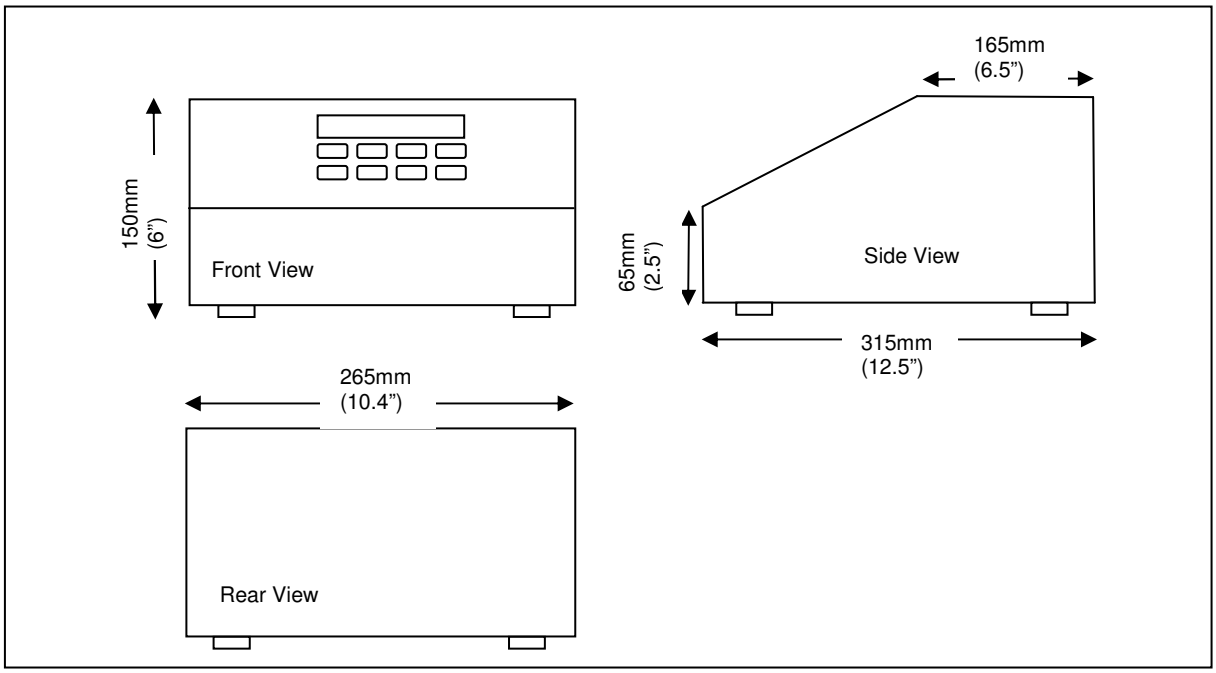
3.1 ANALYSER DIMENSIONS
3.2 EARTH, SHIELD AND POWER CONNECTIONS
3.3 CONNECTING THE OUTPUT CHANNELS
3.4 CONNECTING THE ALARMS
3.5 CONNECTING THE HORN RELAY
3.6 USING THE AUTOMATIC OXYGEN CHECK SYSTEM
3.7 CONNECTING THE PRINTER

COMMISSIONING

3.8 CONNECTING POWER - COLD START
3.9 CONNECTING POWER - WARM START
3.10 COMMISSIONING - SET-UP MODE
3.11 RUN MODE
3.12 CHECKING THE ALARMS
3.13 THE OXYGEN SENSOR
3.14 SENSOR CALIBRATION - OXYGEN
3.15 SENSOR CALIBRATION - CARBON DIOXIDE

INSTALLATION

3.1 ANALYSER DIMENSIONS



Case Dimensions

3.2 EARTH, SHIELD AND POWER CONNECTIONS

All external wiring for the 4 – 20mA outputs, alarm relays and printer / computer port should be shielded. All earth and shield connections should be connected to the earth terminal number 47, and the cabinet earth stud.

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.

IMPORTANT

Before connection of mains power check that the mains voltage selector switch is in the correct position. This switch is inside the front of the cabinet, below the keyboard. Remove the two top, forward screws and swing the front lid forward carefully, being careful not to stress the ribbon cables.

ELECTRICAL CONNECTIONS

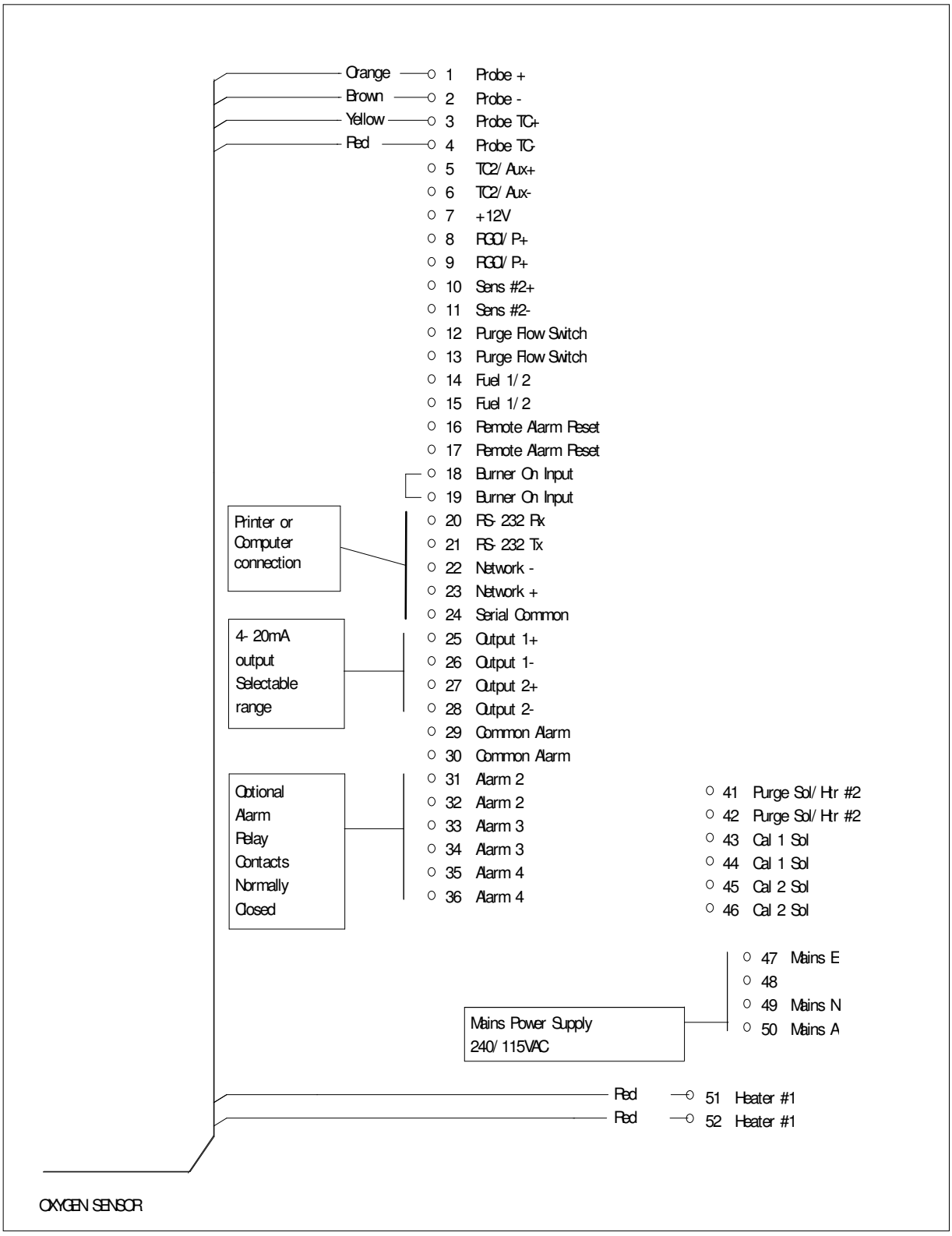


Figure 3.2 Internal Oxygen Sensor Connections

All wiring should comply with local electrical codes. All earth and shield connections should be connected to the earth stud on the inside left hand side of the case. Before connection of mains power check that the 115 / 230 volt power selector switch is set to the correct voltage (lower circuit board on the right hand side).

3.3 CONNECTING THE OUTPUT CHANNELS

The two 4 to 20 mA DC output channels are capable of driving into a 1000Ω load.

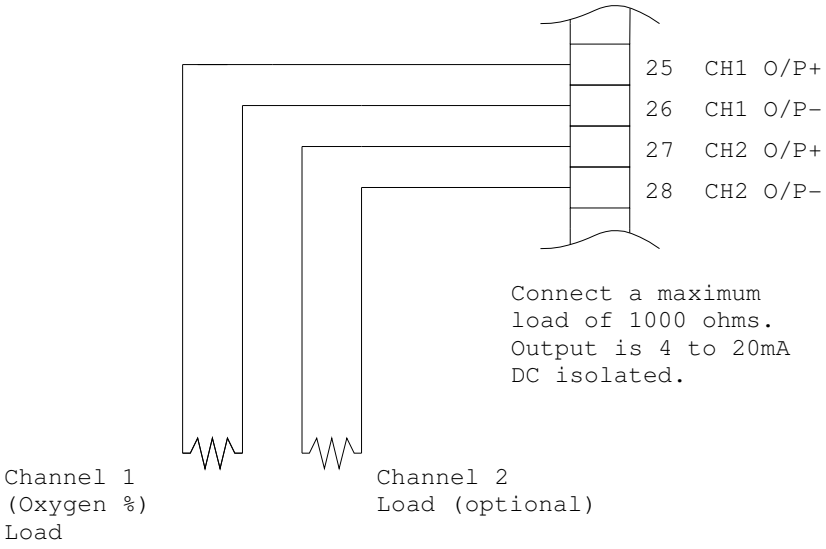


Figure 3.4 Connections for Transmitter Output Channels.

3.4 CONNECTING THE ALARMS

A common alarm, which should be connected for all installations initiates on alarms functions described below. Three additional alarm relays are available for selectable functions as listed in Section 4.2 and 4.3. Each relay has normally closed contacts. The contacts will open in alarm condition except for the optional horn function which operates with normally open contacts. Relays are connected as follows:

Relay	Terminal Numbers
Common Alarm	29 & 30
Alarm 2	31 & 32
Alarm 3	33 & 34
Alarm 4	35 & 36

Common Alarms All of the following conditions will cause a common alarm -

- ADC Calibration Fail
- DAC Calibration Fail
- Oxygen Sensor Fail
- Oxygen Heater Fail
- Oxygen Sensor TC Open
- Gas Pump Fail
- Mains Frequency Check fail
- Oxygen Gas Calibration Check Error
- Carbon Dioxide Sensor Fail
- Watchdog Timer

The watchdog timer is a special alarm. It will force the common alarm to activate in the event of a microprocessor failure. There will not be an alarm message displayed, but the analyser will reset.

Alarms can be accepted by either pressing the alarm button (viewing the alarm messages), or by temporarily closing a switch connected to terminals 16 & 17, REM ALARM RESET.

Alarm relay 2 to 4 Select any one or all of the following for each relay. Refer to Section 5.5, steps 45 to 47

- High oxygen
- Low oxygen
- Very low oxygen
- Oxygen sensor under temperature
- Calibration check in progress
- Alarm horn function (Relay 4 only)

3.5 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. The contacts (terminals 35 and 36) will be closed whenever the alarm light is flashing. Refer to Figure 3.2.

3.6 USING THE AUTOMATIC OXYGEN CHECK SYSTEM

CAUTION

The purge and calibration solenoid valves are supplied with mains voltage. This supply has electrical shock danger to maintenance personnel. Always isolate the analyser before working with the purge and calibration solenoid valves.

The on-line oxygen calibration system is optional. The gas change-over solenoid must be mounted external to the cabinet. Typical connection details are shown in Figure 3.5.
For details on its operation refer to Section 2.9.

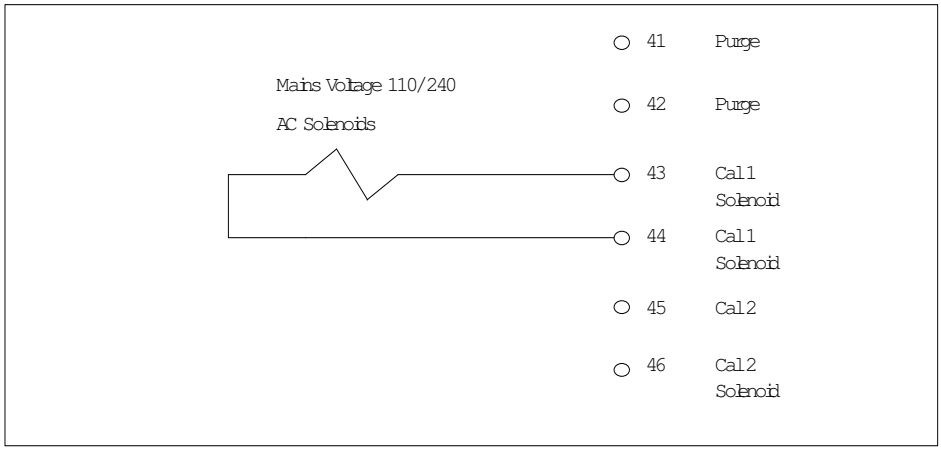
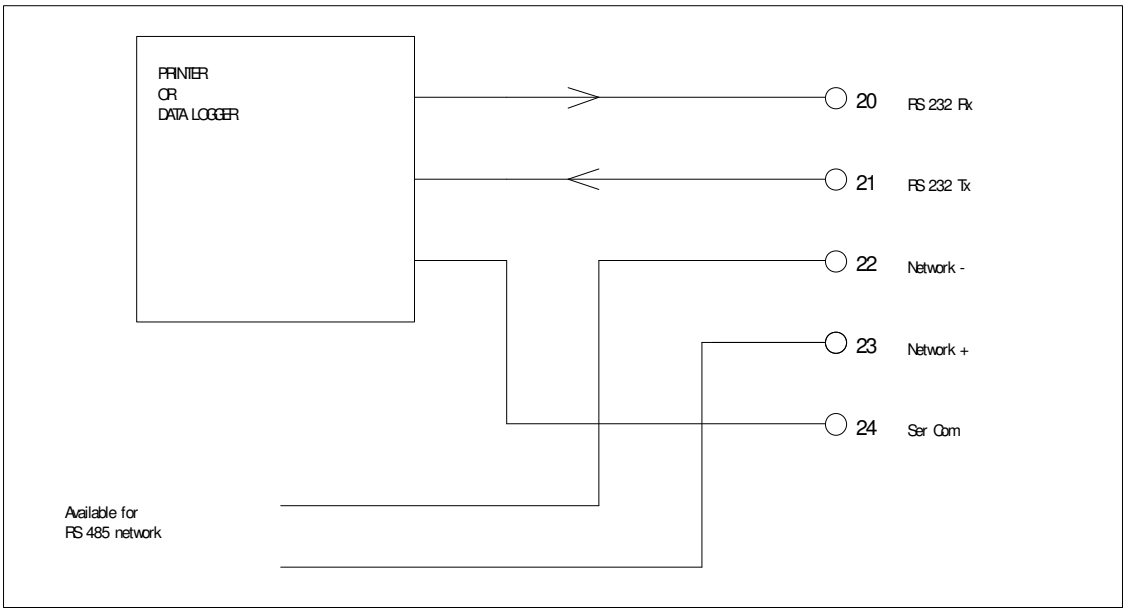


Figure 3.5 Automatic Oxygen Calibration check Solenoid Connection

3.7 CONNECTING THE PRINTER



Serial Port Connections

A printer with a serial port, or a data logger, or a computer terminal may be connected to RS 232-C or the network port. Data is logged out of the port as arranged in Set-up functions 57 to 60. The baud rate is selectable in set-up function 59. The RS-232 protocol for the serial port is eight data bits, one stop bit, no parity.

