Critical Environment Technologies™

Operation Manual

Rev. E | 2014.10

GEM-II Self Contained Gas Detector

www.critical-environment.com

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1 POLICIES

1.1 Important Note

Read and understand this manual prior to using this instrument. Carefully read the warranty policy, service policy, notices, disclaimers and revisions on the following pages.

This product must be installed by a qualified electrician or factory trained technician and according to instructions indicated in this manual. This instrument should be inspected and calibrated regularly by a qualified and trained technician. For more information, refer to Sections *8 Calibration* and *10 Maintenance* of this manual.

This instrument has not been designed to be intrinsically safe. For your safety, **do not** use it in classified hazardous areas (explosion-rated environments).

INSTRUMENT SERIAL NUMBER:

_____

PURCHASE DATE:

_____

PURCHASED FROM:

_____

1.2 Warranty Policy

- Disconnect power before servicing
- Caution: More than one live circuit
- Supply: 24 V (nominal, 50 or 60 Hz)
- Certified for electrical shock and electrical fire hazard only

Critical Environment Technologies Canada Inc. (CETCI), also referred to as the manufacturer, warrants this instrument, (excluding sensors, battery packs, batteries, pumps and filters) to be free from defects in materials and workmanship for a period of **two years from the date of purchase from our facility.** The sensors have a warranty period of **one year on a pro-rated basis from the date of purchase from our facility**. If the product should become defective within this warranty period, we will repair or replace it at our discretion.

The warranty status may be affected if the instrument has not been used and maintained per the instructions in this manual or has been abused, damaged, or modified in any way. This instrument is only to be used for purposes stated herein. The manufacturer is not liable for auxiliary interfaced equipment or consequential damage.

Due to ongoing research, development, and product testing, the manufacturer reserves the right to change specifications without notice. The information contained herein is based on data considered accurate. However, no warranty is expressed or implied regarding the accuracy of this data.

All goods must be shipped to the manufacturer by prepaid freight. All returned goods must be pre-authorized by obtaining a Returned Merchandise Authorization (RMA) number. Contact the manufacturer for a number and procedures required for product transport.

1.3 Service Policy

CETCI maintains an instrument service facility at the factory. Some CETCI distributors / agents may also have repair facilities; however, CETCI assumes no liability for service performed by anyone other than CETCI personnel.

Repairs are warranted for 90 days after date of shipment (sensors have individual warranties).

Should your instrument require non-warranty repair, you may contact the distributor from whom it was purchased or you may contact CETCI directly.

Prior to shipping equipment to CETCI, contact our office for an RMA #. All returned goods must be accompanied with an RMA number.

If CETCI is to do the repair work, you may send the instrument, prepaid, to:

Attention: Service Department
Critical Environment Technologies Canada Inc.
Unit 145, 7391 Vantage Way
Delta, BC, V4G 1M3

Always include your Returned Merchandise Authorization (RMA) number, address, telephone number, contact name, shipping / billing information, and a description of the defect as you perceive it. You will be contacted with a cost estimate for expected repairs, prior to the performance of any service work.

For liability reasons, CETCI has a policy of performing all needed repairs to restore the instrument to full operating condition.

Pack the equipment well (in its original packing if possible), as we cannot be held responsible for any damage incurred during shipping to our facility.

1.4 Copyrights

This manual is subject to copyright protection; all rights are reserved. Under international and domestic copyright laws, this manual may not be copied or translated, in whole or in part, in any manner or format, without the written permission of CETCI.

1.5 Disclaimer

Under no circumstances will CETCI be liable for any claims, losses or damages resulting from or arising out of the repair or modification of this equipment by a party other than CETCI service technicians, or by operation or use of the equipment other than in accordance with the printed instructions contained within this manual or if the equipment has been improperly maintained or subjected to neglect or accident. Any of the foregoing will void the warranty.

Under most local electrical codes, low voltage wires cannot be run within the same conduit as line voltage wires. It is CETCI policy that all wiring of our products meet this requirement.

It is CETCI policy that all wiring be within properly grounded (earth or safety) conduit.

1.6 Revisions

This manual was written and published by CETCI. The manufacturer makes no warranty or representation, expressed or implied including any warranty of merchantability or fitness for purpose, with respect to this manual.

All information contained in this manual is believed to be true and accurate at the time of printing. However, as part of its continuing efforts to improve its products and their documentation, the manufacturer reserves the right to make changes at any time without notice. Revised copies of this manual can be obtained by contacting CETCI or visiting www.critical-environment.com.

Should you detect any error or omission in this manual, please contact CETCI at the following address:

Critical Environment Technologies Canada Inc.
Unit 145, 7391 Vantage Way, Delta, BC, V4G 1M3, Canada
Toll Free: +1.877.940.8741
Telephone: +1.604.940.8741
Fax: +1.604.940.8745
Email: marketing@cetci.com
Website: www.critical-environment.com

In no event will CETCI, its officers or employees be liable for any direct, special, incidental or consequential damages resulting from any defect in any manual, even if advised of the possibility of such damages.

2 INTRODUCTION

2.1 General Description

Thank you for purchasing our GEM-II self-contained gas detector.

The GEM series gas detection systems are economical, self-contained, gas detectors for non-hazardous (non-explosion rated) commercial applications. They are available in two basic configurations: one sensor models and two sensor models. The sensors can be configured as one integral (A-type), one remote (B-type), one integral and one remote (D-type), or two integral (E-type).

A basic system provides one set of LED indicating lights representing "Power", "Fail", "Low (Warning) Gas Alarm", 'High Gas Alarm", an integral audible alarm with door mounted silence push-button, audible time delay, field settable relay time delays and two alarm relays. In either system, the LED lights provide visual indication of the status of each channel (Int = internal sensor, Ext = external sensor or second channel).

Gas specific electrochemical sensors for toxic gases and Oxygen (O_2) are available as are MOS solid-state sensors for refrigerants and catalytic sensors for combustible gases. All GEM integral sensors are packaged as plug-in "smart" sensor modules to reduce field maintenance time.

If after reading through the manual, you have any questions, please do not hesitate to contact our service department for technical support.

2.2 Key Features

- Single or dual channel
- Network multiple units
- Integral plug & play "smart" sensors or remote sensors
- 4 – 20 mA linear output signal
- Three conduit entry ports
- Thermal resetting fuse
- LED light indicators
- Two 5-amps SPDT relays
- RoHS compliant circuit boards
- CSA & UL certified

2.3 Model Designations

2.3.1 Type A – Single Channel

Choices for GEM-A:

- One integral electrochemical sensor.

NOTES: Optional LED digital display is shown in the photo.

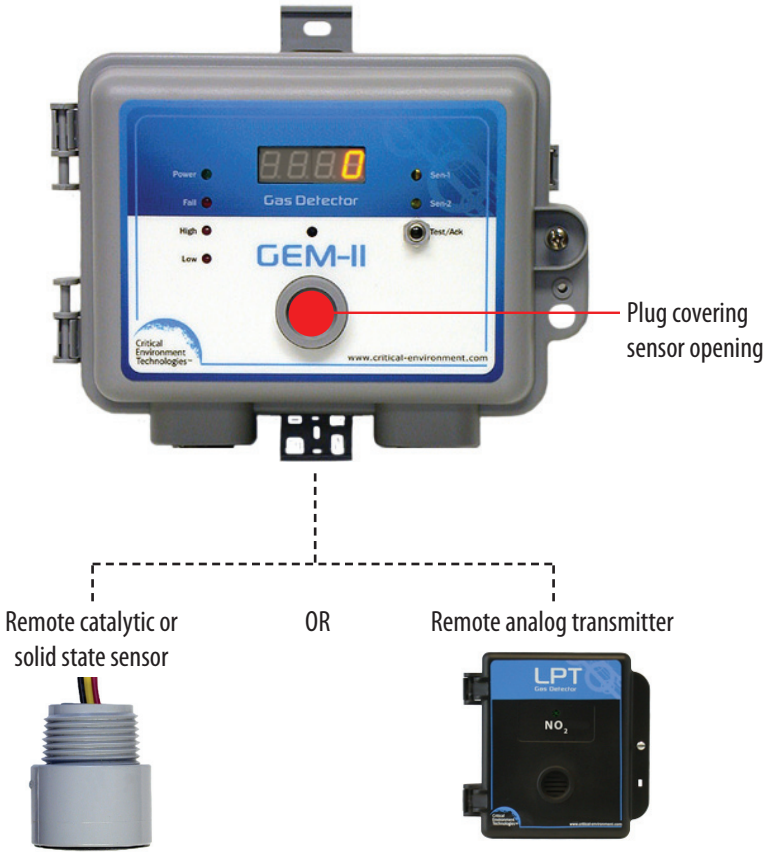
Opening for integral sensor (example: CO) to monitor diffused air and gas.

2.3.2 Type B – Single Channel Controller

Choices for GEM-B:

- One remote catalytic or solid state sensor
- One remote LPT-A or LPT series analog transmitter

NOTES: Optional LED digital display is shown in the photo.



Wiring requirements:

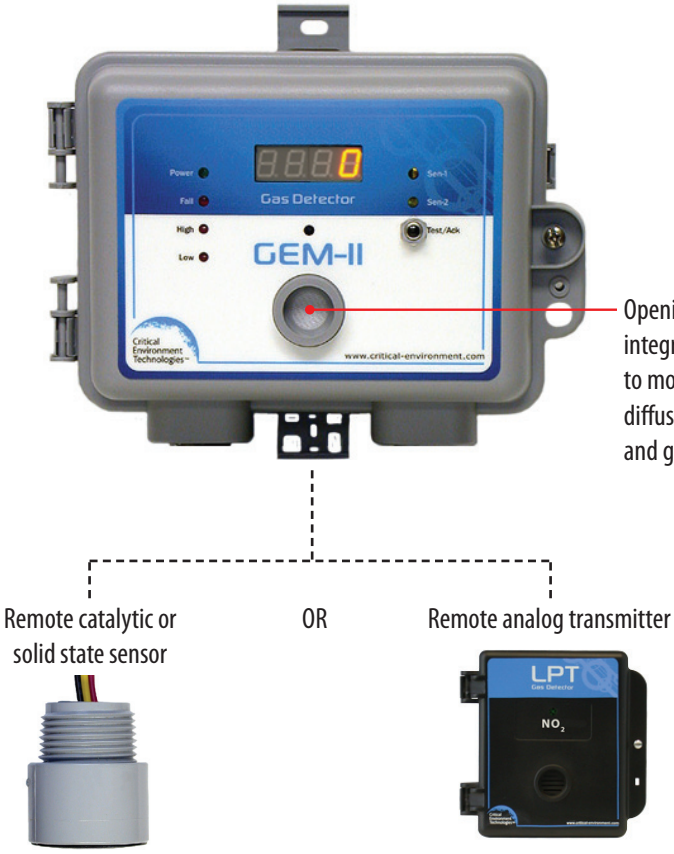
- 3-conductor, 18 gauge to remote sensor.
- 3-conductor shielded to remote analog transmitter.

