NET SAFETY MONITORING INC.

MILLENNIUM II
Gas Sensor

Oxygen (O2) Sensor
User Manual

Model: ST340X-25-ASSY

ISO 9001:2000

QMI REGISTERED

Part Number: MAN-0093 Rev 0
June 2008

IMPORTANT INFORMATION

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Net Safety Monitoring Inc. products are carefully designed and manufactured from high quality components and can be expressed to provide many years of trouble free service. Each product is thoroughly tested, inspected and calibrated prior to shipment. Failures can occur which are beyond the control of the manufacturer. Failures can be minimized by adhering to the operating and maintenance instructions herein. Where the absolute greatest of reliability is required, redundancy should be designed into the system.

WARRANTY

Net Safety Monitoring Inc warrants this sensor against defective parts and workmanship for a period of 6 months from date of purchase. No other warranties or liability, expressed or implied, will be honoured by Net Safety Monitoring Inc. Contact Net Safety Monitoring Inc. or an authorized representative for details.

We welcome your input at Net Safety Monitoring Inc. If you have any comments please contact us at the telephone number or address below or visit our web-site, www.net-safety.com, and complete our on-line customer survey.

If further language translation for this manual is required please contact:

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INTRODUCTION

The ST340 Oxygen sensor is designed specifically for use with any Millennium II series transmitters. This state of the art “Smart” sensor is both versatile and reliable for fast, accurate and continuous monitoring of gases in extreme environments.

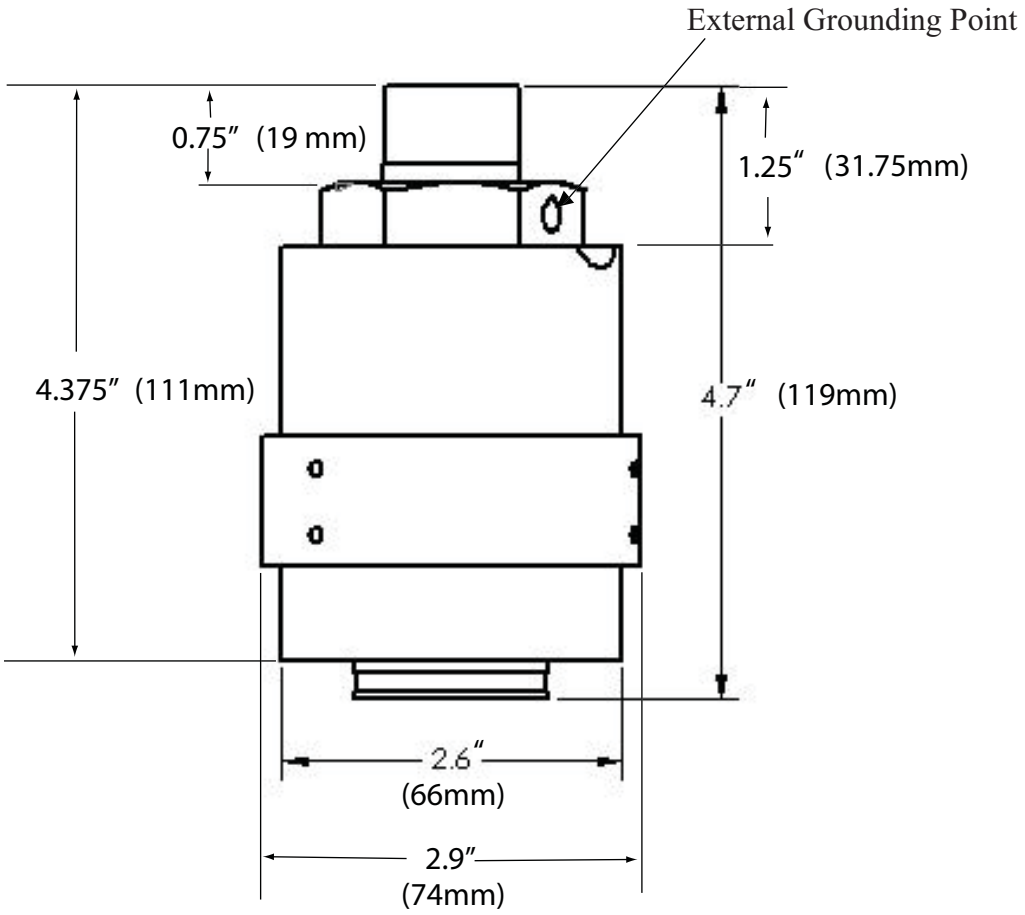
THE PRODUCT

The sensor assembly consists of a factory sealed explosion proof housing rated for hazardous locations and a replaceable sensor module. This sensor is designed to only operate with the Millennium II series Transmitters. If the sensor is connected to any other model transmitters, it will not function and may result in the sensor being damaged.

