MILLENNIUM II BASIC
Single Channel Transmitter

User Manual

ISO 9001:2000

QMI REGISTERED

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October 26, 2010

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 its electronic assemblies against defective parts and workmanship for a period of 36 months from date of purchase. Warranties on sensors may be viewed in each specific sensor manual. No other warranties or liability, expressed or implied, will be honored by Net Safety Monitoring Inc. Contact Net Safety Monitoring Inc. or an authorized representative for details.

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

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INTRODUCTION

To complement the Millennium II Transmitter, the Millennium II Basic single channel gas transmitter, offers a comparable level reliability. Combined with state of the art “Smart” sensors, users will receive a detection system which is both versatile and reliable for fast, accurate and continuous monitoring of gases in extreme environments.

THE PRODUCT

TRANSMITTER/CONTROLLER

A Millennium II gas detection system is composed of a field mounted transmitter\controller and Millennium II series sensors which may be integrally mounted to the controller or remotely mounted as far as 2000 feet away.

The transmitter is certified for use in hazardous locations and is available as a single sensor system. Some operator controls including calibration can be accessed without opening the enclosure (housing) by using other communication devices and the attached magnet to actuate the reed switch. Available outputs are: conventional 0.0 to 20mA analog, Analog/ HART, electromechanical relays or Modbus RTU digital.

THE MANUAL

This manual has been designed to guide the user through each procedure, ensuring that transmitters and sensors are configured, operated and maintained properly. Guidelines and warnings are included to ensure safe and proper functioning of the equipment. **The manual gives the overall operational and functional features of transmitters with sensors and may not have sensor specific information**. **Refer to sensor manuals for information specific to each sensor including detailed calibration instructions**. If you encounter any problems, see the troubleshooting section of this manual or contact factory.

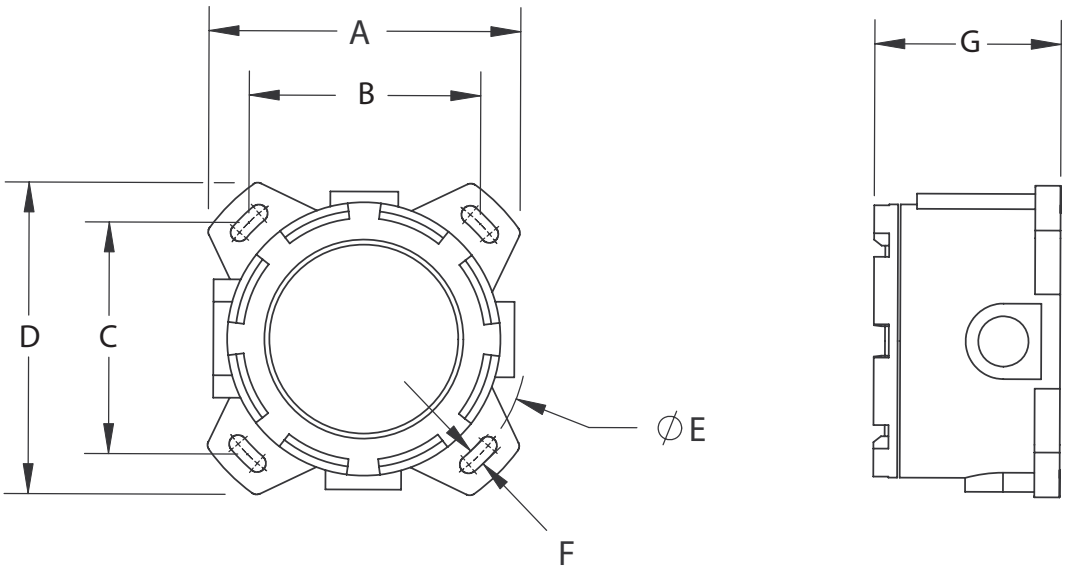
Enclosure Dimensions

The table and diagram below shows the Millennium II Basic Transmitter enclosure (housing), available in Aluminum (AL6061) and Stainless Steel (316SS).

Table 1: Millennium II Basic enclosure in Inches (in) and Millimeters (mm)

Millennium II Basic Transmitter enclosure	A		B		C		D		E		F		G	
	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm	in	mm
Transmitter (AL)	4.8	122	3.6	91	3.6	91	4.8	122	5.1	130	0.3	7.6	3.0	76
Transmitter (SS)	4.7	119	3.6	91	3.6	91	4.7	119	5.1	130	0.3	7.6	3.2	81

Figure 1: Transmitter enclosure Dimensional Drawing



SECTION 1: Installation

1.1 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.

1.2 Mounting

Ensure transmitter and sensor are securely mounted, taking into consideration all requirements. Sensors may be installed directly to transmitters or remotely using a Certified Net Safety junction box. See Figure 7, Figure 8 and Figure 9 when mounting sensor remotely.

SECTION 2: Wiring and installation

2.1 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.

Warning Do not open the transmitter enclosure in a classified area (Do not open when an explosive atmosphere may be present).

Guidelines

- The safety ground connection in the transmitter is a green screw found in the enclosure.
- If the 4 – 20mA signal is not used, connect a jumper between the 4 – 20mA terminal and the Common terminal to allow analog current levels to be monitored at the Test Jacks on the faceplate.
- The use of shielded cable is highly recommended for signal, input, output and power wires. Refer to section '2.1.2 Cable choice and guidelines' to help eliminate interference caused by extraneous electrical or electromagnetic 'noise'. To meet IEC 61000-1, IEC 61000-4 EMI requirements, follow the recommendations listed under Section '2.1.2 Cable choice and guidelines'.
- In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment.
- For effective communication, Net safety limits sensor separation to 2000 feet using 16AWG wires.
- Modbus RS-485 connection 2-wire mode, multipoint serial line available. Up to 16 addresses allowed.
- When developing a RS-485 chain of devices, the last device in the chain requires an end of line termination resistor (120 Ohms).
- Transmitter connector terminals accommodate wire from 14 to 20 AWG.

2.1.1 Seals

Warning The use of conduit wiring seals is recommended to further protect the system against 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. The cementing material used on the Millennium II sensors is suitable for an operating temperature range of (-55°C to +85 °C).

Guidelines

- 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'.
- Threaded connections on the enclosure between the enclosure and conduit pipe need to be sealed with thread tape, such as Teflon tape, or something similar.
- Hydrophobic filters (IPF-001) may be used to protect sensors from water.
- It is the responsibility of the installer to install conduit seals where necessary, and to design conduit runs to ensure that condensation does not accumulate and collect inside the enclosure.

2.1.2 Cable choice and guidelines

Radio Frequency Interference (RFI) can be caused by nearby electrical devices (transformers, high voltage equipment) as well as handheld communications devices/radios, which when activated, may impede the proper functioning of the transmitter and sensor. Selecting the right instrumentation cable and making proper grounding connections within the junction box will reduce or eliminate interference. Visible symptoms of Radio Frequency Interference (RFI) include inconsistent, incorrect and erratic LEL and PPM readings.

Important Wiring Guidelines

Fire and gas detection instruments are an important part of a safety alarm and shutdown system. The system is composed of:

- detection instruments
- customer connected equipment
- wiring

Net Safety designs and manufactures its detection equipment under rigid quality control management systems and makes every effort to design for the harshest of industrial environments. The other components of the system – the customer-connected equipment and wiring – are also important contributors to the overall quality and performance of the safety system.

It is important to implement wiring that ensures the reliability and integrity of the safety system.

Field wiring practices and the choice of cable type specified vary from project to project. Poor practices and choices are often found to be the source of unwanted system disruptions. Radio Frequency Interference (RFI) and Electro-Magnetic Interference (EMI) are usually very powerful disruptive forces in industrial facilities and these forces act upon the system through the wiring.

Follow the wiring specifications and guidelines in this manual carefully. The cable used should be a very high quality instrument grade, certified for the application conditions, consisting of a rugged protective outer jacket, an overall electrical shield of fine braided copper or metallic foil, and internal pairs or triads of foil shielded copper wire of suitable gauge for the power conducted over the specified length.

The shields must be electrically continuous from the instrument junction box through other junction boxes and finally to the connected equipment. The shield must be connected to a suitable ground sink as specified in the instrument manual in order to protect the system from electrical disturbances.

Recommended cable and guidelines

The type of cable and shielding practices are especially important when sensor is separated from transmitter via junction box. NSM recommends using CSA armored instrumentation cable (ACIC 2PR 16AWG, 300V, ISOS, PVC) when rigid (steel) conduit is not used. See Figure 2. This cable should be used between the PLC/PANEL/DCS and the Millennium II Basic Transmitter, as well as between the Millennium II Basic Transmitter and the junction box.

Additional notes:

In general, communication cables and power cables should not run in parallel for any significant length, and should not be carried in the same cable tray. Through inductance, high currents in power cables can induce significant ‘noise’ in communication cables running parallel alongside power cables.

See cable preparation procedure on next page.

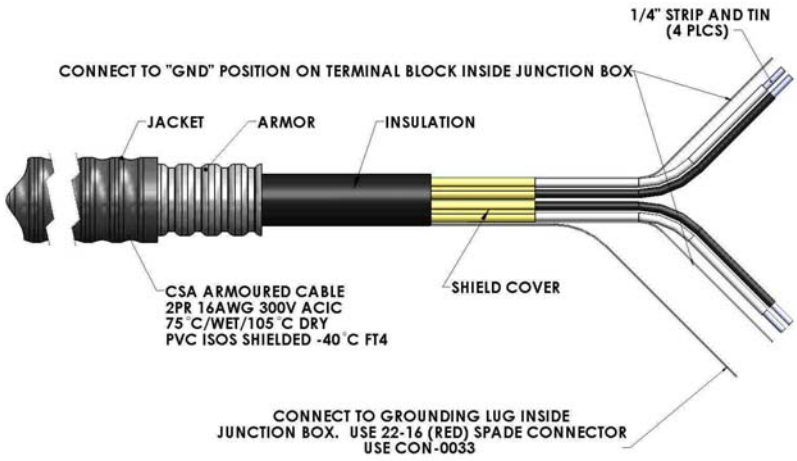
Armored Cable preparation procedure:

1. Prepare the armored instrument cable as illustrated in Figure 2 and follow all assembly and/or preparation instructions provided by the cable and/or cable gland manufacturer.
2. Install cable gland and reducer onto the cable.
3. Ensure four (4) inches of wire length is available for connecting to terminals inside the junction box.

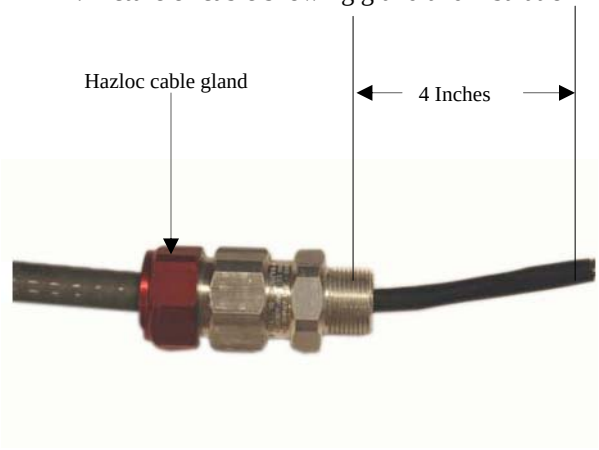
4. Use a small flat head screw driver when connecting wires to connector terminals. See Figure 3.
5. Connect sensor wires to the appropriate terminals. See Figure 2C, Figure 5, Figure 6, Figure 8 and Figure 9.

