



Rapidox 2100ZF Oxygen Analyser

Instruction Manual

Revision 3.7

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Declaration of Conformity

Manufacturer: Cambridge Sensotec Ltd.
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Product Names: Rapidox portable oxygen gas analyser

Model Numbers: RX2100ZF

Conform to the following specifications:

EMC: EN 61326:2006 Electrical equipment for measurement,
control and laboratory use

Declaration: I declare that the above products conform to the applicable requirements of the LVD Directive 2006/95/EC and the EMC Directive 2004/108/EC and is CE marked accordingly.

Signature:



Name:

Dr. Mark Swetnam

Title:

Managing Director

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Cambridge Sensotec Limited

Date:

4th May 2009

WEEE Regulations 2006



Cambridge Sensotec takes its responsibilities under the WEEE Regulations extremely seriously and has taken steps to be compliant line with our corporate and social responsibilities. In the UK, Cambridge Sensotec has joined a registered compliance scheme "WeeeCare" (WeeeCare registration number WEE/MP3538PZ/SCH).

UK users only: If you have purchased any electronic or electrical product from Cambridge Sensotec since 2007 and would like to dispose of it correctly under the WEEE scheme, please contact us and we will be happy to either arrange the collection of the waste or have it returned to our offices for recycling. All our in-house manufactured products are scheme compliant and carry the WEEE label indicating that it is NOT allowed to be disposed of in a landfill site.

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1. Introduction

The Rapidox 2100ZF (Z = Zirconia F= Front Mounted Sensors) oxygen analyser allows fast and accurate oxygen analysis over the full oxygen range (10^{-20} ppm to 100% O₂). The Rapidox provides continuous on-line oxygen analysis, with a typical response time of less than 4 seconds for a 90% response to a step change in gas compositions.

The sensor head comprises a zirconia ceramic tube, which is heated up to 650°C in order for it to conduct oxygen ions. Power for the sensor heater is supplied and accurately controlled by a regulated power supply incorporated in the analyser.

The analyser is packed with features including programmable alarm circuits, programmable analogue outputs, easy calibration (user selectable gases), RS232 communications and complete communications / data logging software.

Additional sensors may be attached via the auxiliary socket which will read most standard 4-20mA transmitters. Currently the Rapidox can be configured to read pressure, vacuum and dew-point sensors. Others can be adapted on request.

2. Features

- ✓ Very fast measurement response (typically 1-4 seconds for a 90% response).
- ✓ Full measurement range available (10^{-20} ppm to 100% O₂).
- ✓ Accuracy $\pm 1\%$ of the actual measured oxygen with a precision of $\pm 0.5\%$.
- ✓ Easy calibration procedure requiring any two or three gas mixtures (air is usually one).
- ✓ Independent Type K thermocouple fitted as standard 0-1250°C.
- ✓ Simple installation, low maintenance, sensor life expectancy typically 17,500 hours. Pre-calibrated sensors available.
- ✓ Large back-lit LCD display (16 x 2 characters).
- ✓ RS232, 0-5V and 4-20mA current loop outputs (both programmable).
- ✓ Fully programmable alarm circuits.
- ✓ Full data logging software accessed via RS232 connection to a PC (RS485 available on request).
- ✓ Optional pressure, vacuum or dew-point sensor attachment
- ✓ Helium & vacuum operating mode

3. Technical Specification

Property	Specification
Supply Voltage	90-260VAC, 50/60Hz
Power consumption	100W (max)
Analyser dimensions	W250mm X D263mm X H150mm
Weight	3.5 kg
Display	16 × 2 character (9mm) back-lit LCD
Warm up time	3-4 minutes at 20°C
Operating heater voltage	13-15V
Normal operating temperature	5-35°C
Outputs: O ₂ & temperature OR auxiliary	0-5V (user-programmable) into minimum 5kΩ
O ₂ & temperature OR auxiliary	4-20mA current loop (user-programmable) into maximum 500Ω
High and low alarms	Relay contacts – fully user-programmable
All data and parameters	RS232 or RS485 - data streamed on demand
Calibration	Requires 2 or 3 user-selectable gas compositions (air is default plus another two)
Thermocouple	Type K fitted to standard compensated plug. Range 0-1250°C, accuracy ± 1°C

Table 1: Rapidox Analyser

Property	Specification
Cable	2m high temperature silicone sheathed cable, fully shielded. Nickel quick release plug
Max sustained gas temperature	650°C
Temperature of metal housing	150 to 200°C
Life expectancy	> 17,500 hours
Range of measurement	10 ⁻²⁰ ppm to 100% O ₂
Response time (@ gas flow rate 1l.min ⁻¹)	Approximately 4 secs for a 90% step change (e.g., from 21% to 100% O ₂)
Accuracy	± 1% of the actual oxygen concentration
Precision of measurement	± 0.5% of the reading
Maximum working pressure	10 bar (depends on gas and temperature) 200 bar burst pressure
Minimum working pressure	Vacuum tight down to below 10 ⁻⁴ Torr
Sensor Replacement	Pre-calibrated sensor can be supplied for immediate installation

Table 2: Rapidox Sensor

4. Precautions

Make sure you read and understand these instructions and keep them safe for later use. The unit should not be exposed to extreme temperatures $< -5^{\circ}\text{C}$ or $> 60^{\circ}\text{C}$. Normal operating temperature is $5-35^{\circ}\text{C}$. Avoid direct sunlight. Do not use liquid cleaners, aerosols or solvents to clean the case. Use a damp cloth for cleaning. Do not use this equipment near water. Avoid touching the LCD display as this may cause permanent damage. Make sure the rear ventilation slots and the fan on the rear panel are free of obstruction.

There are no user serviceable parts in this unit. Do not attempt to repair yourself. Refer all servicing to qualified Cambridge Sensotec personnel.

5. Warning

The sensor head and metal surroundings become hot ($>100^{\circ}\text{C}$) during use and careful consideration should be taken to avoid the risk of burn injury.

This unit is NOT designed for use in life support situations. No responsibility can be held for injury or loss of life caused by inappropriate use of this equipment.

6. Rapidox Operating Instructions

6.1 *Sensor Location*

The sensor head (see Figure 1) comprises a small tube of high purity zirconia, which becomes an oxygen conductor when heated to approximately 650°C (see Figure 2). The ceramic can be damaged if the sensor head is knocked or dropped, so care must be taken when handling it.

Select a suitable location for the sensor bearing in mind that the temperature of the measurement gas must be less than 650°C and ideally below 350°C where the sensor tip is located. The outer part of the sensor must be in ambient air. Cambridge Sensotec can supply a selection of sensor housings (see Figure 3) to allow access in awkward situations, and if necessary a small pump can be installed to sample the gas remotely.



Figure 1: The zirconia oxygen sensor

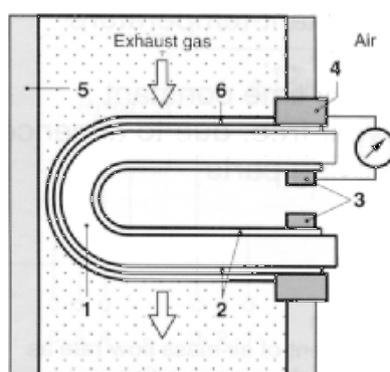


Figure 2: Oxygen sensor schematic, 1 = zirconia electrolyte, 2 = electrodes, 3 = contact, 4 = housing, 5 = sample pipe, 6 = ceramic protective coating (porous)

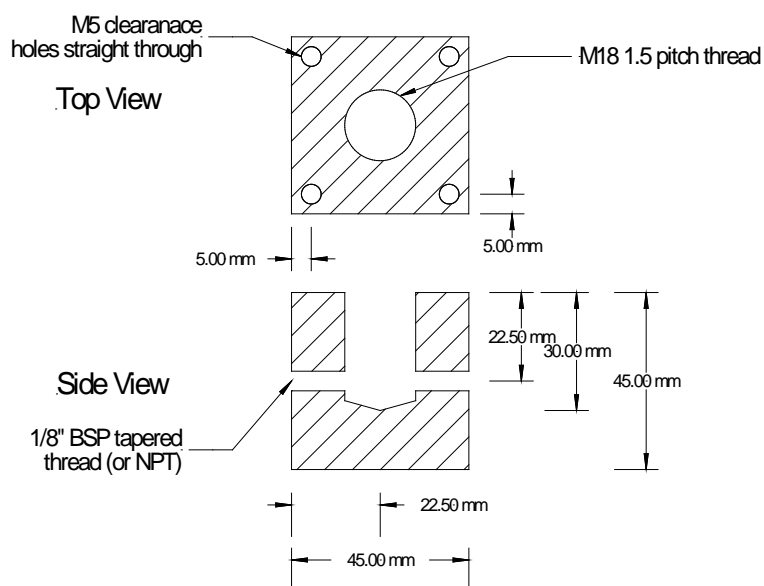


Figure 3: Schematic showing sensor attached to gas pipe adapter (supplied). Gas flows across the sensor via pipes attached to the nipple fittings.

As with all electronic devices, the Rapidox sensor signal may be affected by strong electromagnetic noise interference although this has been minimised by careful shielding. Please ensure that wherever possible, the sensor head and analyser are kept away from sources of electrical noise. Ensure that the sensor cable is not touching any hot surfaces and is kept away from areas that are generating electrical noise. The cable is designed to withstand temperatures of up to 150°C for short periods (<15 seconds).

The sensor is threaded with an 18mm 1.5mm pitch thread, which is a standard tap size for automotive spark-plugs. Ensure that the sensor is tightened down securely so that no gas can escape around the thread. A selection of gaskets is available for different applications (e.g. working above pressures of 1 bar or under vacuum conditions). The sample chamber is tapped with a 1/8" NPT tapered thread. BSPT fittings will also fit this tap.

6.2 The Rapidox Analyser - Front and Rear Panels



Figure 4: Rapidox 2100Z front panel. Numbers are referred to in the text.



Figure 5: Rapidox 2100Z rear panel. Numbers are referred to in the text

6.3 The Rapidox Analyser - Menu System

All of the user-programmable functions are accessed via a menu system which is controlled using the front panel Keypad (2). To access the menu press the ENT button and to escape and return to the operating screen press ESC at any time. The menu system flow chart is shown in Appendix 1 at the end of this manual.

7. Getting Started

Ensure that the Rapidox analyser is located away from extreme heat and dirt environments. Plug the unit in to a suitable supply (noting the information on the serial sticker and using the power cable supplied) using the rear power socket (8). Make sure that the cooling fan (9) is not obstructed during operation. Connect the sensor plug to the front of the Rapidox using the 5-way Cannon type socket (3). If you require temperature measurement ensure that the type K thermocouple is plugged into the type K socket on the rear panel (7). If you are using an external pressure, vacuum or dew-point sensor connect this to the 3-way Cannon type socket labelled Auxiliary (4)


Turn the unit on using the red power switch on the front (5). The LCD (1) will display the firmware version and serial number followed by the message "HEATING SENSOR". The sensor will take approximately four minutes to come up to temperature, after which the Rapidox will begin to take measurements. The progress of the sensor heater is shown in the form of a bar graph on the LCD (1).

Allow thirty minutes for the box to stabilise fully. This allows the components of

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the analyser to reach a stable working temperature. During this warm-up period it is common for the baseline oxygen to drift by a small amount, which may be corrected by re-calibrating.

7.1 Display Behaviour

Once at temperature the LCD display (1) will show the oxygen reading on line 1 and the temperature / auxiliary sensor (if fitted) reading on line 2. This can be changed to temperature, pressure or dewpoint if required (see section 7.9). The lower right hand corner of the LCD will display the oxygen range selected (H=high, M=Medium & L=Low). The symbol AL1 or AL2 may also appear to the bottom right of the LCD if the alarm system is enabled and an alarm condition applies. A black circle  next to the word "O2" indicates that the unit is operating in Helium Mode (see 7.10). The oxygen sensor reading may show U/Range or O/Range when its limits are reached, and error messages will be displayed if there is a fault with the sensor. See Table 3 for more details:

Oxygen Sensor Display Possibilities	
O ₂ Reading > 9999.9%	Display shows "O/Range"
O ₂ Reading > 10e ⁻²⁰ ppm and < 9999.9%	Display shows the normal oxygen reading in % or ppm
O ₂ Reading < 10e ⁻²⁰ ppm	Display shows "U/Range"
O ₂ Measurement is not within the H or M Range selected	Display shows "Change Range"
O ₂ Reading is flashing	Indicates that the connected pressure sensor is out of range and automatic pressure correction is on.
O ₂ Sensor takes > 10 minutes to warm up	Display shows "Possible sensor Fault" because the sensor heater is failing.
O ₂ Sensor has failed completely or become disconnected	Display shows "No sensor or sensor Fault"
O ₂ Sensor is OK but the pressure sensor (if fitted) is faulty and the auto pressure correction mode is selected	Display shows "FAULT" flashing.
Type K Thermocouple Display Possibilities	
Tc Reading > 1251°C	Display shows "O/Range"
Tc Reading > 1250°C	Display flashes to warn the measurement limit is approaching
Tc Reading > 0°C and < 1250°C	Displays the normal temperature reading in °C or °F
Tc Reading < 0°C	Display shows "U/Range"
Tc Sensor is disconnected	Display shows "FAULT"
Auxiliary Sensor (Pressure, Vacuum or Dewpoint) Display Possibilities	
Sensor Transmitter gives > 20.0mA signal	Display shows "O/Range"
Sensor Transmitter gives > 4.0mA and < 20.0mA	Display shows the normal reading of the sensor connected
Sensor Transmitter gives < 4.0mA	Display shows "U/Range"

Table 3: Different display possibilities depending on the sensor reading.

7.2 Menu Access / Passwords

The analyser has an option to set a password that will restrict access to the menus. The password menu is disabled by default in the factory. If you wish to password protect the analyser press ENT and scroll down to the PASSWORD option (Menu option 14). Pressing ENT again will ask you for the default password which is "0000". Enter this using the UP and DOWN arrows. Once the password has been entered successfully you can choose between ENABLE and DISABLE in the menu using the UP and DOWN keys.

