Vector Field Control Unit
Operating Manual

810-0001

ESP SAFETY INC

Technology of the Future...Protection for today

Table of Contents

It is important that this entire manual be thoroughly read and understood prior to installing or operating the Vector FCU. Any deviation from this manual may impair system performance and compromise safety.

Il est important que ensemble de ce manuel soit soigneusement lu et compris avant l'installation ou l'utilisation du FCU Vector. Toute déviation de ce manuel pourra altérer l'exécution du système et la sécurité des compromis.

Date	Revision	Description	Approval/ECO
12/09/14	A	Release to production	141209A
1/27/15	B	Relay Contact Rating	150119A
1/30/15	C	Relay Contact Spec	150130A
10/07/15	D	Conversion Formula	151007A
04/25/2016	E	Updated marks & French warnings	160425A
06/30/2016	F	Updated marks	160630A
7/20/2016	G	Updated Disclaimer	160720A

1.0 Introduction

1.1 Product Overview

Vector is a state-of the-art field control unit that performs as an integrated control terminal and display for ESP Safety's gas detector product line. The Vector Field Control Unit can be remotely located up to 500 feet away from a gas detector*. A detector can also be attached directly to the display housing to produce a unified detector/display unit.

** Refer to Wire Size Chart (Appendix 2) for maximum distances for remote location of gas detectors*

Key Features

- A vivid, 2.7" (diagonal) 128x64 pixel resolution OLED screen simultaneously displays a wide range of data including gas concentrations, alarm levels, faults and operational modes.
- Analog 4-20 w/ HART, RS-485 Modbus RTU, and 4 relays are standard data communication channels of the Vector FCU
- Non-intrusive, on-site detector calibration via a HART field communicator or magnetic wand.
- Event log is stored in on-board memory and is accessible via RS-485 Modbus RTU
- Operating temperature range of -50^{o}C to 75^{o}C (-58^{o}F to 167^{o}F)
- Configurable to control & monitor up to 2 detectors
- SIL certification by independent 3rd party agency (pending)
- 316SS construction, explosion-proof housing, Class 1, Division 1

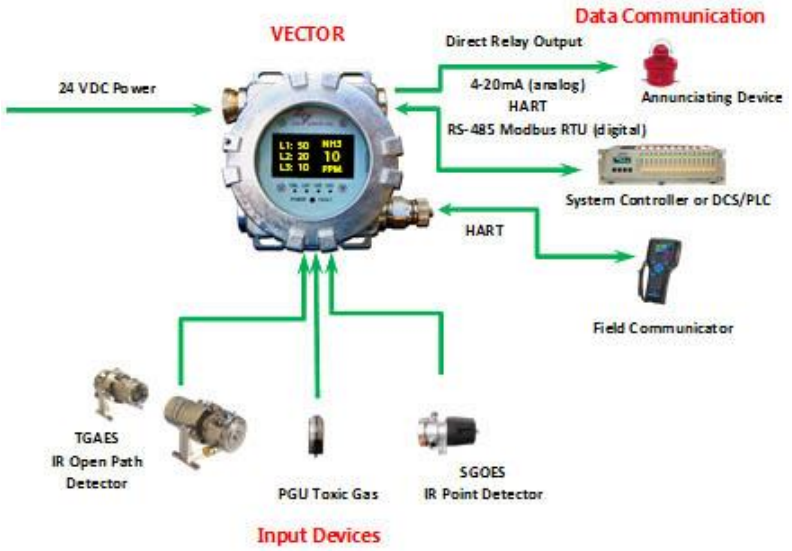
Display

- A non-intrusive operator interface is achieved by using a magnetic wand with the menu-driven OLED screen
- Bi-color status LED indicates operational mode and fault

Our Mission

ESP Safety, Inc.'s mission is to provide complete turn-key protection solutions beginning with the design stage, through system installation and commissioning, and on-going field service in hazardous environments. Our line of industry-leading products, services, and systems benefits society, saves lives, and preserves capital resources.

Figure 1-1: Vector Communications



Principles of Operation

The Vector Field Control Unit uses a RS-485 digital communications link to acquire and display data from local or remote gas detectors. A data acquisition and control system may monitor the data collected by Vector by means of a second RS-485 digital communications link, HART, two standard industrial 4-20mA current loops, or by relay contacts.

The RS-485 digital communications links utilize the Modbus® RTU protocol. This protocol allows all Vector commands and data to be transferred. The Modbus RTU protocol is a Master-Slave protocol. Slave devices cannot transmit data without receiving a request from a Master. The Slave devices cannot communicate with each other.

The relay contacts may be used to trigger alarms and/or other emergency operations such activating blowers, operating valves, or shutting down equipment. The relays can be configured using ESP Commander or HART to open or close when an alarm threshold is reached. A fault relay output is provided to indicate sensor malfunction, sensor failure, or power supply voltage errors. The factory default settings for the Alarm relays are normally open (NO), the Fault relay is normally closed (NC).

The 4-20 mA loop #1 drives the output signal for the first sensor and also can be used for HART communications. If the 4-20 mA output is not connected to a measurement load resistor, the “NO420” DIP switch on the terminal board may be closed to enable Hart communications. The second 4-20 mA loop drives the output signal for the second sensor but does not allow HART communications. The 4-20 mA outputs are current sourcing outputs. To improve noise immunity, the 4-20 outputs are isolated from the system ground. If legacy wiring does not permit a dedicated current loop wire pair, the (-) 4-20 output can be connected to the 0V terminal (power supply return) on the Vector terminal board by closing the “3WIRE” DIP switch.

Vector Components

A. Explosion proof housing
B. Conduit entry for Field Wiring (3/4" NPT), x2
C. OLED display
D. Conduit entry for Sensor (3/4" NPT), x2
E. HART communication port , x1
F. LED Indicators
G. Magnetic keypad, x4

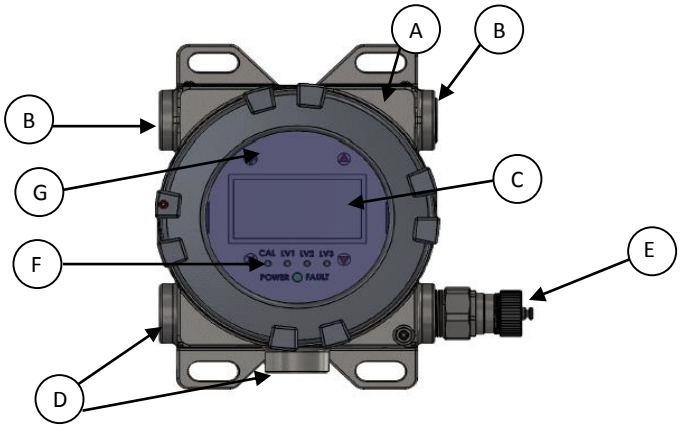


Figure 1-2: Vector Components

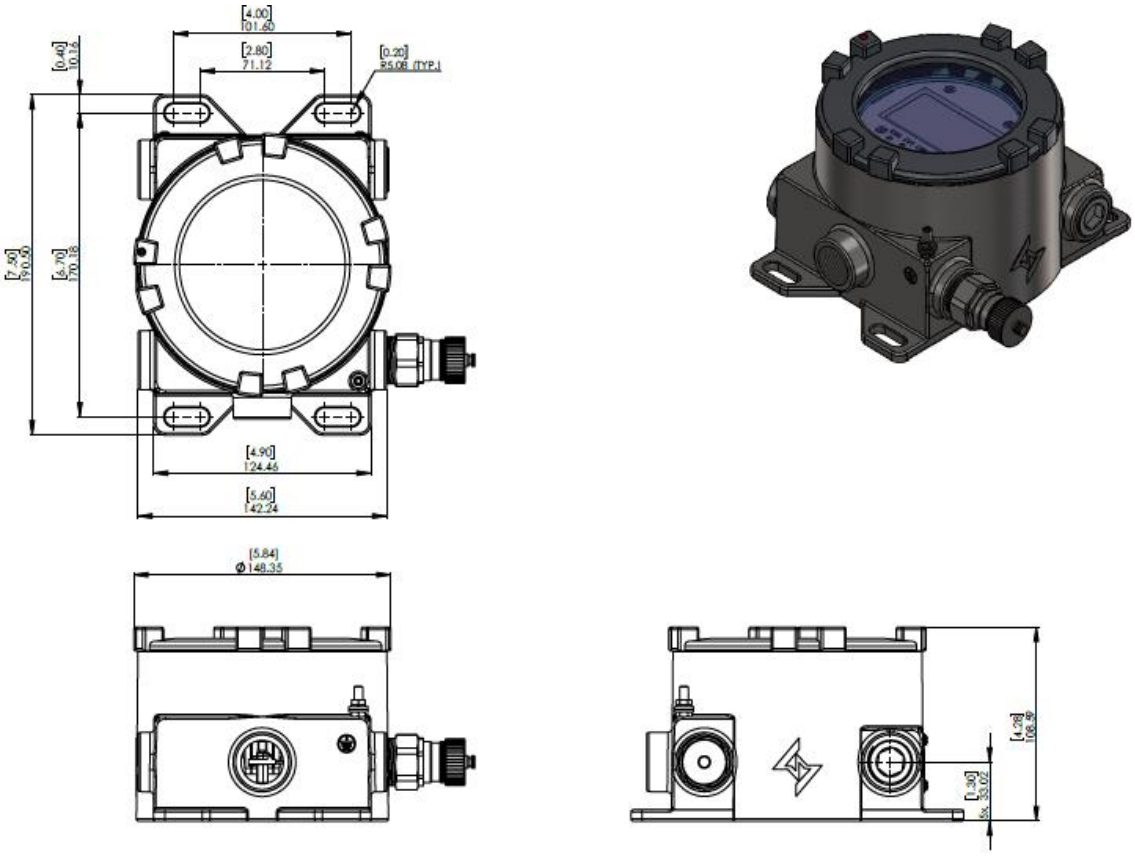


Figure 1-3: Vector Dimensions

2.0 Specifications and Technical Data

Mechanical Characteristics	
Material	Stainless Steel (Type 316)
Conduit Connection	¾" NPT 2 connections for Sensors 2 connections for Field Wiring
Dimensions	7.50" x 5.60" x 4.28" (190.5mm x 142.24mm x 108.71mm)
Weight (no sensors)	12.80lb (5.80 kg)
Electrical Characteristics	
Input Voltage	+24VDC Nominal (+18 to 32VDC)
Power Consumption	4.3 W-standby; 5.3 W-during alarms 12.0 W-w/ heater on (temp ≤ -30°C)
Output From Vector FCU	2x +4-20mA industry standard analog output Normal operation output = 4.00 to 20mA (0 to full scale) +/-0.01mA Fault output = 1.74mA. +/-0.02mA Calibration output = 3.14mA +/-0.02mA Over range >115% full scale = 22.4 mA +/-0.02mA Digital RS-485 Modbus RTU See Modbus Register Map in Appendix 4 Note: Registers 201 and 217 must be monitored for over range to maintain approval
Alarm Relays	Contacts rating Form 1A, 0-60VDC/VAC peak, 0.75A 3 User Programmed Alarm Relays (factory default setting: NO) 1 Fault Condition Programmed Relay (factory default setting: NC) All of the relays have programmable settings such as delay, latching, NO/NC, increase/decrease threshold
Sensor Interface to Vector Transmitter	Digital RS-485 Modbus RTU *Note: All ESP Safety gas detector products can be interfaced with the Vector FCU
Vector Response Time	2 seconds nominal; 3 seconds maximum. The total response time depends on the specific sensor(s) attached to Vector.
Vector Boot & Warm Up Time	30 seconds. The total warm-up time depends on the specific sensor(s) attached to Vector.
Sensor Types / Model	Electrochemical: PGU-E Infrared (open path): TGAES Infrared: PGU-IR Photo Ionized: PGU-P Infrared (point): SGOES Catalytic: PGU-C
Operational Characteristics	
Humidity Range	Up to 100%, non-condensing (Withstands up to 100% RH for short periods)
Operating Temperature	Standard Operation: -58°F to +167°F (-50°C to +75°C)
Storage Temperature	-76°F to +185°F (-60°C to +85°C)
Ingress Protection	IP66/67
RFI/EMI Protection	EN50081-1 / Class B E> 50270 *Operates with no interference from a 5 watt walkie talkie keyed (transmitting) at 1 meter
Annunciators (LED)	Simultaneously indicates gas concentrations, alarm levels, faults and operational modes. Bi-color status LED indicates operational mode and fault. Three LED indicators for Alarms activation A fourth LED indicates the unit is in calibration mode
Displayed Information (Illuminated OLED Display)	Continuous sensor data Gas Type Measuring Units Three Fixed Alarm Thresholds Graphic display of trending data of gas concentration for the last 3 minutes

2.1 Vector Factory Default Values	
Relays	Alarm Relays: Normally Open; Fault Relay: Normally Closed

2.2 Gas Detector Default Values

Detector	Gas Name	Formula	Engr Units	Default Limit 1	Default Limit 2	Default Limit 3	Range
PGU-IR	Methane	CH4	%LEL	20	30	50	0 - 5.0 Vol%
PGU-IR	Propane	C3H8	%LEL	20	30	50	0 - 2.1 Vol%
PGU-IR	Carbon Dioxide	CO2	Vol%	0.5	1	2	0 - 5.0 Vol%
PGU-P	Isobutylene	C4H8	ppm	20	50	100	0 - 200 ppm
PGU-E PGU-C	Hydrogen	H2	%LEL	20	30	50	0 - 4.0 Vol%
PGU-E	Oxygen	O2	Vol%	22.5	19.5	18	0 - 30.0 Vol%
PGU-E	Carbon Monoxide	CO	ppm	10	20	30	0 - 100 ppm
PGU-E	Hydrogen Sulfide	H2S	ppm	10	20	30	0 - 100 ppm
PGU-E	Nitrogen Dioxide	NO2	ppm	5	10	15	0 - 20 ppm
PGU-E	Sulfur Dioxide	SO2	ppm	5	10	15	0 - 20 ppm
PGU-E	Ammonia	NH3	ppm	10	20	30	0 - 100 ppm
SGOES	Methane	CH4	%LEL	20	30	50	0 - 5.0 Vol%
SGOES	Propane	C3H8	%LEL	20	30	50	0 - 2.1 Vol%
TGAES	Methane	CH4	LELm	1	2.5	5	0 - 5.0 LELm
TGAES	Propane	C3H8	LELm	1	2.5	5	0 - 5.0 LELm

Note: Ranges are factory configured and depend on whether US or EU standards are in effect.

Extended exposure of a catalytic sensor to certain concentrations of combustible gases in air may introduce stress to the sensor that could adversely affect its performance. Calibration should be carried out and/or the sensor replaced after an alarm due to indication of a high concentration.

Une exposition prolongée d'un capteur catalytique à certaines concentrations de gaz combustibles dans l'air peut introduire le stress au capteur qui pourrait nuire à sa performance. La calibration doit être effectué et / ou le capteur remplacé après une alarme du fait à l'indication d'une concentration élevée.

