DUOSENSE-M CO/NO2 GAS DETECTOR

CALIBRATION TECHNOLOGIES INC.
GAS DETECTION SPECIALISTS

Installation and Operation Manual

Warning

Use this product only in the manner described in this manual. If the equipment is used in a manner not specified by Calibration Technologies, the protection provided by the equipment may be impaired.

This equipment should be installed by qualified personnel.

For technical support, contact:

CTI
920 N Tradewinds Pkwy
Columbia, MO 65201
phone: 866-394-5861
email: sales@ctigas.com
website: ctigas.com

Table of Contents

GENERAL DESCRIPTION

The DuoSense-M gas detector is a Modbus device for carbon monoxide and nitrogen dioxide which utilizes proven electrochemical sensor technology for fast and accurate detection. A maximum of 255 Modbus devices can be networked on the M255 controller.

The standard detection ranges of the DuoSense-M provides real-time continuous monitoring of carbon monoxide levels accurately down to 10 ppm, with an upper detection limit of 200 ppm. It will monitor Nitrogen Dioxide accurately down to 0.5 ppm, with an upper detection limit of 10 ppm.

The transmitter circuit board is sealed with conformal coating, protecting sensitive electronic components and copper tracing from corrosion.

LCD digital display
Inside the detector enclosure is an LCD display, 1" x 1", to assist with initial setup and calibration.

Communication
The communication protocol for the DuoSense-M is industry standard RS-485 MODBUS.

Enclosure
The enclosure for the DuoSense-M is a specially vented chemical-resistant polycarbonate enclosure to protect the sensor from accidental damage.

The additional wall plate with steel safety cage protect the detector from physical damage and allows for pillar mounting.

Warehouse Kit (optional)
The warehouse kit provides the sensor enclosure physical protection. It includes an aluminum wall plate designed to be strapped to a vertical-support steel pillar but can also be mounted on a wall. The included 36" nylon straps hold it securely to the pillar. A heavy-duty 10 gauge chrome-plated steel safety cage protects the sensor enclosure from all angles of attack, and also allows the enclosure lid to open unimpeded.

Figure 1. DuoSense-M detector

INSTALLATION

Installation Guidelines:
One of the most important considerations when installing CO and NO2 detectors is that they must be easily accessible for calibration and maintenance. Carbon monoxide is almost the same molecular weight as air and will mix throughout the space equally. Nitrogen dioxide is heavier than air and will accumulate at the floor level. Even though these heated gases may rise once they exit the vehicle exhaust system, they will quickly cool and sink (particularly NO2 gas). Therefore, it is best to always install the sensor in the breathing zone, approximately 3-5 feet from the floor. This mounting location will provide the best personnel protection. The height at which employees will be working should also be taken into consideration.

As a general rule of thumb for vehicle exhaust, install sensors no further than 50 feet from CO and NO2 gas sources (7,500 sq feet coverage). See the installation guidelines in the next section for more details.

Mounting considerations:
- Most probable location(s) of the target gas.
- Air movement in the area due to ventilation or ambient conditions.
- Environment (temperature, humidity, wind, etc.)
- Presence of interference gases.
- Out of harm's way (physical damage).

Installation Guidelines:
- The sensor is shipped with labels installed over the electrochemical cells to preserve cell life. The cells will not detect gas with this label installed. Remove labels and discard during installation.
- Always mount sensor vertically.
- Keep detector and wire runs away from mercury vapor lights, variable speed drives, and radio repeaters to prevent electrical interference.
- Protect detector from physical damage (forklifts, etc).
- Never mount the sensor in CA (controlled atmosphere) rooms. Normal atmospheric levels of oxygen are required for operation.
- More than one sensor should be installed in each room for highly critical locations.

Duct mount
The duct-mount installation option allows the sensor element to be installed in an HVAC duct to monitor for the presence of the target gas.

Maximum air velocity should not exceed 83 feet per second (5,000 feet per minute).

Contact CTI for duct mount options.

