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Net Safety™ Millennium Toxic Gas Detector

User Manual

Models:

MLP-A/AR/AD-ST1XXX

MLP-LP-A/AR/ARS-ST1XXX

EMERSON™
Process Management

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Introduction

The Millennium series is a part of Net Safety's innovation in a line of continuously evolving industrial gas detectors and sensors. The microcontroller based system provides fast, accurate and continuous monitoring of gases in extreme environments.

The Product

The electrochemical toxic gas sensor is a tested and proven design which ensures accurate and reliable response to toxic gases. The sensor will operate in the most severe environments whilst ensuring that detection of dangerous and toxic gases is being consistently done.

The Controller (Transmitter)

The Millennium Controller has an explosion-proof Housing, rated Class 1, Division 1, Groups B, C, and D for hazardous applications. It was designed for either a one-man, intrusive calibration or two-man non-intrusive calibration. The Controller has convenient user interface functionality to make installation, operation and maintenance easy.

The Manual

The manual has been designed to make installation of the Millennium product easy. To ensure proper installation, follow the steps outlined in the following pages. If you encounter problems during operation, consult the troubleshooting section or contact your sales representative.

SECTION 1: PLAN

1.1 LOCATE CONTROLLER / SENSOR

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

- Locate the controller where it will be accessible and visible.
- Carefully locate sensor in an area where gases may potentially accumulate.
- Use redundant systems to enhance protection and reliability.
- Light gases tend to rise; heavy gases tend to accumulate in low areas.
- Consider the air movement patterns within the facility.
- Consider the construction of the facility (such as trenches where heavy gases may accumulate 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. The two most common installations options are as follows.

Option 1

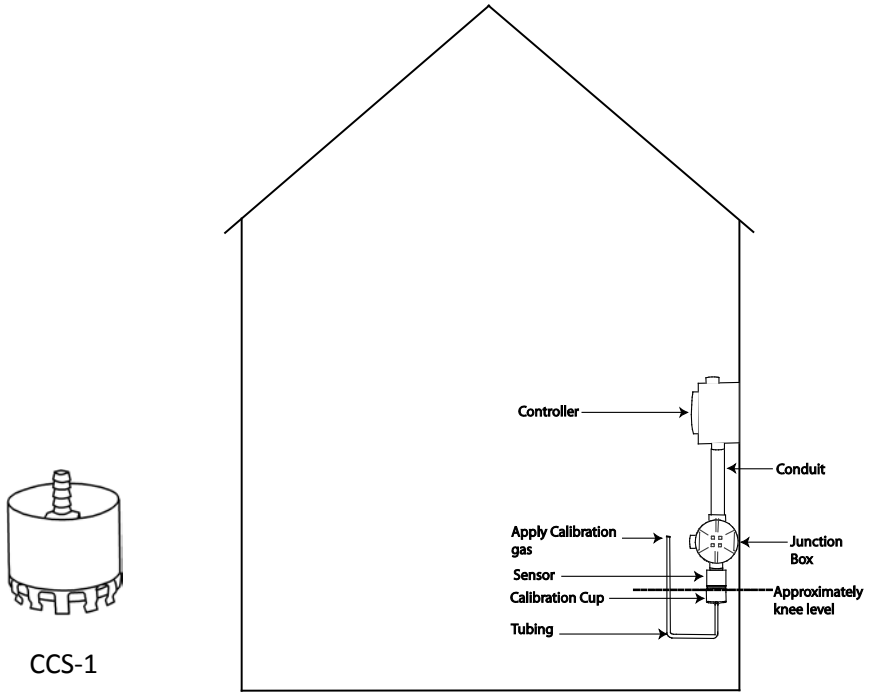
Locate the sensor separate from the controller using a Certified Junction Box. **If the Net Safety Multi-purpose Junction Box is being used, refer to MAN-0081 for terminal designations.**
The controller is located near eye- level. Conduit is run from the controller to the sensor. A Calibration Cup (CCS-1) can be attached to the sensor. Tubing can be run from the CCS-1 to a convenient location accessible for calibration gas to be injected.

Option 2

The sensor is attached directly to the controller. See "Wiring – Controller and Sensor" for details. The CCS-1 and tubing is used to facilitate calibration.

TIP: The Calibration Cup (CCS-1) allows for tubing to be affixed to a sensor mounted in remote locations. The tubing s directed to a level, usually close to the controller, for easy injection of calibration gas. The calibration cup can also act as a splash guard, protecting sensors mounted low to the ground.

Figure 1: Locate Sensor/Controller - Separated

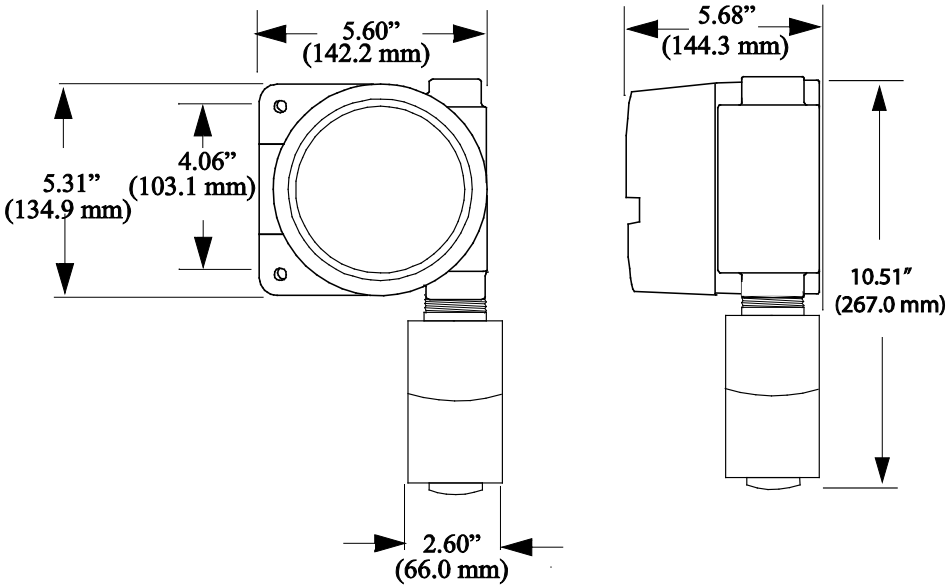


CCS-1

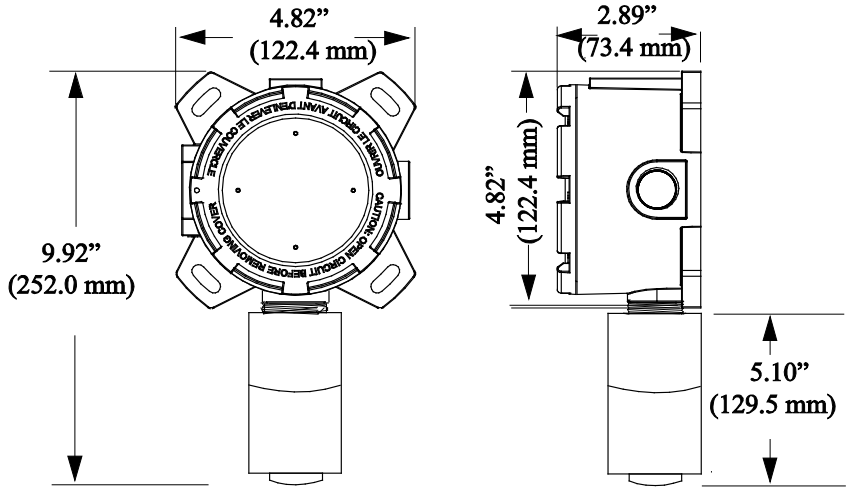
Figure 2 below shows the Controller with sensor and the Multipurpose Junction box with sensor.