Analog outputs conversion formulas:

- 4-20mAout = [(16 * concentration) / Full scale range] + 4
- Concentration = [(4-20mAout - 4) / 16] * Full scale range

Example:
A 0-100ppm NH3 detector reads 10ppm. 4-20mAout = [(16*10) / 100] + 4 = 5.6mA

2.3 Certifications

FM C US APPROVED	Explosion Proof Intrinsically Safe (XP-AIS): Class 1; Division 1; Group A, B, C, D; Temp T4 AEx d[ia]: Zone 1; Group IIC, Temp Class T4 NOTES: 1. For the AEx db rated VECTOR Control Unit, consult the manufacturer for dimensional information on the flameproof joints for repair. 2. **All Unused device openings must be closed using a suitably certified plug**. 3. For Field Connections Use wire rated 20°C greater than maximum ambient temperature Enclosure Type 4X; IP Rating IP67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: FM 3600, FM 3610, FM 3615, FM 3810, FM 6320, FM 3640, ANSI/ISA 60079-1, ANSI/ISA 60079-0, ANSI/ISA-12.13.01-2002, ANSI/ISA-12.13.04-2007, ANSI/ISA-920001, ANSI/NEMA 250, CSA C22.2 Nos. 0.4, 0.5, 30, 94, 142, 152, 157, 60529, CAN/CSA 60079-0, CAN/CSA60079-1, CAN/CSA 60079-11, ANSI/IEC 60529
CSA®	Explosion Proof Intrinsically Safe (XP-AIS): Class 1; Division 1; Group B, C, D; Temp T4 Ex db[ia]: Zone 1; Group IIC, Temp Class T4 Enclosure Type 4X; IP Rating IP67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: CSA C22.2 Nos. 0.4., 0.5, 30, 94, 152, 157, 60529, CAN/CSA 60079-0, CAN/CSA 60079-1, CAN/CSA 60079-11
ATEX IEC Ex CE 2014/34/EU	CE 0470 Ex II 2/1 G Ex db[ia Ga] IIC T4 Gb NOTES: 1. For the Ex db rated VECTOR Control Unit, consult the manufacturer for dimensional information on the flameproof joints for repair. 2. **All Unused device openings must be closed using a suitably certified plug**. 3. For Field Connections Use wire rated 20°C greater than maximum ambient temperature IP 67 Temperature Range: -50°C ≤ Ta ≤ 75°C FM15ATEX0050X Standards: EN60079-0, EN60079-1, 4, EN60079-29-1-2007, EN 50270, EN 50271, EN 60529
IEC IECEx	Ex db [ia] IIC T4 NOTES: 1. For the Ex db rated VECTOR Control Unit, consult the manufacturer for dimensional information on the flameproof joints for repair. **2. All Unused device openings must be closed using a suitably certified plug.** 3. For Field Connections Use wire rated 20°C greater than maximum ambient temperature IP 67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: IEC 60079-0, IEC 60079-1, 4, IEC 60079-11, IEC 60079-29-1, IEC 60079-29-4, IEC 60529

This Approval does not include or imply Approval of apparatus to which the subject instrumentation may be connected. In order to maintain an FM Approved system, the apparatus to which this instrument is connected, must also be Approved by FM Approvals.

This Approval does not include or imply Approval of gas detector heads or other apparatus to which the subject instrument may connected. In order to maintain an FM Approved system, the measurement input signal to which this instrument is connected must also be FM Approved

The vector field control and display unit complies with the relevant gas detection performance standard listed on the label when connected to a Detector that also has been evaluated to the same gas detection performance standard

3.0 Safety Considerations

Guidelines

Before installing and operating the VECTOR, be sure to read this entire manual. Failure to follow these guidelines could result in impaired product performance and safety hazards.

Lisez la notice d'emploi avant utilisation ; il est important de bien en comprendre le contenu.

For maximum safety:

- Installation and operation of the Vector should be performed only by properly trained personnel who have thoroughly read and understand this manual.
    - L'installation et le fonctionnement du vecteur doivent être effectuées que par du personnel formé qui ont bien lire et comprendre ce manuel
- Vector wiring should comply with all governing electrical codes, standards and regulations.
    - Le câblage Vector doit conformer aux tous les codes électriques, les normes et règlements en vigueur.
- Never operate the Vector if the casing is damaged.
    - Ne jamais utiliser l vecteur si le boîtier est endommagé.
- Do not open the Vector case when the unit is energized.
    - Ne pas ouvrir le cas Vector lorsque l'unité est sous tension.
- Perform regular testing and maintenance as outlined in the Maintenance section.
    - Réaliser des tests et entretien réguliers tel que décrit dans la section maintenance.
- Ensure that alarm notification and control systems associated with the Vector and its detectors are switched off before any testing or maintenance to avoid unwanted operation of alarms and control equipment.
    - Assurer que les la notification d'alarme et systèmes de contrôle associés au Vector et ses détecteurs sont deux hors tension avant tout test ou de maintenance afin d'éviter le fonctionnement intempestif des alarmes et des équipements de contrôle.

Verify conduits are sealed within 18 inches of the Vector

- Vérifier les conduits sont scellés à l'intérieur de 18 pouces de Vector
- Also see the individual sections in this manual for relevant specific safety guidelines.
    - Voir aussi les sections individuelles dans ce manuel pour les consignes de sécurité spécifiques pertinentes.

Explosion Protection Means

The table below describes the Vector explosion protection design features. Refer to Appendix 5 for additional details.

Feature	Protection Means
Enclosure of Current Carrying Parts	The casing includes threaded joints with controlled tolerances to meet explosion-proof requirements for installation in Class I, Division I, Group A, B, C and D US Class I, Division I, Group B, C, and D CANADA T4 locations.
Case Mechanical Strength	The high mechanical strength of the case is able to withstand high explosive pressures without rupture or failures of mechanical parts. The case design is in accordance with FM 3600, FM 3615, IEC 60079-0, and IEC 60079-1.
Manufacturing Control Of Casing	Important parameters include: • Maximum width and minimum length of threaded joints • Surface roughness of the joined parts • The number of complete intact threads at the conduit entry point
Ignition Temperature	The ignition temperature of the surrounding environment is limited by the outside surface temperature of the housing, which does not exceed 75°C
Securing of Bolts, Joints and Grounding	Spring washers, lock washers, and lock nuts maintain the integrity of the bolted connections by preventing loosening of the bolts.
Joined Parts Protection	Anti-seize lubricant is applied on the critical joints
Casing Ingress Protection	The design of the casing meets the requirements of class IP67 in accordance with IEC 60529-004.
Sealing Cables at Conduit Entry	Use approved hazardous location sealed conduit fittings

4.0 Installation

Component Parts and Delivery Set

The Vector FCU component parts and delivery set consists of the following:

- One Vector Field Control Unit
- One Vector FCU Operating Manual
- Accessory Kit (bolts, nuts, washers, etc.).

  Supplied: 4 ea. 3/8”x 1-1/2” bolts w/ nuts & washers
- Calibration magnet (magnetic wand), P/N 611-0005
- If a PGU sensor is ordered with the VECTOR, the PGU assembly will be attached to the Vector FCU

Compare the contents of the set to the packing list to be sure all items were received. If any items are missing, contact ESP Safety Inc.

Visual Examination

Before installing the Vector FCU, examine the unit to ensure that:

- The nameplates and warning labels are in place.

- The external surfaces and joined surfaces of the Vector FCU casing are free of dents or damage.
- Make sure all removable parts are joined to the casing as tightly as possible.

4.1 Guidelines for locating the Vector FCU and associated gas detectors

There are no standard rules for selection and placement of sensors since the optimum sensor choice location is unique for each application. Before installing the Vector and associated detectors, check the conditions at the installation site to make a placement determination.

The following guidelines can assist in determining the best possible placement of the Vector FCU and associated detectors:

- Locate the Vector FCU detectors near potential gas leak sources and away from excessive heat, light, wind, dust, water, vibration, shock, and radio frequency interference (RFI).
- Ensure the installation location has sufficient space to accommodate the Vector FCU detectors housing and all necessary cabling.
- Mount the PGU sensor pointing down
- Mount the SGOES detector pointing horizontally
- Mount Open Path detector at a minimum height 2.2 meters (if possible)
- Mount the Vector FCU in an easily accessible location for reading the digital display and calibration checks
- Reference the Intrinsically Safe Apparatus Control Drawing (Appendix 7) for information on Hart communications.
- For installations in humid environments, we recommend a conduit seal with a drain below the level of the Vector unit be included in the field wiring.

Preparing for installation

- Before installation, evaluate the gas leak locations and other conditions such as wind or air currents at the test site and configure the unit for that particular need. Also, be sure to consult local installation codes.

Selection of gas sensor location is critical to the overall performance of the VECTOR. Five factors play an important role in the selection of sensor locations:

- Density of the gas to be detected
- Most probable leak sources within the industrial process
- Ventilation and prevailing wind conditions
- Personnel exposure
- Maintenance access

Density of Detected Gas

If the target gas is heavier than air, the sensor should be located within 4 feet of grade. Heavier than air gases will tend to settle in low-lying areas. For gases lighter than air, sensor placement should be 4-8 feet above grade in open areas or in pitched areas of enclosed spaces.

Probable Leak Sources

Leak sources include flanges, valves, tubing, and connections of the sealed type where seals may either fail or wear. All potential leak sources and Vector FCU mounting locations are best determined by facility engineers with experience in similar processes.

Ventilation & Prevailing Winds

Normal ventilation or prevailing wind conditions can dictate efficient location of gas PGE sensors so that migration of potential gas clouds is quickly detected.

Personnel Exposure

Consideration should be given to placement of detectors in areas where personnel may be exposed. Account for ventilation, wind direction and potential gas cloud size when determining the number and location of gas detectors.

Maintenance Access

Consideration should be given to providing easy access for maintenance personnel. Sensor location should also take into account the proximity to contaminants that may foul the sensor prematurely.

Tools Required for Mounting

- 18-Inch adjustable crescent wrench (spanner wrench) with 2-inch or greater span for installation and removal of cover and the PGU sensor(s)
- 2mm "Flat Head" screwdriver for protective cover lock screw and wire terminal block clamps
- Two (2) slotted, flared-tip screwdrivers (75mm x 2.5mm) for removal of the control module from the housing (see Figure 4-5)

4.2 Mounting

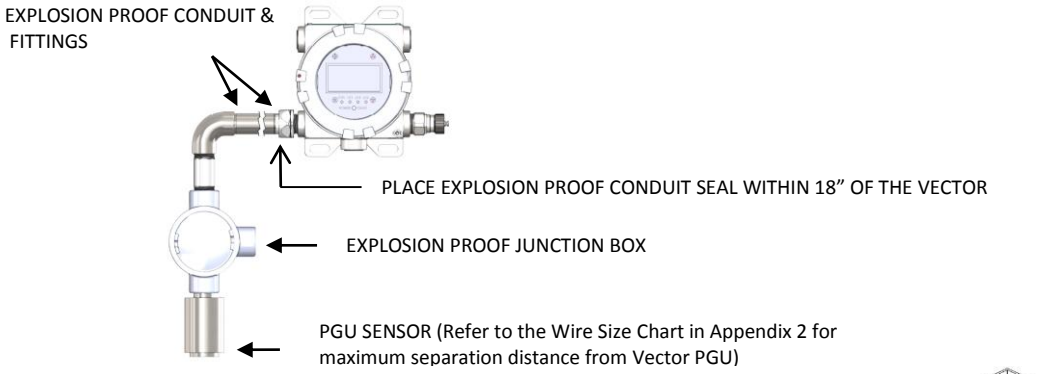
Mount the Vector Field Control Unit housing with the faceplate oriented at a vertical plane to reduce the possibility of dirt and dust building up on the window.

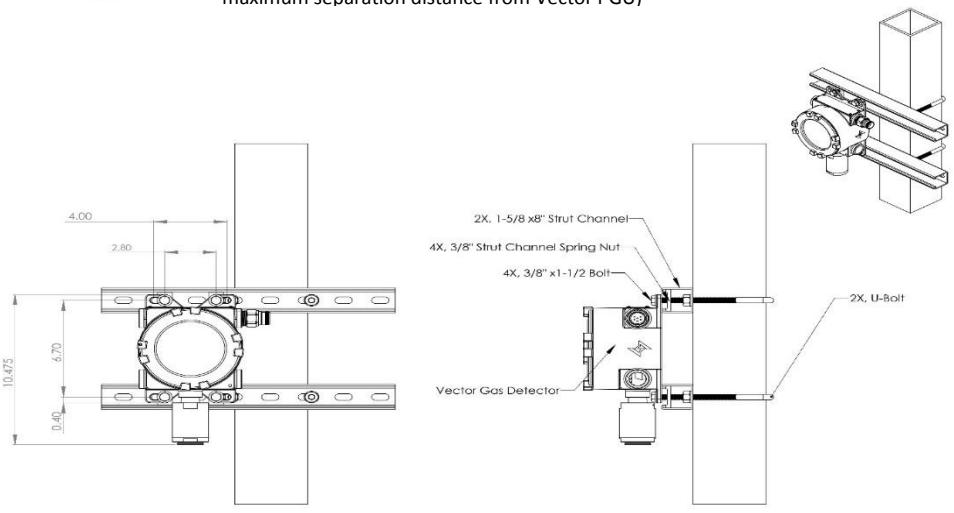
Suggested pole and wall mounting configurations are shown in Figure 4.3.

Connect the explosion proof conduit or cable to the Vector Field Control Unit housing.

Connect the explosion proof conduit or hazardous location rated cable with sealed gland to the detector.

FIGURE 4-1: REMOTE CONFIGURATION





4.3 Wiring Requirements

Caution: All cable/conduit entries must either be sealed within 18 inches with an appropriate and certified sealing plug and cable gland or directly connected to an explosionproof conduit system if installed in a hazardous area.
Attention: Toutes les entrées câble / conduit doivent soit être scellé chaque 18 pouces avec un approprié et certifié bouchon et presse-étoupe ou bien directement relié à un système de conduit antidéflagrante si elle est installée dans une zone dangereuse d'étanchéité.

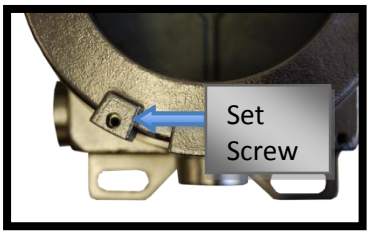
- If installing connection cables in an explosion proof conduit, do not use the same conduit to carry wiring for any other purpose or equipment.
- If installing the remote sensor in a hazardous area, the electrical connection between the Vector FCU and the remote sensor must be rated for the hazardous environment.
- Minimum 14 AWG (2.08 mm^2) shielded cable conductors are required for optimal performance. The gauge of the wire used determines the maximum distance between the controller and the remote sensor.
- When using analog outputs use shielded twisted pair conductors to prevent electromagnetic interference
- When communicating via Modbus, twisted pair wiring is required for both the power and signal wires. Each pair must be shielded to eliminate electromagnetic interference.
- For reliable communications between the Vector and the Host master, connect the Host RS-485 common or signal ground to the Vector RS-485 common terminal. This is especially important when connecting to an isolated RS-485 port. Failure to do so could result in communications failures and possible damage to either the Host or Vector RS-485 transceivers.

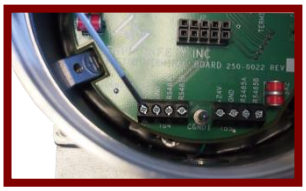
Step 1- Remove Protective Cover

Figure 4-4: Cover Removal

Loosen the set screw on the Protective Cover approx. one turn.

Remove the explosion proof protective cover by turning counter clockwise. The handle of a crescent or spanner wrench can be used as a lever with the cover removal tabs.



Step 2- Remove Control PCBA Module	**Figure 4-5: Remove Control Module**  Separate the control module from the terminal board by using the two (2) slotted, flared-tip screwdrivers (75mm x 2.5mm). Insert the ends of the screwdrivers into the insertion points on the module. Remove the module by prying the module away from the terminal board, using the Vector housing as cantilever points, and applying even pressure to either side.  Insertion Point (1ea at opposite ends) 
Step 3- Electrical Connections	**Figure 4-7: Screw Clamp Terminal Block**  Use a 2mm flathead screwdriver to turn the screw counterclockwise to open the terminal, insert the wire, and turn clockwise to secure terminal.
Step 4- Re-assemble the Vector Field Control Unit	After wiring is completed, insert the control module and attach the explosion proof protective cover onto the Vector Field Control Unit and secure by tightening the housing cover lock screw.

Caution: All cable/conduit entries either be sealed within 18 inches with an appropriately Hazardous location certified sealing plug, gland or fitting.

Attention: Toutes les entrées câble / conduit doivent soit être scellé chaque 18 pouces avec un approprié et certifié bouchon et presse-étoupe ou bien directement relié à un système de conduit antidéflagrante si elle est installée dans une zone dangereuse d'étanchéité.

Remote Sensor Wiring to Vector Field Control Unit

The sensors can be remotely located from the Vector Field Control Unit. Refer to the Wire Size Chart in Appendix 2 to determine maximum distance the sensor can be located from the Vector FCU. In this mode the Vector Field Control Unit is a transmitter for information generated at the sensor location. Remove the detector module from the enclosure using an 18 inch adjustable wrench (or equivalent) and ensure the detector is firmly attached to conduit.

Figure 4-8: PGU Connection to Terminal Block TB-4 & TB-5

Installation Wiring

There are several methods of wiring connections for the Vector Field Control Unit. To accommodate this variety and provide ease of installation, the Vector Field Control Unit includes all hardware and connections for any configuration determined by the user. This makes the unit well suited for new and replacement applications.