THE MANUAL

This manual has been designed to ensure the sensor / detector is set-up, operated and maintained properly. If you encounter any problems, see the troubleshooting section of this manual.

Figure 1: Sensor Dimensional Drawing: Measurements are in inches and millimeters (mm)



Transmitter and Sensor Housing Dimensions

The tables below give the dimensions of the Millennium II transmitter housing with sensor and Millennium II Basic transmitter with sensor. Both transmitter housings and sensors are offered in Aluminium (AL) or Stainless Steel (SS).

Table 1: Millennium II housing and sensor dimensions (**A** through **H**) in Inches(in) and Millimeters(mm)

Millennium II transmitter housing	**A**		**B**		**C**		**D**		**E**		**F**		**G**		**H**	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
Transmitter & sensor(AL)	6.3	160	5.6	142	5.4	137	9.7	246	6.0	152	5.7	145	2.6	66	2.9	74
Transmitter & sensor(SS)	5.9	150	5.1	130	4.6	117	8.9	226	6.0	152	5.8	147	2.6	66	2.9	74

Table 2: Millennium II Basic housing and sensor dimensions (**A** through **J**) in Inches and Millimeters

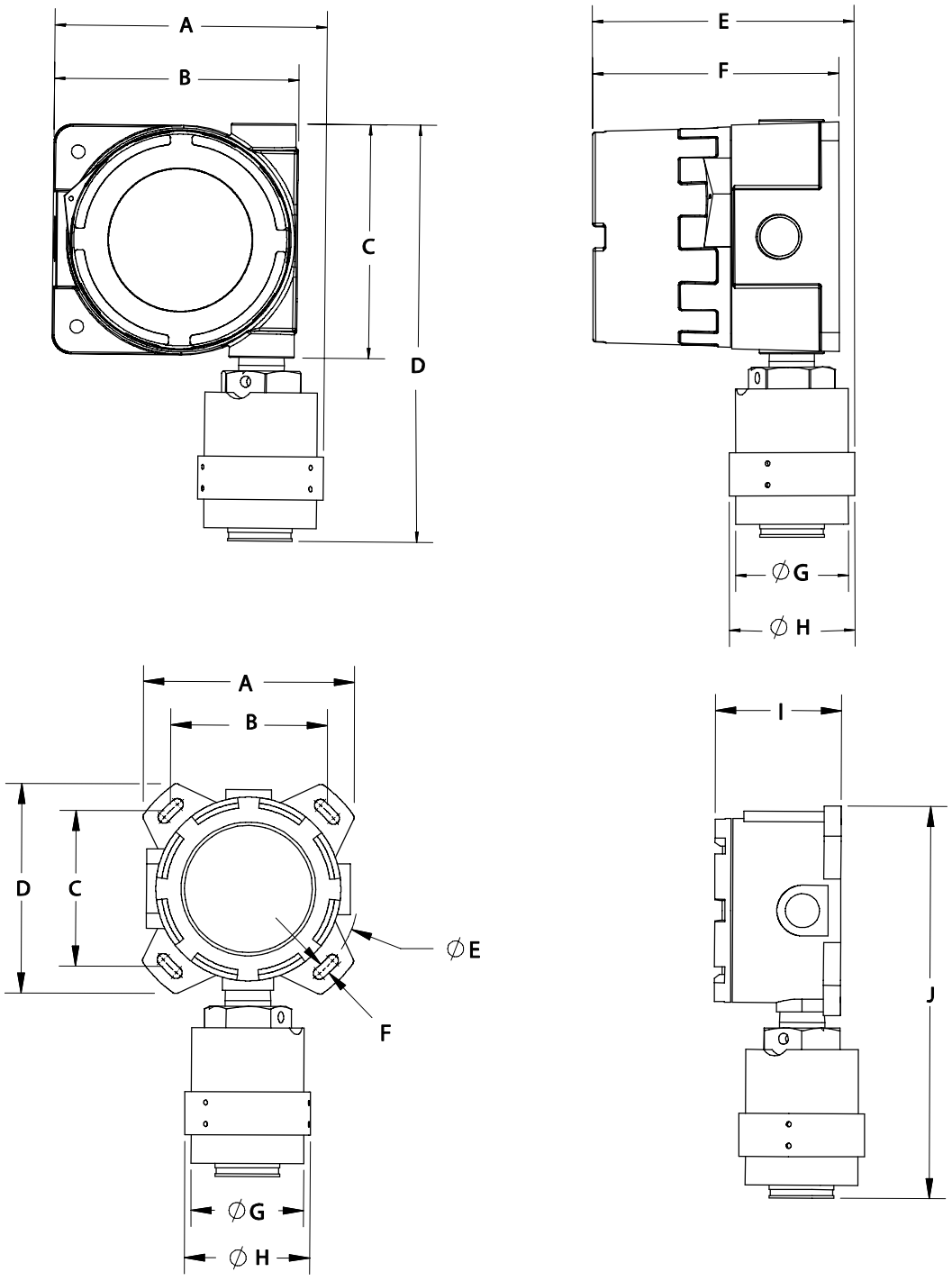
Millennium II Basic & sensor	**A**		**B**		**C**		**D**		**E**		**F**		**G**		**H**	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
Transmitter & sensor(AL)	4.8	122	3.6	91	3.6	91	4.8	122	5.1	130	0.3	7.6	2.6	66	2.9	74
Transmitter & sensor(SS)	4.7	119	3.6	91	3.6	91	4.7	119	5.1	130	0.3	7.6	2.6	66	2.9	74