Figure 2: Dimensional Drawing

Controller with sensor



Multi-purpose Junction box with sensor

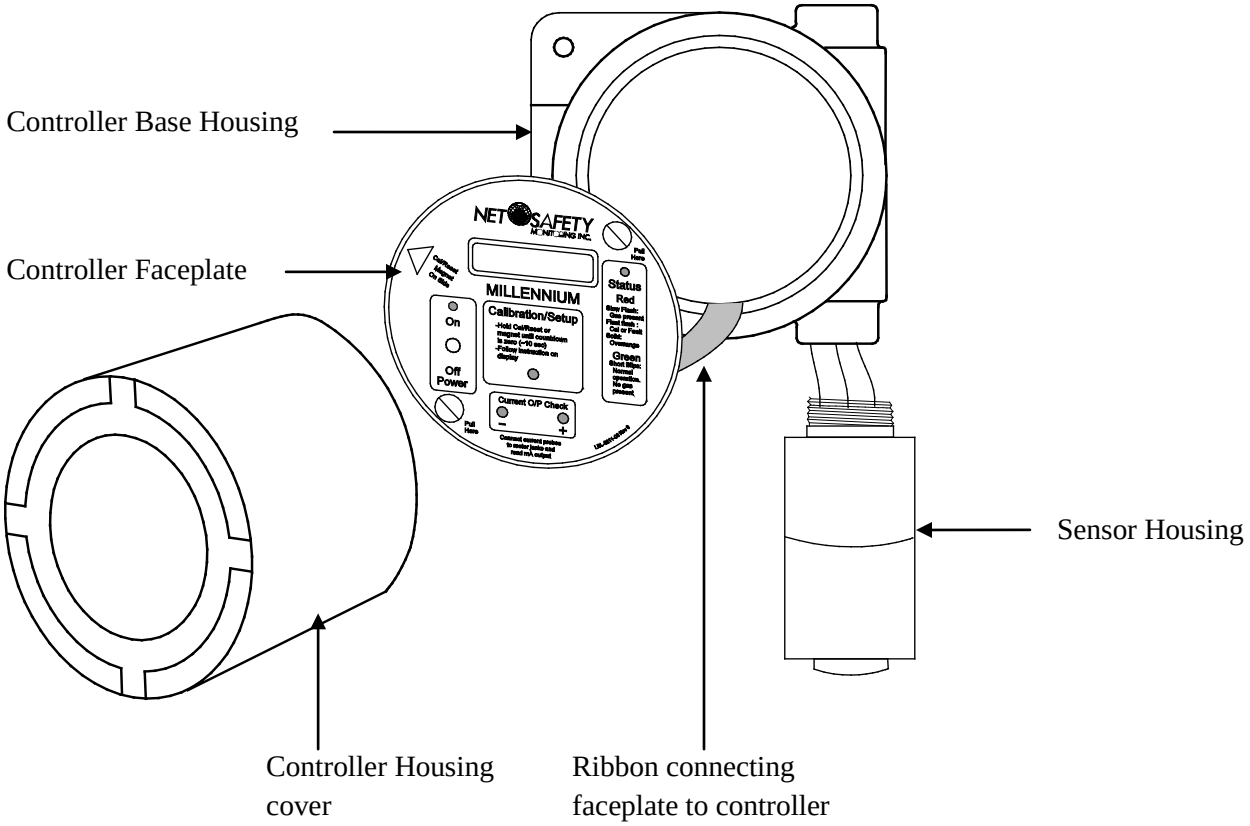


SECTION 2: Install

Unpack

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

Figure 3: Components



Note: ST1XXX series sensors are shipped in a white plastic container inside the packaging. Remove sensor from container then carefully fit sensor inside Sensor Housing prior to operation.

External Equipment. It is necessary that reliable monitoring and indicating devices or systems be connected to the detector. These devices must be designed to produce clear visual and audible danger signals when high signal levels occur.

Mount

The controller should be mounted near eye-level and be easily accessible for calibration and maintenance purposes. The sensor should be placed where gas is likely to accumulate.

Ensure all devices are securely mounted, taking into consideration all requirements.

If necessary use the Face Rotation Option to mount the Millennium Controller at a different orientation. Refer to “Face Rotation Option” for detailed instructions.

SECTION 3: Wire

Field Installation

Warning Wiring codes and regulations may vary. Wiring must comply with 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. See some wiring considerations below.

- If the 4–20 mA signal is not used, connect a jumper between the 4–20 mA terminal and the Common terminal.
- The use of shielded cable is highly recommended for signal, input, output and power wires to protect against interference caused by extraneous electrical or electromagnetic 'noise'.
- In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment.
- The maximum distance between sensor and controller is limited by the resistance of the connecting wiring, which is a function of the gauge wire being used. See Appendix B.
- When developing a RS-485 chain of devices, the last device in the chain requires end of line termination.
- RS-485 connection 2-wire, multipoint serial line.

Seal

The use of seals is recommended to further protect the system against any unwanted water ingression, and equipment should be installed according to applicable local electrical codes. Seals are especially recommended for installations that use high-pressure or steam cleaning devices in proximity to the transmitter and/or sensor.

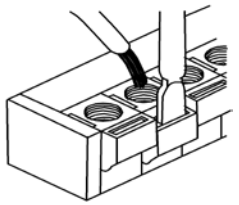
- Water-proof and explosion-proof conduit seals are recommended to prevent water accumulation within the enclosure.
- Seals should be located as close to the device as possible and not more than 18 inches (46 cm) away.
- Explosion-proof installations may require an additional seal where conduit enters a non-hazardous area. Ensure conformity with local wiring codes.
- When pouring a seal, use a fibre dam to ensure proper formation of the seal. Seals should never be poured at temperatures below freezing.
- The jacket and shielding of the cable should be stripped back to permit the seal to form around the individual wires. This will prevent air, gas and water leakage through the inside of the shield and into the enclosure.

- It is recommended that explosion-proof drains and conduit breathers be used. In some applications, alternate changes in temperature and barometric pressure can cause 'breathing' which allows moist air to enter and circulate inside the conduit. Joints in the conduit system are seldom tight enough to prevent this 'breathing'.

Connecting Wires

1. Use a small screw driver to gently press down and hold the spring connector open.
2. Insert appropriate wire into open connector hole.
3. Release screw driver to secure wire.

Figure 4: Securing wires



Board Assembly

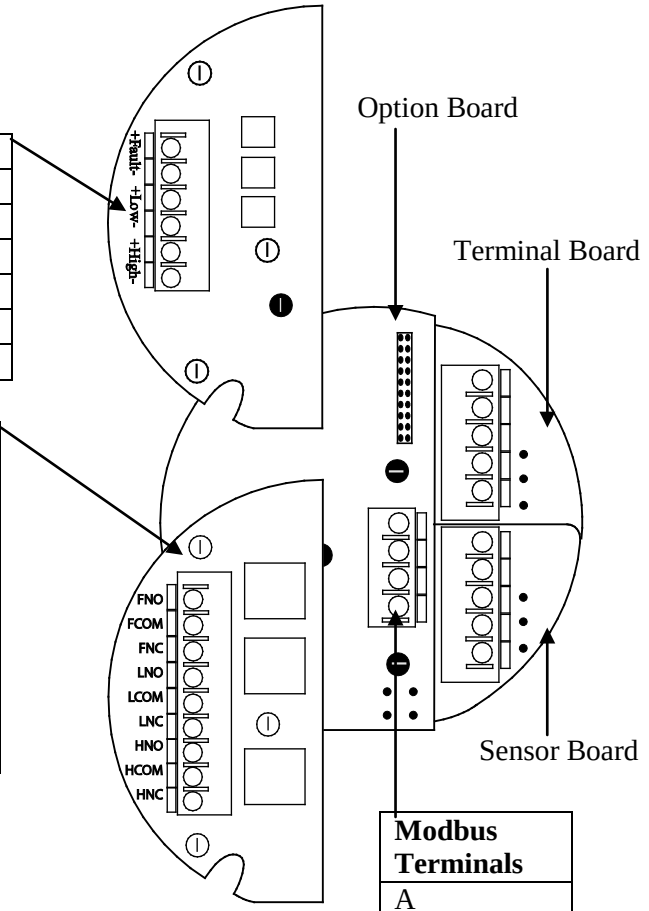
There are three different user- allowed removable boards; relay board (Solid State or Electromechanical), Option board and Modbus board. These Boards are field replaceable. Simply loosen the locking standoffs, remove one board, insert the other board and tighten screws. Depending upon requirements, either an Electromechanical or Solid State Relay Board module can be used.

Note: Boards are susceptible to ESD. Refer to Appendix A: Electrostatic Sensitive Device (ESD)

Figure 5: Millennium Module Boards

Solid State Relay Board	
Fault	+
	-
Low	+
	-
High	+
	-

Electromechanical Relay Board		
FNO	Fault	Normally open
FCOM		Common
FNC		Normally closed
LNO	Low	Normally open
LCOM		Common
LNC		Normally closed
HNO	High	Normally open
HCOM		Common
HNC		Normally closed



Modbus Terminals
A
B
COM
-

Sensor and Controller

Warning Power to the unit must be OFF before wiring. Also ensure area is de-classified before removing housing cover.

Note: The sensor may be factory fitted to the controller. If so, you need only connect the Power Terminals.

1. Remove the Controller's Housing Cover.
2. Connect the sensor to the Sensor Terminals (if necessary) and the Power Terminals to power and output signal wires.
3. Turn controller on (put ON/OFF Switch in 'On' position).
4. Replace Controller's Housing cover. Apply power to unit.
5. Ensure display reads **Start Delay**, Status LED is Red Slow Flash and current output displays 3.0 mA. This is the start-up delay sequence which will last approximately 90 seconds.

Refer to Tables 1and 2 along with Figure 6, for wiring.