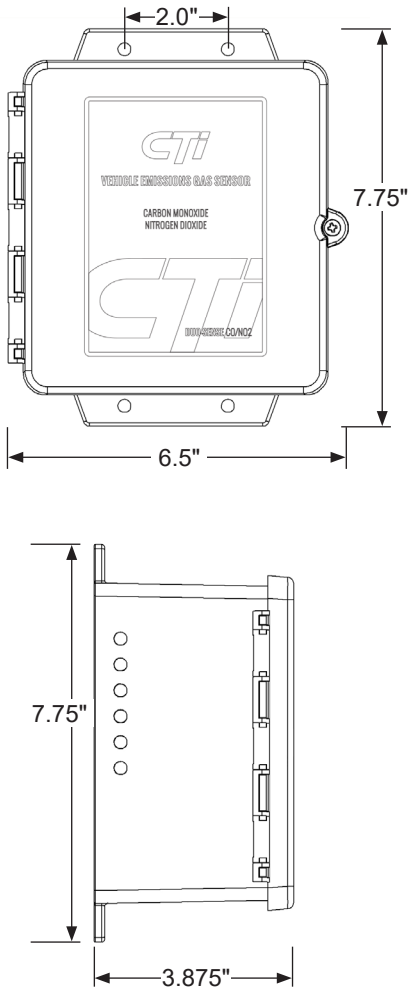


Figure 2. Physical dimensions

WIRING

Overview

The DuoSense-M comes equipped with RS-485 Modbus communication only.

Electrical Power: 24 VDC regulated, 10 mA.

- Always disconnect power at the controller before performing any wiring at the sensor.
- Do not pull detector wiring with AC power cables. This can cause electrical interference.

Terminal blocks are plug-socket type to make wiring easier. Since the RS-485 and power wiring are doubled-up in the terminals, the plugs can be removed without interrupting communications and power for all devices downstream on the network.

Electrical wiring must comply with all applicable codes.

Terminal	Connection	Description
24V	24Vdc power	+24Vdc Power
GND	Power supply ground	
A	RS-485 A	RS-485 Modbus Communication
B	RS-485 B	
SHIELD	Drain wire	

Figure 3. Wire terminal table

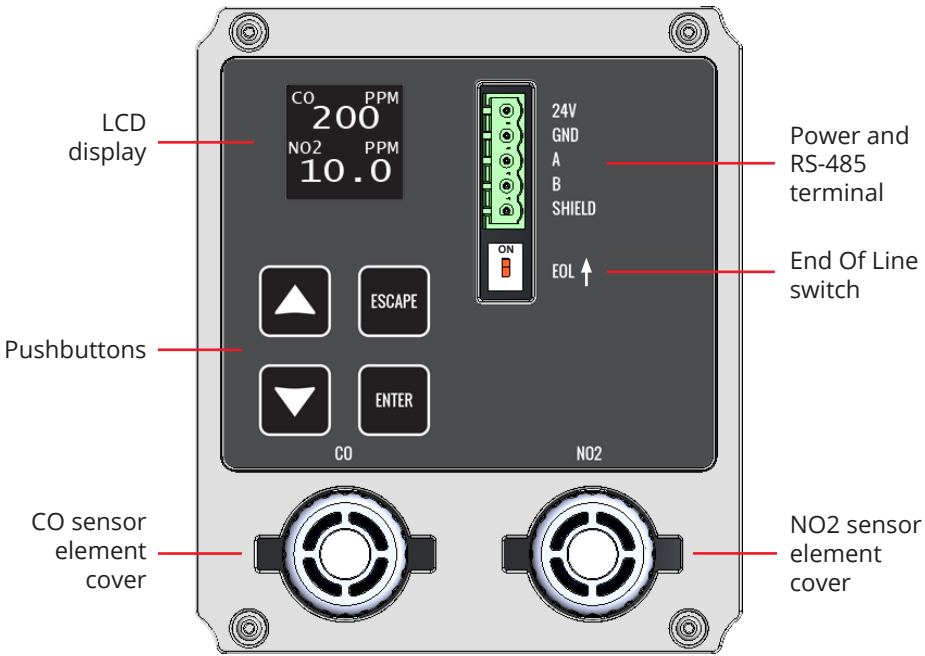


Figure 4. Circuit board layout / wire terminals

RS-485 Modbus wiring

Follow these wiring instructions carefully! Failure to do so will result in installation error, cause system errors, and void all warranties.

Modbus communication wiring

It is recommended to pull 24Vdc power cable with the communication cables. These cables can share the same conduit.