Vector FCU Connections

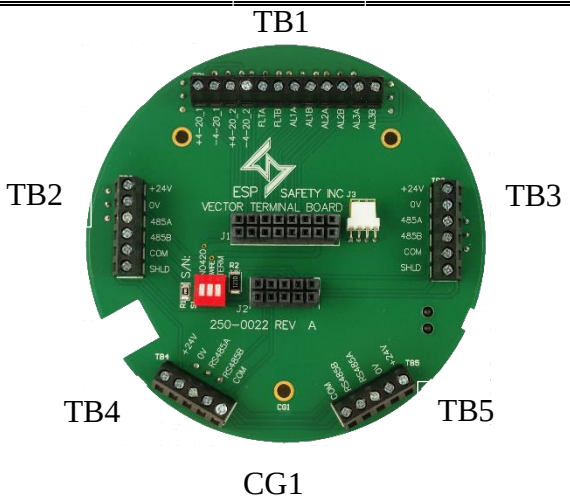


Figure 4-9: Terminal Board

Connection	Label	Function
TB1-1	+4-20_1	Channel 1 +4-20mA output (sourcing)
TB1-2	-4-20_1	Channel 1 4-20mA loop common
TB1-3	+4-20_2	Channel 2 +4-20mA output (sourcing)
TB1-4	-4-20_2	Channel 2 4-20mA loop common
TB1-5	FLTA	Fault contact (software configurable)
TB1-6	FLTB	Fault contact (software configurable)
TB1-7	AL1B	Level 1 contact (software configurable)
TB1-8	AL1B	Level 1 contact (software configurable)
TB1-9	AL2A	Level 2 contact (software configurable)
TB1-10	AL2B	Level 2 contact (software configurable)
TB1-11	AL3A	Level 3 contact (software configurable)
TB1-12	AL3B	Level 3 contact (software configurable)

TB2-1	+24V	+24VDC Power In
TB2-2	0V	+24VDC Supply return (common/GND)
TB2-3	RS485A	RS-485A host connection
TB2-4	RS485B	RS-485B host connection
TB2-5	COM	RS-485 common
TB2-6	SHLD	Shield

CG1	EGND	I.S. Ground to EGND

Connection	Label	Function
TB3-1	+24V	+24VDC Power In
TB3-2	+24RTN	+24VDC Supply return (common/GND)
TB3-3	RS485A	RS-485A host connection
TB3-4	RS485B	RS-485B host connection
TB3-5	COM	RS-485 common
TB3-6	SHLD	Shield

TB4-1	+24V	+24VDC Power to Sensor
TB4-2	0V	+24VDC Sensor GND
TB4-3	RS485A	Sensor RS-485A connection
TB4-4	RS485B	Sensor RS-485B connection
TB4-5	COM	Sensor RS-485 common

TB5-1	+24V	+24VDC Power to Sensor
TB5-2	0V	+24VDC Sensor GND
TB5-3	RS485A	Sensor RS-485A connection
TB5-4	RS485B	Sensor RS-485B connection
TB5-5	COM	Sensor RS-485 common
SW 1-ON	NO420	Places 250Ω Across 4-20mA_1 loop If needed for Hart Communications
SW2-ON	3WIRE	Jumpers the -4-20mA legs to 0V power in terminal for legacy 3 wire 4-20mA connections.
SW3-ON	TERM	Engages RS-485 termination resistor for host com port

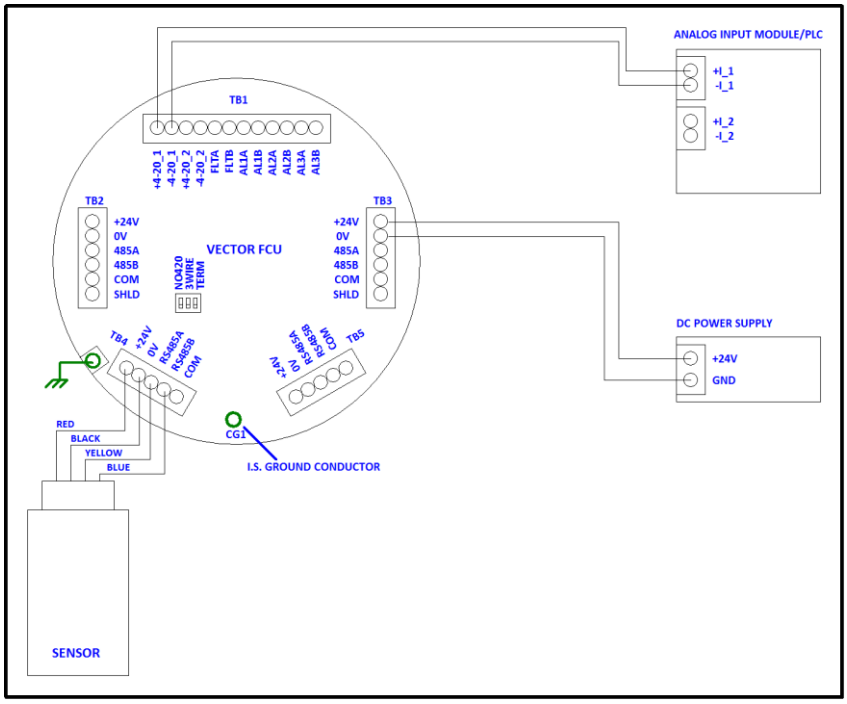


Figure 4-10: Vector wiring to analog input module with current inputs and single sensor

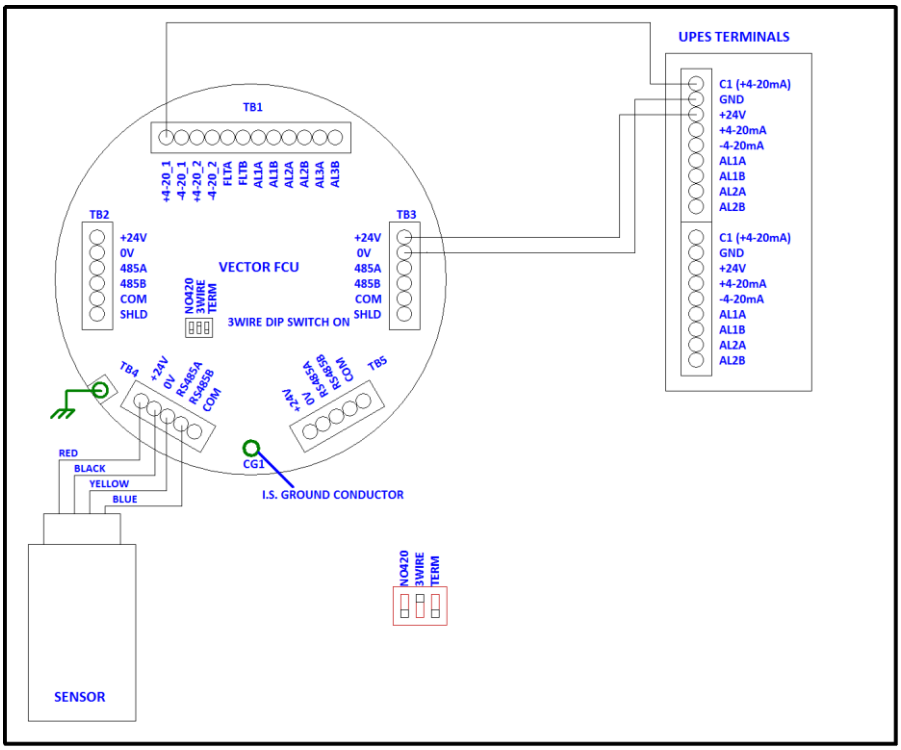


Figure 4-11: Vector FCU to UPES Controller wiring

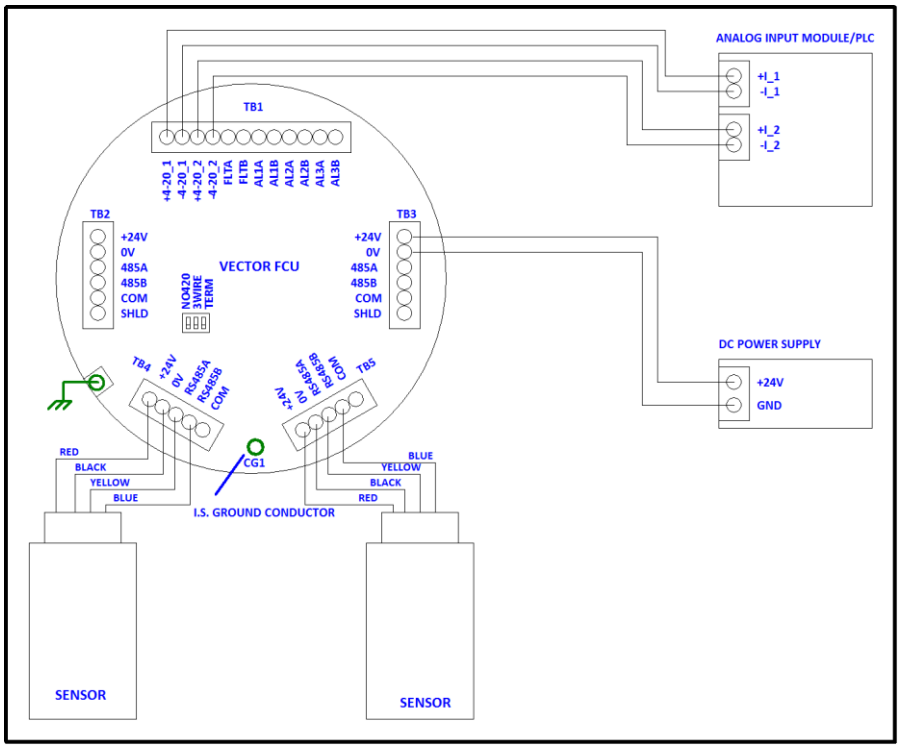


Figure 4-12: Vector wiring to analog input module with current inputs and two sensors

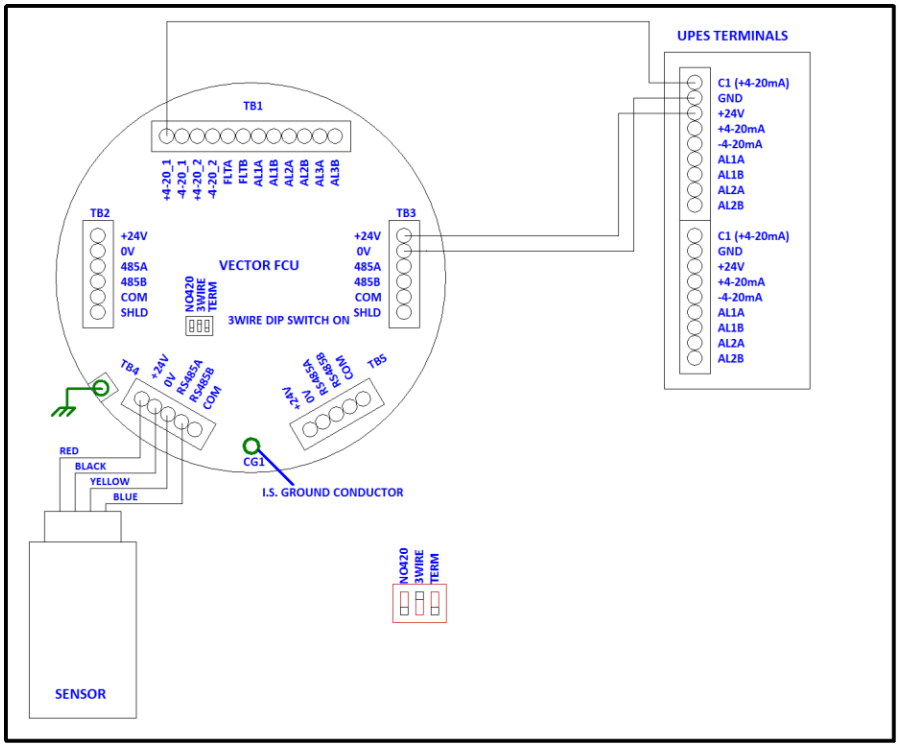


Figure 4-13: Legacy 3-wire 4-20mA connection to Vector FCU

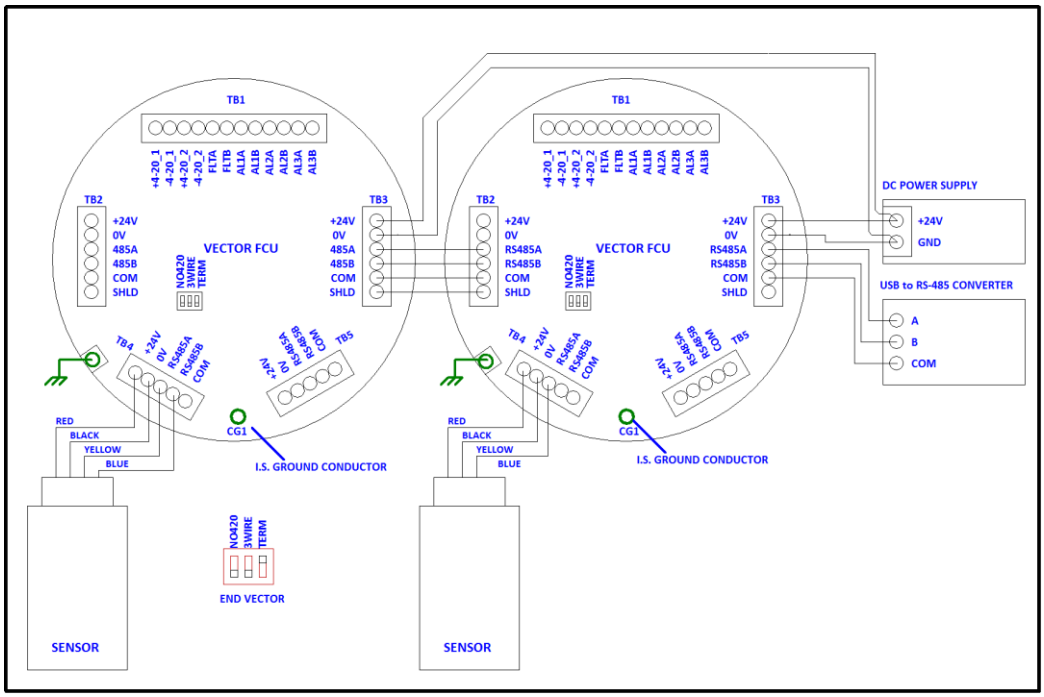


Figure 4-14: Two Vector FCUs with daisy-chained RS-485 communications

NOTE: When using this configuration, S1-3 (Term) must be closed in the last unit on the chain, providing signal termination. All other units must have S1-3 open.

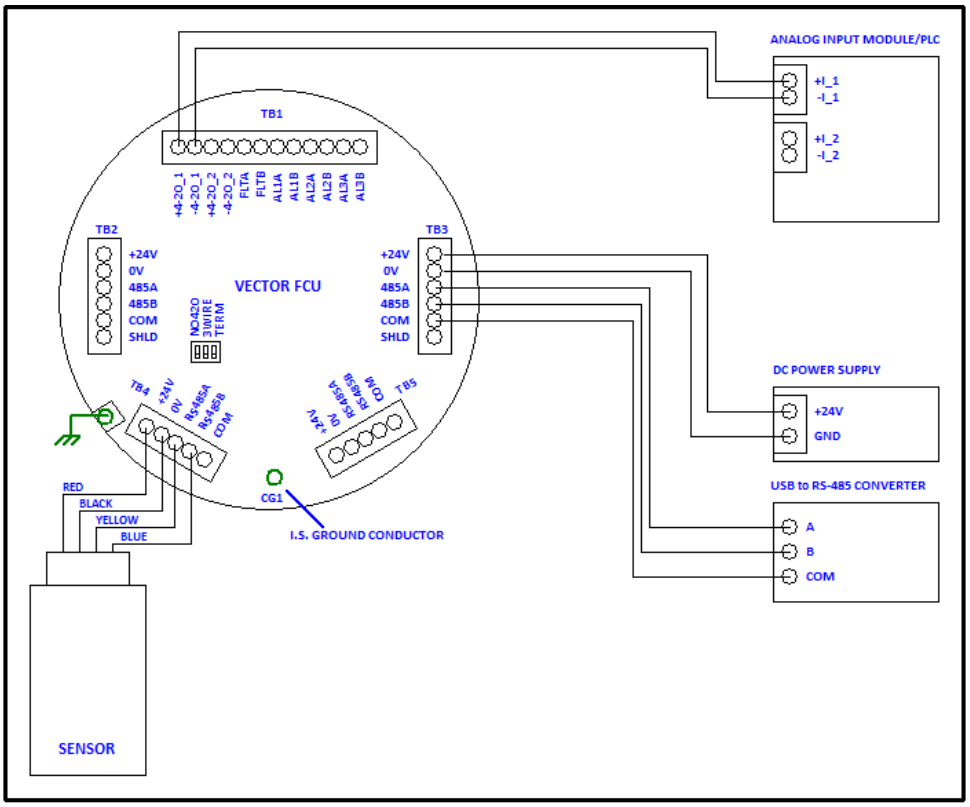


Figure 4-15: Vector wiring to RS-485 to ESP Commander or SCADA

- For reliable communications between the Vector and the Host master, connect the Host RS-485 common or signal ground to the Vector RS-485 common terminal. This is especially important when connecting to an isolated RS-485 port. Failure to do so could result in communications failures and possible damage to either the Host or Vector RS-485 transceivers.