Figure 2: Cable preparation

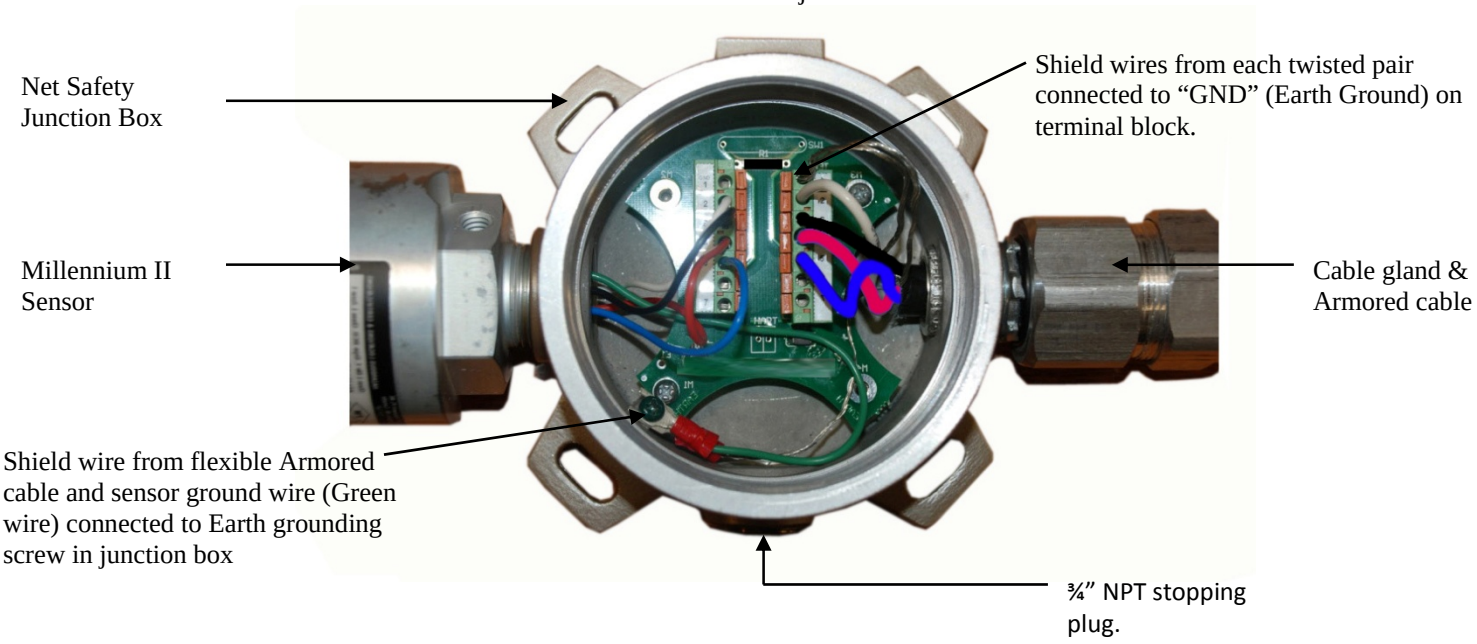
A: Drawing showing of cable without gland



B. Picture of cable showing gland and insulation



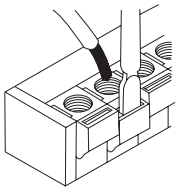
C. Picture of cable wired to junction box and sensor



Warning ⚠ Before wiring, ensure that the power being supplied to the transmitter is switched off.

When connecting cable wires, use a small screwdriver to gently press down and hold the spring connector open. Insert the appropriate wire into the open connector hole, releasing the screwdriver to secure the wire. See Figure 3 below.

Figure 3: Connecting wires



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

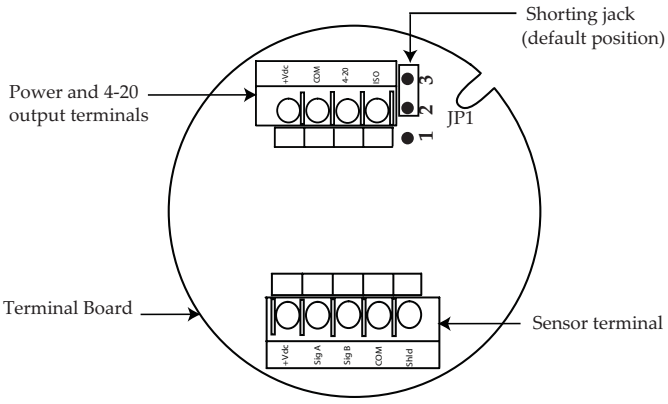
2.1.3 Analog output, isolated supply, non-isolated supply and jumper configuration

The analog output may be powered from the main instrument power supply or a separate, independent power supply in which case an isolated wiring configuration is necessary. These configurations only apply to Analog and Analog/HART model transmitters.

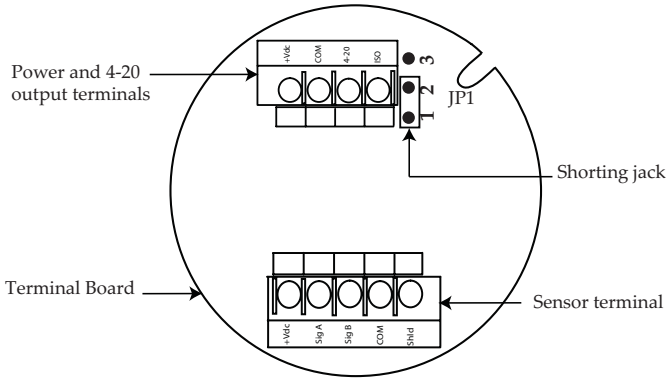
To set a Non-isolated or Isolated current output, simply move the Jumper/shorting jack located at JP1 near the Power and output terminals, to either the Non-isolated or Isolated current position. **For Non-isolated current output, ensure pins 3 & 2 at JP1 location on the terminal board are jumpered (shorted)**. See Figure 4A and Figure 5 for reference. Factory standard models ship with jumper in the Non -isolated current output position (default position). **For Isolated current output, pins 1 & 2 at JP1 should be jumpered (shorted)**. See Figure 4B and Figure 6 for reference.

Figure 4: Non-Isolated and Isolated current jumper

A. Non-isolated current output configuration (**default**).
Pin 3 and Pin 2 jumpered at JP1



B. Isolated current output configuration.
Pin 1 and Pin 2 jumpered at JP1



Warning Always ensure that JP1 jumper is in the correct position depending on the current output configuration chosen.

2.1.4 Wiring drawings

The drawings below are general ways in wiring the system showing analog signal output. Consult qualified personnel on specific wiring requirements.

Figure 5: Non-isolated terminal connection (for Analog & Analog/HART models)

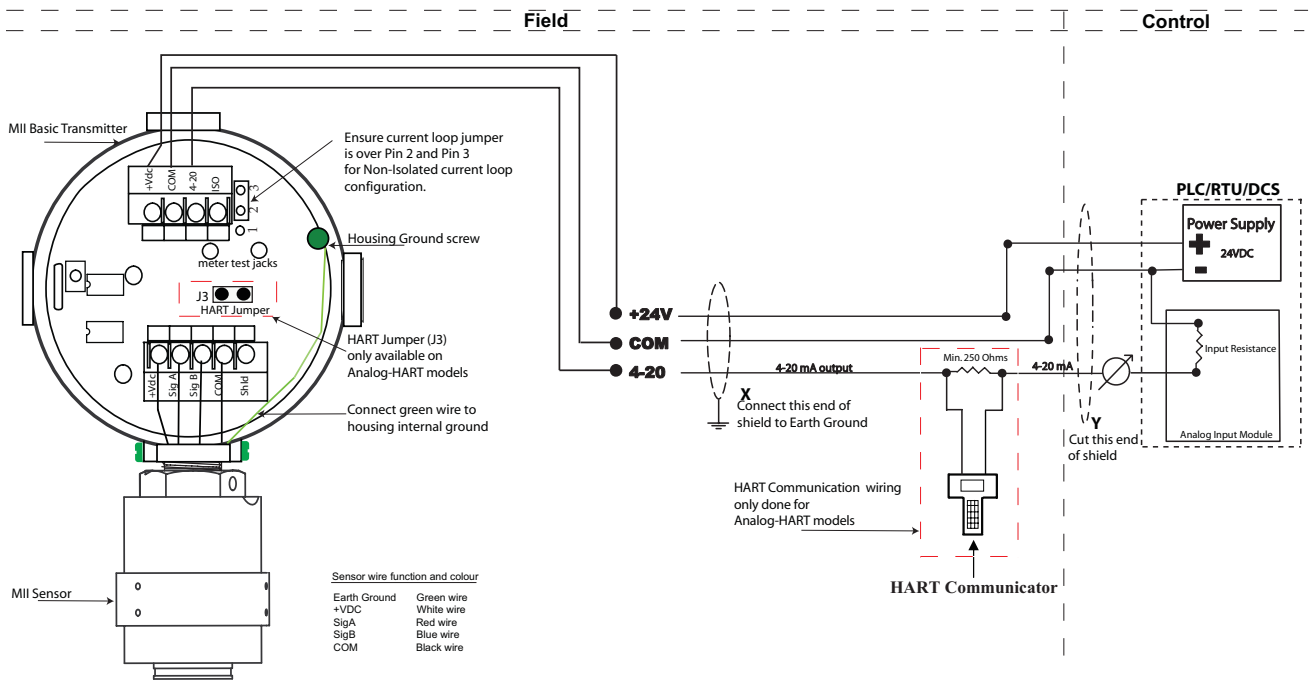
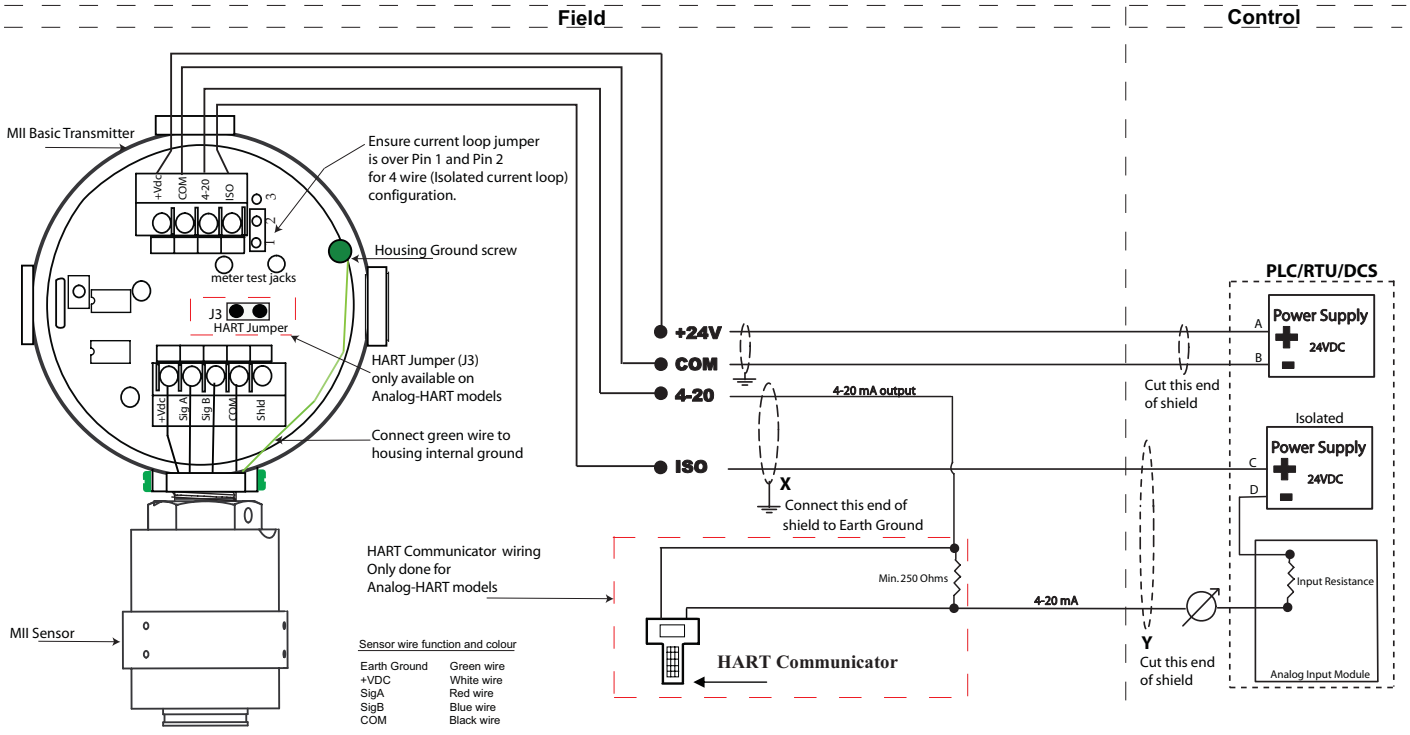


