



INSTRUCTION MANUAL
OXIGRAF O2iM
NEMA 4X Oxygen Deficiency Monitor

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1. Warnings, Cautions and Notes



Warning: Indicates a potentially harmful condition that can lead to personal injury.

- Do not use the O2iM oxygen analyzer in the presence of flammable gases. Use of this instrument in such an environment may present an explosion hazard.



Caution: Indicates a condition that may lead to equipment damage or malfunction.

- Recommended calibration gases are 21.00 and 99.99% oxygen with nitrogen as the balance gas. Pure nitrogen may not be used as a calibration gas, as the analyzer does not operate at 0% oxygen.
- Calibration gases should be instrumentation grade and be supplied with a Certificate of Analysis (COA) indicating an accuracy of $\pm 0.03\%$.
- Do not expose the O2iM to more than 1 psig (1200 mb absolute) pressure. A “High Pressure” warning will flash if the cell pressure is above 1200 mb, indicating possible erroneous readings. Use an external flow control valve to regulate the flow.
- A calibration error alarm is generated if the cal set point does not match the cal gas concentration.
- Calibration should not be performed until the analyzer has been warmed up for at least 10 minutes.
- Always protect the sensor from water and dust by using the hydrophobic gas filter on the sample inlet.
- Humidity (water vapor) dilutes or displaces oxygen in air mixtures; the monitor does not correct for humidity.

Note: Indicates points of special interest or emphasis and are intended to provide for more efficient or convenient operation.

- This analyzer is a CLASS 1 LASER PRODUCT. It contains an embedded laser diode. The user cannot come into contact with the emission of laser radiation unless the laser housing is disassembled. This requires special tools and is not part of any user operation, maintenance or service procedure.

2. Introduction

2.1 Product Description

This document describes the operation and user interface of the Oxigraf O2iM NEMA 4X oxygen deficiency monitor. The O2iM integrates an Oxigraf oxygen sensor with auto calibration, vacuum fluorescent alphanumeric display (VFD), keypad, limit detection relay, 4-20 mA analog output, horn and strobe alarms, a serial communication link with Oxigraf protocol and an optional multipoint gas sampling system.

The O2iM measures and displays the oxygen concentration in a gas sample drawn through the instrument. Gas is pumped sequentially from up to four input sample ports, through the oxygen sample cell, and out the exhaust port. An internal filter in the input line prevents contamination of the sensor. A solenoid valve enables automatic single point calibration.

Autocal enables the O2iM to operate unattended for extended periods. With nothing to deteriorate, wear out or degrade over time, the O2iM is virtually maintenance-free.

Measured oxygen concentration in percent volume fraction is displayed on a front panel alphanumeric VFD display. Two lines of 16 characters show numeric data and the parameter units or other information. The instrument mode is controlled via a front panel keypad array. Eight keys select the mode (O2, Setup, Test, Cal 1, Cal 2, Flow, Alarms, and Help) while the other keys facilitate selection and modification of parameters.

A warning horn and strobe is installed. The alarm may be programmed to activate on various conditions of low O₂, high O₂, and analyzer fault conditions.

A terminal board provides the physical interface for DC power input, analog output, relays, and serial link connections. The 100 to 230 VAC power is supplied by the user, or the user can connect the terminal board directly to user-supplied DC power source. The terminal board also has connections for the RS-232 and RS-485 links that provide for remote computer control and data acquisition. The measured oxygen is displayed on the VFD display as well as driving a 4-20 mA output current proportional to O₂ concentration. The 4 mA and 20 mA O₂ value endpoints are programmable from the front panel.

A SPDT alarm relay is also activated in response to oxygen concentration

The Oxigraf sensor uses laser diode absorption technology to measure oxygen concentration in the gas sample. A laser diode produces light in the visible spectrum at 760 nanometers, which is absorbed by oxygen. To analyze oxygen the laser beam is focused through the sample gas onto a detector. Oxygen concentration is inversely proportional to the amount of light reaching the detector. An analysis is made every 10 ms., with the analyzer automatically zeroing at each measurement interval by electronically tuning the laser to oxygen non-absorption wavelength. The peak absorption measurement and line width measurement are used in an Oxigraf proprietary algorithm to compute O₂ concentration independent pressure or foreign gas composition.

<p>Note: This analyzer is a CLASS 1 LASER PRODUCT. It contains an embedded laser diode. The user cannot come into contact with the emission of laser radiation unless the laser housing is disassembled. This requires special tools and is not part of any user operation, maintenance or service procedure.</p>
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2.2 Options

The O2iM can be factory configured for specific applications. Some variations are:

- 5-Relay Terminal board. Each relay may be set up to close on high O₂, low O₂, or both. Two additional relays indicate system OK status and sample flow/pressure status. The four relays may also be assigned as individual channel alarms when the multipoint scan option is installed.
- Four channel sequential multipoint gas sampler
- Internal battery backup system that will keep the O2iM operating and reporting (including any of our remote indicators) for one hour if the external power is interrupted
- Remote indicator light module (wall mount for control rooms, etc)
- Hazardous area remote indicator light module
- Remote rackmount indicator light panel with digital display.
- Fixed XC, LN, or dual mode operation
- Hazardous area operation with Z-Purge for Class 1, Div 2 locations

Many of these can be installed in a single unit. Contact Oxigraf for details.

2.3 Accessories

The following accessories for the O2iM are available from Oxigraf:

- Low cal Gas (21.00% O₂ in nitrogen) “QD” 35 liter non-refillable cylinder Oxigraf part no. 2901-0020
- High cal Gas (99.99% O₂ in nitrogen) “QD” 35 liter non-refillable cylinder Oxigraf part no. 2901-0010
- Aluminum tubing kit
- Polyurethane tubing kit

2.4 Specifications

2.4.1 Performance Conditions

The performance specifications are valid under the following conditions:

Ambient temperature	5 to 40° C (40 to 105° F) operating; -20 to 60° C (-2 to 140° F) storage
Cell pressure	10.2 to 17.4 PSI (700 to 1200 mb) (500 to 900 mm Hg)
Warm-up for full accuracy	10 minutes
Altitude	Two point calibration required after change in altitude of 2000 feet
Humidity	0 to 95%, non-condensing (at 40° C or lower)