Table 2(cont'd)

Millennium II Basic & sensor	**I**		**J**	
	in	mm	in	mm
Transmitter & sensor(AL)	3.0	76	9.0	229
Transmitter & sensor(SS)	2.8	71	8.9	226

Figure 2 below, shows the dimensions of the Millennium II transmitter with sensor and the Millennium II Basic transmitter with sensor.

Figure 2: Sensor with Millennium II series transmitters dimensional drawing



SECTION 1: Plan

1.1 Locate Sensor

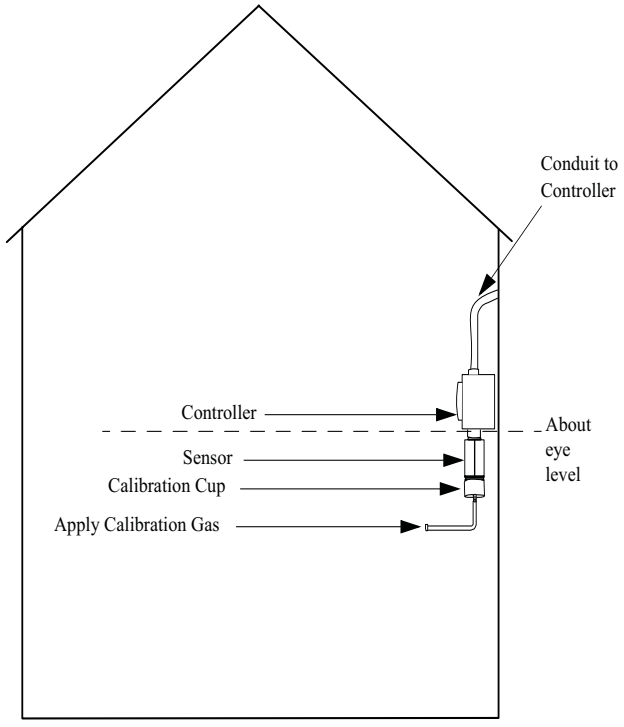
Prior to the installation process, a location plan for placing the sensor should be developed. Although there are no absolute rules determining the quantity of detectors or location of a sensor, the following points should be considered when planning the installation.

- Carefully locate the sensor in an area where gases may potentially accumulate. (Remember, light gases tend to rise and heavy gases tend to accumulate in low areas).
- Use redundant systems to enhance protection and reliability.
- Consider the air movement patterns within the facility.
- Consider the construction of the facility such as trenches where heavy gases or peaks where light gases, may accumulate.
- Seek advice from experts knowledgeable about the primary gas to be detected.
- Use common sense and refer to the regulatory publications that discuss guidelines for your industry.

1.2 Sensor Non-Separated

The sensor is attached directly to a transmitter and located in the appropriate location for detecting the gas in question.

Figure 3: Locating Sensor



1.3 Sensor Separated

Locate the sensor separate from a transmitter using a 'junction box / separation kit'. The transmitter is located near eye-level for easy access and the sensor is located where the gas is likely to accumulate. A calibration cup is clipped onto the bottom of the sensor housing and the calibration tubing is attached to the calibration cup and runs to a convenient place for applying calibration gas(air) eliminating the need to access the sensor directly.

To compensate for distance when remotely calibrating, in separation orientation, decrease the tubing diameter or increase the calibration gas flow rate between the gas canister and sensor. On initial install, always confirm tubing run is not affecting calibration. Calibrate the sensor using tubing run and then confirm readings directly at sensor by applying calibration gas (air) and comparing the output results. They should be accurate to the calibration gas concentration used.