- RS-485 communication cable, 22 AWG, 2-conductor twisted pair, shielded, stranded, with drain wire (Alpha Wire 6460, Belden 3077F, or equivalent).
- 4,000 ft max per Modbus channel.
- Avoid splices and T-taps. All terminations should be made at network device wire terminals.
- Wire shields must be connected at all shield terminals, creating a continuous shield run from the controller to the device at the end of the line.
- Maximum of 210 devices per Modbus channel.

Each DuoSense-M gas detector has a communication port with three terminals: A, B and SHLD. On these three terminals the communication cable is connected so that all devices that take part in the communication are connected in parallel. All of the 'A' terminals must be connected together and all of the 'B' terminals must be connected together, respectively. These wires can be doubled-up in each terminal.

For "end of line" devices, set the EOL switch position to "ON". For all other devices, verify that the EOL switch is in the "OFF" position (see Figure 4).

Terminal Block Plug (Field Wiring):
24V: To 24Vdc terminal of power supply.
GND: To ground terminal (0V or -) of power supply.
RS-485-A: To RS-485-A terminals of next and previous devices in line.
RS-485-B: To RS-485-B terminals of next and previous devices in line.
SHLD: To case (earth) ground of monitoring equipment.

Device power wiring

- Use 18 AWG, 2-conductor, shielded, stranded with drain wire (General Cable C2534A or equivalent).

Assuming an even distribution of devices on the channel (cable run), use this rule of thumb for device power wiring:

- On 4,000 ft power cable, maximum of 50 sensors.
- On 3,000 ft power cable, maximum of 70 sensors.
- On 2,000 ft power cable, maximum of 100 sensors.
- On 1,000 ft power cable, maximum of 210 sensors.

Caution: To prevent excessive voltage drops and/or power supply overloads, consider all 24Vdc devices on each

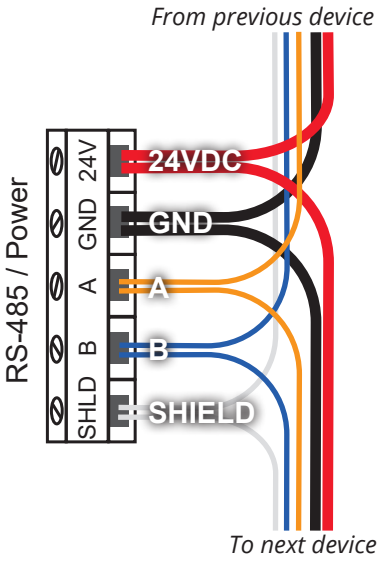


Figure 5. Device wire terminals

power supply. Total current draw for all devices should not exceed the power supply rating at the controller.

If the supply voltage drops below a device's minimum supply voltage at any device on the network, a power supply should be added at that point on the power cable.

Additional 24Vdc power supplies can be added at the controller and distributed throughout the Modbus channels as needed.

Due to voltage drops across a series of Modbus devices, at some point the minimum voltage at which the devices

can operate at will require a power supply to be added to the channel. For the DuoSense-M detectors, 12Vdc is the lowest operating voltage. At this point on the channel, an additional power supply should be added. (refer to Figure 5) Notice the RS-485 communication wiring continues on to the next device, whereas there's a break in the power wiring and the new power supply starts at the next device.

