USER INSTRUCTION MANUAL
ANALOX SUB Mk II P
(SPECIAL VERSION FOR OCEANWORKS)

OXYGEN AND CARBON DIOXIDE MONITOR
WITH AUTOMATIC PRESSURE COMPENSATION

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1 PACKAGING CONTENTS CHECK

a) Analox Sub Mk II P main unit.
b) Calibration Adaptors
c) External supply and Serial Interface cable (as free issued by Oceanworks)
d) User Manual
e) Test Certificate
f) Data Logging / Alarm Setpoint Maintenance Software

2 INTRODUCTION

The ANALOX SUB Mk II P is a combined oxygen and carbon dioxide (CO_2) monitor. Oxygen is monitored by an electrochemical cell and CO_2 is monitored by an infra red absorption technique. Pressure compensation is automatically applied to the CO_2 data.

The unit can be powered internally by alkaline batteries or by an external D.C. supply.

In addition to the power switch, the standard instrument has only one operator control. A single pushbutton controls backlights for each of the liquid crystal displays (LCD), and can also be used to reset the elapsed time. A further four pushbuttons mounted internally are designed for use by a technician when calibrating the instrument.

The unit is built in a waterproof enclosure which is vented to prevent collapse in hyperbaric environments. The lid of the unit should only be opened in clean, dry environments. This should only be necessary for calibration purposes or for changing batteries. The battery life is long enough that during typical usage in a disabled submarine incident, there should be no need to change the batteries.

Gas levels are monitored by diffusion across waterproof membranes built into the unit. The user should ensure that the instrument's gas inlet ports remain as clean as possible to prevent the protective membranes from becoming blocked.

This special version built for Oceanworks has been modified as follows:

a) Oxygen measured in the range 0-1500mBar and displayed as Percent Oxygen
b) Carbon Dioxide measured and displayed in the range 0-50mBar
c) Pressure measured in the range 0-10 Bar Absolute and displayed as Feet Sea Water
d) Two alarms incorporated for the oxygen channel: one high and one low going alarm
e) Two alarms incorporated for the carbon dioxide channel: one high and one very high (or danger) alarm.
f) A different connector specified by the customer which combines both the external power and the RS232 serial interface.

3 OPERATION

The external appearance of the instrument is as shown in Figure 1.

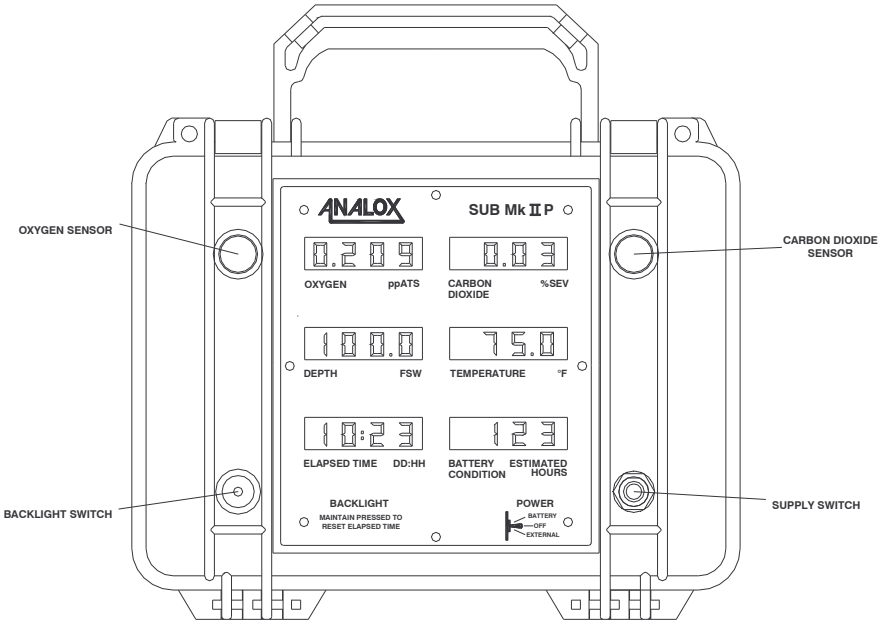


Figure 1: External View of Instrument

Operation of the device is very simple since there are no operator controls, except for the power switch and a single pushbutton switch. To switch the unit on, press the power switch to either the 'Battery' or 'External' position. Either an external supply or batteries must be installed in order for the unit to operate.

If the unit does not turn on, perform the following checks:

a) check that either the external power supply or batteries are healthy
b) check that the fuses in the external supply line or the battery circuit are not blown

On powering up the instrument, the sensor readings may take a short time to settle, particularly the CO_2 sensor, which can take about 40 seconds to ‘warm up’. During this period, it is quite normal to observe erroneous sensor readings.

Sensor readings are updated approximately every two seconds.

The choice of measurement units for each parameter is defined at the time of order and is factory set. For this special version, the settings are as follows:

a) Oxygen readings are displayed in % (Percent Oxygen)
b) CO_2 readings are displayed in mBar.pp (millibar partial pressure)
c) Depth readings are displayed in FSW (Feet Sea Water).
d) Temperature readings are displayed in °F (Fahrenheit).

The battery condition indicator provides an estimate of the number of hours battery life remaining. The actual battery life achieved can be heavily influenced by temperature. It is possible under certain conditions to considerably exceed the estimated battery life.

The instrument readings will remain accurate until the batteries are exhausted. The brightness of the backlights will fade as the batteries discharge. When the Battery Condition indicator reaches 0 hours, new batteries should be inserted.

The battery condition indicator will indicate ‘E-Pr’ when the instrument is operating from an external power supply.

The backlight is turned on by momentarily pressing the pushbutton on the front of the instrument. The backlight will turn off automatically after a short period. A flashing indicator is built into the backlight switch to show that the instrument is operating. This can also be used to locate the backlight switch in dark conditions.

The Elapsed Timer is reset to zero by maintaining the pushbutton pressed for approximately two seconds. The Elapsed Time is displayed as the number of days and hours since the timer was last reset. The timer is maintained even when the instrument is switched off. The timer will stop when it reaches 99 days and 23 hours.

It is intended in a disabled submarine incident for example, that the Elapsed Timer is reset at the start of the incident. The timer will then indicate the elapsed time from the start of the incident in days and hours.

During operation, the following alarms are annunciated:

Alarm Name	Factory Set Value (Refer Note 1)	Indication on display
Oxygen Low Alarm	19.0%	'O2 L' alternating with O2 reading
Oxygen High Alarm	24.0%	'O2 H' alternating with O2 reading
Carbon Dioxide High Alarm	5.0 mBar CO2	'CO2. H' alternating with CO2 reading
Carbon Dioxide Very High (Danger) Alarm	10.0 mBar CO2	'CO2.d' (danger) alternating with CO2 reading

The alarms may be muted by pressing the backlight switch. Operation of the alarms may be configured using the software provided. As supplied, the alarms are set to un-latched operation and may be muted via the backlight switch. Alternative options are that the alarms may be latched, and/or non-muteable. A small amount of hysteresis is included for each alarm. Refer to Section 6.2 for details regarding alarm configuration.

1 The factory set value may be overridden using the software provided.

4 INSTALLING BATTERIES

4.1 SAFETY WARNING

Analox have used Duracell D-type batteries in Analox Sub products for a number of years.

In February 2004, a batch of batteries exhibited problems when pressurised during factory tests. Some failed at pressures as low as 2.4Bar Absolute.

This appears to have been a batch problem. A different batch of batteries exhibited normal behaviour. Duracell are currently investigating the problem.

We therefore feel obliged to warn users of the potential problems which may occur after changing batteries.

The problem will not be apparent until the batteries are subjected to pressure, which may be at the time the instrument is most needed.

All batteries now supplied with Analox hyperbaric products are tested to determine that they are suitable, and then labelled 'Analox Hyperbaric Tested'.

These batteries are also available as spares from Analox as Part No 2557-4625.