The other option is to RESET the password to a new value. The password must be

4 digits long and can be any combination of numbers from 0-9. Make sure that the new password is noted down!

If the password function has been enabled then in the future the password prompt will display each time the menu system is accessed. After the correct password is entered then the full menu will be accessible. You can make as many changes as you want to the different menu options and only press ESC once you have finished. Pressing ESC takes you out of the password protected area and you will have to re-enter the password to go back in again. Note that changes to a menu option will only be registered if the ENT button is used to complete the final step of the item – pressing ESC while stepping through an option aborts any changes made.

If the password has been forgotten please contact Cambridge Sensotec who will advise you on how to recover it.

7.3 *Rapidox Calibration*

Once the unit is at temperature it may be necessary to calibrate the sensor. Full calibration is a simple procedure requiring only two or three gases (one of which is normally air – 20.95%). The three gas values are user-selectable during calibration and can be changed by using the front keypad (2) or the communications software described in section 8, and the calibration values can be stored on file for later use.

Care must be taken to calibrate the analyser so that, whenever possible, the range of measurement lies between the two calibration point extremes. For example, if you are working at 10ppm but have calibrated the analyser between 21% and 100% then the analyser will be inaccurate. You would need to calibrate at, say, 1ppm and 21% to be sure of good accuracy. The procedure is as follows:

- 1) Bearing in mind the points made above, decide which two (or three) gases you are going to use for calibration. If you are constantly working at a particular range of compositions then it would be wise to obtain small cylinders of calibration gas with analysis certificates. Cambridge Sensotec can supply these. Press the ENT button on the front panel keypad (2) to access the menu system. The calibration function is option 1 on the menu list, which can be scrolled using the UP and DOWN arrows. Press ENT again to enter the calibration menu. Use the UP and DOWN arrows to select O₂ HIGH, O₂ MIDDLE or O₂ LOW and press ENT to proceed. The top line of the display shows the current calibration gas stored and the bottom line of the display shows the prompts. If the gas value is not what you require you can edit the value (in ppm scientific notation – see Table 4) using the up and down and right arrows on the keypad. The cursor flashes underneath the digit to edit. For example air (20.95%) should be entered as 2.095E+05ppm (209,500ppm). Note that you cannot go backwards to edit a digit to the left of the cursor. Instead keep pressing the RIGHT button and the cursor will wrap around back to the beginning. Alternatively press ESC

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to start again. Press ENT when you are ready to proceed.

[illegible]

Table 4: Examples of common scientific format with their equivalent ppm and percent values

- 2) The sensor needs to be exposed to the first calibration gas from a cylinder (or exposed to ambient air, 20.95% if this is the calibration gas of choice). Allow several minutes to pass to flush the sensor properly. Wait for the top line of the display (1) to become stable. To complete the calibration press and hold the ENT button for two seconds. During this time you will see a bar graph progress across the lower display. The analyser will then recalibrate and display "O₂ recalibrated" and then return to normal run mode. The display will now correctly read the value of the first calibration gas. Note that if the ENT button is released before two seconds have elapsed, the recalibration will be aborted and when the analyser eventually returns to run mode it will use the existing calibration.
- 3) Note that the analyser should be calibrated at normal ambient pressure. If a pressure sensor is fitted to the auxiliary socket AND the pressure correction mode is set to AUTO then it is still possible to perform an accurate calibration at pressures other than ambient. However above 25mbar (gauge) or below -25mbar (gauge) the display will flash and "P?" will display to warn you that the pressure is either above or below the range recommended for accurate calibration.
- 4) The analyser predicts the correct signal from the sensor during calibration and if this is outside the range of expected values then the display will flash and display "G?" to warn you that either the cal gas flowing over the sensor is different to the value you have programmed OR the sensor may be old and approaching the end of its life. Check before proceeding!
- 5) To calibrate against the second or third calibration gas, repeat the procedure from 2 but this time press ENT followed by the UP or DOWN button to scroll through to the "O₂ Middle" or "O₂ Low" screen. Flush the sensor chamber with the second calibration gas allowing several minutes for the new gas to flush through. Wait for the display to become stable before pressing the ENT button for two seconds. The analyser will then recalibrate and display "O₂ recalibrated" and then return to normal run mode. The display will now correctly read the value of the calibration gas.

- 6) The analyser is now correctly calibrated and will read accurately between these two calibration points. Note that this procedure can be performed remotely using the software described in section 8. You can now repeat this process for the third calibration gas if required.
- 7) If at any time, you encounter difficulties and wish to restore the machine to its factory set calibration, use the configuration software provided and load the default settings (described in section 8.4 below). Each machine is provided with a unique file that contains the factory settings. This is located on the CD-ROM provided and is copied onto your PC during the installation process.
- 8) Note that the three calibration points are independent of each other so you can calibrate the analyser in any order you desire. However please note that O₂ HIGH must always be greater than O₂ MIDDLE which must always be greater than O₂ LOW. Typically the factory settings are: O₂ HIGH=20.95%, O₂ MIDDLE=0.1% (1000ppm) and O₂ LOW=0.001% (10ppm).

NB You must always perform a FULL calibration to achieve good accuracy.

7.4 *Cleaning the Sensor*

You can clean the sensor at any time by pressing ENT on the keypad and scrolling down to option 2 “Clean Sensor” or using the software described in section 8.7. Press the ENT button to proceed. The screen displays “Clean Sensor?”. Press ENT again and the cleaning will take place. The procedure takes approximately five seconds and the LCD display shows the progress of the operation. Once finished, the analyser will take a few seconds to re-stabilise. The sensor is cleaned each time the unit is switched on prior to operation. If you are operating in gases with large amounts of soot, there is a risk that the sensor surfaces will become contaminated with particulates, which will impair performance if allowed to build up. The cleaning operation pumps oxygen through the zirconia tube, which burns the particulates away from the sensor surface.

7.5 *Oxygen Range*

The Rapidox 2100Z has three oxygen measurement ranges which can be programmed using the Keypad (2) or the software provided (section 8.5.1). Always select the most appropriate range in order to achieve maximum resolution from the analyser. The three ranges are labelled HIGH, MEDIUM & LOW.

- | | |
|------------------|---|
| 1. High | from 0.1% to 100% oxygen |
| 2. Medium | from 1ppm to 100% oxygen |
| 3. Low | from 10 ⁻²⁰ ppm to 100% oxygen |

The range currently in use is displayed in the bottom right hand corner of the LCD display by the character L, M or H. To change the range select option 3 “Set O₂

Range” and press ENT. Use the UP & DOWN arrows to select the required range and press ENT to finish. If the measurement is out of range then the display will flash with the message “Change Range” to warn you to change over to a lower range to continue reading.

7.6 Alarms

The Rapidox is fitted with two independent and fully programmable alarm relay outputs, which can be programmed to be either normally open (N/O) (closes on alarm) or normally closed (N/C) (opens on alarm). You have the option of assigning each alarm to the oxygen, auxiliary or temperature sensors, as well as enabling the alarm relay circuits, enabling an audible buzzer and enabling a visual warning on the screen.

The alarms can be programmed by the user via the keypad (2) on the front panel or using the software provided (section 8.5.2). To change the alarm settings scroll down the menu to no. 4 “Set Alarms” and press ENT. Now use the UP & DOWN arrows to select “Alarm 1” or “Alarm 2” and press ENT. The next screen shows the message “Assign To:”. Use the UP and DOWN arrows to select O₂, AuxIn or Temp depending on which measurement you want the alarm to work with, and press ENT to proceed. The default is O₂.

The next settings configure the behaviour of the alarm. Use the UP & DOWN arrows to select ON or OFF for the following parameters:

1. **OUTPUTS:** This enables the rear panel relay outputs when ON is selected
2. **AUDIBLE:** This enables or disables the audible buzzer inside the unit which will sound in an alarm condition
3. **VISIBLE:** This enables or disables warning messages on the LCD screen on the front of the Rapidox. During an alarm condition either “AL1” or “AL2” (or a combination of both) will flash at the bottom right hand corner of the display.
4. **POLARITY:** This determines whether you are setting a rising or falling alarm. Use the arrows to change the direction of the alarm to up or down. A rising alarm means that the alarm will be silent at values below the set-point but as soon as the value rises above the set-point the alarm will be triggered
5. **SETPPOINT:** The current alarm set-point is displayed in scientific notation (see Table 4) with a flashing cursor under the first digit. Use the UP & DOWN arrows to change the digit and the RIGHT arrow to progress until the correct value is displayed. When done, press ENT to proceed to the next setting.
6. **CONTACTS:** The relay outputs can be set to either normally open (N/O) or normally closed (N/C). The factory default is N/O, meaning the contacts will close when an alarm condition occurs. Press ENT to save all the above settings for the selected alarm.

Alarm 2 can be set in exactly the same way as described above and both alarm

circuits are completely independent of each other. Note that you must programme all the parameters for each alarm for the settings to be saved. The bottom line of the LCD will display “Alarm x set” (where ‘x’ is the selected alarm channel) to confirm that the settings have been saved.

The alarm circuit relays are accessed via the terminal block on the rear panel and are clearly labelled. Alarm 1 is assigned to the terminals labelled “Alarm High” and Alarm 2 is assigned to the terminals labelled “Alarm Low”. The relay circuit is rated at 24V 0.5amps maximum.

The alarm limits for oxygen are set to a minimum of 10^{-20} ppm and a maximum of 1000%. Under certain conditions (e.g. the sensor becomes disconnected) the Rapidox will set the alarm channel to OFF to prevent false alarms, and the relay contacts for the affected channel will go to the programmed N/O or N/C setting. For more information please refer to Table 4 in section 7.7 below.

7.7 *Analogue Outputs*

The Rapidox analyser provides various analogue outputs. The standard industrial analogue outputs (0-5V and 4-20mA) for both oxygen, and temperature (or internal pressure) are accessible via the terminal block (6) on the rear panel. These outputs have a 12 bit resolution (approximately 1 in 4000) and the lower and upper values are fully user-programmable using the keypad (2) or the software provided (section 8). In the case of oxygen, three output mode options are provided for setting the outputs, in order to give the user maximum flexibility:

1. **LIN (ppm):** The linear oxygen output mode setting produces an output that is scaled linearly between 0 and 5V (or 4 and 20mA). So, for example, if the scale is set $0V = 0\% O_2$ and $5V = 100\% O_2$ then 2.5V would indicate an oxygen reading of 50% O_2 . The scaling of this example is shown in the following plot, from which other intermediate values can also be read. This setting is more suitable for medium to high ranges of oxygen, or where the user wishes to monitor oxygen over a narrow range.

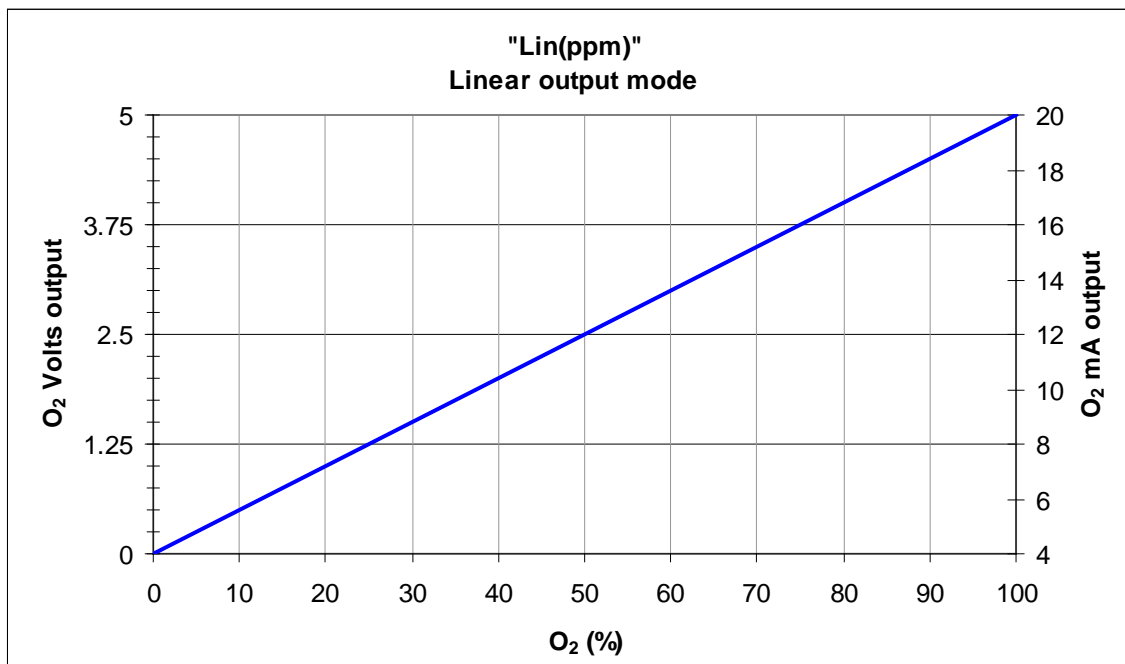


Figure 6: Graph showing the linear output mode option for oxygen

The following general formulae can be used to calculate the oxygen from the voltage or current outputs when set to the linear output mode:

Output type	Formula for calculating oxygen from analogue output signal
0-5V	$O_2 = V_{out} / 5 * (O_{2H} - O_{2L}) + O_{2L}$
4-20mA	$O_2 = (mA_{out} - 4) / 16 * (O_{2H} - O_{2L}) + O_{2L}$

Where: O_{2L} = user setting of oxygen for 0V or 4mA output ¹
 O_{2H} = user setting of oxygen for 5V or 20mA output ¹
 V_{out} = the measured voltage output in volts
 mA_{out} = the measured current output in mA

¹ O_2 , O_{2L} and O_{2H} must all be in the same units.