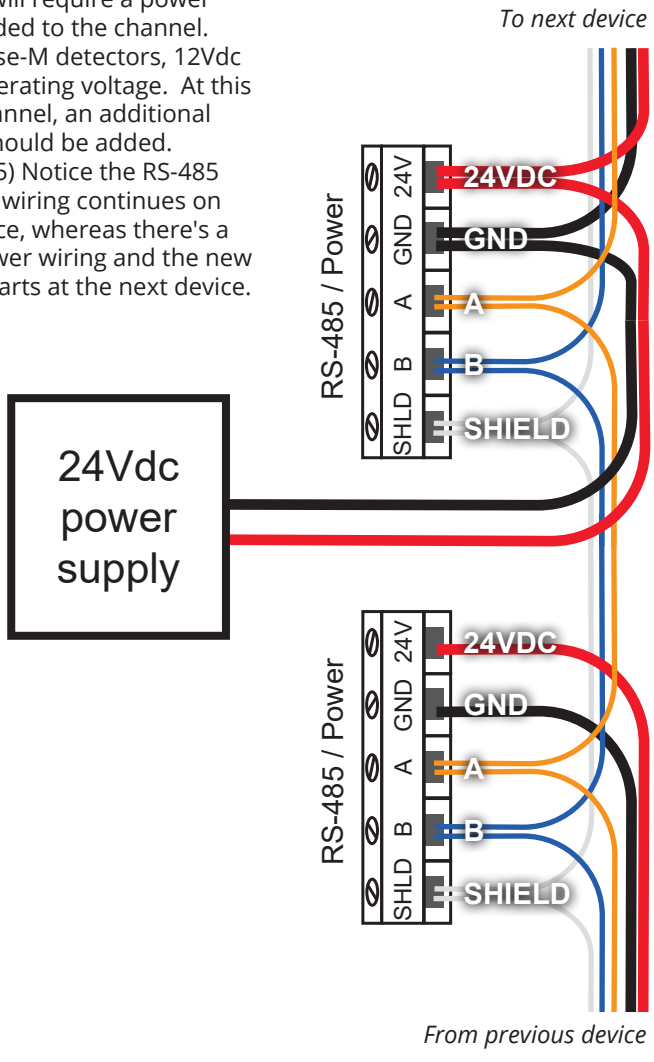


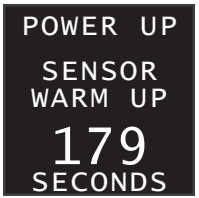
Figure 5. Adding a 24Vdc power supply

OPERATION

Pre-power up

Before applying power, make a final check of all wiring for continuity, shorts, grounds, etc. It is usually best to bypass or disconnect external alarms and other equipment from the gas detection system until the initial start-up procedures are completed.

Powering up



Upon power up, allow timer to countdown before any adjustments are made to the sensor while the sensor stabilizes.

Any button press returns to the home screen.

LCD screen

The LCD provides indication of the gas concentration, along with gas type and unit of measurement. It is also used for sensor calibration and setting the Modbus address.

Inactivity of the operator interface after 5 minutes will return to the Home screen.

Operator Interface

All operator functions are performed from the pushbuttons on the panel inside the sensor enclosure. In some fields, the arrow keys can be held in to dramatically increase the speed at which the number increments/ decrements.

Below is a list of the common key functions used for the menu operations:

Enter key is used to enter edit mode once inside the screen. In edit mode, the screen colors will invert to indicate edit mode. Pressing Enter again to save changes.

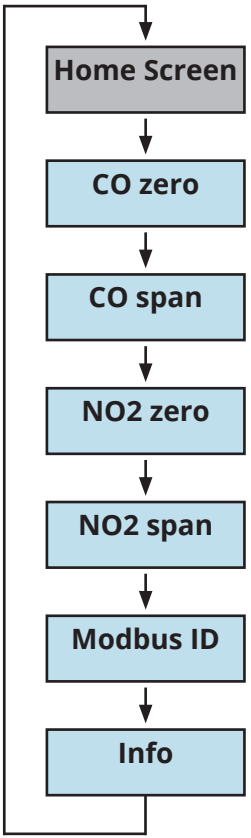
Escape key is used to return to the Home screen.

Up/Down keys are used to navigate the screens and change values.

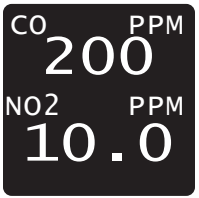
Screens

There are five screens which are all accessible from the Home screen.

To navigate the screens, press the ▲ or ▼ arrows from the Home screen. Press the ENTER key to enter into edit mode of that screen. Use the ▲ ▼ arrows to make changes. Press ESCAPE to exit and save changes to that screen. See Modbus and Calibration instructions on the following pages.



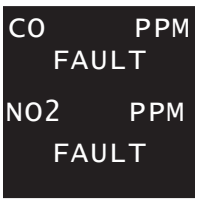
Home screen

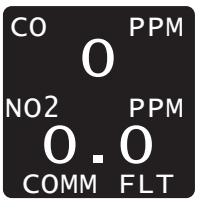


When the DuoSense-M is powered up, the Home screen is displayed. The home screen is the default screen when exiting any of the other four screens or after 5 minutes of inactivity from the user.