2.3.3 Type D – Dual Channel

Choices for GEM-D:

- One integral electrochemical sensor (Channel1) PLUS one remote catalytic or solid state sensor (Channel 2).
- One integral electrochemical sensor (Channel1) PLUS one remote LPT-A or LPT series analog transmitter (Channel 2).

NOTES: Optional LED digital display is shown in the photo.



Wiring requirements:

- 3-conductor, 18 gauge to remote sensor.
- 3-conductor shielded to remote analog transmitter.

2.3.4 Type E – Dual Channel

Choices for GEM-E:

- Two integral electrochemical sensors (Channel 1 & 2)

NOTES: Optional LED digital display is shown in the photo.

Opening for TWO integral sensors to monitor diffused air and gas.

Common application is engine exhaust: gasoline or diesel sensors are both integral in the GEM type E version.

3 INSTRUMENT SPECIFICATIONS

3.1 Technical Specifications

GAS TYPE
Carbon Monoxide (CO)
Combustible Gases (catalytic) Hydrogen (H_2), Methane (CH_4), Propane (C_3H_8)
Nitrogen Dioxide (NO_2)
Nitric Oxide (NO)
Oxygen (O_2)
Refrigerants (solid state) R22, R134A, R402A, R404A, R407C, R410A, R422A, R422D, R507A
Sulphur Dioxide (SO_2)
TVOCs (solid state)

MECHANICAL	
Standard Enclosure	General purpose PVC
Standard Weight	600 g (1.2 lb)
Standard Size	5.3" x 6.8" x 2.6" (135 mm x 173 mm x 66 mm)
Watertight Enclosure	Water / dust tight polycarbonate
Watertight Weight	700 g (1.4 lb)
Watertight Size	5.1" x 7.1" x 4.0" (130 mm x 181 mm x 102 mm)

ELECTRICAL	
Power Requirement	15 - 30 VDC or 12 - 28 VAC
Current Draw	Approximately 125 mA
Wiring	VDC three-conductor shielded VAC four-conductor shielded
Circuit	Analog design with microprocessor and user settable time delays, accessible with DIP switches on circuit board.
Fuse	Automatic resetting thermal

INPUT / OUTPUT	
Outputs	Linear 4 - 20 mA (single)
Distance	Maximum 500 ft between controller and remote solid state sensor using minimum 18 gauge wire.
Relays	Two S.P.D.T. dry contact relays, rated 5 amps @ 240 VAC. **NOTES:** 1. System is configured such that all relays are "FAIL SAFE" (relay coils are always energized in non-alarm state). 2. Relays are "common" to both channels (activated by either channel).

USER INTERFACE	
Display	Common set of LED indicating lights for "Power", "Fail", "Low (Warning) Gas Alarm", "High Gas Alarm"

Audible	Integral piezo audible alarm rated 80 dB @ 10' c/w door mounted silence push-button. **NOTES:** Audible alarm & silence push-button are right side mounted on water tight enclosure.
Time Delays	
Delay "ON" (on make), DIP switch	Low alarm relay: 2 minutes High alarm relay: 5 minutes
Delay "OFF" (on break), DIP switch	Also known as "minimum run time" Low alarm relay: 10 minutes High alarm relay: not available
Audible (on make), DIP switch	10 minutes
	NOTES: Time delays can be changed by user. Reference Section *7 Operation*. DIP switches are still used to enable or disable time delays.

SENSOR

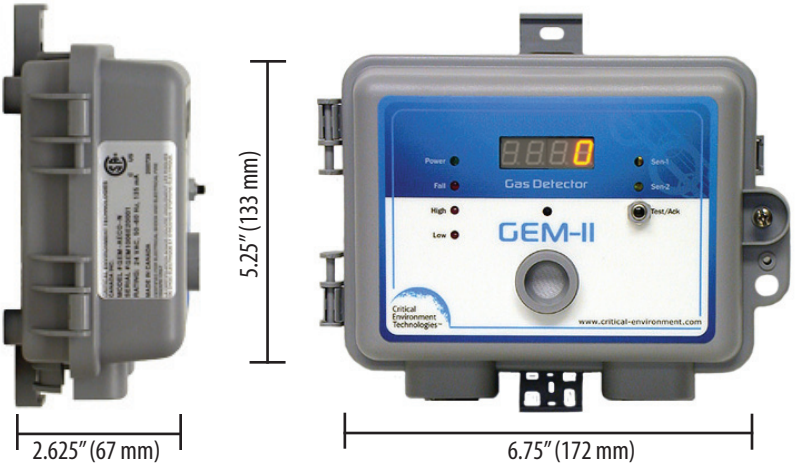
Enclosure	Molded PVC
Integral	Electrochemical only **NOTES:** All integral electrochemical gas sensors are packaged as "smart" sensor modules.
Remote	Solid State sensor for refrigerants and TVOCs Catalytic sensor for combustible gases Analog transmitter, LPT-A or LPT (4 – 20 mA signal)

ENVIRONMENTAL *(sensor dependant)*

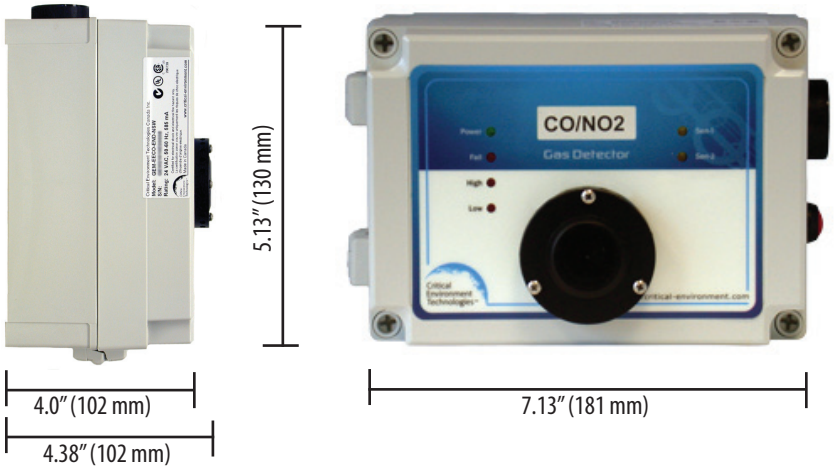
Operating Temperature	-20°C to 50°C (-5°F to 120°F)
Operating Humidity	15 - 90% RH non-condensing

CERTIFICATION	
CSA	Certified
UL	Certified

3.2 Standard Enclosure Dimensions



3.3 Watertight Enclosure Dimensions



4 SENSOR SPECIFICATIONS

4.1 Common Sensor Specifications

Carbon Monoxide (CO)	
Type	Electrochemical
Response Time	<30 seconds to 90% of signal response
Operating Temperature	0°C to 50°C (32°F to 120°F)
Repeatability	± 10% of set point
Life Span	3 years in air (under normal conditions)

Nitric Oxide (NO)	
Type	Electrochemical
Response Time	<30 seconds to 90% of signal response
Operating Temperature	0°C to 50°C (32°F to 120°F)
Repeatability	± 10% of set point
Life Span	2 years in air (under normal conditions)

Nitrogen Dioxide (NO_2)	
Type	Electrochemical
Response Time	<30 seconds to 90% of signal response
Operating Temperature	0°C to 50°C (32°F to 120°F)
Repeatability	± 10% of set point
Life Span	3 years in air (under normal conditions)

Sulphur Dioxide (SO_2)	
Type	Electrochemical
Response Time	<30 seconds to 90% of signal response
Operating Temperature	0°C to 50°C (32°F to 120°F)
Repeatability	± 10% of set point
Life Span	2+ years in air (under normal conditions)

Temperature (°C or °F)	
Range	-20°C to 40°C (-4°F to 104°F)

4.2 Remote Sensor Specifications

1. Remote sensor module: The remote sensor housing accommodates one catalytic or one solid-state sensor. 2. Any 4-20 mA analog transmitters manufactured by CETCI (LPT-A or LPT series).

Combustible Gases	
Type	Catalytic
Response Time	<10 seconds to 90% of signal response
Operating Temperature	-10°C to 50°C (14°F to 122°F)
Repeatability	± 10% of set point
Life Span	5 years in air (under normal conditions)
Typical Gas Examples	Hydrogen (H_2), Propane (C_3H_8), Methane (CH_4)

Refrigerants	
Type	Solid state
Response Time	<120 seconds to 90% of signal response
Operating Temperature	0°C to 40°C (32°F to 104°F)
Long Term Drift	< 5% signal loss / month at ambient temperatures
Repeatability	± 10% of set point
Life Span	5 years in air (under normal conditions)
Typical Gas Examples	R11, R12, R22, R134A, R404A, R407C, R410A, R422A, R422D, R438A, R507A

4.3 Calibration Extending Firmware (CEF) and Sensor Aging

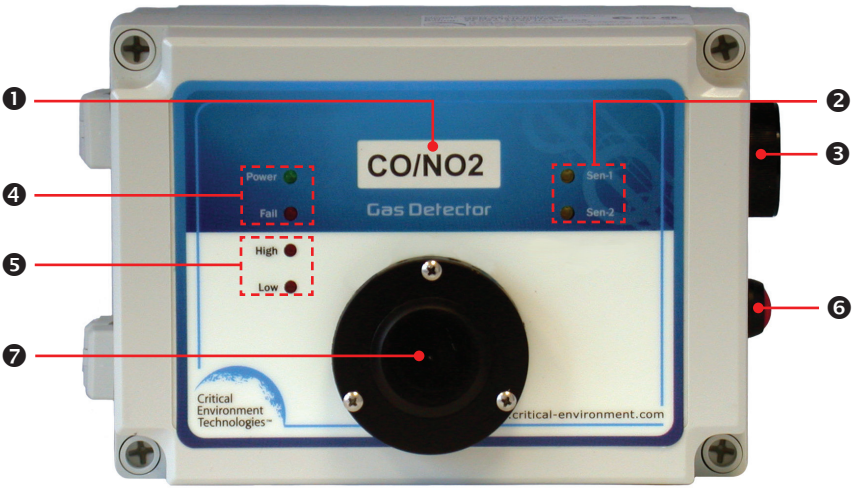
GEM systems with integral electrochemical sensors have been programmed with our CEF (Calibration Extending Firmware). This firmware takes into consideration the aging of the electrochemical CO, NO and NO_2 sensors so that less frequent calibrations are acceptable in non-critical applications such as parking garages. The system tracks the age of the sensor and automatically compensates for the degraded output of the sensor as it ages.