2.4.2 Performance Specifications

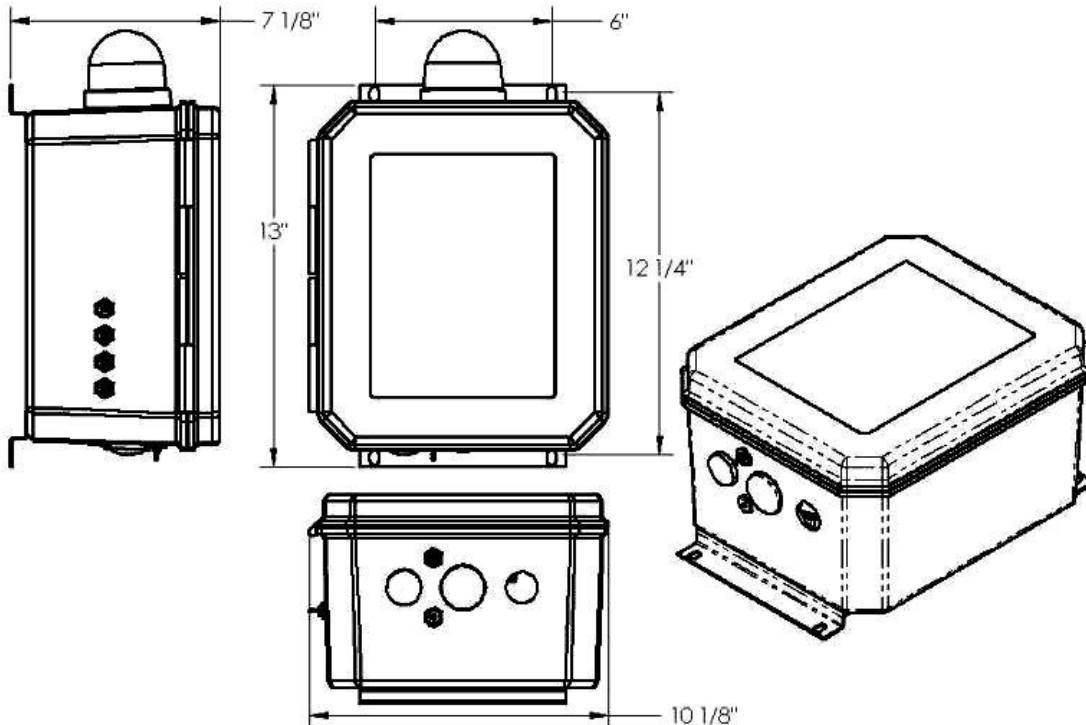
Range:	5 to 100%
Resolution:	0.1%
Stability (24 hrs):	+/- 0.5%
Linearity:	+/-0.2%
Cross-sensitivity:	+0.2%, and gas mixture.
Response time;	1s @350 ml/min flow and electronic filter setting 6.
Alarms (4):	Oxygen A, Oxygen B, Low Flow, System Check
Relays:	Form C (SPDT), 5 A, 250 VAC rating.
Analog Output:	4 – 20 mA programmable from front panel
Sample Inlet Fittings:	10-32 UNF, 1/16 " flex tubing barbs std.

2.4.3 Electrical Specifications

Sensor power requirements	15 to 32 VDC, 1.4 A max, 0.4 A typical at 24 VDC
AC power supply	100 to 230 VAC, 50 to 60 Hz

2.4.4 Mechanical Specifications

Dimensions	See Below
Weight	8 lb. (5 Kg)



3. Getting Started

3.1 Analyzer Installation

3.1.1 Mounting the Analyzer

The O2iM enclosure is NEMA 4X rated for exposure to water and dust. Try to conform to the following guidelines when selecting a location for mounting.

- Do not expose the analyzer to direct sunlight, which may increase the internal temperature above the specification limit.
- Mechanical vibration can cause an increase in sensor noise. Mount the analyzer on vibration isolators if significant vibration or shock is expected.
- Use waterproof conduit fittings installed in the holes provided at the bottom of the enclosure.
- Extreme thermal transients can disrupt analyzer operation. Shield the enclosure from air convection that may rapidly heat or cool the analyzer.

3.1.2 Power

The O2iM requires 24 VDC nominal (+20 to +32 VDC range) at 1.4 amps max, which may be provided by the user or by the internal AC power supply. DC power is connected to the TB1 terminal strip on the terminal board. Note that the DC input power ground is also connected to the sensor chassis ground. A 3-amp 2AG fuse (F2) on the controller board protects the sensor electronics.



Caution: The sensor electronics may be damaged by reverse connection of the DC power supply.

If the AC power supply is connected, provide a source of 100 to 230 VAC, 50 – 60 Hz power to the power supply terminal strip. The power supply has an internal fuse but it is advisable to install an inline 1-amp fuse in the AC line. The DC power supply output is connected to the power input terminals at TB4.

3.1.3 RS-232 Interface

The O2iM can interface via a serial RS-232 data stream to the user's system. The default data format is 9600 baud, 8 bit, no parity, with alternate baud rates of 2400, 4800, 19200, and 38400 selected by interface commands. The signals present are Ground, RXD, (input) and TXD (output) at terminal board TB2 pins 10, 11, and 12. Note that RS-232 UART is shared with the RS-485 Modbus interface so only one interface may be active at a time. If the Modbus address is ≥ 240 then the Modbus protocol will be enabled on the RS-232 interface.

Note: The RS-232 communications protocol and O2iM command set are covered in the Remote Instrument Operation document.

3.1.4 RS-485 Interface

The RS-485 interface provides an alternate serial I/O channel to the O2iM via terminals at TB3 (RS-485 +, RS-485 -, and Gnd). The default data format is 9600 baud, 8 bits, even parity for the Modbus protocol. Installing a jumper block at JP2 enables RS-485 bus termination. Note that RS-232 UART is shared with the RS-485 interface so only one interface may be active at a time. The Modbus address must be between 1 and 239 to enable communication via the RS-485 interface.

3.1.5 4 – 20 mA Analog Output

A measure of percent oxygen is available at the 4 – 20 mA analog output on TB2. The oxygen concentration at 4 mA and 20 mA is a programmable parameter that can be set via the keypad. The 4 to 20 mA current output is a non-isolated active current source referenced to the TB2 Gnd terminal. The maximum output voltage is equal to the O2iM DC supply voltage minus 2 volts. For example, if the supply voltage is 24 volts then the maximum output voltage at 20 mA is 22 volts.

Note: The 4 – 20 mA signal ground is connected to the sensor chassis ground and DC power supply ground.

3.1.6 Relay Contacts

The standard unit has a single alarm relay as described in the next section. The other relays described below are on the optional 5-relay board.

Access to five SPDT relays (P&B PE series) is provided at the TB3 and TB4 terminal strips. For DC resistive loads the relay contacts are rated for 5 amps at 30 volts open circuit, decreasing to 0.25 amps at 300 volts open circuit. For AC resistive loads the contacts are rated for 5 amps at 250 VAC open circuit.