The home screen provides a real-time indication of the CO and NO2 gas concentrations.

Fault/Comm condition





A fault condition can occur if the DuoSense-M detects on-board hardware or software failures. FAULT will flash on the screen and the corresponding fault relay(s) will change states at the controller.

A communication fault can occur if the DuoSense-M loses communication with the controller. This is usually a wiring problem but can also occur if another device on the network shares the same Modbus ID. COMM FAULT will flash on the screen.

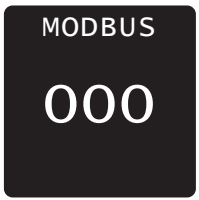
Info

The Info screen is viewable only.

SW Ver: Software version.
SN: Detector serial number.

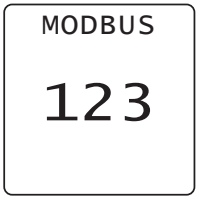
Note: Software version for this manual is 1.0. Contact CTI for other software version manuals.

Modbus ID



Use this screen to assign the detector's Modbus address. Select a number between 1 and 255. Each detector must have a unique address to communicate to the controller. The default address is 0 when shipped. Setting the address to 0 disables the communications.

Press the ENTER key to enter into edit mode of that screen. The screen colors will invert to indicate edit mode.



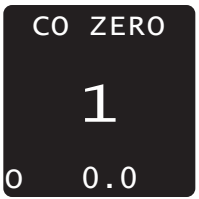
Use the ▲ ▼ arrows to make changes. Press ESCAPE to exit and save changes. Press ESCAPE again to return to the home screen.

Calibration

Zero

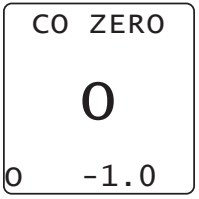
After the sensor is installed and has been powered up for at least 1 hour, the unit can be zero calibrated by the following:

Use the ▲ arrow key to scroll to the CO sensor **Zero** adjust screen. The current PPM concentration and offset is displayed.



If a zero calibration is necessary, follow the next steps. Otherwise, press the ▲ arrow key to go to CO sensor **Span** adjust.

Press the ENTER key for edit mode and then apply Zero Air gas at 0.5 to 0.8 L/minute or zero the sensor in clean air. Then press the ▲ or ▼ arrow keys until the value equals 0 ppm. A ppm offset value is dislayed at the bottom of the display for troubleshooting purposes.

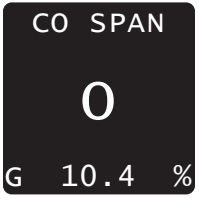


Zeroing is complete. Remove the zero calibration gas at this time. Press ESCAPE to exit edit mode and save the value.

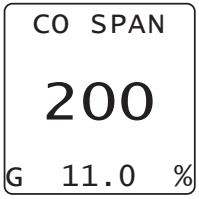
Any adjustments made should be notated at this time if required.

Span Adjust

Use the ▲ arrow key to scroll to the CO sensor **Span** adjust screen. The current PPM value and % of gain applied is displayed.



Press the ENTER key for edit mode and apply Span gas at 0.5 to 0.8 L/minute. The concentration of the span gas should be between 25 and 100% of the full-scale range of the sensor.



Once the output signal has peaked (or 2 minutes maximum for CO and 5 minutes max for NO2), use the ▲ ▼ arrows to change the value on the display to match the value of the span gas. A % gain value is displayed at the bottom of the screen for troubleshooting purposes.

Spanning is complete. Remove the span calibration gas at this time. Press ESCAPE to exit edit mode and save the value.

Any adjustments made should be notated at this time if required.

Use the ▲ arrow key to scroll to the NO2 sensor **Zero** adjust screen and repeat the same Zero and Span steps from the previous Calibration section.

Note: If an extreme gain adjustment was applied, the sensor may be at or near the end of its useful life. This may be due to the age of the sensor, high exposure to the target gas or other environmental factors.

Note: If the span calibration failed, check the calibration gas cylinder pressure and flow, as well as the hose and adaptor to make sure the gas is getting to the sensor. Replace the sensor element at this time. See ***Sensor Replacement*** section of this manual for instructions.