- LOG (ppm):** This setting produces an output that is scaled logarithmically between 0V and 5V (or 4 and 20mA). So, for example, if the scale is set to 0V = 0.0001% (1 ppm) and 5V = 100% (1000000 ppm) then 2.5V would indicate an oxygen reading of 0.1% (1000 ppm). This scale is more suitable for large ranges of oxygen down to very low ppm levels. Note that because the scaling is logarithmic 0V cannot be set to 0% oxygen since $\log(0)$ is $-\infty$! The lowest permitted setting is 0V = 10^{-20} ppm (or 10^{-24} %) O_2 . The scaling of this example is shown in the blue line in following plot, from which other intermediate values can also be read. For comparison, the red line shows the limitations of using the linear oxygen output mode over the same range.

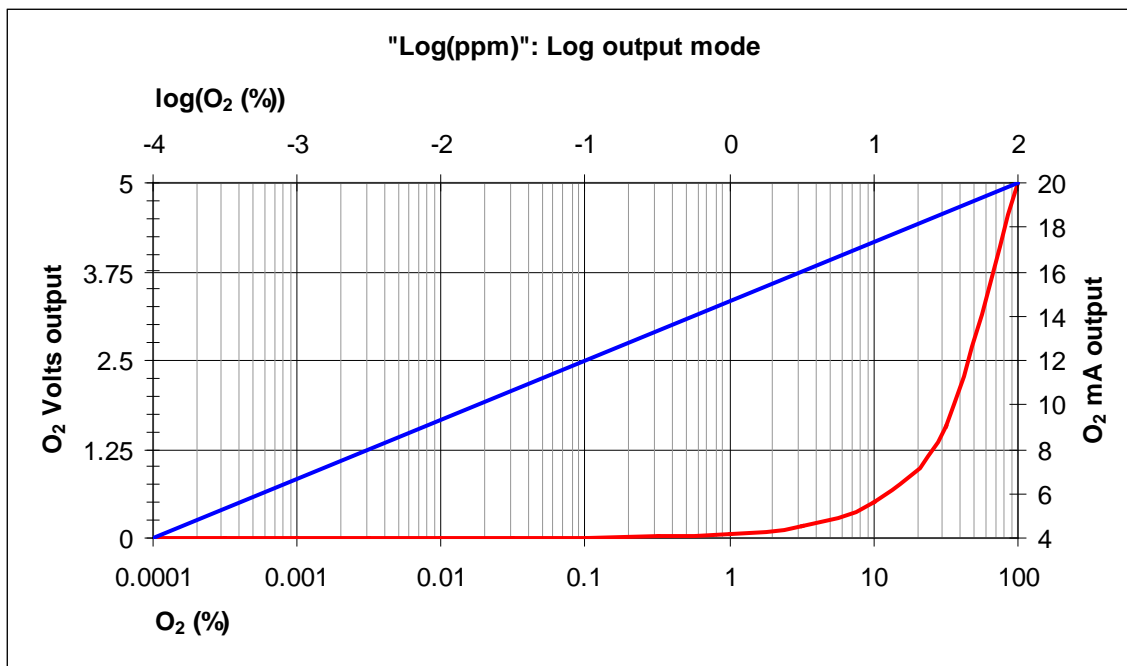


Figure 7: Graph showing the logarithmic output mode option for oxygen (blue) compared with linear mode (red).

The following general formulae can be used to calculate the oxygen from the voltage or current outputs when set to the log output mode:

Output type	Formula for calculating $\log_{10}(O_2)$ from analogue output signal
0-5V	$\log_{10}(O_2) = V_{\text{out}} / 5 * \log_{10}(O_{2H} / O_{2L}) + \log_{10}(O_{2L})$
4-20mA	$\log_{10}(O_2) = (mA_{\text{out}} - 4) / 16 * \log_{10}(O_{2H} / O_{2L}) + \log_{10}(O_{2L})$

Where: O_{2L} = user setting of oxygen for 0V or 4mA output ²
 O_{2H} = user setting of oxygen for 5V or 20mA output ²
 V_{out} = the measured voltage output in volts
 mA_{out} = the measured current output in mA

² O_2 , O_{2L} and O_{2H} must all be in the same units.

Note: $O_2 = 10^{\log(O_2)}$

- 3. RAW (mV):** This setting is for certain customers who like to monitor the raw sensor EMF signal. The signal from a sensor goes from approximately -50mV at 100% O_2 through zero at approx 5% O_2 and to +1000mV at extremely low O_2 levels. So, for example, if the scale is set to 0V (output) = -50mV (sensor voltage at approximately 100% O_2) and 5V (output) = 250mV (sensor voltage at approximately 1ppm O_2) then 2.5V would indicate a sensor voltage of 100mV. The scaling of this example is shown in the following plot, from which other intermediate values can also be read.

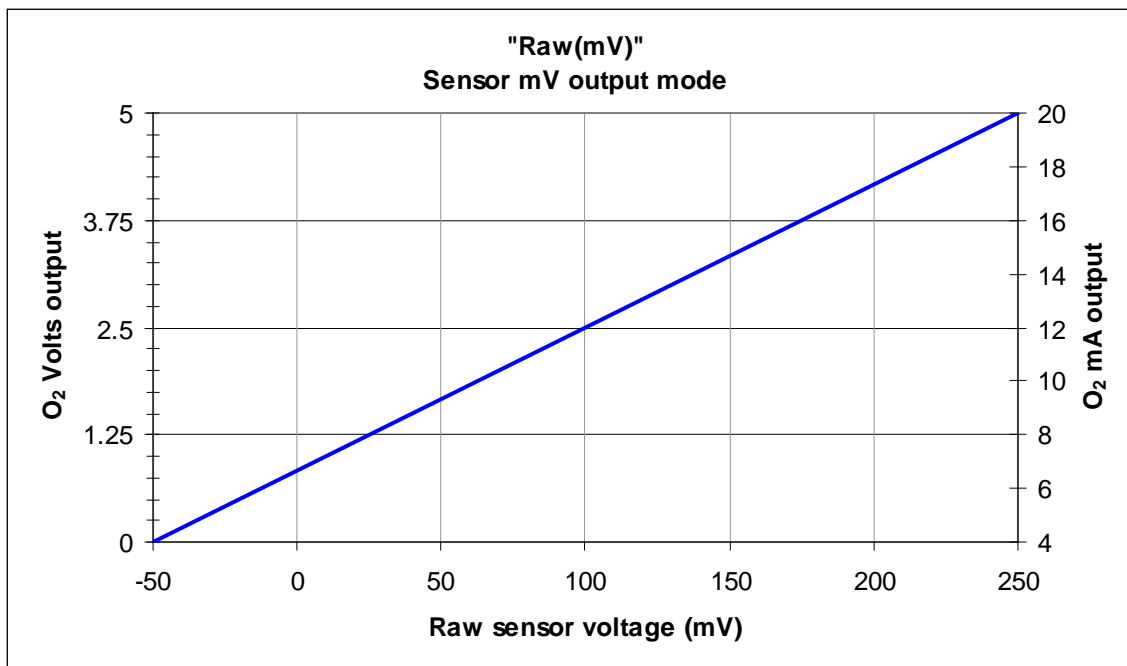


Figure 8: Graph showing the raw sensor mV output mode option for oxygen

The following general formulae can be used to calculate the oxygen sensor raw voltage (O_{2mV}) from the voltage or current outputs when set to the raw sensor voltage output mode:

Output type	Formula for calculating sensor mV from analogue output signal
0-5V	$O_{2mV} = V_{out} / 5 * (O_{2mVH} - O_{2mVL}) + O_{2mVL}$
4-20mA	$O_{2mV} = (mA_{out} - 4) / 16 * (O_{2mVH} - O_{2mVL}) + O_{2mVL}$

Where:

- O_{2mVL} = user setting of oxygen mV for 0V or 4mA output
- O_{2mVH} = user setting of oxygen mV for 5V or 20mA output
- V_{out} = the measured voltage output in volts
- mA_{out} = the measured current output in mA

The auxiliary outputs can be set to Temperature or AuxIn (Pressure or Dewpoint). The first option will output the value read from the thermocouple when attached. The second option will output the value read from the attached auxiliary sensor.

To modify the oxygen analogue output range scroll down the menu to option 5 "Set Outputs" and press ENT. Use the UP & DOWN arrows to select the output type either "lin(ppm)", "log(ppm)" or "raw(mV)" and press ENT. You can now edit the lower and upper values using the UP & DOWN and RIGHT arrows. Once programmed the new values remain in the memory until they are edited again in the future.

To select and modify the auxiliary outputs scroll down to menu option 5 "Set Outputs" and press ENT four times. Use the up and down arrow buttons to choose between "Temperature" or "AuxIn" and press ENT. If "Temperature" is selected then you can change the low and high range using the same procedure

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described above. The range is set between 0°C and 1250°C. If “AuxIn” is selected then the permissible range is the full scale of the sensor attached.

Note that if the auxiliary output is assigned to temperature and the temperature units are set to “None” then the outputs will be set to 0V and 0mA.

Note that the voltage (0 to 5V) and current (4 to 20mA) outputs are locked together, so that these outputs cannot be set independently of each other. In normal operation therefore, 0V output always corresponds to 4mA and 5V always corresponds to 20mA output.

During initial warm up of the Rapidox when the display reads the serial number the output sent to the rear terminal for oxygen will stay at 2mA (0.625V) which is the standby signal. If at any stage a sensor becomes disconnected internally, or the signal exceeds the measurable range for that sensor, then the display will indicate there is a fault and the outputs will change to 1mA (0.3125V) which is the sensor fault signal. This will recover as soon as the sensor is reconnected and the fault cleared. Additional current and voltage signals are provided by the analyser to give an indication of various conditions and these are described in Table 4 below, together with the status of the alarms during the condition:

O₂ Analogue Outputs		Description	Explanation	Alarms ⁽³⁾
Current ⁽¹⁾ (4-20mA)	Voltage ⁽²⁾ (0-5V)			
1mA	0.3125V	Fault	There is a sensor fault on the oxygen sensor, and/or the auxiliary input sensor type is pressure and pressure mode is set to automatic (pressure compensation active) and the pressure sensor has a fault condition.	De-activated
2mA	0.625V	Start up	The analyser is still initialising or the O ₂ sensor is going to temperature.	De-activated
2.5mA	0.78125V	Sensor under range	The O ₂ sensor reading is under range.	Active
3mA	0.9375V	Sensor over range	The O ₂ sensor reading is over range.	Active
3.5mA	1.09375V	Sensor operating out of specification	The O ₂ sensor reading is in range but the auxiliary sensor type is pressure and the pressure mode is set to automatic (pressure compensation active) and the pressure sensor is out of range.	Active
4 to 20mA	0 to 5V	Normal operating output	The O ₂ sensor is operating normally and readings are in range. If the auxiliary input sensor type is pressure and the pressure mode is set to automatic (pressure compensation active), then that is also working normally and its readings are in range.	Active
Aux Analogue Outputs		Description	Explanation	Alarms ⁽³⁾
Current ⁽¹⁾ (4-20mA)	Voltage ⁽²⁾ (0-5V)			
1mA	0.3125V	Fault	The assigned sensor has a fault or is missing.	De-activated
2mA	0.625V	Start up	The analyser is still initialising.	De-activated
2.5mA	0.78125V	Sensor under range	The assigned sensor reading is under range.	Active
3mA	0.9375V	Sensor over range	The assigned sensor reading is over range.	Active
4 to 20mA	0 to 5V	Normal operating output	The assigned sensor is operating normally and readings are in range.	Active

Table 5: Analogue output settings and alarm status for certain conditions

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Notes:

- 1 The current outputs are active self-powered outputs - they are not loop powered.
- 2 The voltage (0 to 5V) outputs produce non-zero voltages during start-up, fault and over/under range conditions - if 1V to 5V outputs are required, with these conditions indicated by corresponding voltages between 0V and 1V, the current outputs can be used with a 250 Ohm load resistor.
- 3 Alarms are de-activated during start up initialisation, and when a fault condition occurs on the assigned sensor. If assigned to the oxygen sensor, alarms are also de-activated when going to temperature.
- 4 If the oxygen sensor is under range, and the oxygen range is not already set to LOW, the oxygen range should be changed to a lower range, until the under range condition no longer occurs.

7.8 *Setting the Display Units*

The notation used by the display is fully programmable to suit your needs using the keypad (2) or the software provided. The following options are available to you:

1. **Oxygen:** The oxygen reading can be displayed in percent (e.g. 20.95%), ppm (e.g. 0.01ppm) or scientific (e.g. 2.095E+05ppm see Table 4). If percent is selected the Rapidox will display oxygen as a percentage down to 0.1% and ppm below this value. At values less than 1ppm the display switches to scientific notation for the remainder of the range. There are also options to display the oxygen reading in terms of a pressure (units will be the same as the units selected for pressure) or a nitrogen balance (%N₂) reading. In this case the reading displayed is 100-O₂% =N₂ so for example in air 21% the nitrogen balance reading will display 79% N₂. Note that this is NOT an actual nitrogen reading.
2. **Temperature:** The thermocouple reading can be displayed in Celsius (°C) or Fahrenheit (°F). There is an option to display “None” which keeps the second line of the LCD blank if the second line is set to display temperature.
3. **Pressure:** If an optional pressure sensor is attached to the Auxiliary socket (4) the reading can be displayed in mbar, bar, psi, torr or kPa.
4. **Dew-Point:** If an optional dew-point sensor is attached to the Auxiliary socket (4) the reading can be displayed in °Cdp, °Fdp or ppm(V).

To programme these options scroll down to menu no. 6 “Set Units” and press ENT. Use the ENT key to progress through the list and the UP & DOWN keys to select the required units. Once selected press ENT to store and return to the main menu.