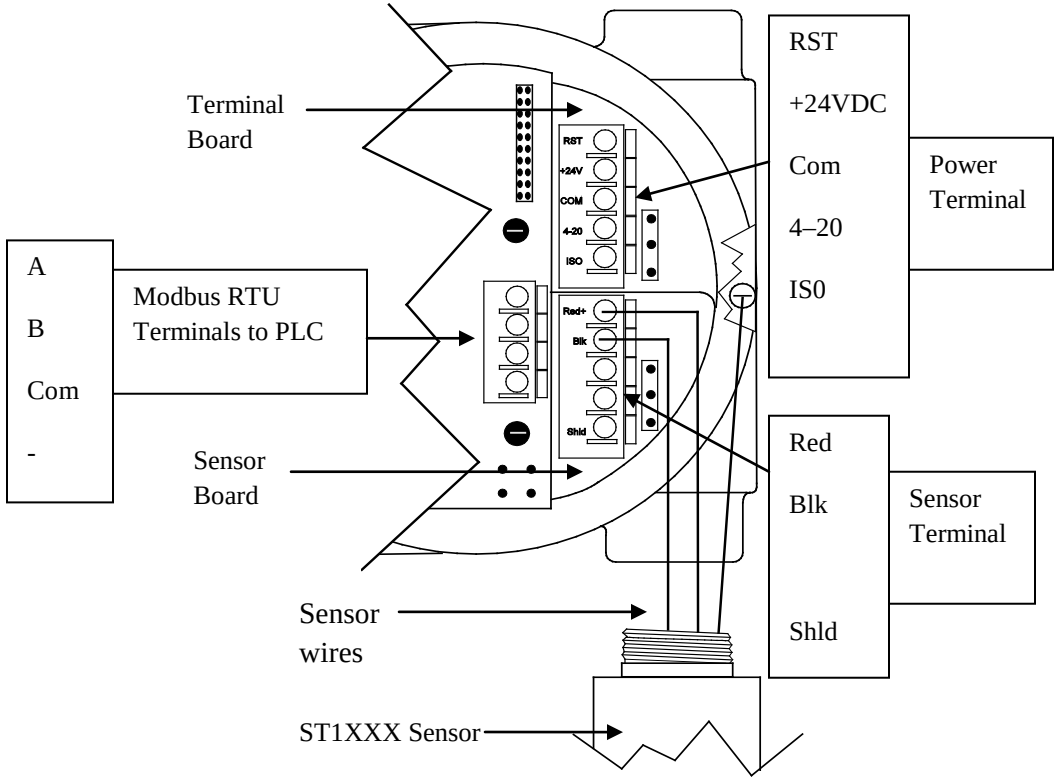
Table 1: Sensor Terminal connection

Sensor Terminals		
Sensor Wire		**Terminal designations**
Red	↔	Red(+24V)
Black	↔	BLK(Sig)
Shield	↔	Shld

Table 2: Controller Terminal connection

Power Terminals		
Controller (Terminal Board)		**Power Connections**
RST	↔	Remote Reset
+24VDC	↔	Power(+)
COM	↔	Power(-)
4–20	↔	Current loop output
ISO	↔	+24V isolated 4–20

Figure 6: Wiring - Controller and Sensor



Note: If the 4–20 mA signal is not used, connect a jumper between the 4–20 terminal and the COM terminal on the Terminal Board.

Relay Board

Refer to Figure 5, "Millennium Module Boards" for relay board location and termination.

RS-485 Communication

Connect devices in a chain via the Modbus terminals. The last device in the chain requires end of line termination. Refer to "Modbus Termination".

Sensor Separation

Since the sensor must be located where gas is likely to accumulate and the controller where it can be easily reached, it is often necessary to "separate" the controller and sensor. This is done with the aid of the Sensor Separation kit. The Sensor Separation kit is composed of a **Net Safety Multi-purpose Junction Box** and terminal strip. **For terminal definitions refer to the Multi-purpose Junction Box manual (MAN-0081).**

Shielded copper instrument wire (minimum 18 AWG) should be used for separations up to 500 feet. Shielded copper instrument wire (minimum 16 AWG) should be used for separations up to 2000 feet. Consult the factory if greater separation distance is required.

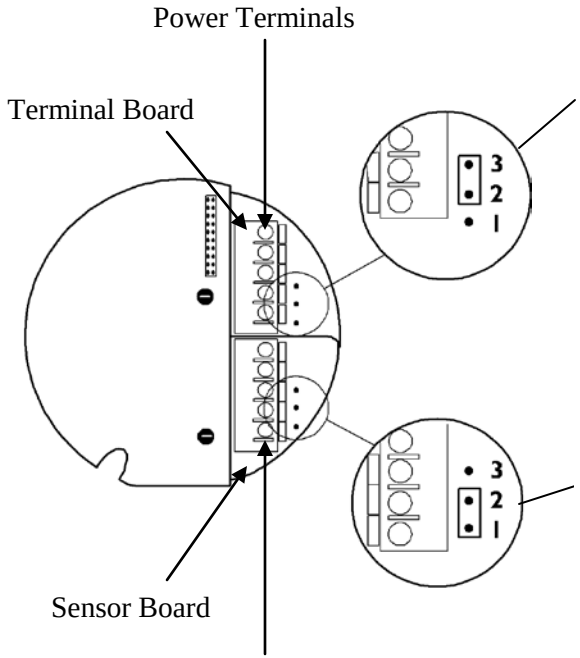
Note: When sensor is separated from controller, always ensure that the controller is supplying the required voltage to the sensor terminals inside the junction box. Refer to Table 1, "Sensor Terminal connection". Also if the 4–20 mA signal is not used, connect a jumper between the 4–20 terminal and the COM terminal on the Terminal Board.

CURRENT OUTPUT

To set the current output, simply move the jumper located on the Terminal Board near the power terminals, to the isolated or non-isolated current position. Refer to Figure 7.

Note: Unless otherwise specified, all models ship with this jumper in the non-isolated current position (Pin 2 and Pin 3 jumpered). Refer to Figure 7.

Figure 7: Jumper Position



Jumper positions to set power source for current output.

Isolated & Non-Isolated Current Jumper - Place Jumper (shorting jack) over Pin 3 and Pin 2 (default position) for Non-Isolated configuration (source). Place Jumper over Pin 1 and Pin 2 for remaining configurations. See Figure 8.

Termination Jumper – Non- functional in this application and can be placed in any position or removed.

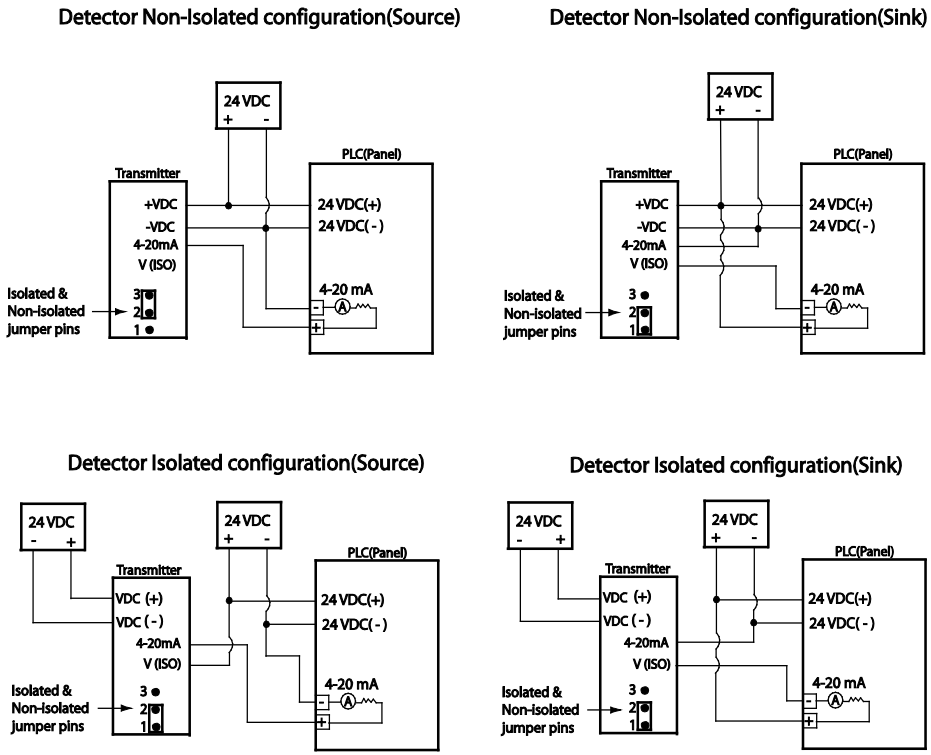
NON-ISOLATED AND ISOLATED POWER CONFIGURATIONS

For current source using Non-Isolated configuration, the jumper must remain in the default position (Pin 2 and Pin 3 jumpered). The jumper is placed over Pin1 and Pin 2 for current sink using Non-Isolated configuration.