START-UP TEST

Sensor can be response tested and/or span calibrated immediately after power up.

Start-Up test:

1) Expose sensors to target gas.

2) Verify that each sensor responds when exposed to the target gas, causing intended alarm functions.

MAINTENANCE

The DuoSense-M gas detector is designed for long life and minimal maintenance. For proper operation, it is essential that the calibration schedule be adhered to.

Guidelines:

- The detector is shipped with a factory calibration.
- Sensors should be calibrated 6 months from purchase date and calibrated on 6-month intervals thereafter.
- Calibration should be performed with certified calibration gas. Calibration kits and replacement cylinders are available from CTI.
- All tests and calibrations should be logged.
- Always disconnect power at the controller or 24Vdc power supplies before performing any wiring at the sensor.

SENSOR REPLACEMENT

Sensor Life: The electrochemical cells are extremely reliable, but several things can cause depletion of the chemistry within the cell, including:

- Age (degradation over time).
- Continuous, long term exposure to gases.

Typical cell life for vehicle emission applications:

CO cell: 5-10 years
NO2 cell: 2-3 years

When the cell becomes depleted, a replacement sensor element can be ordered from CTI.

Simply unscrew the sensors cover and unplug the sensor element from the circuit board.

Replacement sensor element order #:

Order #	Description
SENS-CO-EC	Carbon Monoxide electrochemical replacement sensor element
SENS-NO2-EC	Nitrogen Dioxide electrochemical replacement sensor element

Note: The new replacement cell should be calibrated upon installation. The sensor requires up to a 1-hour stabilization time before zeroing but can be span-calibrated immediately.

TROUBLESHOOTING

Communication Fault:

A Communication fault can occur if the detector loses communication with the controller. COMM FAULT will flash on the screen until communication is restored.

This is usually a wiring problem but can also occur if another detector on the network shares the same Modbus ID or if there is a hardware failure of the detector.

Check the RS-485 Modbus communication wiring. In most cases, if there is a break in communication wiring, all detectors after the break will be inoperative and should be obvious when viewed at the controller. If the COMM FAULT is isolated to only one detector, check all wiring and screws terminals at the detector. See page 6 for wiring recommendations. Contact CTI if problem persists.

SPECIFICATIONS

Input Voltage: +24 VDC, (10-30 Vdc), power supply with isolation or class II power supply
Max Current Draw: 10mA
Display: LCD, monochromatic, 0.9"x0.9"
Communication: RS-485, Modbus RTU
Terminal Block Plug (Field Wiring): 26-12 AWG, torque 4.5 lbs-in.

Wiring Connections:
Comms: RS-485 communication cable, 22 AWG, twisted pair, shielded, stranded, with drain wire (Alpha Wire 6460, Belden 3077F, or equivalent)
Power: 18 AWG, 2-conductor, shielded, stranded with drain wire (General Cable C2534A or equivalent).
Enclosure:
Injection-molded, washdown-duty, polycarbonate sensor housing with hinged lid and captive screw. For non-classified areas.

Dimensions:
7.75" high x 6.5" wide x 3.875" deep
Weight: 3 lbs
Operating Temperature:
-4°F to 122°F (-20°C to 50°C)
Certification: SGS Listed:
Conforms to UL 61010-1
Certified to CSA C22.2 No. 61010-1

Sensor element	SENS-CO-EC	SENS-NO2-EC
Sensor technology	Electrochemical	Electrochemical
Gas	Carbon Monoxide (CO)	Nitrogen Dioxide (NO2)
Detection range (ppm)	0-200	0-10
Resolution (ppm)	1	0.1
Cal gas range (% of full-scale)	25 to 100	25 to 100
Response time seconds (T90)	<60	<120
Recovery time seconds (T10)	<120	<180
Linearity (% of full-scale)	+/- 1%	+/- 1%
Accuracy (% of full-scale)	+/- 2%*	+/- 2%*
Operating Temperature (°F/°C)	-40 to +122 / -40 to +50	-4 to +122 / -20 to +50
Operating humidity (RH)	15-90%	15-90%

* Dependent on calibration gas accuracy and time since last calibration.