Installation Review Prior to Startup

Once the mounting, cabling, and alarm relay installation has been completed, the Vector is ready to begin the power-on sequence.

Before applying power to the system for the first time, review the steps below:

- Verify that the Vector has been properly mounted and grounded.
- Verify that all conduit / cable gland entries have been tightened and sealed if necessary.
- Verify that all sensor wiring has been installed correctly.
- Verify that the enclosure has been connected to an earth/ground.
- If using a remotely located gas detector(s), verify that the connections between the Vector and the gas detector(s) are secure and functional.
- Verify that the Vector cover is securely installed and locked with the housing cover lock screw.
- Disconnect or power down all output devices and alarms to prevent false actuation.

Once you are ready to begin startup, verify that the power supply is connected properly and verify the power supply voltage with the Vector is disconnected at the source. The Vector is powered by 24 VDC (18 to 32 VDC voltage range).
After completing the above, the Vector is ready to be powered on.

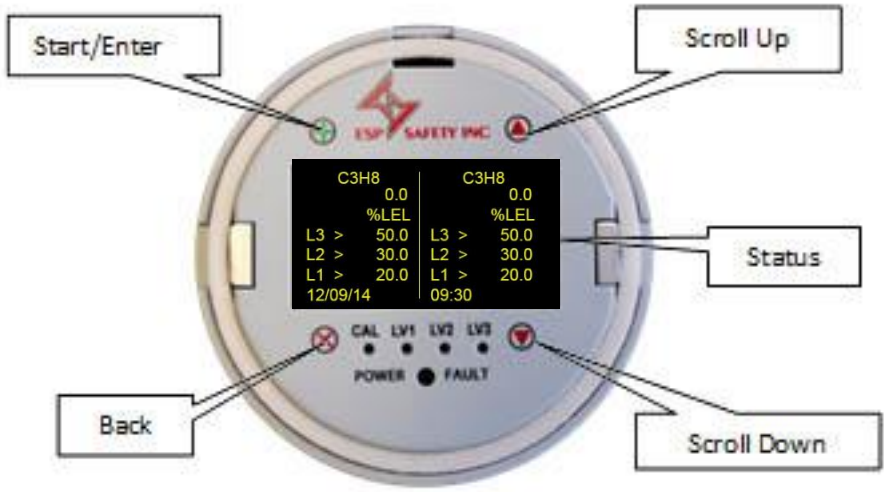
Startup Procedure Apply power to the system. Upon first power-up, the Vector should be allowed to stabilize and allow the sensor(s) to initialize.	**Figure 4-16 Initialization Screen** 
After 30 seconds, the Operational Status indicator diode will glow green and all information will be available on the display.	**Figure 4-17: Operation Screen** 

5.0 Vector Operation

5.1 Vector Display Operations

When used in conjunction with a magnetic wand (P/N 611-0005), the display on the Vector FCU may be used to perform several basic configuration functions. Four touch points for the magnetic wand surround the display. The functions of the touch points are as follows:

Start / Enter – selects a function to be performed
Back – cancel a pending function or exit the current function



Scroll Up – selects the item above the current one, or may be used to increase a numeric digit by one
Scroll Down – selects the item below the current one, or may be used to decrease a numeric digit by one
Status - alarm values and alarm state information
If the magnetic wand is placed on the "SCROLL UP" or "SCROLL DOWN" touch point and held there, the display will scroll approximately every 0.5 seconds.

The status line on the display shows the following information:

- current month, day, and (2 digit) year in mm/dd/yy format
- the current time in hh:mm 24 hour format
- status code (refer to table for code conditions). Display unit of measure unless a code condition is met.

Status Code Conditions:

CHKSM – ROM checksum error
PSVLT – less than18V or greater than32V supply voltage
RAMCK – RAM error
NOCFG – Sensor configuration table not loaded
OVRNG – sensor over ranged

UNDRG – sensor under ranged

Figure 2-1: Touch Wand Points

Figure 2-3: Boot Display

Start Up Display Information:

1. Unit serial number
2. Modbus U slave address for host port
3. Firmware version number
4. Firmware checksum

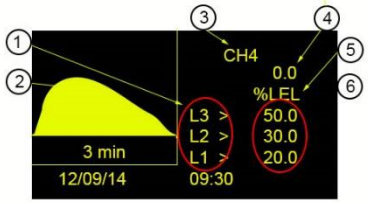


Figure 2-4: Single Gas Display

Single Gas Display Information:

1. Alarm direction indicator for Alarm Limits 1-3. ">" indicates that values higher than the specified limit value will be considered to be in alarm. "<" indicates that lower values will be considered to be in alarm.
2. Graphical display showing the gas concentration for the last 3 minutes.
3. Gas identifier for the gas concentration being displayed.
4. Measured gas concentration.
5. Engineering units for gas concentration.
6. Value of Alarm Limits 1-3. Units are the same as those for the measured gas concentration

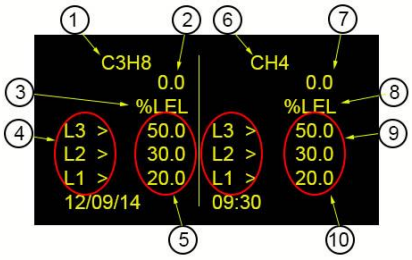
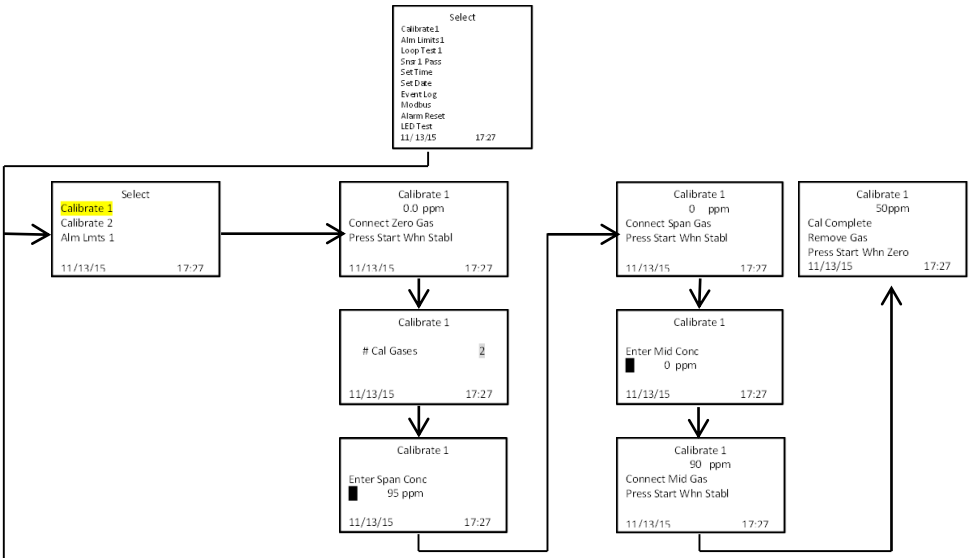


Figure 2-5: Two Gas Display

Two Gas Display Information:

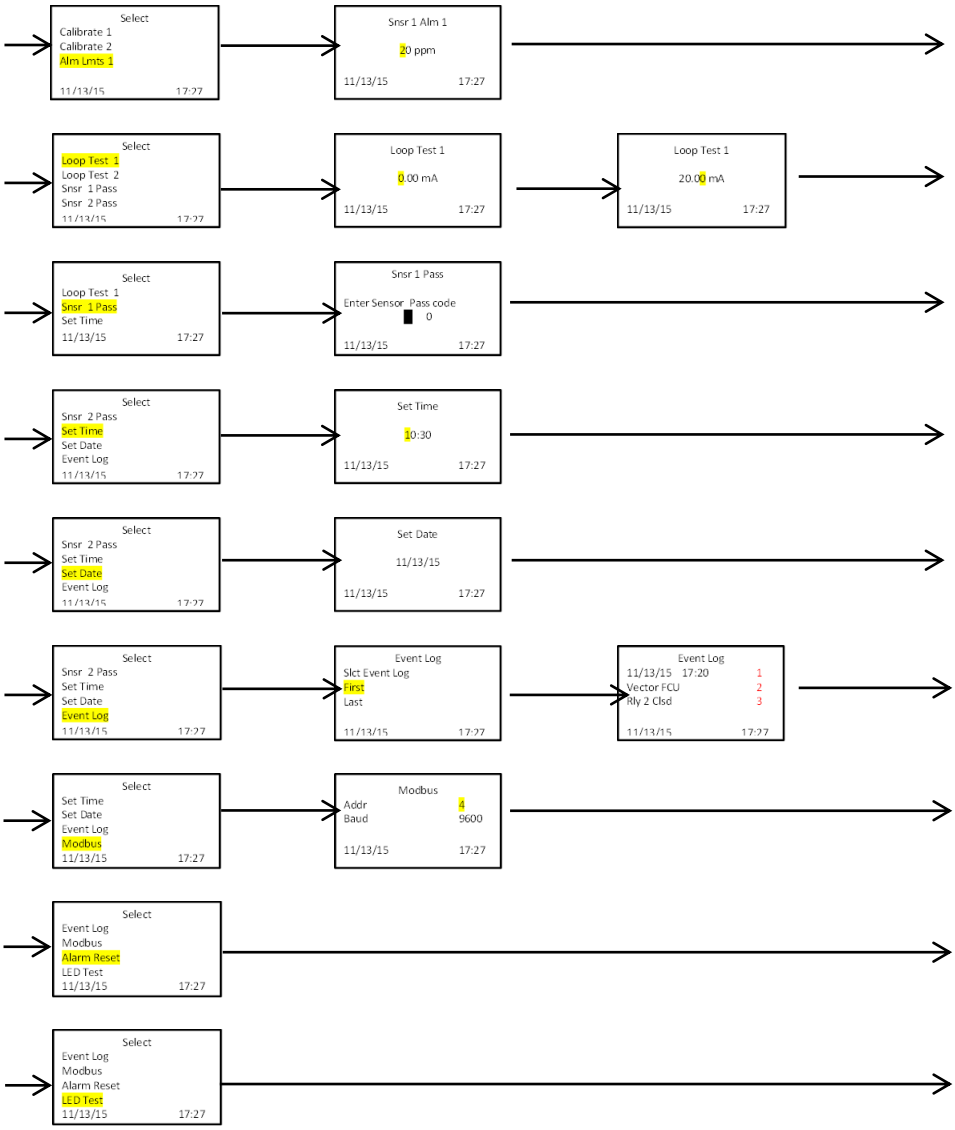
1. Gas identifier for Sensor 1. Typically, this is the chemical formula for gas concentration being displayed.
2. Measured gas concentration for Sensor 1.
3. Engineering units for gas concentration for Sensor 1.
4. Alarm direction indicator for Sensor 1 alarm limits 1-3. ">" indicates that values higher than the specified limit value will be considered to be in alarm. "<" indicates that values lower than the specified limit value will be considered to be in alarm.
5. Value of Sensor 1 alarm limits 1-3. Units are the same as those for the measured gas concentration.
6. Gas identifier for Sensor 2. Typically, this is the chemical formula for gas concentration being displayed.
7. Measured gas concentration for Sensor 2.
8. Engineering units for gas concentration for Sensor 2.
9. Value of Sensor 2 alarm limits 1-3. Units are the same as those for the measured gas concentration. Note that if alarm function is disabled, value will not be shown.
10. Alarm direction indicator for Sensor 2 alarm limits 1-3. ">" indicates that values higher than the specified limit value will be considered to be in alarm. "<" indicates that lower values will be considered to be in alarm.

5.2 Vector Menu Structure



See Section 6 for details
Alternative Methods:
ESP Commander
HART Communicator

See Section 5.2.1 for details
Alternative Methods:
ESP Commander
HART Communicator

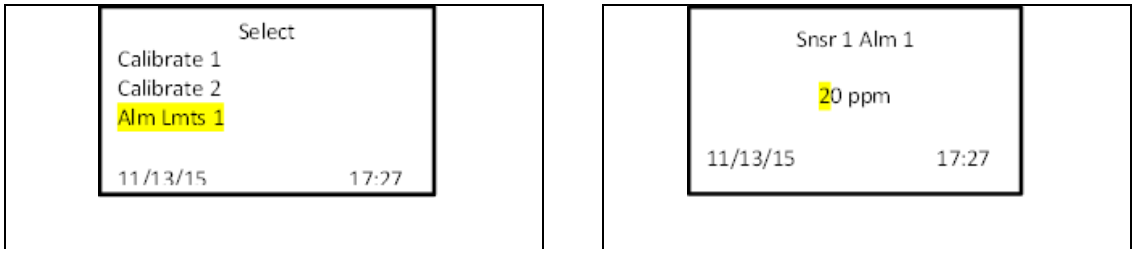


5.2.1 Changing Alarm Trigger Level Settings

The alarm trigger levels may be set by one of three methods:

- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface
- HART Communicator

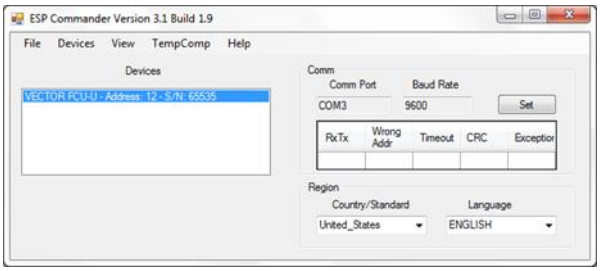
Setting the alarm trigger levels using the Vector OLED.



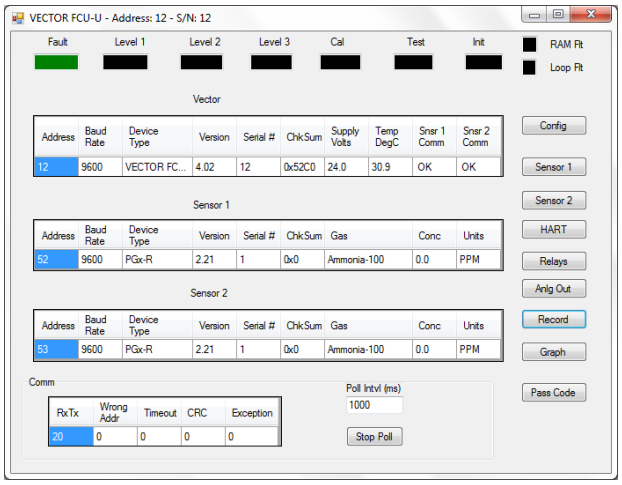
Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Alm Lmts 1 and hit the Select key. The Alarm Limit screen will be shown.	Use the Start point to move to the first digit and then use the arrow marks to change the value up or down. The Start point will move from one digit to the next. When done, the second alarm point values will be shown. Repeat for all three alarm settings.

Setting the alarm levels using ESP Commander

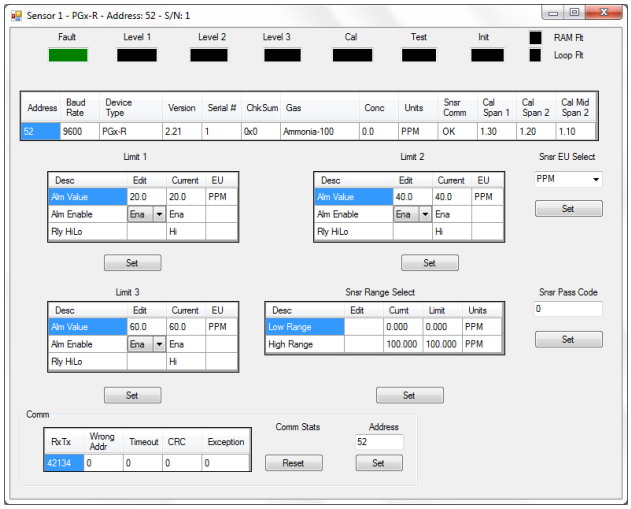
- Start ESP Commander and select Devices/Scan All.



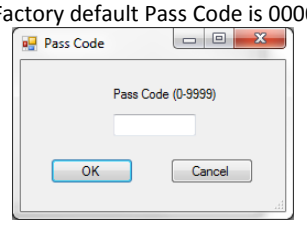
- Select the Vector unit.