COMMISSIONING

3.8 CONNECTING POWER - COLD START

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

Check that the mains supply voltage switch is in the correct place for the supply voltage. The mains voltage selector switch is located on the terminal circuit board, beside the power transformer.

To perform a 'COLD START', remove LK1 link, labelled 'COLD START' on the 1630-1 PCB (under the shield). Turn the power on. The analyser will load the factory default settings for all of the set-up functions including the calibration voltages. Replace the cold start link when the message 'Replace c/s Link' appears on the LCD.

After a 'COLD START', it is advisable to set all new variables in the set-up mode, including calibration voltages, time and date, however the instrument will be fully operational without any further adjustments.

3.9 CONNECTING POWER - WARM START

A 'WARM START will be performed when the power is applied with the COLD START link in place. All the set-up function will have been retained as they were when the power was last turned off in the memory module M1 on the 1630-1 circuit board.

3.10 COMMISSIONING - SET-UP MODE

Press the SET-UP button to select the set-up mode. Most of the default settings of the functions will be correct, or will have been pre-set at the factory. Refer to Section 5.5 for more details.

Check the following set-up functions suit your particular use -

1 to 5	Date / time
6 to 9	Reference voltages
11 & 12	Oxygen sensor calibration
14 to 21	Output channel configuration
25 to 27	Output channel #1
28 to 30	Output channel #2
31	Sample mode
35	Auto gas calibration checking
44 to 56	Alarm set-up

3.11 RUN MODE

When the analyser is turned on it will go to RUN mode. The SET-UP / RUN button will toggle between the two modes. The upper line of the display will now read the oxygen or oxygen and carbon dioxide if the optional carbon dioxide module has been installed in the front section of the cabinet. If the oxygen sensor temperature is not above 650°C (1200°F), a "Sensor Low Temperature" message be flashed on the lower line. The sensor temperature can be checked on the lower line of the display.

3.12 CHECKING THE ALARMS

If any alarms are present the alarm LED will 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.

3.13 THE OXYGEN SENSOR

The zirconia oxygen sensor provides an absolute measurement of oxygen partial pressure. There are no calibration adjustments, apart from 'SENSOR OFFSET', which can be selected to be trimmed automatically (See Section 5.5.10 & 5.5.11). The sensor EMF for a span gas is either correct or the sensor is faulty.

To check that the sensor is functioning correctly, firstly check that the high sensor impedance alarm is not activated by pressing the alarm button if the alarm LED is flashing. The display would show 'SENSOR FAIL'. The actual impedance can be displayed on the lower line. It should be less than 3kΩ.
A new measure of the impedance can be made any time by pressing the 'Auto Cal' button while in 'RUN' mode.
Once it has been established that the sensor impedance is normal, the sensor offset may be tested and set. Refer to Section 5.5.10 & 5.5.11. A normal flow of air must be in the gas sample line when testing sensor offset.

3.14 SENSOR CALIBRATION – OXYGEN SENSOR

There is only one calibration adjustment necessary for the 1637 oxygen sensor. This is the Sensor Offset. An incorrect value for the sensor offset will affect an oxygen reading at 21% by about 1% oxygen in every 1 mV of offset, but will have very little effect on oxygen readings below 2% oxygen.

To remove this error, ensure that the normal volume of gas is passing through the gas sample line (approximately 300 cc/min). In this condition, the zirconia sensor should have no oxygen partial pressure difference across the cell. (Air is also used as reference gas).

NOTE:

If 'YES' has been selected in 'set-up' step 10, the offset will be automatically trimmed to keep the analyser reading 20.9%.

If 'NO' has been selected in 'set-up' step 10, the offset can been entered manually in set-up 11, by reading the sensor 'EMF mV' from the lower line of the display while in 'RUN' mode.

A manual gas calibration check may also be performed if an external 2-way solenoid is connected. This may be performed simply by pressing the 'CAL 1' button on the keyboard. The analyser electronics should also be calibrated according to Section 5.5, Set-up Function Details.

3.15 SENSOR CALIBRATION – CARBON DIOXIDE SENSOR

After power has been applied to the 1637, the carbon dioxide transducer will function almost immediately, however it is recommended that it is allowed to stabilise for about 15 minutes before making any measurements.

The calibration of the 1637 carbon dioxide module has two main parts -

Calibration of the ZERO
Calibration of the SPAN or MID gas

Both parts can be done from the keyboard of the 1637, and the only additional equipment required is a bottle of a SPAN gas of carbon dioxide. The SPAN gas percentage can be between 20% and 100%, but is usually 100% or a gas that is being used commonly in your process.

Calibrate at least the ZERO once every two months. For best performance, also calibrate the SPAN or MID gas.

NOTES: -

For best results when calibrating the CO_2 sensor, please observe the following guidelines.

- Don't connect the test gas directly to the sample pipe of the 1637. Allow the analyser to suck the gas in using the internal pump, as it would in normal use. This can be done by piercing a plastic hose on the outlet of the gas bottle with the hypodermic needle.
- Piercing the plastic hose with the hypodermic needle and allow the gas to flow for about 30 seconds before initiating a calibration sequence from the 1637 keyboard.
- If a zero and span / mid gas calibration is to be carried out, always start with the zero calibration.
- If a MID gas calibration is to be performed, make sure that the gas bottle percentage is set into set-up 13, "CO2 Mid Gas %".
- If a calibration has been unsuccessful due to an interrupted gas flow, contaminated calibration gas, or excessive case temperature (ie: >50°C (120°F)), re-initiate the calibration from the 1637 keyboard.
- ***Do not under any circumstances tamper with or open the CO_2 analysis chamber.*** Doing so will void the manufacturers warranty. There are no user serviceable parts inside, and any tampering will drastically reduce it's performance and lifetime. Any Analysis chamber sent back for repair which has been tampered with will have to be replaced.
- If the carbon dioxide module fails, it should be sent back to the manufacturer for repair and factory re-calibration.

CO_2 ZERO CALIBRATION
Leave the hypodermic needle open to the air for at least 30 seconds.
Use the function keys to get to set-up mode number 12, "CO_2 Calibrate".
Select "Cal Zero" and press the ENTER key to lock that selection.
Press the SETUP/RUN key to return to RUN mode.
The display will read -

```
CO2 Calibration
.......
```

The zero calibration takes about 50 seconds and as the calibration progresses, more '.' symbols will appear on the display.
After the calibration is complete, the option in set-up 12 will return to "CO_2 Cal Done".

CO_2 SPAN CALIBRATION
Insert the sample hypodermic needle into a hose from a gas supply of 100% CO_2.
Open the gas supply and let at least 1 litre per minute flow through the hose. (The 1637 will draw less than 0.5 lpm)
Leave the 100% gas flowing through the analyser for at least 30 seconds.
Use the function keys to get to set-up mode number 12, "CO_2 Calibrate".
Select "Cal Span" and press the ENTER key to lock that selection.
Press the SETUP/RUN key to return to RUN mode.
The display will read -

```
CO2 Calibration
.......
```

The span calibration takes about 40 seconds and as the calibration progresses, more '.' symbols will appear.
After the calibration is complete, the option in set-up 12 will return to "CO_2 Cal Done".

NOTE: It is important that the gas flow rate is the same when using the calibration gas and the sampling gas.

NOTE:
Watch for an alarm on completion of the calibration. If the alarm light is flashing, press the alarm button. If a "Cal Fail Alarm" is present as a new alarm (the word 'acc', in lower case, is at the right hand end of the alarm message), the calibration has NOT been completed successfully. The cause will be because -

The gas flow was not stable or
The internal temperature is too high (> 50°C (>120°F))

Re-start the calibration by selecting set-up function 12.

OPERATOR FUNCTIONS

4

SECTION
NUMBER

4.1	DISPLAY BUTTON
4.2	ALARM BUTTON
4.3	ALARM SCHEDULE
4.4	POWER LAMP
4.5	GAS SAMPLE PUMP
4.6	4 – 20 / 0 – 20mA OUTPUTS

OPERATOR FUNCTIONS (RUN MODE)

4.1 DISPLAY BUTTON

The upper line on the display will always read oxygen % or ppm, or oxygen % and carbon dioxide.

The following are available for display on the lower line.

1. OXYGEN SENSOR EMF (millivolts)
2. OXYGEN SENSOR TEMPERATURE
3. OXYGEN SENSOR IMPEDANCE, a measure of integrity of the oxygen sensor's electrode.
4. SAMPLE OXYGEN (AND CARBON DIOXIDE)
5. AMBIENT TEMPERATURE
6. DATE –TIME
7. RUN HOURS SINCE LAST SERVICE
8. DATE OF LAST SERVICE
9. BALANCE GAS (%). A calculation of the balance of the volume of gas being sampled. Oxygen and carbon dioxide are subtracted from 100% if 'O_2/CO_2' is selected in set-up 32. If 'Display Sample' or 'Fast Sample' is selected in set-up 31, the BALANCE GAS is calculated from the SAMPLE values of oxygen and carbon dioxide.

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 34 on the keyboard. In addition to the above lower line displays, the analyser will automatically display:

10. OXYGEN NOT READY, until the sensor is over 650°C (1200°F). If the heater does not get the sensor up to 650°C (1200°F) within 20 minutes, the "OXYGEN NOT READY" message will be replaced by a "HEATER FAIL" alarm.
11. SENSOR CALIBRATION, occurring for oxygen Cal Gas

NOTE

The run time will be the period of time the analyser is powered. This timer can be used as a sensor replacement and / or gas generator service schedule aid. The start time is reset by changing the 'SERVICE DAY' in set-up mode.

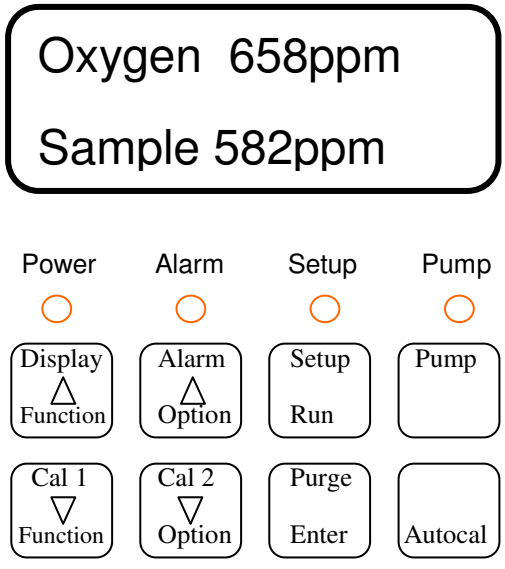


Figure 4.1 Operator's Panel

4.2 ALARM BUTTON

Repeatedly pressing the '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 in lower case), displayed alongside. New alarms will not have 'ACC' (in upper case) 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. Alarms may also be accepted remotely by a temporary closure of a switch connected to terminal 16 & 17, 'REMOTE ALARM RESET'.

The alarm 'LED' will flash when there is an un-accepted 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 (if Alarm 4 has been selected as a 'Horn' relay) that will re-initiate on any new alarms.

4.3 ALARM SCHEDULE

4.3.1 SUMMARY OF ALARMS - COMMON ALARM

1. 'Oxygen Sensor Fail'
Oxygen cell or electrode failure (high impedance); (inhibited under 650°C (1200°F)).

2. 'Heater Fail'
In the first 20 minutes of power being applied to the heater after being switched on, this alarm will not occur, but a 'Sensor Low Temp' display will occur and common alarm relay will be activated. Refer to Section 6.10. If an ADC alarms occurs, the sensor's heater will be automatically turned off.

3. 'Sensor TC Open'
The oxygen sensor thermocouple is open circuit. The heater will switch off.

4. 'Gas Pump Fail'
The Sample gas pump in the analyser has failed.

5. 'ADC Cal Fail'
The analog to digital converter has been found to fall outside the normal calibration specifications. In this case the oxygen sensor heater will automatically be turned off.

6. 'Mains Freq'
The sample of the mains frequency has failed.

7. 'DAC Cal Fail'
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. This alarm is inhibited if 'Not Used' is selected in set-up 14. Refer to Section 2.8.

8. 'Gas Cal Err'
Oxygen sensor does not correctly calibrate to calibration check gas.

9. 'BB RAM Fail"
The battery backed memory module has failed in service. It is the plug-in battery like module on the 1630 -1 board, labelled M1.

10. 'CO_2 Gen Fail'
The carbon dioxide module has had a general electronic failure. See set-up 12.
The carbon dioxide module has failed to communicate with the 1637. See set-up 12.

11. 'CO_2 Cal Fail'
The carbon dioxide module has failed to do a complete calibration. The carbon dioxide module may have measured the calibration gas at well off the expected level. Re-try the calibration. See set-up 12.

12. 'CO_2 High Temp'
The temperature of the carbon dioxide module is too high. Move the 1637 to a cooler operating area. The ambient operating temperature is 5 to 45°C (40 to 110°F).

13. 'CO_2 Gas Drift'
The calibration gas has been unstable during a calibration. Let the gas flow for 30 seconds before starting the calibration. Re-try the calibration.

14. 'CO_2 Lamp Fail'
The infra red source in the carbon dioxide module is open circuit. The analyser will have to be returned to the factory for repairs.

12. 'CO_2 Coms Fail'
The communications link between the carbon dioxide module and the 1637 analyser has failed. Try turning the power off and on. The two LED's on the inside of the front door should both be flashing to show receive and transmit activity.

15. 'CO_2 Zero Error'
The carbon dioxide module and the 1637 are not communicating correctly. Turn the power off and back on again. If this does not clear the alarm, contact Novatech Controls, service department.

16. 'Watchdog Timer'
Microprocessor error. This alarm will not appear on the display. The common alarm relay will be forced open circuit. If the watchdog timer senses a malfunction in the microprocessor, it will attempt to reset the analyser every 2 seconds. After two attempted resets the common alarm relay contacts will go open circuit.

4.3.2 SUMMARY OF ALARMS - SELECTABLE ALARMS

There are three user configureable alarm relays. Any or all of the following functions can be selected for each relay.

16. 'O_2% High'
The measured oxygen level is above the level set in set-up 44, and the alarm delay set in set-up 45 has expired. See Section 5.5.39 for more details.

17. 'O_2% Low'
The measured oxygen level is below the level set in set-up 46, and the alarm delay set in set-up 47 has expired. See Section 5.5.41 for more details.

18. 'O_2% Very Low'
The measured oxygen level is below the level set in set-up 48, and the alarm delay set in set-up 49 has expired. See Section 5.5.43 for more details.

19. 'Sensor Temperature'
The oxygen sensor temperature is under 650°C (1200°F). The oxygen reading is therefore invalid. If the oxygen sensor heater has been on for more than 20 minutes and the temperature is less than 650°C (1200°F) a 'Heater Fail' alarm will occur.

20. 'Cal in Progress'
An oxygen calibration check is occurring, either manual (in RUN mode) or automatic

21. 'High CO_2 Alarm'
The measured carbon dioxide level is above the level set in set-up 50, and the alarm delay set in set-up 51 has expired. See Section 5.5.45 for more details.