Users are free to choose to buy their own batteries, but we recommend that you test that they perform under pressure prior to critical usage of the instrument.

4.2 Main Batteries

The instrument is fitted with four 'D' size 1.5v alkaline cells. Although the instrument will operate from other types of D size battery, their use is not recommended. The operating life using batteries such as zinc chloride or nickel cadmium will be significantly less than with alkaline. Batteries with cell voltages in excess of 1.5v must not be fitted.

The instrument is designed such that if a set of new alkaline batteries is installed at an annual maintenance, and if the equipment is then powered for 1 hour every month for testing purposes, then in the event of a disabled submarine incident, the batteries will power the instrument for in excess of ten days. A disabled submarine incident is believed to be no longer than seven days, therefore under these conditions, there will be no need to access the batteries during the incident. It is assumed that the backlight would only be used on an occasional basis during this period, since it has the biggest effect on battery life.

To replace the batteries:

a) In dry conditions (to prevent damage) open the lid of the instrument using the two catches beside the handle
b) Undo the two velcro retaining straps around the batteries
c) Ease each battery from its clips - use one hand to grip the battery and the other hand to apply a little pressure to release the clips.
d) Insert the new batteries, taking care to observe the polarity markings on each of the battery holders, and ensuring that the battery is retained by the clips in the holder.
e) Refasten the Velcro retaining straps to prevent the batteries becoming dislodged from their holders inadvertently.
f) Close the lid of the instrument, and secure in place with the two catches.

4.3 Backup Batteries

The instrument is also fitted with 2 additional LR43 Alkaline Manganese cells to maintain the Real Time Clock within the instrument. The Real Time Clock is used to calculate the elapsed time and for instruments with the datalogging option.

These cells are mounted on the main printed circuit board on the underside of the lid. The batteries should be replaced at 5 year intervals. Observe the polarity markings on the cell holders, positive uppermost.

The instrument will operate without these batteries fitted, although the Elapsed Time function will not operate whilst switched off. Datalogging functions (where fitted) will also be affected.

5 EXTERNAL CONNECTIONS

This special version of the instrument is fitted with a connector which permits connection of external power and an external RS232 device (eg a personal computer).

The connector, selected by the customer, is an Impulse MCBH-8-MP male plug mounted to the rear of the instrument. The mating cable mounted socket required is an MCIL-8-FS

The pin out of these connectors is shown below:

Pin No	Function	Cable Core Colour	Connect To
1	+24V DC (any stabilised DC voltage between 8V and 40V is permissible)	Black	External Supply (+)
2	0V DC	White	External Supply (-)
3	RS232 Ground	Red	PC Serial Port Ground (Pin 5 of 9 way D-type)
4	RS232 TX Out	Green	PC Serial Port Rx Input (Pin 2 of 9 way D-type)
5	RS232 RX In	Blue	PC Serial Port Tx Output (Pin 3 of 9 way D-type)
6	Spare	Brown	
7	Spare	Yellow	
8	Shield (Not internally connected)	Orange	Optional cable shield

NOTE: This connector is identical to the Sub MkIIF system supplied with the same order, but the SubMkIIF system uses a different pin out for the Serial Interface. Take care to make the correct connections.

The external supply must be a stable DC supply in the range 8-40V. Typical current consumption figures are shown below

Input Voltage (V DC)	Load Current (without backlight) (mA)	Load Current (with backlight) (mA)
8.0	160	315
12.0	105	340
24.0	55	290
40.0	37	270

6 REMOTE COMMUNICATIONS

The Remote Communications via the Serial Interface is required for the following purposes:

a) To use the built in data logging facility
b) To configure the alarm setpoints and operating mode.
c) To request data output of the displayed parameters

All data communications with the instrument must use a baud rate of 9600 baud, 1 start bit, 8 data bits, no parity and 1 stop bit. No handshaking is required.

6.1 Data Logging Access

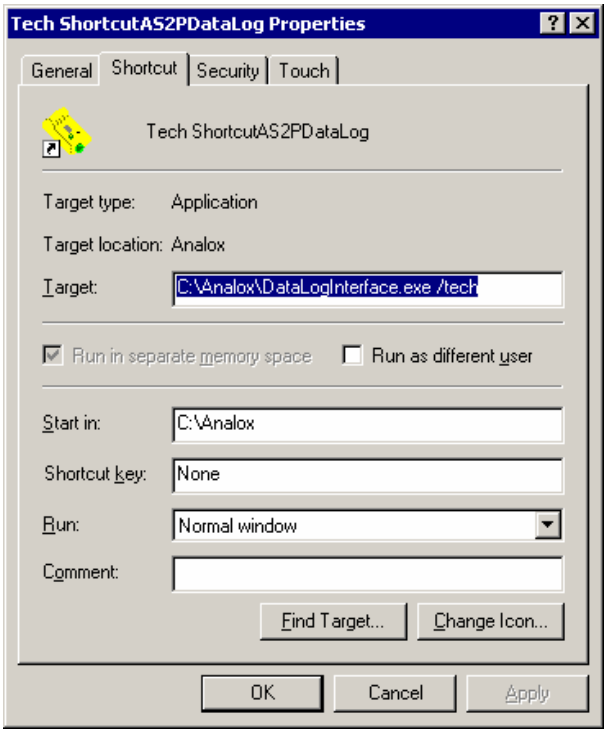
Refer to Section 8 for details of the data logging, and installation of the supplied software.

6.2 Configuration of Alarm setpoints and operating modes

Access to these options requires you to create a copy of the shortcut supplied with the software, and to edit it as follows.

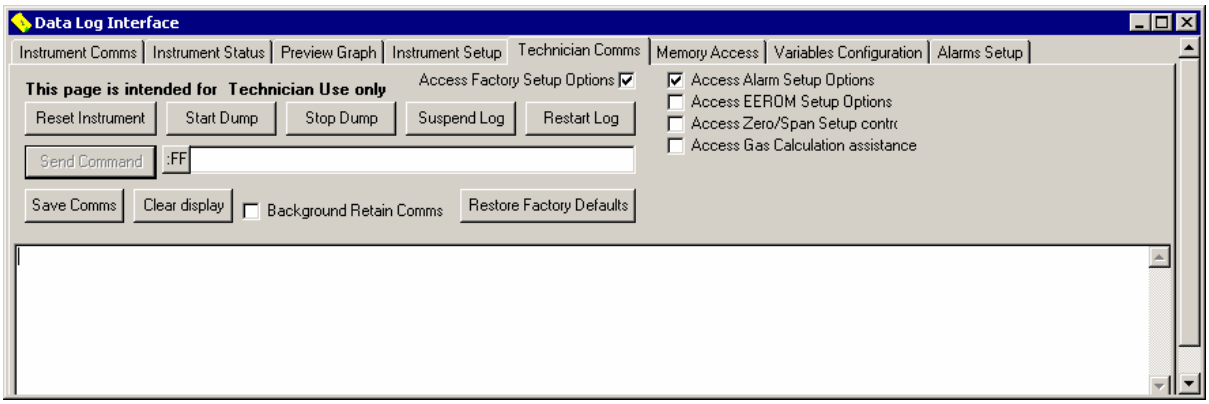
a) Click once on the shortcut, then select Edit, Copy and then Edit, Paste.
b) Right hand click once on the copy of the shortcut, and select rename. Alter the name of the shortcut to 'Tech ShortcutAS2PDatalog '
c) Right hand click on the shortcut again and select Properties.
d) Add '/tech' to the Target as shown below, and then click OK.
e) You now have two shortcuts to the software. The Tech shortcut will do everything that the normal shortcut does, but the normal shortcut will not give access to the configuration pages.

NOTE: Take care with the Technician shortcut, as if used incorrectly, you can affect operation of the instrument.