- Click the button on the right column for the sensor to be set.

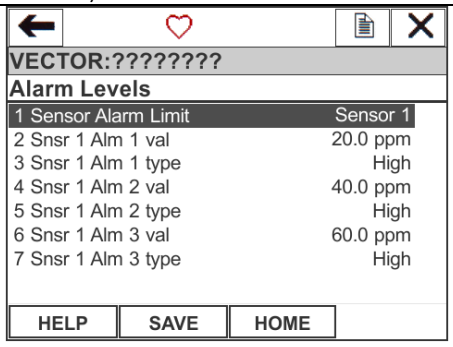


- For each alarm trigger level set of the three available, enter the new alarm value in the Edit column and click Set to apply the new value. Close the window when done.
- When prompted, enter the Passcode. Factory default Pass Code is 0000.

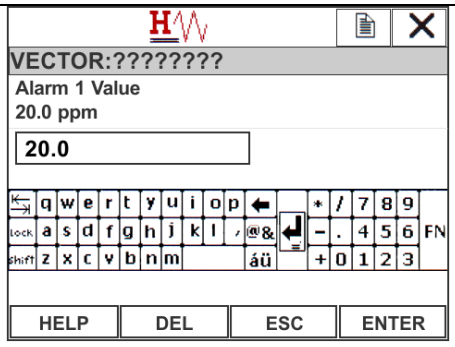


Setting the alarm trigger level using the Hart Communicator.

- Refer to Appendix 3, HART Communicator Menu Tree, for an overview of the HART functions.
- Navigate to the Output Condition menu (Online\Device Setup\Detailed Setup\Output Condition\Alarm Levels).



Select Snsr 1 Alm 1 val to set the alarm trigger value.

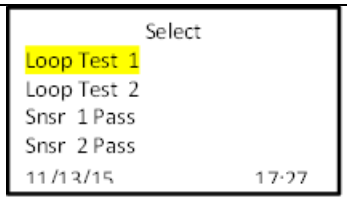


Use the keyboard layout to select the desired value and touch Save to accept. Repeat for the other two alarm levels for this sensor, if desired.

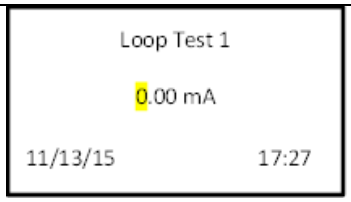
5.2.2 Measuring the Output Loop Current

The Loop Test allows selecting an output current to be measured at a 4-20mA output loop. There are two loops available; one loop is used for each sensor that may be attached.

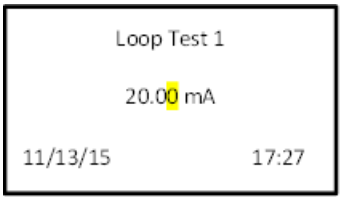
The output cannot be adjusted from the Vector display, but can be done using ESP Commander or the Hart Communicator. Please see the Calibration section 6 in this manual for more details.



Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Loop Test 1 or 2 and hit the Select key. If only one sensor is attached, Loop Test 2 will not be shown in the menu.



Touch the Start point to move from one digit to another and use the up/down points to set the desired value. After the final digit has been set and Start touched again, the desired current will be output on the relay.



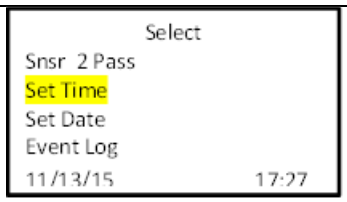
After the measurement has been made, touch the Start button to select another current value to measure or touch the Back point to exit.

5.2.3 Setting the Date and Time

The date and time may be set by one of two methods:

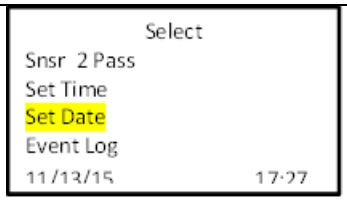
- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface

Setting the date and time using the Vector display and the magnetic wand.

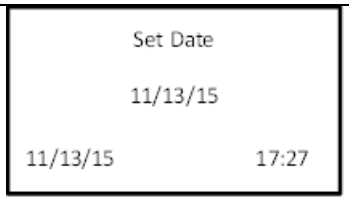


Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Set Time and hit the Select key. The Alarm point screen will be shown.

Use the Start point to move to the first digit and then use the arrow marks to change the value up or down. The Start point will move from one digit to the next. Use the Back point to return to the previous menu.



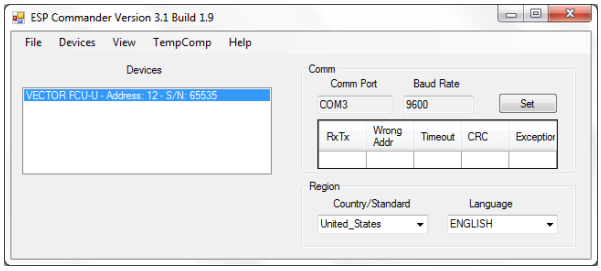
Use the arrow marks to scroll down to Set Date and hit the Select key. The Alarm point screen will be shown.



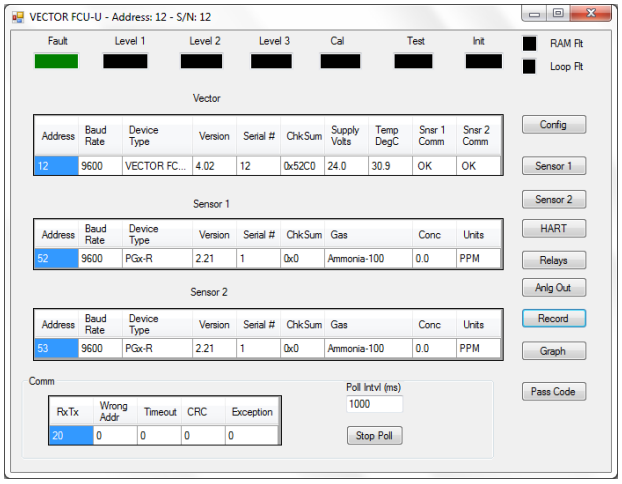
Use the Start point to move to the first digit and then use the arrow marks to change the value up or down. The Start point will move from one digit to the next. Use the Back point to return to the previous menu.

Setting the date and time using ESP Commander

- Start ESP Commander and select Devices/Scan All.

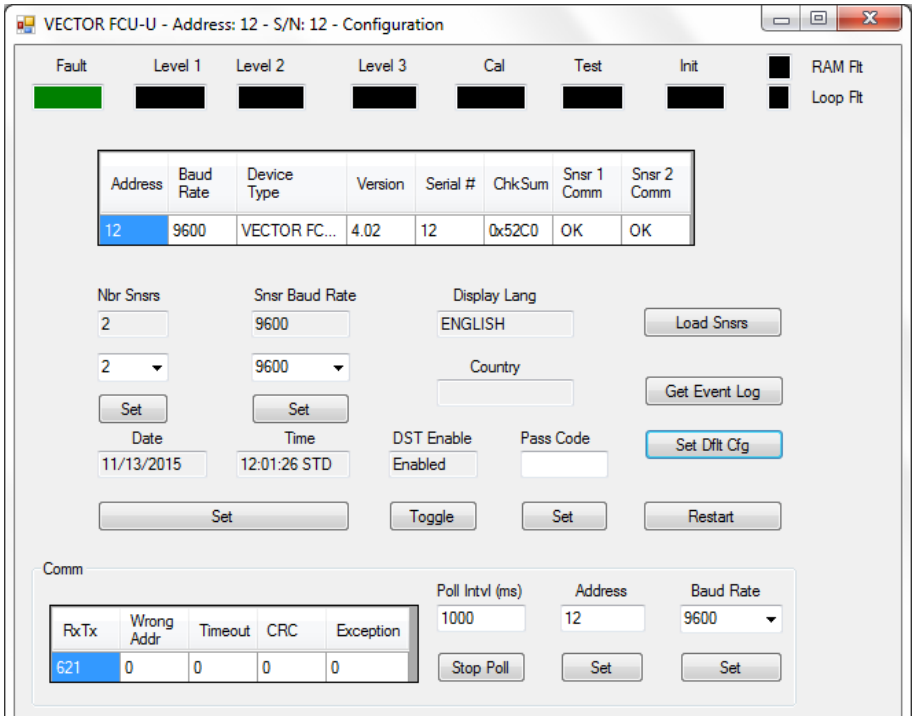


- Select the Vector unit.



- Click the Config button.
    - Click the Set button under the Date and Time. The values from the ESP Commander computer system will be applied.
    - Daylight Savings Time (United States) may be toggled under DST Enabled.

NOTE: If Pass Code hasn't been entered before, a Pass Code window will prompt the user to enter the Pass Code.

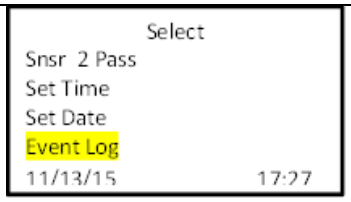


5.2.4 Viewing the Event Log

The Event log may be viewed by one of two methods.

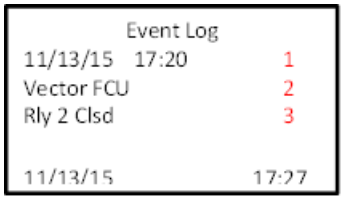
- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface

Viewing the Event Log using the Vector display and a magnetic wand.



Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Event Log and hit the Select key.

Touch the UP/DOWN scroll points to select either "First" or "Last". If "First" is selected, the event log display will start with oldest (earliest) event. If "Last" is selected, the event log display will start with the most recent event. Touch the START point to activate the event log display.



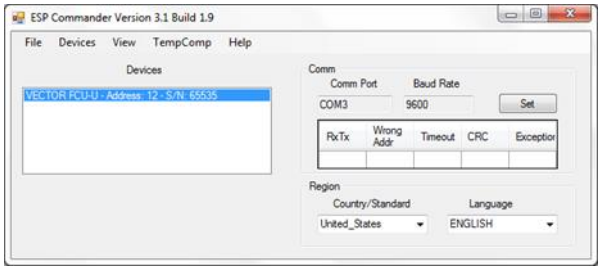
Each event log entry contains the following information:

1. Date and time the event occurred.
2. Source of the event:
   - Vector FCU
   - Sensor 1
   - Sensor 2
3. Event description

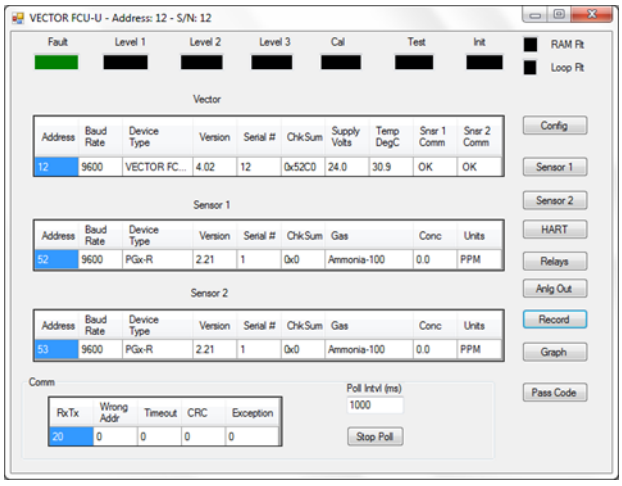
The UP/DOWN scroll points may be used to move through the entries in the log. Touching the BACK point will exit the display.

Viewing the Event Log using ESP Commander.

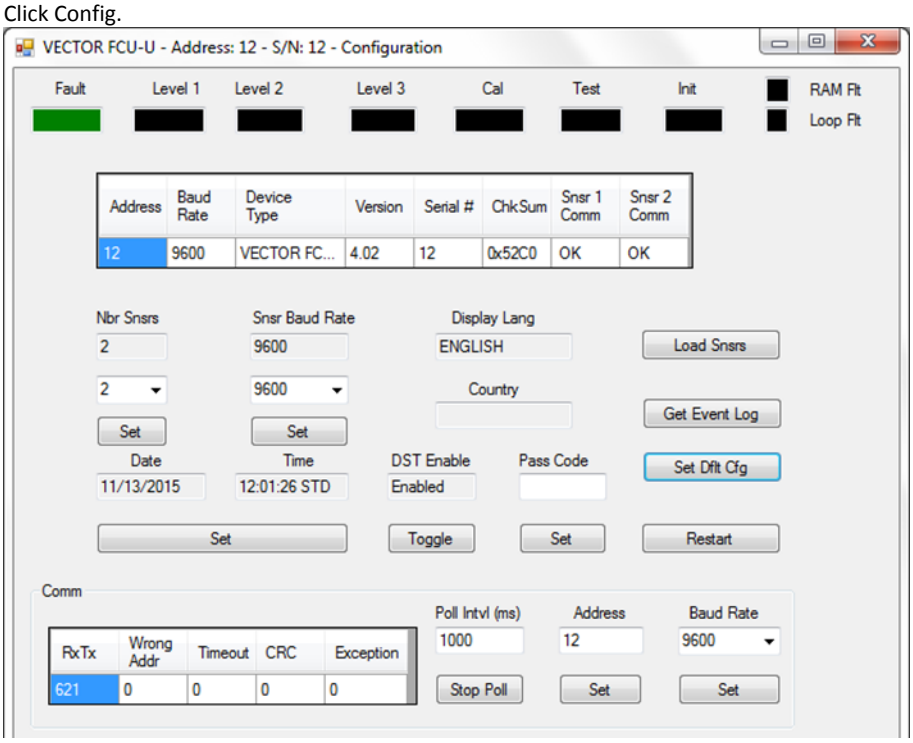
- Start ESP Commander and select Devices/Scan All.



  - Select the Vector unit.



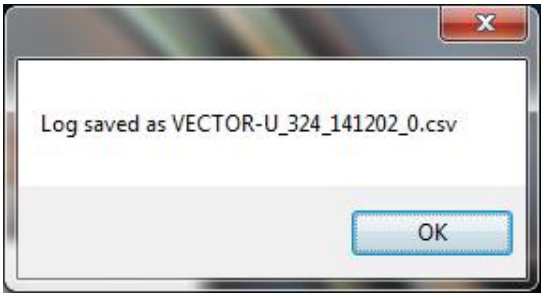
- Click Config.



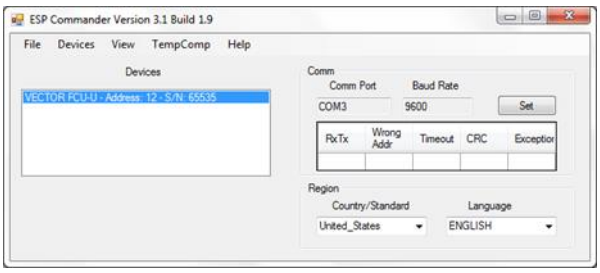
- Click Get Event Log to download the Event Log.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

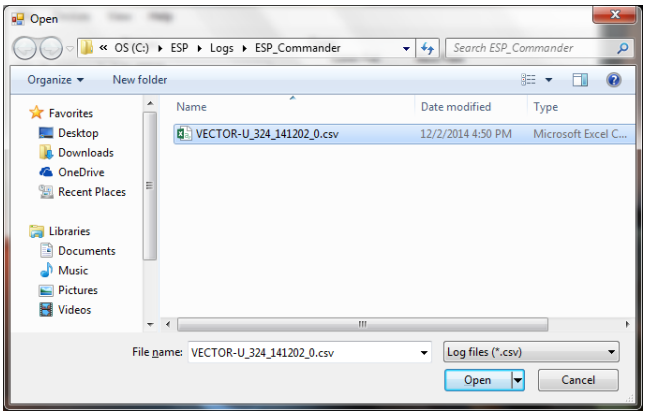
- The log will be downloaded in CSV format to \ESP\Logs\ESP_Commander.
- This file contains all the data, but no headers or easy way to interprete if viewed in Excel or a similar program. However, ESP Commander can show a formatted version once it has been downloaded.



- Go to the initial ESP Commander window (usually still open).