SECTION 2: Installation

2.1 Unpack

Carefully remove all the components from the packaging and check them against the enclosed packing list. Inspect all components for any obvious damage such as broken or loose parts. If you find any components missing or damaged, notify the representative or Net Safety Monitoring immediately.

2.2 Mount

The sensor is mounted directly to either transmitter housing or to a separation junction box housing through the ¾" NPT conduit entry. Both the transmitter and separation kit housings have mounting holes to allow mounting to wall or pole as desired. Mounting kit hardware is required when mounting to a pole.

2.3 Wiring

2.3.1 Field Installation

Warning ⚠ Wiring codes and regulations may vary. ATEX requires that supply connection wiring must be rated at least 5°C above the maximum ambient temperature of 85°C. Wiring must comply with all applicable regulations relating to the installation of electrical equipment in a hazardous area and is the responsibility of the installer. If in doubt, consult a qualified official before wiring the system.

Guidelines

When separating the sensor from the transmitter, the use of shielded cable is highly recommended for sensor wiring to protect against interference caused by extraneous electrical or electromagnetic 'noise'. To meet IEC 61000-1, IEC 61000-4 EMI and MIL-W16878D Type B/N, Multi-Conductor Braid Shield Cable is recommended.
In applications where the wiring is installed in conduit, the conduit must not be used for wiring to other electrical equipment.
The maximum distance between the sensor and transmitter is limited by the resistance of the connecting wiring, which is a function of the gauge of the wire being used. We limit 2000 ft with 16 AWG wire for communication.(See Appendix B)

Earth Grounding

An external ground is required. One method is to connect the external ground to the grounding point on the housing. See Figure 1 for location.

Conduit Entry Protection

The sensors can be mounted directly onto a certified transmitter via the ¾" NPT nipple through which lead wires are used for connection or separately with the use of certified junction boxes.

2.3.2 Sensor Wiring

Warning ⚠ Do not open the transmitter in a classified area(Do not open when an explosive atmosphere may be present). Ensure the power to the transmitter is switched off before connecting sensor wires.

Warning ⚠ Avoid touching electronic components, as they are susceptible to electrostatic discharge (ESD). Refer to Appendix A, "Electrostatic Sensitive Device (ESD)".

Connect the colored sensor wires to the sensor terminals in the applicable transmitter. Refer to the Table 3 for the sensor terminal definitions.

Table 3: Sensor Terminal Definitions of Millennium II Transmitters

Sensor Terminals	Sensor Wire	White	Red	Blue	Black	Green
	Marked	+VDC	Sig A	Sig B	COM	Shld
	Function	10.5 - 32VDC	A	B	Common/Supply Ground	Earth Ground

NOTE: When separating sensor from transmitter using Net Safety separation kit, refer to Multi-purpose Junction Box Manual (MAN-0081) for terminal designations.

SECTION 3: Operation

3.1 Configuration Settings

All configuration settings are accessed through the Millennium II series transmitter. This is done by setting dip switches on the Millennium II Basic and by selecting menu options in the Millennium Transmitter. See relevant transmitter manual.

3.2 Sensor Power Up

When power is applied to the sensor, a 60 second power up routine will begin, where the sensor is being automatically tested to ensure proper functionality. Refer to applicable Millennium II transmitter manual for status indications during this period.

3.3 Sensor Communication

The ST340 sensor uses a proprietary protocol to communicate to the Millennium II transmitter series. The sensor should never be connected to any device other than the Millennium II series transmitters. Selected dip switches and menu options are communicated to the sensor by the transmitter. These configurations are stored in the sensor's memory. If the configuration settings are not done correctly, the sensor will not communicate properly with the transmitter.

SECTION 4: Output

4.1 Alarm and Fault Outputs

Sensor alarm and fault outputs are generated by the Millennium II transmitter series based on communication with the sensor, however, some output values, registers, etc, may vary depending on sensor type.

4.1.1 Other Available Outputs

All available outputs are associated with the Millennium II series transmitters. These outputs are: Current output, Relay Output, RS 485 Modbus (RTU) Output and HART Communication Output. Refer to the specific Millennium II series transmitter manual for more information.