7.9 *Setting the Display Options*

The user can select the LCD refresh rate and the parameter displayed on the bottom line using the keypad or the software provided. Scroll down the menu to option no. 7 “Set up Display” and press ENT. Use the UP & DOWN arrows to select either the LCD refresh rate or Line 2 Options:

1. **LCD Refresh Interval:** The frequency of the display update can be selected from 0.1 to 1.5 seconds. The current setting can be edited using the same method as described previously. Once edited press ENT to store and return to the main menu. The default setting is 0.3 seconds.
2. **Line 2 Options:** The information displayed on line 2 of the LCD can be chosen by the user. The options are Temperature (displayed 0-1250°C or °F), Auxiliary (displayed in mbar, bar, psi, torr or KPa when a pressure or vacuum sensor is fitted or °Cdp, °Fdp or ppmV when a dew-point sensor is fitted), Alternate T/A (both temperature and the auxiliary sensor are displayed alternately) or the date and time (the date is displayed in local format and the time as HH:mm:ss). Use the UP & DOWN arrows to select the required option and press ENT to store and return to the main menu.

7.10 Operating Mode

The Rapidox has some additional features to enable the unit to work in helium gas mixtures or in vacuum systems as described below. These can be programmed using the keypad on the front panel or the software provided. The default setting is “Normal”.

7.10.1 Helium

Helium presents a challenge to the analyser because of the high thermal conductivity of the gas. In normal mode the heater setting is not powerful enough to cope with the cooling effects of helium, so the “Helium Mode” should be selected. This allows the Rapidox to operate with helium flowing over the sensor. The analyser will give good readings in helium but the following points should be noted:

1. The sensor response time is slightly reduced compared to oxygen operation
2. The sensor will require a new calibration to operate correctly in helium (i.e. using helium calibration gases)
3. The sensor will tend to overshoot when changing gas compositions rapidly as it needs more time to cool and heat up.
4. The Rapidox will not function properly in other gases (e.g. air) whilst in helium mode. Only helium mixtures should be used.

When the helium mode is selected it is normal for the Rapidox to enter cooling mode and then briefly go back into heating mode until the new heater setting is reached and settles down. The same happens when returning to ‘normal’ mode of operation. When helium mode is selected the symbol “●” appears on the top line of the display alongside the word “O2” to remind you.

7.10.2 Vacuum

This option allows the user to operate the Rapidox as though it were a vacuum gauge. The sensor will respond to changes in vacuum in the same way as changes in oxygen. So for example if the vacuum is increased to 500mbar (-500mbar gauge) then the sensor will change from 20.95% to 10.5% as there is a linear relationship between vacuum and oxygen partial pressure. However the following points should be noted:

1. The assumption mentioned above is only valid if the vacuum pump is removing all gas molecules in the same ratio. Otherwise there will be a disagreement. This is normally the case but if a gas such as argon is used then this tends to be removed preferentially by vacuum pumps because of the large molecule size.
2. The sensor should be attached to the vacuum system using one of the special vacuum fittings available from Cambridge Sensotec.

The sensor will respond well in moderate vacuums but under very high vacuum in the presence of hydrocarbons (e.g. from the vacuum pump mist) the sensor can suddenly give extremely low readings. This is caused by the organics reacting with the tiny amount of oxygen remaining. All the oxygen is effectively burnt in close proximity to the sensor and the sensor will give a spuriously low reading.

To programme the mode of operation scroll down the menu to no. 8 "Operating Mode" and press ENT. Use the UP & DOWN arrows to select the required mode: Normal (factory default for oxygen measuring), Helium (for use in helium gases) & Vacuum (for use in vacuum systems). Press ENT to store the mode into memory and return to the main menu.

7.11 Pressure Mode

With an optional pressure sensor attached to the auxiliary input the user has the option of using the reading from the sensor to correct for changes in gas pressure and hence oxygen pressure. A manual pressure correction value for ambient pressure conditions can also be entered to improve accuracy of the correction (factory setting is 1013 mbar). To access this function scroll down to menu option 9. "Pressure Mode" and press ENT. The desired mode can then be selected using the UP & DOWN arrows and pressing ENT to store and return to the menu. The two modes available are:

1. **None:** This is the factory setting. If this mode is selected then there is no pressure correction performed on the oxygen reading. The pressure and oxygen sensor act independently. If the sensor is working in air (20.95%) and the pressure is doubled to 2 bar then the reading will also double to 41.9%. This is the correct oxygen partial pressure in air at 2 bar since there is a simple linear relationship between pressure and concentration.
2. **Auto:** If the Auto mode is selected then the Rapidox takes then reading

from the pressure sensor and corrects the oxygen partial pressure to maintain a concentration reading. The sensor AND pressure sensor must both be located in the same gas line or apparatus for this function to be meaningful. If the sensor is working in air (20.95%) and the pressure sensor is fitted in-line then if the pressure suddenly jumped to 2 bar the oxygen reading would remain at 20.95% because the sensor has been corrected for the pressure change. This allows users who are working with fluctuating pressures to maintain a 'meaningful' reading of oxygen concentration that will only be affected by changes in gas composition and not gas pressure.

Note that when this mode is activated the user will be asked to enter a value for the current ambient pressure to improve the accuracy of the correction. The factory default is 1013mbar which is the average ambient pressure for the UK. The ambient pressure at your location will depend on altitude and prevailing weather conditions.

Note that if the pressure sensor is disconnected or fails to operate during operation with Auto compensation enabled, then the LCD will display "FAULT Press." on the second line, and the analyser will automatically suspend Auto compensation while the fault exists. The pressure sensor should be reconnected or replaced. If the fault occurs when the pressure mode is set to "None" the "FAULT Press." message is only displayed if the second line of the LCD is set to display pressure.

Note that Auto pressure compensation is also suspended if the auxiliary sensor type is set to "None".

7.12 *Setting the Baud Rate*

If you are using the software for data logging you can choose the communications speed (Baud Rate) by scrolling down the menu to no. 10 "Set Baud Rate" and using the UP & DOWN arrows to select either 9600 or 57600. Press ENT button again to store and return to normal operation. The default factory setting is 57600. The supplied Rapidox data logging software automatically detects the current setting when connecting. If you are using other software, make sure that its baud rate matches the one selected otherwise you won't be able to communicate with the Rapidox.

7.13 *Setting Date & Time*

The date and time can be programmed either using the software programme or from the menu on the analyser itself. Scroll up to menu option no. 11 "Set Date/Time" and press ENT. The current date is displayed as "Date: dd/mm/yy" with the flashing cursor under the year. The prompts at the bottom of the screen indicate what to do: use the UP and DOWN arrows to change the value above the flashing cursor and press ENT to progress. The cursor always starts under the year value as this will dictate how the months behave e.g., during a leap year. Once all the values are programmed correctly press ENT to change the time and finally ENT to

return to the main menu. If you make a mistake at any time you can press ESC to return to the main menu and then press ENT again. Note that if you re-programme the date and time using the software then this will overwrite any changes you have just made and will use the current date and time of the PC.

Note that the exact date format will depend on the country you are in and the language and local settings of the PC which you have used to connect to the analyser: in order to set the local date format, use the “Utility” drop-down menu in Cambridge Sensotec’s Rapidox data logging software, and “Set date and time”. So for example in the USA you would now see the date as mm/dd/yy. The local date format will be stored along with the date and time in the Rapidox.

7.14 *Auxiliary Sensor Configuration*

The auxiliary socket (4) on the front panel is used to connect the optional pressure, vacuum or dew-point sensor. Before using this function make sure the auxiliary socket has been programmed correctly. Scroll down to menu option 12 “Aux In Setup” and press ENT. At the prompt use the UP & DOWN arrows to select either “Pressure” for a pressure (or vacuum) sensor, “H₂O” for a dew-point sensor or “None” if nothing is connected. Press ENT again to set the 4mA and 20mA range of the sensor being used following the directions given previously.

Attach the sensor cable using the 3-way Cannon type socket and the reading will be displayed on the second line of the LCD. If this does not happen then you must select the correct display option using the instructions in section 7.9.

The auxiliary sensor can be used as a totally independent sensor or in the case of the pressure sensor can be used to correct for oxygen partial pressure measured by the oxygen sensor. This is explained in section 7.11. The scale of the pressure sensor (e.g., 0-10 bar) can be programmed by the user to allow different sensor heads to be used.

7.15 *Type K Thermocouple*

The type K thermocouple (supplied) is connected via the socket on the rear panel (7). When fitted correctly the LCD display will show the temperature in °C. If this is not the case then you need to select the display option in the menu system as described in 7.9. Press ENT and scroll down to no. 7 “Display Setup”. Press ENT to access and then press the DOWN arrow to select “Line 2 Options”. Press ENT to access this menu. Select “Temperature” (or “Alternate T/A” to alternate the temperature and auxiliary sensor readings) and press ENT to confirm. The display should now read the temperature. If you want to display the temperature in °F instead of °C select option 6 “Set Units” on the menu and press ENT again to access “Temperature”. Select the desired units (or “None” to disable the temperature sensor) with the UP & DOWN arrows and press ENT to proceed to the next step. You must complete settings for all sensors and press ENT in order to save the settings and return to the main menu.

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The thermocouple is an independent measurement from the oxygen sensor, and it is not necessary to have it connected for oxygen measurements. The thermocouple can be positioned anywhere you desire but typically it is placed in close proximity to the oxygen sensor so the measurement gas temperature may be recorded. The type K thermocouple measurement displays 0 to 1250°C and is accurate +/- 1%.

7.16 RS232 / RS485 Port

It is possible to factory set the data communications port to either RS232 or RS485. Once configured at the factory it is not possible to change unless the unit is returned to Cambridge Sensotec Ltd.

Data from the RapiDox is sent on demand to the 9-way 'D' type socket (8) on the rear panel and can be read using a simple terminal programme such as 'HyperTerminal' in Windows, or with the user's own custom software. Alternatively a simple and convenient data logger programme is included with the supplied software and is described in section 9 below.

7.16.1 RS232 Protocol

Oxygen data can be read from the RS232 port at the back of the RapiDox. The default RS232 configuration is 57600-8-N-1, as shown in this example for COM1:

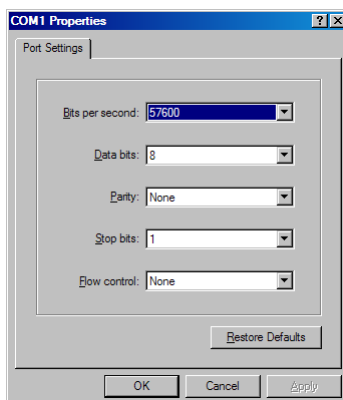


Figure 9: RapiDox default COM properties box

Alternatively, the baud rate can be reduced to 9600 via the “Set Baud Rate” menu item, using the front panel keypad on the RapiDox. This setting is stored in EEPROM.

Connection: Connect to RS232 socket at the back of the RapiDox using a 9 way D-type plug. Signals are as follows:

RapiDox D-type Socket:	PC/PLC:
Pin# 2 = Data Out	→ Data In (RX)
Pin# 3 = Data In	← Data Out (TX)

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Pin# 5 = Common/Gnd -- Common/Gnd

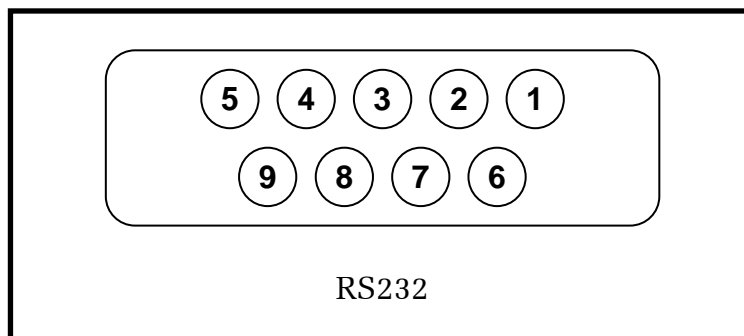


Figure 10: Rapidox RS232 pin configuration

All other pins (1,4,6,7,8,9) = Don't care

Reading Data: Data is read using command "D". Send the single character "D" to the Rapidox. The Rapidox replies with one of the following responses. All valid responses end with [CR] & [LF] (where [CR] = ASCII 13 and [LF] = ASCII 10).

Response: !Initialising[CR][LF]

Meaning: Rapidox is still initialising

Response: !Sensor heating[CR][LF]

Meaning: Rapidox is still heating sensor to operating temperature

Response: !Sensor cooling[CR][LF]

Meaning: Rapidox is still cooling sensor to operating temperature. This can happen when switching from Normal to Helium operating mode.

Response: !Cleaning sensor[CR][LF]

Meaning: Rapidox has finished heating sensor and is cleaning the sensor for 5 seconds

Response: !User setup active

Meaning: The configuration menu has been activated via the front panel keypad. The menu will automatically time out 60 seconds after the last key was pressed, or press the keypad's ESC key to return immediately to normal run mode.

Response: !Possible sensor fault

Meaning: The sensor has failed to reach operating temperature within 10 minutes from power up. This may be due to the age of the sensor, or because a high thermal conductivity gas is being used.

Response: !No sensor or sensor fault[CR][LF]

Meaning: Sensor is not connected, or there is a fault in the sensor

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Response: d2.959E+05,-1.426E+01,2.000E+00,3.619E+01,23:19:40,14/01/00,
M,,AL1&2[CR][LF]
Meaning: "d" means data is being sent
"2.959E+05" is Oxygen reading in ppm
"," = data separator
"-1.426E+01" is Oxygen sensor reading in mV
"," = data separator
"2.000E+00" is pressure sensor reading in bar, or dew-point sensor
reading in °Cdp (if connected)
"," = data separator
"3.619E+01" is temperature sensor reading in °C
"," = data separator
"23:19:40" is Rapidox time
"," = data separator
"14/01/00" is Rapidox date in DD/MM/YY format
"," = data separator
"M" is the current oxygen "range" setting (L,M,H)
"," = data separator
"," = data separator
"AL1&2" means both alarm conditions 1 and 2 exist **
[CR] = ASCII 13 (Carriage Return character)
[LF] = ASCII 10 (Line Feed character)

** If no alarm conditions exist, this data is empty, so the response would look
like:

d2.959E+05,-1.426E+01,2.000E+00, 3.619E+01,23:19:40,14/01/00,M,,[CR][LF]

Response: ?