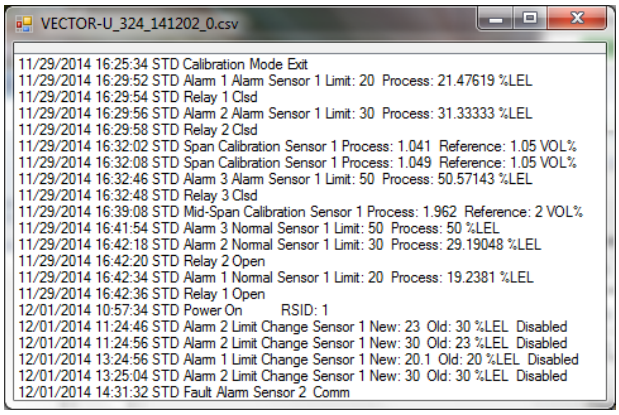


- Select View/Event Logs.



NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

- Find the event log that was just downloaded and click Open.
  - Older logs can be selected if needed.



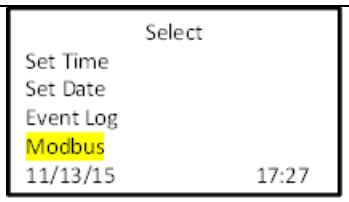
  - The event data will be displayed with information about each event.

5.2.5 Changing the Vector Modbus Address and Baud Rate

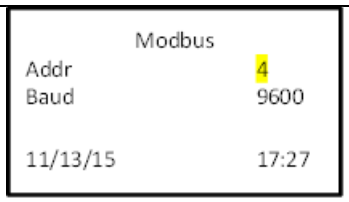
The Modbus address for the Vector may be set by one of two methods.

- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface

Setting the Vector Modbus address and Baud rate using the Vector OLED.



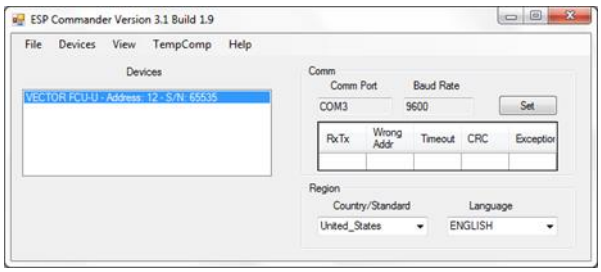
Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Modbus and hit the Select key



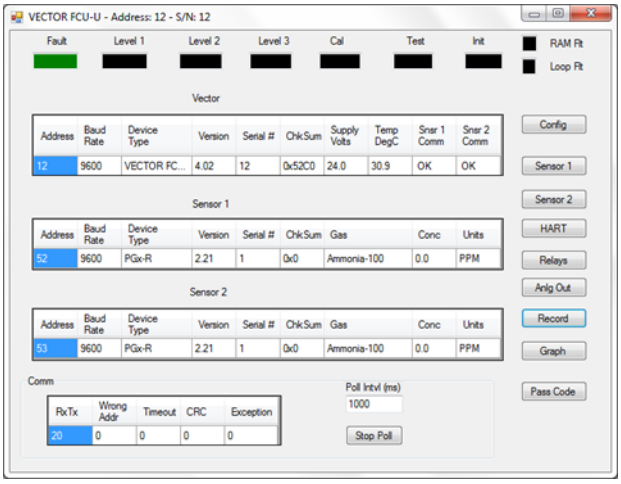
Use the Start point to move to the first value and then use the arrow marks to change the value up or down. The Start point will move from one value to the next. Both the Address and Baud rate are changed with the same method.

Setting the Vector Modbus address and Baud rate using ESP Commander.

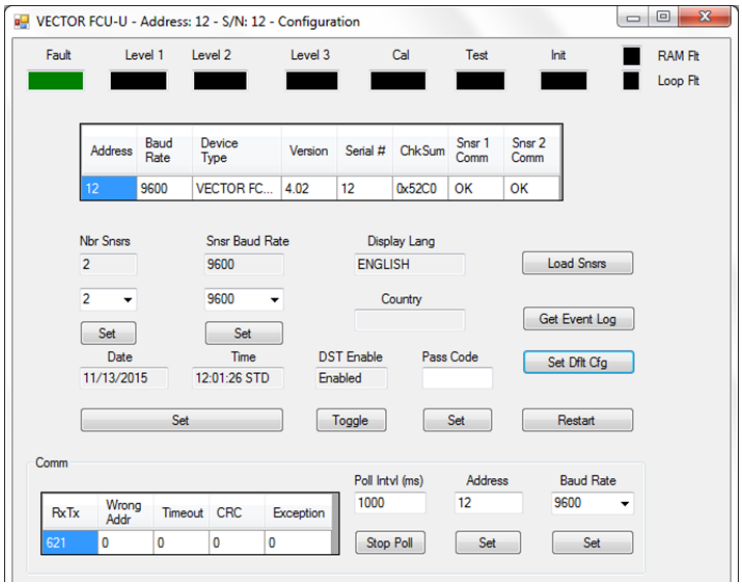
- Start ESP Commander and select Devices/Scan All.



- Select the Vector unit.



- Click Config.
  - Enter the desired value into the Address or Baud Rate boxes and click Set to apply.

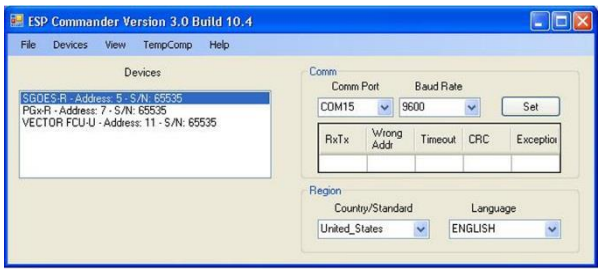


NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

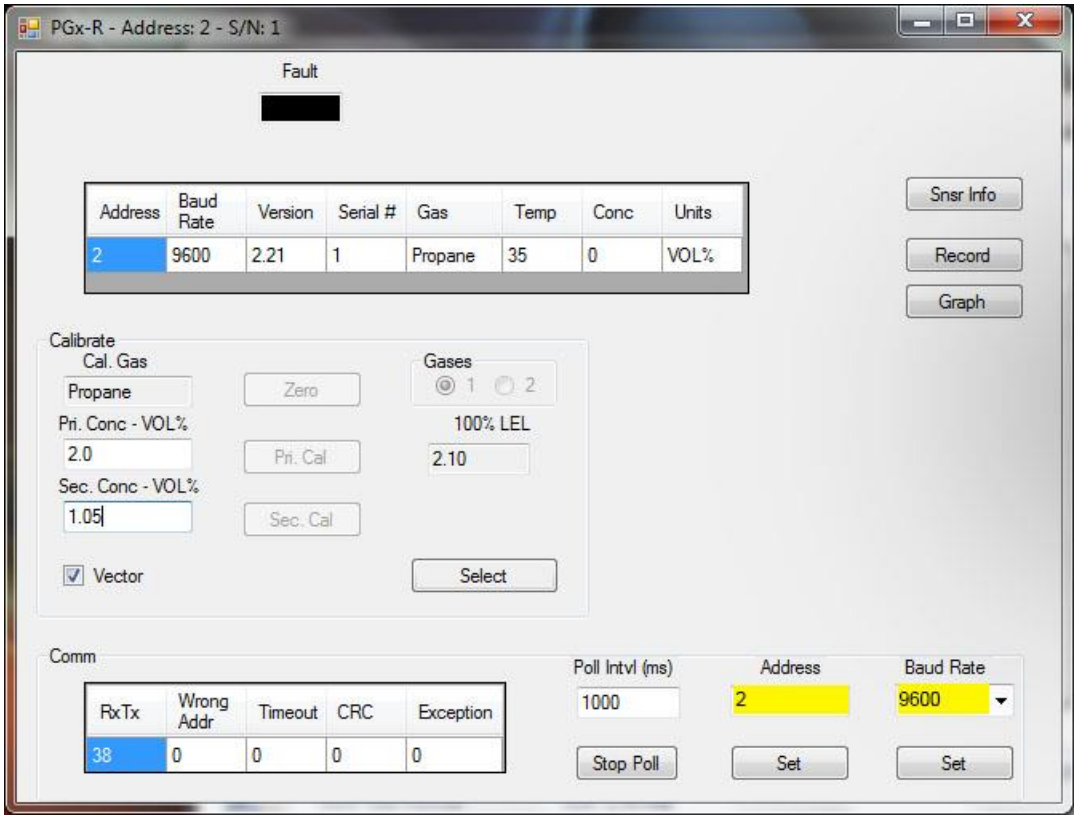
5.2.6 Changing a Sensor Modbus Address and Baud Rate

The Modbus address for a sensor may be set using ESP Commander.

- Start ESP Commander and select Devices/Scan All.



- Double click the sensor to be set. Note the SGOES unit shown in the window above is being used as a sensor.



- Change the address or baud rate as required.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

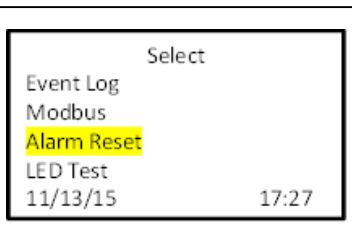
5.2.7 Resetting an Alarm

The relay for alarm three is latched per FM requirements. Once triggered by an event it will continue to be latched closed unless reset, though the LED indicator for the alarm will clear.

The alarm three relay may be reset by one of three methods:

- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface
- HART Communicator

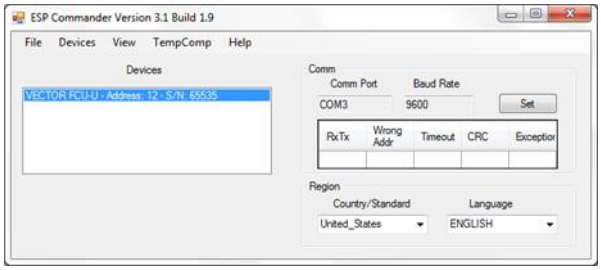
Clearing the relay using the Vector display and the magnetic wand.



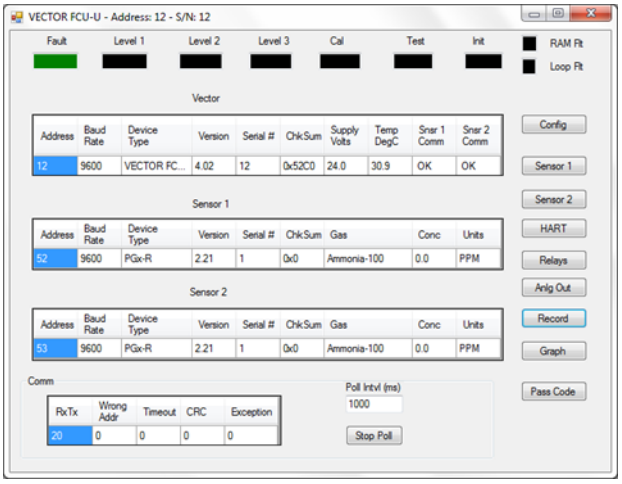
Use the magnet to select the Start point and then use the UP/DOWN scroll points to move through the available functions. Use the arrow marks to scroll down to Alarm Reset. Select the Start point to reset the alarm.

Clearing the relay using ESP Commander

- Start ESP Commander and select Devices/Scan All.

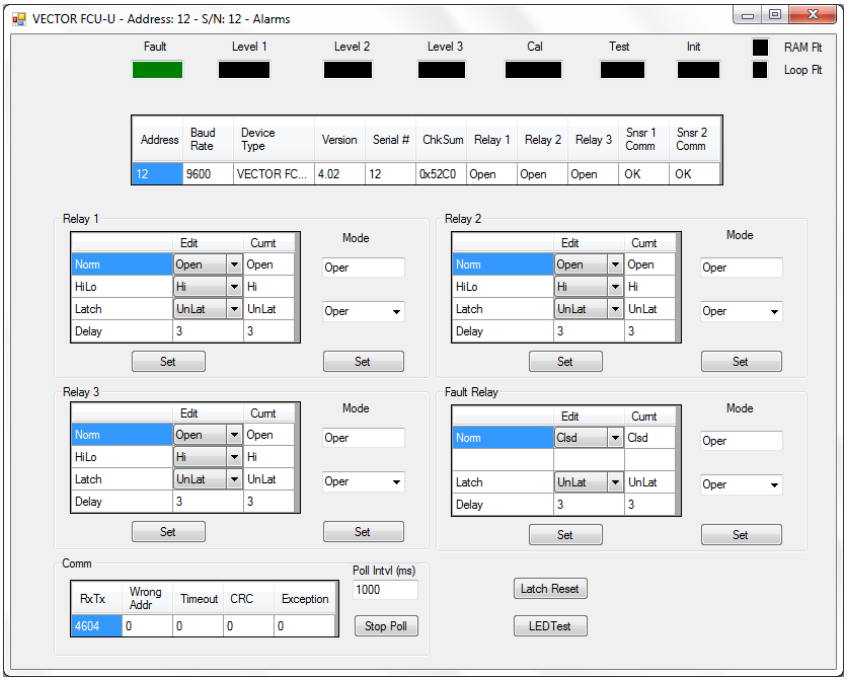


- Select the Vector unit.



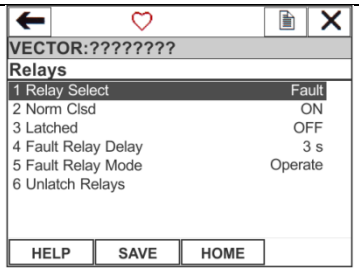
- Select the Relay button on the right hand column.
    - Click Latch Reset.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

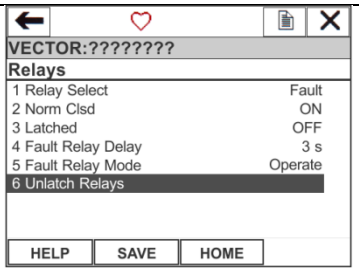


Clearing the relay using the Hart Communicator

- Refer to Appendix 3, HART Communicator Menu Tree, for an overview of the HART menu and functions.
- Navigate to the Relays menu (Online\Device Setup\Detailed Setup\Output Condition\Relays).



Verify Alarm 3 is shown next to Relay Select. If not, select Relay Select and scroll down to select Alarm 3.

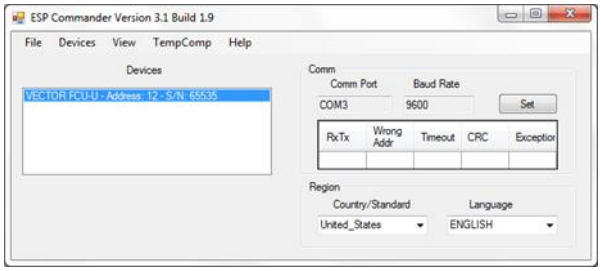


Scroll down and select Unlatch Relays. The relay will return to its normally open configuration.

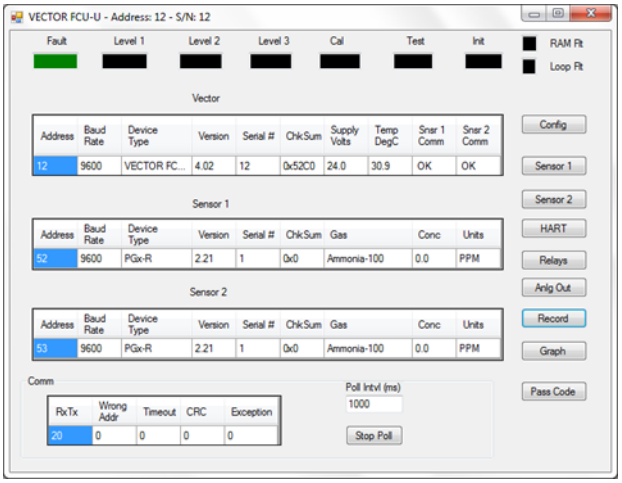
5.3 Enabling or Disabling Alarm Relays

The alarm relays may be enabled or disabled by ESP Commander using the Modbus RTU interface.

- Start ESP Commander and select Devices/Scan All.

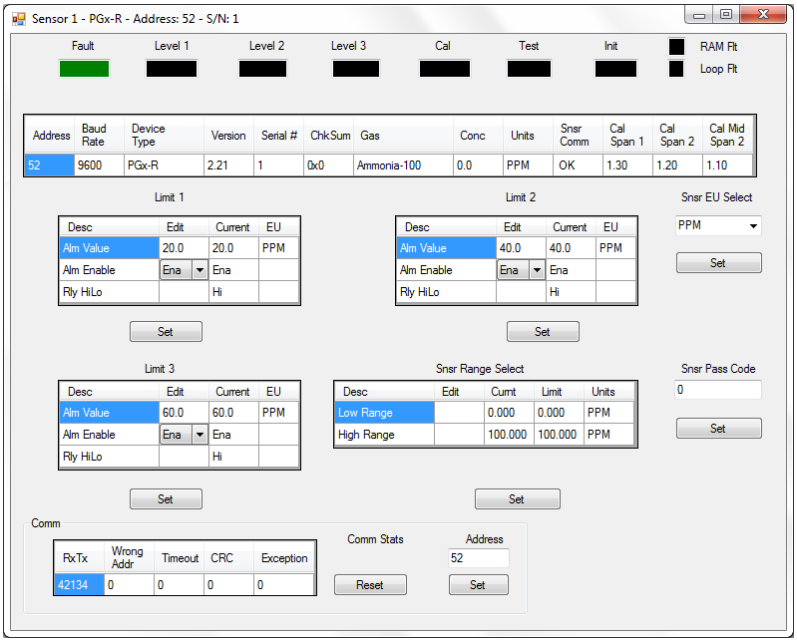


- Select the Vector unit.