4.1.2 Modbus registers

Table 4 below shows the user accessible Modbus registers and meaning

Table 4: Modbus registers and meaning

Reg #	Meaning	Readable	Writeable
40001	Concentration value as calculated by sensor	X	
40002	Sensor status	X	
40003	Sensor Temperature	X	
40027	Sensor Range	X	X
40101	Resets the sensor		X
40102	Initialize zero & span *(**to calibrate sensor, enter channel #)***		X
40104	Zero only *(**to zero sensor, enter channel #)***		X

* **Note**: For the Millennium Basic transmitter enter '1' in register 40102 to calibrate the sensor and '1' in register 40104 to Zero the sensor.

The Oxygen sensor only requires zeroing in ambient air for calibration, so either register 40102 or register 40104 may be used, as both commands will result in a proper calibration cycle.

SECTION 5: Maintaining

5.1 Millennium II Basic Transmitter DIP Switch configurations

The Oxygen sensor is used with all available Millennium II series transmitter models. The tables below show the DIP Switch settings for the different alarm configurations when the Relay model Millennium II Basic transmitter is being used. There are three Alarm Modes. Two Alarm Points are available under each mode. See Tables 6, 7, 8 and 9 for reference.

5.1 .1 Alarm Status and Alarm Mode DIP Switch Settings

DIP Switch 3 positions 2 and 3 are used to setup the alarm status, while DIP Switch 3 positions 1 and 4 are used to select the different Alarm Modes. The Alarm Modes available are: Above-Above, Below-Below and Below-Above. The default Alarm Mode is Below-Below.
Above–Above means the alarm will be activated when oxygen level is above Alarm Point 1 or above Alarm point 2. Below-Below means the alarm will be activated when oxygen level is below Alarm Point 1 or below Alarm Point 2 and Below-Above means the alarm will be activated when the oxygen level is below Alarm Point 1 or above Alarm point 2.

Note: Relay 1 is associated with Alarm Point 1 and Relay 2 is associated with Alarm point 2.

Table 5: DIP Switch 3 Positions for Alarm Status

DIP Switch 3 Alarm Status Settings			
Position 2	**ON**	**Energized**	**Defines Relay Coil status**
	OFF	**De-Energized**	
Position 3	**ON**	**Latching**	**Defines Relay Latch status**
	OFF	**Non-Latching**	

Table 6: Dip Switch 3 Positions for Alarm Mode

DIP Switch 3 Alarm Mode Settings				
Position 1	**ON**	**ON**	**OFF**	**OFF**
Position 4	**ON**	**OFF**	**ON**	**OFF**
Alarm Mode	**Above-Above**	***Below-Above**	*** Below-Above**	**Below-Below**

Note: There are two configurations for Alarm Mode (* Below-Above)

5.1 .2 Alarm Points Definition

Under the available Alarm Modes the user is allowed to setup two Alarm Points; Alarm Point 1 and Alarm Point 2. DIP Switch 1 position 1 and position 2 are used to set the Alarm Point 1, while DIP Switch 1 Positions 3 and 4 are used to setup Alarm Point 2. For Alarm Modes Above-Above and Below-Below as seen in Table 7 and Table 8, the user can decide which value will be Alarm Point 1 or Alarm Point 2. Under Alarm Mode Below-Above, Alarm Point 1 and Alarm Point 2 are distinct as seen in Table 9.

Table 7: Alarm Points for Alarm Mode (Above-Above)

Alarm Mode: Above- Above		
Alarm Point 1 / 2	**Position 1/ position 3**	**Position 2 / Position 4**
22.0%	OFF	OFF
22.5%	OFF	ON
23.0%	ON	OFF
23.5%	ON	ON

Table 8: Alarm Points for Alarm Mode (Below-Below)

Alarm Mode: Below- Below		
Alarm Point 1 / 2	**Position 1/ position 3**	**Position 2 / Position 4**
19.5%	OFF	OFF
19.0%	OFF	ON
18.5%	ON	OFF
18.0%	ON	ON

Table 9: Alarm Points for Alarm Mode (Below-Above)

Alarm Mode: Below- Above		
Alarm Point 1	**Position 1**	**Position 2**
19.5%	OFF	OFF
19.0%	OFF	ON
18.5%	ON	OFF
18.0%	ON	ON
Alarm Mode: Below- Above		
Alarm Point 2	**Position 3**	**Position 4**
22.0%	OFF	OFF
22.5%	OFF	ON
23.0%	ON	OFF
23.5%	ON	ON

5.1.3 Calibrating with the Millennium II Basic Transmitter.

When calibrating use 20.9% air from canister or surrounding air, provided it is not contaminated. It is recommended that this sensor be calibrated every 3 months (90 days) to ensure proper functioning.

Follow the steps below for Calibration / Normal Calibration Procedure.