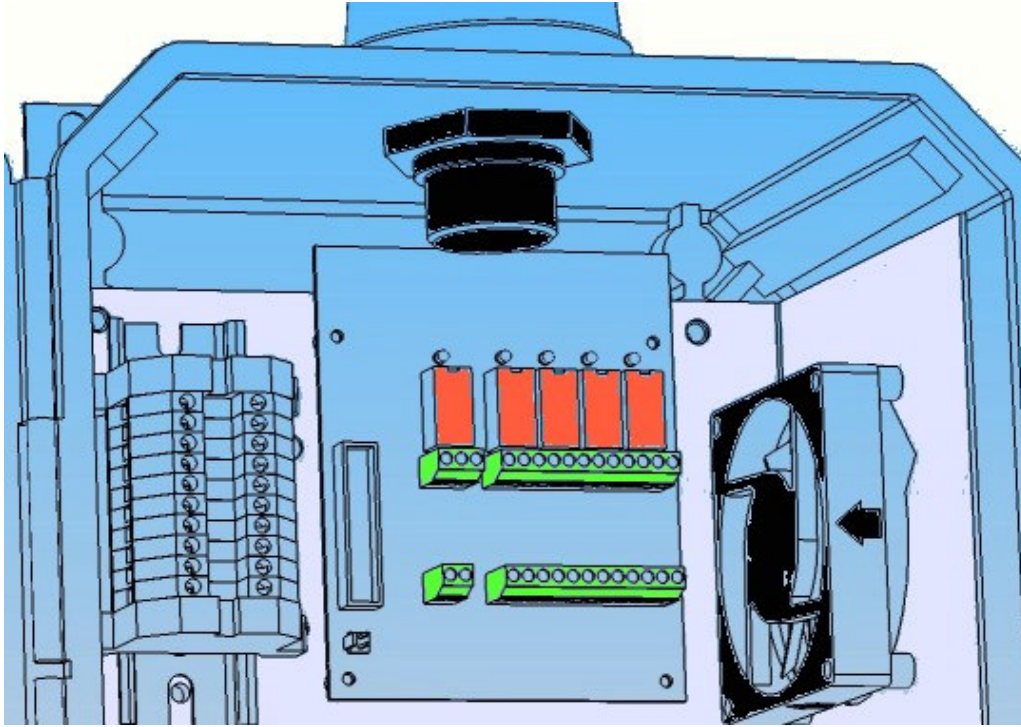
The limit A and limit B relays can be programmed to activate on conditions of high O₂, low O₂, or both. In addition, each limit relay can be configured to latch or flash on an alarm condition. A latched limit detector is reset by pressing any key, if the limit condition that set the latch is no longer true. Limit relay activation can be delayed from the assertion of the limit condition by setting the Alarm Delay parameter to the delay time. Transient limit or warning conditions shorter than the delay time will not result in a limit alarm.

The WARNING relay activates on detection of a system problem such as low flow, high pressure, or self-test failure. The SYS OK relay is turned on when the analyzer has warmed up and passed its internal self-test process. The optional ALARM relay activates under various programmable conditions of limit and warning conditions. It normally drives the horn and strobe but may be used as an external system alarm contact.

When the multipoint sampler is installed the Channel Relay Mode may be enabled. In this case the LIMIT A, LIMIT B, WARNING, and SYS OK relays are reassigned as individual channel alarms. A specific relay will activate only if an alarm condition is true for that channel. The flash and latch setup options still apply to the limit detectors and will drive the channel relays appropriately.

A global failsafe mode may also be programmed that inverts the relay drive for an alarm or warning condition. The normal state of the LIMIT A, LIMIT B, and WARNING relays will be ON, and the specific relay will turn off when the alarm or warning condition becomes true. In Channel Relay Mode the failsafe mode applies to the four channel alarm relays. In both modes an active warning condition will turn off the limit or channel alarm relays irrespective of the limit detector status.

The relay logic can also be configured in Exclusive Mode, which activates only the highest priority alarm or status relay. This mode is intended for driving a remote four-light indicator where it is necessary to have only one light illuminated at a time. The priority ranking, from low to high, is SYS OK, WARNING, LIMIT B, and LIMIT A.



Relay	Normal Mode	Channel Relay Mode
Horn/Strobe	On when limit and warning conditions specified by the Horn/Strobe setup are true.	
System OK	On when self test is good and absorption line lock achieved.	On when a channel 1 alarm state is active
Warning	On when warning status is active for low supply voltage, low sample flow, high pump drive, high or low cell pressure, or absorption over range.	On when a channel 2 alarm state is active
Limit A	On when O2 is greater than High Threshold A or lower than Low Threshold A. Disabled when both limit values set to zero.	On when a channel 3 alarm state is active
Limit B	On when O2 is greater than High Threshold B or lower than Low Threshold B. Disabled when both limit values set to zero.	On when a channel 4 alarm state is active

3.1.7 Alarm Relay

The ALARM relay is activated by a programmable combination of LIMIT 1, LIMIT 2, and WARNING conditions. The alarm relay can be programmed to pulse every 5 seconds if an alarm condition is caused by a warning (low flow, system not OK, etc). Limit conditions result in continuous alarm relay activation, if enabled. An active alarm is muted for a programmable time delay by pressing any key. The limit detector latches, if enabled, will also be reset for the alarm-acknowledge time duration when a key is pressed. See section [5.24](#) for more details.

3.1.8 Horn and Light

The 24 VDC powered horn and strobe are normally connected to the ALARM relay, but may be connected to any of the relay contacts depending on the application. The horn produces 100 dB at 1 meter. The light is a field replaceable 24 V incandescent bulb in a weatherproof housing.

3.1.9 Gas Sample Connection

The Oxigraf O2iM oxygen analyzer is a diverting oxygen monitor with up to four multiplexed input ports. A water/dust barrier filter must be installed at the inlets. The standard inlet tubing comes with a replaceable PTFE hydrophobic filter for this purpose. Replacement filters are available from Oxigraf.

Gas may be flowed under pressure with the sample pump off or on. If flow exceeds pump settings the pump will automatically turn off. Gas flow should be adjusted between 50 and 350 ml/min if an external flow regulator is used. If the internal sample pump is used, flows of 50 to 250 ml/min may be selected via the front panel keypad (the pump is factory set to 150 ml/min).

Note: Flow rates above 350 ml/min can result in excessive O2 measurement noise.

3.1.9.1 Pressurized Gas using an External Flow Control

Connect the gas sources to the sample inlet ports. Using an external pressure regulator and flow control valve, set gas flow to deliver 50 to 350 ml/min. Note that the sample multiplexer blocks the flow on channels that are not selected.

Note: Press the FLOW key and use the built-in flow meter to display flow. If gas pressure is too high, a high-pressure warning may be initiated. This should be corrected before calibrating or attempting an O2 analysis. Check that the internal tubing connections are intact before proceeding, should this occur.