MODBUS REGISTER MAP

Input Register Map

Input Reg	Register	Type	NR	Min	Max	Notes
2	Xmtr SN	IR	2	0	999999999	
8	PCB SN	IR	2	0	999999999	
10	S1 Zero	IR	2	-1,000,000.000	1,000,000.000	PPM (((0 to 2B)-1B)/1000)
12	S1 Span	IR	2	-1,000,000,000	1,000,000,000	PPM (((0 to 2B)-1B)/1000)
14	S1 Unit of Measure	IR	3	ASCII	ASCII	5 Char, 2 ASCII bytes per Reg
17	S1 Gas Short	IR	5	ASCII	ASCII	9 Char, 2 ASCII bytes per Reg. Short Name
22	S1 Gas Long	IR	11	ASCII	ASCII	20 Char, 2 ASCII bytes per Reg. Long Name
33	S2 Zero	IR	2	-1,000,000,000	1,000,000,000	PPM (((0 to 2B)-1B)/1000)
35	S2 Span	IR	2	-1,000,000,000	1,000,000,000	PPM (((0 to 2B)-1B)/1000)
37	S2 Unit of Measure	IR	3	ASCII	ASCII	5 Char, 2 ASCII bytes per Reg
40	S2 Gas Short	IR	5	ASCII	ASCII	9 Char, 2 ASCII bytes per Reg. Short Name
45	S2 Gas Long	IR	11	ASCII	ASCII	20 Char, 2 ASCII bytes per Reg. Long Name
56	S1 Cal Interval	IR	1	0	24	Months, 30 days/month if no RTC is available
57	S2 Cal Interval	IR	1	0	24	Months, 30 days/month if no RTC is available
58	HW Revision	IR	1	0	65535	
62	Xmtr SW Revision	IR	1	0	255.255	Major [b15..b8], Minor [b7..b0]
90	Signal 2 Value	IR	1	-0.2500	1.2500	% FS (((0 to +15,000)-2,500)/10,000)
91	Signal 1 Value	IR	1	-0.2500	1.2500	% FS (((0 to +15,000)-2,500)/10,000)
93.b0	Device Power Up	b0		FALSE	TRUE	Device is in Power-Up Mode
93.b2	S1 Over Range	b2		FALSE	TRUE	Signal is Overranged
93.b4	S1 Fault	b4		FALSE	TRUE	Sensor has a Fault
94.b2	S2 Over Range	b2		FALSE	TRUE	Signal is Overranged
94.b4	S2 Fault	b4		FALSE	TRUE	Sensor has a Fault

WARRANTY

Limited Warranty & Limitation of Liability

Calibration Technologies, Inc. (CTI) warrants this product to be free from defects in material and workmanship under normal use and service for a period of two years, beginning on the date of shipment to the buyer. This warranty extends only to the sale of new and unused products to the original buyer. CTI's warranty obligation is limited, at CTI's option, to refund of the purchase price, repair, or replacement of a defective product that is returned to a CTI authorized service center within the warranty period. In no event shall CTI's liability hereunder exceed the purchase price actually paid by the buyer for the product.

This warranty does not include:

a) routine replacement of parts due to the normal wear and tear of the product arising from use;

b) any product which in CTI's opinion has been misused, altered, neglected or damaged by accident or abnormal conditions of operation, handling or use;

c) any damage or defects attributable to repair of the product by any person other than an authorized dealer or contractor, or the installation of unapproved parts on the product

The obligations set forth in this warranty are conditional on:

a) proper storage, installation, calibration, use, maintenance and compliance with the product manual instructions and any other applicable recommendations of CTI;

b) the buyer promptly notifying CTI of any defect and, if required, promptly making the product available for correction. No goods shall be returned to CTI until receipt by the buyer of shipping instructions from CTI; and

c) the right of CTI to require that the buyer provide proof of purchase such as the original invoice, bill of sale or packing slip to establish that the product is within the warranty period.

THE BUYER AGREES THAT THIS WARRANTY IS THE BUYER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. CTI SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, WHETHER ARISING FROM BREACH OF WARRANTY OR BASED ON CONTRACT, TORT OR RELIANCE OR ANY OTHER THEORY.

CT50-DOC2-1
Software version 2.3
20230220

CALIBRATION TECHNOLOGIES INC.
GAS DETECTION SPECIALISTS