5 FEATURES & FUNCTIONS

5.1 Standard Exterior Enclosure

NUMBER	FEATURE	FUNCTION
❶	Digital Display	Optional LED digital display
❷	LED Sensor Indicators	Indicates Channel 1 or Channel 2
❸	Door Latch	Secures door
❹	LED Indicators	Indicates Power & Fail
❺	Door Screw	Secures door
❻	Gas Alarm LED	Indicates High and Low alarm levels
❼	Alarm Acknowledge-Test	Push button for alarm acknowledgement & testing
❽	Audible Alarm	Internal audible alarm
❾	Sensor Opening	To monitor diffused air and gas
❿	Padlock Opening	For padlock

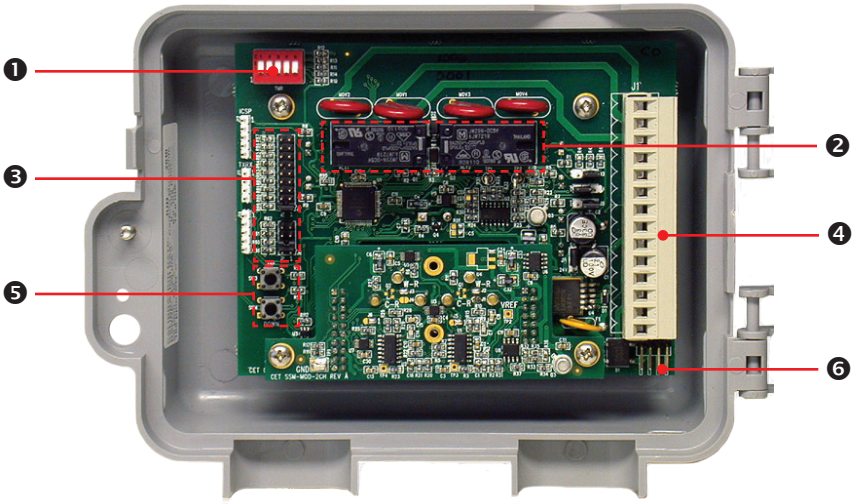
5.2 Watertight Exterior Enclosure



NUMBER	FEATURE	FUNCTION
❶	Digital Display	Optional LED digital display
❷	LED Sensor Indicators	Indicates Channel 1 or Channel 2
❸	Audible Alarm	Watertight audible alarm & silence push button
❹	LED Indicators	Indicates Power & Fail
❺	Gas Alarm LED	Indicates High and Low alarm levels
❻	Silence Button	Watertight silence push button
❼	Splash Guard	Optional splash guard secured with stainless steels screws

NOTE: Audible alarm and silence push button were moved to right of enclosure to maintain water tightness of enclosure.

5.3 Interior System Layout



NUMBER	FEATURE	FUNCTION
❶	Dip Switches	For access to time delays
❷	Dry Contact Relays	For Low & High Alarm
❸	Jumpers	For calibrations & other service set-up functions
❹	Wiring Terminal	Pluggable wiring terminal
❺	Push Buttons	For service access & additional test functions
❻	Half Wave / Full Wave Jumper (J2)	For configuring for 24 VAC operation

6 INSTALLATION

6.1 AC and DC Wiring

The GEM is a low voltage powered gas detector. All wiring should be run within properly grounded (earth or safety) conduit. Signal output and supply should be in shielded cable. The remote sensor wiring should be done with four conductor shielded 18 awg stranded wire in a separate conduit from all other wiring.

THREE WIRE CONNECTION

If providing VDC or VAC Ground Referenced use terminals 12 & 13. This is now a Half Wave device in this configuration Please observe polarity. The Ground referenced AC must be connected to terminal 12. J2 open. Factory default.

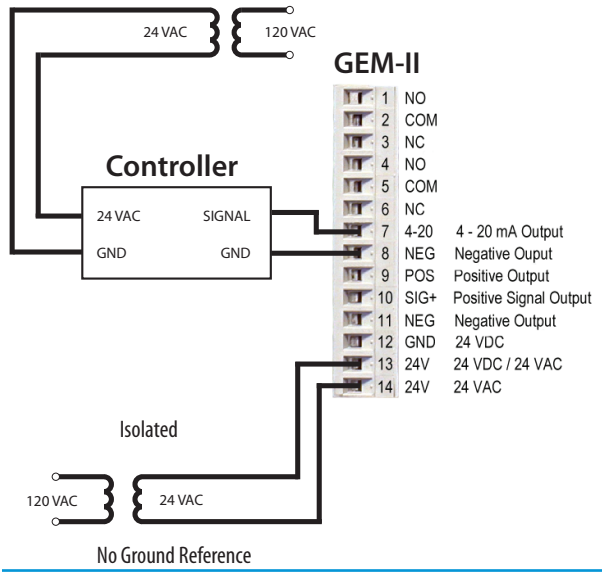
FOUR WIRE CONNECTION

If providing VAC power, using terminals 13 & 14. This is now a Full Wave device in this configuration, and requires a isolated supply (separate 24 VAC transformer with NO Ground connections) and J2 be shorted.

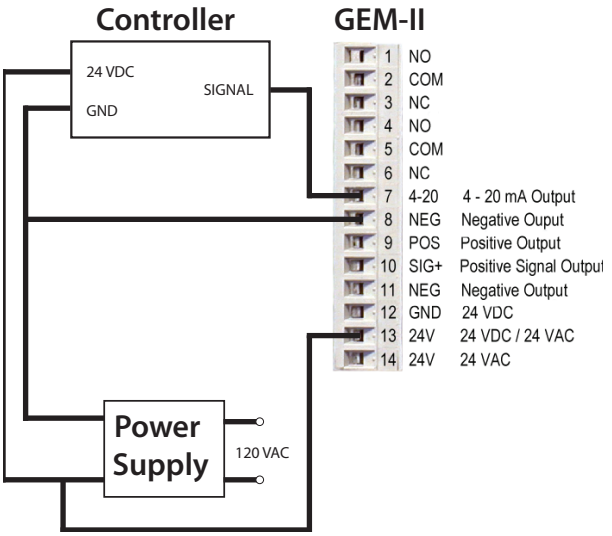
See drawings below – if uncertain contact CETCI service for assistance.