3.1.9.2 Using the Built-in Sampling Pump

Press the FLOW key, then the SETUP key and set a flow in the range of 50 to 250 ml/min. Connect the atmospheric pressure gas sources to the inlet ports of the analyzer.

Note: If the internal sample pump is operating, a pressurized gas source may cause a gas flow higher than the pump flow set point. This condition causes the pump to turn off and may result in a high-pressure warning.

3.1.10 Cal Gas Connection

A single cal gas port is available for the autocal connection. The input characteristics of a cal gas port are identical to those of the gas sample port. The cal gas flow may be displayed by pressing the FLOW key twice. Additional details on calibration gas connections can be found in section [4.4.3](#).

4. Operation

4.1 Understanding the User Interface

The 12-key keypad and 32-character VFD display allow instrument configuration and readout of oxygen concentration. The keypad uses capacitive non-contact technology to provide touch sensing through the sealed enclosure. Key sensing works best by deliberate finger contact in the center of the key legend without bridging to other keys. Liquid water on the keypad surface may disrupt keypad operation, which can be corrected by wiping the surface dry.

In general, main operational modes are selected by pressing O2, TEST, CAL, FLOW, ALARM, or HELP keys, while the SETUP key opens the configuration setup menu. Parameter modification is affected by pressing the UP or DOWN key to increment or decrement the value, and pressing the ENTER key to store it. If the ENTER key is pressed prior to either UP or DOWN then a specific value can be entered using the keypad in numeric mode. After the desired value is set press the ENTER key to exit the parameter entry state.

4.2 Analyzer Power-Up

On power-up the analyzer displays the software version number and “Search...” followed by the laser temperature control error. When a line is found and initially locked the status changes to “Lock...” and the measured O2 value. After a period of stabilization the O2 reading replaces the version string and the instrument enters the normal display mode. If the cell temperature is not yet stabilized a “Warmup...” message will be shown in the status line. Pressing the O2 key before lock-up will transition directly to the Run state.

The Run state is the normal operational mode of the analyzer where oxygen is measured, displayed, and compared against limit conditions. All other states described in the Operation Section are for configuration or self-test of the analyzer.

Note: Refer to the Troubleshooting Section if the analyzer fails measure oxygen within two minutes of power-up.

4.3 Operational Modes

4.3.1 Run Mode – O2 Key

Run mode is the default analyzer state on power-up, and can be selected from any state by pressing the O2 key. In this mode the oxygen concentration is displayed along with the sample flow rate or alarm/warning conditions. The analyzer can also be configured in multipoint sample mode if the sample multiplexer valves are installed. In this case the analyzer display will also show the currently selected channel in addition to the oxygen concentration of the previous channel. For more details on multipoint sampling, see the Multipoint Sampling Guide.

The analyzer must be in Run mode to detect and generate alarm conditions that drive the alarm relay, activate the horn/strobe, and display alarm/warning messages. A timer can be set up (Mode Dwell Time) to assure that Run mode is resumed after a period of keypad inactivity. Note that the level detector, warning, and system OK relays are updated in any mode. This insures that keypad activity will not disrupt control or monitoring devices connected to the analyzer relays.

4.3.1.1 Multipoint Scan Mode

When the multipoint scan mode is enabled the gas sample applied to the cell is selected from one of four input ports by the gas sample multiplexer. The active channel may be incremented by pressing the O2 key or at a programmable frequency. The display shows the currently selected channel and the measured oxygen concentration of the previous channel. The lower line of the display shows the sample flow rate and any alarm or warning messages.

4.3.1.2 Oxygen Measurement Modes

The analyzer can operate in two fundamental measurement modes, cross sensitivity mode (XC) and low noise mode (LN). In XC mode the area of the oxygen absorption line is measured to compensate for broadening due to foreign composition. This makes measurements in this mode nearly independent of gas composition, which is useful where there is strong interference as with gasses such as He, Ar, N₂O, and CO₂. XC mode has more O₂ measurement noise than LN mode due to the line area measurement.

LN mode improves on the noise performance of XC mode by only relying on the peak absorption amplitude for computation of oxygen concentration. This mode is useful where the measurement range is limited; the interference weak (as with N₂); or the oxygen concentration is very low or near 100%. The cross sensitivity is worst at a 50/50 gas mixture and becomes linear at low and high O₂ concentrations, where it can be calibrated out.

Depending on the factory configuration it may be possible to switch to an alternate mode or range using the Setup function. Each mode and range has its own independent set of calibration and pressure compensation factors that are loaded when the mode or range is changed. Consequently, each mode or range must be individually calibrated prior to use. In addition to the oxygen concentration the lower line of the display will show the sample flow rate and active alarm or warning conditions.

4.3.2 Setup Mode – SETUP Key

The SETUP key is used to access instrument configuration parameters. Each press of SETUP advances one parameter, while the BACK key can be used to move up in the list. Entering Setup from O₂ mode always starts at the top of the list. If Setup is entered from the Cal 1, Cal 2, Flow, or Alarm modes then the parameters appropriate to that mode will be shown first. A displayed parameter is modified by pressing the Up or Down key multiple times to get the desired value, then pressing the ENTER key to store it. If the ENTER key is pressed prior to UP or DOWN then the keypad can be used in numeric mode to enter a specific value, which is stored by pressing ENTER again.

4.3.3 Low Point Calibrate – CAL 1 Key

Press the CAL 1 key to display the current O₂ reading and the lower cal point, typically the minimum O₂ value expected for that range. Low cal points are distinct for each range or mode, with the value displayed being controlled by the current O₂ measurement range or mode. Pressing the ENTER key while in this mode starts the calibration cycle. A cal gas with an O₂ concentration equal to the cal point value should be flowing through the analyzer.

The low cal gas valve will be activated when the CAL 1 key is pressed. The low cal gas must be connected to the low cal gas inlet before pressing the ENTER key to start the calibration sequence.

4.3.4 High Point Calibrate – CAL 2 Key

Press the CAL 2 key to display current O₂ reading and the upper cal point, typically near 100%. High cal points are distinct for each range or mode, with the value displayed being controlled by the current O₂ measurement range or mode. Pressing the ENTER key while in this mode starts the

calibration cycle. A cal gas with an O₂ concentration equal to the cal point value should be flowing through the analyzer.

4.3.5 Gas Sampling - FLOW Key

Press the FLOW key to display the measured sample flow rate and pump drive level. If the autocal feature is enabled, pressing the FLOW key again will turn on the low cal gas valve and display the cal gas flow rate and pump drive level. The high cal gas flow and pump level will be displayed if the key is pressed a third time.