- Click the button on the right column for the sensor to be set.
  - To disable an alarm, select the value in the drop box next to Alrm Enable for the alarm to be modified. Click Set to apply the change. Close the window when done.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code



5.4 Changing the Relay Alarm Latching Mode

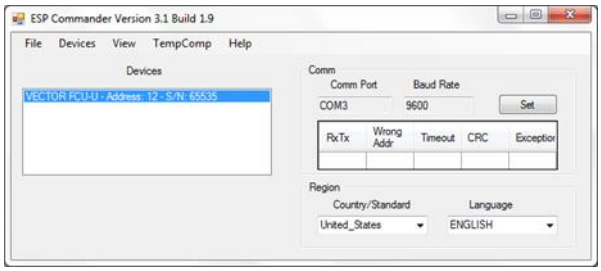
The alarm relays can be set to latch after triggering; after the event has passed the relay will remain closed until reset. Alarms 1 and 2 can be set to latched or unlatched: the default is unlatched. The Alarm 3 relay cannot be set to unlatched per FM requirements.

The Alarm Trigger Mode for the Vector may be set by one of two methods.

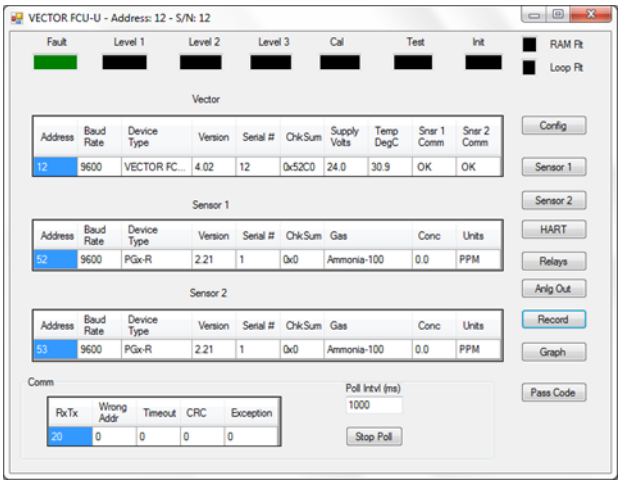
- ESP Commander using the Modbus RTU interface
- HART Communicator

Setting the Alarm Trigger Mode using ESP Commander.

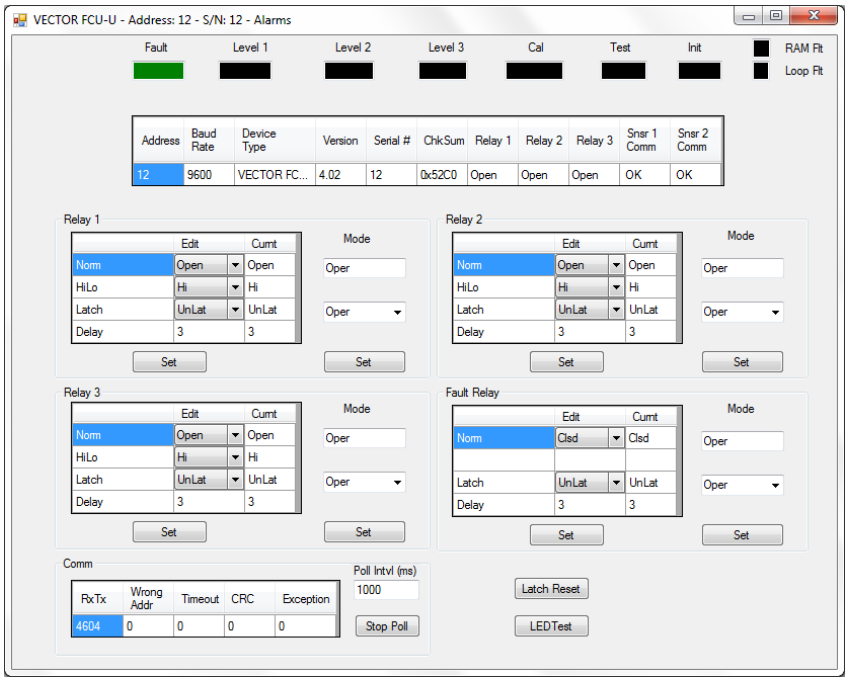
- Start ESP Commander and select Devices/Scan All.



- Select the Vector unit.



- Click Relays.

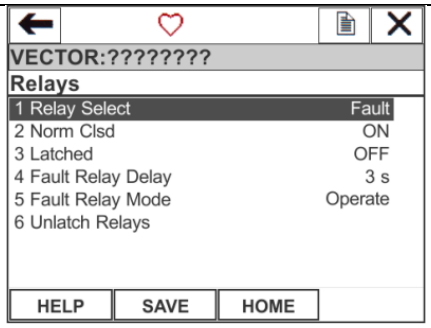


- Select Latched or Unlatched from the drop boxes next to the relay to be changed and click Set to confirm the change.
    - Note that Alarm 3 will not change if set to Unlatched.

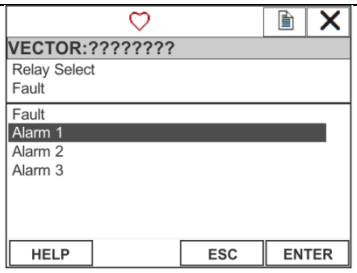
NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code

Setting the Alarm Trigger Mode using the Hart Communicator.

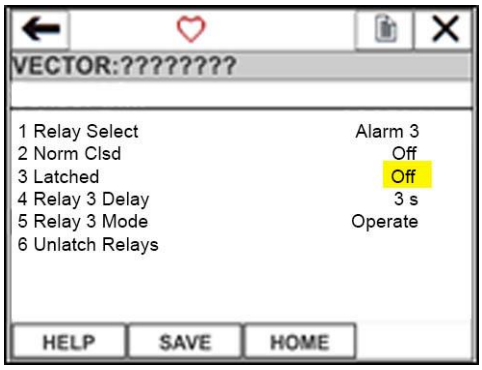
- Refer to Appendix 3, HART Communicator Menu Tree, for an overview of the HART menu and functions.
- Navigate to the Relays menu (Online\Device Setup\Detailed Setup\Output Condition\Relays).



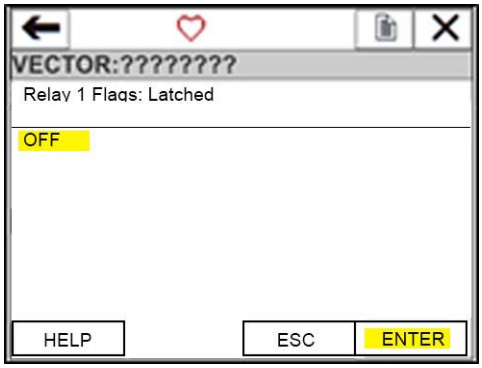
Verify the relay to be modified is selected. If not, select Relay.



Scroll down to select the Alarm Trigger to change and select Enter.



Click the setting for Latched.

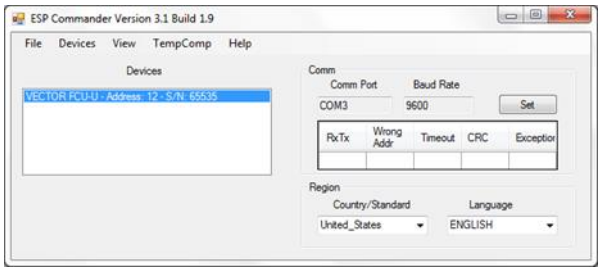


Click OFF or ON to change the state and click Enter to confirm.

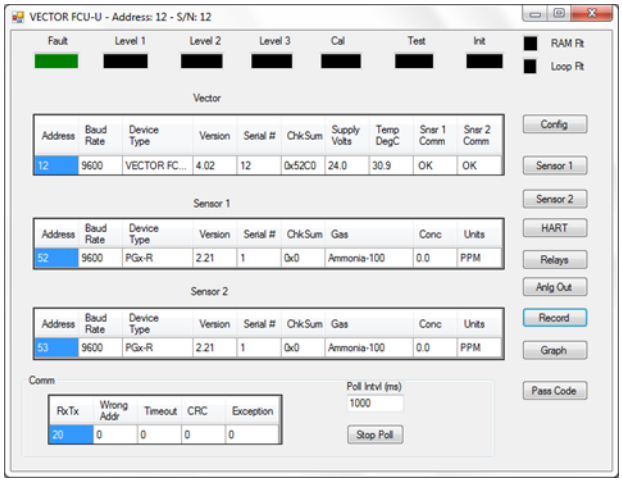
5.5 Changing the Relay Mode

The alarm relays are set by default to trigger when target gas reaches or goes above specified trigger setting. In some applications (e.g. Oxygen), it would be preferred to trigger whenever the gas level falls on or below the trigger setting. The alarm relay mode may be enabled or disabled by ESP Commander using the Modbus RTU interface.

- Start ESP Commander and select Devices/Scan All.

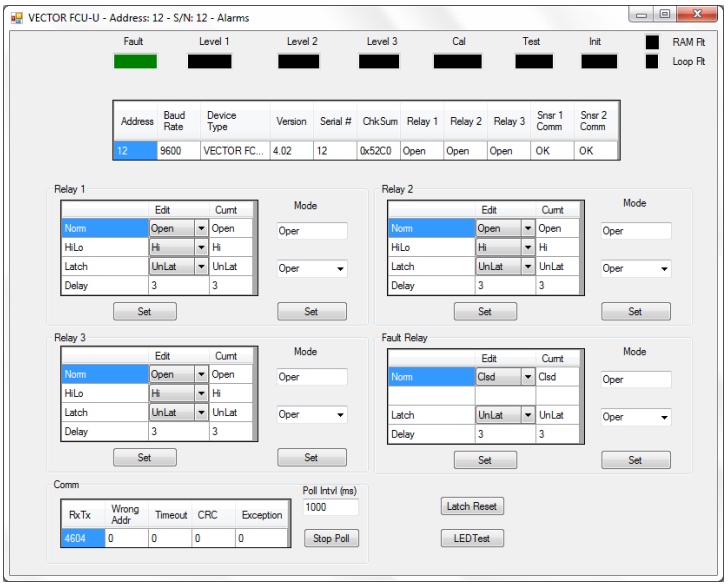


- Select the Vector unit.



- Click the Relay button on the right hand column.
  - Select Latched or Unlatched from the drop boxes next to the relay to be changed and click Set to confirm the change.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code



5.6 Adding, Changing, or Removing a PGU Gas Sensor

Before removing the cover please ensure the device is completely powered down and switch off any output loads normally activated by the Vector.
Avant de retirer le couvercle s'il vous plaît assurer le dispositif est complètement mise hors tension et éteindre aucune charge de sorties normalement activés par le Vector.

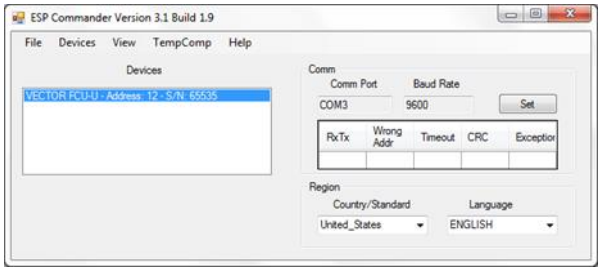
Adding, changing, or removing a PGU Gas Sensor requires ESP Commander.

To add or change a new PGU sensor:

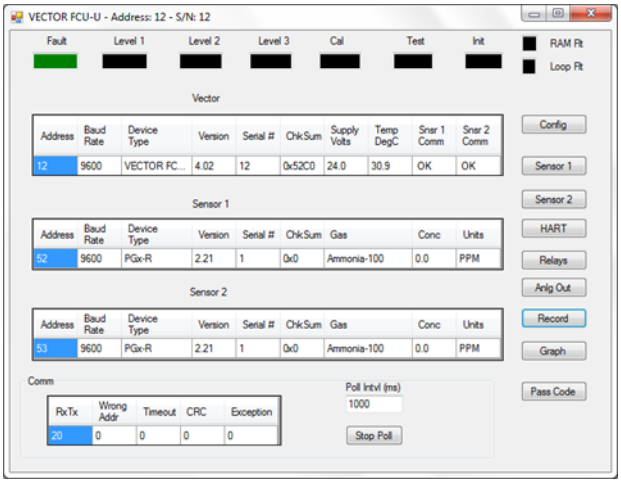
- Remove the cover per the instructions above.
- Remove the hole plug from the lower right corner of the enclosure if adding a sensor.
- Install or remove the sensor.
- Wire per the wiring instructions in the Installation section 4.0.

Enable or disable the second sensor channel.

- Start ESP Commander and select Devices/Scan All.

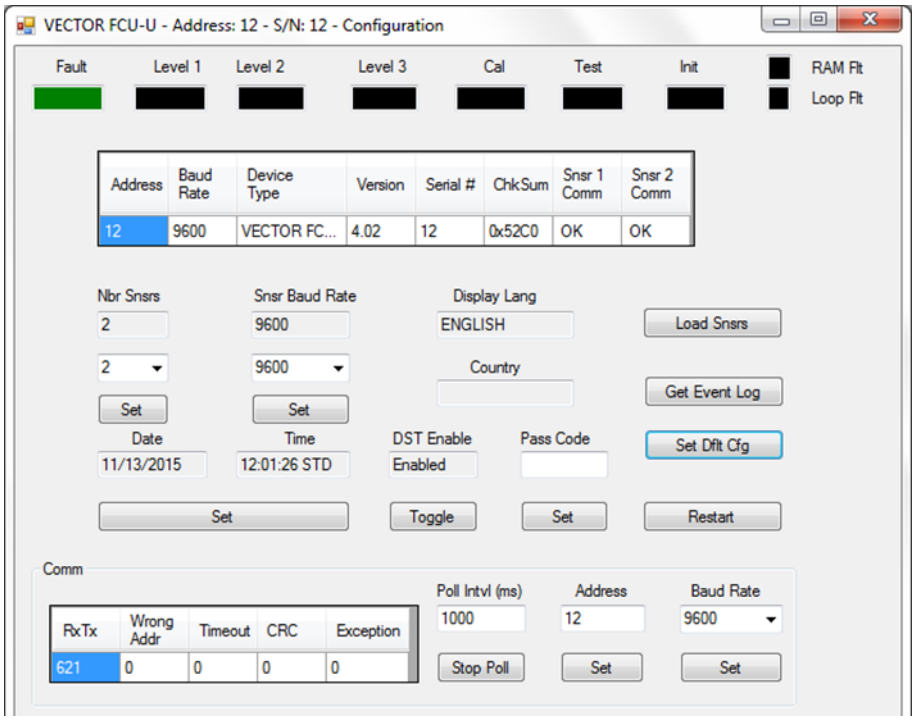


- Select the Vector unit.



- Click Config.
    - Enter the desired value into the Nbr Sensor box and click Set to apply.

NOTE: If Pass Code has not been requested before, a Pass Code window will be prompted to enter Pass Code



- Calibrate the new or changed PGU sensor per the Calibration instructions in Section 6.0.

6.0 Calibration Procedures

6.1 Calibrate the Gas Sensors

Sensors attached to the Vector Field Control Unit may be calibrated by one of three methods:

- Vector OLED display and magnetic wand
- ESP Commander using the Modbus RTU interface
- HART Communicator

The term ZERO GAS in these calibration procedures refers to a gas with a zero concentration of the gas to be detected by the calibration detector.

The term SPAN GAS in these calibration procedures refers to a *Full Scale* gas mixture.

The term MID-SPAN GAS in these calibration procedures refers to a gas mixture of intermediate concentration between zero and full scale.

Sensor Calibration using the OLED and Magnetic Wand

Refer to the Display Operations section for an overview of the display functions. The example shown below is for a propane sensor connected as the second sensor.