IMPORTANT: WIRING EXAMPLES: NON GROUNDED REFERENCE SUPPLIES ONLY

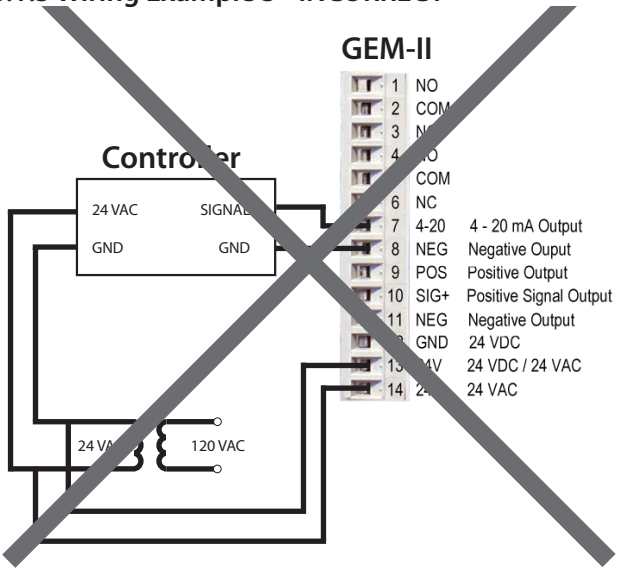
6.1.1 Wiring Example 1



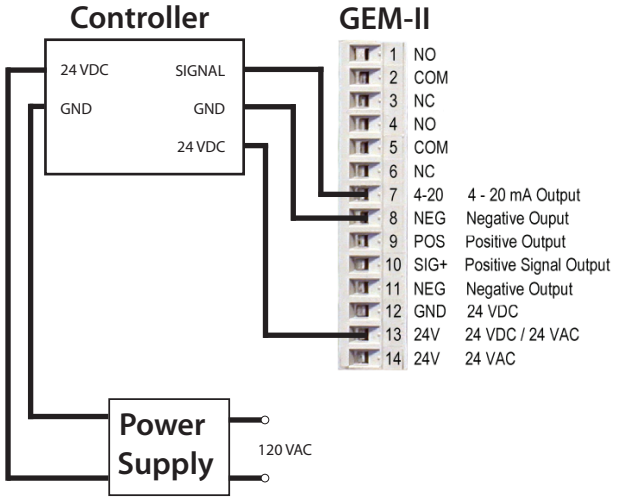
6.1.2 Wiring Example 2



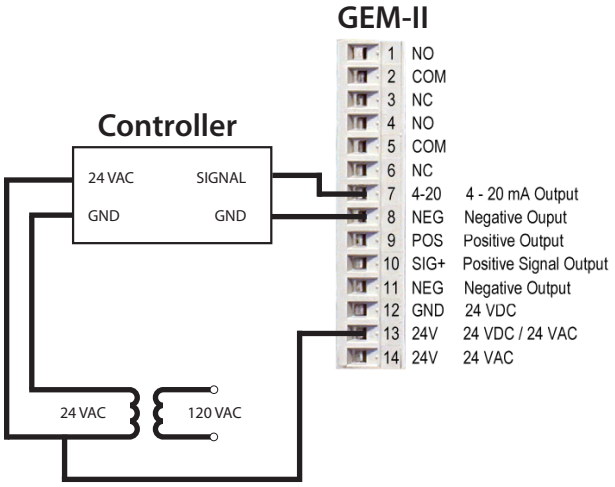
6.1.3 Wiring Example 3 - INCORRECT



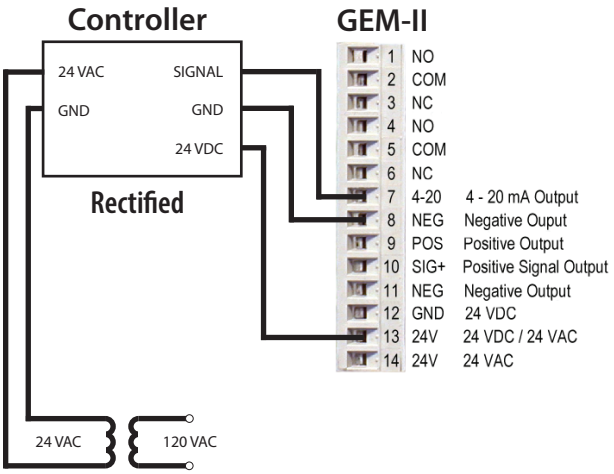
6.1.4 Wiring Example 4



6.1.5 Wiring Example 5 (J2 Removed)



6.1.6 Wiring Example 6 (J2 Removed)



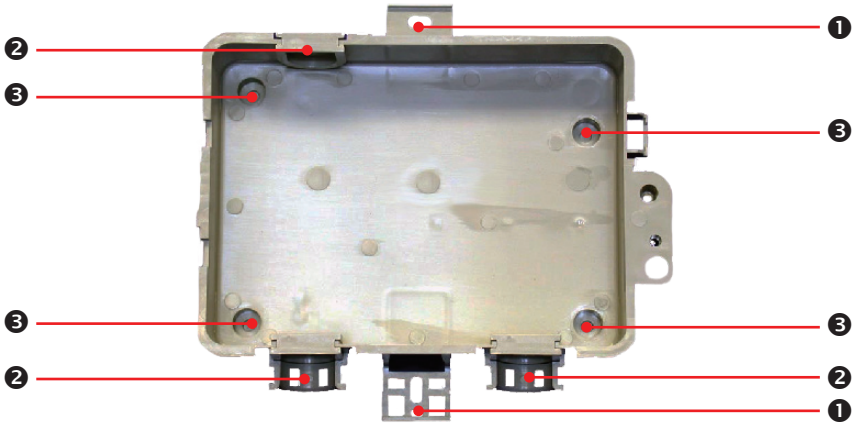
6.2 Sensor Mounting Heights

GAS	APPLICATIONS / TYPES	SUGGESTED MOUNTING HEIGHT
Carbon Monoxide (CO)	Gas engine exhaust	4 - 6 ft from the floor
Nitric Oxide (NO)	Diesel engine exhaust	
Nitrogen Dioxide (NO_2)	Diesel engine exhaust	
Sulphur Dioxide (SO_2)	All	6" from the floor
Combustibles	Propane (C_3H_8)	
	Methane (CH_4)	on or near ceiling (within 12")
	Hydrogen (H_2)	
Refrigerants	All	6: fromthe floor or near likely spot for leakage

NOTE: CETCI considers 4 - 6 ft from the floor as the "Breathing Zone" when it applies to sensors installed for vehicle exhaust applications.

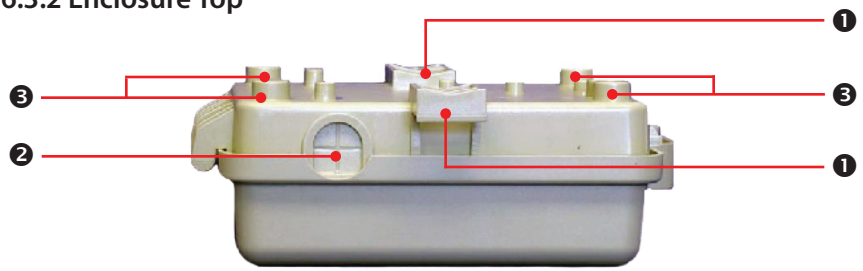
6.3 Standard Enclosure Mounting Components

6.3.1 Enclosure Base



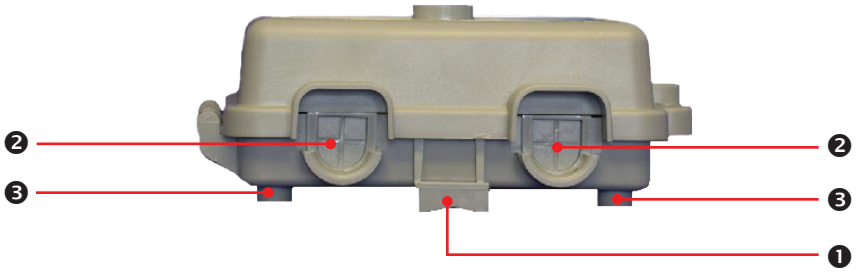
NUMBER	FEATURE
❶	Molded-in mounting bracket
❷	Conduit Entry
❸	Alternative mounting holes

6.3.2 Enclosure Top



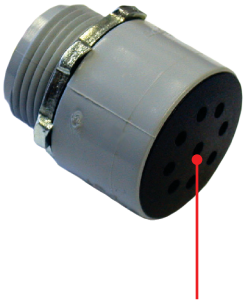
NUMBER	FEATURE
❶	Molded-in mounting bracket
❷	Conduit Entry
❸	Alternative mounting holes

6.3.3 Enclosure Bottom

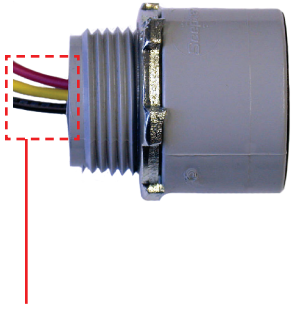


NUMBER	FEATURE
❶	Molded-in mounting bracket
❷	Conduit Entry
❸	Alternative mounting holes

6.4 Remote Sensor Housing



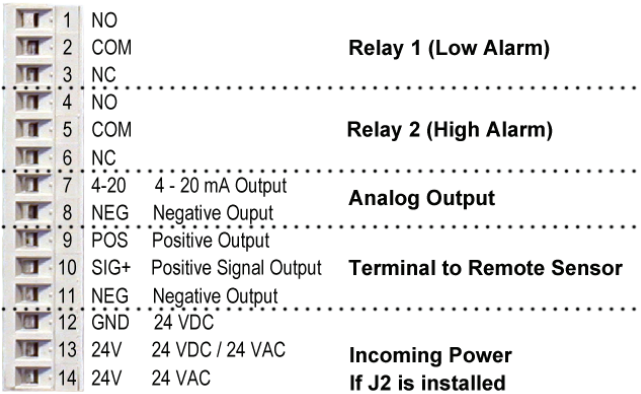
Catalytic or solid state sensor breathes through these openings.



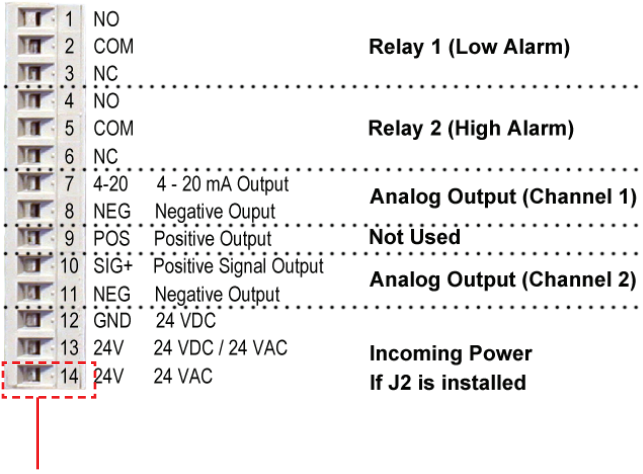
Wiring:
1. Red (+)
2. Yellow (Signal)
3. Black (-)

6.5 Wiring Connections

6.5.1 Types A, B and D



6.5.2 Type E



Has a sticker placed over area that says See Wiring. Remove to install J2.

6.6 Important Notes for Wiring

GEM is a low voltage powered gas detector. If providing VAC power, use terminals 12 & 13. If providing VDC power, use terminals 12 & 13 and observe polarity. Reference Section *6.5 Wiring Connections*.

Fan / alarm control wiring is terminated at terminals 1 to 6. The relays are designed to switch fan "starters" not the fans directly. The relay contacts are rated 5 amps @ 240 VAC each, S.P.D.T.

An analog output of 4 - 20 mA is available for one or two sensors. Channel 1 sensor analog outputs are achieved by wiring to terminals 7 & 8 and observe polarity. Channel 2 sensor analog outputs are achieved by wiring to terminals 10 & 11.

Specific GEM types will also act as controllers to which remote transmitters can be connected. GEM Type "B" and type "D" will accommodate one remote sensor or analog transmitter. To connect one remote sensor or analog transmitter to a GEM, use terminals 9, 10 & 11 and observe polarity.

6.7 System Installation

There are two exterior mounting brackets, one top and one bottom of the base of the enclosure. Alternatively, remove the slot / Robertson head screw securing the hinged door. There are four only 3/16" diameter corner mounting holes located inside the system enclosure base. Secure the system to any flat surface.

6.7.1 Low Voltage Power

Drill out one or more of the PVC conduit entry hole plugs located at bottom left or right or top left edge of system enclosure base. Reference Section *6.3 Standard Enclosure Mounting Component*s.

If supplying VAC operational power, pull two wires suitable for low voltage from power source to the terminals 13 & 14 for Full Wave operation.

If supplying VDC or VAC, wire to terminals 12 & 13. J2 Removed. Factory default.

NOTE: Maximum distance between the GEM and a remote sensor should not exceed 500 ft.

6.7.2 Wiring to Remote Sensor

Three-conductor, 16 - 18 gauge, stranded wire is required between the control panel and the remote solid-state sensor (reference Section *6.8 Installation Examples, Type D with Onboard & Remote Sensors and Type E with Two Onboard Sensors*). Under most local electrical codes, low voltage wires cannot not be run within the same conduit as line voltage wires. 3-conductor, 16 - 18 gauge wire / cable must be shielded when connecting to a remote analog transmitter. The LPT-A or LPT series remote analog transmitter enclosures have several conduit entry locations (general purpose enclosure).

NOTE: DO NOT use solid-core wire for connection to wiring terminal strip. Any damage caused by using solid-core wire will void warranty. Use stranded wire within conduit ONLY.

6.7.3 Voltage to Remote Sensors

The voltage supplied by the controller to remote solid state sensors should measure approximately 5.0 VDC ± 2%, at the remote sensor. Voltage supplied by the controller to remote analog transmitters should measure approximately 24 VDC nominal. This voltage is factory set at time of manufacturing. If these voltages are not attained after installation, the wrong gauge wire may have been used or the wiring run is too long.

The remote sensor housing comes with a 3/4" conduit thread and nut to allow installation in any standard electrical junction box (to be supplied by the installer). Connect three low voltage wires between it and the controller and observe polarity.

6.7.4 Relay Connections

System relays are dry contacts and designed to operate fan starters or coils to control equipment that draws more than 5 amps start-up and / or operational current.