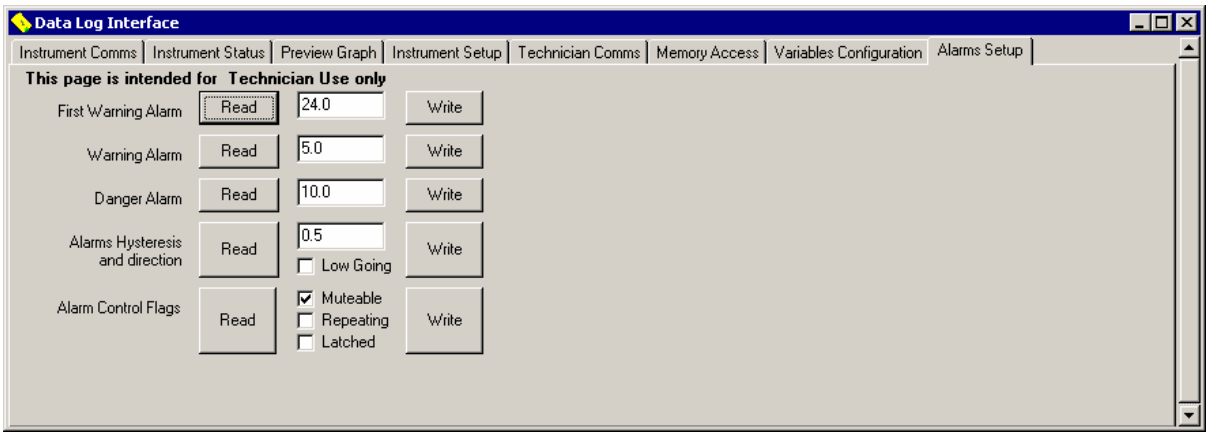


To start up the software in Technician mode to adjust the alarm settings

a) Double click on the Tech shortcut
b) Click on the 'Technician Comms' Tab
c) Tick the box 'Access Factory Setup Options'
d) Drag the window or click on the Maximise button to make the window larger.
e) Tick the box 'Access Alarm Setup Options', such that the screen looks as shown below.



f) Now click on the Alarms Setup tab to bring up the following screen



This screen is really intended for a different product, so please refer to the following notes closely

Alarm Parameter	Adjust via parameter	Initial Value
Oxygen Low	Refer below	19.0%
Oxygen High	First Warning Alarm	24.0%
Oxygen Hysteresis	Refer below	
CO2 High	Warning Alarm	5.0 (relates to 5mBar)
CO2 Very High (Danger)	Danger Alarm	10.0 (relates to 10mBar)
CO2 Hysteresis	Alarm Hysteresis	0.5 (relates to 0.5mBar)
Muteable	Allow the audible sounder to be silenced	Ticked
Repeating	Leave unticked	
Latched	Allow the alarm status to be latched	Unticked

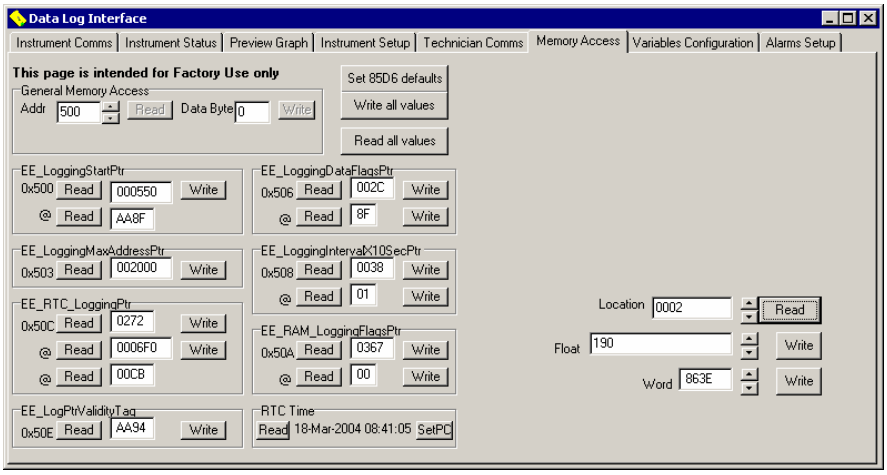
6.3 Additional Oxygen Alarm Control Parameters

The Oxygen Low alarm setpoint and the oxygen alarm Hysteresis are accessed as follows:

Click on the Memory Access tab
Identify the 'Location' box and the 'Float' box in the bottom right hand corner as shown below.

Relevant locations are as shown below

Location	Parameter	Significance
02	Oxygen Low Alarm	190 refers to 19.0% (i.e. decimal point is omitted)
05	Oxygen Hysteresis	5 refers to 0.5%



NOTE: Do not attempt to interfere with the other options on this page. If used incorrectly, you can affect operation of the instrument.

6.4 Mute and Latched Status

A muteable alarm means that if you press the Backlight switch, the audible alarm will be muted.

A latched alarm means that the alarm status will remain in alarm, even after the gas has returned to a safe level, until the Backlight switch has been pressed to Acknowledge the presence of the alarm.

The following combinations are possible

Muteable	Latched	Comments
Yes	No	Press Backlight to mute alarm. If not pressed, alarm will silence when gas level safe
Yes	Yes	Press Backlight to mute alarm If not pressed, alarm will NOT silence until switch is pressed.
No	No	Alarm cannot be muted using switch Alarm will silence when gas level safe

6.5 Data Output of Displayed parameters

The instrument has been configured to respond to a data request. The data request must consist of the following ASCII character string.

:NNA <CR>

Character	Details	Use
1	Colon character (ASCII decimal 58)	Used to mark start of message
2	Upper byte of hexadecimal remote sensor address	Remote sensor address in range 01-3F. (Appears in CO2 display momentarily at switch on) Use FF (Global Address) to communicate with an unknown address
3	Lower byte of hexadecimal remote sensor address	
4	'A' character (ASCII decimal 65)	The Command Byte
5	Carriage Return character (ASCII decimal 13)	Terminator character to indicate and of message. Note the whole message must be received within 0.5seconds of receiving first character.

Do not include additional characters between the 'A' and the <CR>. These are reserved for factory calibration and configuration.

The instrument will respond to this character string with the reply string:

:NN C=LLLL RRRR UUUUU CCCCC P=AAAA +xxxx +xxxx O=AAAA +xxxx +xxxx T=xxxx <CR>

Let's study the fields within this reply.

The basic reply is of the form
:NN <Data> <CR>

Where

Field	Details	Use
1	Colon character (ASCII decimal 58)	Used to mark start of message
2	NN = Remote Sensor Address	as specified in data request
3	Data Field	(Refer Below)
4	Carriage Return character (ASCII decimal 13)	Terminator character to indicate and of message. Note the whole message must be received within 0.5seconds of receiving first character.

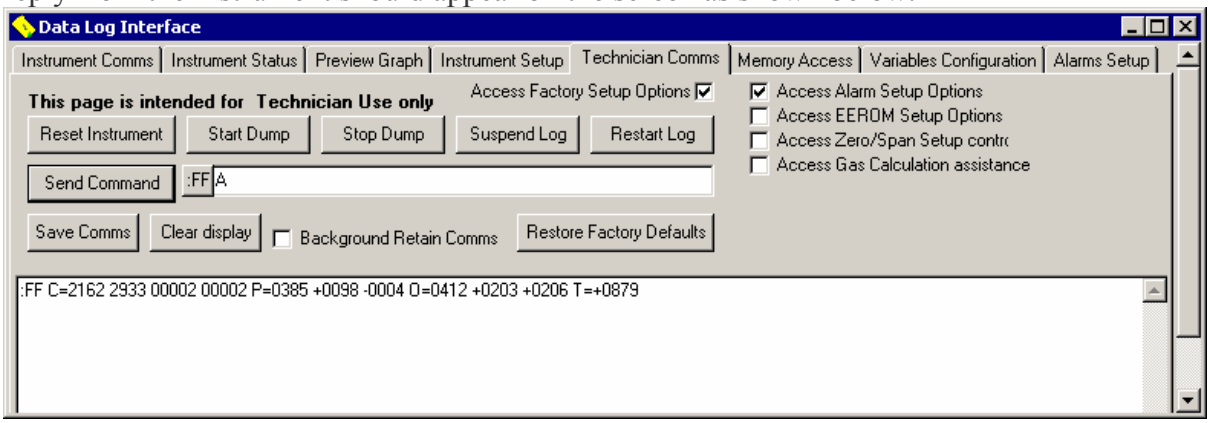
The Data Field consists of the following