1. Confirm successful power up of Transmitter, (green blip/blink of status LED every second: no fault indicated).
2. Bypass any output alarms (recommended).
3. For analog model connect a standard current meter to the Transmitter's Test Jacks (not required but gives visual confirmation).
4. If a gas canister is being used for calibration, apply gas (air) two minutes before calibration is initiated.
5. Press and hold the "**push button**" (or activate the "**Reed switch**" using the magnet) for at least 15 seconds, the status LED flashes green fast, and then goes solid green (first solid green). Keep holding "**push button**" or magnet, after which, status LED goes solid red, release "**push button**" or remove magnet.
6. When the current output is 3 mA (indicated by analog models) and the Status LED is once again solid green (second solid green), apply zero gas (clean air) at a rate of 0.5 liter per minute. If the surrounding air (ambient air) is clean (free from contaminants), then use the surrounding air for calibration.

7. Continue applying clean air when the current output is 3.3 mA(indicated by analog models) and the Status LED is flashing red. If the surrounding air (ambient air) is clean (free from contaminants), then use the surrounding air for calibration.
8. If long tubing runs are being used, increase the air flow rate (1.0 liter per minute) to ensure tubing does not affect calibration results.
9. When calibration is completed the current output will be 3.6 mA (indicated by analog models) and the Status LED solid green. After which, the Status LED will then blip green to indicate normal operation.

Note: A zero / calibration can be done, by releasing the push button at the first solid green in step 5 above and applying clean air. Zeroing the sensor will also result in calibrating, since the sensor is an oxygen sensor.

5.2 Millennium II Transmitter Alarm Configurations

The steps below allow the user to enter the transmitter's menu and select the Alarm Mode for the Oxygen sensor. There are three Alarm Modes. Two Alarm Points are available under each mode.

5.2.1 Alarm Mode Settings

The Alarm Modes available are: Above-Above, Below-Below and Below-Above. The default Alarm Mode is Below–Above.

Above–Above means the alarm will be activated when oxygen level is above Alarm Point 1 or above Alarm Point 2. Below-Below means the alarm will be activated when oxygen level is below Alarm Point 1 or below Alarm Point 2 and Below-Above means the alarm will be activated when the oxygen level is below Alarm Point 1 or above Alarm point 2.

Note: Alarm Points 1 and 2 can be associated with any of the available Alarm relays (Relay 1, 2 or 3). See Transmitter manual (MAN-0076) when navigating through relay option.

Follow the steps below to setup the Alarm Modes in the Transmitter's menu.

1. Enter the main menu, first by pressing any key to get the *"enter main menu"* prompt, then press/select ***menu button 1*** or ***Reed switch 1*** to select *"yes"***.**

2. Use ***menu button 2 (Reed switch 2)*** or ***menu button 1(Reed switch 1***) to navigate *"Alarm Mode Setting"*. Select this option with ***menu button 3(Reed switch 3)***.

3. The display will show "*Only for Oxygen Sensor*", and then show the existing Alarm Modes for each channel. Highlight the channel to be configured with ***menu button 2***(***Reed switch 2***) and select it with ***menu button 3***(***Reed switch 3***) to make the change.

4. After the configuration is completed, highlight "*Exit"* by using ***menu button 2(Reed switch 2)*** and select it with ***menu button 3(Reed switch 3)***.

5. To completely exit main menu , use ***menu button 2(Reed switch 2)*** to navigate to *"Exit"* and select it with ***menu button 3***(***Reed switch 3)***.

5.2 .2 Setting-up Alarm Points (Levels)

Follow the steps below to setup the Alarm Points in the Transmitter's menu.

1. Enter the main menu, first by pressing any key to get the *"enter main menu"* prompt, then press/select ***menu button 1*** or ***Reed switch 1*** to select *"yes"***.**

2. Use m***enu button 2 (Reed switch 2)*** or ***menu button 1(Reed switch 1***) to navigate *"Set Alarm Level"* Select this option with ***menu button 3(Reed switch 3)***.

3. *"Set CH1 Level"* and "*Set CH2 Level*", will be displayed. Select the channel level to be configured by using ***menu button 3***(***Reed switch 3***).

4. The existing alarm levels will be displayed, as CH1 Point 1(or CH2 Point 1) and Ch1 Point 2(or Ch2 Point 2). Highlight the level to be changed and select with ***menu button 3***(***Reed switch 3***)

5. Use ***menu button*** 1(***Reed switch 1***) to increase a displayed value and ***menu button 2***(***Reed switch 2***) to cycle to the next digit.

6. When the desired value is reached, exit by selecting ***menu button 3***(***Reed switch 3***). Keeping selecting "Exit" to fully exit the menu.