Meaning: "D" command was not recognised. Try to send it again.

7.16.2 RS485 protocol

Please contact Cambridge Sensotec for further information on this feature.

7.17 Printing

If you have purchased the printer option then you have the option to print out various data from the analyser straight on to thermal paper. Simply connect the printer to the unit using the serial socket (10) on the rear of the machine and make sure the printer is switched on (battery and mains versions are available). To print the live values on the LCD at any time simply press the RIGHT arrow button on the front panel. Each push of the button will print out the serial number followed by the data in a tabbed format followed by a blank line. If the button is held down, the printer will keep printing data (but not the serial number).

If the last four digits of your firmware version number are 09.03 or greater, then

when first connected or switched on, the printer will print out the machine serial number and firmware versions. If you do not have a printer connected and you attempt to print using the RIGHT arrow button you will get the error message: “Unable To Print”.

7.18 *Load Defaults*

It is possible to restore the machine back to its factory settings by loading the unique default configuration that is supplied on your software CD-ROM. The default set-up can only be accessed using the software provided. Please see section 8.4 for further details.

Alternatively, you can reset to ‘generic’ factory defaults directly from the front panel keypad. Press ENT to enter the user setup menu and select menu option 13 “Load Defaults” and press ENT to proceed. The next screen will say “Load Defaults?” with the prompt to press and hold ENT for 2 seconds to confirm. To complete this press the ENT button until the bar graph has completed and the screen says “Defaults Loaded”. This will give you all the basic settings that are factory set. You will now need to re-calibrate the sensor and check all the settings are suitable.

7.19 *Replacing the Sensor*

After extended use the sensor will begin to fail and will need replacing. Normally this is caused by the sensor heater failing. The Rapidox sensor will not be able to reach its operating temperature anymore and the message “Sensor Heating” will appear on the display permanently when the sensor is located in fresh air. Note that this effect can also happen if the sensor is being operated in hydrogen or helium. Please contact Cambridge Sensotec for advice before replacing the sensor.

A new sensor can be simply connected to the front connector (3) of the analyser as shown in Figure 4. The sensor is available in pre-calibrated and non-recalibrated versions. If you have a non-recalibrated sensor then the analyser will require a full recalibration as soon as the new sensor is up to temperature. If on the other hand you have purchased a pre-calibrated sensor then you simply connect it in place and switch on, and then load the accompanying rxc file using the software. This procedure is described in section 8.5 below. Only once the correct updated rxc file has been loaded into the analyser is it fully recalibrated and ready to take measurements.

8. Rapidox Software Instructions

8.1 *Software Installation*

It is possible to programme a range of variables to the Rapidox using an RS232 (or RS485 if configured) link with a PC running MS-Windows (all versions) and the supplied Rapidox software. The software is installed automatically by inserting the Rapidox CD into the CD-ROM drive. If auto-installation does not start then you can click the Windows START button and select RUN. Type X:\setup.exe where X is the drive letter of your CD. Alternatively access the CD from Windows Explorer or the 'My Computer' icon on your desktop, and double-click on the 'Setup.exe' programme. Follow the on-screen instructions to install the programme onto the hard drive. Once installed, you can access the programme by clicking START - PROGRAMS – Rapidox Software.

The software has been tested successfully on most language machines including Chinese, Korean & Japanese and all current versions of Windows operating system. We do not recommend the use of Vista as connecting devices to this operating system can be problematical at best.

Note that software is 'regionally aware' and will therefore accept and display data using the decimal separator that is set in the PC's Regional Settings in the Control Panel. For example, in the UK or US, you might enter the value 2.5 - in continental Europe this would normally be entered as 2,5 assuming the PC's Regional Settings have been set up to use ',' as the decimal separator.

8.2 *Getting Started*

Make sure that the Rapidox is connected to a free serial port on the rear of your computer. These will nearly always be COM1 or COM2 but the software will scan through the first 16 ports until it finds the Rapidox. The analyser must be switched on for this to succeed and while you are communicating with it. You can programme the variables without a sensor attached, but to monitor the Rapidox properly, the sensor needs to be connected and at operating temperature. On start up the software will locate the Rapidox and display the following page:

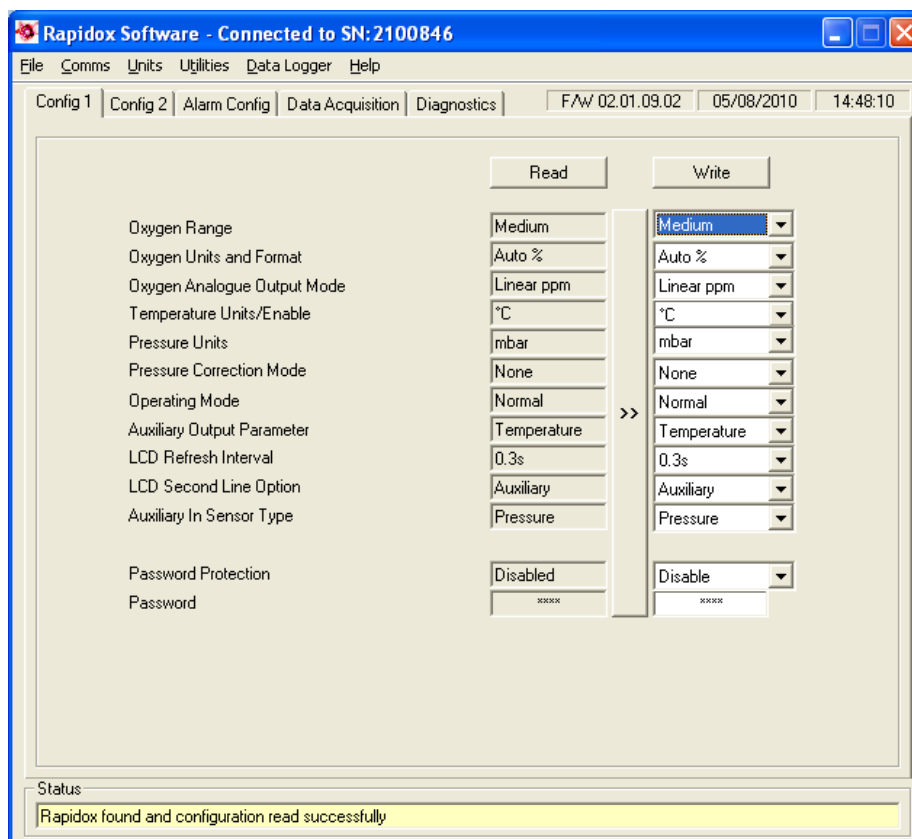


Figure 11: Configuration 1 page. Note the actual values used may differ from those shown above.

The yellow status box at the bottom will display confirmation that the RapiDox was found and the result of the last action, or any error messages if there is a problem with communication. If you experience problems check that your serial cable (supplied) is correctly fitted to a valid serial port, and that you do not have another application open that may be using the same port. There are several types of serial cable available. You must use a cable as supplied where there are straight through connections, i.e., pin 2 to pin 2, pin 3 to pin 3 and pin 5 to pin 5. Other cable formats will not work. Also check the status of your COM port settings in Device Manager accessed by clicking START – Settings - Control Panel.

8.3 On-Screen Help

You can access the on-screen help facility at any time by clicking on the 'Help' menu on the menu bar and select the 'Help' option or press F1.

8.4 Configuration Page

The configuration page is split into three, and you can switch between them by clicking on the tabs labelled "Config 1", "Config 2" or "Alarm Config". Each page allows the user to reprogramme an array of variables used by the RapiDox. Once written to the RapiDox, the new variables remain permanent until overwritten.

To read the current configuration stored in your Rapidox select 'Read Analyser Configuration' from the 'File' menu, or click the 'Read' button on any of the 'Config' pages. Note that the entries in the boxes on the RHS (under the 'Write' button) will turn red if the value is different to that just read and a red asterisk will appear next to the 'Write' button to warn you that a change has been made. The left-hand set of grey text fields ('read fields') will be updated with the current configuration data. To save this information (e.g., if several people share the same instrument) click the long copy ('>>') button (between the 'Read' and 'Write' columns) on any of the 'Config' pages in order to transfer the data into the edit boxes, select 'Save Configuration as' from the 'File' menu and choose a filename. This data set can be subsequently reloaded at any time by selecting 'Load Configuration File' from the 'File' menu and then selecting the folder where the configuration files have been stored.

If at any time you wish to restore the machine to its factory default settings select 'Default Configuration' from the 'File' menu to load these values. The software will search for a unique '.rxc' file that is loaded onto the PC during the software installation. The filename is 2100***.rxc where *** is the last three digits of the serial number located on the rear of the machine. This file is also located on the CD-ROM that came with the machine. Normally this file is located in the "My Documents" directory but if the software cannot locate it then it will ask you for the serial number to help it search. With the correct rxc file loaded into the 'Read' columns, simply click '>>' (copy) to transfer the defaults into the edit boxes and then click any of the three 'Write' button to load them back into the Rapidox.

The right-hand set of white editable text fields ('write fields') is used to enter new values to be programmed into the Rapidox. The values in these fields can either be entered manually, or copied across from the 'read fields' by clicking the vertical 'Copy' button, and then edited as required, however greyed boxes under the 'Write' buttons are not editable as they contain calibration data; they can only be changed by copying data across from the 'Read' fields. Note that when you click on the copy button all three 'Config' pages are updated at the same time and there is no need to repeat the action when you toggle to the other page. Alternatively, you can load saved configuration data by selecting 'Load Configuration' from the 'File' menu and selecting the required file. In order to programme the analyser select 'Write configuration to the analyser' from the 'File' menu, or click the 'Write' button on any 'Config' page.

8.5 Replacing a Pre-Calibrated Sensor

If you are replacing the oxygen sensor for a new one and you have purchased a pre-calibrated sensor then this will be supplied with a memory stick containing the updated rxc file. The rxc file contains the new calibration values matched to the new sensor and it is important to load this as soon as possible once the sensor has been changed over. Place your memory stick into the PC and run the software so that it connects with the Rapidox unit. Select 'File' and 'Load Configuration' and select the location of your USB memory stick. The filename is 2100***.rxc where *** is the last three digits of the serial number located on the rear of the

machine. With the updated rxc file loaded into the 'Read' columns, simply click '>>' (copy) to transfer the defaults into the edit boxes and then click the 'Write' button to load them back into the RapiDox. The yellow status bar will show you that the update was successful. Your new sensor is now correctly calibrated and ready to use without using any specialist cal gases.

8.6 *Reconfiguring the Analyser*

The on-screen edit boxes contain variables that can be reprogrammed into the RapiDox in exactly the same manner as using the front panel keypad. For a full description please refer to the relevant section in this manual.

The user can choose whether to use ppm or percent notation to edit the text boxes, where appropriate, by selecting the 'UNITS' menu and clicking on 'Percent' or 'ppm'. To access a field, either click inside it or use the TAB key to scroll through them. The field parameters are as follows:

8.6.1 Config 1 Screen

- 1) **Oxygen Range:** See section 7.5 for a full description. Use the drop down box to select LOW, MEDIUM or HIGH. The default setting is Medium.
- 2) **Oxygen Units & Format:** See Section 7.8 for a full description. Use the drop down box to select PPM EXPONENTIAL, PPM MIXED, AUTO%/PPM, PRESSURE or N2 BALANCE %. The default setting is AUTO%/PPM.
- 3) **Oxygen Analogue Output Mode:** See section 7.7 for a full description. Use the drop down menu to select either mV, LINEAR(ppm) or LOG(ppm). The default setting is linear (ppm).
- 4) **Temperature Units/Enable:** See sections 7.8 and 7.15 for a full description. Use the drop down menu to select °C, °F or NONE. If 'None' is selected then the temperature display is completely disabled. The default is °C.
- 5) **Pressure Units:** See sections 7.8 and 7.14 for a full description. Use the drop down menu to select MBAR, BAR, PSI, TORR or KPa as the unit for pressure measurement. The default setting is MBAR.
- 6) **Pressure Correction Mode:** See section 7.11 for a full description. Use the drop down menu to select NONE or AUTOMATIC. The default setting is NONE.
- 7) **Operating Mode:** See section 7.10 for a full description. Use the drop down menu to select NORMAL, HELIUM or VACUUM. The default setting is NORMAL.
- 8) **Auxiliary Output Parameter:** This function allows the user to choose

whether the Auxiliary output terminals on the rear panel (6) are for use with the thermocouple (7) or the optional auxiliary sensor (4). Use the drop down menu to select TEMPERATURE or AUXILIARY IN. The default setting is TEMPERATURE.

- 9) **LCD Refresh interval:** Use the drop down menu to select a refresh rate for the LCD (min 0.1, max 1.5 sec). The default is 0.3 seconds.
- 10) **LCD Second Line Option:** See section 7.9 for a full description. Use the drop down menu to select TEMPERATURE, AUXILIARY IN, TEMP/AUXILIARY IN (alternating), DATE/TIME (alternating). The default setting is TEMPERATURE.
- 11) **Auxiliary Sensor Type:** See section 7.14 for a full description. Use the drop down menu to select either NONE, PRESSURE or DEW-POINT. The default is NONE unless an auxiliary sensor is ordered with the Rapidox and in this case the correct sensor type will be selected.
- 12) **Humidity Units:** See section 7.8 for a full description. Use the drop down menu to select either °Cdp, °Fdp or ppm(V). The default is °Cdp. Note that this menu option only appears if the selected sensor is dew-point.
- 13) **Password Protection:** See section 7.2 for full details. Use the drop down menu to either enable the password or disable the function. Note that if the function is already enabled then you will need to enter the password when prompted to do so, in order to continue. You can change the password when prompted as well. Contact Cambridge Sensotec if you are having problems remembering the password.