Figure 6: Isolated terminal connection (for Analog & Analog/HART models)



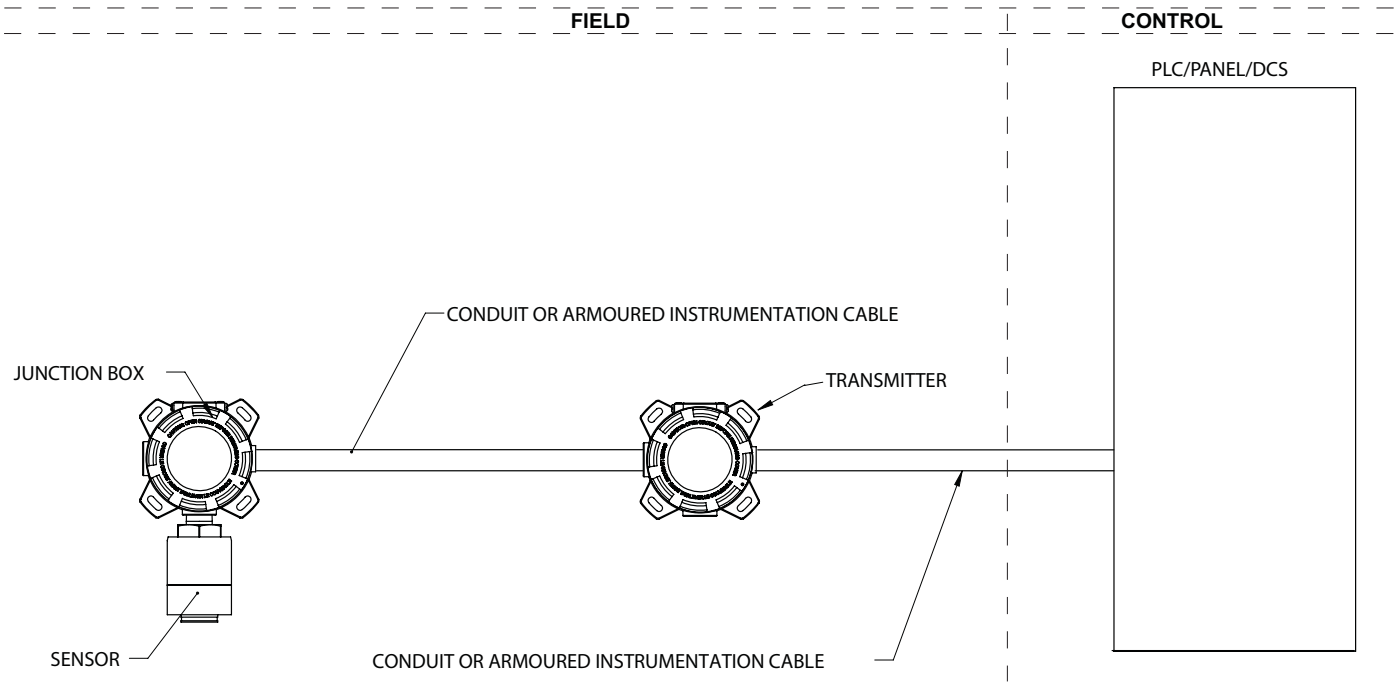
* For Hart Communicator connection in isolated or non-isolated configuration, the Total Loop Resistance must be a minimum of 250 Ohms to a maximum of 600 Ohms. Do not install resistor within Millennium II Basic transmitter.

2.1.5 Remote mounting of sensor

When necessary to mount sensor remotely (separated from transmitter) by way of junction box and conduit, it is important that the installer follow the necessary requirements and guidelines relating to sensor separation and cable selection. See Figure 7 for typical remote mounting of sensor. Also refer to Section '2.1.2 Cable choice and guidelines' for cable selection and wiring guidelines.
When sensors are being mounted remotely, **consult the multi-purpose junction box manual (MAN-0081)** for wiring instructions. Always ensure that the transmitter is supplying 10.5 - 32Vdc across the sensor power terminals of Net Safety junction box (JB-MPD-A/S).

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. For effective communication, Net Safety limits the separation distance between sensor and transmitter to 2000 ft using 16 AWG wire. See Appendix B for information on wire gauge and resistance.

Figure 7: Remote mounting of sensor



2.1.6 Wiring drawings for remote sensor wiring

The drawings below are an analog output drawing showing wiring of sensor to transmitter remotely via a junction box. Consult qualified personnel on specific wiring requirements.

Figure 8: Non-isolated terminal wiring with remote sensor wiring (for Analog & Analog/HART models)

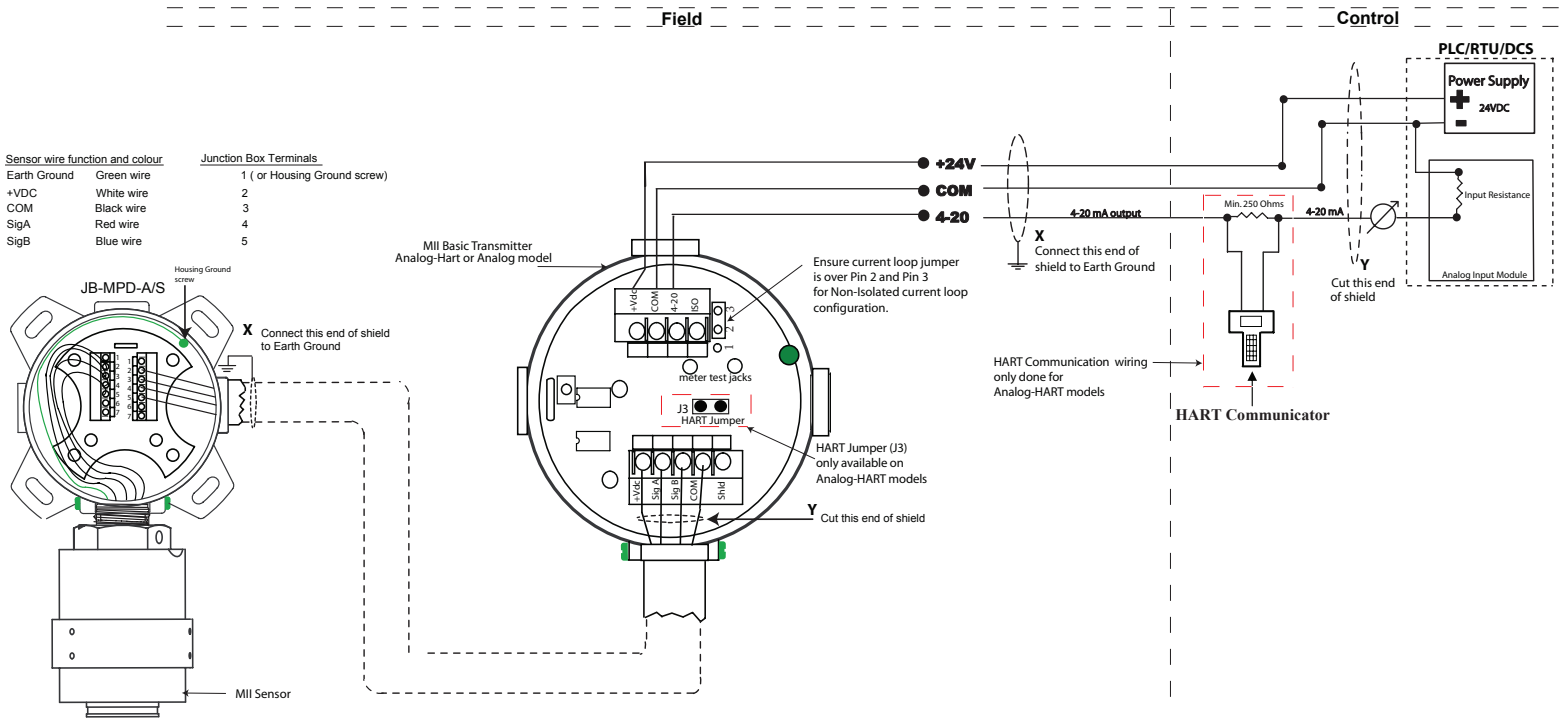
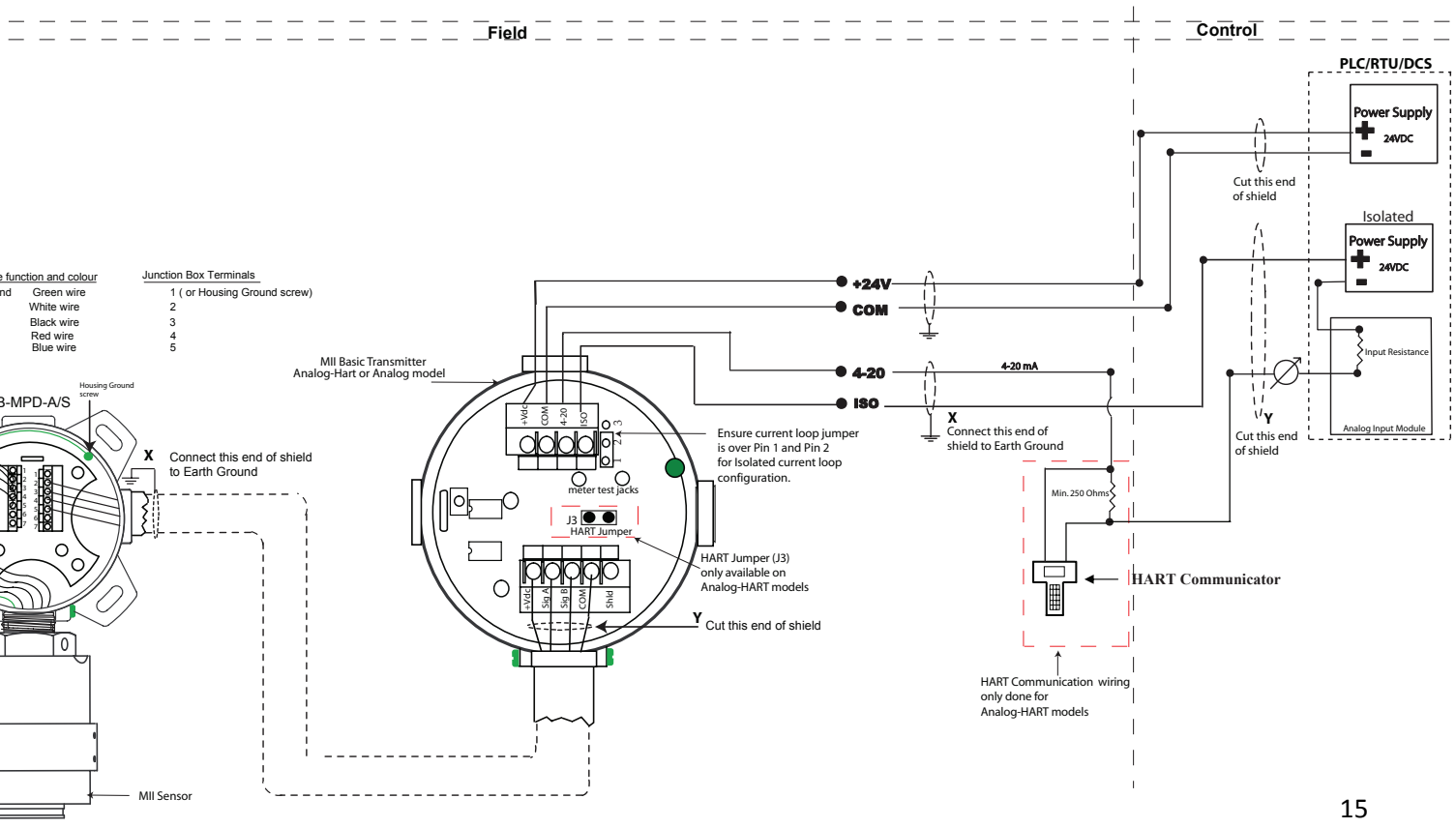