22. 'Low CO_2 Alarm'
The measured carbon dioxide level is below the level set in set-up 52, and the alarm delay set in set-up 53 has expired. See Section 5.5.47 for more details.

23. Alarm Horn
This is not an alarm condition. If one of the three user configureable alarm relays have 'Alarm Horn' enabled, the relay will have closed contacts only when there is an unaccepted alarm on the analyser. Press the alarm button twice to accept any new alarm and to cancel the horn relay. This is only available on relay 4.

4.3.3 ALARM RELAYS

The alarm relays are fail safe. That is, the contacts will be closed during normal operation, and will be open circuit if there is an alarm or if the power is removed from the analyser.

4.4 POWER LAMP

Illuminates when power is connected to the analyser. If the lamp is flashing, the watchdog timer is attempting to reset the microprocessor. Replace the 1630-1 microprocessor PCB.

4.5 GAS SAMPLE PUMP

The gas is driven into the sensor by a small gas pump.
If "Display Sample" mode has been selected in set-up function 31, the pump will start up when the power is turned on but will turn off 15 minutes later unless the analyser is being used. It can be turned on again by pressing the "Pump" button on the front panel.

If the pump is off, the message "Sample Pump Off" will be flashed onto the top line of the display.

In the "Fast Sample" and "Continuous" mode of gas measurement, the pump will run continuously.

4.6 4 - 20 / 0 - 20mA OUTPUTS

There are two analog output channels.
The output function and range can be selected for both channels. See set-up 25 to 30.

NOTE:
If oxygen is selected to be transmitted on either channel, the output current will be driven to 20mA while the sensor heats up to over 650°C.

NOTE:
If "Not Used" is selected for channel 1 output, menu items that relate to both output channels will be hidden.

SETTING UP THE ANALYSER

5

SECTION
NUMBER

5.1 SET-UP MODE SUMMARY
5.2 SET-UP & RUN MODES
5.3 FUNCTION SELECT
5.4 ENTER OPTION OR VALUE
5.5 SET-UP FUNCTION DETAILS

SET-UP MODE SUMMARY

5.1 SET-UP MODE FUNCTIONS

1 Calender Year
2 Calender Month
3 Calender Day
4 Real time clock Hour
5 Real time clock Minutes
6 Reference voltage #1
7 Reference voltage #2
8 Reference voltage #3
9 Reference voltage #4
10 Auto oxygen offset, Yes / No
11 Oxygen sensor offset
12 CO_2 auto calibration
13 CO_2 calibration, mid range gas %
14 Output channel number 1, 4 - 20 or 0 - 20mA mode, or Not Used
15 Output channel number 2, 4 - 20 or 0 - 20mA mode ♣
16 Output channel number 1 calibration ♣
17 Output channel number 1 calibration, 4mA trim ♣
18 Output channel number 1 calibration, 20mA trim ♣
19 Output channel number 2 calibration ♣
20 Output channel number 2 calibration, 4mA trim ♣
21 Output channel number 2 calibration, 20mA trim ♣
22 Service record year
23 Service record month
24 Service record day
25 Transmitter Output Channel 1 scale ♣
26 Transmitter Zero Channel 1 ♣
27 Transmitter Span Channel 1 ♣
28 Transmitter Output Channel 2 scale ♣
29 Transmitter Zero Channel 2 ♣
30 Transmitter Span Channel 2 ♣
31 Sample mode
32 Display mode
33 Centigrade / Fahrenheit Selection
34 Lower Line Display Functions

35 Cal Gas, Yes / No

Set-up steps 36 to 42 may be skipped automatically, depending on the selection in set-up step 35.

36 First cal gas time
37 Oxygen Content of Cal Gas 1
38 Maximum Acceptable Positive Error Gas 1
39 Maximum Acceptable Negative Error Gas 1
40 Period Between Gas 1 Autocals
41 Duration of Autocal Gas 1
42 Freeze Time Gas 1

43 Reset level
44 High oxygen alarm level
45 High oxygen alarm delay time
46 Low oxygen alarm level
47 Low oxygen alarm delay time
48 Very low oxygen alarm level
49 Very low oxygen alarm delay time
50 High carbon dioxide alarm level
51 High carbon dioxide alarm delay time
52 Low carbon dioxide alarm level
53 Low carbon dioxide alarm delay time
54 Alarm relay number 2 function select

Set-up steps 55 and 56 may be skipped automatically if a version 1.6 of the 1637-2 PCB is installed.

55 Alarm relay number 3 function select
56 Alarm relay number 4 function select

Set-up steps 57 an 60 may be skipped automatically if carbon dioxide is installed..

57 Serial communications mode
58 Data to Print
59 Print Log Period
60 Printer Baud Rate

61 Sample Gas pump selection
62 Damping factor

♣ If "Not Used" is selected in set-up 14 these functions will be hidden.

5.2 SET-UP & RUN MODES

For the SET-UP mode keyboard to operate, press the SET-UP / RUN button. The set-up light will come on when the SET-UP mode has been entered.

NOTE:
SET-UP mode cannot be entered if the keyboard lock switch on the inside of the analyser is in the UP position. The keyboard lock switch can be found on the door PCB (1630-2), on the lock side, at the top. If access is attempted while the keyboard is locked, the message **'Illegal Access'** will be displayed.

The temperature of the oxygen sensor may fall if the SET-UP mode is used for more than 2 minutes.

While the analyser is in SET-UP mode the outputs will be frozen. On the analyser label all of the functions written in BLUE will now operate. If there are no buttons pressed for 1 minute the analyser will automatically revert to the RUN mode.

If purges or an auto-calibration check occurs while the analyser is in SET-UP mode, they will be delayed until the analyser is returned to RUN mode.

To cancel an automatic purge or calibration check cycle, press AUTO CAL button while in RUN mode.

5.3 FUNCTION SELECT

When the SET-UP mode is entered, the analyser will automatically display 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.

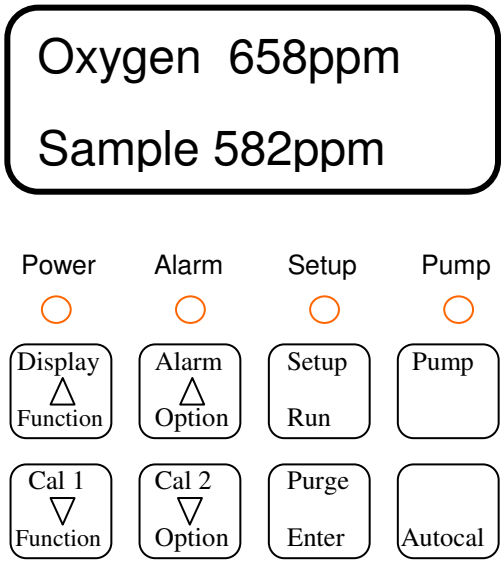
5.4 ENTER OPTION OR VALUE

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' set-up items 34 and 58 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 right hand side of the lower line.



1637 Oxygen Analyser Keyboard

5.5 SET-UP FUNCTION DETAILS

Note: The * indicates the factory default setting after a COLD-START. See Section 6.1

Note: ♣ If "Not Used" is selected in set-up 14 these functions will be hidden

1. CALENDER YEAR

Options

Select the current year for the real time clock / calender.
The cold start default sets the date and time to the software version date.

2. CALENDER MONTH

Options

Select the current month for the real time clock / calender.

3. CALENDER DAY

Options

Select the current day for the real time clock / calender.

4. REAL TIME CLOCK HOUR

Options Select the current hour for the real time clock. (24 hour format)

5. REAL TIME CLOCK MINUTES

Options

Select the current minutes for the real time clock.

6. REFERENCE VOLTAGE #1

Options

Set the value of the reference voltage as read on a 3 3/4 digit multimeter (See Section 6.2 for further details).
27.55 mV *

7. REFERENCE VOLTAGE #2

Options

Set the value of the reference voltage as read on a 3 3/4 digit multimeter (See Section 6.2 for further details).
193.60 mV *

8. REFERENCE VOLTAGE #3

Options

Set the value of the reference voltage as read on a 3 3/4 digit multimeter (See Section 6.2 for further details).
1202.00 mV *

9. REFERENCE VOLTAGE #4

Options

Set the value of the reference voltage as read on a 3 3/4 digit multimeter (See Section 6.2 for further details).
2479.00 mV *

Set-up items 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. Connect a 3 1/2 digit multimeter negative lead to the test point marked 'C' to the right of the PCB on the inside of the door (labelled 'REF VOLTS'). Measure the four voltages on the test point marked 1 to 4 with the positive lead. Refer to Figure 6.2 in the 1637 manual. Enter the measured values in set-up items 6 to 9. Whenever new values are entered the D/A section should be re-calibrated, Refer to Section 6.3.

10. AUTO OXYGEN SENSOR OFFSET

The sensor offset voltage is produced by small temperature differences within the oxygen sensor. The voltage is normally between +3 to -3mV. This error can be automatically removed by selecting 'YES'.

The only time 'NO' should be selected is when the analyser is being used to measure gases between 16 and 26% oxygen. The oxygen sensor offset should then be manually entered using set-up step 11.

Options

Yes *
No

11. SET O_2 SENSOR OFFSET - MANUAL

The offset only needs to be set manually when the analyser is being used to measure gasses within 16 and 26% oxygen content.

To check a sensor offset on site, the sensor must be sensing air and allowed to settle at the sensor operating temperature for 30 minutes. Read the offset in 'RUN' mode in millivolts on the lower line. Enter the 'SENSOR OFFSET' value eg. if the offset value is -1.2mV, enter -1.2mV. The typical maximum is +/-3mV.

If the manual entry method is being used, make sure that 'NO' to automatic entry is selected in set-up step 10 or the manual value will be over written.

A new EMF offset must be entered whenever a new oxygen sensor is installed to compensate for any offset an individual sensor may have. This will have been set at the factory for a new or serviced instrument.

12. SELECT CO_2 CALIBRATION

Select either 'ZERO' or 'SPAN' calibration of the CO_2 module by pressing the enter key in the usual way. Then return to 'RUN' mode. The analyser will automatically enter the calibration mode. This will take up to 50 seconds. At the end of the calibration, the mode selection in the menu will be returned to "CO2 Cal Done ". A 100% CO_2 gas bottle is required for the 'Cal Span'. A bottle of between 20% and 80% CO_2 is required for the MID gas calibration, and the percentage must be entered into set-up 13 before the MID gas calibration.

If 'ZERO' is selected, the CO_2 module will enter the automatic zero calibration mode. While the zero is being calibrated, make sure that the sample gas is ambient air. If the sample is not stable during the 50 seconds zero calibration period, the 1637 analyser will abort the calibration and instigate a "CO2 Gas Drift" alarm. If this occurs, restart the zero calibration.
If 'SPAN' is selected, the CO_2 module will enter the automatic span calibration mode. While the span is being calibrated, make sure that the sample gas is 100% CO_2. If the sample is not stable during the 30 seconds span calibration period, the 1637 analyser will abort the calibration and instigate a "CO2 Gas Drift" alarm. If this occurs, restart the span calibration.

Options:

1. CO_2 Cal Done *
2. Cal Zero
3. Cal Span
4. Cal Mid% Gas

See also section 3.15, SENSOR CALIBRATION - CARBON DIOXIDE.

13. CO_2 MID RANGE CALIBRATION GAS %

Set the percentage value of the gas to be used for the 'Cal Mid% Cal' in set-up function 12.
See also section 3.15, SENSOR CALIBRATION - CARBON DIOXIDE.
Range: 20 to 80%, Default is 30%.

14. OUTPUT CHANNEL #1, 0 - 20mA or 4 - 20mA

The output channel can be scaled 0 to 20mA or 4 to 20mA to represent the parameter that is selected in set-up function 25.

Options:

1. Not Used *
2. 4 - 20mA
3. 0 - 20mA

15. OUTPUT CHANNEL #2, 0 - 20mA or 4 - 20mA ♣

The output channel can be scaled 0 to 20mA or 4 to 20mA to represent the parameter that is selected in set-up function 28.

Options:

1. 4 - 20mA *
2. 0 - 20mA

16. 4 to 20mA CALIBRATION OPTIONS, CHANNEL #1 ♣

Select the calibration method for the 4 - 20mA output channel #1.
The output channels can be either calibrated by simply pressing the 'AUTO CAL' button, or can be trimmed at both the 4mA and 20mA ends of the scale using an external multimeter.

Options:

1. Auto Calibration *
2. Manual Calibration
3. Set 4mA Trim
4. Set 20mA Trim

If 'AUTO CAL' is selected, the output channel is calibrated when 'Auto Cal' is initiated from the keyboard (See section 6.3).
If 'MAN CAL' is selected, it is necessary to trim both ends of the 4-20mA output range using the 4mA and 20mA options in this menu item. Selecting 'MAN CAL' inhibits the 'Auto Cal' process of this channel.
Always do the 4mA trim first, and then the 20mA trim. After trimming both ends of the scale, return the 'CALIBRATION OPTIONS' menu option back to 'MAN CAL' (not 'AUTO CAL'), or the calibration factors will be over written by the next 'AUTO CAL'.

For more details on calibrating the output channels, see section 6.3.

NOTE: The analyser will only stay in either '4mA TRIM' or '20mA TRIM' modes for 30 minutes before it automatically returns to 'MANCAL'.

17. CALIBRATE 4mA, CHANNEL #1 ♣

This menu item only appears if 'Set 4mA Trim' is selected in Set-up 16.
Range: 0 to 25mA, Default is 4.00mA
For full details on the calibration of the 4 - 20mA output channels, see section 6.3.

18. CALIBRATE 20mA, CHANNEL #1 ♣

This menu item only appears if 'Set 20mA Trim' is selected in Set-up 16.
Range: 0 to 25mA, Default is 20.00mA

19. 4 to 20mA CALIBRATION OPTIONS, CHANNEL #2 ♣

Select the calibration method for the 4 - 20mA output channel #1.
For more details, see Set-up 16 and section 4.5.

Options:

1. Auto Calibration *
2. Manual Calibration
3. Set 4mA Trim
3. Set 20mA Trim

20. CALIBRATE 4mA, CHANNEL #2 ♣

This menu item only appears if 'Set 4mA Trim' is selected in Set-up 19.
Range: 0 to 25mA, Default is 4.00mA
For full details on the calibration of the 4-20mA output channels, see section 6.3.

21. CALIBRATE 20mA, CHANNEL #2 ♣

This menu item only appears if 'Set 20mA Trim' is selected in Set-up 19.
Range: 0 to 25mA, Default is 20.00mA

22. ENTER SERVICE YEAR

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

23. ENTER SERVICE MONTH

Enter the current 'MONTH'.

24. ENTER SERVICE DAY

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

25. TRANSMITTER OUTPUT CHANNEL 1 ♣

Select the type of output required from Channel 1. Linear is the most common output required. The low oxygen range is used for application that have oxygen below 1000ppm (0.1%)
Options:
1. Linear oxygen (0.1 to 100.0%) *
2. Low range linear oxygen (10 to 10,000 ppm)

The output spans are adjustable in Set-up steps 26 and 27.

26. TRANSMITTER ZERO CHANNEL 1 ♣

Select transmitter zero for output Channel 1.
Range 0.0 to 99.9% Oxygen.
Range 0 to 0.999% (9,990ppm) Oxygen.
Default setting is 0.0%.