While in FLOW mode press the SETUP key to modify the flow rate, set the pump mode, and to set up the sample line purge option, if installed. Ordinarily the pump runs continuously under closed loop control to maintain the sample flow at the desired setpoint. Special applications may require that the pump be permanently turned off. Setting the flow setpoint to zero disables pump drive. Note that the Pump Mode function in the Setup menu is for testing only and its setting is not saved in nonvolatile memory.

4.3.6 Alarm Status Mode – ALARM Key

Press the ALARM key to display the current state of the optional alarm relay outputs. Each press of the ALARM key shows the on/off status of the next relay. The BACK key can be used to cycle backwards through the relay list. Pressing the SETUP key while in this state will vector to the start of the alarm threshold setup list for the various alarm conditions.

<i>Relay</i>	<i>Normal Mode</i>	<i>Channel Relay Mode</i>
<i>Horn/Strobe</i>	On when limit and warning conditions specified by the Horn/Strobe setup are true.	
<i>System OK</i>	On when self test is good and absorption line lock achieved.	On when a channel 1 alarm state is active
<i>Warning</i>	On when warning status is active for low supply voltage, low sample flow, high pump drive, high or low cell pressure, or absorption over range.	On when a channel 2 alarm state is active
<i>Limit A</i>	On when O ₂ is greater than High Threshold A or lower than Low Threshold A. Disabled when both limit values set to zero.	On when a channel 3 alarm state is active
<i>Limit B</i>	On when O ₂ is greater than High Threshold B or lower than Low Threshold B. Disabled when both limit values set to zero.	On when a channel 4 alarm state is active

If the multipoint option is installed and the relays are configured in "Channel Relay" mode then the right column above indicates the relay state.

4.3.7 Test Mode – TEST Key

Press the TEST key to enter test mode where the fault memory and critical analyzer parameters are displayed. Test mode also allows emulation of the O₂ concentration by setting a specific value via the keypad. An O₂ ramp function is also available that sweeps the simulated O₂ value from 0 to 100%. This is useful for checking operation of the 4 to 20 mA current and alarm outputs.

<i>Test Mode</i>	<i>Function</i>
Fault Messages	Sequentially display analyzer fault memory, reset by pressing ENTER
Cell Status	Oxygen cell temperature and pressure
Laser Status	Laser temperature setpoint and measured value
Reset Calibration	Press ENTER to reset analyzer calibration to factory defaults
Restart Analyzer	Press ENTER to restart analyzer software
Static Simulation	Simulated O ₂ by keypad entry
Ramp Simulation	Simulated O ₂ by slewing value from 0 to 100%

4.3.8 Help Mode – HELP Key

Press the HELP key to display the Oxigraf service phone number, and a second time to show the instrument model and serial number.

4.4 Calibration

The calibration modes are used to calibrate the oxygen analyzer using a known oxygen concentration. To fully calibrate the sensor two gas samples are required, typically 100% and 21% O₂ certified to 0.03% accuracy. Room air may be used for O₂ calibration but is diluted by water vapor and may vary from 20.5 to 20.9% if not dried.

All calibration modes are incremental, i.e., calibration at one point (high or low) does not affect the calibration at the other point. Consequently, high or low point calibration can be repeated or done in any order.

4.4.1 Manual Calibration

The O2iM analyzer, without the autocal feature enabled, is calibrated manually by applying the calibration gas to the cal input port.

To perform a manual two-point oxygen cal use the following procedure.

- a) Press the CAL 2 key to select High Cal mode and pass the indicated cal gas through the analyzer. If the desired cal gas does not match the indicated value press the SETUP key to correct the analyzer High Cal setting and return to High Cal mode. When the measured concentration value has stabilized, press the ENTER key. The cal factors and oxygen reading will change as a result of this cal cycle. Flow control of the high cal gas is required.
- b) Switch to Low Cal mode by pressing the CAL 1 key and pass the indicated calibration gas through the analyzer. If the desired cal gas does not match the indicated value press the SETUP key to correct the analyzer Low Cal setting and return to Low Cal mode. When the oxygen reading has stabilized press the ENTER key to execute the calibration cycle. Widely separated sample concentrations, such as 100% and 20.9%, will provide the most accurate calibration. The cal factors and oxygen reading will change as a result of this cal cycle.



Caution: Calibration should not be performed until the analyzer has warmed up for at least 10 minutes.

4.4.2 Autocalibration

The O2iM analyzer is equipped with autocal, which enables automatic calibration at a programmable interval or on activation of alarm detector B. Autocal requires an external calibration gas connected to the calibration gas input port. If pressurized, the gas must be pressure regulated to a pressure from 5 to 15 psi. The oxygen concentration value must equal the CAL1 setup value.

Three parameters in the setup menu control autocal operation. The **Autocal Period** enables autocal if it is non-zero and sets the time between autocal cycles with 0.1-hour resolution. The **Cal Valve Delay** parameter sets the delay time from activation of the cal gas valve to the start of the calibration cycle. It compensates for the time to completely fill the oxygen measurement cell with the calibration gas. **Autocal Level B** option triggers an autocal if the level B detector is active. The first autocal cycle will start five seconds after any change to the Autocal Period parameter on return to O2 mode.

Calibration gas for both manual and autocal modes must be supplied via the cal gas input port. The autocal gas valve switches from sample input to the calibration gas source when the CAL1 is selected using the keypad. Multiple presses of the FLOW key cycles through the sample, low cal, and high cal sources to allow display of cal gas flow and pump drive level.

The cal gas flow rate should be regulated to the sample gas flow setpoint by the flow control servo. In some cases the internal cal gas regulator may need adjustment to enable flow regulation. Use the following procedure to adjust the cal gas regulator inside the O2iM enclosure:

- a) With the instrument operating normally press the FLOW key and note the sample flow rate and pump drive level for the sample input stream.
- b) Press the FLOW key again to turn on the low cal gas valve and note the pump drive level.
- c) Adjust the low cal gas regulator with a screwdriver to get the cal gas pump drive level equal to the sample mode drive level.
- d) If the O2iM application does not use the sample pump then adjust the regulator for a cal gas flow rate of 100 to 200 ml/min.
- e) Press the O2 key to return to an oxygen reading. If desired, press the FLOW key again to advance to the high calibration settings. Normally, field calibration of the high setting is not required for this application. Should the user wish to perform this operation, note that external pressure regulation of the 100% O2 cal gas is required.

4.4.3 Connecting the Autocal Input to a Source

As an alternative to the use of a pressurized calibration gas as described in the previous section, the O2iM may be installed with the calibration input connected to a non-pressurized source. This would typically be a different room or area of the building. Tubing is from the calibration input is routed to the other source to eliminate the requirement for maintenance of the pressurized calibration gas system and can eliminate false alarms due to calibration errors caused by inadvertent calibration with a gas cylinder that has become empty.