<C= CO2 Data> <P= Pressure Data> <O= Oxygen Data> <T= Temperature Data>

Where

CO2 Data	LLLL RRRR UUUUU CCCCC	LLLL and RRRR are internal data values used in calculating the CO2 sensor data. UUUUU is the same as CCCCC CCCCC is the compensated CO2 data, which corresponds to the reading on the display. Note that 50.0 mBar will be represented by a number 500 (ie no decimal point)
Pressure Data	AAAA +xxxx +xxxx	AAAA is the ADC reading from the pressure sensor The next value is the calculated pressure in Bar Absolute (1.00 Bar will appear as 100) The final value is the calculated pressure or depth in the units selected for the display. In this case (FSW), 100 FSW will be represented as 1000. (No decimal point).
Oxygen Data	AAAA +xxxx +xxxx	AAAA is the ADC reading from the oxygen sensor The next value is the calculated partial pressure in mBar (200 mBar will appear as 200) The final value is the calculated oxygen reading in the units selected for the display. In this case (%), 20.9% will be represented as 209. (no decimal point).
Temperature Data	xxxx	This value indicates the same as the External Temperature display, (less the decimal point). 75.0°F will appear as 750.

The supplied software allows you to perform this action so that during your own software development you can confirm that the instrument is working as specified above. Using the Technician shortcut to the programme, select the 'Technician Comms' page. Type an 'A' in the box after the 'Send Command' and 'FF' buttons. Then click on 'Send Command' and the reply from the instrument should appear on the screen as shown below.



7 CALIBRATION

Calibration should be performed at 6 month intervals.

Calibration should only be performed by suitably trained personnel familiar with handling and use of calibration gas. Any abuse of the calibration features may render the instrument inaccurate and unusable, although there is a facility to restore the instrument to its original factory configuration if this should occur.

There are four pushbuttons mounted inside the instrument. These are provided for calibration purposes only.

The pushbuttons are marked SW1, SW2, SW3 and SW4. Figure 2 shows their positions on the main printed circuit board inside the instrument.

Supporting the lid in your hands, while you look at the LCD displays, place the forefinger and middle finger of your left hand onto SW2 and SW4. Similarly, place the fingers of your right hand onto SW1 and SW3.

Your right hand now controls SW1 (UP) and SW3 (DOWN), whilst your left hand controls SW2 (ENTER) and SW4 (CANCEL)

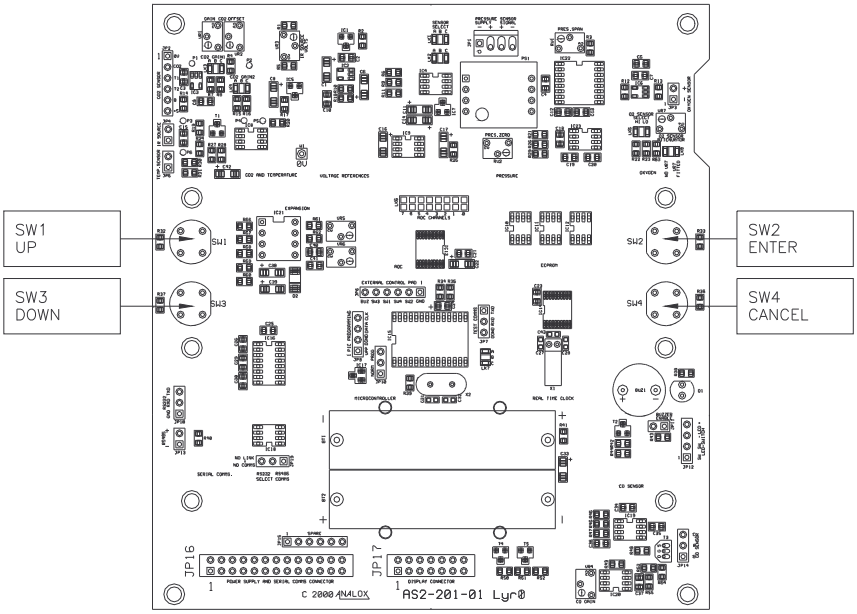


Figure 2: Position of Calibration Pushbuttons

Momentarily pressing the four push buttons at the same time instructs the instrument to display a calibration menu in place of the Elapsed Time and Battery Condition displays.

Initially, the lower displays will show the message CAL O2 L. Pressing UP or DOWN will

cycle through all of the available menu options as shown below

Press Up/Down to select appropriate option

CAL O2 L	Calibrate Oxygen Sensor Low Point
CAL O2 H	Calibrate Oxygen Sensor High Point
CAL CO20	Calibrate Carbon Dioxide Sensor Zero
CAL CO25	Calibrate Carbon Dioxide Sensor Span
CAL Pr L	Calibrate Pressure Sensor Low Point
CAL Pr H	Calibrate Pressure Sensor High Point
CAL tP L	Calibrate Temperature Sensor Low Point
CAL tP H	Calibrate Temperature Sensor High Point
CAL FACt	Select Factory Default Settings

When the desired option has been selected press ENTER. Alternatively press CANCEL to return to normal operation.

Pressing ENTER will cause the instrument to request the user to specify calibration data. Refer to the appropriate section below for further details. The battery condition display will then show the value of the calibration parameter, and the user can adjust the value using the UP and DOWN keys. Pressing CANCEL will abort the calibration, and pressing ENTER will request the calibration to be performed. Before performing the calibration, the instrument will require confirmation. Initially the word 'no' will appear on the Battery Condition display. This must be changed to 'yes' by pressing UP or DOWN, and then confirmed by pressing ENTER. This instructs the calibration to be performed. Pressing ENTER while the display shows 'no', or pressing CANCEL at any time, will prevent the calibration from taking place.

Once entering the calibration menu feature, if no switches are pressed for a period of approximately 2 minutes, the instrument will return automatically to normal operation.

The description above is illustrated in Figure 3.

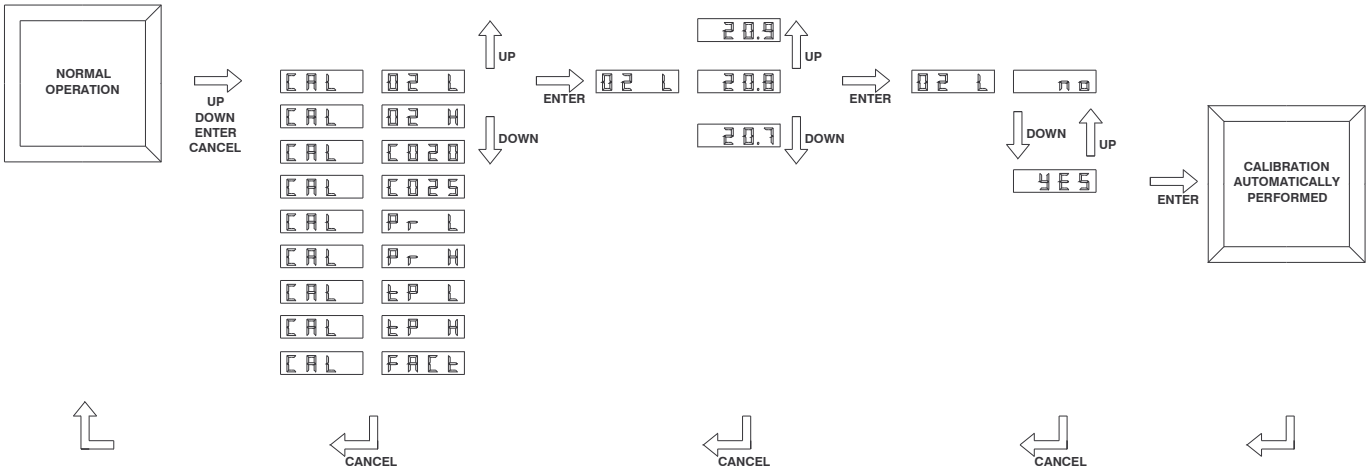


Figure 3: Operation of Pushbuttons during Calibration

7.1 Use Of Calibration Gas

The following sections require the use of calibration gas to calibrate the sensor. The instrument has been designed to allow the use of a wide range of calibration gases from various suppliers.