27. TRANSMITTER SPAN CHANNEL 1 ♣

Select transmitter span for output Channel 1.
Linear Oxygen- Range 0.1 to 100.0% Oxygen. Default setting is 10.0%.
Low Oxygen- Range 0.001 to 1.000% (10 to 10,000ppm) Oxygen. Default setting is 0.100%.

28. TRANSMITTER OUTPUT CHANNEL 2 ♣

Select the type of output required for Channel 2.
Options:
1. Sample Gas, oxygen
2. Linear (Low) Oxygen, 0.1 to 100.0 % *
3. Logarithmic oxygen, 0.1 to 20 %
4. % carbon dioxide
5. Reducing oxygen %
6. Oxygen sensor EMF

29. TRANSMITTER ZERO CHANNEL 2 ♣

The output zero and span of Channel 2 is set in set-up steps 29 and 30. Range limits are shown below.

30. TRANSMITTER SPAN CHANNEL 2 ♣

Output	Zero Range	Span Range	Minium span
SAMPLE GAS, OXYGEN	0.0 to 99.9 %	0.1 to 100 %	0.1 %
LOW OXYGEN	0.0 to 99.9 %	0.1 to 100 %	0.1 %
LOG OXYGEN (see Note 1)	0.1 % oxygen fixed	20 % oxygen fixed	
CARBON DIOXIDE	0 to 80 %	20 to 100.0 %	20 %
REDUCING OXYGEN (see Note 2)	10^{-1} to 10^{-28} % oxygen in one decade steps	10^{-2} to 10^{-30} % oxygen in one decade steps.	Two decades
SENSOR EMF	0 to 1100 mV in 100 mV steps	100 to 1300 mV in 100 mV steps	100 mV

NOTE

1: For log oxygen scale details, Refer to Appendix 2.

2: Note that the reducing oxygen span is shown on the display as the exponent only. -1 represents 1 x 10^{-1} % (0.1%) oxygen.

31. SAMPLE MODE

Options

1. Fast Sample
2. Display Sample *
3. Continuous

Select the option, either 'Fast Sample', 'Display Sample' or 'Continuous' to suit the application.
If a continuous stream of the sample gas is available, then 'Continuous' will allow the alarms to trip on the steady state oxygen level. Set-up step 43 (Reset Level), will be ignored if 'Continuous' is selected here.

If however, the gas is coming from a short duration sample, (eg. food packaging sample withdrawn through a hypodermic needle), the minimum value of oxygen may be retained until another sample is read by selecting 'Fast Sample' or 'Display Sample' The high oxygen alarm will be activated by a high sample level.
'Display Sample' mode is very similar to 'Fast Sample', except the readings are only taken once per second (10 per second for Fast Sample). This means for small head space packets (<100 cc (12 scfm)) the true valley may be missed. The 'Fast Sample' mode is the more precise mode of operation but will not update the display until the valley and peak values have been found.
If the value in set-up 43 (Reset Level) is above 20.9%, and if a sample hold mode (Fast Sample or Display Sample) is selected here, the oxygen peak (not valley) will be held as the sample. If the carbon dioxide module is installed, the peak of carbon dioxide will still be held.
Set-up step 62 (Damping Factor), will only be used if 'Continuous' is selected here.

32. DISPLAY MODE

Options

1. Oxygen % *
2. Oxygen ppm
3. O_2 / CO_2 % ppm (only available if a CO_2 module is installed)
4. O_2 / CO_2 % only (only available if a CO_2 module is installed)

The top line of the LCD always shows the oxygen content, but the user may select whether the oxygen will be displayed as a percentage or in parts per million. If the CO_2 option has been installed, both O_2 and CO_2 may be displayed. If option 1 (Oxygen %) is chosen, below 0.1% the display will revert to the ppm form automatically. This selection also affects other functions such as the 4 – 20mA output ranges, gas calibration checking, reset level and alarm trip levels.

If 'O_2 / CO_2 % / PPM' or 'O_2 / CO_2 % only' is selected here in set-up step 32, and 'Fast Sample' or 'Display Sample' was selected in set-up step 31, the SAMPLE on the lower line of the display will also show the peak level of CO_2.

Using 'O_2 / CO_2 % only' option restricts the display to the percentage form only. The display will not go into the ppm mode automatically.

33. CENTIGRADE / FAHRENHEIT SELECTION

Select whether displays and outputs are to be in ° Celsius or Fahrenheit

Options:

1. Celsius (Centigrade) *
2. Fahrenheit

34. 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 to time
2. Run hours since last service
3. Date of last service
4. Oxygen Sensor mV
5. Oxygen sensor temperature
6. Oxygen sensor impedance
7. Sample oxygen (and Carbon dioxide if fitted)
8. Ambient temperature
9. Balance gas

If options already selected are required to be deleted, select the required option and press the 'ENTER' button. The asterisk will be removed.

35. CALIBRATION CHECK GAS, YES / NO

Select to use on line gas span calibration checking or not.

Options:

No Cal Gas *
Yes

During the timed calibration check periods the transmitter outputs will be frozen and the analyser will alarm if readings are not within the accuracy limits sets in set-up functions 38 and 39. If autocal is not required enter 'NO CAL GAS' and the transmitter will step to set-up 43.

36. 1st CALIBRATION CHECK

Enter the time of the first gas calibration.

Range:

1-24 hours. Default setting is 12 O'clock.

37. OXYGEN CONTENT OF CAL GAS

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

Range:

0.1 to 20.9 % oxygen. Default setting is 8.0 % oxygen.

38. MAXIMUM ACCEPTABLE POSITIVE ERROR GAS

Set the maximum positive error above which the 'Gas Cal Error' alarm will be initiated after the timed period set in set-up function 44.

Range:

0.1 to 3.0 % oxygen. The default setting is 0.5 % oxygen.

39. MAXIMUM ACCEPTABLE NEGATIVE ERROR GAS

Set the maximum negative error below which the 'Gas Cal Error' alarm will be initiated after the timed period set in set-up function 44.

Range:

0.1 to 3.0 % oxygen. The default setting is 0.2 % oxygen.

40. PERIOD BETWEEN GAS AUTOCALS

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

Range:

1 to 1999 hours. The default setting is 1 hour.

41. DURATION OF AUTOCAL GAS

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, a 'GAS CAL ERR' will initiate. To determine the minimum time required for a particular configuration of the analyser to settle, manually admit cal gas while observing the oxygen reading in 'RUN' mode by pressing the 'CAL 1' button. Typical minimum times vary from 5 to 15 seconds.

Range:

0 to 90 seconds. The default setting is 10 seconds.

42. FREEZE TIME GAS

After the Cal Gas period, the transmitter output will remain fixed, (frozen) for an adjustable period to allow the sensor reading to return to the correct process level and avoid output 'bumps'. The freeze period time required will depend on the sensor response time.

Range:

10 to 100 seconds in ten second steps. The default setting is 30 seconds. To determine the required freeze time, manually perform a calibration check 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.

43. RESET LEVEL

The RESET level is the trip level which triggers the sampling mode capture of the oxygen level.
By setting the reset level below 20.9% the analyser will capture the minimum oxygen level.
By setting the reset level above 20.9% the analyser will capture the maximum oxygen level.
In order to detect a new 'SAMPLE' oxygen or carbon dioxide level, the oxygen reset threshold must be set below (or above for peak capture) the normal idle oxygen level, but well above (or below for peak capture) the level expected in the sample period.
This level will not be used if 'Continuous' is selected in set-up 31.

Range:

0.1 – 100.0% oxygen. The default setting is 15.0% oxygen.

44. HIGH OXYGEN ALARM

Set the operating point for the high oxygen alarm relay.
The high oxygen alarm has a dual range selected by a link on screw terminals 14 & 15 (FUEL 1 / 2). If the link is **NOT** connecting the two terminals, the range will be 0.1 to 30.0% oxygen. If the terminals have a short circuit link between them, the range will be 10 to 3000ppm oxygen.

Range:

0.1 – 30.0% oxygen. The default setting is 10.0% oxygen.
10 – 3000ppm oxygen. (With screw terminals 14 & 15 linked)

45. HIGH OXYGEN DELAY (only available if 'Continuous' is selected in Set-up 31)

Typically set at 30 seconds.

Range:

0 – 200 seconds. The default setting is 60 seconds.

46. LOW OXYGEN ALARM

Set the operating point for the low oxygen alarm relay. Typically set at 2.5% oxygen.
The low oxygen alarm has a dual range selected by a link on the screw terminals 14 & 15 (FUEL 1 / 2). If the link is **NOT** connecting the two terminals, the range will be 0.1 to 30.0% oxygen. If the terminals have a short circuit link between them, the range will be 1 to 300ppm oxygen.

Range:
0.1 – 30% oxygen. The default setting is 2.5% oxygen.
1 – 300 ppm. (With screw terminals 14 & 15 linked)

47. LOW OXYGEN DELAY (only available if 'Continuous' is selected in Set-up 31)

Typically set at 10 seconds.
Range:
0 – 200 seconds. The default setting is 10 seconds.

48. VERY LOW OXYGEN / FILTER FAIL ALARM

Set the operating point for the very low oxygen alarm level, typically 0.5% oxygen. This limit can be used as an extreme case alarm level where the normal operating level should never be this low.
If an external combustibles active filter is being used in a wave soldering application, link screw terminals 14 & 15. This will automatically select the alarm range from 0.1 to 30ppm. If the measured oxygen level falls below the alarm level, the alarm message will be "Filter Fail".
Range:
0.1 – 30% oxygen. The default setting is 1.5 % oxygen.
0.1 – 30 ppm. (With screw terminals 14 & 15 linked)

49. VERY LOW OXYGEN DELAY (only available if 'Continuous' is selected in Set-up 31)

Set the very low oxygen alarm delay.
Range:
0 – 200 seconds. The default setting is 2 seconds.

50. HIGH CARBON DIOXIDE ALARM

Set the operating point for the high carbon dioxide alarm relay.

Range:
0 – 100 % oxygen. The default setting is 40 % carbon dioxide.

51. HIGH CARBON DIOXIDE DELAY (only available if 'Continuous' is selected in Set-up 31)

Typically set at 30 seconds.

Range:
0 – 200 seconds. The default setting is 30 seconds.

52. LOW CARBON DIOXIDE ALARM

Set the operating point for the low carbon dioxide alarm relay. Typically set at 20 % carbon dioxide.

Range:
0 – 100% carbon dioxide. The default setting is 20 % carbon dioxide.

53. LOW CARBON DIOXIDE DELAY (available if 'Continuous' is selected in Set-up 31)

Typically set at 10 seconds.
Range:
0 – 200 seconds. The default setting is 10 seconds.

54. ALARM RELAY #2

Any or all of the following alarm functions may be used to activate the alarm relay. They may be selected or de-selected using the 'ENTER' buttons as in set-up function 34.

Options :
1. Low oxygen
2. High oxygen
3. Very low oxygen / Filter fail
4. High carbon dioxide
5. Low carbon dioxide
6. Oxygen sensor under temperature
7. Oxygen calibration gas check in progress

55. ALARM RELAY #3

Alarm relay #3 has the same functions available as alarm relay #2. See set-up 54.

56. ALARM RELAY #4

Alarm relay #4 has the same functions available as alarm relay #2. See set-up 54.
In addition an alarm horn function is also available.
If 'Horn' is selected it will override any other selections. A relay selected as a 'Horn' driver will have the relay contacts open circuit if there is an un-accepted alarm, and closed when a new alarm occurs.

57. SERIAL COMMUNICATIONS (not available with CO_2 model)

The RS232 / RS485 serial port can be used to log selected data at a minimum 1 minute interval to a printer (see set-up 59) or can be selected to log - Seconds today, Oxygen sensor EMF, Oxygen level.
The data log period can be set from 5 seconds to 1200 seconds (20 minutes)
Options :
1. Printer *
2. Data logger

58. DATA TO PRINT

Any or all of the following values may be printed on a printer or computer connected to the serial port. They may be selected or de-selected using the 'ENTER' buttons as in set-up step 34. The log period follows in set-up step 59. A sample of a print-out is contained in Appendix 3. RS232C protocol is :

Data word length	Eight bits
Stop bits	One
Parity	None

Oxygen is always printed, plus any of the following
Options :
1. Run hours since last service
2. Date of last service
3. Oxygen Sensor mV
4. Oxygen Sensor temperature
5. Oxygen Sensor impedance
6. Sample oxygen sensor
7. Ambient temperature
8. Balance gas

59. PRINT LOG PERIOD

Select the time interval between data print outs on the printer.
Range: 1 to 2000 minutes

60. 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

61. SAMPLE GAS PUMP SELECTION

There are two pump styles available. The correct style will have been set in the factory. If a cold start is performed, the wrong style may be selected by default. To find out which one is in your analyser, undo the 2 screws on the sides and bring the door forward. If the yellow CM-15 pump has been installed it will be visible on the lower PCB.

The analysers made after February 1999 will have been fitted with software that will allow the sample gas pump to be turned on and off from the front control panel (the button and an LED labelled "Pump"). If an analyser made prior to this date has the software upgraded, the user can use this function to inhibit the pump on / off function. This will keep the pump running continuously, and not have the pump LED illuminated under the front panel label.

Options:

External MV-05	(Black pump mounted on the chassis, at the rear of the cabinet)
Internal CM-15	(Yellow pump mounted on the 1630-2 PCB) *
Continuous	(Only required if an upgrade of the software has been installed in your analyser)

62. DAMPING FACTOR

This factor is only used if 'Continuous' is selected in set-up 31, Sample Mode.
Each time a new reading is read from the oxygen sensor, 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 to 20mA output. The number of readings that are averaged together is adjustable with this function. A value of five for example, means that the new reading from the sensor and the previous four readings are averaged together before being displayed. A value of zero entered here will mean that every new reading from the sensor will be sent to the display unaltered.

The smoothing of the oxygen signal is an exponential function. If a factor of 5 is used, a step change of input signal will take about 5 seconds to reach 63% of the change on the output / display.

Range
0 to 20. Default setting is 5.