Requirements for a remote gas source, non-pressurized:

- Gas source should be clean and dry. This can be accommodated by placing a filter on the inlet of the tubing that will prevent dust or other foreign objects from entering the system.
- Additionally, the cal gas inlet needs to be located where there is no possibility of it being subjected to condensing vapor conditions or submerged. Usually, putting the inlet in a nearby room where there are no possible sources of liquefied gases and the environment is maintained by a normal HVAC system does this.
- Gas sources that could affect the quality of the air should not be present. Small quantities of pressurized gases in a large room will not present a problem for this. Avoid liquefied gas sources.
- The tubing should be routed and the inlet located so that it will not become kinked or otherwise blocked.
- Outdoor location of the inlet is NOT recommended.

Advantages of remote calibration gas inlet, non-pressurized:

- Reduced cost of hardware.
- Reduced maintenance requirements.
- Elimination of possibility of calibration errors due to calibration with an empty gas cylinder. (Causing false alarm)

Advantages of calibration gas, pressurized:

- Traceable gas source.
- Increased absolute accuracy. (By about 0.1%)

Interior air oxygen values:

- Ideal dry air (0% RH) - 20.9% Oxygen
- Comfortable indoor air (40% RH) - 20.7% Oxygen
- Saturated air (100% RH) - 20.4% Oxygen

5. Configuration Parameters

Various configuration parameters are accessible from the Setup menu and can be modified to affect instrument operation. See the description of Setup mode for details on how to view and modify parameters.

5.1 O₂ Filter

The O₂ filter parameters set the time response of the oxygen measurement. The filter parameter, ranging from 0 to 13, selects the type of filtering applied to the measured value.

<i>n</i>	<i>Step Response</i>
0	No filtering
1	20 ms running average
2	40 ms running average
3	80 ms running average
4	160 ms running average
5	200 ms exponential response
6	300 ms exponential response
7	500 ms exponential response
8	1 second exponential response
9	2 seconds exponential response
10	4 seconds exponential response
11	8 seconds exponential response
12	16 seconds exponential response
13	Prediction filter to enhance response time

5.2 Number of Multipoint Channels

If the multipoint scan option is installed then this parameter is used to set the number of channels to scan, ranging from 0 to 4. Set this parameter to zero to continuously sample channel 0 and disable display of the channel number in the O₂ reading display.

5.3 Scan Sample Time

If the multipoint scan option is installed then this parameter sets the time in seconds that each channel is sampled.

5.4 O₂ Measurement Range

The O₂ Measurement Range parameter may be available depending on the factory configuration. Low range allows the instrument calibration to be optimized for a maximum O₂ concentration less than 100%. The front-end analog absorption gain in each range is adjusted by Span Cal for the best signal to noise ratio at the input to the absorption A/D converter. Note that each mode and range has its own independent set of calibration and pressure compensation factors that are loaded when the mode or range is changed. Consequently, each mode or range must be individually calibrated prior to use.

5.5 O₂ Measurement Mode

The O₂ Measurement Mode Setup may be available depending on the factory configuration. XC mode is standard on the O2iM. Factory configuration determines if XC/LN mode choice is available. Press the UP or DOWN key to switch to the alternate mode, if so configured. XC mode offers the best accuracy for gas mixtures that contain components that broaden the oxygen absorption line, such

as N₂O and CO₂. The measurement noise level is higher than LN mode however, which gives accurate results with low noise for N₂ – O₂ mixtures.

5.6 O₂ Low Point Calibration Gas

The low O₂ calibration gas setting specifies the concentration of oxygen for low point cal. Room air can be used as a cal gas (20.8% O₂) but it should be dried to prevent errors due to dilution by water vapor.

5.7 O₂ High Point Calibration Gas

The high O₂ calibration gas setting specifies the concentration of oxygen for high point cal.

5.8 Autocal Period

If the autocal option is installed this parameter sets the time period between autocal cycles. If the autocal period is modified then the next autocal cycle will start 5 seconds after returning to Run mode.

5.9 Autocal Valve Delay

This parameter sets the delay from turning on the cal gas to start of the analyzer calibration cycle. The delay allows time for the cal gas to completely fill the measurement cell.

5.10 Autocal Mode

The autocal mode parameter specifies the type of autocal cycle to perform. The options are Off, Cal 1, Cal 2, and Cal 1 + Cal 2. The last option may not be available depending on the factory configuration. Note that the cal gas must be connected to the cal gas ports even if the Autocal Mode is set to Off.

5.11 Autocal Level B Enable

The level detector B will trigger an autocal if this parameter is set to "On". Autocal cycles will be executed at a maximum rate of 10 per hour if the level B detector is continuously active. This option is useful to correct drift that may cause false activation of the level A detector in oxygen deficiency monitor applications.

5.12 O₂ Current Output Setpoints

The O₂ Current Output Setpoints specify the oxygen concentration corresponding to 4 mA and 20 mA of output current. For example, set O₂ 4 mA I_{out} to 0.00 and 20 mA O₂ I_{out} to 100.00 to scale the 4 to 20 mA current output for 0 to 100% O₂.

5.13 Flow Setpoint

The flow setpoint parameter sets the target flow rate for the sample flow controller. Adjust the flow setpoint to zero to permanently turn off the sample pump.

5.14 Pump State

The Pump State setting is used for testing to enable the flow controller, turn the pump off, or set the pump to maximum flow. The Pump State setting is not saved in nonvolatile memory and will be restored to the flow controller enabled state on power-up. To permanently turn off the pump adjust the Flow Setpoint to zero.

5.15 O2 Alarm Thresholds

The O2 Alarm Threshold parameter set consists of two pairs of high and low oxygen alarm thresholds. Alarm A will be asserted for an oxygen concentration less than the Low A threshold or greater than the High A threshold. Similarly, Alarm B will be asserted for an oxygen concentration less than the Low B threshold or greater than the High B threshold. The O2 Hysteresis parameter prevents oscillation of the alarm output due to noise in the oxygen reading. For the high limit detectors, the thresholds are decreased by the hysteresis value when the oxygen level exceeds the threshold. This has the effect of requiring the oxygen level to decrease by the hysteresis value in order to turn the limit detector back off. Similarly, the low limit threshold is increased when the oxygen level goes below the threshold.

5.16 Low Flow Alarm Threshold

The low flow alarm threshold sets the flow rate limit for the low flow alarm in ml/min.

5.17 Pump Drive Alarm Threshold

The pump drive alarm threshold sets the high pump drive alarm limit in percent drive level.

5.18 Pressure Alarm Thresholds

The high and low-pressure thresholds set the pressure limits for the cell pressure alarm.