Figure 9: Isolated terminal wiring with remote sensor wiring (for Analog & Analog/HART models)



2.1.7 Installation Checklist

Prior to operation it is important to do the following checks.

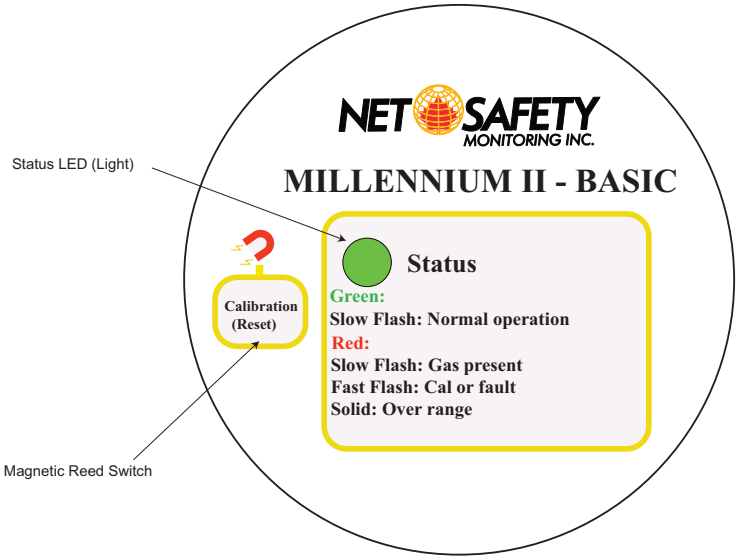
- Ensure transmitter and sensor are properly and firmly mounted.
- Ensure transmitter and sensor are not being obstructed; transmitter and sensor are accessible and target gas is not inhibited from reaching the sensor.
- Remove sensor red protective plastic cap.
- If hydrophobic filters (IPF-001) are being used, check for damage or debris. See the IP 66/67filter Instruction guide (MAN-0109) for instructions.
- If calibration cups (splash guards) are fitted to sensor, ensure a snug fit.
- Ensure adherence to applicable local guidelines and requirements on wiring and sealing of equipment in hazardous and non-hazardous areas.
- Ensure that proper shielding and grounding practices are adhered to, and local codes are being followed.
- Check system operational voltage and conditions. See Table 2, Table 3, Table 4 and Appendix C.
- Check wiring at all termination and junction points; wiring at transmitter terminals, junction box and at power supply. Refer to Figure 5, Figure 6, Figure 8 and Figure 9.

SECTION 3: Transmitter and faceplate description

3.1 Transmitter Power Up

After wiring is completed and power is applied, indicated by the GREEN power LED, a warm-up routine will begin, where the sensor is automatically tested to ensure proper functioning. The Status LED will slowly flash RED and the current output will be 3.0 mA (indicated by Analog models) and then flash green slowly, indicating normal operation. The time taken for the transmitter to complete its warm up cycle is dependent on the type of sensor being used. Refer to “Sensor Power up” section of the specific sensor manual. After the warm up cycle is completed, if the Status LED still slowly flashes RED, the unit should be calibrated. Refer to “Sensor Status Registers, Status LED’s, Current Loop and Meaning” section of this manual. Also refer to specific sensor manual for important calibration details.

Figure 10: Faceplate description



The transmitter faceplate shows the position of the magnetic switch and the status LED. The states of the Status LED indicate are also indicated when the detection system (transmitter with sensor) is in normal operation, when gas is present, calibration and fault status as well as over-range condition. See ‘Section 7.2.3 Sensor Status Registers, Transmitter Status LED, Current output and Meaning,’ for more information on Status LED.

3.1.1 Intrusive access

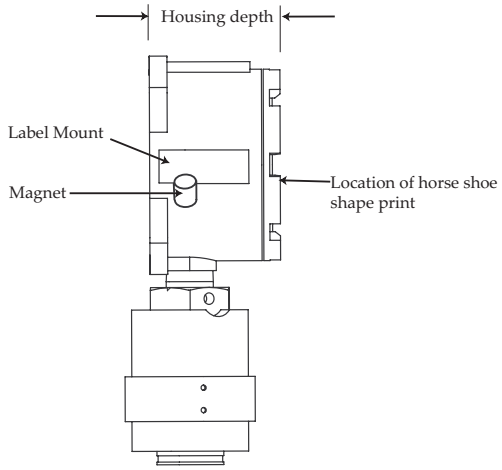
This involves the removal of the top cover and face plate to access the push button switch when calibrating and resetting the transmitter. Pressing and holding the Push button down for up to 3 seconds resets the transmitter; latched alarms are cleared and sensor perform self tests. Holding down the Push button for up to 15 seconds sends the transmitter into full calibration mode. See section on calibration and manual reset for more information.

Warning Do not open the transmitter in a classified area (Do not open when an explosive atmosphere may be present).

3.1.2 Non-intrusive access (magnetic Reed switch Access)

This involves placing and holding the attached magnet next to the base of the label mount as indicated in Figure 11. When the magnet is held for up to 3 seconds, a manual reset will be initiated. If the magnet is held for up to 15 seconds a “Full calibration procedure” will begin. See “manual reset” and “calibration procedure”.

Figure 11: Positioning of magnet



SECTION 4: Output Configurations

The Analog model Millennium II Basic Transmitter provides a 4-20mA signal output, allowing the user/operator with signal representing various conditions and states of the transmitter. See Table 6 for current output and meaning.

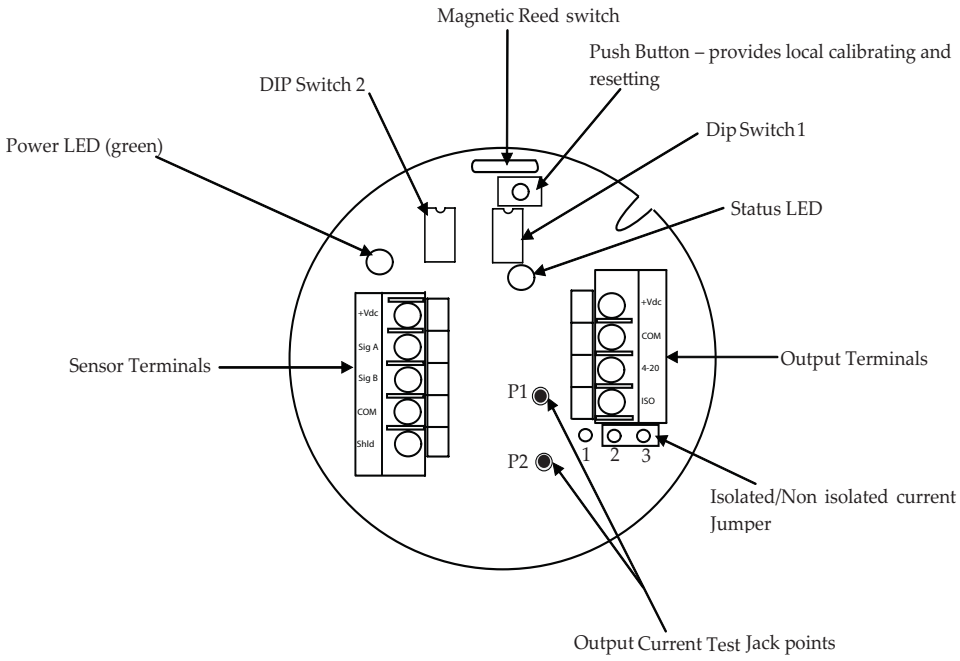
4.1 Analog board assembly

Table 2: Sensor Terminals and Output Terminal Designations

Sensor Terminals	**Sensor Wire**	White	Red	Blue	Black	Green
	Marked	+Vdc	Sig A	Sig B	COM	
	Function	10.5 - 32Vdc	A	B	Comm	Earth Ground

Output Terminals	**Marked**	+Vdc	COM	4 – 20	ISO
	Function	Power (+) (10.5-32)Vdc	Power (-)	Current loop output	Isolate the power for current loop

Figure 12: Analog circuit Board Assembly



4.2 Analog/ HART board assembly

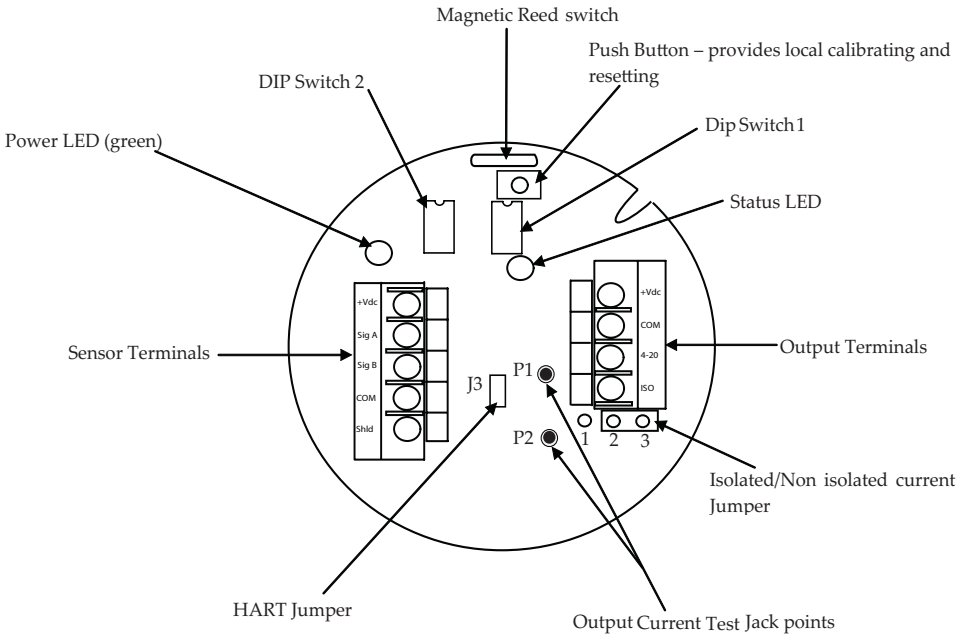
The Analog /HART model Millennium II Basic Transmitter provides the user/operator with the option of using the HART Communicator to gain access to the transmitter settings and output. This allows reviewing, logging and monitoring of data which is ideally suited for maintenance. See Section '7.2.5 HART Communication', for more information.