MAINTENANCE

6

SECTION
NUMBER

TRANSMITTER MAINTENANCE

6.1 COLD START
6.2 A/D CALIBRATION
6.3 D/A CALIBRATION
6.4 PUMP REPLACEMENT
6.5 BACK TO UP BATTERY REPLACEMENT
6.6 ELECTRONIC REPAIRS

SENSOR MAINTENANCE

6.7 TEST EQUIPMENT REQUIRED
6.8 TESTING AN OXYGEN SENSOR
6.9 OXYGEN SENSOR THERMOCOUPLE
6.10 OXYGEN SENSOR HEATER FAILURE
6.11 CO_2 OPTICAL SERVICE

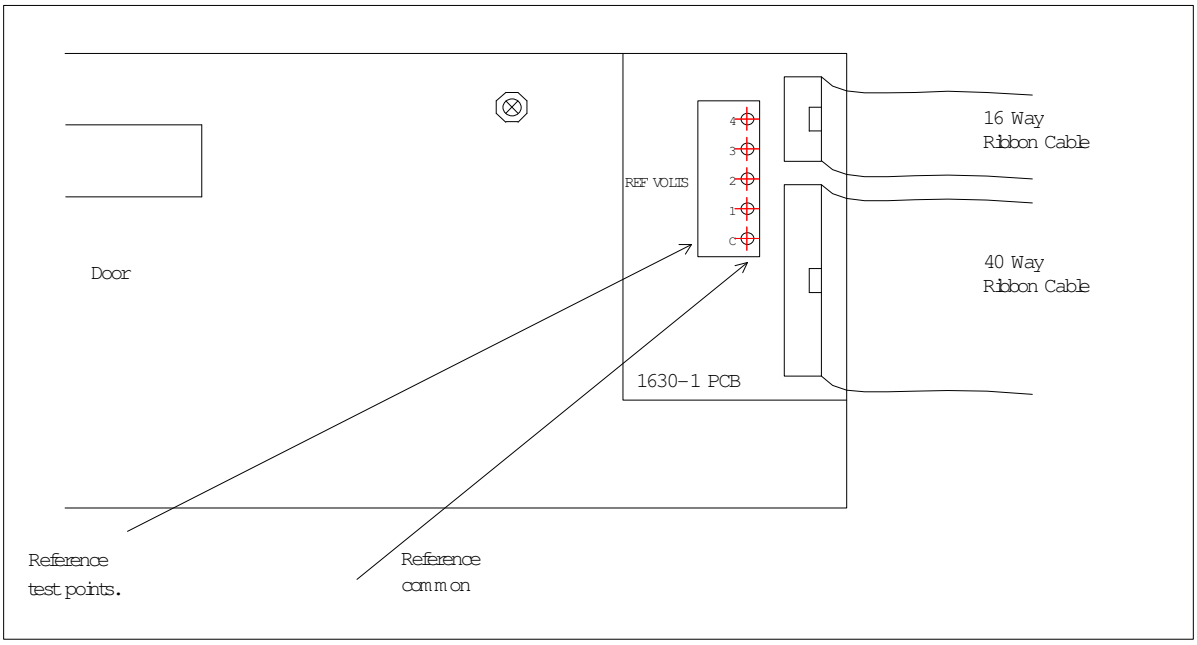
6.1 COLD START

A 'COLD START' will resets all 'Set-up' mode entries to their factory 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 the set-up mode, including calibration voltages and time and date.

To initiate a 'COLD START' -
Turn the mains power off
Remove the 'COLD START LINK' (this is located on the door PCB, next to the keyboard lock switch, behind the shield)
Turn the mains power on. The message "Cold Start....." will be displayed.
Leave the LINK off until the message "Replace c/s Link" is displayed. Replace the LINK.
The date and version number of the software will be displayed.

A 'WARM START', which is performed by applying power with the COLD START LINK in its place, will retain all data previously entered in the Set-up mode.

6.2 A/D CALIBRATION



Location of Calibration Test Points

The analyser maintains its accuracy over a very long by continuously checking itself against internal stabilised references. The only calibration required is to set the actual values of these references into battery backed memory. The analyser will read these references every minute and update its zero and span correction factors. See Section 5.5.6 to 9. These references should be checked every 12 months. An AUTOCAL of the analog output section should always be performed if these references are altered. See Section 6.3.

6.3 D/A (4 - 20mA output channels) Calibration

The calibration can either be done using the 'Auto Cal' or 'Manual Cal'.
Auto Cal
The 'Auto Cal' mode is selected in set-up 16 (and 19 for channel 2).
The analyser will automatically divert the output back to the input, measure the offset and span, and record the calibration factors for each channel.
If either of the channels are selected to be calibrated manually, the factors will not be changed by an 'Auto Cal'.
Manual Cal
The 'Manual Cal' mode is selected in set-up 16 (and 19).
Set the 4mA calibration first and then the 20mA calibration.
1. Select 'Set 4mA Trim' in set-up 16 (or 19).

2. Return to RUN mode.
3. Measure the output on the channel to be calibrated with a digital multimeter. If the current is not exactly 4.00mA, return to set-up mode and change the 4mA calibration factor in set-up 17 (or 20).
4. Re-measure the current while back in RUN mode until the current is within 3.9 to 4.1mA.
5. Return to set-up mode and select 'Manual Cal' in set-up 16 (or 19).

Set the 20mA calibration factor.

6. Select 'Set 20mA Trim' in set-up 16 (or 19).
7. Return to RUN mode.
8. Measure the output on the channel to be calibrated with a digital multimeter. If the current is not exactly 20.00mA, return to set-up mode and change the 20mA calibration factor in set-up 18 (or 21).
9. Re-measure the current while back in RUN mode until the current is within 19.9 to 20.1mA.
10. Return to set-up mode and select 'Manual Cal' in set-up 16 (or 19).

This calibration is now saved in battery backed memory until

The factors are changed in the manual calibration
The analyser is forced into a COLD-START (see section 6.1)
The calibration mode in set-up 16 (or 19) is changed to Auto Cal and an Auto Cal is initiated.

NOTE: The 4mA or the 20mA trim mode will only be held on the output channels for 30 minutes before automatically returning to 'Manual Cal' mode in set-up 16 (or 19).

6.4 PUMP REPLACEMENT

The sample gas pump is mounted on the 1630-2 PCB in the base of the analyser (CM-15 pump) or in the rear of the cabinet (MV-10 pump). The operation of the pump is monitored by the analyser and alarms will be shown if a fault occurs. ("Pump Fail" alarm)
To replace the CM-15 pump, unplug the gas pipes from the pump. Loosen the top pump mounting screw by several turns and remove the lower screw. The nuts are captive into the PCB.

6.5 BACK-UP BATTERY REPLACEMENT

The back-up battery is contained within the battery-like real time clock / memory module, plugged into socket M1. The module is not re-chargeable and should be replaced every three years with stored transmitters with power off or every eight years with transmitters that have had the power on. The memory module must be purchased from Novatech Controls or an agent of Novatech Controls.
After replacing the battery, a COLD START must be forced on the analyser (See 6.1).

6.6 ELECTRONIC REPAIRS

Electronic schematics are included in Appendix 4. 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 test EPROM firmware package and sensor input simulator are also available.

6.7 TEST EQUIPMENT REQUIRED

All measurements are simplified if a 1637 analyser is connected to the oxygen sensor. Readings can then be easily taken of sensor impedance, EMF, temperature and percent oxygen. The analyser also provides proper heater control for the zirconia oxygen sensor.

First check all alarms on the analyser, allowing time for the sensor to heat up after switch on.

An instrument to measure sensor EMF and temperature is required. A 3½ or 4½ digit multimeter can be used for both measurements.

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

A cylinder of calibration gas is required, eg. 2.0% 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 certified to have an accuracy of 0.1% oxygen.

6.8 TESTING AN OXYGEN SENSOR

With the sensor heated to approximately 720°C (1320°F), connect a digital multimeter to the sensor electrode conductors, terminals 1 and 2. If a multimeter is not available, the EMF reading may be taken from the lower line of the display. Allow the analyser to aspirate at approximately 300cc per minute (0.64cfh) for several minutes. The multimeter should read zero millivolts ± 2.0 millivolts.

If not, then there is a problem with the sensor electrodes and the sensor needs refurbishing. Normally a faulty sensor electrode is indicated with a high source impedance. This can be displayed on the lower line of the 1637 display. The measurement will be updated every 60 minutes, or by pressing the 'Auto Cal' button anytime.

To test the source impedance, use the sensor impedance display on the lower line. Refer to Section 5.5.29, Lower Line Display Functions. If the impedance is above 3kΩ, then the electrode needs refurbishing.

Where a sensor electrode requires refurbishing it is suggested that they should be returned to Novatech or an accredited service organisation.

If the sensor 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 normal inlet port of the 1637, at the same flow rate as used when in use. With the calibration gas flowing, the sensor should develop an EMF according to the tables in Appendix 1. If the EMF reading is low then there may be insufficient calibration gas flow. Increase the calibration gas slightly 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 sensor at a high temperature for more than about 15 seconds, the ceramic parts of the sensor and sensor 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 100°C (210°F) per minute.
The sensor accuracy should be within 1% of the EMF according to the tables, with the same offset that was measured with air on both sides of the sensor. If the sensor EMF is not within this tolerance, then it will require the electrodes to be refurbished.

Occasionally, a sensor can develop an offset with a polluted electrode caused by contaminants in the sampled gas stream. Return the sensor or analyser to Novatech or an accredited service organisation.

6.9 OXYGEN SENSOR THERMOCOUPLE

The oxygen sensor is fitted with a 'K' type thermocouple to measure the temperature of the oxygen sensor. This temperature is used in the calculation of oxygen and the control of the heater. The analyser has an alarm function which will advise the operator of an open circuit thermocouple, however bench testing can be performed by simply measuring the thermocouple continuity.

6.10 HEATER FAILURE

A heater failure will cause a 'Sensor Temperature' or 'Heater Fail' alarm. Heaters can be tested with a continuity test. The heater resistance should be approximately 100Ω. Should the heater be open or short circuited, replace the heater assembly.

6.11 CO_2 OPTICAL SERVICE

Ensure that a particle filter is always fitted on the hypodermic needle to protect the CO_2 analysis chamber.
Do not under any circumstances tamper with or open the CO_2 analysis chamber. Doing so will void the manufacturers warranty. There are no user serviceable parts inside.
Any tampering will drastically reduce it's performance and lifetime. (Factory calibration values will be disturbed)
If the carbon dioxide sensor fails, it should be sent back to the manufacturer for repair, and factory re-calibration.

APPENDICES

1. OXYGEN SENSOR EMF TABLE
2. % OXYGEN SCALE TO LOGARITHMIC
3. SAMPLE LOG PRINT OUTS
4. CIRCUIT SCHEMATICS

APPENDIX 1

ZIRCONIA OXYGEN SENSOR OUTPUT (mV)

% OXYGEN	mV at 720°C (1320°F)	PPM OXYGEN	mV at 720°C(1320°F)
20.0	0.99	(1000 ppm = 0.1%)	
19.5	1.53	1000	114.4
19.0	2.09	950	115.5
18.5	2.66	900	116.6
18.0	3.25	850	117.9
17.0	4.47	800	119.2
16.5	5.11	750	120.5
16.0	5.77	700	122.0
15.5	6.45	650	123.6
15.0	7.15	600	125.3
14.5	7.87	550	127.2
14.0	8.62	500	129.2
13.5	9.40	450	131.5
12.5	11.05	400	134.0
12.0	11.92	350	136.9
11.5	12.83	300	140.2
11.0	13.78	250	144.1
10.5	14.78	200	148.8
10.0	15.82	150	155.0
9.5	16.92	100	163.7
9.0	18.08	50	178.5
8.5	19.30	40	183.3
8.0	20.60	30	189.4
7.5	21.98	20	198.1
7.0	23.45	10	212.9
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		
0.1	114.39		
'K' TC mV	**29.965**		

These tables are based on the Nernst equation:

Sensor e.m.f. = 0.02154 x T x 1n (20.95/% oxygen), where T = ° K (° C + 273).

APPENDIX 2

% OXYGEN SCALE to 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 3

SAMPLE LOG PRINT-OUTs

Novatech Controls 21-02-1996 14:27:30
OXYGEN 1.23 %
Servc'd 20/02/02
Emf 15.2mV
Sensor Deg 703C (1297°F)
Sensor Imp 0.1K
Sample Oxygen = 853 ppm
Ambient T 24.3C (75.7°F)
Next Print at 14:30:30 21-02-1996

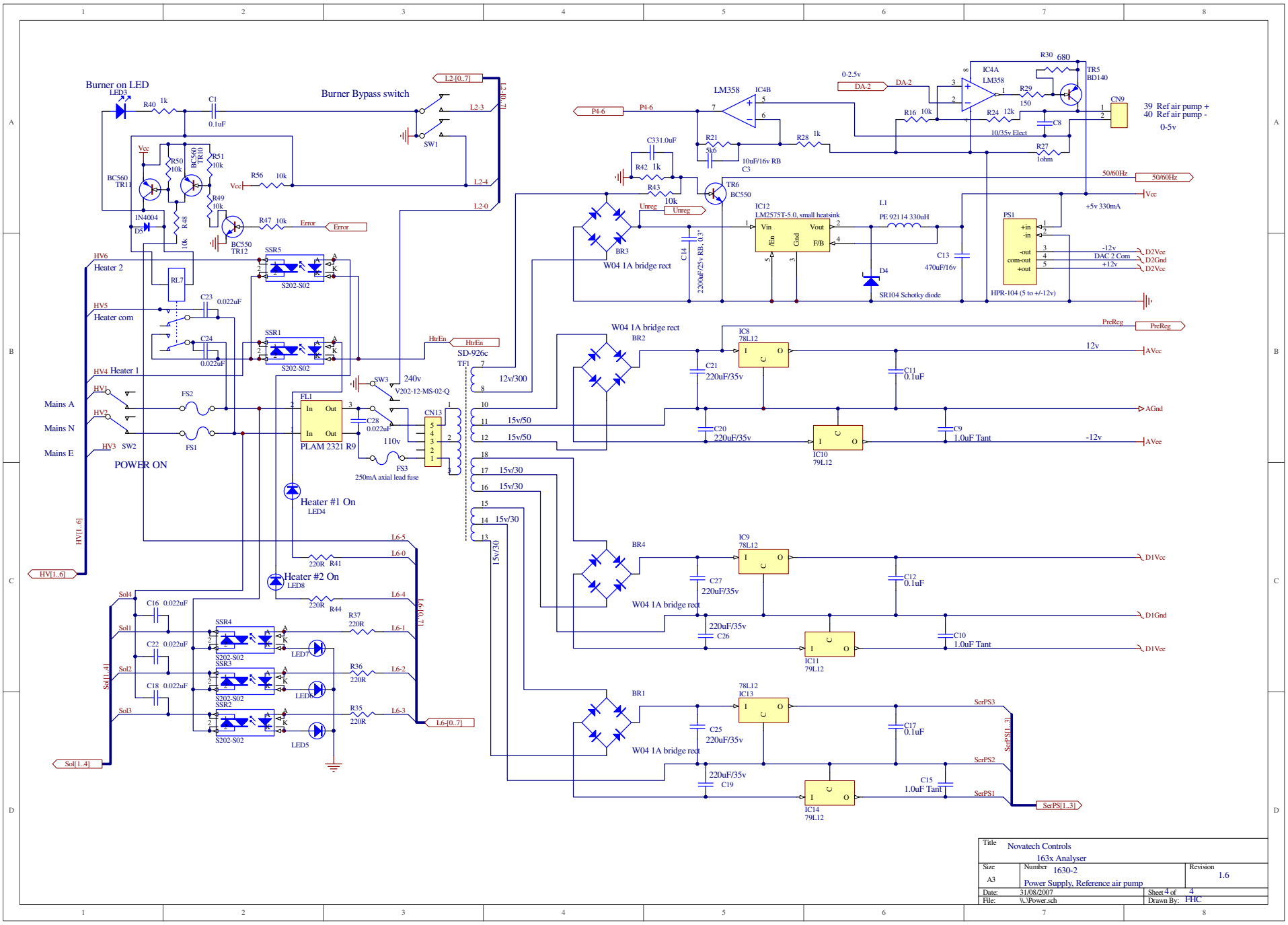
Sample log print out using 'Printer' mode (Section 5.5, set-up 57)