8.6.2 Config 2 Screen

	Read	Write
O2 Calibration gas 1 (%)	20.95	20.95
O2 Calibration gas 2 (%)	0.1	0.1
O2 Calibration gas 3 (%)	0.001003	0.001003
Calibration constant A	-8.9913	-8.9913
Calibration constant B	103.7253	103.7253
Calibration constant C	192.7947	192.7947
O2 Analogue out high: 5V/20mA = (ppm)	25	25
O2 Analogue out low: 0V/4mA = (ppm)	0.001	>> 0.001
Aux Analogue out high: 5V/20mA = (°C)	1250	1250
Aux Analogue out low: 0V/4mA = (°C)	0	0
Absolute ambient pressure (mbar)	1013	1013
Aux sensor range at 20mA (mbar)	33000	33000
Aux sensor range at 4mA (mbar)	0	0
Oxygen impedance setting	600	600
Helium impedance setting	650	650

Status

Figure 12: Configuration 2 screen. Note the actual values used may differ from those shown above.

- 14) **Calibration Gas 1, 2 & 3:** These boxes are greyed out in this version and the data is for information purposes only. If you want to change the current calibration gas then follow the procedure given in section 8.7.
- 15) **Calibration Constant A B & C:** These boxes contain the calibration constants that the Rapidox calculates automatically when you perform a calibration. You will see that they change each time you perform a new calibration. Generally the air value should be approximately -10mV and a low ppm value (eg 10ppm) would be approximately 180mV.
- 16) **O₂ Analogue Output (0V/4mA & 5V/20mA):** Use these two boxes to set the High and Low oxygen values for the analogue outputs (6) on the rear panel. For example if you want 4mA to represent 1% and 20mA to represent 21% then enter these two values into the appropriate boxes. The value can be entered either in % or ppm depending on the units selected. The default is %. The default values are 25% for the high setting and 0.001% for the low setting. However, if the 'Oxygen Analogue Output Mode' on the 'Config 1' page is set to 'Raw mV' then the values entered are in mV.

- 17) **Auxiliary Analogue Output (0V/4mA & 5V/20mA):** Use these two boxes to set the High and Low auxiliary values for the analogue outputs (6) on the rear panel. For example if you want 0V/4mA to represent 0°C and 5V/20mA to represent 1250°C (for temperature) then enter these two values into the appropriate boxes. The units are automatically determined by the settings made for the auxiliary sensor type.
- 18) **Absolute Ambient Pressure:** Use this box if you want to enter the current ambient pressure (in mbar). This value is used in the automatic pressure correction function only and provides enhanced accuracy in the correction. The default is 1013mbar which is the average ambient pressure in the UK.
- 19) **Auxiliary Sensor Range:** Use these two boxes to set the range of the auxiliary sensor. If the sensor type is pressure or vacuum then enter in terms of mbar or if it is a dew-point sensor then enter in terms of °Cdp. Make sure that the scale here matches the scale printed on the auxiliary sensor otherwise errors will occur in the readings.
- 20) **Oxygen and helium impedance setting:** These values are for information purposes only and cannot be adjusted. They control the temperature of the heater for the two modes of operation by setting the impedance of the zirconia cell to a pre-determined value. These values are only displayed in the engineering version of the software.

8.6.3 Alarm Config Screen

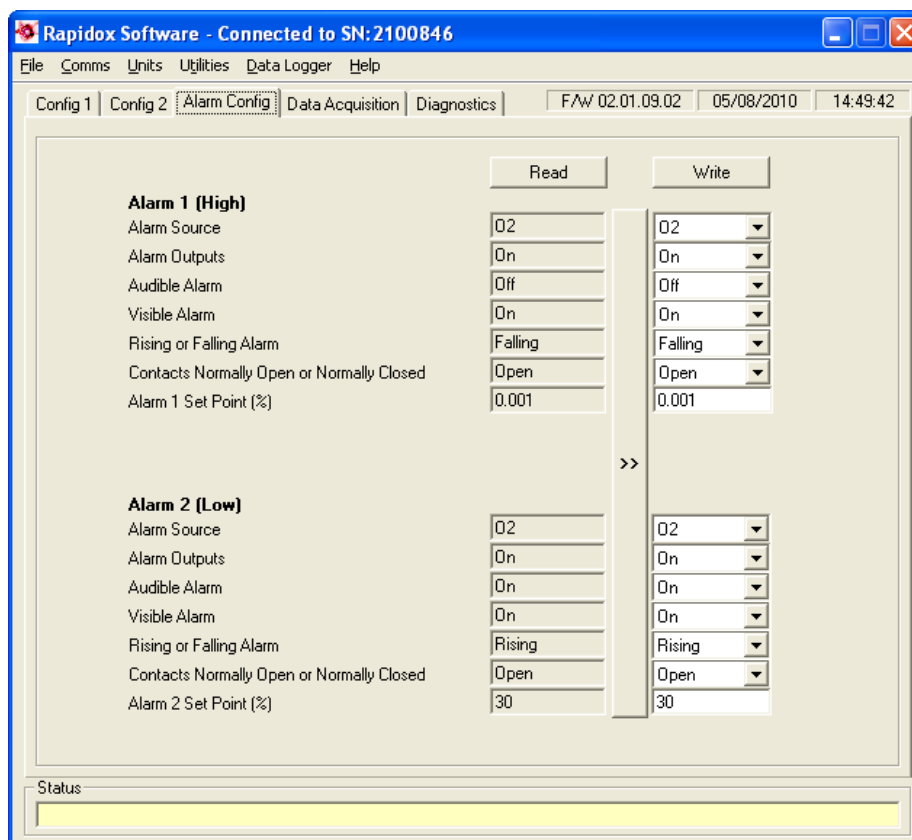


Figure 13: Alarm configuration screen. Note the actual values used may differ from those shown above.

- 21) **Alarm Source:** Use the drop down box to assign a detector to the alarm. If you want the alarm to be based on oxygen readings select oxygen from the drop down list. The choices are: oxygen, auxiliary in (pressure, vacuum or dew-point type) or temperature.
- 22) **Alarm Outputs:** This option enables or disables the alarms on the rear panel (labelled Alarm High +/- and Alarm Low +/-). Make sure these are enabled if you wish to use the signals from the alarm circuit.
- 23) **Audible Alarm:** This option enables or disables the audible buzzer fitted to the Rapidox internally. When an alarm condition occurs the buzzer will emit a continuous noise to alert the operator.
- 24) **Visible Alarm:** This option enables or disables the visual warning on the front LCD. When enabled and an alarm condition occurs the message "AL1" or "AL2" will flash in the lower right hand corner.
- 25) **Rising or falling Alarm:** This option allows the alarm to be set as a rising or falling type. If the alarm is rising then the reading must rise above the set-

point for the alarm to be activated. If the alarm is falling then the reading must fall below the set-point for the alarm to activate.

- 26) **Contacts N/O or N/C:** This option allows the user to programme how the relay contacts are set on the rear panel. Normally Open means that the contacts are open circuit when an alarm is not activated and Normally Closed means that the contacts are closed when the alarm is not activated.
- 27) **Alarm Setpoints:** Use this box to programme the set-point value at which you want the alarm to activate. The units are in %, ppm °Cdp or mbar depending on which sensor you have assigned to the alarm.

Once you have finished editing the parameters, select 'Write Configuration to Analyser' from the 'File' menu (or click the 'Write' button) and the new data set will be written to the Rapidox. The Rapidox is reprogrammed using the new configuration. The software then reads the new settings back from the Rapidox and displays them in the boxes on the left-hand side confirming that the configuration was successful. When you have finished programming the analyser for new calibration gases you must recalibrate the instrument to benefit from the changes.

8.7 On-Screen LCD

It is possible to display an LCD emulator on the desktop of your PC. This reproduces exactly the display on the Rapidox unit and is convenient if you are some distance away from the machine. To activate the LCD, select the 'Utilities' menu and select the 'Show LCD' option. This will display a small window showing the LCD, that can be positioned independently anywhere on the desktop.

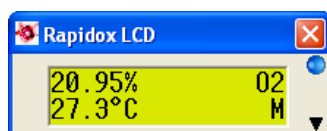


Figure 14: On-screen LCD. Values shown are for illustrative purposes only.

The blue LED indicator will flash to show that the display is updating.

8.8 Remote Calibrating and Cleaning

With the on-screen LCD display active it is possible to remotely calibrate the analyser and clean the sensor. Click on the down arrow icon in the bottom right-hand corner of the LCD display to expand the window:

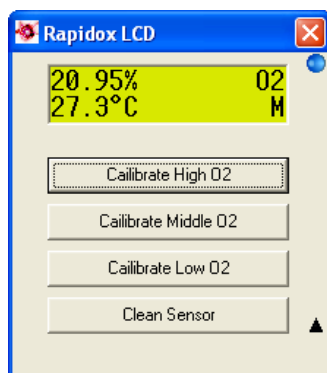


Figure 15: Remote calibration and clean function. Values shown are for illustrative purposes only.

Use the four buttons to calibrate or clean the sensor directly from the PC. Before calibrating the analyser with gas, make sure that you know the exact O₂ concentration in your gas bottle AND you have a calibration certificate from the gas supplier confirming the concentration. You can calibrate the analyser in any order but remember that the gas value for O₂ High must be greater than the gas value for O₂ Middle, which must be greater than the gas value for O₂ Low. Allow sufficient time for the calibration gas to pass over the sensor and let the reading on the LCD stabilise. This is extremely important to perform a successful and accurate calibration.

The software uses the three calibration gas values already stored in the Rapidox as a starting point. These are typically High = 20.95%, Middle = 0.1% and Low = 0.001% as set in the factory but may be different if the user has recalibrated with other gas values in the past. Either way you are given an option to change the cal gas value before proceeding to the actual calibration.

Assuming you are using fresh air (20.95%) to calibrate O₂ High then simply click on the button labelled "Calibrate High O₂" to see the following:

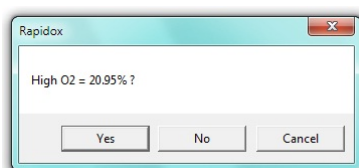


Figure 16: Calibration Gas Confirmation Screen.

If the current stored value is correct and matches your cal gas value then simply click "Yes" to proceed. If you are using a different value to the one you see on the screen then click "No" to change it as shown below:

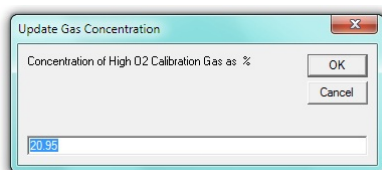


Figure 17: Calibration Gas Update Screen.

Enter your new value in the units as instructed and click “OK” to proceed. This value will then be stored until you want to change it again. You will now see the following screen:

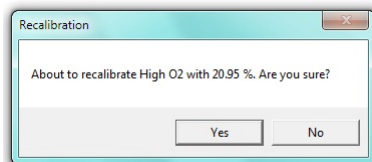


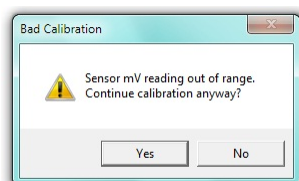
Figure 18: Calibration Confirmation Screen.

This is your final chance to change your mind before committing to a calibration. Check carefully that the gas value on the screen actually matches the value of your calibration gas before clicking on “Yes” to complete the calibration. At this point you should observe that the LCD display will reset itself to the correct calibration. You can now proceed with the rest of the calibration process by selecting the Middle and Low gases in the same manner.

8.9 Calibration Error Messages

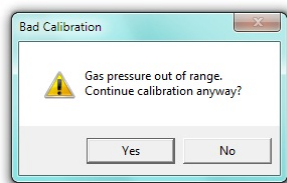
During the calibration process described in 8.7 above it is possible to receive screen error messages as described here.

- 1) **Bad Sensor Reading:** The Rapidox software makes a prediction of the expected sensor mV for each calibration gas value entered. If the mV signal coming from the sensor is out of the expected range the following message is displayed:



This normally indicates one of two things: that you are using the wrong cal gas value compared with the actual gas flowing over the sensor OR the sensor is getting old and can no longer output the expected signal required for a healthy calibration.

- 2) **Bad Pressure Reading:** The Rapidox software checks to see what the gas pressure is before allowing the calibration to continue. If the pressure is outside the range -25mbar to +25mbar (gauge) then the following message is displayed:



This normally indicates that you are allowing gas from a cylinder set at too high pressure to enter the analyser. Try displaying the pressure reading on the second line of the LCD and adjusting the gas regulator to trim it close to 0 mbar. If you are using a standard gas regulator then try switching off the sample pump on the rear of the analyser OR better still use a demand flow regulator and allow the gas to enter the analyser from the draw of the pump.

Note that the above are only advisories and you can proceed with the calibration if you believe everything is checked and correct.

8.10 Software Utilities

The utilities menu is located on the main file menu as shown below:

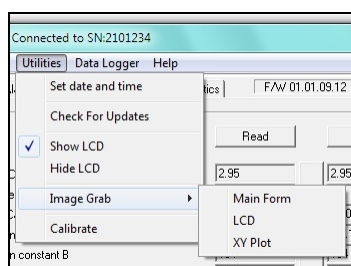


Figure 19: Software Utilities Menu

8.10.1 Setting Analyser Date and Time

The current date and time of your PC are displayed on the configuration screen and can be loaded into the Rapidox by selecting the Utilities menu and clicking the 'Set date and time' option. This information is used in the RS232 data string for data logging purposes. Make sure that your PC clock is set correctly before using this function, as you cannot edit the date and time shown by the Rapidox software. The date and time formats displayed are those set in the PC's Regional Settings.

8.10.2 Check for Updates

This function will check online and advise you if any software updates are available for your machine. This function is not automatic. To update the software you need to visit www.cambridge-sensotec.co.uk and select the support page where a list of downloads are provided.

8.10.3 Image Grabber

This is a simple function to allow the user to copy the software screens into the Windows clipboard. This is useful for diagnosing problems; allowing a quick and simple way of sending the Sensotec technicians actual screen shots of the software. To recover the images simply press CTL+V to paste.