For Isolated configuration using a separate power supply to isolate the current loop, the jumper must be placed over Pin 1 and Pin 2 for source and sink. See Figure 7 and Figure 8.

Note the Jumper position for each configuration.

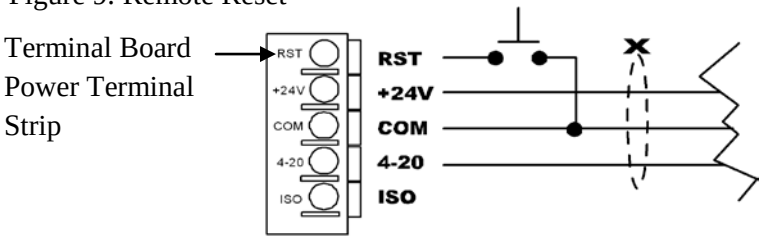
Figure 8: Current Source and Sink Drawing



Remote Reset

If the Millennium relays are set for latching a remote reset can be done to reset the relays. This is done with a normally open Push Button Switch connected between the RST and COM terminals on the Terminal Board. See Figure 9.

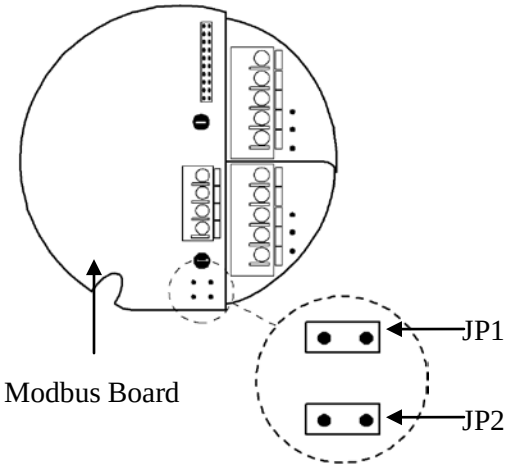
Figure 9: Remote Reset



Modbus Termination

Devices can be networked in a daisy chain. The device located at the end of the chain requires end of line termination. Place both jumpers over the pins as shown in the Figure 10 below.

Figure 10: Modbus Termination Jumpers



SECTION 4: OPERATE

Figure 11: Controller Functionality

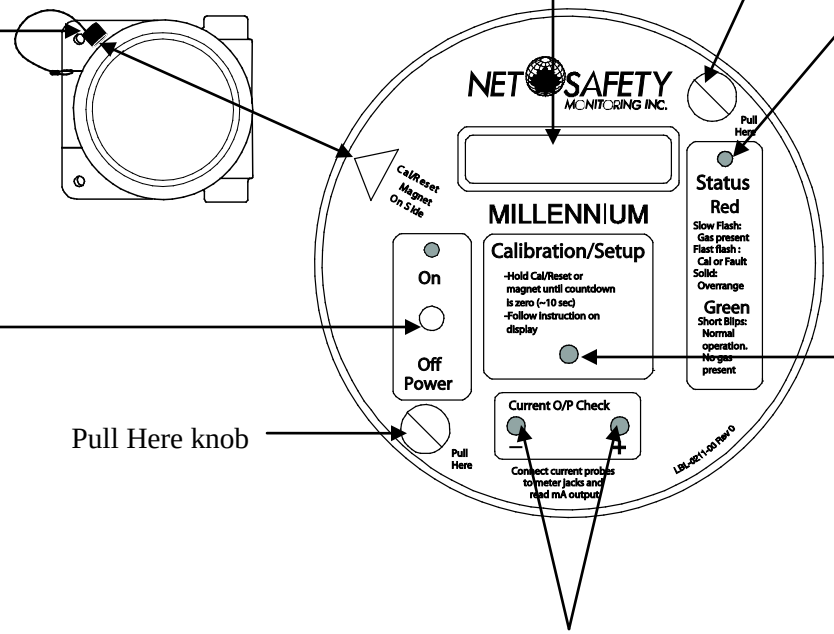
Scrolling 8 character display – provides various status messages and prompts. Refer to "Status LED's, Display Messages and Current Loop"

Pull Here knob – unscrew the two screws and pull to remove faceplate. Removal allows access to terminal boards. The face plate remains attached to the ribbon cable

Magnetic Reed Switch – provides non-intrusive access for programming, zeroing and resetting.

- Place magnet against housing as indicated for less than one second to initiate a basic system reset (clear latched alarm) and make selections.
- Place magnet against housing as indicated and hold to access, select, view settings and zero.

Status Light (flashes Red or Green) to indicate status of unit. Refer to "Status LEDs, Display Messages", for detailed explanation.



ON/OFF Switch – used to turn controller on and off. Housing must be removed to access.

Pull Here knob

Setup Button – provides intrusive access for programming, zeroing and resetting.

- Push for less than one second to initiate a basic system reset (clear a latched alarm) and make selection.
- Push and hold to program, view current settings and zero.

Current Output Check – test jacks to facilitate current loop measurements without breaking external current loop. To take current loop measurements ensure wiring is correct and current loop is closed, and then follow steps below

- Set meter on mA scale and insert meter leads into test jacks.
- Set external devices to bypass, if necessary, to avoid unwanted alarm response
- Perform simulated tests to check output
- Remove meter leads from test jacks and return external devices to normal

Table 3: Status LEDs, Display messages and current loop

State	Current output	Status LED Red or Green		Display
Calibrate sensor	3.0 mA	N/A		N/A
Normal operation	4.0 mA	N/A	Green blip/blink	00 PPM
Start-up delay (90 seconds)	3.0 mA	Red Slow flash	N/A	Start delay
Accessing main menu & options	3.0 mA	N/A		Switch on (10→0)
Memory error	2.5 mA	Red slow flash	N/A	Memory error
Sensor lead open	2.5 mA	Red slow flash	N/A	Sensor Fault
Excess drift (>10%)	2.5 mA	Red blip/blink	N/A	Neg. drift
Auto Zero set	3.0 mA	N/A	Green Solid	Apply clean air
Apply cal. gas	3.3 mA	Red fast flash	N/A	Apply 50% span gas
Span is set, remove gas	3.6 mA	N/A	Green solid	Remove gas
Calibration successful	3.6 mA	N/A	Green solid	Cal. complete
Low alarm set point	N/A	Red flash	N/A	xx Low Alarm
High alarm set point	N/A	Red flash	N/A	xx High Alarm
Extreme over-range	20 mA	Red solid	Green flash	
Gas present	>4–20 mA	Red blip/blink	N/A	1 to 100% full scale
Failed calibration	3.0/ 3.3 mA	Red flash	Green flash	Fail cal.

Table 4: RTU Status register (40002) Read only (binary)

RTU Status Registers and meaning		
RTUstat_fault	0x0001	Fault(sensor)
RTUstat_low_alarm	0X0002	Low alarm tripped
RTUstat_high_alarm	0X0004	High alarm tripped
RTUstat_low_alarm_latched	0X0008	Low alarm latched
RTUstat_high_alarm_latched	0X0010	High alarm latched
RTUstat_power Up	0X0080	Power up delay
RTUstat_cal_cycle	0x0100	Calibration cycle in progress
RTUstat_zeroing	0x0200	zeroing
RTUstat_apply_span_gas	0X0400	Apply span gas
RTUstat_calibrating	0x0800	Calibrating
RTUstat_remove_gas	0x1000	Remove gas
RTUstat_cal_complete	0x2000	Calibration complete
RTUstat_mem_error	0X4000	Memory error

Note: Register 40001 = PPM output (read only)
Register 40002 = RTU status (read only)
Register 40101 = Reset latched relays (write)

Calibration Button

The Calibration Button provides access to the Millennium's Main Menu, which in turn allows calibration and options to be reviewed and set. Refer to Figure 11, "Controller Functionality" , for more information.

- **Press and hold** the Calibration Button to calibrate and access Main Menu.
- **Briefly press** to make a selection (select **YES?**).

Warning Opening the Controller's Housing should be avoided if gases may be present (hazardous environment). Do not power up the system with the housing cover removed unless the area has been de-classified.

Magnetic Reed Switch

The Magnetic Reed Switch is provided to avoid opening the housing in an environment where gas may be present. The Magnetic Reed Switch functions in the same manner as the Calibration Button but in a non-intrusive manner. Refer to Figure 11, "Controller Functionality", for more information.

When using the magnet:

Place and hold the magnet to the Controller's Housing (10 o'clock position) to calibrate and access Main Menu.

Briefly place the magnet to the Controller's Housing (10 o'clock position) to make a selection (select **YES?**).

Power Up

Turn the power switch on. A 90 second warm-up routine will begin. The display reads **Start Delay Millennium Net Safety**, the Status LED will flash slow red and current output displays 3.0 mA.

When power is applied, the system is automatically tested to ensure proper functionality.