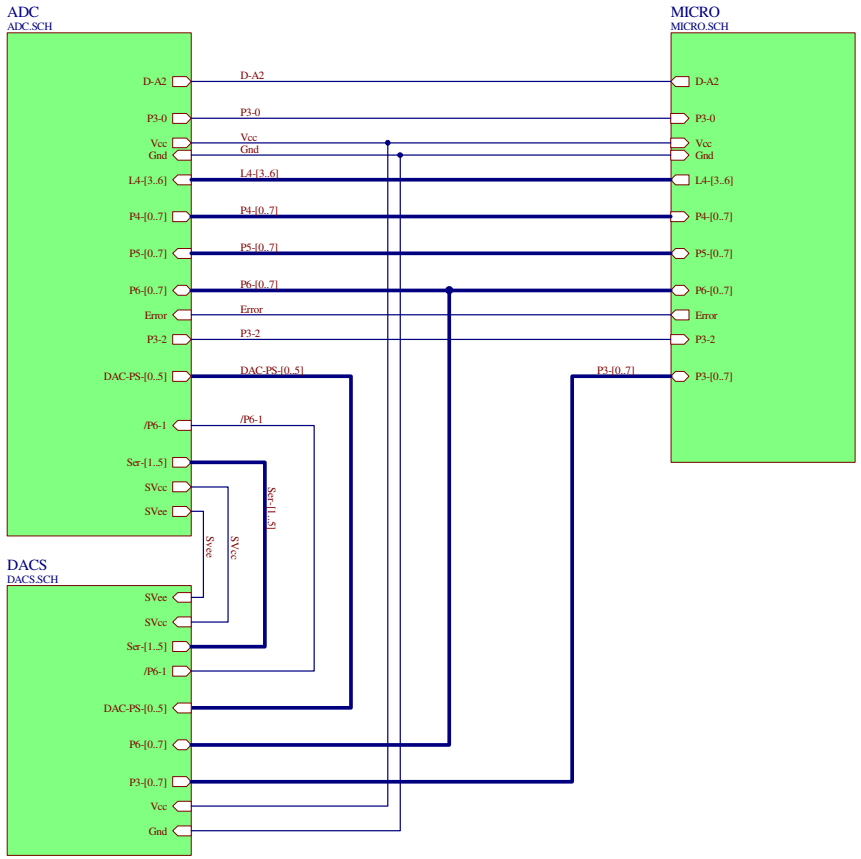
61559 15.2 10.130
61575 15.2 10.130
61591 15.2 10.131
61607 15.2 10.131
61623 15.2 10.130
61639 15.2 10.131
61656 15.2 10.131
61672 15.2 10.130

Sample log print out using 'Logger' mode (Section 5.5, set-up 57)
(Seconds today, oxygen sensor EMF, Oxygen %)

APPENDIX 4

CIRCUIT SCHEMATICS

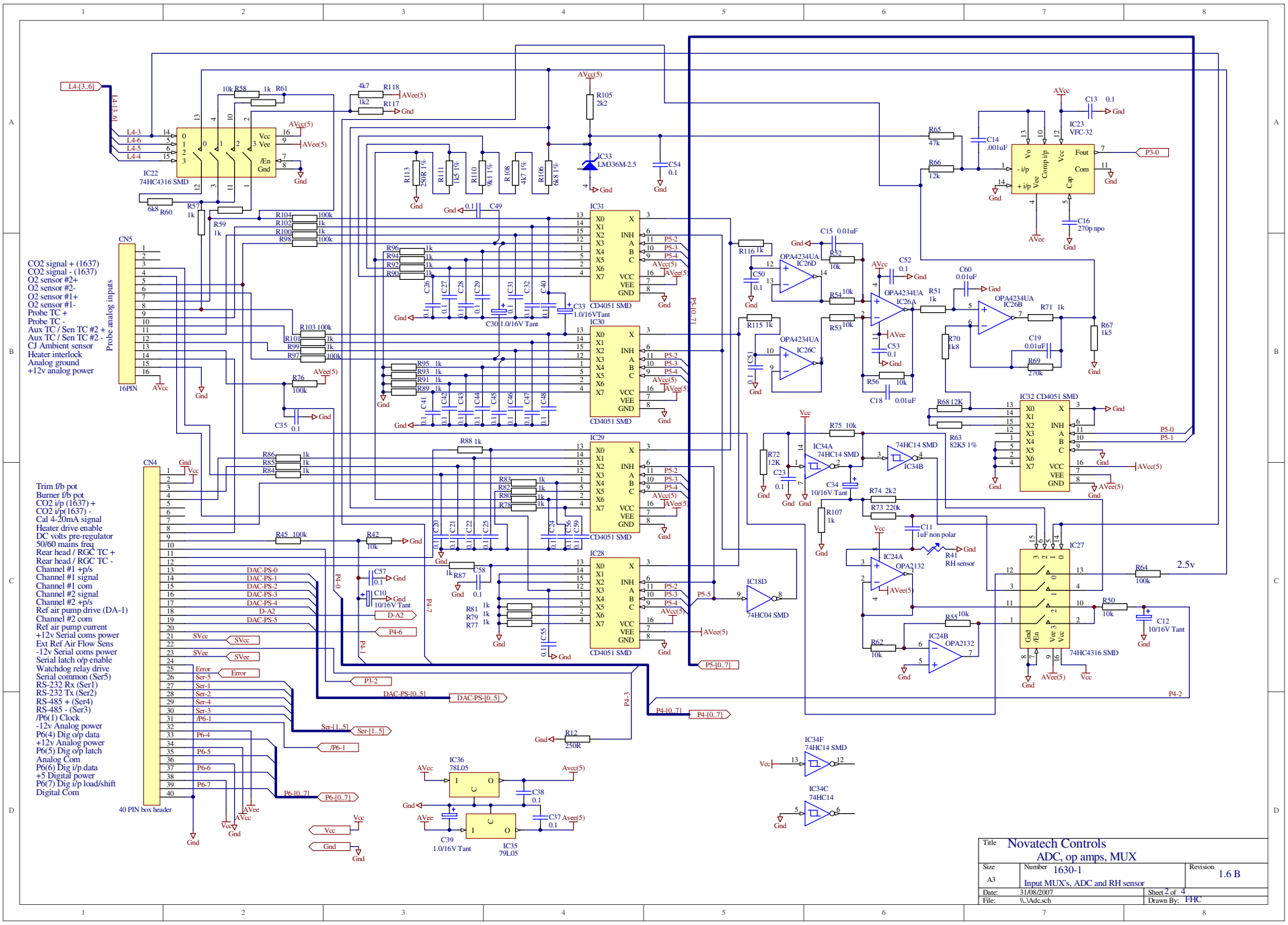

Burner on LED
LED3
R40 1k
C1
0.1uF
Burner Bypass switch
L2-[0..7]
L2-3
SW1
L2-4
L2-0
Vcc
R50 10k
BC560 TR11
BC560 TR10
R51 10k
R49 10k
R48 10k
1N4004
D5
R56 10k
R47 10k
Error
BC550 TR12
HV6
Heater 2
SSR5
S202-S02
RL7
HV5
Heater com
C23 0.022uF
C24
0.022uF
SSR1
S202-S02
HV4 Heater 1
HtrEn
SD-926c
TF1
SW3
240v
V202-12-MS-02-Q
HV1
HV2
HV3 SW2
Mains A
Mains N
Mains E
POWER ON
FS2
FS1
FL1
In Out
In Out
PLAM 2321 R9
C28 0.022uF
110v
FS3
250mA axial lead fuse
CN13
7 12v/300
10 15v/50
11 15v/50
12 15v/50
18
17 15v/30
16 15v/30
15
14 15v/30
13 15v/30
Heater #1 On
LED4
Heater #2 On
LED8
220R R41
220R R44
L6-5
L6-0
L6-4
L6-1
L6-2
L6-3
L6-[0..7]
HV[1..6]
Sol4
Sol1
Sol2
Sol3
Sol[1..4]
C16 0.022uF
C22 0.022uF
C18 0.022uF
SSR4
SSR3
SSR2
S202-S02
R37 220R
R36 220R
R35 220R
LED7
LED6
LED5
P4-6
LM358
IC4B
R21 5k6
C331.0uF
R42 1k
R43 10k
10uF/16v RB
C3
R28 1k
TR6
BC550
0-2.5v
DA-2
IC4A
LM358
R30 680
TR5
BD140
R29 150
R24 12k
R16 10k
10/35v Elect
C8
R27 1ohm
CN9
39 Ref air pump +
40 Ref air pump -
0-5v
50/60Hz
Vcc
+5v 330mA
Unreg
BR3
W04 1A bridge rect
C14
2200uF/25v RB, 0.3"
IC12
LM2575T-5.0, small heatsink
Vin
Vout
/Ein
Gnd
F/B
L1
PE 92114 330uH
C13
470uF/16v
D4
SR104 Schotky diode
PS1
+in
-in
-out
com-out
+out
HPR-104 (5 to +/-12v)
-12v
DAC 2 Com
+12v
D2Vee
D2Gnd
D2Vcc
PreReg
BR2
W04 1A bridge rect
IC8
78L12
C21
220uF/35v
C11
0.1uF
12v
AVcc
AGnd
C20
220uF/35v
IC10
79L12
C9
1.0uF Tant
-12v
AVee
BR4
W04 1A bridge rect
IC9
78L12
C27
220uF/35v
C12
0.1uF
D1Vcc
D1Gnd
C26
220uF/35v
IC11
79L12
C10
1.0uF Tant
D1Vee
BR1
W04 1A bridge rect
IC13
78L12
C25
220uF/35v
C17
0.1uF
SerPS3
SerPS2
SerPS1
SerPS[1..3]
C19
220uF/35v
IC14
79L12
C15
1.0uF Tant
Title
Novatech Controls
163x Analyser
Size
A3
Number
1630-2
Power Supply, Reference air pump
Revision
1.6
Date:
31/08/2007
Sheet 4 of 4
File:
\\..\Power.sch
Drawn By:
FHC