The oxygen and CO_2 sensors are located immediately adjacent to the corresponding displays.

Figure 4 shows the typical arrangement required for calibration.

The calibration adaptor supplied with the instrument will be required during calibration. It should be pushed into the oxygen sensor inlet or the CO_2 sensor inlet dependant on which sensor is being calibrated. The longer pipe should be connected to a calibration gas bottle flow regulator. The shorter pipe is merely an exhaust which prevents atmospheric contamination of the gas in the sensor.

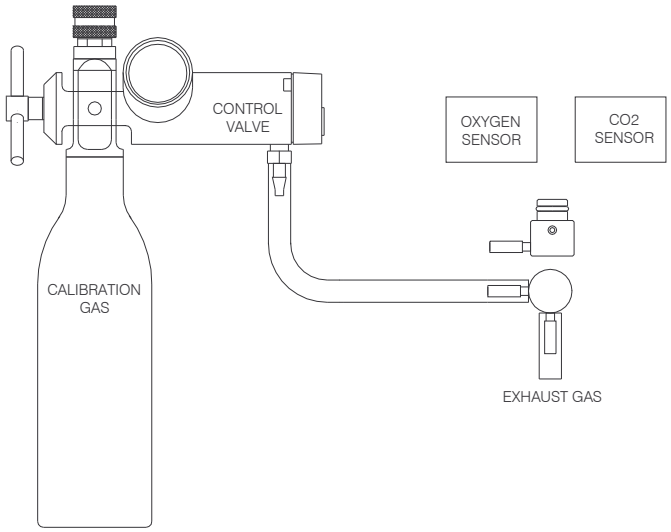


Figure 4: Typical Use of Calibration Gas and Calibration Adaptor

7.2 Oxygen Sensor Calibration

**** NOTE – during the following descriptions, the standard range of 2000mBar must be read as 1500mBar for this Oceanworks special version****

The oxygen sensor provides a varying millivolt output proportional to the partial pressure of oxygen. Two calibration points are provided. The instrument calculates the oxygen concentration by linear interpolation between the calibration points. The calibration parameters are defined as the Percentage of oxygen in the calibration gas. (Eg 20.9 or 100.0% for instance). The instrument determines from the present value of depth, what the expected partial pressure of oxygen should be. It is important that the accuracy of the depth measurement is correct before performing oxygen calibration.

Ideally the calibration points should be near to the lower and upper ends of the oxygen range. The actual range of the oxygen sensor is 0- 2000mBar ppO2. The Low point calibration is expected to be performed using either nitrogen or calibration air. With nitrogen, the calibration can be performed at any depth, whereas with air, the calibration would be best at around 1 Bar Absolute.

The High point calibration is expected to be performed using 100% Oxygen at between 1 and 2 Bar Absolute. An alternative arrangement would be to use the calibration air used for the Low point, but subjected to a higher pressure (eg air at between 5 and 10 Bar Absolute).

EXAMPLE 1 : CALIBRATION OF OXYGEN SENSOR AT NORMAL ATMOSPHERIC PRESSURE AND USE OF 2 GASES (Calibration Air =20.9%O2 and 100% O2)	
1	Prior to proceeding, ensure that the depth (pressure) readout of the instrument is within specification)
2	At atmospheric pressure subject the oxygen sensor to air, using the calibration adaptor supplied and a bottle of calibration air. Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
3	Wait for the instrument reading to settle (allow approximately one minute)
4	Enter calibration mode by pressing all 4 push buttons momentarily
5	Select Cal O2-L by pressing UP/DOWN
6	Press ENTER
7	Press UP/DOWN until the display reads 20.9 (or appropriate value for the calibration air - this is the percentage concentration of oxygen in the calibration gas)
8	Press ENTER
9	Press UP to change 'no' to 'yes'
10	Press ENTER
11	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
12	At atmospheric pressure subject the oxygen sensor to 100% oxygen, using the calibration adaptor supplied and a bottle of calibration oxygen. Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
13	Wait for the instrument reading to settle (allow approximately one minute)
14	Enter calibration mode by pressing all 4 push buttons momentarily
15	Select Cal O2-H by pressing UP/DOWN
16	Press ENTER
17	Press UP/DOWN until the display reads 100.0 (or as appropriate for the gas used- this is the percentage concentration of oxygen in the calibration gas)
18	Press ENTER
19	Press UP to change 'no' to 'yes'
20	Press ENTER
21	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
22	Re-subject the sensor to each of the test gases in turn to confirm that the sensor is working correctly

EXAMPLE 2 : CALIBRATION OF OXYGEN SENSOR USING CALIBRATION AIR AND VARYING THE DEPTH	
1	Prior to proceeding, ensure that the depth (pressure) readout of the instrument is within specification)
2	At atmospheric pressure subject the oxygen sensor to air, using the calibration adaptor supplied and a bottle of calibration air. Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
3	Wait for the instrument reading to settle (allow approximately one minute)
4	Enter calibration mode by pressing all 4 push buttons momentarily
5	Select Cal O2-L by pressing UP/DOWN
6	Press ENTER
7	Press UP/DOWN until the display reads 20.9 (or appropriate value for the calibration air - this is the percentage concentration of oxygen in the calibration gas)
8	Press ENTER
9	Press UP to change 'no' to 'yes'
10	Press ENTER
11	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
12	Now alter the depth experienced by the instrument to between 5 and 9 BarAbs. (ie take the instrument into a pressure environment). Subject the oxygen sensor to air, using the calibration adaptor supplied and a bottle of calibration air. Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
13	Wait for the instrument reading to settle (allow approximately one minute)
14	Enter calibration mode by pressing all 4 push buttons momentarily
15	Select Cal O2-H by pressing UP/DOWN
16	Press ENTER
17	Press UP/DOWN until the display reads 20.9 (or as appropriate for the gas used- this is the percentage concentration of oxygen in the calibration gas)
18	Press ENTER
19	Press UP to change 'no' to 'yes'
20	Press ENTER
21	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
22	Monitor the oxygen readout as the pressure is reduced back to atmospheric pressure and confirm that the sensor is working correctly

7.3 Carbon Dioxide Sensor Calibration

The carbon dioxide sensor works using an infra red absorption technique. It generates maximum signal when exposed to zero CO_2, and minimum signal when exposed to span CO_2. The microprocessor analyses this signal and applies temperature compensation, linearisation and depth compensation as required. Two calibration points are provided. The first point must always be at zero CO_2. The second point should be at around half of the instruments full scale. (ie for a 10% SEV instrument, use of 5% CO_2 at atmospheric pressure is ideal). The calibration parameter is defined as the Percentage of CO_2 in the calibration gas. (eg 5% for instance). Co_2 calibration should always be performed at atmospheric pressure.