NOTES:

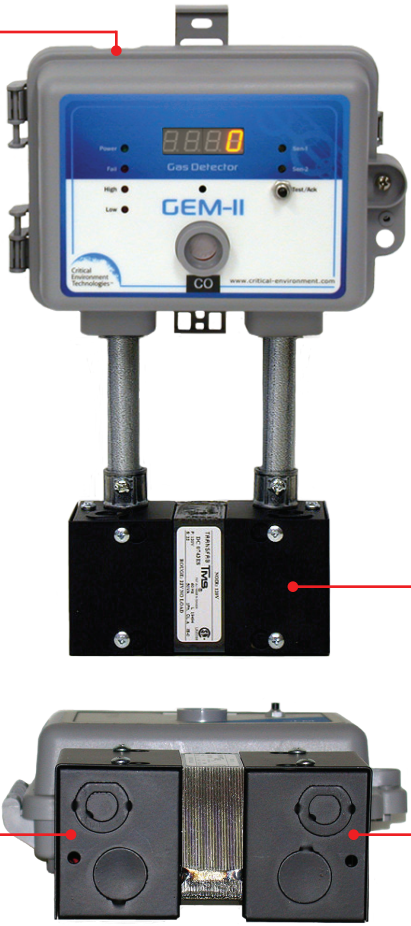
1. The system does not provide any power from these terminals. Dry contacts operate like a switch to simply activate (switch on) or de-activate (switch off) equipment to be controlled, such as fan starters.
2. System relays are S.P.D.T. (single pole, double throw) thereby providing one set of usable dry contacts for each relay. Because the GEM series systems are designed to be fail-safe, any equipment to be controlled by the system relays should be wired to the "NC" (Normally closed) and "COM" (Common) terminals. The relay coils are normally energized in non-alarm state for fail-safe operation.

Upon application of power, the green LED light indicator(s) will illuminate and the LED between Sen-1 & Sen-2 will be blinking but all alarms are disabled for 2 minutes for a system warm up period. After the warm up period, the system may exhibit gas alarm condition(s) if one or both of the sensors has not completely stabilized during the warm up period. This is normal and the length of time the gas alarms exist is dependent upon the length of time since the unit was last powered up and the state of the environment it is installed in. After warm up, only the green power LED(s) illuminate indicating normal operation and the relays are energized indicating normal "Fail-safe" status.

6.8 Installation Examples

6.8.1 Type A with Internal Sensor and Enclosed Transformer

Line voltage can enter through the upper conduit entry port.



GEM Type A is a controller with one integral electrochemical sensor.

Low voltage and line voltage are segregated in this transformer.

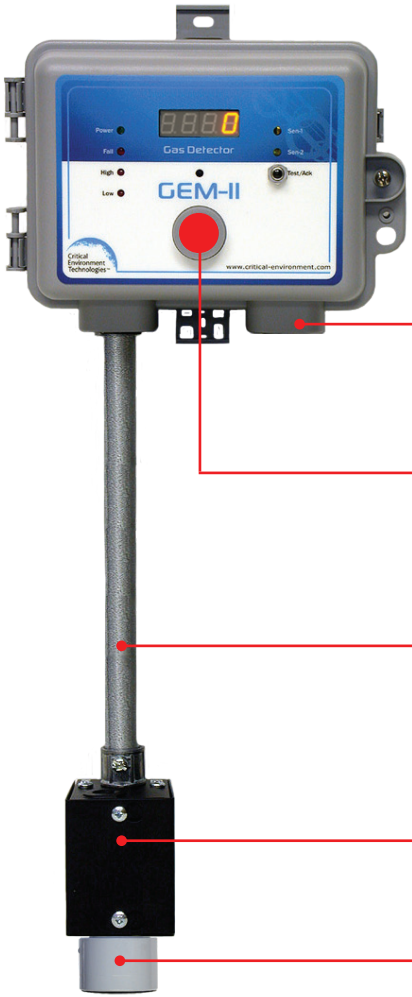
Line voltage side of enclosed transformer.

Line voltage side of enclosed transformer.

NOTES for Type A with Enclosed Transformer:

1. Enclosed transformer shown in this photo is an optional accessory.
2. Conduit stubs shown in this photo are not supplied.
3. This photo is representative of just one way to install transformer.
4. This photo shows the optional LED digital display

6.8.2 Type B with Remote Sensor or Analog Transmitter



GEM Type B is a controller with one remote catalytic or solid state sensor or one remote analog transmitter.

This image shows the GEM Type B with a remote catalytic or solid state sensor.

Mounting height 4 - 6 ft from the floor (the "breathing zone")

Installer supplied low voltage operating power.

Rubber plug covering what would normally be opening for sensor to breathe.

Conduit and 3-conductor wire to remote sensor supplied by installer.

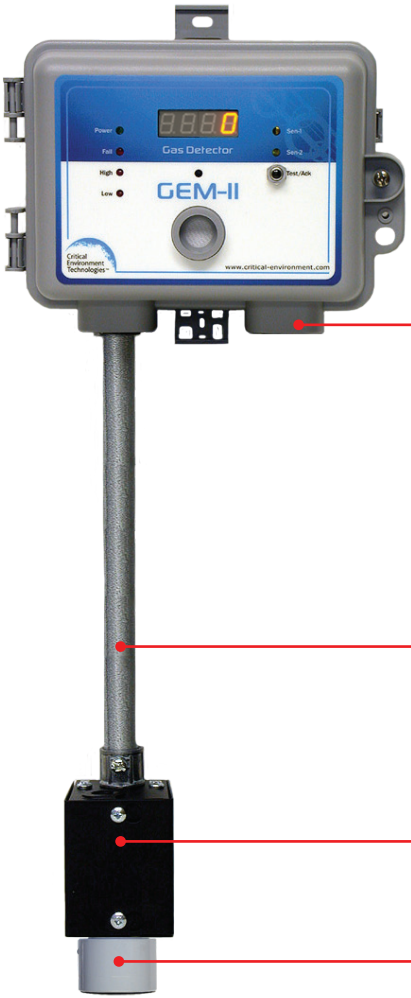
Standard electrical junction box must be supplied by installer

Remote sensor

NOTES for Type B with Remote Sensor or Analog Transmitter:

1. This photo shows the optional LED digital display.
2. In this installation, the remote sensor is for heavier than air gases such as propane or a solid state refrigerant gas so the sensor should be installed 6" from the floor or near the most likley are to leak.

6.8.3 Type D with One Internal & One Remote Sensor



GEM Type D is a controller with one integral electrochemical sensor and one remote catalytic, or solid state sensor, or one remote analog transmitter.

Mounting height 4 - 6 ft from the floor (the "breathing zone")

Installer supplied low voltage operating power.

Conduit and 3-conductor wire to remote sensor supplied by installer.

Standard electrical junction box must be supplied by installer

Remote sensor

NOTES for Type D with One Internal & One Remote Sensor:

1. This photo shows the optional LED digital display.
2. In this installation, the remote sensor is for heavier than air gases such as propane or a solid state refrigerant gas so the sensor should be installed 6" from the floor or near the most likley are to leak.

6.8.4 Type E with Two Internal Sensors

GEM Type E is a controller with two integral electrochemical sensors.

Two integral electro-chemical sensors such as CO (gas engine exhaust) & NO_2 (diesel engine exhaust)

7 OPERATION

7.1 System Operation

In the event of a burned-out, damaged or missing catalytic or solid state sensor element, the controller will indicate fail condition on the front door by illumination of the red fail LED. At this point, both system relays will have reversed state (de-energized) and anything connected to them will be running continuously. Normal system operation will not occur until the fault condition has been rectified. The same condition will occur if the 4 - 20 mA signals from the remote LPT-A or LPT transmitter are broken or interrupted.

NOTES:

1. Fail condition overrides any system time delays that may have been set.
2. Reference photo in Section *5.1 Standard Exterior Enclosure* for location of LEDs, and test-buttons.

In the event of a gas build up beyond the preset low alarm trip point, the CH-1-Int. LED (outer door right side) illuminates, the "Low" alarm level LED (red - outer door left side) illuminates and the low alarm relay de-energizes activating anything controlled by it. If a time delay "ON" has been set (internal DIP switches), then the "Low" alarm LED will "flash" indicating the time delay has been activated and the low alarm relay will not de-energize until the delay has timed out. Once the low alarm relay has de-energized, it will re-energize automatically once the gas alarm condition goes away, unless a time delay "OFF" (minimum run time - internal DIP switches) has been programmed. The same procedure applies to CH-2 Ext. in the case of a two channel (two sensors) system.

In the event of a gas build up beyond the preset high alarm trip point, the "CH-1" LED (outer door right side) illuminates, the "High" alarm level LED (red - outer door left side) illuminates and the high alarm relay de-energizes activating anything controlled by it. If a time delay "ON" has been set (internal DIP switches), then the "High" alarm LED will "flash" indicating the time delay has been activated and the high alarm relay will not de-energize until the delay has timed out. Once the high alarm relay has de-energized, it will re-energize automatically once the gas alarm condition has dispatched. The same procedure applies to the second channel in the case of a two channel (two sensors) system.

NOTE: No minimum run time delay is provided for the high alarm relay.

7.2 Test Functions

A momentary test feature is provided to allow the user to test basic functionality of the circuit. Press the "UP" push-button (internal) for 5-seconds, the audible alarm will beep once to indicate it is in the 5-second test function. Release the "UP" push-button after 5-seconds and an automatic test function will occur.

Alternatively use the silence push-button on the front door to perform the same function.

The low alarm relay will de-energize and the low alarm LED on the front door will illuminate. The low alarm relay will then re-energize while the low alarm LED stays lit for 10-seconds.

Next, the high alarm relay will de-energize, the high alarm LED on the front door will illuminate and the audible alarm will activate. The relay will then re-energize but the high alarm LED and the audible alarm will stay activated for 10-seconds. After 10-seconds, everything resets to normal operating condition.

If a longer test sequence is desired, hold down the "UP" push-button for 10-seconds to activate the low alarm relay, high alarm relay, low alarm LED, and high alarm LED for 15-minutes.

To abort this test, press the internal "UP" push-button or the exterior silence push-button and everything will reset to normal operating condition.

If the GEM is equipped with a digital display, it will indicate "test" during this test period.

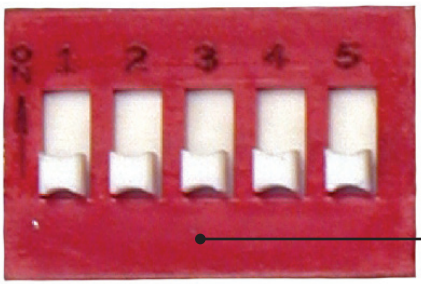
Voltage Output to Test Points "TP-1" and "TP-2":

NOTE: The voltage output when jumper J6 is set to the resting position "1" is 4.0 VDC.