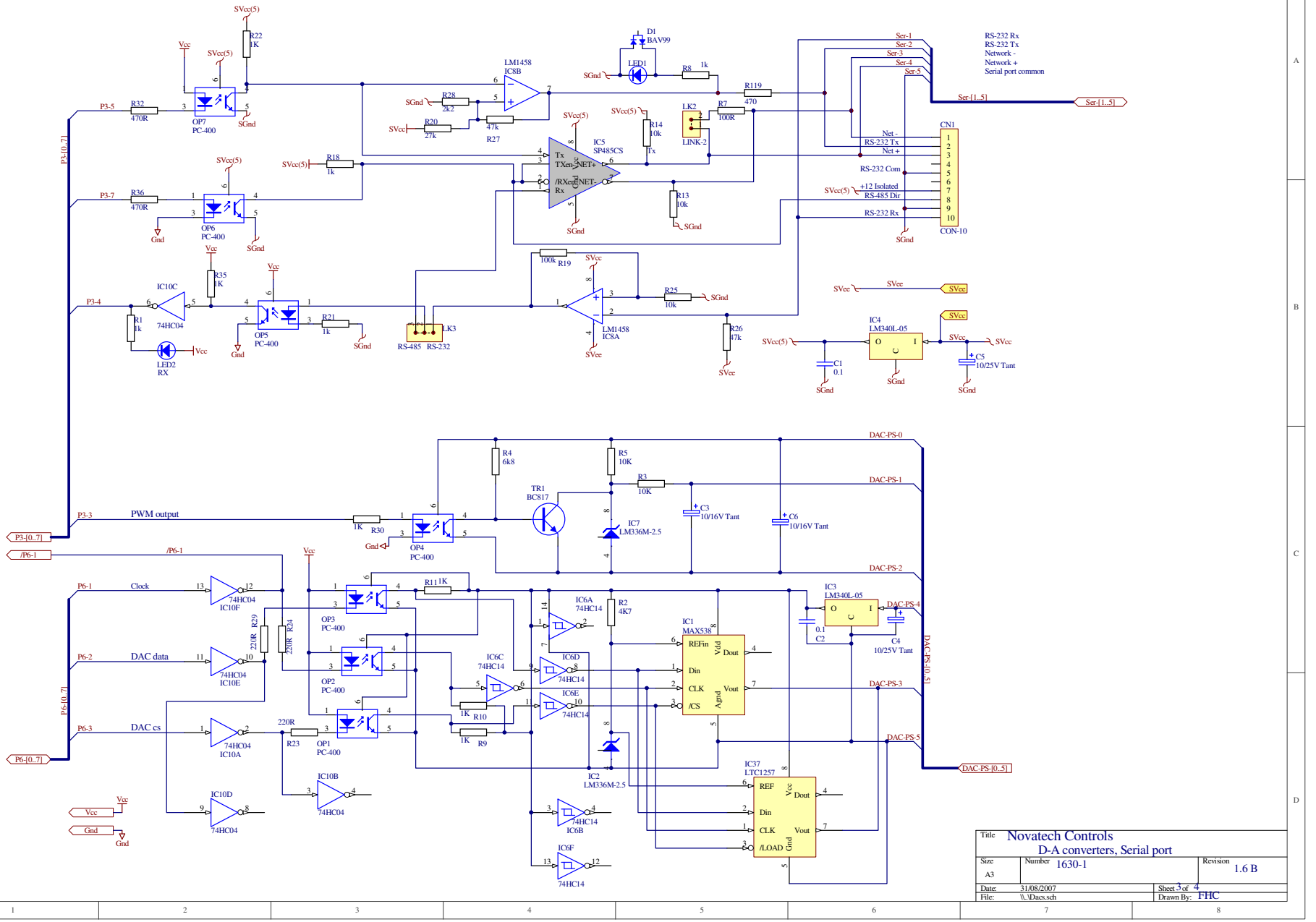


SC1 SC2 SC3 SC4 SC5

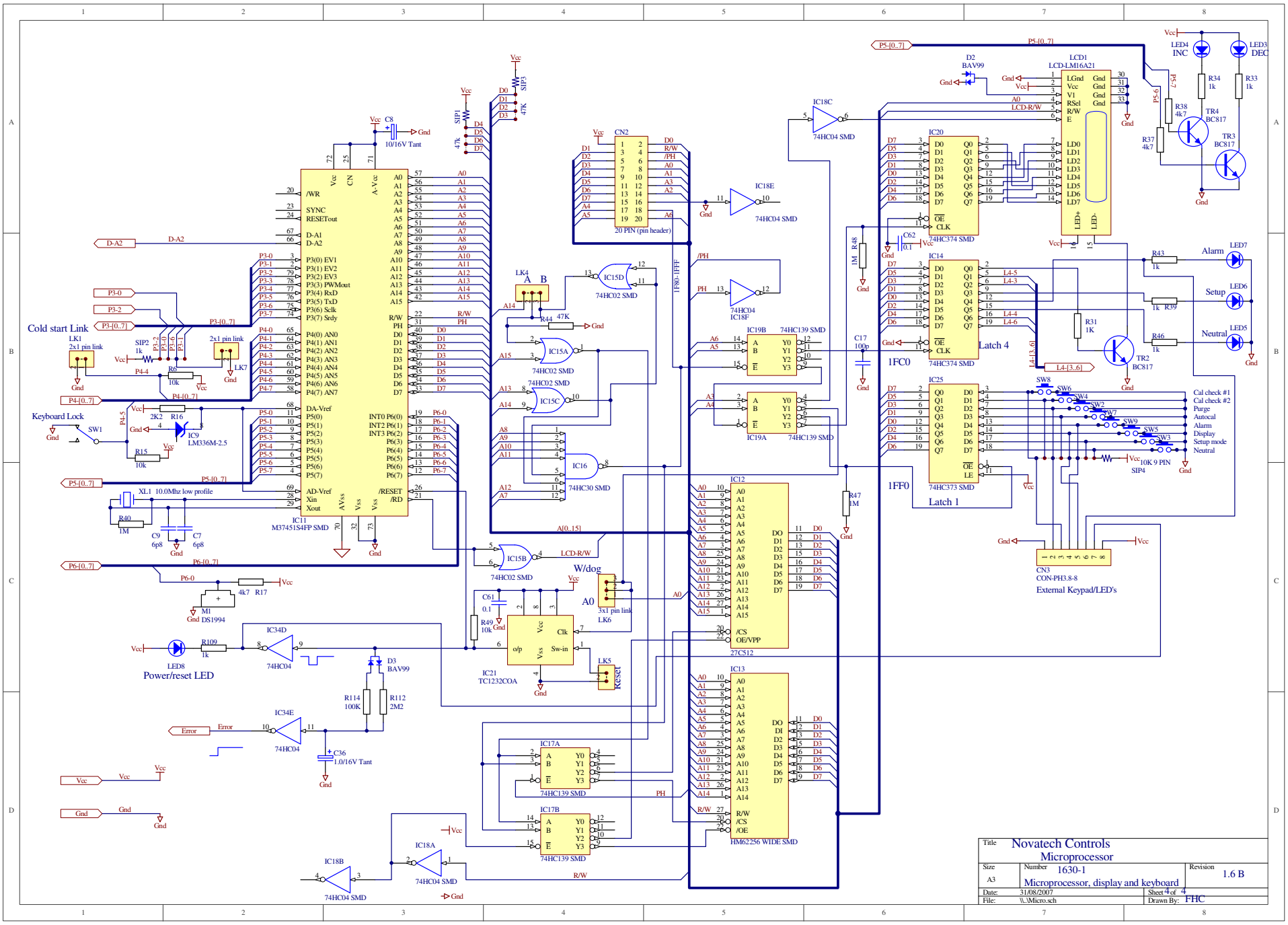
Mounting holes

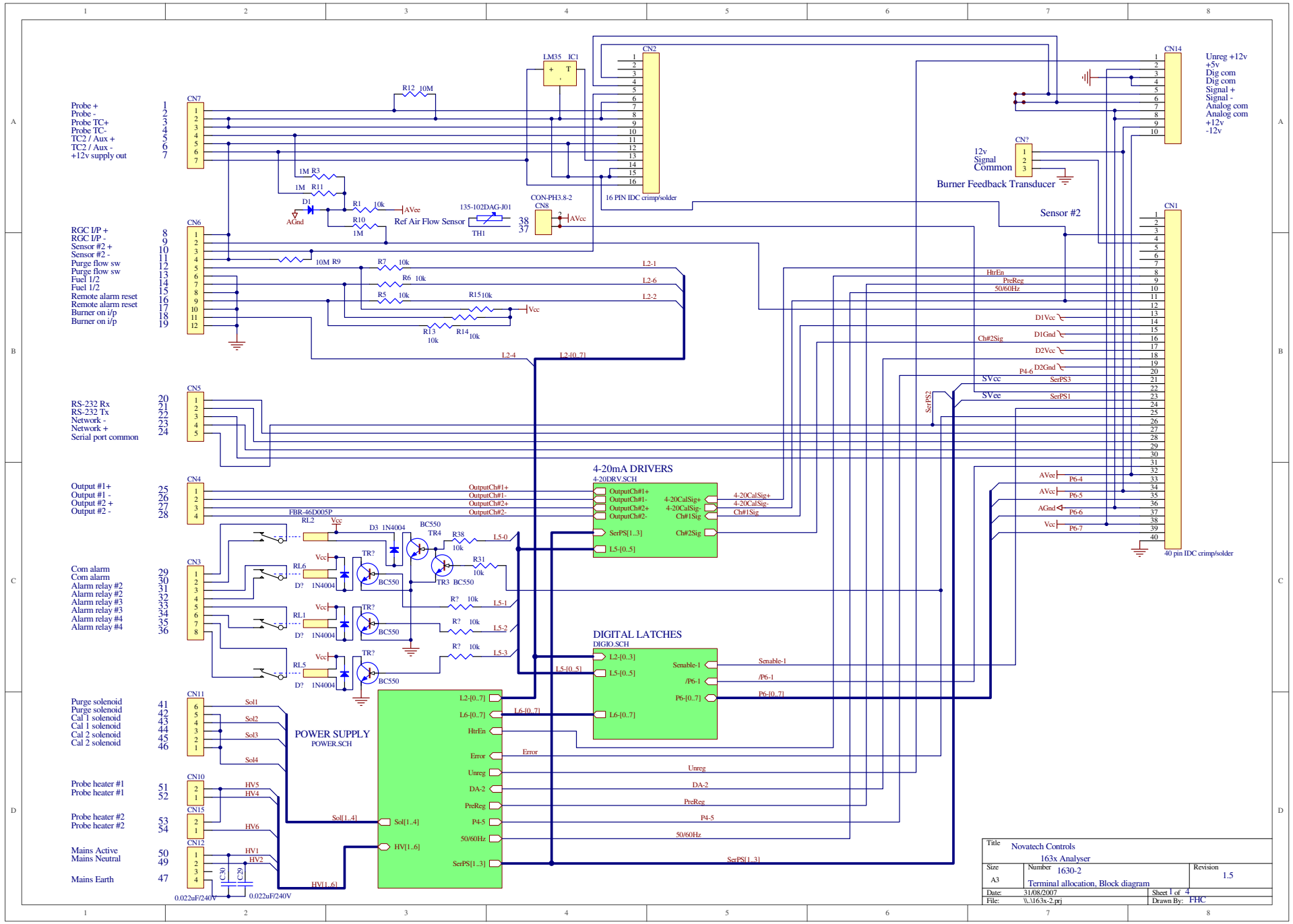
Title	Novatech Controls Master diagram		
Size A3	Number 1630-1 Block Diagram		Revision 1.6 B
Date:	31/08/2007	Sheet 1 of 4	
File:	\\.\1630-1.prj	Drawn By:	FHC

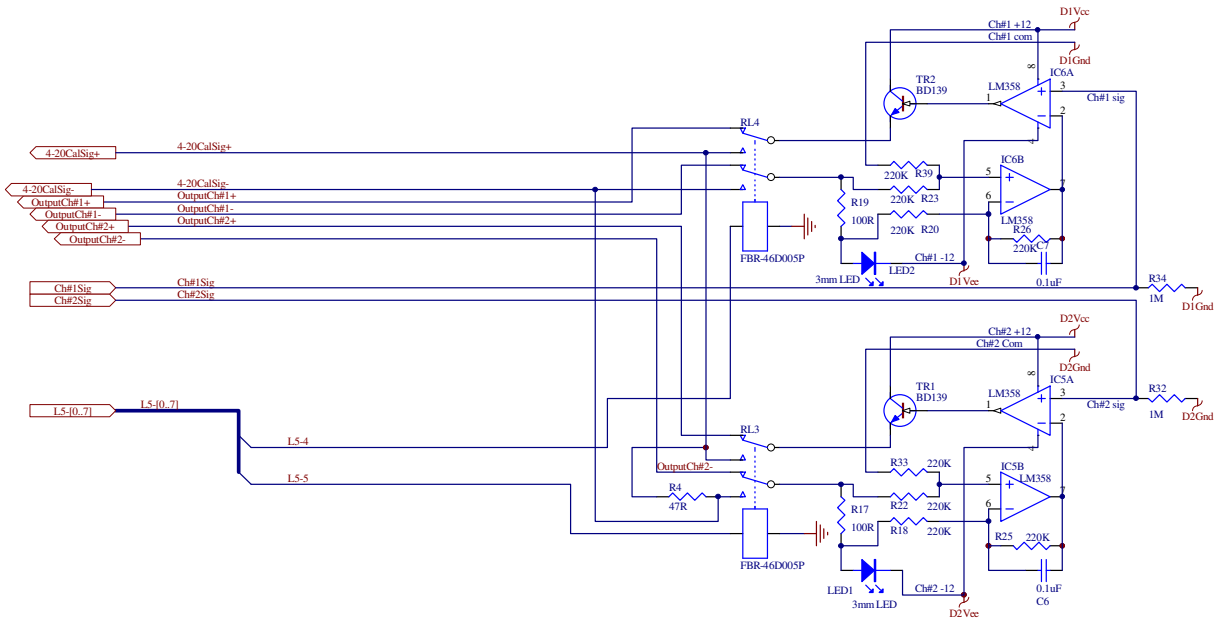

CO2 signal + (1637)
CO2 signal - (1637)
O2 sensor #2+
O2 sensor #2-
O2 sensor #1+
O2 sensor #1-
Probe TC +
Probe TC -
Aux TC / Sen TC #2 +
Aux TC / Sen TC #2 -
CJ Ambient sensor
Heater interlock
Analog ground
+12v analog power
Probe analog inputs
16PIN
Trim f/b pot
Burner f/b pot
CO2 i/p (1637) +
CO2 i/p(1637) -
Cal 4-20mA signal
Heater drive enable
DC volts pre-regulator
50/60 mains freq
Rear head / RGC TC +
Rear head / RGC TC -
Channel #1 +p/s
Channel #1 signal
Channel #1 com
Channel #2 signal
Channel #2 +p/s
Ref air pump drive (DA-1)
Channel #2 com
Ref air pump current
+12v Serial coms power
Ext Ref Air Flow Sens
-12v Serial coms power
Serial latch o/p enable
Watchdog relay drive
Serial common (Ser5)
RS-232 Rx (Ser1)
RS-232 Tx (Ser2)
RS-485 + (Ser4)
RS-485 - (Ser3)
/P6(1) Clock
-12v Analog power
P6(4) Dig o/p data
+12v Analog power
P6(5) Dig o/p latch
Analog Com
P6(6) Dig i/p data
+5 Digital power
P6(7) Dig i/p load/shift
Digital Com
40 PIN box header
IC22 74HC4316 SMD
IC23 VFC-32
IC33 LM336M-2.5
IC31 CD4051 SMD
IC30 CD4051 SMD
IC29 CD4051 SMD
IC28 CD4051 SMD
IC32 CD4051 SMD
IC26A OPA4234UA
IC26B OPA4234UA
IC26C OPA4234UA
IC26D OPA4234UA
IC24A OPA2132
IC24B OPA2132
IC27 74HC4316 SMD
IC34A 74HC14 SMD
IC34B 74HC14 SMD
IC34C 74HC14
IC34F 74HC14 SMD
IC18D 74HC04 SMD
IC36 78L05
IC35 79L05
2.5v
Title Novatech Controls
ADC, op amps, MUX
Size A3
Number 1630-1
Input MUX's, ADC and RH sensor
Revision 1.6 B
Date: 31/08/2007
Sheet 2 of 4
File: \\.\Adc.sch
Drawn By: FHC



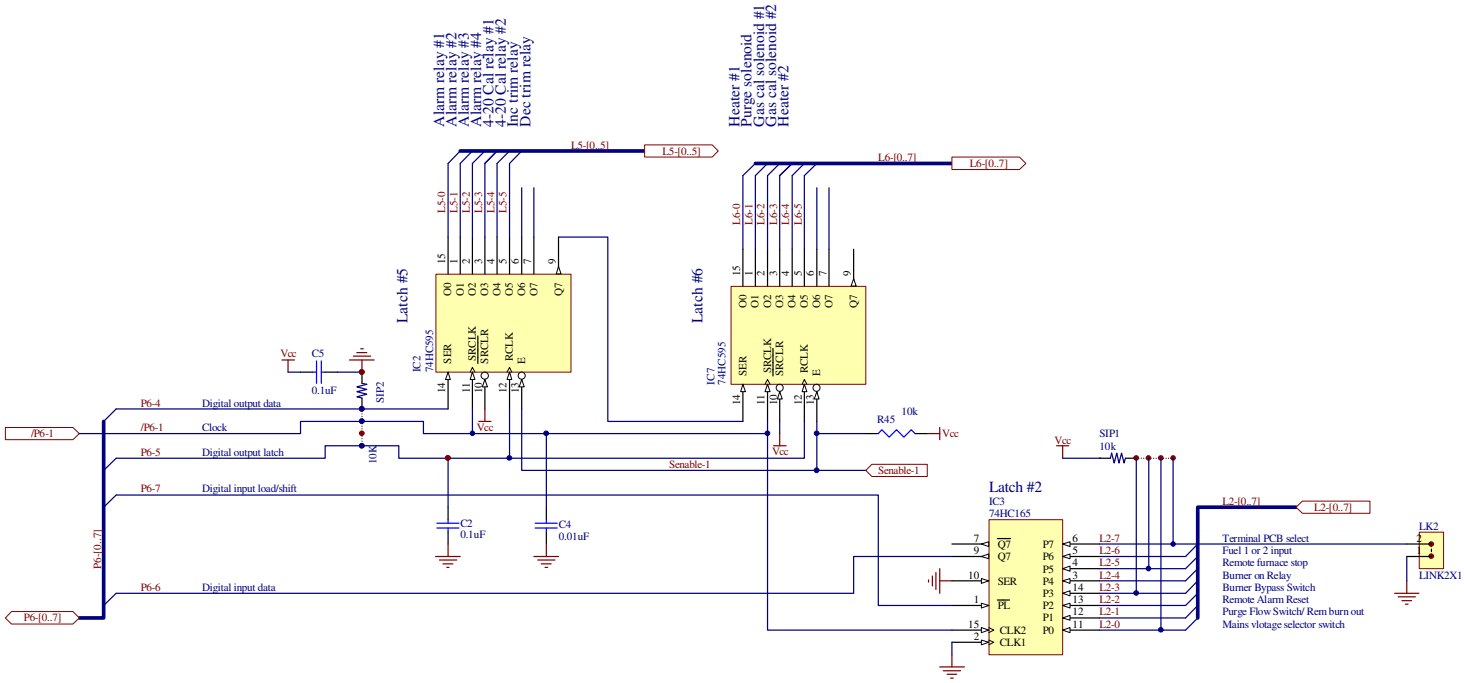
Title	Novatech Controls D-A converters, Serial port	
Size A3	Number 1630-1	Revision 1.6 B
Date: 31/08/2007		Sheet 3 of 4
File: \\..\Dacs.sch		Drawn By: FHC


Cold start Link
Keyboard Lock
Power/reset LED
Latch 4
Latch 1
1FC0
1FF0
External Keypad/LED's
Title
Novatech Controls
Microprocessor
Size
A3
Number
1630-1
Revision
1.6 B
Microprocessor, display and keyboard
Date:
31/08/2007
Sheet 4 of 4
File:
\\.\Micro.sch
Drawn By:
FHC