EXAMPLE 1 : CALIBRATION OF CO_2 SENSOR AT NORMAL ATMOSPHERIC PRESSURE USING ZERO GAS AND SPAN GAS (typically 5.0% CO_2)	
1	Prior to proceeding, ensure that the depth (pressure) readout of the instrument is within specification)
2	At atmospheric pressure subject the CO_2 sensor to zero CO_2 gas, using the calibration adaptor supplied and a bottle of calibration gas (eg 100% nitrogen, or 100% oxygen or calibration air with CO_2 removed). Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
3	Wait for the instrument reading to settle (allow five minutes)
4	Enter calibration mode by pressing all 4 push buttons momentarily
5	Select Cal CO20 (CO_2 Zero) by pressing UP/DOWN
6	Press ENTER
7	Press UP to change 'no' to 'yes'
8	Press ENTER
9	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
10	At atmospheric pressure subject the CO_2 sensor to 5% CO_2 in nitrogen, using the calibration adaptor supplied and a bottle of suitable calibration gas. Adjust the flow of calibration gas to between 0.3 and 1.0 litres per minute.
11	Wait for the instrument reading to settle (allow five minutes)
12	Enter calibration mode by pressing all 4 push buttons momentarily
13	Select Cal CO2S (CO_2 Span) by pressing UP/DOWN
14	Press ENTER
15	Press UP/DOWN until the display reads 5.00 (or as appropriate for the gas used- this is the percentage concentration of CO_2 in the calibration gas)
16	Press ENTER
17	Press UP to change 'no' to 'yes'
18	Press ENTER
19	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
20	Re-subject the sensor to each of the test gases in turn to confirm that the sensor is working correctly

7.4 Pressure Sensor Calibration

The Pressure sensor provides a varying millivolt output proportional to the absolute pressure experienced by the instrument. The pressure sensor is mounted inside the instrument, but there is a Breather Port that allows the pressure inside the instrument to equalise with the external pressure.

Two calibration points are provided. The instrument calculates the pressure by linear interpolation between the calibration points. It then converts the depth to the units used on the display which are typically Metres of Sea Water (MSW) or Feet Sea Water (FSW). The calibration parameters are defined as the Absolute Pressure in BarA at the time of calibration. (Eg 1.00 and 10.00 BarA for instance).

Ideally the calibration points should be near to the lower and upper ends of the pressure range. The actual range of the sensor is 0- 10.00 Bar Abs. The Low point calibration is expected to be performed between 0 and 1.5 BarAbs. The most convenient point will typically be atmospheric pressure.

The High point calibration is expected to be performed in the upper half of the pressure sensor range (i.e. 5-10 Bar Absolute)

The conversion factors used for converting pressure in Bar Absolute to depth in MSW or FSW are as follows:

Pressure in Bar Absolute is first converted to Bar Gauge by subtracting 1.00 Bar Absolute from the sensor reading.

This results in a Bar Gauge sensor reading in the range -1.00 to +9.00 BarG.

The Bar Gauge reading is then either multiplied by 10.0 to arrive at a reading of -10.0 to +90.0 MSW, or multiplied by 32.8083 to arrive at a reading of -30.0 to 300.0 FSW.

EXAMPLE 1 : CALIBRATION OF DEPTH SENSOR AT NORMAL ATMOSPHERIC PRESSURE AND AT 5.0 Bar Absolute	
1	With the instrument at normal atmospheric pressure, determine from a reference standard the actual atmospheric pressure in Bar Absolute (for example let us assume it is 1.02 Bar Absolute (1020 mBar)
2	Ensure that the instrument reading is steady
3	Enter calibration mode by pressing all 4 push buttons momentarily
4	Select Cal Pr-L (Calibrate Pressure Low) by pressing UP/DOWN
5	Press ENTER
6	Press UP/DOWN until the display reads 1.02 (or appropriate value for actual atmospheric pressure) Note this number is assumed to be Bar Absolute.
7	Press ENTER
8	Press UP to change 'no' to 'yes'
9	Press ENTER
10	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
11	Now subject the instrument to a known pressure of between 5 and 10 Bar Abs in a pressure chamber
12	Ensure that the instrument reading is steady
13	Enter calibration mode by pressing all 4 push buttons momentarily
14	Select Cal Pr-H by pressing UP/DOWN
15	Press ENTER
16	Press UP/DOWN until the display reads 5.00 (or as appropriate for the pressure attained). Note this number is assumed to be Bar Absolute.
17	Press ENTER
18	Press UP to change 'no' to 'yes'
19	Press ENTER
20	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
21	Subject the instrument to varying pressures and confirm the correct depth reading (in either MSW or FSW depending on instrument version)

7.5 Temperature Sensor Calibration

The Temperature sensor is a thermistor which changes its resistance with temperature. The sensor is mounted in the gas entry port to the CO_2 sensor.

Two calibration points are provided. The instrument calculates the temperature by linear interpolation between the calibration points. The calibration parameters are defined as the temperature in Centigrade or Fahrenheit at the time of calibration. (eg 10.0 and 30.0 °C or 50.0 and 90.0 F for instance).

Ideally the calibration points should be near to the lower and upper ends of the normal operating temperature range. The actual range of the sensor is 0- 60°C or 32-140.0 F . The Low point calibration is expected to be performed between 0 and 70 (Centigrade or Fahrenheit). The High point calibration is expected to be performed between 25 and 140 (Centigrade or Fahrenheit). These ranges allow the user to convert the range from Centigrade to Fahrenheit if necessary. The preferred ranges for each calibration points are given in the examples below.

EXAMPLE 1 : CALIBRATION OF TEMPERATURE SENSOR IN DEGREES CENTIGRADE	
1	Subject the entire instrument to a steady known temperature of between 0 and 20°C. (for example let us assume it is 15°C)
2	Ensure that the instrument reading is steady
3	Enter calibration mode by pressing all 4 push buttons momentarily
4	Select Cal Tp-L (Calibrate Temperature Low) by pressing UP/DOWN
5	Press ENTER
6	Press UP/DOWN until the display reads 15.0 (or as appropriate value for actual temperature)
7	Press ENTER
8	Press UP to change 'no' to 'yes'
9	Press ENTER
10	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
11	Now subject the entire instrument to a steady known temperature of between 25 and 60°C (for example let us assume it is 30°C
12	Ensure that the instrument reading is steady
13	Enter calibration mode by pressing all 4 push buttons momentarily
14	Select Cal Tp-H by pressing UP/DOWN
15	Press ENTER
16	Press UP/DOWN until the display reads 30.0 (or as appropriate for actual temperature).
17	Press ENTER
18	Press UP to change 'no' to 'yes'
19	Press ENTER
20	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
21	Subject the instrument to varying temperatures and confirm the correct temperature reading

EXAMPLE 2 : CALIBRATION OF TEMPERATURE SENSOR IN DEGREES FAHRENHEIT	
1	Subject the entire instrument to a steady known temperature of between 32 and 70°F. (for example let us assume it is 60°F)
2	Ensure that the instrument reading is steady
3	Enter calibration mode by pressing all 4 push buttons momentarily
4	Select Cal Tp-L (Calibrate Temperature Low) by pressing UP/DOWN
5	Press ENTER
6	Press UP/DOWN until the display reads 60.0 (or as appropriate value for actual temperature)
7	Press ENTER
8	Press UP to change 'no' to 'yes'
9	Press ENTER
10	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
11	Now subject the entire instrument to a steady known temperature of between 75 and 140°F (for example let us assume it is 85°F
12	Ensure that the instrument reading is steady
13	Enter calibration mode by pressing all 4 push buttons momentarily
14	Select Cal Tp-H by pressing UP/DOWN
15	Press ENTER
16	Press UP/DOWN until the display reads 85.0 (or as appropriate for actual temperature).
17	Press ENTER
18	Press UP to change 'no' to 'yes'
19	Press ENTER
20	Observe after a few seconds that the instrument readout changes to the correct value (it may not have been wrong before)
21	Subject the instrument to varying temperatures and confirm the correct temperature reading

7.6 Select Factory Default Settings

It is possible by the incorrect usage of the calibration features to render the instrument virtually unusable. The situation can be recovered by exercising the calibration options correctly.

It may be beneficial to a technician who is experiencing problems to be able to switch to the original factory default configuration. Each of the sensors may then also require calibration, but the readings displayed by the instrument should make sense.

Note also that the alarm settings will revert to the original factory settings.

To select Factory Default settings, proceed as follows:

EXAMPLE 1 : RESTORING FACTORY DEFAULT SETTINGS	
1	Enter calibration mode by pressing all 4 push buttons momentarily
2	Select Cal Fact (Cal Factory Defaults) by pressing UP/DOWN
3	Press ENTER
4	Press UP to change 'no' to 'yes'
5	Press ENTER
6	Test the performance of each sensor and recalibrate as required

8 DATA LOGGING

The data logging option allows the ANALOX SUB Mk II P to record up to 4000 sensor readings and to output the stored data to a computer for analysis purposes.