Attach the meter leads to the two test points (TP-1 & TP-2) located just below the high alarm relay (RL V2) on the main circuit board. Set the meter to volts DC with one decimal point. The range of 0-4.0 VDC is equal to the full measurement range of the sensor. Eg. HVAC CO sensor has a standard measurement range of 0 - 200 ppm. Therefore 4.0 VDC = 200 ppm.

Move the Jumper J6 to position 2 when monitoring the Internal Sensor or in position 3 for the External Sensor.

7.3 Dip Switch Package



Located upper left corner of main circuit board.

Dip switch - position description:

- 5) Audible "on" / "off"
- 4) Audible alarm time delay "on" (5-min.)
- 3) High gas alarm time delay "on" (5-min.)
- 2) Low gas alarm time delay "off" (10-min.)
- 1) Low gas alarm time delay "on" (2-min.)

NOTES:
1. Dip switches in the "up" position are "on".
2. Time delay durations can be changed by user.
3. Fixed delay durations indicated above are factory default settings.

7.4 Internal Audible Alarm Operation

If DIP switch "5" is in the "up" position, the internal audible alarm responds to whatever commands it is given by the microprocessor in the circuit.

If DIP switch "5" and DIP switch "4" are in the "up" position, the audible alarm responds after the user preset time delay function for the audible alarm has timed out.

If DIP switch "5" is in the "down" position, the audible alarm does not respond at all.

The internal audible alarm normally activates with a steady tone when a "high" gas alarm condition exists.

The internal audible alarm normally activates with a pulsing tone when a fault condition exists.

A fault condition could consist of any of the following:
- Remote catalytic or solid state sensor failure (open loop)
- Analog signal from a remote LPT-A or LPT is not registering with the GEM.
- Smart sensor board is not plugged into the main board.

NOTE: Fault conditions automatically override the ON / OFF DIP switch "5" if it has been set to the "up" position to turn the audible alarm off.

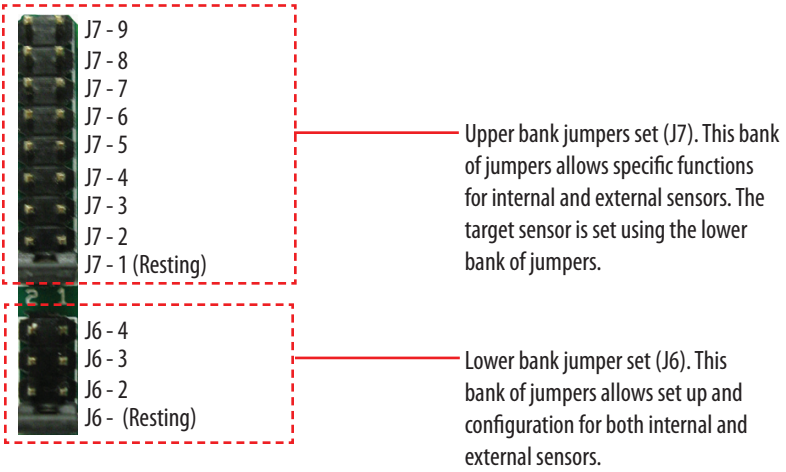
7.5 Jumpers

There are two banks of jumpers located directly below the DIP switches. One bank of nine (9) jumpers ("J7" upper bank) and one bank of four (4) jumpers ("J6" lower bank). These jumpers allow the user to perform a wide range of set up and calibration functions. The following table details the jumper settings for each bank of jumpers and explains the function enabled when these jumper positions are selected.

NOTE: Always set jumper from J6 first followed by jumper from J7.

FUNCTION DESIRED	J6 LOWER JUMPER BANK	J7 UPPER JUMPER BANK
Resting (Jumpers for the Upper Bank, J7 are disabled)	1	1
Setting Span Gas Value	2 (Internal Sensor)	2
Perform Zero (Null) Calibration	2 (Internal Sensor)	3
Perform Span Calibration	2 (Internal Sensor)	4
Adjust Low Gas Alarm Ascending Value	2 (Internal Sensor)	5
Adjust High Gas Alarm Ascending Value	2 (Internal Sensor)	6
Adjust Low Gas Alarm Descending Value	2 (Internal Sensor)	7
Adjust High Gas Alarm Descending Value	2 (Internal Sensor)	8
Enable / Disable Current Output	2 (Internal Sensor)	9
Setting Span Gas Value	3 (External Sensor)	2
Perform Zero (Null) Calibration	3 (External Sensor)	3
PERFORM SPAN CALIBRATION	3 (External Sensor)	4
Adjust Low Gas Alarm Ascending Value	3 (External Sensor)	5
Adjust High Gas Alarm Ascending Value	3 (External Sensor)	6
Adjust Low Gas Alarm Descending Value	3 (External Sensor)	7
Adjust High Gas Alarm Descending Value	3 (External Sensor)	8
Enable / Disable Current Output	3 (External Sensor)	9

NOTE: Jumper - 4 location on the lower jumper bank (J6) is used to set custom time delays for relays and internal audible alarm. These functions will be explained in another section of this manual.



NOTE: In this photo, the jumper tab for both banks of jumpers is covering "J1" resting position.

7.6 Adjusting Alarm Set Points

Equipment Required: Voltmeter 1 mV resolution if using Open Door calibration or setting Alarms, Philips screw driver if using Open Door calibration or setting Alarms.

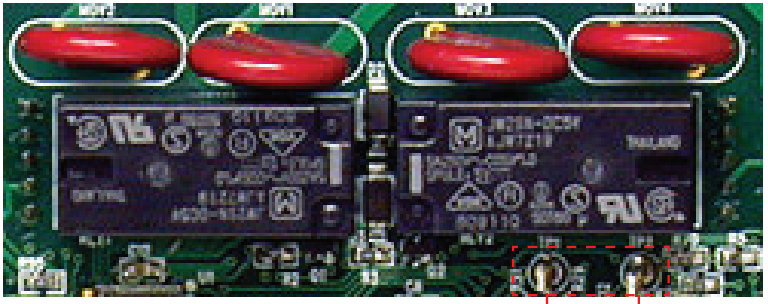
The GEM is configurable as single or dual channel detector and as such there are two ascending gas alarm set points and two descending gas alarm set points. Almost all installations of the GEM will use the factory default alarm set points. Default set points are as follows:

SENSOR	LOW ALARM	HIGH ALARM	RANGE
Carbon Monoxide (CO)	25 ppm	100 ppm	200 ppm
Nitric Oxide (NO)	35 ppm	50 ppm	100 ppm
Nitrogen Dioxide (NO_2)	0.7 ppm	1.5 ppm	10 ppm
Sulphur Dioxide (SO_2)	1.0 ppm	5.0 ppm	20 ppm
Propane (C_3H_8), Methane (CH_4) or Hydrogen (H_2)	10% LEL	20% LEL	50% LEL
Refrigerants	500 ppm	1,000 ppm	2,000 ppm
Temperature (°C)	30°C	40°C	60°C
Temperature (°F)	75°F	90°F	100°F

Reference table in Section *7.5 Jumpers*. If the GEM has been equipped with an LED digital display, set values according to what is displayed. If the GEM has been supplied without a digital display, you will require a digital multi-meter.

Attach the meter leads to the two test points (TP-1 & TP-2) located just below the high alarm relay (RL V2) on the main circuit board (reference photo below). Set the meter to volts DC with one decimal point. Time delays are set using a voltage reference of 0-4 VDC. Reference the tables in Section *7.7 Time Delays for Relay Operations*.

Move the jumper on the lower jumper bank J6 from its resting position (P-1) and place it on the appropriate jumper position as indicated in the table below top achieve the desired alarm setting. Use the "UP" or "DOWN" push-buttons to set the desired alarm value. Once all alarm settings have been set to desired values, move the jumper back to its resting position on the lower jumper bank J6. All new values will be written to the EEPROM.



FUNCTION DESIRED	J6 LOWER JUMPER BANK		J7 UPPER JUMPER BANK
	Int	Ext	
SET LOW ASCENDING ALARM VALUE	P2	P3	P5
SET HIGH ASCENDING ALARM VALUE	P2	P3	P6
SET LOW DESCENDING ALARM VALUE	P2	P3	P7
SET HIGH DESCENDING ALARM VALUE	P2	P3	P8

Alarm settings for GEM detectors are voltage settings. The range of 0 - 4.0 VDC is equal to the full measurement range of the sensor. E.g. HVAC CO sensor has a standard measurement range of 0-200 ppm. Therefore, 4.0 VDC = 200 ppm. Reference the formula below and the table in Section *7.5 Jumpers*.

DESIRED SET POINT / SENSOR RANGE = % OF RANGE

e.g. 100 ppm / 200 ppm = 50% of range
50% OF 4.0 VDC = 2.0 VDC.
Therefore the required voltage setting to achieve an alarm set point of 100 ppm is 2.0 VDC.

7.6.1 Voltage Reference Table for Alarm Settings

SENSOR / GAS	MEASUREMENT RANGE	LOW ALARM SET VOLTAGE	HIGH ALARM SET VOLTAGE
CO	0 - 200 ppm	25 ppm / 0.50 VDC	100 ppm / 2.00 VDC
CO	0 - 200 ppm	35 ppm / 0.70 VDC	200 ppm / 4.00 VDC
NO_2	0 - 10 ppm	0.7 ppm / 0.28 VDC	1.0 ppm / 0.40 VDC
NO_2	0 - 10 ppm	2.0 ppm / 0.8 VDC	5.0 ppm / 2.00 VDC
O_2	0 - 25.0% Volume	19.5% Vol. / 3.12 VDC	23.0% Vole. / 3.68 VDC
O_2	0 - 25.0% Volume	17.0% Vol. / 2.72 VDC	18.5% Vol. / 2.96 VDC
O_3	0 - 2.00 ppm	0.10 ppm / 0.20 VDC	0.30 ppm / 0.60 VDC
O_3	0 - 2.00 ppm	0.30 ppm / 0.60 VDC	1.00 ppm / 2.00 VDC
NO	0 - 100 ppm	25 ppm / 1.00 VDC	50 ppm / 2.00 VDC
H_2S	0 - 50 ppm	10 ppm / 0.80 VDC	15 ppm / 1.20 VDC
SO_2	0 - 20 ppm	2 ppm / 0.40 VDC	5 ppm / 1.00 VDC
H_2	0 - 4,000 ppm	1000 ppm / 1.00 VDC	2000 ppm / 2.00 VDC
C_3H_8	0 - 50% LEL	10% LEL / 0.80 VDC	20% LEL / 1.60 VDC
C_3H_8	0 - 50% LEL	20% LEL / 1.60 VDC	40% LEL / 3.20 VDC
CH_4	0 - 50% LEL	10% LEL / 0.80 VDC	20% LEL / 1.60 VDC
CH_4	0 - 50% LEL	20% LEL / 1.60 VDC	40% LEL / 3.20 VDC
H_2	0 - 50% LEL	10% LEL / 0.80 VDC	20% LEL / 1.60 VDC
Freons (R series)	0-2000 ppm	500 ppm / 1.00 VDC	1000 ppm / 2.00 VDC

7.7 Time Delays for Relay Operations

GEM offers a wide range of time delay settings that are user configurable. If the GEM has been equipped with the LED digital display option, read the values on the display as you change them to suit your application. If the GEM does not have a digital display, you will require a digital volt meter set to volts DC, one decimal point. The following tables are a guideline to follow to achieve desired time delays. Voltage reference is 0 - 4 VDC.