5.2.3 Calibrating with the Millennium II Transmitter

The need to accurately detect and monitor oxygen levels is also facilitated by the Millennium II Transmitter. The controller also offers some flexibility in the use of calibration gas (air) value. If the calibration gas (air) is not 20.9%, the transmitter will allow calibration to be performed with calibration gas (air) within the range of 18-24%. To select the calibration gas (air) value, enter the transmitter's main menu and select '*cal. gas value'* and enter the value. Refer to MAN-0076 when navigating through menu options.

Follow the steps below for Calibration Procedure.

1. Enter the main menu, first by pressing any key to get the *"enter main menu"* prompt, then press/select ***menu button 1*** or ***Reed switch 1*** to select *"yes"***.**

2. When *"Calibrate Sensor?"* is displayed, select the enter key (***menu button 3*** or ***Reed switch 3***).

3. When *"Calibrate Sensor #1?"* is highlighted, press the enter key (***menu button 3*** or ***Reed switch 3***) if this is the sensor to be calibrated.

4. If Sensor #2 is to be calibrated, select the down arrow key (***menu button 2*** or ***Reed switch 2***) to scroll to *"Calibrate Sensor #2?"*

5. Select the desired sensor to be calibrated (1 or 2) by activating the enter key (***menu button 3*** or ***Reed switch 3)***.

6. Select *"YES"* (***menu button 1*** or ***Reed Switch 1***) to confirm the selection.

7. If the user wants to use a gas canister with the *"Z & Span"* option, apply 0.5 liter per minute air two minutes prior to initiating calibration then select *"Z & Span"* using (***menu button 1*** or ***Reed Switch 1***). The unit will first zero itself then display "*Apply 20.9 % air (or cal gas value)* and then go into calibration mode.

8. If "*Zero*" is selected the unit will zero itself then go into calibration mode. Ensure that surrounding air it is free from contaminants if it is being used for calibration.

9. *"Cal Complete"* will be displayed when calibration is complete.

Note: Air used for calibration can either be from the gas canister or surrounding air (clean air).

5.3 Sensor Replacement Procedure

When a calibration can no longer be performed or the sensor is not operating properly it will require replacing.

To replace the sensor module:

1. Remove power from sensor.
2. Remove the locking ring by loosening the set crews with Allen Key tool.
3. Remove the bottom part of the sensor housing by turning in a counter clockwise rotation to expose sensor module.
4. Using the Teflon pull tab pull sensor straight down out of the sensor housing until sensor is completely removed from the housing.
5. Align replacement sensor with pins inside top section of the housing and push on outer plastic ring until sensor is seated properly. DO NOT PUSH ON CENTER ELEMENT.
6. Install and tighten the bottom part of the sensor housing by turning in a clockwise rotation.
7. Install the locking ring by tightening the set crews with Allen Key tool.
8. Restore power to sensor.

5.4 Troubleshoot

Sensors and Controllers / Transmitters are not designed to be repaired in the field. If a problem should develop, first check for faulty wiring, confirm proper voltage to detector, and attempt a calibration. If the problem persists, please contact Net safety's service department first by phone to try and resolve the issue. If the issue cannot be resolved, please follow the procedure below on how to return equipment.

5.5 Spare Parts / Accessories

Table 6: Available Spare Parts

Description	Net Safety Part Number
Calibration Cup / Splash Guard	CCS-1
Separation Kit	JB-MPD-A (aluminum) or JB-MPD-S (316 stainless steel)
Dust Filter Assembly	DSC-1
Replacement Oxygen (O2) Sensor	ST340-25

5.6 How to Return Equipment

A Material Return Authorization number is required in order to return equipment. Please contact Net Safety Monitoring at **(403) 219-0688**, before returning equipment or consult our Service Department to possibly avoid returning equipment.

If you are required to return equipment, include the following information:

1. A Material Return Authorization number (provided over the phone to you by Net Safety).
2. A detailed description of the problem. The more specific you are regarding the problem, the quicker our Service Department can determine and correct the problem.
3. A company name, contact name and telephone number.
4. A purchase order, from your company, authorizing repairs or request for quote.
5. Ship all equipment, prepaid to: **Net Safety Monitoring Inc.,**
   2721 Hopewell Place NE,
   Calgary, Alberta, Canada, T1Y 7J7
6. Mark all packages: **RETURN for REPAIR**.
7. Waybills, for shipment outside Canada, must state: **Equipment being returned for repair**
   All charges to be billed to the sender

Ensure a duplicate copy of the packing slip is enclosed inside the box indicating item 1 – 4 along with the courier and account number for returning the goods.