After warm-up, the controller will enter normal operation, the display reads **00 PPM**, Status LED will blip/blink Green and the analog output will change to 4.0 mA.

Current Loop Measurement (Test Jacks)

Use a standard meter to measure current loop during various states. The Controller's Housing cover must be removed to access the Test Jacks.

Refer to Table 3: "Status LEDs, Display Messages and Current Loop," for a detailed list and Figure 11, "Controller Functionality", for more information.

Status LED

The Status LED will remain solid, flash, blip and/or blink either Red or Green, to indicate various states. Refer to Table 3, "Status LEDs, Display Message".

The Main Menu

The Main Menu provides access to various functional settings and viewing of current settings.

- Calibrate Sensor.
- Review Relay Settings (optional) - Review the current Fault, Low and High alarm settings. This is a read only option.
- Set Relay Options (optional) - Set the Low and High alarm settings.
- Select Modbus Options (option only available if Modbus board is used i.e. digital model)
- Set-up extreme over-range –Enable /Disable Fault relay and/or Latch display during a sensor over-range condition.
- Restricted Menu-Select low power options.
- Select a display language - English, Spanish or French.

Note: The current output will drop to 3.0 mA while accessing the Main menu.

Accessing the Main Menu

There are two ways to access the Main Menu:

- Calibration Button found on the faceplate (the housing cover must be removed to access)
- Magnetic Reed Switch (a magnet must be used to activate)

Main Menu Functionality

1. Ensure that the controller has been turned on and no fault is present.
2. Hold the magnet against the Reed Switch or press and hold the Calibration Button until the message **Switch On** displays and the countdown (10 to 0) finishes.
3. An option will scroll across the display followed by the prompt **YES?**
4. To select an option, momentarily place the magnet to the Reed Switch or press the Calibration Button at the **YES?** prompt.
5. If you do not wish to select that option wait until the next option appears and then select **YES?**.
6. A selection is acknowledged with a flashing **YES**.
7. If no option is selected, the controller returns to **00 PPM** (normal operation).

SECTION 5: Calibrate

Calibration Procedure

Warning The calibration procedure requires about 5 minutes to complete. If gas is not applied at the appropriate time, a calibration failure may occur. Refer to "Calibration Failure" for specific information.

Once the controller and sensor have been wired and powered up, **the sensor requires a warm-up period of 24 hours BEFORE first calibration.** Repeat the calibration if necessary, to ensure desired results. See Figure 12.

The controller and sensor must be calibrated using 50% span of full scale with a flow rate of 0.5 litres per minute, with the gas of concern (target gas).Confirm the gas concentration required by referencing the calibrating gas label on the sensor housing. The concentration of gas corresponding to 100% of full scale is converted to a linear 4–20 mA output signal which can be powered from the primary dc supply of the instrument or an isolated supply.

Biased Sensor - Ammonia

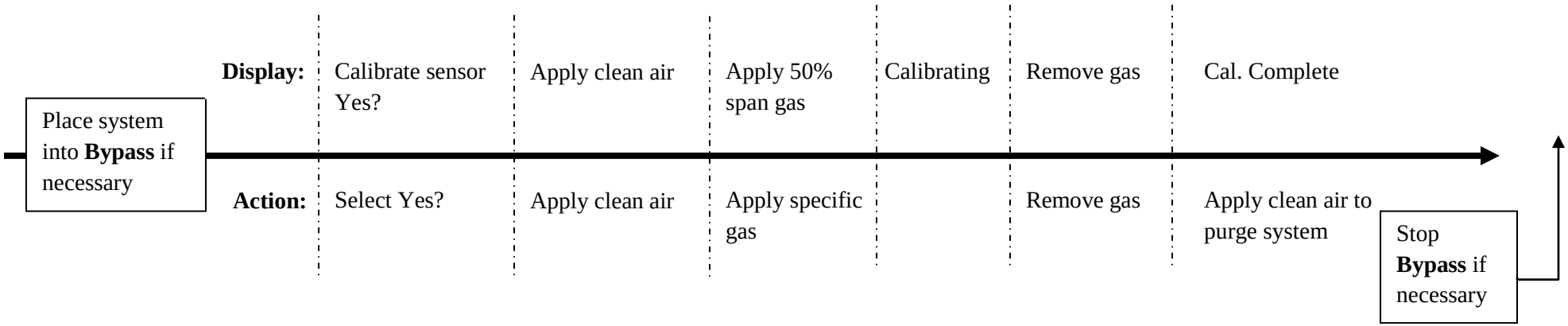
Biased sensors, such as Ammonia have set up, monitoring or calibration requirements which are unique due to the nature of the specific gas. **Sensors will require a 24 hours warm up period**. Refer to the following instructions when installing biased sensors.

- Place unit into system bypass during the 24 hour warm up period and initial calibration to avoid alarm activation.
- Sensors must be powered up with controller for a minimum of 24 hours before initial site calibration.
- **Once powered up, the display will show PPM full range and the corresponding current output will be 20mA**. The range and current output will begin to drop within the 24 hours of being powered up. After which the base line signal will be stable.
- Prior to calibration, ensure ambient air surrounding the sensor is clean and free of interfering gases. If in doubt, use a portable detector.
- Humidity levels in the surrounding air during the sensor calibration should be similar to those expected during normal operation.
- **Do not use bottled dry air as the zero reference when calibrating Ammonia sensors – use ambient air.**
- Begin calibrating when clean ambient air is confirmed at the sensor. The system will use the ambient air reading as the zero setting. After which the specific calibration gas can be applied at a flow rate of 0.5 litres per minute. See “Calibration Procedure”.
- Recalibrate three weeks after initial calibration, and then begin regular maintenance cycle.

Note: Chlorine sensors will also exhibit similar characteristics to biased sensors mentioned above. **A warm up period of 24 hours** should also be allowed for **Chlorine sensors**. **Use clean surrounding air when zeroing. Do not use bottled dry air for zeroing**.

Warning To compensate for frictional loss and dilution over the distance when remotely calibrating (sensor wired for separation), decrease the tubing diameter or increase the calibration gas flow rate. Always confirm calibration by applying gas directly at the sensor.

Figure 12: Calibration Procedure



Steps in Calibration Procedure

Refer to "Remote Calibration", if remote calibration is to be performed.

1. Confirm successful power up of controller—LED Blip/blink green every 2 seconds; no fault indicated. Allow sensor to warm up for 24 hours.
2. Flow certified Clean AIR at a rate of 0.5 litres per minute through the calibration cup for 1 minute to ensure clean air environment. **Use clean ambient air for biased sensors: Ammonia sensors. This also applies to Chlorine sensors.**
3. Press and hold the Calibration Button or use the Reed Switch to access the Main Menu and wait for countdown (10-0) to complete.
4. When **Calibrate Sensor YES?** displays, use the Calibration Button or Reed Switch to select **YES?** Selection will be confirmed by a flashing **YES**.
5. When **Apply Clean Air** displays, apply clean air. **Use clean ambient air for biased sensors: Ammonia sensors. This also applies to Chlorine sensors.**
6. Wait for Apply 50% Span Gas to display and apply specific gas at a rate of 0.5 litre per minute.
7. The display will show **Calibrating**, as the internal settings are being adjusted.
8. Remove span gas when the message **Remove Gas** displays. Status LED is solid green and current output 3.6 mA.
9. The message **Cal. Complete** will display when calibration is completed.
10. Apply clean air again to purge system. **Use clean ambient air for biased sensors: Ammonia sensors. This also applies to Chlorine sensors.**

Note: Always apply test gas after calibration to verify operation.

Remote Calibration

The preferred tubing has an inside diameter of 3/16 inches; stainless steel tubing is excellent, plastic tubing is good. Within 10 ft/35 m, a flow rate of 0.5 litres per minute can be used but 1.0 litre per minute is recommended. Always use 1.0 litre per minute for distances (calibration tube lengths) between 10 ft to 100 ft. Contact Net Safety if a remote calibration distance is greater than 100 ft/30 m is required.

Abort Calibration

The Calibration procedure can be aborted. When the display shows **Apply 50% Span Gas**, press and hold the Reed Switch or Calibration Button until the countdown '**10-0 Abort Calibration**' completes. After which the display shows **Cal. Complete** then returns to **00 PPM**.

Calibration Failure

If the calibration procedure fails, the display shows **Fail Cal**, the Status LED alternates Red/Green flashes and the analog output changes back and forth from 3.0–3.3 mA.

The unit remains in a failed state until a Manual Reset. After the Manual Reset, the unit will return to normal operation based on previous calibration values. See "Manual Reset" for instructions.

SECTION 6: Monitor

Review Relay Settings

This is a **read-only mode**; changes cannot be made.