Table 3: Sensor Terminals and Output Terminal Designations

Sensor Terminals	**Sensor Wire**	White	Red	Blue	Black	Green
	Marked	+Vdc	Sig A	Sig B	COM	
	Function	10.5 - 32Vdc	A	B	Comm	Earth Ground

Output Terminals	**Marked**	+Vdc	COM	4 – 20	ISO
	Function	Power (+) (10.5-32)Vdc	Power (-)	Current loop output	Isolate the power for current loop

Figure 13: Analog/HART circuit Board Assembly



Note: For Hart Communicator connection in isolated or non-isolated configuration, the Total Loop Resistance must be a minimum of 250 Ohms to a maximum of 600 Ohms. Do not install resistor within Millennium II Basic Transmitter.

4.3 Relay board assembly/configuration

This assembly has three relays; the Fault Alarm relay, the Low Alarm relay and the High Alarm relay. **By default, the Fault Alarm relay is fixed as Energized and Non-latching and cannot be changed**. The Low Alarm relay and the High Alarm relay may be configured as Energized or De-energized and latching or Non-latching. **By default the Low and High Alarm relay contacts are De-energized and Non-latching.**

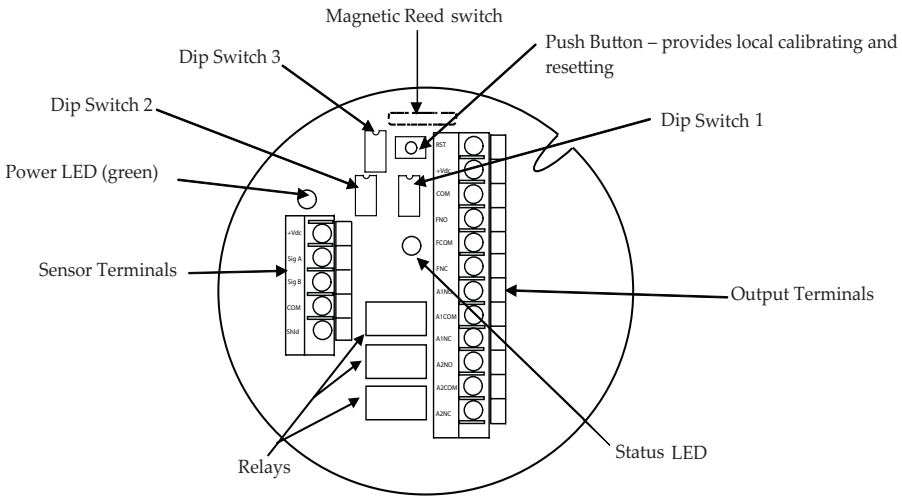
Table 4: Sensor Terminals and output Terminal Designations

Sensor Terminals	Sensor Wire	White	Red	Blue	Black	Green							
	Marked	+Vdc	Sig A	Sig B	COM								
	Function	10.5 - 32Vdc	A	B	Comm	Earth Ground							
Output Terminals	Marked	RST	+Vdc	COM	FNO	FCOM	FNC	A1NO	A1COM	A1NC	A2NO	A2COM	A2NC
	Function	Remote Reset	Power (+) (10.5-32)Vdc	Power (-)	Fault			Alarm 1 (Low Alarm)			Alarm 2 (High Alarm)		

Relay definitions

Fault Alarm contacts: Fault Normally Open (FNO), Fault Common (FCOM), and Fault Normally Closed (FNC).
Low Alarm contacts: Alarm 1 Normally Open (A1NO), Alarm 1 Common (A1COM) and Alarm 1 Normally Closed (A1NC).
High Alarm contacts: Alarm 2 Normally Open (A2NO), Alarm 2 Common (A2COM) and Alarm 2 Normally Closed (A2NC).

Figure 14: Relay circuit Board Assembly



4.4 Digital board assembly/configuration

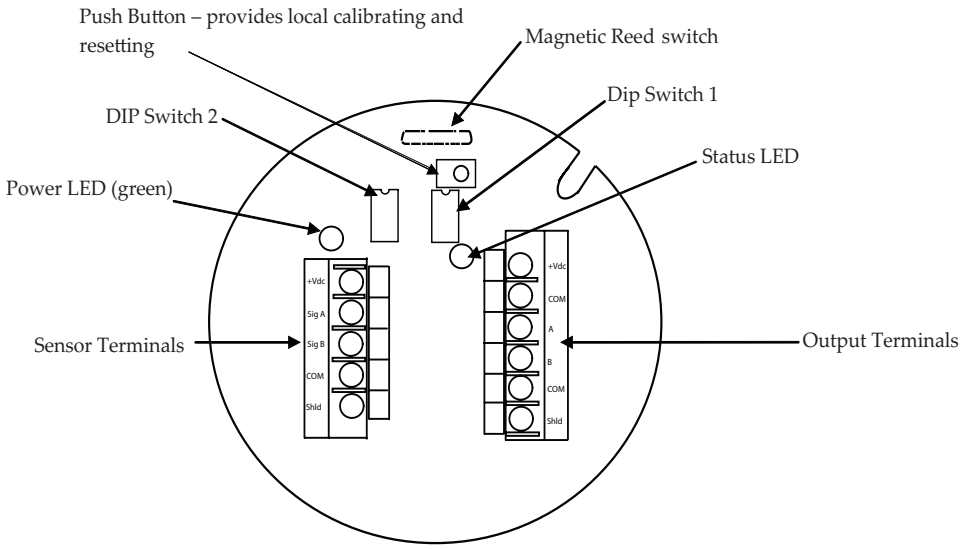
This assembly allows digital output utilizing Modbus Digital RS-485 protocols. See Section '7.2.4 RS-485 Modbus RTU'.

Table 5: Sensor Terminals and Output Terminal Designations

Sensor Terminals	**Sensor Wire**	White	Red	Blue	Black	Green
	Marked	+Vdc	Sig A	Sig B	COM	
	Function	10.5 - 32Vdc	A	B	Common	Earth Ground

Output Terminals	**Marked**	+Vdc	COM	A(positive)	B(negative)	COM	Shld
	Function	Power (+) (10.5-32)Vdc	Power (-)	Modbus RTU Terminal A	Modbus RTU Terminal B	Modbus RTU Terminal Common	Shield

Figure 15: Digital circuit Board Assembly



SECTION 5: Operation

5.1 DIP Switch Settings

When using **Digital Transmitter Models (M2B-D), Dip Switch 1 and 2 are used for Modbus settings**. Gas curves can be selected for IR sensors and Toxic sensors range/scale changed by computer communicating with transmitter. This is done by accessing a specific Modbus Register. Refer to the specific sensor manual. For **Relay Transmitter Models, Dip Switch 1 and 3** are used to set alarm levels, while **DIP Switch 2** is used to select gas curves for IR sensors and change the range/scale of Toxic sensors. **DIP Switch 2 is not used** to configure **Catalytic Bead sensors**. DIP Switch 1 and 3 are also utilized when using Oxygen sensors. For **Analog and Analog/ HART Transmitter Models, DIP Switch 2** is used to select IR sensor gas curves and Toxic sensor ranges. When **Analog and Analog/ HART Transmitter Models are used with Catalytic Bead sensors**, **DIP Switch 2 positions should not be altered.**

5.1.1 DIP Switch settings for Relay configuration

DIP Switch 1 and DIP Switch 3 as seen below show the settings for relay alarm levels and status. **DIP Switch 3 *position 4***, is used in conjunction with DIP Switch 1, if needs be, to setup the alarm level. The user is allowed to fully utilize, if necessary, all the percentages offered. To arrive at the desired low alarm level, add different percentages, whilst taking note of the sensor's range/scale. **The high alarm level (A2) is automatically set to twice the low alarm level (A1)**.

Example: For a sensor with range/scale of 50ppm, and DIP Switch 1 set with positions 2 and 4 'On' (8%+2%) the low level alarm point would be (10% of 50ppm) which is 5ppm, automatically making the high level alarm point 10ppm.

DIP Switch 1 Settings			
Position	**Status**	**Value**	**Function**
Position 1	On	16%	**DIP Switch 1 positions are used in conjunction with DIP Switch 3, *position 4*, if needs be, to set the Alarm point (% of full scale or range)**
	Off	0%	
Position 2	On	8%	
	Off	0%	
Position 3	On	4%	
	Off	0%	
Position 4	On	2%	
	Off	0%	

DIP Switch 3 Settings			
Position	**Status**	**Value**	**Function**
Position 1	ON	RFU	Not used now
	OFF	RFU	
Position 2	ON	Energized	Defines Relay Coil Status
	OFF(**default**)	De-energized	
Position 3	ON	Latching	Defines Relay Latch Status
	OFF(**default**)	Non-Latching	
Position 4	**ON**	**32%**	***Used with DIP Switch 1 to set the Alarm Point, (% of full scale/range) if needs be*.**
	OFF	**0%**	

Note: The gas curve or range should only be changed when the sensor and transmitter are in "NORMAL" state. After powering up, the transmitter Status LED will slowly flash green to indicate normal operating state. The system should be recalibrated with 50% of the specific target gas if the sensor's range is changed.

5.1.2 Digital Modbus DIP Switch Settings

DIP Switch 1 selects the MODBUS address. DIP Switch 2 defines the MODBUS settings. Position 1 and 2 of DIP Switch 2 selects the BAUD rate of the MODBUS. Positions 3 and 4 of DIP Switch 2 select the data format of the MODBUS data link. These DIP Switches must be set before the Millennium II Basic is powered up. Once the device is powered up the setting will be locked until another power down and up cycle.