9. Rapidox Data Logging Software

9.1 *Introduction*

The Rapidox software includes a full data logging facility. Data can be saved to a file automatically at regular intervals and the format is compatible with spreadsheet programmes such as MS-Excel. A live-time graphing facility is also included which has many powerful features. Note that the data logging facility will only function if the analyser is in run mode: in any other mode (e.g., user menu active or sensor heating) logging will be suspended until the analyser returns to normal run mode.

9.2 *Setting up the Data Logger*

Click on the tab labelled 'Data Acquisition' to display the following page:

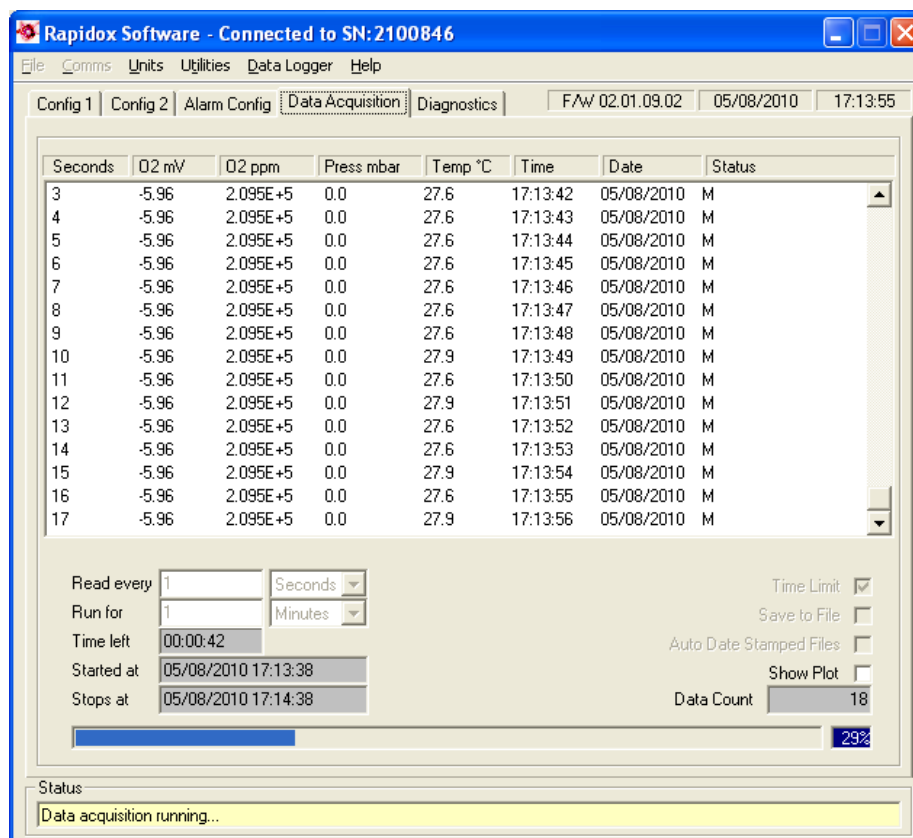


Figure 20: Data Logging page

During logging, data from the analyser is shown in the central area of this page. The data is displayed in the following columns: time (in seconds, minutes or hours, according to the setting of the 'Read every' drop-down box), the raw signal from the sensor (in mV), the oxygen value (in ppm scientific notation), pressure in mbar (if pressure sensor is attached) or dew-point in °Cdp (if a dew-point sensor is attached), the type K thermocouple reading (in Celsius), the time (in HH:MM:SS format), the date (in regional format), and analyser status (displaying the oxygen range setting, the operating mode and "AL1", "AL2" or "AL1&2" if one or both alarms are activated).

To start data logging select the frequency of measurement by entering a time and selecting a unit from the drop down list. For example if you wish to log data once every minute type 1 in the box labelled 'Read every' and select 'Mins' from the drop down menu.

You can open the NOTES window at any time by selecting 'Notes' from the 'Data Logger' drop down menu. A small text box appears in which you can type a text message. This note is then saved as a header in the data file set and can be viewed along with the data.

You can either choose to have data logged continuously until 'Stop' is selected from the 'Data Logger' menu, or you can choose to set a time limit for data logging by checking the box labelled 'Time Limit', and then setting the duration in the 'Run For' box and selecting units with the drop down list. For example if you

wish to log data for thirty minutes type '30' in the box and select 'Mins' from the drop down list.

9.3 *Running the Data Logger*

If you wish to save the data into a file for later use, check the 'Save to File' box before selecting 'Run' from the 'Data Logger' menu. You will be prompted for a file name and location before data logging commences. The file and path information will appear in the box at the top of the page labelled 'Data File Name'. If you forget to select file saving before starting a run, you will nevertheless be prompted at the end as to whether you wish to save the run data.

The blue progress bar displays the state of completion of the run, and the blue box to the right of it displays the same information as a percentage. You can stop the run at any time by selecting 'Stop' from the 'Data Logger' menu. The yellow Status bar at the bottom of the page gives information about the data logging operation.

Once data logging is complete you may open the text format data file using any compatible spreadsheet programme such as MS-Excel, and use the data to generate plots and reports. You can save files with a ".txt" extension (the factory default) or a ".csv" extension, and whichever was last used will become the new default. See section 10.21 "Working with Spreadsheets" for more on this topic.

You can pause the data logger at any time by selecting 'Data logger' and 'Pause'. Click 'Data logger', 'Resume' to continue logging from where you left off, noting that the clock keeps ticking during the pause period.

9.4 *Auto Date Stamped Files*

If you are planning to run the data logger for extended periods of time then you should consider checking the 'Auto date stamped file' option. This feature will save the data at midnight for the previous twenty four hours and so on until the data logging is complete OR the user interrupts it. The data file is stored with a date suffix in brackets in yy-mm-dd format.

This feature ensures that data is saved periodically in sensible sized files. This will prevent the computer from crashing and will also ensure that the data is small enough to fit into an MS-Excel spreadsheet

As an example, the user wishes to run the data logger for seven days recording every minute starting at lunchtime on 12th November 2005. He starts the data logger with the auto-date stamp function enabled. When prompted he gives the filename as "test1.txt". In this situation the data logger will run from lunchtime to midnight and then save the first file as "test1 (2005-11-12).txt". The data logger then clears and continues for another twenty four hours until midnight the following day. The data is then stored as "test1 (2005-11-13).txt". This will continue for seven days when the data logger will finish.

After this the user will have a sequence of files:

```
test1 (2005-11-12).txt  
test1 (2005-11-13).txt  
test1 (2005-11-14).txt  
...
```

And so on. Combined together they represent all the data over the last seven days. Note that the Rapidox uses the computer clock and date to perform this action, so make sure that they are correct before starting a run.

To view the data in its entirety the user would need to load each file in turn back into e.g., MS-Excel to combine them.

9.5 *Live-Time Graphing Screen*

The Rapidox data logging package includes a live-time graphing facility that allows you to monitor the progress of your data in a graphical format (see Figure 21). To access the graph check the box labelled 'Show Graph'. The graph will appear in a new window, and can be accessed at any time without disturbing a run that is already in progress. You can select 'Run' and 'Stop' from the 'Data Logger' menu in the graphing window to begin and end data logging, and the window can be minimised to (and restored from) the task bar while logging data.

To close the window and return to the main data logging page select 'Close Plot' from the 'File' menu or click on the close window button.

The features of the graph window are described below:

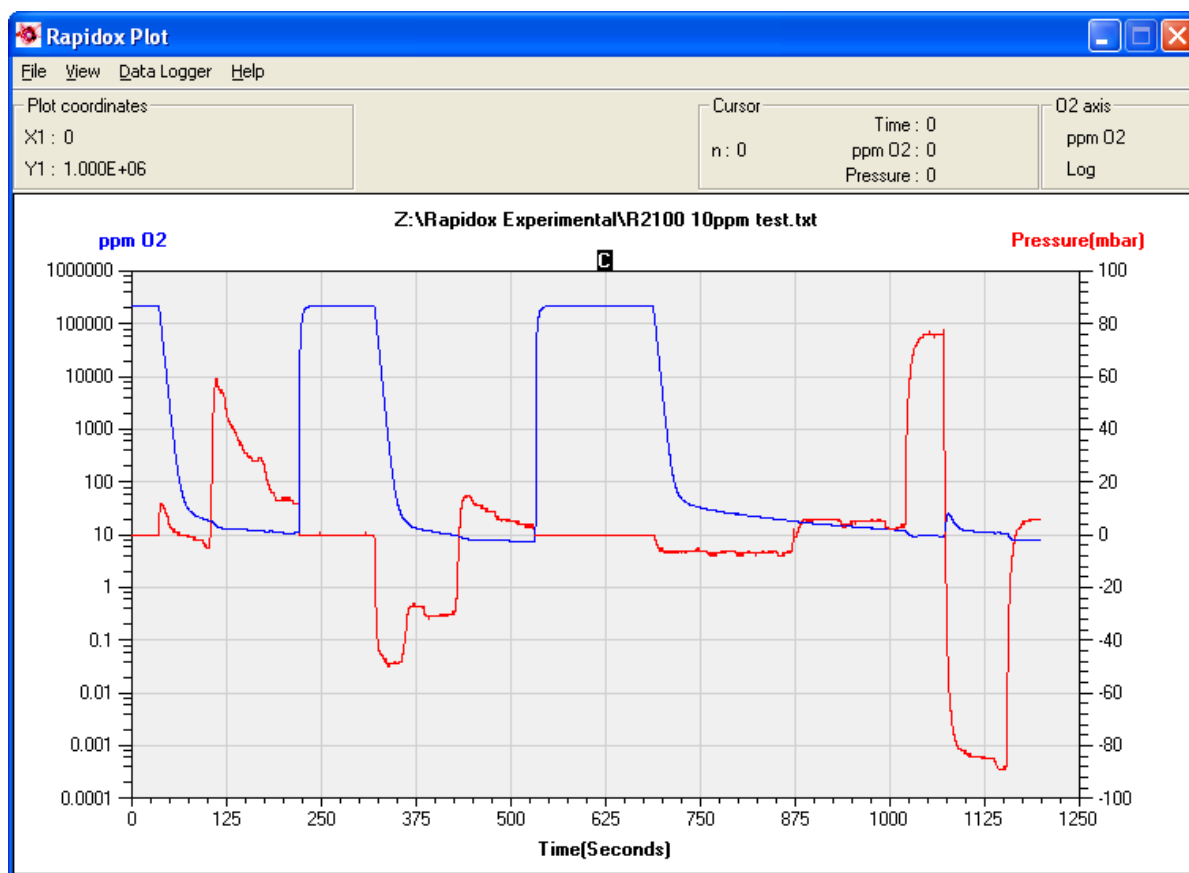


Figure 21: Live-time graphing screen

9.6 Main Graph Window

The graph is an XY plot, with time plotted on the X-axis, oxygen plotted on the primary Y-axis (Y1) and temperature or Auxiliary sensor (if connected) plotted on the secondary Y-axis (Y2). The X-axis and the two Y-axes auto-scale during data logging so that all data points are shown on the graph.

9.7 Plot Colours

The default colours used on the graph are set to blue for oxygen and red for temperature. To change the colours double-click on the coloured axis label at the top of each axis. A colour palette window will appear (see Figure 22) and a new colour can either be chosen from a colour box, or for more variety, by clicking the 'Define Custom Colours >>' button. Click on 'OK' to select the new colour or 'Cancel' to return to the graph without change.



Figure 22: Plot colour palette menu accessed by double-clicking on the axes titles.

9.8 Graph Titles and Labels

If you want to change the text of the graph axis labels, place the mouse pointer over the text and do a single left click to enter edit mode. The text can then be modified. Similarly, to change the title of the graph, place the mouse pointer over the title and click once to edit. If you choose not to enter a title the graph will display the path and filename of the run as the new title once the run has finished. Note that these changes are only temporary and will be overwritten by the defaults if a new run is started or the graph window is closed and reopened. They are provided so that the plot may be printed with alternative labels.

9.9 Plot Co-ordinates

The box labelled 'Plot co-ordinates' to the upper left of the graph window displays the actual plot co-ordinate value at the mouse pointer. This can be used to get a quick oxygen value from the graph. Simply place the mouse pointer at a place of interest and read the corresponding X1 and Y1 values in the box.

9.10 Last data point

During data acquisition, the box labelled 'Last data point' will appear at the upper middle of the graph window. It displays the last data values read from the analyser.

9.11 Using the Cursor

Clicking and holding the left mouse button with the pointer over the **C** at the top of the plot area activates the cursor, which appears as a vertical dashed line on the plot. While keeping the mouse button pressed, you can now move the pointer anywhere in the plot area or on the **C** in order to move the cursor. The box labelled 'Cursor' to the upper right of the graph window will display actual values

for oxygen, temperature, time and the data point number (n) at or immediately to the left of the cursor position. The cursor can be used to investigate actual data values at specific points of interest on the graph.

9.12 *Zooming*

You can zoom in to any part of the oxygen plot by simply placing the mouse pointer on the new graph start position and then clicking and dragging a new box to re-size the graph. The label on the box to the upper left of the graph window will change to 'Zoom box co-ordinates', and an extra set of co-ordinates, labelled X2 and Y2, will appear, showing the co-ordinates in X and Y units of the second corner of the zoom rectangle as you drag the mouse pointer. The plot will zoom and auto-scale when you release the mouse button. This can be repeated if you wish to zoom in even further. To zoom back to the original size select 'Zoom Full' from the 'View' menu.

Note that although you can use the zoom facility during a live run, the graph will auto-scale to full size with each new data point.

9.13 *Y-Axis Graph Units*

You can toggle the Y1 oxygen units at any time from percent to ppm and vice versa. Select 'O₂ Units' from the 'View' menu and choose either percent or ppm. The current selection is then displayed in the top right box labelled 'O₂ Axis'.

9.14 *Oxygen Scale*

You can display the Y1 oxygen axis in linear or logarithmic format at any time by selecting 'O₂ Scale' from the 'View' menu. The current selection is then displayed in the top right box labelled 'O₂ Axis'. Note that the zoom function is disabled when you are viewing on a log scale.