An Analox utility installed on the computer allows the instrument to be configured to store any combination of oxygen, carbon dioxide, depth or temperature at selected time intervals varying from 10 seconds to 30 minutes.

The user could for instance opt to record just the carbon dioxide reading at 30 minute intervals. In this case 4000 readings will provide an endurance of about 3 months. Alternatively, the user could opt to record all four parameters at 10 second intervals, in which case the endurance would be approximately 2.5 hours.

By choosing an appropriate interval, the user can store the maximum amount of information over a chosen time period.

A cable is normally supplied to connect the Analox Sub to the serial port on a PC. The cable is fitted with a 9 way female D-type connector. With this special version using the Impulse connector, the user will have to make up the necessary interconnecting cable.

8.1 Installation of Data Logging Software on a PC

The datalogging software is compatible with IBM Personal Computers and compatibles running Windows 95, 98 or 2000 software.

1 Insert the floppy disk provided into the floppy disk drive on your computer

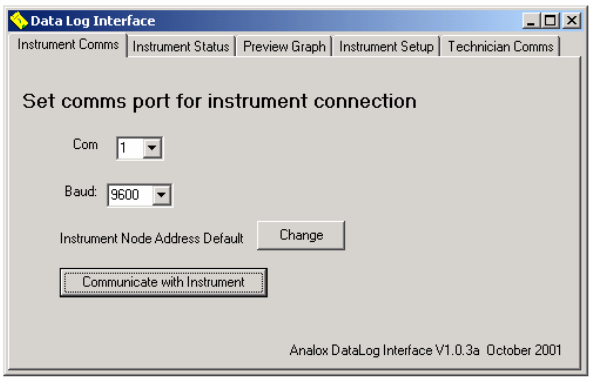
2 From the Start Menu on your desktop select RUN.

3 Type A:INSTALL.BAT or use the Browse feature to locate the file INSTALL.BAT on the Floppy Disk Drive (assumed to be A:). Whilst the file is installing an MSDos type screen will appear, this will disappear when installation is complete.

4 Install.Bat simply transfers the file DataLogInterface.exe to the directory C:\Analox

5 Now create a shortcut to the programme on your desktop
   a. On your desktop, click with the right hand mouse button and select New, and then Shortcut
   b. Navigate using the Browse button to select the file C:\Analox\DataLogInterface. Click OK to select this programme.
   c. Press NEXT
   d. Enter a name by which you would like to refer to the Shortcut, or just leave it as the default name
   e. Click Finish

6 From your desktop now double click on the new shortcut Icon that you have just created
7 The following screen will appear.



8 Now connect the PC to the Analox Sub using the data lead and ensure that the Sub is switched on. Note whether it is connected into COM1, COM2, COM3 or COM4 on the PC. (Note if you have one of the older 25 way D-type ports on your PC, you will also need a 25 way to 9 way D-type adaptor).

9 Ensure that the correct 'COM' port is selected – press the Selection arrow adjacent to 'Com' and select 1 to 4 as appropriate. This setting will be remembered the next time you start the programme.

10 Always ensure that the Baud rate is set to 9600, to which it will default.

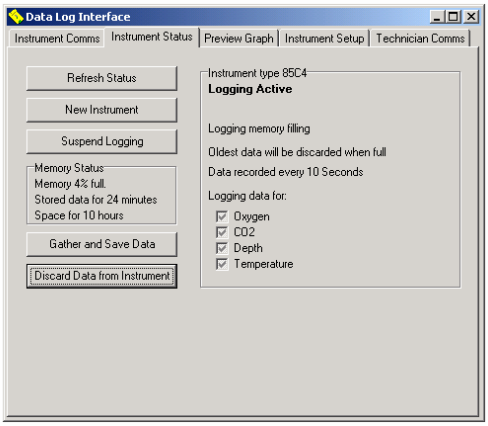
11 Click on the 'Communicate with Instrument' button. You will see a message 'Please wait' and if successful, the 'Instrument Status' tab will be selected.

12 If you get a message 'No Reply from Instrument' check the following:

a. The Analox Sub is switched on
b. The D-type connector is connected between the Analox Sub and PC
c. The correct COM port is selected.
d. No other devices are attempting to use the COM port (eg mouse drivers)

Now click 'OK' to the No Reply from instrument message and retry communications.

13 When you successfully establish communications, the following screen will appear. You are now ready to use the programme.



8.2 Data Logging Programme Overview

The datalogging programme is split into a number of pages or tabs. These are Instrument Comms, Instrument Status, Preview Graph, Instrument Setup and Technician Comms as shown in the diagram below. Additional pages may also be accessed through the Technician Comms page.

Instrument Comms appears during the installation process, the Instrument Status, Preview Graph and Instrument Setup pages are used during datalogging set up, activation and data retrieval. The 'Preview Graph' is a small utility, allowing you an overview of the data that has been logged. It is not intended to replace the need for a spreadsheet. To use the graph select the variable that you wish to view and a graph will be automatically generated. This process will suspend logging; you will therefore need to click on the 'Restart logging' button on the Instrument Status page.

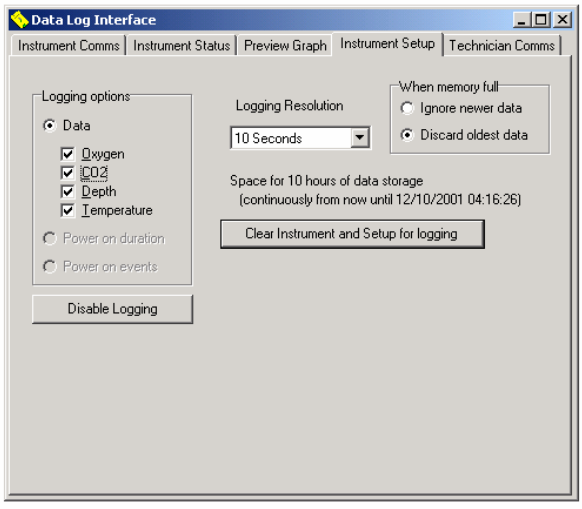
The Technician Comms page should not be used, it is to be used only under guidance from an Analox technician.

The Instrument status page provides a summary of the instruments datalogging status and is shown in the diagram above. This page shows the Memory status of the Analox Sub. The Information Panel to the right of the screen shows us that logging is Active, i.e. the instrument is currently logging. The instrument has been configured to discard the oldest stored data when the memory is full. The instrument is recording all parameters (Oxygen, carbon dioxide, depth and temperature) at 10 second intervals. All of these features are configurable on the Instrument Setup page. The 5 command buttons will be explained in Section 8.4.

8.3 Data Logging Configuration

Click on the 'Instrument Setup' tab.

The following screen will appear



Disable Logging:
If you do not want datalogging to take place at all, press the 'Disable Logging' button. 'Logging disabled' will be shown on the Instrument Status page.

Logging Options:
Select the data items that you wish to record from O_2 , CO2, Depth and Temperature, by clicking on the box next to the parameter you require, if the box has been successfully selected a ✓ will appear.

Logging Resolution:
Select the Logging Resolution you require by clicking on the ▼ arrow, and then clicking on the time interval you want. This is the time interval between logged readings, which can be set to one of various values between 10 seconds and 30 minutes. Please be aware that the shorter the time interval, the shorter the data storage period. For example logging just CO2 at 2 minute intervals will give approximately 3 weeks of continuous data storage, whereas logging O2, CO2, Depth and Temperature at 10 second intervals will result in approximately 10 hours of continuous data storage. The wording 'continuous' refers to the unit logging whilst left permanently switched on. If the instrument is switched off, e.g. overnight, this time period will be extended.