DIP Switch 1 settings for Modbus

DIP Switch 1				
Position 1	Position 2	Position 3	Position 4	MODBUS Address
OFF	OFF	OFF	OFF	16
ON	OFF	OFF	OFF	15
OFF	ON	OFF	OFF	14
ON	ON	OFF	OFF	13
OFF	OFF	ON	OFF	12
ON	OFF	ON	OFF	11
OFF	ON	ON	OFF	10
ON	ON	ON	OFF	9
OFF	OFF	OFF	ON	8
ON	OFF	OFF	ON	7
OFF	ON	OFF	ON	6
ON	ON	OFF	ON	5
OFF	OFF	ON	ON	4
ON	OFF	ON	ON	3
OFF	ON	ON	ON	2
ON	ON	ON	ON	1

Digital Modbus DIP Switch Settings (cont'd)

DIP Switch 2 settings for Baud rate setting

DIP Switch 2		
Position 1	Position 2	BAUD Rate
OFF	OFF	19200
OFF	ON	9600
ON	OFF	4800
ON	ON	2400

DIP Switch 2 settings for Format bits

DIP Switch 2		
Position 3	Position 4	Date Format
OFF	OFF	8 bits data, no parity bit, 2 stop bits (also compatible to 1 stop bit)
OFF	ON	8 bits data, no parity bit, 2 stop bits
ON	OFF	8 bits data, odd parity bit, 1 stop bits
ON	ON	8 bits data, even parity bit, 1 stop bits

5.1.3 Analog & Analog/ HART DIP Switch Settings

DIP Switch 1 is not utilized when using the Millennium II Basic Analog and Analog/HART models. DIP Switch 2 settings / positions, are utilized for different gas curves when using IR sensors and for changing toxic sensor ranges. Refer to specific sensor manuals to see the combinations of DIP Switch 2 positions and when it is utilized.

SECTION 6: Calibration

6.1 Calibration Procedure

Prior to attempting calibration read and understand the calibration procedure below. Also see Figure 16 for additional reference.

The following calibration procedure should be followed to ensure an accurate correlation between the output signals and the gas concentration. For accurate performance, **the Millennium II Basic Transmitter is calibrated using 50% span gas**.

6.1.1 Guidelines

Calibration is recommended after the Millennium II Basic and sensor are installed. Calibration should be performed after at least 24 hours. Refer to specific sensor manuals for details on calibrating.

Note: The calibration procedure can be aborted by resetting the unit.

6.1.2 Full 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 Test Jacks (not required but gives visual confirmation). See Figure 12 and Figure 13 for Test Jacks location.
4. 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.
5. 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). **Recommendation**: Flow ZERO AIR at a rate of 0.5 liter per minute or more to the sensor.
6. When the current output is 3.3 mA (indicated by analog models) and the Status LED is flashing red, apply specific calibration gas (50% of full span). **Recommendation**: Flow span gas at a rate of 0.5 liter per minute to the sensor for direct sensor calibrations. If separated and using long tubing runs increase gas flow rate to ensure tubing does not affect calibration results.
7. When the current output is 3.6 mA (indicated by analog models) and the Status LED is solid green, remove the gas.
8. Apply zero gas, (clean air), again to purge the system.
9. After the sensor is purged of gas, the transmitter will return to normal operation.

Warning ⚠ Always apply test gas after any calibration to verify accuracy. When applying test gas, make sure the system is bypassed to avoid unwanted shutdowns.

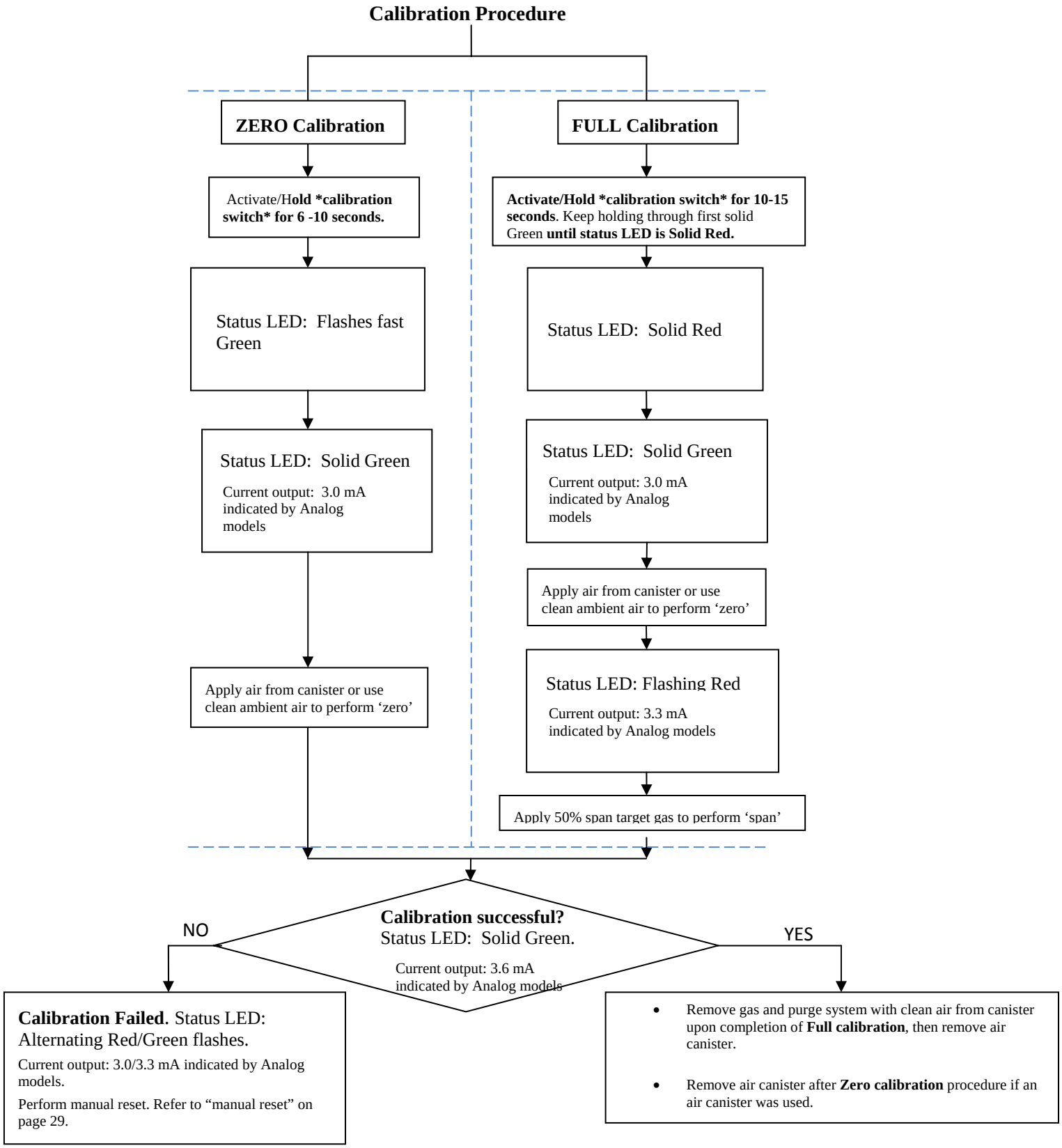
6.1.3 Zeroing (Quick Calibration) Procedure

This option is useful if the sensor's zero point has drifted as a result of a change in the ambient conditions.

Note: Zeroing does not require the application of a calibration gas. It does, however, require that no contaminated gas is present in the ambient air, if the surrounding air is being used.

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 models, connect a standard current meter to the transmitter Test Jacks (not required but gives extra visual indication). See Figure 12 and Figure 13 for Test Jacks location.
4. Press and hold the "**push button**" or activate "**Reed switch**" using the magnet until the status LED flashes green fast, and then goes solid green. Release the push button/deactivate the Reed switch.
5. When the Status LED is solid green, the current output will be 3 mA (indicated by analog models). Apply zero gas (clean air). **Recommendation**: Flow ZERO AIR at a rate of 0.5 liter per minute or more to the sensor.
6. Zeroing (Quick calibration) is completed, when the current output is 3.6 mA (indicated by analog models) after which, the Status LED blip/blinks green every second (current output of 4 mA). Remove the zero gas, or allow the transmitter to return to normal operation if ambient (clean surrounding) air was used.
7. Normal operation is confirmed by a current output of 4mA (indicated by analog models) and the Status LED blipping/blinking green every second.

Figure 16: Calibration flow chart



Note: * See Figures 12, 13, 14 & 15 when locating calibration switch (push button) or magnetic switch. Full descriptions of the two calibration procedures can also be found on pages 26 & 27.

6.1.4 Calibration Failures

If the calibration procedure fails, the Status LED will alternate red and green flashes with the analog output changing back and forth from 3.0 to 3.3 mA. The unit will remain in a failed state until it is manually reset.

6.1.5 Manual Reset

A manual reset is required after a calibration failure or to clear a latched alarm. Simply press and hold down the *"calibration switch"* for up to 3 seconds, recycle power, or place and hold the flat surface of the magnet near the Reed switch for up to 3 seconds. The status LED will fast flash green, then slowly flash red, indicating reset, after which, the Status will flash green slowly, to indicate normal operation.

SECTION 7: Monitoring and outputs

7.1 Fault monitoring

Self-testing circuitry continuously checks for problems that could prevent proper response. When power is applied, the micro transmitter automatically tests the system to ensure that it is functioning properly. During normal operation, it continuously monitors the signal from the sensor. In addition, a 'watchdog' timer is maintained to ensure the program is running correctly. When a system fault is detected, the Status LED will flash red fast and fault signal will output a 2.5 mA signal.

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

7.2 Outputs

The Millennium II Basic is available with a number of different output configurations. These include analog 4-20mA, Relay outputs from Mechanical relays, RS-485 Modbus RTU, and HART communication

7.2.1 Analog 4-20mA

A 4 – 20 mA 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; a 4.0 – 20.0 mA output indicates the presence of a gas. Current outputs under 4.0mA are used for maintenance or fault indications.

7.2.2 Relay

The relay option comes with Mechanical Form C SPDT contacts rated 5 Amps at 30 Vdc/250 Vac. Three (3) relay outputs are available. The fault relay is fixed and cannot be altered. The two alarm relays are configurable. They can be configured as energized or de-energized and latching or non-latching. See "Relay board assembly / configuration" for more information.

7.2.3 Sensor Status Registers, Transmitter Status LED, Current output and Meaning

Table 6 below, shows the sensor status registers, and the Transmitter current output, along with corresponding status LED and meaning.

Table 6: Current output and meaning

Reg. Value	Current Output (mA)	Status LED		Meaning
		Red	Green	
0	4 – 20	Slow Flash (Gas found)	Flash (No Gas)	Normal Sensor operation – regularly calculates gas concentration.
1	3.0		Solid	Sensor is zeroing itself (Cal Mode)
2	3.3	Very Fast Flash		Sensor is waiting until it detects application of cal gas.
3	3.3	Very Fast Flash		Sensor waits until gas level stabilizes, then begins spanning.
4	3.6		Solid	Spanning is complete, user asked to remove gas.
5	3.6		Solid	Displayed for 4 seconds once gas decreases to 3% FS after user asked to remove cal gas.
6	2.5	Very Fast Flash		Sensor is not calibrated, requires user to calibrate.
7	3.0	Slow Flash		Sensor is waiting for 90 seconds to allow the signal to stabilize (Start Delay)
9	3.0/3.3	Solid	Solid	Signal was too unstable to acquire accurate zero after 90 seconds
10	3.0/3.3	Solid	Solid	Displayed for 4 seconds is the cal gas was removed prematurely **OR** is a 90 second time limit has elapsed and the signal was too unstable to acquire accurate data
11	2.5	Fast Flash		**FAULT DETECTED:** Temperature below absolute minimum temperature range (-40°C).
12	2.5	Fast Flash		**FAULT DETECTED:** Temperature above absolute maximum temperature range (+75°C).
13	2.5	Fast Flash		**FAULT DETECTED:** Input voltage <8V.
14	2.5	Fast Flash		**FAULT DETECTED:** Input voltage >33V.