5.19 Relay Latch Mode

Limit detectors A and B can be set to latching mode using this setup parameter. In latch mode the limit detector will remain active even when the activation condition (high or low O2) is removed. The latch is cleared by pressing the ENTER key. If the activation condition (high or low O2) is still present then the latch will not be reset

5.20 Relay Flash Mode

Limit detectors A and B can be set to flash when activated at 0.85 Hz and 0.45 Hz, respectively, using this setup parameter.

5.21 Relay Failsafe Mode

This parameter (if set to "On") enables the relay failsafe mode. For the standard relay allocation failsafe mode inverts the drive to the WARNING, LIMIT A, and LIMIT B relays, which causes them to deactivate on an alarm/warning condition. The SYS OK relay is not affected because it is already in failsafe mode. For the channel relay allocation all four relays, corresponding to channels 0 - 3, are logically inverted by the failsafe mode option.

In failsafe mode a warning condition will also turn off the level detector or channel alarm relays independent of the level detector outputs.

5.22 Relay Exclusive Mode

Relay exclusive mode, enabled by this parameter, allows activation of only the highest priority alarm or status relay. This mode is intended for driving a remote four-light indicator where it is necessary to have only one light illuminated at a time. The priority ranking, from low to high, is SYS OK, WARNING, LIMIT B, and LIMIT A.

5.23 Relay Allocation

The limit detector, warning, and system OK relays may be allocated to provide global status for all channels or to indicate individual channel alarm / warning conditions. The global setting (SysOK/Warn/A/B) activates the limit A and B relays when any channel triggers the A or B limit detector. The WARNING and SYS OK relays are driven independent of the current channel status.

The channel relay mode (Channels 0-3) allocates each channel a relay, each of which is driven by the limit detectors A and B qualified by the channel number. In this mode the alarm relay should be set to respond to warning conditions.

5.24 Horn/Strobe Mode

The Horn/Strobe mode determines the conditions for activation of the alarm relay, which is typically connected to the audio alarm and strobe light. The activation condition is a function of the limit alarms, (high/low O₂) flow warning (flow, pressure, pump drive or low supply voltage) and system fault as shown in the following table. Settings of 8-11 cause the alarm relay to activate at a 5 Hz rate with a 3% duty cycle when a warning or fault condition is detected. The alarm relay is only activated in Run mode and deactivated on any key press for the duration specified by the Alarm Acknowledge Time parameter.

<i>Horn/ Strobe Setting</i>	<i>Activation Condition</i>			<i>Alarm Relay State</i>
	<i>Alarm A</i>	<i>Alarm B</i>	<i>Warning/ Fault</i>	
0				Off
1	Steady			Continuous on Alarm A
2		Steady		Continuous on Alarm B
3	Steady	Steady		Continuous on Alarm A or B
4			Steady	Continuous on Warning/Fault
5	Steady		Steady	Continuous on Alarm A or Warning/Fault
6		Steady	Steady	Continuous on Alarm B or Warning/Fault
7	Steady	Steady	Steady	Continuous on Alarm A or B or Warning/Fault
8			Flash	Flash on Warning/Fault
9	Steady		Flash	Continuous on Alarm A, Flash on Warning/Fault
10		Steady	Flash	Continuous on Alarm B, Flash on Warning/Fault
11	Steady	Steady	Flash	Continuous on Alarm A or B, Flash on Warning/Fault

The priority for simultaneous situations is Alarm A, then Alarm B and finally Warning, from high to low. Note that Alarm A and Alarm B are disabled when a fault condition exists, but not when a warning is occurring.

5.25 Alarm Delay

The alarm delay time can be set in the range of 0 to 9999 seconds. An alarm condition must be true for the alarm delay time in order to be recognized and generate an alarm.

5.26 Alarm Acknowledge Time

The Alarm Acknowledge Time determines the time, ranging from 1 to 9999 seconds, that an alarm will be silenced after pressing the any key. If the alarm condition is still true after expiration of the acknowledge time, it will be activated again.

5.27 Mode Dwell Time

The Mode Dwell Time, ranging from 0 to 9999 seconds, determines the time that the analyzer will remain in one of the setup modes with no keypad activity. Since the alarm relay drive conditions are only checked in O2 mode, this setting insures that alarm scanning will continue after one of the setup modes is used.



Caution: Run mode restoration is disabled if the Mode Dwell Time is set to zero.

5.28 Beep Volume

The beep volume, ranging from 0 to 10, determines the keypad beep intensity. The keypad beep is disabled if the beep volume is set to zero.

Note: Beep Volume does not affect the volume of the alarm horn.

5.29 Keypad Lock

The Keypad Lock parameter sets the password for unlocking the keypad for parameter modification. If the Keypad Lock is nonzero then the O2iM will be locked in O2 mode on power-up. Press the ENTER key, the one to 4 character keypad lock code, and the ENTER key again to unlock the keypad for normal operation. Pressing the BACK key while in O2 mode can lock the keypad. Entering the keypad code will acknowledge an alarm condition that becomes active while the keypad is locked. The keypad lock feature may not be available depending on the factory configuration.



Warning: A PC running the OEMX monitor program is required to reset a forgotten keypad code.

6. Service

6.1 Troubleshooting Guide

Problem	Possible Cause	Solution	Refer To
Incorrect O ₂ value is displayed	Unit out of calibration.	Reset factory default calibration, then repeat Cal 1	4.3.3
Unit will not calibrate.	O ₂ concentration of low cal gas too far from displayed O ₂ value.	Reset factory default calibration, then repeat Cal 1	4.3.3
O ₂ measurement is not close to known gas concentration	Calibration Entered with inappropriate cal gas.	Reset factory default calibration, then repeat Cal 1	4.3.7 4.3.3
Calibration drifts from original setting.	Sensor not at operating temperature when a 2-point cal was performed.	Verify unit has fully warmed up and gas temperature is at 45°C, then recalibrate.	4.2 4.3.3
Unstable O ₂ value is displayed	Sample line filter not installed or filter is the wrong pore size.	Check that proper filter is installed.	3.1.9
Repeated Low O ₂ Alarm	Alarm set point is higher than current measurement	Check O ₂ source	4.3.6 5.15
Repeated High O ₂ Alarm	Alarm set point is lower than current measurement	Check O ₂ source	4.3.6 5.15
Repeated low flow alarm.	Blocked or pinched sample inlet line.	Change or repair inlet sample line.	3.1.9
Low flow, pump On	Sample line filter is clogged.	Change filter.	3.1.9
Pump does not operate.	Flow rate is set to 0 and/or pump is off.	Set desired flow rate and/or turn pump on.	3.1.9.2 4.3.5 5.14
O ₂ measurement drift	Internal sample line leak possibly due to high over pressure.	Check for leaks by sampling 99.99 % O ₂ then occlude sample line. If leaking, reading will drift toward room air reading of 20.9%. Call service.	3.1.9.1 3.1.10 4.3.5
O ₂ measurement drift	Internal line leak after flow sensor	Display flow, and then block outlet port. Flow should drop to near zero. If not call service.	3.1.9.2 4.3.5
Displayed O ₂ value is zero or does not appear after 2-minute warm-up.	Laser diode output is not locked to oxygen line due to overheating or laser aging.	Power off and Restart Analyzer (after cooling if necessary). If restart is possible, then perform 2-point cal to reset laser control parameters. If these measures fail, contact Oxigraf service.	4.3.1 4.4.1 4.3.7
Displayed O ₂ value is zero or does not appear after 2-minute warm-up.	Moisture has condensed on cell windows.	Power on for 1 hour with dry gas at inlet to dry the cell.	