VOLT READING AT TEST POINTS	TIME DELAY IN MINUTES
0	N/A
0.02	0.1
0.04	0.2
0.06	0.3
0.08	0.4
0.10	0.5
0.12	0.6
0.14	0.7
0.16	0.8
0.18	0.9
0.20	1.0
0.22	1.1
0.24	1.2
0.26	1.3
0.28	1.4
0.30	1.5
0.32	1.6
0.34	1.7
0.36	1.8
0.38	1.9
0.40	2.0
0.42	2.1

VOLT READING AT TEST POINTS cont'	TIME DELAY IN MINUTES cont'
0.44	2.2
0.46	2.3
0.48	2.4
0.50	2.5
0.52	2.6
0.54	2.7
0.56	2.8
0.58	2.9
0.60	3.0
0.62	3.1
0.64	3.2
0.66	3.3
0.68	3.4
0.70	3.5
0.72	3.6
0.74	3.7
0.76	3.8
0.78	3.9
0.80	4.0
-	-
1.0	5.0
1.2	6.0
1.4	7.0
1.6	8.0
1.8	9.0
2.0	10.0
2.2	11.0
2.4	12.0

VOLT READING AT TEST POINTS cont'	TIME DELAY IN MINUTES cont'
2.6	13.0
2.8	14.0
3.0	15.0
3.2	16.0
3.4	17.0
3.6	18.0
3.8	19.0
4.0	20.0

7.7.1 Procedure for Setting Time Delays

Move jumper from resting position (position-1) on lower bank jumper set (J6) to position-4. This is the system configuration position. Next, select the jumper position on upper bank jumper set (J7) to achieve the desired function. Reference photo in Section *7.5 Jumpers*. Reference the table below for appropriate jumper position locations.

Once the desired jumper position has been achieved, use the "UP" or "DOWN" push-buttons to make changes. Changes can be viewed on the LED digital display if the GEM is equipped with one. If the GEM is not equipped with a digital display, connect a digital multi-meter to test points "TP-1" and "TP-2" and use the voltage tables in Section *7.7 Time Delays for Relay Operations*.

Once desired time delays have been set, move jumper back to resting position (P1) of upper jumper bank J7. If additional time delays are desired, move the jumper to the appropriate position and once again use the push-buttons to set desired voltage to achieve desired time delay.

Once all desired time delay settings have been achieved, move jumper back to position-1 on upper jumper bank J7 and move jumper back to position-1 on lower jumper bank J6. At that point, all new settings will be written to the EEPROM.

FUNCTION	UPPER JUMPER BANK "J7"
Low alarm "ON" time delay	P2
Low alarm "OFF" time delay	P3
High alarm "ON" time delay	P4
Audible alarm "ON time delay	P5

7.8 Temperature Display - Unit of Measure

The GEM systems all have an "on board" temperature chip from which information is used to temperature compensate certain sensors. This temperature chip can also be used as a second sensor in applications where the user requires both a gas measurement and a temperature measurement. To switch between Celsius and Fahrenheit displayed values, follow this procedure.

Move jumper from resting position (position-1) on lower bank jumper set (J6) to position-4 and jumper on J7 to position-8. Now pressing the "UP" push-button will display the temperature in Celsius and the output to test points "TP-1" and "TP-2" is 4.0 V. If the "DOWN" push-button is pressed, the temperature is displayed in Fahrenheit and the output to the test points is 0 V.

Once the desired unit of measure has been achieved, move jumper back to position-1 on upper jumper bank J6. At that point, all new settings will be written to the EEPROM.

NOTE: Temperature sensor is always considered channel-2 (external).

7.9 Latching Relay Functions

The GEM relays can be configured as "latching" for some applications.

To achieve this, move the jumper from resting position (position-1) on lower bank jumper set (J6) to position-4. This is the system configuration position. Next, select the jumper position-9 on upper bank jumper set (J7).

Pressing the "UP" push-button activates the "latching" function and output to test points "TP-1" and "TP-2" is 4 V. Pressing the "DOWN" push-button de-activates the latching function and the output to test points "TP-1" and "TP-2" is 0 V.

Once the desired latching or non-latching function has been achieved, move jumper back to position-1 on upper jumper bank J7 and move jumper back to position-1 on lower jumper bank J6. At that point, all new settings will be written to the EEPROM.

7.10 LED Digital Display

The GEM system allows for a certain amount of customization of the LED digital display:

- The display can be switched completely off.
- The display brightness level can be adjusted to low or high for best visibility in your application.
- The display can indicate the gas type only with no numerical value for some applications.

FUNCTION	JUMPER SETTING
Switch digital display "ON"	Jumper "J3" bridge P2 & P3
Switch digital display "OFF"	Jumper "J3" bridge P1 & P2
Low brightness level for display	Jumper "J4" bridge P1 & P2
High brightness level for display	Jumper "J4" bridge P2 & P3
Display only gas name (acronym)	Jumper "J5" bridge P1 & P2
Display gas values as well as gas name	Jumper "J5" bridge P2 & P3

NOTES:

1. The default setting for detectors leaving the CETCI factory with an LED digital display are:
   I. Display is "ON"
   II. Brightness level is "Low"
   III. Display indicates gas type and gas value.
2. The typical operation of the LED digital display is: Gas name is shown for 1-second then gas value is shown for 2-seconds. The sequence is the same for 1 or 2-channel systems.

8 CALIBRATION

8.1 Calibration Specifications

8.1.1 Gas

Calibration span gases should be at least ± 5% accuracy and have a current date stamp. Gas generators should have a current dated cell installed. Service personnel should flow zero emissions air or 20.9% volume Oxygen (O_2) before attempting to null adjust toxic gas sensors. In some cases Nitrogen (N_2) can be substituted for zero air. Contact CETCI for clarification. Nitrogen (N_2) is required to null (zero) Oxygen (O_2) and Carbon Dioxide (CO_2) sensors.

If an inappropriate concentration of span gas is applied during calibration, calibration may succeed but it does not mean the equipment has been calibrated properly. CETCI is not responsible for improperly calibrated transmitters. Follow manual instructions carefully.

8.1.2 Exception

Flow Nitrogen (N_2) over Oxygen (O_2) sensors before attempting to null adjust them. If the service person is confident of air quality and is careful (do not exhale in the direction of the Oxygen sensor being serviced while span adjusting). Oxygen in the breathing environment can be used as a fairly accurate source of span gas (20.9% volume) "in a pinch". It is not recommended to use this procedure for all span adjustments of Oxygen sensors.

8.1.3 Regulators & Flow

Calibration gases that are lighter than or the same weight as air (CO, O_2, etc.) should be flowed at 0.5 LPM. Gases heavier than air (NO_2, Cl_2, etc.) should be flowed between 0.5 and 1.0 LPM. Fixed flow regulators provide more accuracy. Gases should be flowed over the sensor for at least 2.5 - 4 minutes. Carbon Monoxide sensors settle out very quickly, but sensors for reactive gases (NH3, etc.) will take longer to stabilize to the calibration gas. All cylinder regulators supplied by CETCI use a fixed flow orifice.

8.1.4 Adapters

The proper calibration adapter should be utilized to allow the gas to properly diffuse around the sensor. They are available from CETCI. A humidification chamber is recommended to be utilized for all catalytic and solid state sensors except Ammonia. This is also available from CETCI.

8.2 Calibrating Sensors

8.2.1 Calibration Frequency

- Parking garage detectors: Once every 12 months
- OHS applications: Once every 6 months (OHS: Occupational Health & Safety)
- Sensor targeting gases with very low TLVs: Chlorine (Cl_2), Ozone (O_3), etc. Ethylene Oxide (C_2H_4O), etc.: Once every 6 months.

Gas Testing Frequency/Bump Testing: For the purposes of safety in OHS applications, sensors should be gas tested once every month to confirm response.

NOTE: A calibration label should be applied after every calibration to confirm work performed and the date it was confirmed. If a controller is involved, the alarm set points should be indicated on a label on the front door of the enclosure so anyone working in the environment can be aware.

Calibration is achieved at the GEM controller if the sensor is integral. If the sensor is remote (LPT-A or LPT series analog transmitter) the calibration is achieved at the transmitter using the procedure indicated in the operation manual provided with it.

Required Equipment: Digital multi-meter, Calibration kit, Calibration gases

Users can order the calibration kit, calibration accessories and/or gases from any CETCI authorized distributor or they can supply their own gas and equipment as long as the gas meets the minimum specifications.

8.3 Calibration Procedure

The calibration procedure within the second generation GEM controller is jumper automated (there are no potentiometers to adjust). To achieve calibration the user must first tell the GEM what concentration of span he is going to flow over the sensor. Within the controller, calibration is a voltage setting. The range of 0-4.0 VDC is equal to the full measurement range of the sensor. Eg. HVAC CO sensor has a standard measurement range of 0 - 200 ppm. Therefore 4.0 VDC = 200 ppm. Prior to attempting to calibrate, determine or calculate the voltage value required. Consult the *7.6.1 Voltage Reference Table for Alarm Settings* in Section *7.6 Adjusting Alarm Set Points* for standard voltages. If the value desired is not indicted, use the following formula to calculate the voltage required:

CALIBRATION SPAN GAS VALUE / 50% OF RANGE SENSOR RANGE = % OF RANGE

e.g. 100 ppm / 200 ppm = 50% of 4.0 VDC = 2.0 VDC
Therefore the required voltage setting to calibrate with 100 ppm is 2.0 VDC.

NOTE: When calibrating solid-state sensors for combustibles or refrigerants, the span gas must be humidified. The use of a CETCI humidification chamber is required. The humidification chamber sits in line between the cylinder of span gas and the calibration adapter. Remove the sponge inside the chamber and wet it under the tap. Squeeze out the excess water so it is not dripping wet and place it back inside the chamber. As gas flows over through the chamber, it absorbs water which acts to humidify it and the humidified span gas flows over the sensor.