Table 6: Current output and meaning (cont'd)

Reg. Value	Current Output (mA)	Status LED		Meaning
		Red	Green	
15	2.5	Fast Flash		Sensor Element Failure
16	20.0	Solid		The concentration value is greater than the allowed range; the sensor is displaying its maximum concentration value.
17	2.5	Fast Flash		**FAULT DETECTED:** Sensor baseline has drifted into a "Negative Gas Concentration" region (Zero Drift) and requires re-calibration.
18	4-20	Fast Flash		Sensor is nearing end of life. Replace at next calibration.
20	2.5	Fast Flash		**FAULT DETECTED:** A critical memory fault has occurred.
21	2.5	Fast Flash		**FAULT DETECTED:** A fault has occurred in the sensor's onboard power supply.

Note: A slow flash is defined as the Status LED being 'ON' for 50 milli-seconds and 'OFF' for 1 second, while a fast flash is the LED being 'ON' for 250 milli-seconds and 'OFF' for 250 milli-seconds and a very fast flash is the LED 'ON' for 50 milli-seconds and 'OFF' for 50 milli-seconds.

7.2.4 RS-485 Modbus RTU

Modbus Digital RS-485 Modbus RTU protocol is used. Refer to sensor manuals for specific Modbus registers and meaning.

The Millennium II Basic transmitter utilizes 2- wire Modbus RS-485 multi serial mode. This Modbus solution implements a 2-wire electrical interface in accordance with the EIA/TIA-485 standards. For this MODBUS configuration, it is important that a third wire be used for connecting all the 'Common' (COM) in the chain. Also a 120 Ohm line termination is required for the last device in the line. See Figure 17. The Instrument Engineer is responsible for calculating line length and adhering to MODBUS protocols.

Figure 17: Two wire Modbus configuration

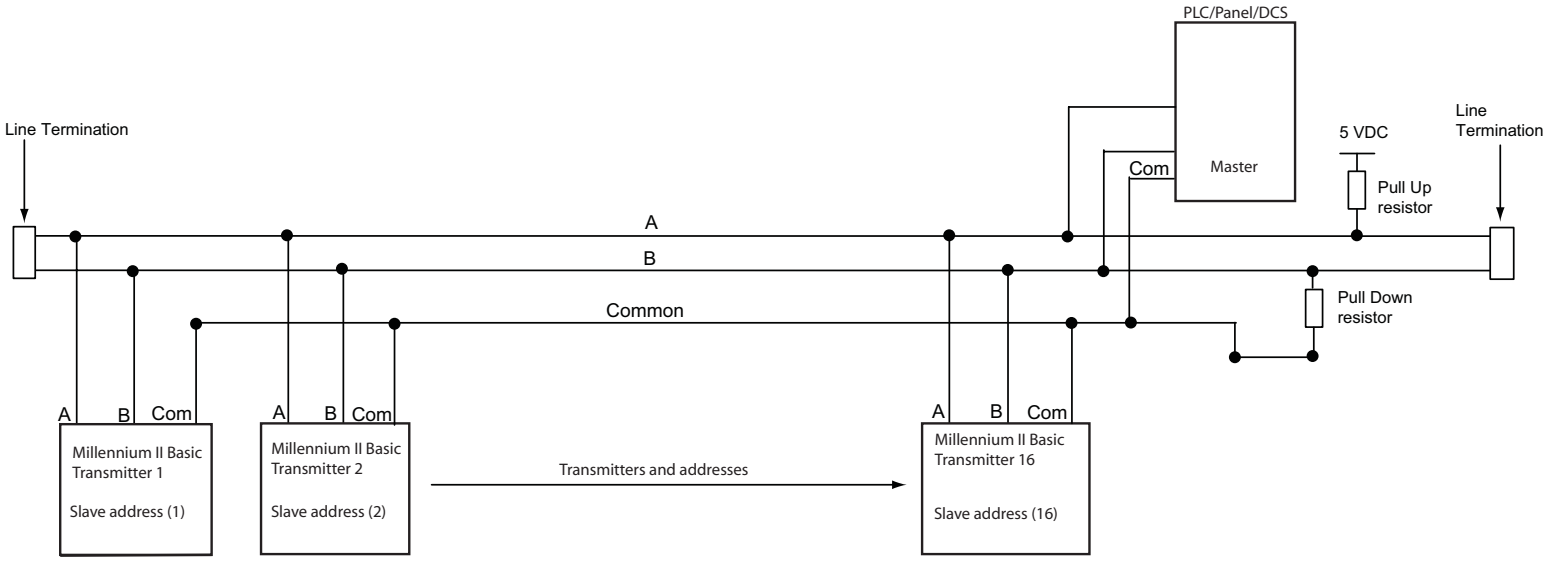


Table 7: Modbus Registers

Reg#	Meaning	Readable	Writeable
40001	Concentration value as calculated by sensor (RTUsensor_out), Channel 1	X	
40002	Sensor status (RTUsensor_stat)	X	
40003	Temperature of sensor element housing in Kelvin (RTU temperature)	X	
40011	Calibration gas value	X	
40021	Sensor class	X	
40022	Low alarm value	X	X
40023	High alarm value	X	X
40027	Current sensor range	X	X
40101	Reset sensor		X
40102	Full calibration / Normal calibration		X
40104	Zero calibration / Quick calibration		X

7.2.5 HART Communication

The HART protocol is a powerful communication technology enabling users to exploit the full functionality of the Millennium II Basic Transmitter.

The HART Communicator may be connected to the Analog/HART model Millennium II Basic Transmitter via the HART Port connector (HPT-001) which provides the necessary interface for communication. The HART Port connector is fitted to one of the ¾" NPT conduit entries and its communication wires fitted to the HART Pins located at J3 on the Analog/HART PCB. The HART Communicator probe wires (leads) are then connected to HART Port connector contact points. HART Communication may also be done remotely using a designated Net Safety Multipurpose Junction box (JB-MPH-A/S). See the HART Port connector manual (MAN-0083) for more details. Also see Figure 5, Figure 6, Figure 8 and Figure 9, if connecting the HART Communicator directly in the 4-20mA signal wiring.

Note: When remote HART Communication is being done, ensure the HART Jumper is connected across pins at J3. See Figure 5, Figure 6, Figure 8 and Figure 9 when location Jumper at J3. By default the jumper is connected across pins.

When the system is powered up, the communicator will search for the Millennium II Basic Transmitter and when a connection is established, the communicator will show the device information. If the Millennium II Basic Transmitter Device Description (DD) is loaded into the communicator, the communicator can access all the information and features of the Millennium II Basic Transmitter. If the communicator is not programmed with the specific DD, the Millennium II Basic Transmitter can still work with the communicator as a generic device. Refer to Appendix D for complete information.

7.2.6 HART Menu Structure

The Hart Menu structure exists when using the HART Communicator and allows the user to see all existing options, Device status, Calibration information and History. Refer to Appendix E for the Structure and menu tree.

SECTION 8: Maintaining

8.1 Periodic response check

Net Safety Monitoring recommends that a bump test be performed every 90 days to ensure continued functionality and accuracy of the detection system. Full calibration is recommended when the sensor fails to meet acceptable accuracy standards. This involves the application of calibration gas to the sensor, then the observation of the response LED's, analog output, and external monitoring equipment. Be sure to prevent unwanted response of external monitoring devices and equipment during this procedure. If the Millennium II Basic response to calibration gas is within the specified accuracy then it is not necessary to perform a calibration.
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 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).

8.2 Troubleshooting

Response to the input should be checked and, if necessary, calibration should be performed whenever the accuracy of this check is not satisfactory. The system should also be checked when sensor or transmitter is added or removed. If problems should develop, first check for faulty wiring, confirm proper voltage to transmitter and attempt a calibration. If problems persist, please contact Net Safety's Service Department first by phone to try and resolve any issues. If issues cannot be resolved, please follow the procedure on 'how to return equipment'.

8.3 Spare Parts /Accessories

Table 8: Spare Parts Numbering

Net Safety Part Number	Description
CCS-1	Calibration Cup / Splash Guard
DSC-1	Dust Filter Assembly
IPF-001	IP66/67 Hydrophobic Filter
JB-MPD-A or JB-MPD-S	Separation Kit
TX-M2B-AH	ML2B Hart Board fully populated
TX-M2B-A	ML2B Current loop board fully populated
TX-M2B-D	ML2B Modbus board fully populated
TX-M2B-R	ML2B Relay board fully populated

8.4 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[1]

Distance (Feet)	AWG #20 0.5mm2	AWG #18 0.8mm2	AWG #16 1.0mm2	AWG #14 2.0mm2
100	1.02	0.64	0.40	0.25
200	2.03	1.28	0.80	0.51
300	3.05	1.92	1.20	0.76
400	4.06	2.55	1.61	1.01
500	5.08	3.20	2.01	1.26
600	6.09	3.83	2.41	1.52
700	7.11	4.47	2.81	1.77
800	8.12	5.11	3.21	2.02
900	9.14	5.75	3.61	2.27
1000	10.20	6.39	4.02	2.53
1250	12.70	7.99	5.03	3.16
1500	15.20	9.58	6.02	3.79
1750	17.80	11.20	7.03	4.42
2000	20.30	12.80	8.03	5.05
2250	22.80	14.40	9.03	5.68
2500	25.40	16.00	10.00	6.31
3000	30.50	19.20	12.00	7.58
3500	35.50	22.40	14.10	8.84
4000	40.60	25.50	16.10	10.00
4500	45.70	28.70	18.10	11.40
5000	50.10	32.00	20.10	12.60
5500	55.80	35.10	22.10	13.91
6000	61.00	38.30	24.10	15.20
6500	66.00	41.50	26.10	16.40
7000	71.10	44.70	28.10	17.70
7500	76.10	47.90	30.10	19.00
8000	81.20	51.10	23.10	20.20
9000	91.40	57.50	36.10	22.70
10000	102.00	63.90	40.20	25.30

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

Appendix C: Millennium II Basic Specifications

TRANSMITTER	Relay	Analog	Analog/HART	Digital
Electrical				
Power Consumption (with sensor attached)	<200 mA @ 24 Vdc			
Voltage Range	10.5 – 32 Vdc	10.5 – 32 Vdc	18 – 32 Vdc	10.5 – 32 Vdc
RFI, EMC, Immunity	RFI: 150 to 170 MHz and 450 to 470 MHz, 5W FM radio at 1 meter away; EMC: IEC 61000-1-4 and IEC 61000-4-3 Severity Level 2			
Display				
Display	Power and Status LED's (Separate status for Normal, Fault & Alarm)			
Environmental				
Temperature	Certified : -55°C to +85°C			
RH	0 – 99% RH non-condensing			
Enclosure				
Metallurgy	Copper Free Aluminum(AL6061) or Stainless Steel (SS316)			
IP/NEMA	IP67 / NEMA 4X (Note: See sensor manuals for sensor certified temperatures).			
Weight (without sensor)	Aluminum(AL6061) enclosure: 0.8 kg (2.0 lbs), Stainless Steel(SS316) enclosure: 1.6 kg (3.5 lbs)			
Mounting	Surface Mount, Pipe Mount & other mounting options available.			
Outputs	(3) 5A @ 30Vdc/250Vac Form C contacts (Fault, low, high)	4 – 20 mA - into a maximum loop impedance of 800 Ohms @ 32Vdc or 150 Ohms @ 10.5Vdc. Isolated or non-isolated loop supply	4–20 mA with HART communication protocol	RS 485 Modbus RTU
Approvals				
Approvals	Class I, Div I Grps BCD; Class I, Zone 1 AEx/Ex d IIB+H2, T5, IP67, Type 4X, Certified -55°C to +85°C FM ATEX: CE 0575 Ex II 2G, Ex d IIB+H2, T5, IP67, Certified -55°C to +85°C. FM07 Certified to FM 6320, CSA-C22.2 No. 152, ANSI/ ISA-92.0.01, **ANSI/ISA-92.03.01**, **FM6340, EN61779-1**, EN61779-4			

Appendix D: HART Communication

HART Communication with the Millennium II Basic is necessary to monitor the internal status and modify the factory settings. This appendix provides guidance on establishing HART Communication. Refer also to Appendix E for description of the communication menu structure/tree when using the HART Handheld Communicator.