9.15 *Second Y Axis*

The secondary Y axis located on the right hand side of the graph can be used to display either temperature taken from the type K thermocouple, pressure taken from the pressure sensor or dew-point taken from the dew-point sensor fitted to the Auxiliary socket on the front. It is not possible to display temperature and pressure / dew-point at the same time. The axis is linear and auto-scaling. To select the mode of the secondary axis select 'View' and then 'Second Axis Display'. Choose from 'None', 'Temperature', 'Pressure' or 'Dew-point'.

9.16 *Loading an Old Run*

A previously logged data file can be loaded and viewed by selecting 'Open Data

File' from the 'File' menu and selecting the appropriate TXT or CSV file. A progress bar is displayed while the data is being imported. Note that very large data files may take several seconds to load. The data is re-graphed and you can zoom, label axes, change colours etc., before printing the graph.

9.17 *Printing Graphs*

You can print the graph at any time by selecting 'Print Plot' from the 'File' menu. This will bring up the printer dialogue box for your specific printer where you can choose various printing options. Make sure that the printer page is set to landscape to obtain a full size print out.

9.18 *Data Logging in the Background*

It is possible to begin data logging and then minimise the windows in order to continue working with another application. To minimise the graph simply click on the minimise button on the blue title bar at the top of the window. You can then use the ALT + TAB keys to take you to other programmes already running. To return to the graph simply maximise from the start menu bar or press ALT + TAB again. If the graph does not redraw immediately select 'Zoom Full' from the 'View' menu to redraw.

9.19 *Pausing the Data Logging*

You can pause the data logging at any time during the run by selecting the 'Data Logger' menu and selecting 'Pause'. Repeat the action to continue, noting that the live graph will draw a straight line between the paused points to keep continuity of the axes. The clock keeps ticking during the pause period.

If you decide to access the menu of the Rapidox using the front keypad during data logging, then the software will pause automatically. A message appears on the screen informing the user that the unit is being accessed from the keypad. Once the menu has been exited, the software will continue data logging from where it left off. The clock keeps ticking during the pause period.

9.20 *Changing the Data Logging Parameters Mid-run*

Once the data logging has begun it is not possible to modify the original total length of time that the data logging will run for, but you may change the sample interval time by pausing the data logger and then entering a new value for the time interval. The data logger can then be resumed with the new values in place. Note that you can not change units (e.g. seconds to hours) once logging has started. If you originally selected seconds then you may change the current value to a new value between 1 and 3600 seconds, if you originally selected minutes then you may change between 0.02 and 360 and if you selected hours you may change between 0.01 and 6 hours. You can of course stop the run at any time using the

'Data Logger', 'Stop' menu option.

9.21 Working with Spreadsheets

The data logger saves data files in a standard comma separated ASCII text format which can be readily imported into spreadsheet programmes such as MS-Excel, in order to produce plots and reports as desired. For specific information on how to import text files into your spreadsheet programme please refer to the help guide supplied with the programme.

Data is saved in comma separated value format, with a '.txt' file extension as the initial programme default. However, when entering the file name, you can instead select a '.csv' extension: the programme will register the last used file extension as the new default. The '.csv' extension is recognised by MS-Excel, so that opening the file will automatically run MS-Excel, and this may be of benefit if your regional decimal separator is period '.' rather than comma ','. However, if your decimal separator is comma, you should continue to use the '.txt' extension and open the file explicitly from within your spreadsheet programme, defining the field delimiter as 'comma' where appropriate.

9.22 Disaster Recovery

To prevent catastrophic loss of important data during a computer crash or power failure, the data is automatically saved point by point in a temporary file called 'Rapidox temporary data file 2100xxx.txt', where 2100xxx is the serial number of your Rapidox. This file is located in the "My Documents" folder and can be renamed or copied to recover data that would otherwise be lost. Note that this file is overwritten each time 'Run' is selected from the 'Data Logger' menu so make sure all data is recovered successfully before starting another run.

Note that during a run using the 'auto date stamped' feature, the temporary data file is wiped clean as soon as the previous data set has been saved successfully. In the case of a crash the temporary data file should be used to recover the last day's worth of data that was not saved to the hard disc.

9.23 Diagnostics

The Rapidox software includes a diagnostics page that is accessed from the tab labelled 'Diagnostics'. This screen will display various values and settings that are operating inside your machine. There is no editing possible on this page – it is purely for information and to enable technical support help you should you experience difficulties with your machine. You may be asked to record values from this page if trouble shooting is required.

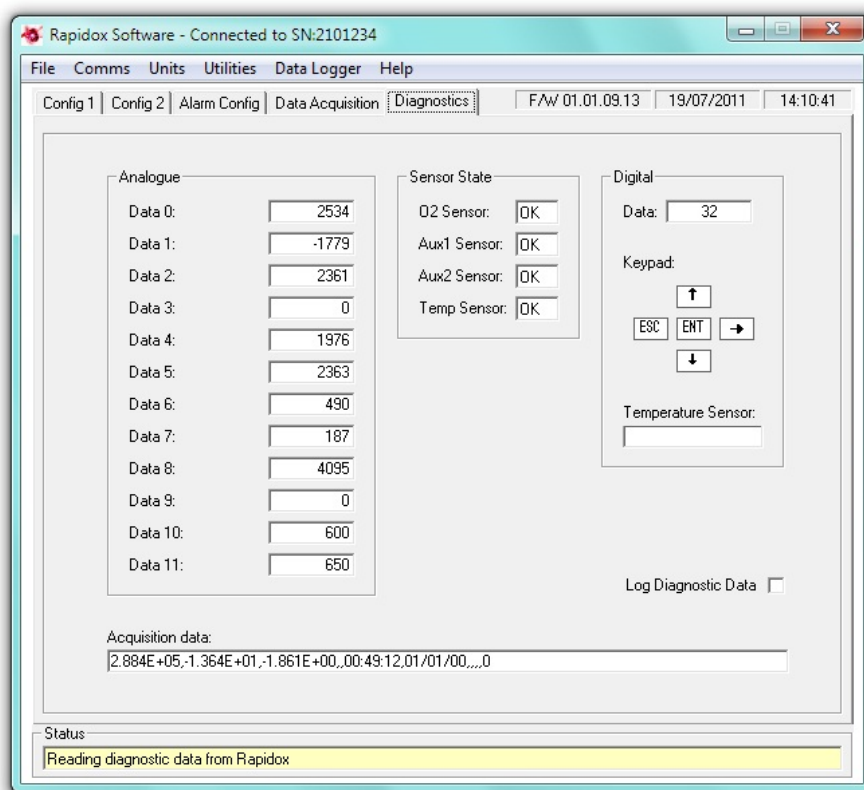


Figure 23: Rapadox Diagnostics Page

1. **Analogue:** The live analogue values displayed in this pane are voltage measurements coming directly from the computer chip inside the analyser. They are for information purposes only but are a useful diagnostics tool for Sensotec staff, as unusual values can indicate a particular fault. To help Sensotec diagnose a fault please capture this window as shown above using the screen capture function described in section 8.9 above and e-mail it to support@cambridge-sensotec.co.uk
2. **Sensor State:** These boxes should all indicate “OK” on a healthy analyser. Note that the temperature probe needs to be connected on the rear panel (7) in order to test here. The possible messages are “OK” “High” “Low” or “Fault”. The High and Low messages indicate that the sensor is out of normal range. The fault message will only display if the sensor is disconnected or has failed in some way.
3. **Digital:** The digital signals coming directly from the computer chip inside the analyser can be monitored here. To test the keypad is working correctly try pushing the buttons and watching the panel. A correctly functioning key will turn the box red on the screen and the digital value for that particular key will show in the data box. If the analyser has an external thermocouple correctly fitted (2100 and 3100 series only) then this will display a signal in the “Temperature Sensor” box.
4. **Log Diagnostic Data:** If you check this box then the

software will automatically start to save a diagnostic file in the "My Documents" directory called "Rapidox diagnostics data XXXX.txt (where XXXX is the serial number of your machine). Note the following:

- Diagnostic data is logged every 6 seconds, or every second if your software has the "Enable fast log" check box.
- Logging diagnostic data is controlled entirely by the "Log diagnostic data" check box - logging starts as soon as it is checked, and stops when it's unchecked.
- If you switch to a different tab diagnostic data logging will be suspended, so the general rule when logging diagnostic data is check the "Log diagnostic data" check box and then leave the software alone until you want to stop logging.
- There is no file name option, so rename the last diagnostic data file before logging new diagnostic data.
- Diagnostic data contains raw data from the analyser as well as either status messages (such as "Sensor heating") or acquisition data as you would get from the normal data acquisition file. However, unlike normal data acquisition, it isn't suspended if the heater loses control. Diagnostic data saving will only be suspended if there's a comms glitch between the PC and the Rapidox, or if you try to interact with the Rapidox via software. The file is created at the start of the run, and as with the temporary data file, each data line is appended, so you can look at the file at any time. You can therefore have a look at the file at any time (for example by opening it in Notepad or by copying and saving it with a .CSV extension for Excel) and see whether there are any anomalies.

E-mail the file to support@cambridge-sensotec.co.uk so we can help diagnose the problem.

10. Troubleshooting

Q: The Rapidox says 'sensor heating' but won't begin measuring.

A: Check to see if the sensor is getting hot. If it is then make sure the cable plug is located firmly in the socket (2). If you are still having problems contact Cambridge Sensotec for advice. If the sensor stays cool then the internal heater has failed and the sensor needs replacing. This problem can also occur if you are using helium gas without selecting the helium mode in the menu.

Q: The Rapidox won't power up at all.

A: There are fuses located on the power socket on both live and neutral lines. These are standard 20mm slow blow 2A fuses available from a supplier such as RS Components.

Q: The Rapidox gives strange readings that are way off the expected values.

A: Check to make sure which three calibration gases are selected. Are they the

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same as the actual gases you used to perform the calibration? If not you can change their values using the software. Also check to see that the pressure sensor is working correctly and is measuring the same pressure as the oxygen sensor is being exposed to, if the pressure correction mode is set to 'Auto'.

Q: The sensor does not read 20.9 - 21.0% in air (actual value is 20.95%).

A: If the room air is very humid, it will slightly affect the observed measurement or the sensor may have drifted slightly because of natural ageing. If you are using air as a calibration point then simply do a quick re-calibration in the air to compensate for this.

Q: I messed up the calibration procedure and the analyser is not working properly.

A: Return the box to the factory defaults using the instructions given in section 7.18

Q: The date and time information on the RS232 is incorrect.

A: The date, time and other features are user-programmable via the configuration software, or via the front panel using the built-in configuration menu. If using the software, make sure that the time and date are correct on the PC you are using before attempting to reprogramme the Rapidox. Also, the date format must be set via the software, and uses the setting from the PC that was last used to set the date and time. The factory default date format is DD/MM/YY.

Q: The software will not talk to the Rapidox.

A: Make sure that you are using the correct cable, as supplied (pin 2 to pin 2 etc). A crossed RS232 cable (pin 2 to pin 3 etc.,) will not work. Make sure that your COM ports are recognised by your computer. Check in your Windows device manager to see if there are any conflicts. If you have an internal modem fixed to your PC you may experience difficulties using this software. Contact Cambridge Sensotec for further advice.

Q: I selected 'Write Configuration to Analyser' and now the Rapidox is way off calibration.

A: Only select 'Write Configuration to Analyser' once all the values are correctly entered in the boxes on the right. The best procedure is to 'Read Analyser Configuration' and then press 'Copy' so the values in the boxes are the same as those stored in the Rapidox memory. You can then edit these values and then select 'Write Configuration to Analyser' when finished.

Q: How do I get back to the factory calibration for my instrument.

A: Select 'Load Configuration File' from the 'File' menu and look for the "2100xxx.rxc" file on your CD, where "2100xxx" is the serial number of your unit. Select this file and then select 'Write to the Analyser'. This will load the factory calibration back into the Rapidox. Alternatively you can use 'Default Configuration' on the 'File' menu which will automatically try to load "2100xxx.rxc".

11. Warranty

The Rapidox analyser has been carefully tested and inspected before shipment and is guaranteed to be free from defective materials and workmanship for a period of twelve months from date of purchase and delivery. The sensor head is replaceable and has a life expectancy in excess of 17,500 hours. However, if the analysis gas contains corrosive gases or large quantities of particulates, sensor life may be shortened. In the case of the latter, it is normally possible to insert a filter prior to the sensor head to remove the particulate material.

11.1 *Conditions of Warranty:*

- 1) This warranty is in addition to and does not affect any statutory rights of consumer purchasers. This warranty is valid worldwide on a “back to base basis”.
- 2) This warranty covers breakdowns due to design or manufacturing faults; it does not apply to damage, however caused, wear and tear, neglect, unauthorised adjustment or repair, or any items of limited natural life.
- 3) In the event of failure, please take the following action:
 - a) Refer to the “Troubleshooting” section of your instruction manual to identify and possibly correct the problem.
 - b) If the fault cannot be resolved, please contact the Cambridge Sensotec service and repair centre at the address given on the cover of the manual.
- 4) The warranty period applicable shall be 12 months from the date of delivery provided that:
 - a) Notice in writing of the defects complained of shall be given to Cambridge Sensotec (The Seller) upon their appearance, and
 - b) such defects shall be found to have arisen from the Seller's faulty design, workmanship or materials, and
 - c) The defective goods shall be returned to the Seller's premises at the Purchaser's expense if so requested by the Seller.
 - d) Any repaired or replaced goods shall be redelivered by the Seller free of charge to the original point of delivery but otherwise in accordance with and subject to these Conditions of Sale.
 - e) Alternatively the Seller shall be entitled at its absolute discretion to refund the price of the defective goods in the event that such price shall already have been paid by the Purchaser to the Seller, or, if such price has not been so paid, to

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relieve the Purchaser of all obligation to pay the same by the issue of a credit note in favour of the Purchaser in the amount of such price.

APPENDIX 1: MENU FLOWCHART FOR RAPIDOX 2100 (ZF & ZR)