1. Press and hold the Calibration Button or hold the magnet to the Reed Switch to enter the Main Menu; wait for the countdown, from 10 to 0, to end.
2. When **Review Relay Settings** displays press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
3. The Fault Alarm is **fixed** (**Energized**/**Non-Latching**) and displays first, then the Low Alarm level, coil and latch status display, followed by the High Alarm level, coil and latch status.
4. At this point, the option to **Set Relay Options YES?** is displayed.

Table 5: Default Relay settings

Millennium model: MLP-A/AR/AD-ST1xxx-xxx or MLP- LP-A/ARS/AD-ST1xxx-xxx	Low & High Relay Coil Status(default indicated by *)				Fault Relay coil status fixed as non-latching & energized (default indicated by ϴ)	
ST1xxx-xxx sensor series	Latching	Non-Latching (Default)	Energized	De-energized (Default)	Non-Latching (Default)	Energized (Default)
ST1200-100 100 ppm range		*		*	ϴ	ϴ
ST1200-50 50ppm range		*		*	ϴ	ϴ
ST1200-20 20ppm range		*		*	ϴ	ϴ
ST1300-20 20ppm range		*		*	ϴ	ϴ
ST1500-10 10 ppm range		*		*	ϴ	ϴ

Table 5: Default Relay settings (cont'd)

ST1600-500 500 PPM RANGE		*		*	Θ	Θ
ST1700-100 100 PPM Range	**25 ppm**	**50 ppm**		*	Θ	Θ
ST1250-10 10 PPM Range	**2 ppm**	**5 ppm**		*	Θ	Θ

Set Relay Option

Use to set the alarm level, coil status and latch status for the Low and High Alarm relays. The **Fault Alarm Relay is fixed by default**. The above table describes the default settings for the relays.

Note: The High and Low relay configurations are set up independent of each other.

Steps in setting relay options

There are two settings for Relay Options: Low and High. The Fault Relay is fixed as Energized/Non-latching and cannot be changed. The low alarm level, coil energization and latch status are set first; high alarm level, coil energization and latch status are then set. All ranges are in PPM. Low and High alarm levels will be displayed if reached.

1. When **Set Relay Options YES?** displays press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. The message **Set Low** displays. For controller with ST1200-100 sensor, the Low Alarm set-point starts at 5 ppm and then increments by 5ppm and goes up to 95 ppm.
2. When the required level displays, press the Calibration Button or use the Reed Switch to select. The level selected will flash to confirm the selection.
3. The message **Coil Status** displays. The display then shows **Energized YES?** and then **De-Energized YES?**.
4. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. If no selection is made, Coil Status option is repeated.
5. The message **Latch Status** displays. The display then shows **Latching YES?** and then **Non-Latching YES?**.
6. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. If no selection is made, Latch Status option is repeated.
7. The message **Set High** displays. The High Alarm level cannot be set to a value lower than the Low Alarm level or higher than the maximum of 100% of the maximum range. The High Alarm level starts at 10 ppm for controller with ST1200-100 sensor and increments by 5ppm and goes up to 100 ppm.
8. Repeat Steps 3 through 6 to complete the High Alarm level, coil and latch status settings.

Note: If no selection is made, a 5 minute timer expires, in which case the unit returns to normal operation.

Modbus Options

Digital RS-485 Modbus RTU protocol is used. There are two Modbus options: Node Address and Baud Rate.

Node Address

Each device connected to the chain must be assigned a unique node address (1 to 255). The last number in the address is selected first.

1. When **Modbus Setup? YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.

2. The current node address will display **Node: 000**.
3. Wait for the prompt **New Address? YES?** and press the Calibration Button or use the Reed Switch to select.
4. Use the Calibration Button or Reed Switch to select each of three numbers in the new address:
   - select the last number in the address first: **0** thru **9**.
   - select the next number in the address: **0** thru **9**.
   - select the first number in the address last, i.e. **0 1 2**.

Baud Rate

The transmission speed must be defined.

1. When **Modbus Setup? YES?** displays, press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.
2. After setting the Node Address, the current Baud Rate will display **XX.X BPS**.
3. Wait for the prompt **New Baud Rate? YES?** and press the Calibration Button or use the Reed Switch to select.
4. The available baud rates will display: **2400s**, **4800s**, **9600s**, **14.4s**, **19.2s**, **28.8s**, **38.4s**, **57.6s.**
5. Use the Calibration Button or use the Reed Switch to select the required baud rate when it displays.
6. The flashing **YES** confirms the selection.

Set-Up response to extreme Over-range Gas Signal

Exposure to an extremely high over-range level of gas

If the electrochemical sensor is exposed to the target gas, at a level greater than full scale, there may be damage to the sensing element and it should be replaced or carefully evaluated to determine if it is operating normally. In its default configuration, the Millennium controller responds by communicating a fault via the display and activating the Fault relay while maintaining a High alarm status.

The Millennium controller is user configurable to enable or disable the Fault Relay and latching of the associated output responses.

- Setting **Enable Fault Relay** will cause the extreme over-range condition to trigger the fault relay; setting **Disable Fault Relay** will prevent the Fault Relay from tripping in this situation
- Setting **latch all outputs** will cause the display and Fault Relay to latch and require a manual reset using the CAL/Reset button after the alarm condition has returned to normal.

Note: Factory default settings are Enable Fault Relay/Latch all outputs.

To configure the controller

1. Press and hold the calibration button or use the magnet to enter the main menu; wait for the countdown, from 10 to 0, to end. Several menu selections will scroll on the display.
2. When **Set-up extreme over-range? YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms entry to the set-up menu.

3. The message **Enable Fault Relay? YES?** Displays. Press the Calibration Button or use the Reed Switch to enable the Fault Relay or wait for the next message **Disable Fault Relay? YES?** to display. Press the calibration Button or use the Reed Switch to disable the Fault relay response to extreme over-range condition. The flashing **YES** confirms the selection. If no selection is made, the next option is displayed.
4. The message, **Latch all outputs? Yes?** displays. Press the calibration Button or use the Reed Switch to select the latching function or wait for the message, **Non-latching outputs? YES?** to display. Press the Calibration Button or use the Reed Switch to select the non- latching function. The flashing **YES** confirms the selection. If no selection is made, the unit returns to normal operation.

Enter Restricted Menu

The Restricted Menu allows you to select Low Power Options (optional)

1. Press and hold the Calibration Button or hold the magnet to the Reed Switch to enter the Main Menu; wait for the countdown, from 10 to 0, to end.
2. When **Enter restricted menu YES?** displays, press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.
3. When **Are you sure? YES?** displays press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.

Set Low Power Options - Optional

Some Millennium versions (Low power versions) have two optional low power features to reduce overall power consumption. Use this option to:

- Dim the LED display. The display will still be visible in most lighting conditions. (Dimmed display - default setting)
- Disable the 4 to 20 mA analog output for applications requiring only relay output (4 to 20 mA disabled - default setting)
  1. Enter restricted Menu (refer to “Enter restricted Menu”)
  2. When **Set Low Power Options YES?** displays press the Calibration Button or use the Reed Switch to select.
     The flashing **YES** confirms the selection.
  3. When **Lower Display Brightness YES?** displays press the Calibration Button or use the Reed Switch to select or wait until **Display Full Brightness YES?** displays and select. The flashing **YES** confirms the selection.
  4. When **Disable 4 - 20mA O/P YES?** displays press the Calibration Button or use the Reed Switch to select or wait until **Enable 4 - 20mA O/P YES?** displays and select. The flashing **YES** confirms the selection.

Select Display Language

Display language selection appears after the Restricted Menu.

1. After the Restricted Menu the option **Select Display Language YES?** displays. Press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.
2. When the required language displays (**English**, **Espanol**, **Francais**) press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.

Note: The factory default language is English.

Alarms

Sensor Fault

Warning The fault detection circuitry does not monitor the operation of external response equipment or the external wiring to these devices. It is important that these devices be checked periodically to ensure they are operational.

Self-testing circuitry continuously checks for problems that could prevent proper response. When power is applied, the microcontroller automatically tests the system to ensure that it is functioning properly. During normal operation, it continuously monitors the signal from the internal sensor source. In addition, a "watchdog" timer is maintained to ensure the program is running correctly. When a system fault is detected, the Status LED flashes Slow Red, the display shows **Sensor Fault** and the analog output changes to 2.5 mA.

Sensor Drift

It is a normal characteristic of gas sensors to exhibit a slow drift from zero. When the amount of drift exceeds 10%, since the last calibration, the analog output switches to 2.5 mA, the Status LED Blips/blinks Red and the display shows **Neg Drift**. This message will remain until a Manual Reset and the system is re-calibrated. Refer to “Manual Reset”. When the analog output switches to 2.5 mA due to drift, the sensor will still respond and transmit reasonable analog output signals if gas is present.

Gas Present

When gas is present **1 to 100% Full Scale** will display, the analog output switches between 4 and 20 mA and the Status LED blips/blinks Red.