Establishing Local HART Communication with the Millennium II Basic Transmitter.

1. Unscrew the protective cap from the HART Communication port of the Millennium II Basic.
2. Connect the HART Communicator probes to the 2 terminals inside the HART Port, (non-polarized).
3. Press the “on” key to the switch on the HART Communicator.
4. Double tap “HART Application” on the screen, the communicator will try to make a connection with Millennium II Basic. If the connection is made, the “Online” menu appears when the Communicator is connected to the Millennium II Basic. This menu provides important information about the device.

The HART protocol incorporates a “Device Description Language,” (DDL) that enables HART instrument manufacturers to define and document their product in a consistent format. This format is readable by handheld communicators, PC’s and other process interface devices that support DDL.

For the Millennium II Basic Transmitter, HART handheld Communicators, PC’s and other process interface devices must support the latest 16 bits manufacture ID and 16 bits device ID. For the 375 communicator the software version must be at least version 2.0.

Notes:

- Proper analog signal output termination and minimum loop resistance must be completed in all cases to enable HART Communication. Failure to provide proper analog signal output loop resistance will preclude all HART Communication.
- If the HART Communication is not programmed with specific DD or does not support 16 bits IDs, the Millennium II Basic can still connect to the communicator but in the Generic HART Communication mode. In this mode, HART Communication with the Millennium II Basic will be established, but the Communicator will not recognize the Millennium II Basic. Generic HART Communication will not provide access to the Millennium II Basic DDL menu and important set-up, diagnostics or operation functions, such as calibration, loop test, current gas type and sensor range.

Procedures to determine if the Millennium II Basic DDL is loaded in your communicator

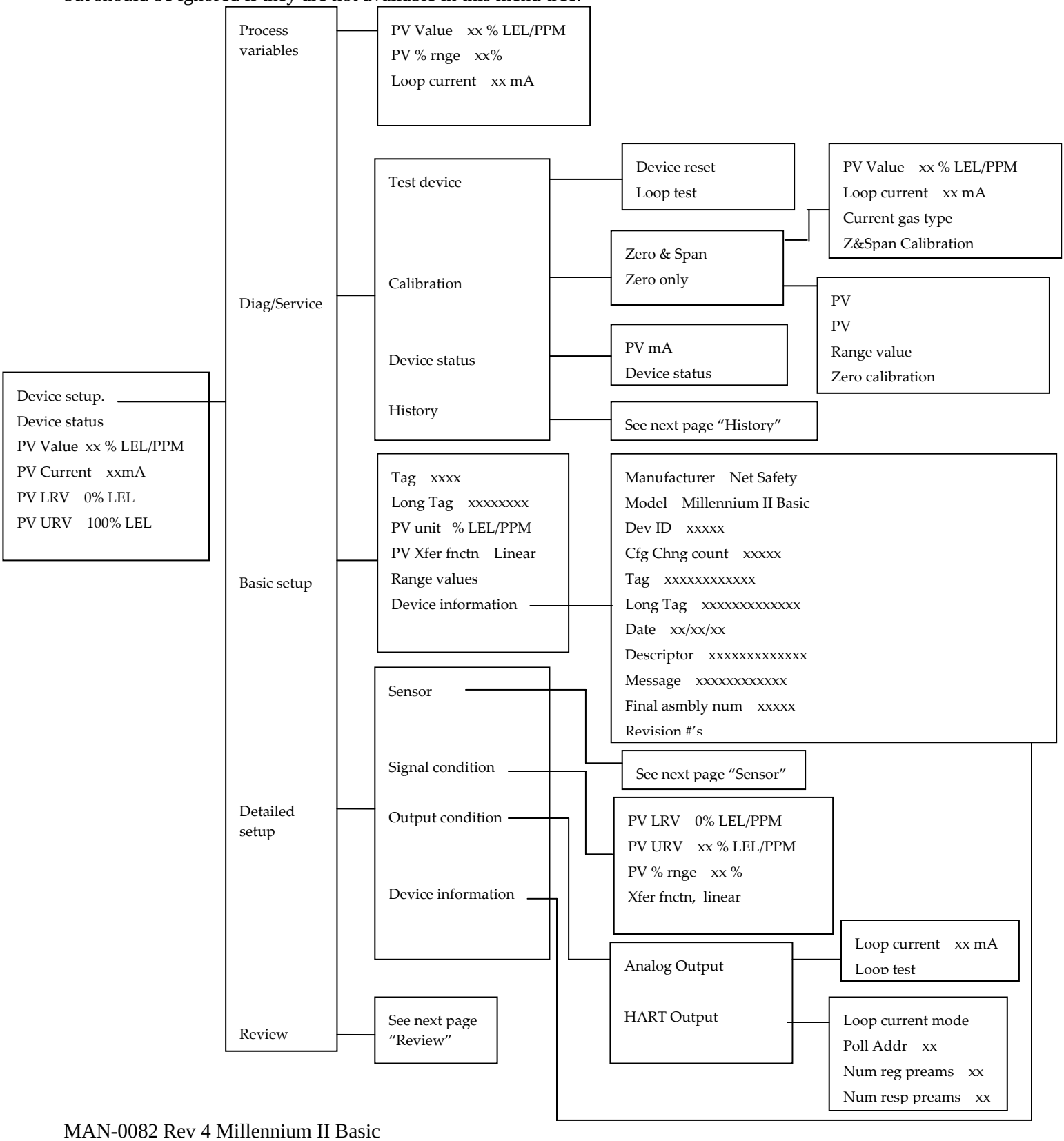
1. From the main menu, select the HART Application.
2. From HART Application, select Offline menu.
3. From the Offline menu, select New Configurations to show the list of device descriptions programmed into you HART Communicator. The Manufacturer menu displays a list of each manufacturer with the available DDL’s.
4. Select Net-Safety and the display will show the list of available device types.

If you cannot find Net-Safety or Millennium II Basic device under Net-Safety on your Communicator, the specific DDL is not programmed into communicator. Your HART Communicator will require a DDL upgrade in order to access all the Millennium II Basic functions.

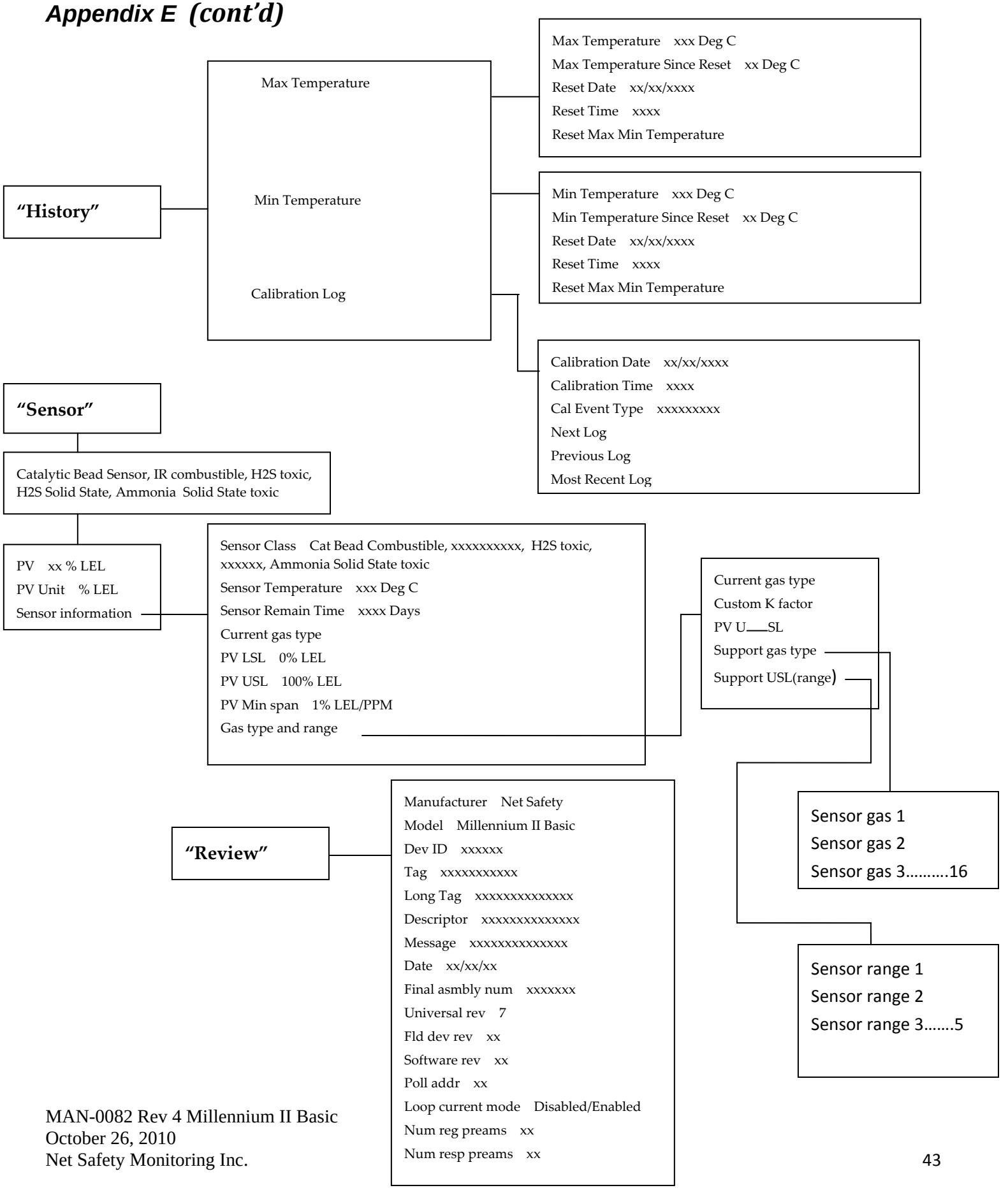
The HART Communication Foundation, (www.hartcomm.org), manages the HCF Approved DDL Library and programming sites for HCF Approved field communicators. A complete listing of the DD Library is available for download and provides manufacturer and device type file identification.

Appendix E: HART Menu Tree

This section displays a general menu tree for Millennium II series sensors. Menus may exist when using communicator but should be ignored if they are not available in this menu tree.



Appendix E (cont'd)



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