Probe +
Probe -
Probe TC+
Probe TC-
TC2 / Aux +
TC2 / Aux -
+12v supply out
CN7
R12 10M
LM35 IC1
CN2
16 PIN IDC crimp/solder
1M R3
1M R11
D1
R1 10k
AVcc
AGnd
R10 1M
Ref Air Flow Sensor
135-102DAG-J01
TH1
CON-PH3.8-2
CN8
RGC I/P +
RGC I/P -
Sensor #2 +
Sensor #2 -
Purge flow sw
Purge flow sw
Fuel 1/2
Fuel 1/2
Remote alarm reset
Remote alarm reset
Burner on i/p
Burner on i/p
CN6
10M R9
R7 10k
R6 10k
R5 10k
R15 10k
R13 10k
R14 10k
Vcc
L2-1
L2-6
L2-2
L2-4
L2-[0..7]
RS-232 Rx
RS-232 Tx
Network -
Network +
Serial port common
CN5
Output #1+
Output #1 -
Output #2 +
Output #2 -
CN4
FBR-46D005P
RL2
D3 1N4004
BC550
TR4
R38 10k
R31 10k
TR3 BC550
RL6
RL1
RL5
D? 1N4004
TR?
BC550
R? 10k
L5-0
L5-1
L5-2
L5-3
OutputCh#1+
OutputCh#1-
OutputCh#2+
OutputCh#2-
Com alarm
Com alarm
Alarm relay #2
Alarm relay #2
Alarm relay #3
Alarm relay #3
Alarm relay #4
Alarm relay #4
CN3
4-20mA DRIVERS
4-20DRV.SCH
SerPS[1..3]
L5-[0..5]
4-20CalSig+
4-20CalSig-
Ch#1Sig
Ch#2Sig
DIGITAL LATCHES
DIGIO.SCH
L2-[0..3]
L5-[0..5]
L6-[0..7]
Senable-1
/P6-1
P6-[0..7]
Purge solenoid
Purge solenoid
Cal 1 solenoid
Cal 1 solenoid
Cal 2 solenoid
Cal 2 solenoid
CN11
Sol1
Sol2
Sol3
Sol4
POWER SUPPLY
POWER.SCH
Sol[1..4]
HV[1..6]
Probe heater #1
Probe heater #1
CN10
HV5
HV4
Probe heater #2
Probe heater #2
CN15
HV6
Mains Active
Mains Neutral
Mains Earth
CN12
HV1
HV2
C30
C29
0.022uF/240V
0.022uF/240V
L6-[0..7]
Error
Unreg
DA-2
PreReg
P4-5
50/60Hz
SerPS[1..3]
12v
Signal
Common
CN?
Burner Feedback Transducer
Sensor #2
CN14
Unreg +12v
+5v
Dig com
Dig com
Signal +
Signal -
Analog com
Analog com
+12v
-12v
CN1
HtrEn
PreReg
50/60Hz
D1Vcc
D1Gnd
D2Vcc
D2Gnd
SVcc
SVee
SerPS3
SerPS1
SerPS2
P4-6
P6-4
P6-5
P6-6
P6-7
40 pin IDC crimp/solder
Title
Novatech Controls
163x Analyser
Size
A3
Number
1630-2
Terminal allocation, Block diagram
Revision
1.5
Date:
31/08/2007
Sheet 1 of 4
File:
\\.\163x-2.prj
Drawn By:
FHC



Title	Novatech Controls 163x Analyser		
Size A3	Number 1630-2 4-20mA Output Drivers		Revision 1.5
Date:	31/08/2007	Sheet 3 of 4	
File:	\\.\4-20drv.sch	Drawn By:	FHC



Title	Notatech Controls 163x Analyser	
Size: A3	Number: 1630-2 Digital input/output	Revision: 1.5
Date: 31/08/2007	Sheet 2 of 4	
File: \\.\Digio.sch	Drawn By: FHC	

Declaration of Conformity

Application of Council Directives:

89/336/EEC (92/31/EEC)
72/23/EEC

Standards to which conformity is declared:

EN550011.1:1995 (ISM, Group 1, Class B)
EN55014:1995 (Clause 4.2)
EN50082-2 (Industrial)
EN61010-1
AS61000.4.5:1999
IEC-68-2-2
IEC-68-2-3
AS1099.2.6

Manufacturer's name: **Novatech Controls Pty Ltd**

Manufacturer's address: 309 Reserve Road
Cheltenham VIC 3192
AUSTRALIA

Type of equipment: Oxygen Transmitter
Equipment Class: ISM, Group 1, Class B

Model Number: 1630 Series Transmitter
1231 Oxygen Probe
1234 Oxygen Sensor

I hereby declare that the equipment specified herein conforms to the above directive(s) and standards(s).

Full Name: **Fraser Chapman**
Position: **R & D Manager**

1. ***Interpretation***

In these conditions:

(a) `Seller' means Novatech Controls Pty. Ltd. ABN 57 006 331 700 of 309 Reserve Road, Cheltenham Victoria, 3192 which is the seller of the goods.

(b) `Buyer' means the buyer of the goods specified in the seller's quotation, or in the buyer's order for the goods.

(c) `Goods' means the products and, if any, services specified in Buyer's, orders or Seller's order acknowledgments from time to time.

(d) Nothing in these conditions shall be read or applied so as to exclude, restrict or modify or have the effect of excluding, restricting or modifying any condition, warranty, guarantee, right or remedy implied by law (including the Trade Practices Act 1974) and which by law cannot be excluded, restricted or modified.

2. ***General***

These conditions (which shall only be waived in writing signed by the seller) prevail over all conditions of the buyer's order to the extent of any inconsistency.

3. ***Terms of sale***

The goods and all other products sold by the seller are sold on these terms and conditions.

4. ***Seller's quotations***

Unless previously withdrawn, seller's quotations are open for acceptance within the period stated in them or, when no period is so stated, within 60 days only after its date. The seller reserves the right to refuse any order based on this quotation within 7 days after the receipt of the order.

5. ***Packing***

The cost of any special packing and packing materials used in relation to the goods are at the buyer's expense notwithstanding that such cost may have been omitted from any quotation.

6. ***Shortage***

The buyer waives any claim for shortage of any goods delivered if a claim in respect for short delivery has not been lodged with seller within seven (7) days from the date of receipt of goods by the buyer.

7. ***Drawings, etc.***

(a) All specifications, drawings, and particulars of weights and dimensions submitted to the buyer are approximate only and any deviation from any of these things does not vitiate any contract with the seller or form grounds for any claim against the seller.

(b) Except as referred to in Clause 13.1 herein, the descriptions, illustrations and performances contained in catalogues, price lists and other advertising matter do not form part of the contract of sale of the goods or of the description applied to the goods.

(c) Where specifications, drawings or other particulars are supplied by the buyer, the seller's price is made on estimates of quantities required. If there are any adjustments in quantities above or below the quantities estimated by seller and set out in a quotation, then any such increase or decrease are to be adjusted on a unit rate basis according to unit prices set out in the quotation.

8. ***Performance***

Any performance figures given by the seller are estimates only. The seller is under no liability for damages for failure of the goods to attain such figures unless specifically guaranteed in writing. Any such written guarantees are subject to the recognised tolerances applicable to such figures.

9. ***Acknowledgment regarding facilities for repairs or parts***

The buyer acknowledges that the seller does not promise or represent that facilities for the repair of the goods, or that parts of the goods are or will be available. The buyer must ensure that each purchaser of the goods from the buyer receives notice that the seller does not promise that facilities for the repair of the goods will be available; or parts for the goods will be available.

10. ***Delivery***

(a) The delivery times made known to the buyer are estimates only and the seller is not be liable for late delivery or non-delivery.

(b) The seller is not be liable for any loss, damage or delay occasioned to the buyer or its customers arising from late or non-delivery or late installation of the goods.

(c) The seller may at its option deliver the goods to the buyer in any number of instalments unless there is an agreement in writing between the parties to the effect that the buyer will not take delivery by instalments.

(d) If the seller delivers any of the goods by instalments, and any one of those instalments is defective for any reason:

(i) it is not a repudiation of the contract of sale formed by these conditions; and

(ii) the defective instalment is a severable breach that gives rise only to a claim for compensation.

11. ***Passing of risk***

Risk in the goods passes to the buyer upon the earlier of:

(a) actual or constructive delivery of the goods to the buyer; or

(b) collection of the goods from the seller or any bailee or agent of the seller by the buyer's agent, carrier or courier.

12. ***Loss or damage in transit***

(a) The seller is not responsible to the buyer or any person claiming through the buyer for any loss or damage to goods in transit caused by any event of any kind by any person (whether or not the seller is legally responsible for the person who caused or contributed to that loss or damage).

(b) The seller must provide the buyer with such assistance as may be necessary to press claims on carriers so long as the buyer:

(i) has notified the seller and the carriers in writing immediately after loss or damage is discovered on receipt of goods; and

(ii) lodges a claim for compensation on the carrier within three (3) days of the date of receipt of the goods.

13. ***Guarantee***

13.1 The seller's liability for goods manufactured by it is limited to making good any defects by repairing the defects or at the seller's option by replacement, within a period as specified in Seller's catalogues or other product literature for specified cases or not exceeding twelve (12) calendar months after the goods have been dispatched (whichever is the lesser period) so long as:

(a) defects have arisen solely from faulty materials or workmanship;

(b) the damage does not arise from:

(i) improper adjustment, calibration or operation by the buyer;

(ii) the use of accessories including consumables, hardware, or software which were not manufactured by or approved in writing by the seller;

(iii) any contamination or leakages caused or induced by the buyer;

(iv) any modifications of the goods which were not authorised in writing by the seller;

(v) any misuse of the goods by the buyer or anyone for whom the buyer has legal responsibility (including a minor);

(vi) any use or operation of the goods outside of the physical, electrical or environmental specifications of the goods;

(vii) inadequate or incorrect site preparation; and

(viii) inadequate or improper maintenance of the goods.

(ix) fair wear and tear of the product in an environment in respect of which the Seller has informed the Buyer in catalogues or other product literature that the period of usefulness of the product is likely to be shorter that twelve 12 months.

(c) the goods have not received maltreatment, inattention or interference;

(d) accessories of any kind used by the buyer are manufactured by or approved by the seller;

(e) the seals of any kind on the goods remain unbroken; and

(f) the defective parts are promptly returned free of cost to the seller.

13.2 The seller is not liable for and the buyer releases the seller from any claims in respect of faulty or defective design of any goods supplied unless such design has been wholly prepared by the seller and the responsibility for any claim has been specifically accepted by the seller in writing. In any event the seller's liability under this paragraph is limited strictly to the replacement of defective parts in accordance with para 13.1 of these conditions.

13.3 Except as provided in these conditions, all express and implied warranties, guarantees and conditions under statute or general law as to merchantability, description, quality, suitability or fitness of the goods for any purpose or as to design, assembly, installation, materials or workmanship or otherwise are expressly excluded. The seller is not liable for physical or financial injury, loss or damage or for consequential loss or damage of any kind arising out of the supply, layout, assembly, installation or operation of the goods or arising out of the seller's negligence or in any way whatsoever.

14. ***Seller's liability***

14.1 The seller's liability for a breach of a condition or warranty implied by Div 2 of Pt V of the Trade Practices Act 1974 (other than s 69) is limited to:

(a) in the case of goods, any one or more of the following:

(i) the replacement of the goods or the supply of equivalent goods;

(ii) the repair of the goods;

(iii) the payment of the cost of replacing the goods or of acquiring equivalent goods;

(iv) the payment of the cost of having the goods repaired; or

(b) in the case of services:

(i) the supplying of the services again; or

(ii) the payment of the cost of having the services supplied again.

14.2 The seller's liability under s 74H of the Trade Practices Act 1975 is expressly limited to a liability to pay to the purchaser an amount equal to:

(a) the cost of replacing the goods;

(b) the cost of obtaining equivalent goods; or

(c) the cost of having the goods repaired, whichever is the lowest amount.

15. ***Prices***

(a) Unless otherwise stated all prices quoted by vendor are net, exclusive of Goods and Services Tax (GST) and the buyer agrees to pay to the seller any GST in addition to the price.

(b) Prices quoted are those ruling at the date of issue of quotation and are based on rates of freight, insurance, customs duties, exchange, shipping expenses, sorting and stacking charges, cartage, the quotation, cost of materials, wages and other charges affecting the cost of production ruling on the date is made.

(c) If the seller makes any alterations to the price of the goods or to any of their inputs either before acceptance of or during the currency of the contract, these alterations are for the buyer's account.

16. ***Payment***

The purchase price in relation to goods is payable net and payment of the price of the goods must be made on or before the thirtieth day from the date of invoice unless other terms of payment are expressly stated in these conditions in writing.

17. ***Rights in relation to goods (Romalpa clause)***

The seller reserves the following rights in relation to the goods until all accounts owed by the buyer to the seller are fully paid:

(a) ownership of the goods;

(b) to enter the buyer's premises (or the premises of any associated company or agent where the goods are located) without liability for trespass or any resulting damage and retake possession of the goods; and

(c) to keep or resell the goods including any goods repossessed pursuant to 17(b) above;

If the goods are resold, or goods manufactured using the goods are sold, by the buyer, the buyer shall hold such part of the proceeds of any such sale as represents the invoice price of the goods sold or used in the manufacture of the goods sold in a separate identifiable account as the beneficial property of the seller and shall pay such amount to the seller upon request. Notwithstanding the provisions above the seller shall be entitled to maintain an action against the buyer for the purchase price and the risk of the goods shall pass to the buyer upon delivery.

18. ***Buyer's property***

Any property of the buyer under the seller's possession, custody or control is completely at the buyer's risk as regards loss or damage caused to the property or by it.

19. ***Storage***

The seller reserves the right to make a reasonable charge for storage if delivery instructions are not provided by the buyer within fourteen days of a request by the seller for such instructions. The parties agree that the seller may charge for storage from the first day after the seller requests the buyer to provide delivery instructions.

20. ***Returned goods***

(a) The seller will not be under any duty to accept goods returned by the buyer and will do so only on terms to be agreed in writing in each individual case.

(b) If the seller agrees to accept returned goods from the buyer under para (a) of this clause, the buyer must return the goods to the seller at the seller's place of business referred to at the head of these conditions.

21. ***Goods sold***

All goods to be supplied by the seller to the buyer are as described on the purchase order agreed by the seller and the buyer and the description on such purchase order modified as so agreed prevails over all other descriptions including any specification or enquiry of the buyer.

22. ***Cancellation***

No order may be cancelled except with consent in writing and on terms which will indemnify the seller against all losses.

23. ***Indemnity***

The buyer indemnifies on a continuing basis on a fully indemnity basis the seller from and against any liability, loss, expense or demand for or arising from any false, misleading, deceptive or misdescriptive representation or statement made by the buyer in respect of the goods to any person. This indemnity survives termination of this agreement by either part for any reason.

24. ***Exclusion of representations and arrangements***

Except as referred to in Clause 13.1herein, these terms and conditions supersede and exclude all prior and other discussions, representations (contractual or otherwise) and arrangements relating to the supply of the goods or any part of the goods including, but without limiting the generality of the foregoing, those relating to the performance of the goods or any part of the goods or the results that ought to be expected from using the goods.

25. ***No waiver***

The failure of any part to enforce the provisions of this agreement or to exercise any rights expressed in this agreement is not to be a waiver of such provisions or rights an does not affect the enforcement of this agreement.

26. ***Force Majeure***

If by reason of any fact, circumstance, matter or thing beyond the reasonable control of the seller, the seller is unable to perform in whole or in part any obligation under this agreement the seller is relieved of that obligation under this agreement to the extent and for the period that it is so unable to perform and is not liable to the buyer in respect of such inability.

27. ***Buyer Acknowledgement***

The Buyer acknowledges that the above provisions of these Conditions of Sale are reasonable and reflected in the price and the Buyer accepts the risks of the Buyer associated with these Conditions of sale and/or shall issue accordingly.

28. ***Place of contract***

(a) The contract for sale of the goods is made in the state of Victoria Australia.

(b) The parties submit all disputes arising between them to the courts of such state and any court competent to hear appeals from those courts of first instance.