***Note** there is a slight overhead every time the instrument is switched on and off, so the number of data points recorded will be slightly reduced each time the instrument is switched off and on. In normal daily use this reduction will not be apparent.*

Full Memory:
This option enables you to specify what the instrument should do when its datalogging memory is full.
You may choose to 'Ignore newer data' if for example you are conducting a specific test run , using a short logging resolution, and you only require data from that test. By ignoring new data you will ensure that you retain your test data until you have been able to download it to a PC.
You may choose to 'Discard older data' if you want the instrument to essentially keep on logging for ever, and you only intend to download the data following an incident you want to investigate.

Once you have set each of the 3 options described above (Logging Data, Logging Resolution and Memory Full options), press 'Clear Instrument and Setup for Logging'. This transfers the selected options to the instrument. It also transfers the date and time from your PC to the instrument. Make sure the Date and Time on your PC are correct!

You will be asked to confirm whether logging should 'Start Immediately', or the next time the instrument is switched on ('Start at next Power-Up'). This enables you to optimise the data storage time by leaving the instrument switched off until it is required.

8.4 Data Logging Retrieval of Data

1. Start up the Datalogging programme by clicking on the shortcut on your desktop.

2. Click on the 'Communicate with Instrument' button. This will automatically take you to the Instrument Status page.

3. The Memory Status will show the Status of the instrument at the present moment in time. If you wish to refresh this status simply click the 'Refresh Status' button.

4. Press the 'Suspend Logging' button if you wish to stop the Analox Sub storing data temporarily. The Analox Sub will automatically resume the next time it is switched on, or when the Restart Logging 'button' is pressed.

5. Press the 'Gather and Save Data' button to transfer data from the Analox Sub to the PC. Note this will automatically Suspend logging if you have not already done so.

6. Please wait patiently while the instrument transfers data to the PC. An estimate is provided of the time required for the data transfer to complete. If no problems occur in the transfer process, a screen will appear inviting you to save the log file.

7. In the Save as type box, select the type of file that you wish to save. Let us assume that we are trying to create a Microsoft Excel spreadsheet. Therefore select an Excel compatible .csv file. (CSV stands for a Comma Separated Variable file, and is a format that most spreadsheet programmes will recognise).

8. Now select the folder and enter the filename that you wish to use for the file. The programme will remember the filenames that you have used previously. Initially the default will be c:\My Documents\0Analox00. If you choose to retain this format, the programme will automatically suggest the next number 0Analox01, 0Analox02 etc for future files. The 0 at the start is meant to signify which instrument you are transferring data from if using multiple instruments.

9. You will then be asked if you want to delete the data already in the instrument. Answer Yes or No as appropriate. Answering 'Yes' will avoid retrieving the same data again at a future date. You will then be asked when you want logging to commence, click 'Start Immediately' or 'Start at next Power-Up' as appropriate.

   You may choose not to discard the data until you have inspected the data for correctness and click No. This will leave the data shown in the Memory Status. You can then use the 'Discard the Data From the Instrument' button to delete the data at your own discretion. You will need to reactivate the logging by clicking the 'Restart logging' button.

10. If you are retrieving data from a number of instruments, connect the PC to the next instrument and press the 'New Instrument' button. Retrieve the data as explained in steps 5 to 9.

8.5 Data Logging Data Analysis

Microsoft Excel is not provided with the Analox system. If you do not have a copy of Microsoft Excel, other spreadsheets will also allow access to the data. These instructions are limited however to the use of Excel. You may choose to access the data in a variety of ways, either via Excel or Windows Explorer. These instructions are based on loading the file from Excel.

1. Start Microsoft Excel from your Start Menu or from your desktop.

2. Select File, Open and then navigate to the folder in which you chose to store the data file (e.g. in c:\My Documents).

3. Select files of Type 'Text Files'. All of the CSV files in the chosen folder will appear. Click on the file that you wish to inspect, and then click on 'Open'

4. The data from the file will then appear in a standard Excel Worksheet.

5. Note that the first column of data is the date and time of the reading. This field is too wide to fit in the standard width of the cell. Click on the 'A' at the top of the column, and then select Format, Column, and Autofit Selection. Or simply drag the column separator between 'A' and 'B' to achieve the right width.

6. Select the right format for the Date and Time. Click on 'A' at the top of Column A, then press Format, Cells. On the 'Number' tab, under category, select 'Date', and then under 'Type' select 03-04-97 13:30 or similar.

7. Now to graph the CO2 reading, click on the 'A' at the top of Column A, then press and hold the CTRL key on the keyboard, and click on the 'C' at the top of the CO2 column. Then click on Insert, Chart (or press the small Chart Icon on the toolbar if you have one).

8. Under 'Chart Type' choose XY scatter, and under 'Chart Sub Type' choose the type of lines that you wish on the chart. (Hint – Use Scatter with data points connected by lines).

9. Now press 'Finish' or choose 'Next' if you wish to refine the appearance of the graph.

10. A graph will appear on the screen with the x-axis showing the date and time, and the y-axis showing the CO2 reading.

11. The basic appearance of the graph can now be edited, but to do so requires familiarity with Microsoft Excel. There are several books available at almost any computer store on this subject.

9 MAINTENANCE

Maintenance consists of the following tasks:

FREQUENCY	
Daily	Check that the instrument is maintained in a clean state. In particular ensure that the gas inlet ports and breather port are unobstructed. When necessary, clean the instrument with a dampened cloth.
	Check the battery condition indicator. Change the batteries when the indicator is near to zero
Six Monthly	Check the accuracy of the readings by subjecting the instrument to calibration gas, a known pressure reference, and a known temperature reference. If necessary, recalibrate the instrument as detailed in Section 7
Annually	Where the instrument is used as a standby for use in emergencies, replace the main batteries as detailed in Section 4.2
	Consider replacing the oxygen sensor. The sensor should last for 2 years when exposed to air at normal atmospheric pressure. If used in enriched oxygen or hyperbaric conditions, the sensor will be used up more rapidly. Replace annually depending on type of usage
Five Yearly	Change the Backup batteries as detailed in Section 4.3
	Replace the carbon dioxide sensor (must be factory fitted to ensure correct calibration and compensation)

10 SPECIFICATION

Power Source	External DC supply. 8-40V DC, with regulation of better than +/- 300mV.	
Batteries	4 x 'D' size alkaline cells for power 2 x LR43 Alkaline Manganese cells for real time clock backup	
Fuses	Individual fuses for the two supply sources, fuses 1A-T.	
Display Panel	6 x 4 character LCD displays, character size 8mm x 5mm Oxygen, carbon dioxide, depth, temperature, elapsed time and battery condition	
Operator controls	Pushbutton to control display backlight, reset elapsed time and mute/acknowledge alarms Backlight times out after 15 seconds when turned on.	
Oxygen Sensors	Analox 9100-9212-9HSUB oxygen sensor with 2-3 year life at 0.21 Bar ppO_2.	
	Range	0-1500 mBar ppO_2
	Accuracy	±2.5 mBAR PPO2 for 190-250mBAR PPO2, ±15mBAR PPO2 for the remainder of the range from 0 to 1500mBAR PPO2.
Pressure Sensor	Analox solid state bridge sensor	
	Range	0-10BarA
	Accuracy	< 0.25% of range
CO_2 Sensor	Analox BL5 low power, long life infra red sensor with microprocessor applied pressure compensation	
	Range	0-50 mBar $ppCO_2$
	Accuracy	3% of range (i.e. +/- 1.5mbar $ppCO_2$) when 0.8< ambient pressure < 4 Bar Absolute and 0 < ambient $ppCO_2$ < 25mbar Otherwise: 6% of range (i.e. +/- 3mbar $ppCO_2$)
Operating Temperature	0°C to 40°C compensated	
Storage Temperature	-5°C to 50°C with oxygen sensor installed -30°C to +70°C with oxygen sensor removed	
Humidity	0-100% Relative Humidity (non-condensing)	
Dimensions	235 x 190 x 110 mm (excluding connector)	
Weight	<2.2kg (with batteries installed)	