8.4 Calibrating the Internal Sensor

8.4.1 Setting Span Gas Value (internal sensor)

Step 1:
Move jumper on J6 to position-2 and move jumper on J7 to position-2. The audible alarm beeps once for confirmation. The system is now waiting for the user to set the desired value.

Step 2:
Attach digital multi-meter leads to test points TP-1 and TP-2.

Step 3:
Using the UP or DOWN push-buttons, achieve the calculated voltage on the digital multi-meter. Reference Section *8.3 Calibration Procedure*.

Step 4:
Move jumpers from J6 & J7 back to their respective resting positions.

8.4.2 Calibrating the Null (Zero) Value (internal sensor)

Step 1:
Attach regulator to cylinder of zero air, insert calibration adapter into the sensor opening in the front of the enclosure door, and open regulator valve fully allowing zero air to flow over sensor. Use a slight twisting motion as you gently push the calibration adapter into the sensor opening. If the calibration adapter is hard to insert, moisten the O-ring seal slightly then try re-inserting it.

Step 2:
Move jumper on J6 to position-2 and move jumper on J7 to position-3. The audible alarm beeps once for confirmation. The system is now starting the zero calibration stabilization time (30-seconds).

Step 3:
Attach digital multi-meter leads to test points TP-1 and TP-2. Reference Section *8 Calibration*. The voltage should be 0.0 VDC. If the audible sounds with repetitive beeps, see Section *8.8 Forcing Calibration*. The audible will beep twice when the calibration begins. Leave the zero air flowing over the sensor until the GEM audible beeps three times indicating the procedure is finished (1-minute).

Step 4:
Move jumpers from J6 & J7 back to their respective resting positions and remove the zero air or Nitrogen.

8.4.3 Calibrating the Span Gas (internal sensor)

Step 1:
Attach regulator to cylinder of span gas.

Step 2:
Insert the calibration adapter into the sensor opening in the front of the enclosure door. Open regulator valve fully and allow span gas to flow over sensor.

Step 3:
Move the jumper on J6 to position-2 and move jumper on J7 to position-4. The audible alarm "beeps" once for confirmation. The system is now starting the span calibration stabilization time (30 seconds).

Step 4:
Attach digital multi-meter leads to test points TP-1 and TP-2. Monitor the voltage. It should start moving towards the voltage calculated for the span gas value (reference Section *8.3 Calibration Procedure*).

If the audible sounds with repetitive beeps, see Section *8.8 Forcing Calibration*.
The audible will beep twice when the calibration begins. Leave the span gas flowing over the sensor until the GEM audible beeps three times indicating the procedure is finished (2-minutes).

Step 5:
Move jumpers from J6 & J7 back to their respective resting positions and remove the span gas.

8.5 Calibrating Second Internal Sensor

Calibration of the second internal sensor has only one difference from the first internal sensor calibration. Move the jumper from J6 to position-3 then follow the same procedure as outlined in Section 8.4.1 to 8.4.3 using J6 position-3.

8.6 Calibrating Remote Catalytic or Solid State Sensor

8.6.1 Setting Span Gas Value (remote catalytic or SS sensor)

Step 1:
Move jumper on J6 to position-3 and move jumper on J7 to position-2. Audible alarm beeps once for confirmation. The system is now waiting for the user to set the desired value.

Step 2:
Attach digital multi-meter leads to test points TP-1 and TP-2. Reference Section *8 Calibration*.

Step 3:
Using the UP or DOWN push-buttons, achieve the calculated voltage on the digital multi-meter. Reference Section *8.3 Calibration Procedure*.

Step 4:
Move jumpers from J6 & J7 back to their respective resting positions.

8.6.2 Calibrating the Null (Zero) Value (remote catalytic or SS sensor)

Step 1:
Attach regulator to cylinder of zero air, attach flow adapter and open regulator valve fully allowing zero air to flow over sensor. Use a slight twisting motion as you gently push the calibration adapter into the sensor opening. If the calibration adapter is hard to insert, moisten the O-ring seal slightly then try re-inserting it.

Step 2:
Move jumper on J6 to position-3 and move jumper on J7 to position-3. The audible alarm beeps once for confirmation. The system is now starting the zero calibration stabilization time (30 seconds).

Step 3:
The audible will beep twice when the calibration begins. Leave the zero air flowing over the sensor until the GEM audible beeps three times indicating the procedure is finished (1 minute).

Step 4:
Move jumpers from J6 & J7 back to their respective resting positions and remove the zero air or Nitrogen.

8.6.3 Calibrating the Span Gas (remote catalytic or SS sensor)

Step 1:
Attach regulator to cylinder of span gas.

Step 2:
Attach flow adapter and open regulator valve fully (fixed flow regulators only) allowing span gas to flow over sensor.

Step 3:
Move the jumper on J6 to position-3 and move jumper on J7 to position-4. The audible alarm "beeps" once for confirmation. The system is now starting the span calibration stabilization time (30 seconds).

Step 4:
The audible will beep twice when the calibration begins. Leave the span gas flowing over the sensor until the GEM audible beeps three times indicating the procedure is finished (2 minutes).

Move jumpers from J6 & J7 back to their respective resting positions and remove the span gas.

8.7 Calibrating 4-20 mA for Incoming Analog Transmitter

N**OTE:** The GEM is configured at the factory and should not require this type of calibration unless it is not functioning properly. Specialized equipment is required; only perform these functions after consulting the factory. This NOTE applies to Sections 8.7.1 through 8.7.4.

To perform this function, you will require either an accurate current source able to generate a 4.0 mA and 12.0 mA current signal or a CETCI analog transmitter that can supply the correct current values.

8.7.1 Using a Current Source to Calibrate the Null

Step 1:
Connect current source to pin 10 and ground to pin-11. For zero calibration, set the current source to 4.0 mA. Move the jumper on J6 to position-3 and the jumper on J7 to position-3. The audible will beep once for confirmation. The system is now starting the zero calibration stabilization time (30 seconds).

Step 2:
Attach digital multi-meter leads to test points TP-1 and TP-2. Monitor the voltage. If the audible sounds with repetitive beeps, see Section *8.8 Forcing Calibration*. The audible will beep twice when the calibration begins. The audible beeps three times indicating the procedure is finished (2 minutes).

Step 3:
Move jumpers from J6 & J7 back to their respective resting positions.

8.7.2 Using a Current Source to Calibrate the Span

Step 1:
Connect current source to pin 10 and ground to pin-11. For span calibration set the current source to 20.0 mA. Move the jumper on J6 to position-3 and the jumper on J7 to position-4. The audible will beep once for confirmation. The system is now starting the span calibration stabilization time (30 seconds).
Step 2:
Attach digital multi-meter leads to test points TP-1 and TP-2. Monitor the voltage. If the audible sounds with repetitive beeps. Reference Section *8.8 Forcing Calibration*. The audible will beep

twice when the calibration begins. The audible beeps three times indicating the procedure is finished (2 minutes).

Step 3:
Move jumpers from J6 & J7 back to their respective resting positions and remove the current source.

8.7.3 Using a CETCI Analog Transmitter to Calibrate the Null

Step 1:
At the transmitter:

For zero calibration on the transmitter, move the jumper to position-2 and set the voltage at TP-1 and TP-2 for "0" volts DC. If transmitter has been calibrated, TP-1 and TP-2 should be reading "0" volts DC.

At the GEM:

Move the jumper from J6 to position-3 and the jumper from J7 to position-3 The audible will beep once for confirmation. The system is now starting the zero calibration stabilization time (30 seconds).

Step 2:
Attach digital multi-meter leads to test points TP-1 and TP-2. Monitor the voltage. It should start moving towards zero gas value "0". Reference Section *8.3 Calibration Procedure*. If the audible sounds with repetitive beeps. Reference Section *8.8 Forcing Calibration*. The audible will beep twice when the calibration begins. The audible beeps three times indicating the procedure is finished (2 minutes).

Step 3:
Move jumpers from J6 & J7 back to their respective resting positions.

8.7.4 Using a CETCI Analog Transmitter to Calibrate the Span

Step 1:
At the transmitter:

With the transmitter still connected, move the jumper to position-2 and set voltage at TP-1 and TP-2 for 2.00 VDC.

At the GEM:

Move jumper from J6 to position-3 and the jumper from J7 to position-2.
Using the UP and DOWN push-buttons, set the voltage to 2.00 VDC.

Step 2:
Now, move the jumper from J6 to position-3 and the jumper from J7 to position-4. The audible will beep once for confirmation. The system is now starting the span calibration stabilization time (30 seconds).

Step 3:
Attach digital multi-meter leads to test points TP-1 and TP-2. Monitor the voltage. If the audible sounds with repetitive beeps. Reference Section *8.8 Forcing Calibration*. The audible will beep twice when the calibration begins. The audible beeps three times indicating the procedure is finished (2 minutes).

Step 4:
Move jumpers from J6 & J7 back to their respective resting positions and remove the transmitter.

8.8 Forcing Calibration

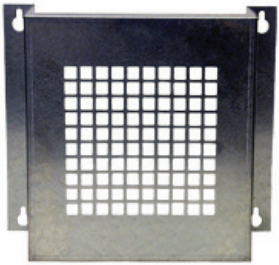
If during the calibration procedure the GEM starts to display underflow or overflow or the audible alarm starts to beep at a 1-second interval, the technician will need to determine if the GEM sensor is more than 30% out of calibration or if the incorrect gases or gas values have been applied. If the gases are confirmed to be correct the technician can override the automatic calibration and force the GEM to accept the new values. This procedure requires the technician to press both the UP and DOWN push-buttons at the same time to cause the "forced calibration".

9 ACCESSORIES

9.1 Calibration Kit

Calibration kits and gases are available from the CETCI factory. Many gases are carried in inventory but not all. Check with any CETCI authorized distributor for availability of specific gas types. Gas cylinders cannot be shipped overseas. Part number CET-715A-CK1.

9.2 Metal Protective Guard



The metal protective guard is heavy duty metal protective guard to help protect against abrasive damage, theft and vandalism to the transmitters. This is an added preventative in addition to the product enclosure.

It is made from 16-gauge galvanized steel and has ½" (13 mm) square openings in the front to allow gas and air to flow through to the sensor. With only four slotted mounting holes, installation and removal for gas detector servicing is easy.

Enclosure	16 gauge galvanized steel
Weight	1.7 kg (3.8 lbs)
Size	10.0"W x 9.5"H x 4.75"D (254 mm W x 241 mm H x 121 mm D)

10 MAINTENANCE

The GEM series system requires virtually no maintenance other than regular calibration of the integral and / or remote sensors and ensuring that excess water or dust is not somehow entering the enclosure and physically damaging the circuit board or internal components.

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