Contact Oxigraf with any question or further problem. The Oxigraf phone number can be displayed on the unit by pressing the HELP key once. Pressing it a second time will display the firmware version and the unit serial number.

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6.2 Warranty

Oxigraf warrants that the analyzer is free from defects of material and construction for a period of one (1) year. The liability of Oxigraf, if any, shall be limited solely to the replacement or repair of the analyzer at the option of Oxigraf and does not include shipping costs or other incidental or consequential damages.

This warranty is null and void if the analyzer is subjected to misuse, negligence, accident or repairs other than those performed by Oxigraf.

Claims for damage during shipment must be filed promptly with the transportation company. All correspondence concerning the equipment must specify both the model name and number, and the serial number as it appears on the equipment.

6.3 Return of goods Procedure

Prior to returning an analyzer for warranty repair, contact the Oxigraf service department and request an RMA (Return of Materials Authorization) number. Repackage the analyzer in the original shipping box or another suitable container. Clearly mark the shipping address and RMA number on the outside and send with shipping and transportation charges prepaid to:



1170 TERRA BELLA AVENUE MOUNTAIN VIEW, CA 94043
TEL (650) 237-0155 FAX (650) 237-0159
oxigraf@oxigraf.com <http://www.oxigraf.com>

Appendix A – Menu Structure

Key	Function	Display Line 1	Display Line 2
O2:	Display O2 and current channel	Ch 1 O2: 20.7%	Flow: 150 ml/m
Setup	O2 Filter setpoint	O2 Filter	7: 500 ms FIR
	Number of multipoint scan channels (H)	Scan Channels	4
	Scan time per channel (H)	Scan Sample Time	1 sec/channel
	O2 Measurement mode XC	Oxygen: 20.7%	Mode: XC
	Low cal gas concentration	O2 Low Cal	20.90% Oxygen
	High cal gas concentration	O2 High Cal	100.00% Oxygen
	Autocal period	Autocal Period	0.5 hours
	Cal valve delay	Cal Valve Delay	2 sec
	Autocal mode setup	Autocal Mode	Cal 1
	Autocal O2 level trigger enable	Autocal Level B	Off
	4 mA O2 value	O2 4 mA Iout	0.00% Oxygen
	20 mA O2 value	O2 20 mA Iout	100.00% Oxygen
	Set O2 measurement mode	Oxygen: 20.9%	Mode: XC
	Flow setpoint	Flow Setpoint	150 ml/min
	Pump On/Off/Max	Flow: 150 ml/m	Pump State: On
	Low O2 limit A	Low O2 Alarm A	19.50% Oxygen
	High O2 limit A	High O2 Alarm A	Off
	Low O2 limit B	Low O2 Alarm B	Off
	High O2 limit B	High O2 Alarm B	40.00% Oxygen
	O2 limit hysteresis	O2 Alarm Hyst	0.10% Oxygen
	Low flow alarm	Low Flow Alarm	30 ml/min
	Pump drive level alarm	Pump Drive Alarm	Off
	Low pressure alarm	Low Pres Alarm	100.0 mb
	High pressure alarm	High Pres Alarm	1200.0 mb
	Relay latch mode	Relay Latch	Limit A
	Relay flash mode	Relay Flash	Limit B
	Relay failsafe mode	Relay Failsafe	Off
	Relay exclusive mode	Relay Exclusive	Off
	Relay normal/channel mode allocation	Relay Allocation	SysOK/warn/A/B
	Horn/Strobe mode control	Horn/Strobe	5: warning+A
	Alarm delay	Alarm Delay	1 sec
	Alarm acknowledge time	Alarm Ack Time	20 sec
Mode idle dwell time	Mode Dwell Time	20 sec	
Keypad beep volume	Beep Vol (1-10)	7	
Keypad Lock	Keypad Lock	1234	
Modbus enable address (H)	Modbus Address	Off	
Test	Display fault history memory	Fault Messages:	Reset with ENTER
	Display cell pressure/temperature	Pres: 1013.0 mb	Temp: 45.00 C
	Display laser temperature	Lz Set: 23.25 C	Lz Temp: 23.27 C
	Reset Calibration Parameters	Press ENTER key	To reset...
	Restart O2iM software	Press ENTER key	To restart...
	Enter simulated O2 reading	Oxygen: 78.45%	Simulation
	Ramp simulated O2 from 0 to 100%	Oxygen: 34.56%	Simulation Ramp
Cal 1	Cal 1 O2, execute with Enter key	Oxygen: 20.9%	Low Cal 20.90%
Setup	Low cal gas concentration	O2 Low Cal	20.90% Oxygen
Setup	Continue with normal setup menu...		
Cal 2	Cal 2 O2, execute with Enter key	Oxygen: 98.4%	High Cal 100.00%
Setup	High cal gas concentration	O2 High Cal	100.00% Oxygen
Setup	Continue with normal setup menu...		
Flow	Display sample flow and pressure	Flow: 150 ml/m	Pres: 1013.0 mb
Setup	Flow setpoint	Flow Setpoint	150 ml/min

Key	Function	Display Line 1	Display Line 2
Alarm	Show alarm relay status	Alarm Relays...	Horn/Strobe: Off
		Alarm Relays...	System OK: On
		Alarm Relays...	Warning: On
		Alarm Relays...	Alarm A: On
		Alarm Relays...	Alarm B: Off
Back	Step back through alarms	Alarm Relays...	<previous msg>
Setup	Low O2 limit A	Low O2 Alarm A	19.50% Oxygen
Setup	Continue with normal setup menu...		
Help	Service help information	Oxigraf Service	650-237-0155
	O2iM version and serial number	O2iM v1.25	S/N: 06784-04983
Back	Go to previous state within submenu		

Note: (H) = optional hidden parameter may be disabled by factory configuration

Appendix B – Terminal Board Diagrams

Terminal Board Rev A