Sensor Life

Depending on various factors, sensor response may slowly deteriorate over a period of years. If calibration becomes impossible for any reason, the display will show **Fail Cal**, the analog output will switch repeatedly between 3.0 mA and 3.3 mA and the Status LED alternates Red and Green flashes.

Reset

Manual Reset

A Manual Reset is required after a calibration failure or to clear a latched relay alarm. Simply place and hold the magnet against the Reed Switch or press and hold the Calibration Button for 3-5 seconds. The unit will return to normal operation using previous calibration values.

Remote Reset

If the Relay Option is set to **Latching** (refer to “Steps in Setting Relay Options”) and an open Push Button Switch is connected between the RST terminal and the COM terminal on the Terminal Board, Remote Reset is possible. Also refer to Figure 9: Remote Reset.

Outputs

Relays (Optional)

Note: The Fault relay output is not used to activate an automatic shutdown procedure. The fault output indicates a potential problem with the controller.

Standard Electro-mechanical relay outputs have Form C SPDT contacts rated 5 Amps at 30 VDC/250 VAC. Three relay outputs are available; one for Fault, one for Low Alarm and one for High Alarm. All relays have Normally Open (NO) and Normally Closed (NC) contacts available at the output terminals.

The Fault relay is set for normally energized operation and is non-latching. If a system fault is detected, the Fault relay becomes de-energized. The Fault relay is factory set and cannot be altered. The Low alarm and High alarm relays can be selected for either normally energized or normally de-energized operation and latching or non-latching.

An optional low power Solid State relay board comes with Form A contacts rated 2.5 Amps at 60 VAC/DC and selectable energized/de-energized, latching/ non-latching configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified.

Modbus

Digital RS-485 Modbus RTU protocol is used.

Register 40001 = PPM output (read only)
Register 40002 = Status (read only)
Register 40101 = Reset latched alarms (write)

Note: Many registers are used by the controller. Please do not write outside the registers.

Current

A 4–20 mA dc current output is used to transmit the alarm status and fault codes to other devices. This output can be wired for isolated or non-isolated operation. A 4.0 mA output indicates normal operation; $> 4.0 \leq 20.0$ mA output indicates the presence of gas. Current output of 2.5 mA indicates the presence of a system fault.

SECTION 7: Maintain

Periodic Response Check

We recommend the Millennium be verified or calibrated every 3 months. A typical response check involves the application of calibration gas to the sensor, then the observation of the response LEDs, Analog output, display and external monitoring equipment. Be sure to prevent unwanted response of external monitoring devices and equipment during this procedure. If the Millennium response to calibration gas is within its specified accuracy then it is not necessary to perform a calibration. For example, when 50% of full scale is applied, the response is expected to be between 11.5 mA (47% of full scale) and 12.5 mA (53% of full scale). An additional consideration is the accuracy and tolerance of the calibration gas which may be + or - a few percent. If the calibration gas is + or - 10% of full scale then the reading may be from 10.7 mA (42% of full scale) to 13.3 mA (58% of full scale).

Troubleshoot

Response to the input should be checked and, if necessary, calibration should be performed whenever any of the following occur. Refer to "Calibration Procedure", for calibration instructions.

- Excess negative drift is indicated by 2.5 mA current output.
- Sensor or transmitter is connected or disconnected.
- Long term or high concentration exposure to gas.

See “Table 6: Troubleshooting guide” for assistance in troubleshooting. Also refer to “How to Return Equipment”, if returning equipment.

Repairs to Net Safety products should not be performed in the field. Repairs to faulty or damaged equipment should only be performed at the factory; otherwise warranty on the product will be voided.

Table 6: Troubleshooting guide

Condition	Possible Cause	Possible Solution
Intermittent power	• Faulty power supply or /wiring. • Voltage is below operational voltage. • Failed electronic component(s).	• Correct power supply or / wiring. • Correct input voltage to unit. • Contact factory.
Unit not powering up	• Faulty wiring/power supply. • Voltage is below operational voltage. • Blown inline fuse. • Water invasion of electronics. • Failed electronic component(s).	• Correct wiring and power supply. • Correct input voltage to unit. • Replace inline fuse. • Contact factory. • Contact factory.
Unit powers up without display	• Loose electronic boards. • Water invasion of electronics. • Failed electronic component(s).	• Tightly fit electronic boards. • Contact factory. • Contact factory.
Sensor fault displays	• Faulty power supply. • Faulty sensor. • Faulty sensor wiring. • Faulty junction box wiring. • Water invasion of electronics/ junction box. • Failed electronic component(s).	• Replace or correct power supply. • Replace sensor. • Correct sensor wiring at controller. • Correct junction box wiring. • Contact factory. • Contact factory.
Unstable 4–20 mA signal	• Unshielded cables used for wiring. • Water invasion of electronics. • Failed electronic component(s)	• Use shielded cables for wiring. • Contact factory. • Contact factory.
No 4–20 mA Output Signal	• Current loop wiring is open. • Missing or incorrect placement of current output jumper. • Current output is disabled by default for Low powered Millennium units. • Failed electronic component(s)	• Close 4–20 mA signal loop. • Place current output jumper in correct position. See ‘Current Output’. • Enable 4–20 mA signal under ‘restricted menu’ option. • Contact factory.
Undesirable change in relay state	• Incorrect relay settings in menu. • Voltage applied to relay contacts outside relay ratings.	• Correct relay settings in menu. • Correct voltage applied to relay dry contacts. See Appendix for specification.

	• Failed electronic component(s).	• Contact factory.
Chattering relays (Mechanical relay units)	• Voltage is below operational voltage. • Loose electronic boards or/ loose wiring. • Failed electronic component(s).	• Correct input voltage to unit. • Tightly fit electronic boards or/ fit wires. • Contact factory.

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**

Waybills, for shipments from outside Canada, must state:

Equipment being returned for repair

All charges to be billed to the sender

Also, please 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.

All Equipment must be Shipped prepaid. Collect shipments will not be accepted. Pack items to protect them from damage and use anti-static bags or aluminium-backed cardboard as protection from electrostatic discharge.

Spare Parts/Accessories

Table 7: Part numbering

Net Safety Part Number	Description
ST1200-10-C3M	H_2S sensor (0–10ppm range)
ST1200-20-C3M	H_2S sensor (0–20ppm range)
ST1200-50-C3M	H_2S Sensor (0–50ppm range)
ST1200-100-C3M	H_2S Sensor (0–100ppm range)

ST1250-10	HF(Hydrogen Fluoride) (0–10ppm range)
ST1300-20	SO_2 (Sulfur Dioxide) Sensor (0–20ppm range)
ST1300-100	SO_2 (Sulfur Dioxide) Sensor (0–100ppm range)

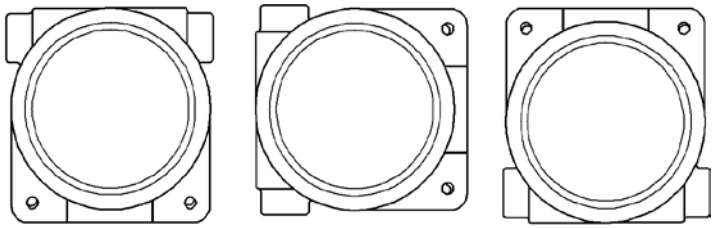
Table 7: Part numbering (cont'd)

ST1500-10	Cl_2 (Chlorine)Sensor (0–10ppm range)
ST1600-500	CO(Carbon Monoxide) Sensor (0–500ppm range)
ST1700-100	NH_3 (Ammonia) Sensor (0–100ppm range)
PCBA-0252B	Terminal Connector Board
JB-MPNS-A/S	Aluminum or Stainless Steel Junction Box with no switch
FRO-001	90 Degrees Rotation Plate
THSG-FULL	Sensor housing toxic ST1XXX
THSG-FULL-SS	Sensor Housing toxic ST1XXX
ML7-TX500	Transmitter for Toxic MLP-LP series c/w Display, Terminal and Input Boards
ML7-TX100	Transmitter for Toxic MLP series c/w Display, terminal and Input Boards
ML7RS303	Solid State relay Board for MLP series
ML7RS305	Mechanical Relay Board for MLP series
ML7OP100	Option Board c/w connectors for use with ML7-303 or ML7 305 Relay Boards
ML7-ORL305	Electromechanical Relay Board (ML7-305) c/w Option board (ML7-OP100)
ML7-0RS303	Solid State Relay Boards (ML7-RS303) c/w Option Board(ML7-OP100)
ML7-MB100	ML7 MODBUS Output Board for MLP series
Magnet-1	Magnet assembly
CCS-1	Calibration Cup

FACEPLATE ROTATION OPTION

In some applications, it is necessary for the Millennium Controller to be mounted in a non-standard orientation. To accommodate such installations and ensure that the display will appear at the correct angle for viewing, the PCB Assembly can be rotated inside the Controller's housing.