Pack items to protect them from damage and use anti-static bags or aluminum-backed cardboard as protection from electro-static discharge.

ALL equipment must be shipped prepaid. Collect shipments will not be accepted.

Appendix

Appendix A: Electrostatic Sensitive Device (ESD)

Definition: Electrostatic discharge (ESD) is the transfer, between bodies, of an electrostatic charge caused by direct contact or induced by an electrostatic field.

The most common cause of ESD is physical contact. Touching an object can cause a discharge of electrostatic energy—**ESD**! If the charge is sufficient and occurs near electronic components, it can damage or destroy those components. In some cases, damage is instantaneous and an immediate malfunction occurs. However, symptoms are not always immediate—performance may be marginal or seemingly normal for an indefinite period of time, followed by a sudden failure.

To eliminate potential ESD damage, review the following guidelines:

- Handle boards by metal shields—taking care not to touch electronic components.
- Wear grounded wrist or foot straps, ESD shoes or heel grounders to dissipate unwanted static energy.
- Prior to handling boards, dispel any charge in your body or equipment.
- Ensure all components are transported and stored in static safe packaging
- When returning boards, carefully package in the original carton and static protective wrapping
- Ensure **ALL** personnel are educated and trained in ESD Control Procedures

In general, exercise accepted and proven precautions normally observed when handling electrostatic sensitive devices. A warning label is placed on the packaging, identifying product using electrostatic sensitive semiconductor devices.

Appendix B: Resistance Table

Distance (Feet)	AWG #20	AWG #18	AWG #16	AWG #14	AWG #12	AWG #10	AWG #8
100	1.02	0.64	0.40	0.25	0.16	0.10	0.06
200	2.03	1.28	0.80	0.51	0.32	0.20	0.13
300	3.05	1.92	1.20	0.76	0.48	0.30	0.19
400	4.06	2.55	1.61	1.01	0.64	0.40	0.25
500	5.08	3.20	2.01	1.26	0.79	0.50	0.31
600	6.09	3.83	2.41	1.52	0.95	0.60	0.38
700	7.11	4.47	2.81	1.77	1.11	0.70	0.44
800	8.12	5.11	3.21	2.02	1.27	0.80	0.50
900	9.14	5.75	3.61	2.27	1.43	0.90	0.57
1000	10.20	6.39	4.02	2.53	1.59	1.09	0.63
1250	12.70	7.99	5.03	3.16	1.99	1.25	0.79
1500	15.20	9.58	6.02	3.79	2.38	1.50	0.94
1750	17.80	11.20	7.03	4.42	2.78	1.75	1.10
2000	20.30	12.80	8.03	5.05	3.18	2.00	1.26
2250	22.80	14.40	9.03	5.68	3.57	2.25	1.41
2500	25.40	16.00	10.00	6.31	3.97	2.50	1.57
3000	30.50	19.20	12.00	7.58	4.76	3.00	1.88
3500	35.50	22.40	14.10	8.84	5.56	3.50	2.21
4000	40.60	25.50	16.10	10.00	6.35	4.00	2.51
4500	45.70	28.70	18.10	11.40	7.15	4.50	2.82
5000	50.10	32.00	20.10	12.60	7.94	5.00	3.14
5500	55.80	35.10	22.10	13.91	8.73	5.50	3.46
6000	61.00	38.30	24.10	15.20	9.53	6.00	3.77
6500	66.00	41.50	26.10	16.40	10.30	6.50	4.08
7000	71.10	44.70	28.10	17.70	11.10	7.00	4.40
7500	76.10	47.90	30.10	19.00	12.00	7.49	4.71
8000	81.20	51.10	23.10	20.20	12.70	7.99	5.03
9000	91.40	57.50	36.10	22.70	14.30	8.99	5.65
10000	102.00	63.90	40.20	25.30	15.90	9.99	6.28

Resistance shown is one way. This figure should be doubled when determining closed loop resistance.

Appendix C: Millennium II Oxygen (O2) Sensor Specifications

SENSOR	Oxygen (O2)
Performance	
Response Time	T95 ≤ 15 sec
Zero Drift	+/- 5% per year
Environmental	
Temperature	Operational: -40°C to +50°C
RH	0 – 99% RH non condensing
Metallurgy	Aluminum or 316 SS
Nema Rating	NEMA 4X
Separation	
Separation	Up to 2000 feet / 600 meters
Approvals	
Approvals	CE 0575 Ex II 2 G, EEx d IIB + H2, T4 DNV-2006-OSL-ATEX-0475X -40°C < Ta < +75°C

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