Figure 13: Non-standard Orientation



Note: Ensure orientation allows for connections and excess wire within controller.

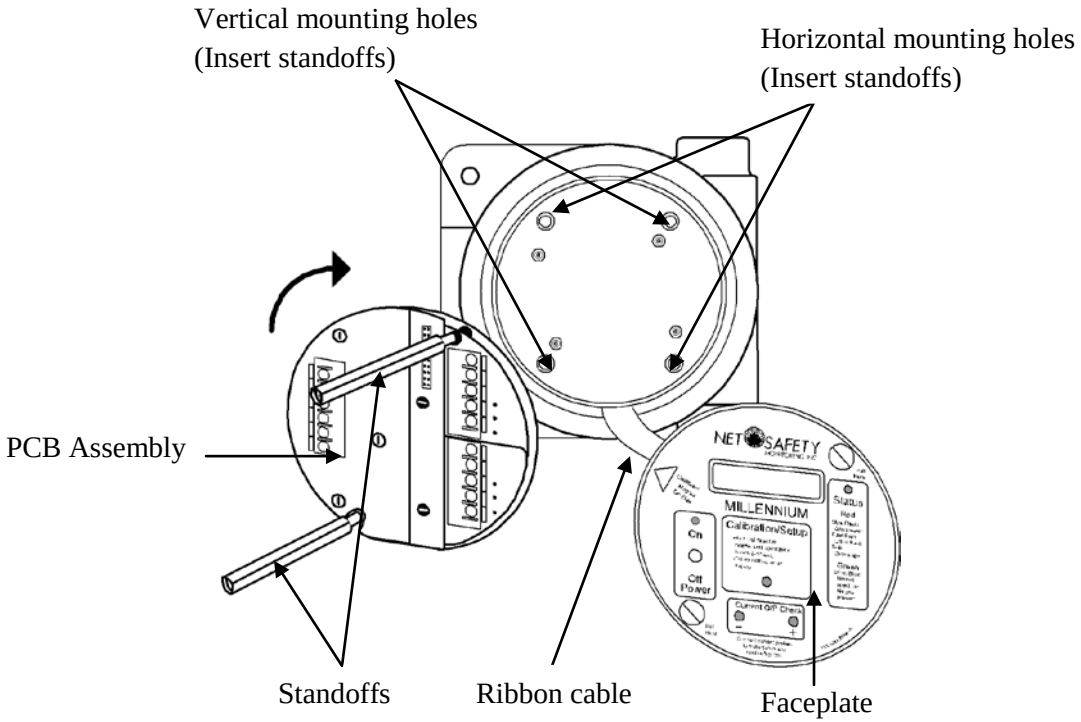
Rotate PCB Assembly

Warning Ensure area s declassified.

1. Remove the Controller's Housing Cover.
2. Turn the power to the detector off.
3. Unscrew both the knobs marked "Pull Here".
4. Lift Controller faceplate from Housing and allow to hang from ribbon cable.
5. Unscrew the two metal standoffs.
6. Carefully remove the PCB Assembly from the Housing.
7. The Rotator plate is secured to the bottom of the Housing and is accessible after the PCB Assembly has been removed.
8. Rotate the PCB Assembly to desired position and line up the standoffs with the mounting holes.
9. Insert standoffs in the appropriate horizontal or vertical mounting holes.
10. Tighten standoffs to secure PCB Assembly.
11. Replace faceplate and tighten "Pull Here" knobs.
12. Return power to detector and replace Housing Cover.

See Figure 14: PCB Assembly Rotated.

Figure 14: PCB Assembly Rotated



Appendix A: Electrostatic Sensitive Device (ESD)

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, or ESD shoes or heel grounders to dissipate unwanted static energy
- Prior to handling boards, dispel any charge in your body or equipment
- Ensure 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

Appendix B: Resistance Table (cont'd)

Distance (Feet)	AWG #20	AWG #18	AWG #16	AWG #14	AWG #12	AWG #10	AWG #8
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

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

Appendix C: Sensor Specifications

SENSOR ELEMENT	Hydrogen Sulfide H_2S (ST1200)	Sulfur Dioxide SO_2 (ST1300)	Carbon Monoxide CO (ST1600)	Hydrogen Fluoride HF (ST1250)	Chlorine Cl_2 (ST1500)	Ammonia NH_3 (ST1700)	Oxygen O_2 (ST1400)
Operating Temperature Range	-40°C to +50°C (-40°F to +122°F)	-20°C to +50°C (-4°F to +122°F)	-20°C to +50°C (-4°F to +122°F)	-20°C to +35°C (-4°F to +95°F)	-20°C to +50°C (-4°F to +122°F)	-10°C to +50°C (+14°F to +122°F)	-20°C to +50°C (-4°F to +122°F)
Range of Detection	0–10 ppm 0–20 ppm 0–50 ppm 0–100 ppm	0–10 ppm 0–20 ppm 0–100 ppm	0–200 ppm 0–500 ppm 0–1000 ppm	0–10 ppm	0–10 ppm	0–100 ppm	0–25% Vol.
Response Time	<30 secs to T90	<15 secs to T90	<30 secs to T90	<90 secs to T90	<60 secs to T80	<90 secs to T90	<15 secs to T95
Span Drift	<2% of full scale/ month	<2% of full scale/ month	<5% of full scale/ year	<5% of full scale	<2% of full scale/ month	<2% of full scale/ month	<5% of signal loss/ year
Accuracy/ Repeatability	3% of full scale/ 1% of full scale	3% of full scale/ 2% of full scale	3% of full scale/ 1% of full scale	3% of full scale/ 1% of full scale	±2 ppm or ±15% of reading, whichever is greater/ 2% of full scale	2%/10% of signal	
Enclosure Material	Anodized power coated aluminum (optional stainless steel)						
Certifications	CSA and NRTL/C certified for hazardous locations Class I, Division 1, Groups C and D IEC Rating Ex d IIB T6			Field Certified Class I, Division 2, Groups C and D			

Weight	0.5 kg (1.0 lbs)

Note: Sensor temperatures below the lower temperature rating or less may have slower response times and readings may show higher than expected.

Controller Specifications

Millennium Controller Specifications					
Millennium	**4-20mA Analog Output**	**Low Power board 4–20 mA Analog and Relay Output (Solid State) display dimmed**	**4–20mA with Relay Output module**	**Low Power board 4–20 mA Analog Output (disabled) and Relay Output (Solid State) display dimmed**	**RS-485 MODBUS RTU Digital Communications**
Power Consumption 12VDC	Maximum 1.13 W	Maximum 0.77 W	Maximum 1.74 W	Maximum 0.51 W	Maximum 1.28 W
Power Consumption 12VDC @ 50 span	Maximum 1.38 W	Maximum 1.04 W	Maximum 2.10 W	Maximum 0.78 W	Maximum 1.59 W
Power Consumption 24VDC	Maximum 1.32 W	Maximum 0.96 W	Maximum 2.00 W	Maximum 0.71 W	Maximum 1.44 W
Power Consumption 24V dc @ 50 span	Maximum 1.76 W	Maximum 1.42 W	Maximum 2.21 W	Maximum 1.05 W	Maximum 1.85 W
In-Rush Current @ 24VDC	5.0A @10µs–40µs 0.090A after 2ms	5.28A @10µs–40µs 0.080A after 2ms	5.2A @10µs–40µs 0.110A after 2ms	5.32A @10µs–40µs 0.080A after 2ms	5.1A @10µs–40µs 0.100A after 2ms
Operating voltage	10.5 to 32VDC				
Operating temp range	-40 °C to +85 °C (-40 °F to + 185 °F)				
Humidity Range	0 to 95% Relative humidity, non-condensing				
Enclosure material	Powder coated Copper Free Cast Aluminum or Stainless Steel				
Weight without sensor	Aluminum enclosure 2.4 kg (5.3 lbs), Stainless Steel (SS316) enclosure 2.6 kg (5.5 lbs)				
Certifications	Aluminum enclosure		316 Stainless Steel enclosure		
	C US Class I, Div. 1, Groups BCD; Class 1, Zone 1, AEx/ Ex d IIB+H2,T5,IP67, TYPE 4X, -55°C <Ta< +85°C		C US Class I, Div. 1, Groups BCD; T5,IP67, TYPE 4X, -55°C <Ta< +85°C		
	4 to 20 mA - Into a maximum loop impedance of 800 Ohms @ 32 VDC or 150 Ohms at 10.5 VDC. Isolated or non-isolated loop supply. **Premium version -** Form C contacts rated 5 Amps at 30 VDC/250 VAC. Selectable energized/de-energized, latching/non-latching configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified**.** **Low Power Version -** Form A contacts rated 2.5 Amps at 60 VAC/DC. Selectable energized/de-energized latching/non S latching				

	configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified. Digital RS 485 Modbus RTU Protocol.

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