Using the magnetic wand, touch the START point to bring up the function select display.

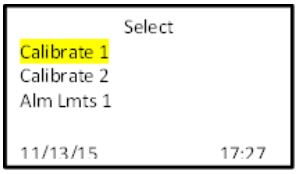


Figure 5-1: Function Select Display

Step 1

Using the Up and Down touch points, select "Calibrate 1" to calibrate the first sensor or select "Calibrate 2" to calibrate the second sensor (if present).

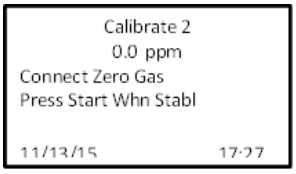


Figure 5-2: Zero Calibration Screen

Step 2

Apply the zero gas to the sensor and wait for the reading to stabilize. Using the magnetic wand, touch the "START" point. This will complete the sensor zero calibration.

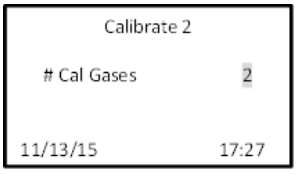


Figure 5-3: Calibration Gas Count Selection

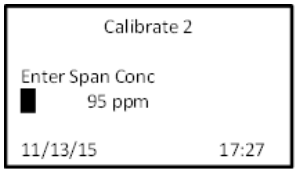


Figure 5-4: Span Gas Concentration Entry

Step 3
Using the magnetic wand, touch the Up and Down points to select the number of gases to be used for sensor span calibration. Valid values are 1 or 2. Touch the START point to proceed.
Note: The use of a mid-span gas aids in accurate calibration of the gas detector, especially if there is a nonlinearity in the gas detector response.

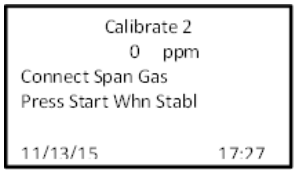


Figure 5-5: Span Gas Calibration

Step 5
Attach the span gas to the sensor. When the reading has stabilized, touch the "START" point to calibrate the instrument span.

Step 4
Using the magnetic wand, enter the concentration of the span gas. Touch the Up and Down points to adjust value of each digit. Touch the "START" point to advance to the next digit. Note that the position of the decimal point is fixed. Touch the START point after the last digit is edited to proceed.

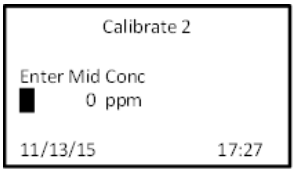


Figure 5-5: Mid-Span Gas Concentration Entry

Step 6
This screen will not appear if a single (1) gas span calibration was selected. Using the magnetic wand, enter the concentration of the mid-span gas. Touch the Up and Down points to adjust value of each digit. Touch the "START" point to advance to the next digit. Note that the position of the decimal point is fixed. Touch the START point after the last digit is edited to proceed.

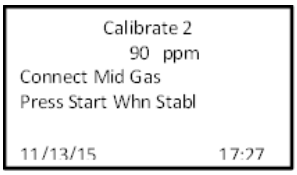


Figure 5-6: Mid-Span Gas Calibration

Step 7
Attach the mid-span gas to the sensor. When the reading has stabilized, touch the "START" point to calibrate the instrument at mid-span.
Remove the mid-span calibration gas from the sensor. Wait until the displayed gas concentration drops to zero. Touch the "START" point to exit the calibration procedure.

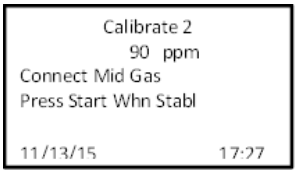


Figure 5-7: Calibration Complete

Step 8
The Alarm 3 latch will stay set until reset either by restarting the unit or doing an alarm reset.

Scroll down to Alarm Reset and select with the Start point. Select it again to reset the Alarm 3 latch.

Sensor Calibration using ESP Commander

The Vector FCU passes Modbus messages directly to/from the attached sensors. Hence, the procedure for calibrating attached sensors is identical to that for calibrating stand-alone sensors.
The example shown below is for a propane SGOES sensor connected as the second sensor attached.

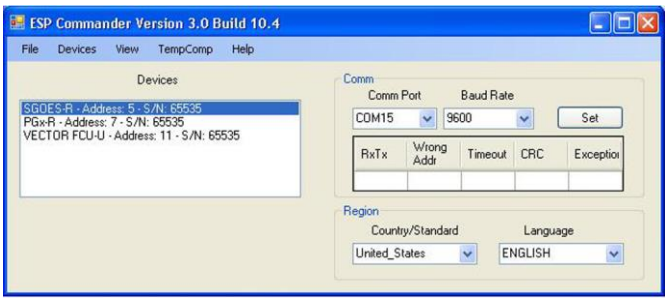


Figure 5-8: Main ESP Commander Form

On the *Devices* list of the main ESP Commander form, double click on the sensor to be calibrated. This will open the form for the selected sensor.

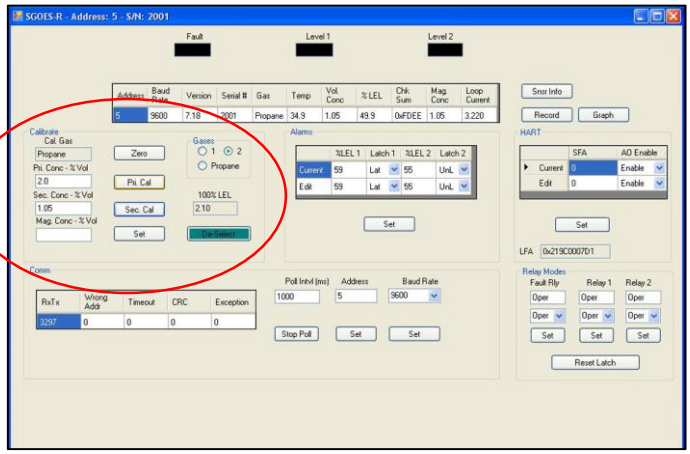


Figure 5-9: SGOES Form

Note the calibrate panel in the upper left quadrant of the form. A similar panel may be found on the forms for the PGU and TGAES sensors.

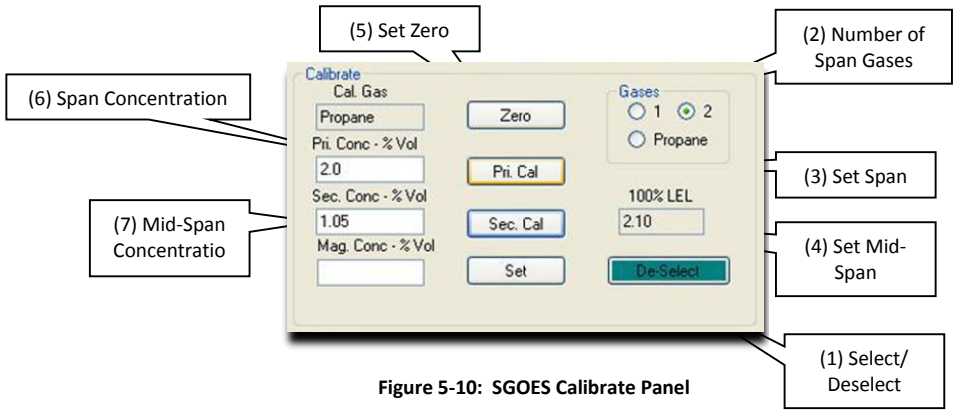


Figure 5-10: SGOES Calibrate Panel

Step 1

Press the (1) Select/Deselect button to start the calibration sequence. The button will change color to show that the calibration mode is active.

Step 2

Attach a zero gas to the sensor. When the gas concentration stabilizes, press the (5) Set Zero button to set the sensor zero point.

Step 3
Select the (2) Number of Span Gases to be used for calibration using the radio buttons.

Step 4
Enter the Span Gas concentration in the units shown in the (6) Span Concentration box.

Step 5
Apply the span gas to the sensor. When the gas concentration stabilizes, press the (3) Set Span button to set the sensor span calibration point.

Step 6
If a two span gas calibration was selected, enter the Mid-Span Gas concentration in the units shown in the (7) Mid-Span Concentration box.

Step 7
If a two span gas calibration was selected, apply the mid-span gas to the sensor. When the gas concentration stabilizes, press the (4) Set Mid-Span button to set the sensor mid-span calibration point

Step 8
Remove the calibration gas and allow the sensor gas concentration to return to zero. When the concentration has returned to zero, press the (1) Select/Deselect button to end the calibration sequence

Sensor Calibration using a HART Communicator

Refer to Appendix 3, HART Communicator Menu Tree, for an overview of the HART functions.
The example shown below is for a propane sensor connected as the second sensor attached.

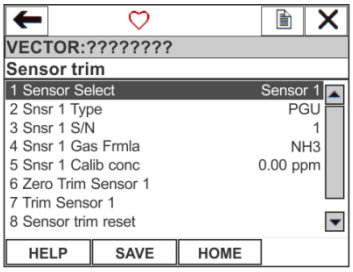


Figure 5-11: Sensor Select Display

Step 1:
Navigate to the Sensor Trim display. Highlight the Sensor Select item. Then select it to select the sensor to be calibrated: Sensor 1 or Sensor 2.

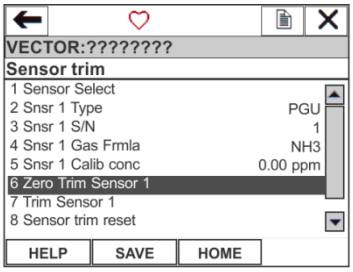


Figure 5-12: Sensor Trim Display (Zero)

Step 2:
Highlight the *6 Zero Trim Sensor* item. Then select it to initiate the zero calibration sequence

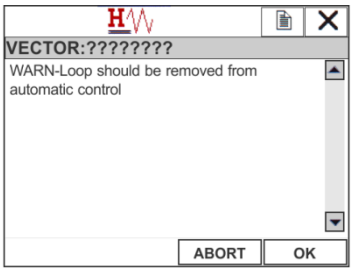


Figure 5-13: Warning Message

Warning Message 1:
Note the warning message. As a safety precaution, any alarms or devices controlled by the gas sensor output should be disabled at this time.

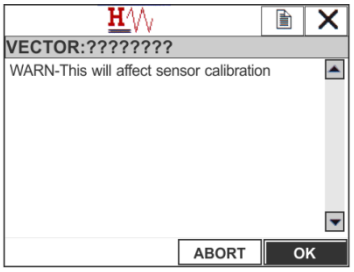


Figure 5-14: Warning Message 2

Warning Message 2:
Note the warning message. The user may abort the calibration sequence at this point if calibration is not desired at this time.

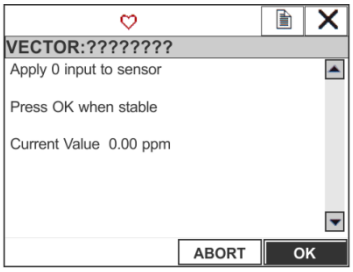


Figure 5-15: Sensor Zero Calibration

Step 3:

Apply the zero gas to the sensor and wait for the reading to stabilize. Press "OK" to complete the sensor zero calibration. Press "ABORT" to cancel the calibration sequence. Remove the zero gas from the sensor.

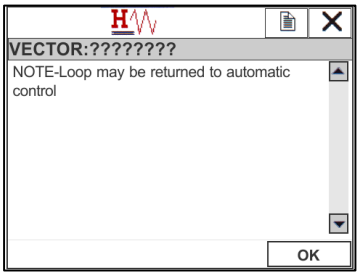


Figure 5-16: Warning Message

Warning Message 3:

Note the warning message.

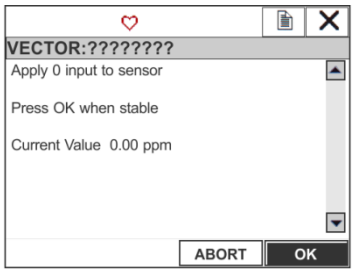


Figure 5-17: Zero Calibration Exit

Step 4:

If span calibration is not desired, any alarms or devices controlled by the gas sensor output may be re-enabled at this time.

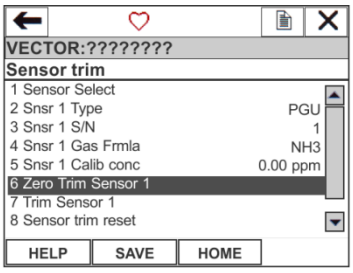


Figure 5-18: Sensor Trim Display (Span)

Step 5:

Highlight the *7 Trim Sensor* item. Then select it to initiate the span calibration sequence.

Figure 5-14: Zero Calibration Exit

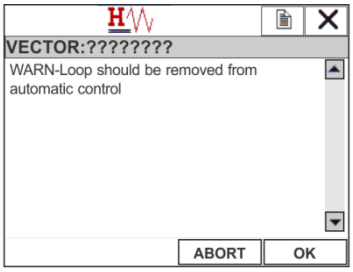
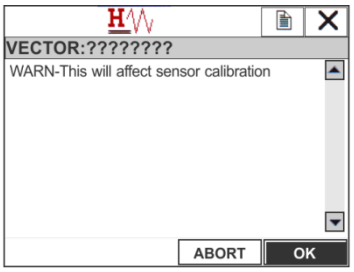


Figure 5-19: Warning Message

Warning Message 1:

Note the warning message. As a safety precaution, any alarms or devices controlled by the gas sensor output should be disabled at this time.



Warning Message 2:

Note the warning message. The user may abort the calibration sequence at this point if calibration is not desired at this time.

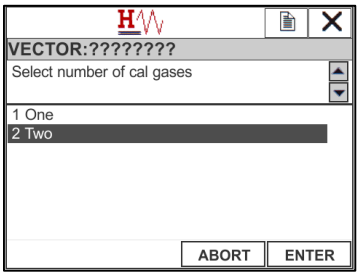


Figure 5-20: Span Gas Count Select

Step 6

Select the number of span gases to be used for calibration: 1 or 2.

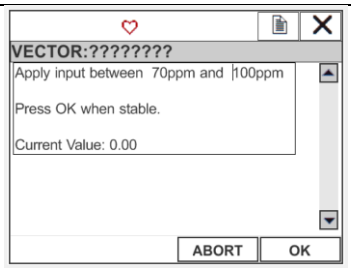


Figure 5-21: Span Gas Calibration

Step 7:

Attach the span gas to the sensor. When the reading has stabilized, press "OK" to calibrate the instrument span.

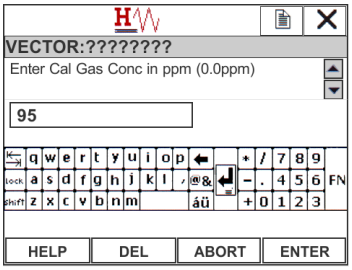


Figure 5-22: Span Gas Concentration Data Entry

Step 8:

Enter the Span Gas Concentration in the units specified. Press "ENTER" to complete.

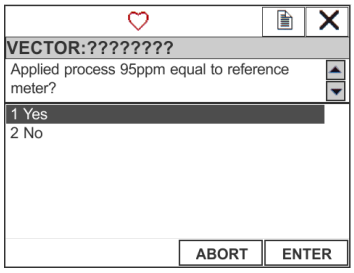


Figure 5-23: Span Calibration Confirm

Step 9:

If the span calibration was successful (displayed concentration matches span gas concentration), select "Yes". The calibration sequence will proceed. If not, select "No". The span calibration will be repeated.

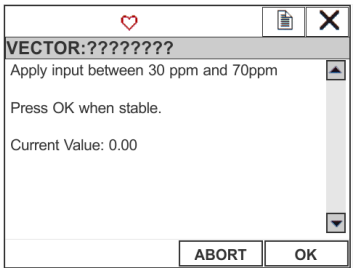


Figure 5-24: Mid-Span Gas Calibration

Step 10:

This display will appear only if a 2 gas span calibration was selected.

Attach the mid-span gas to the sensor. When the reading has stabilized, press "OK" to calibrate the instrument at mid-span.

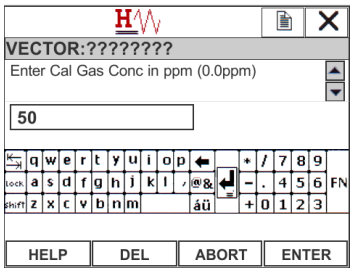


Figure 5-25: Mid-Span Gas Concentration Data Entry

Step 11:

This display will appear only if a 2 gas span calibration was selected.

Enter the Mid-Span Gas Concentration in the units specified. Press "ENTER" to complete.

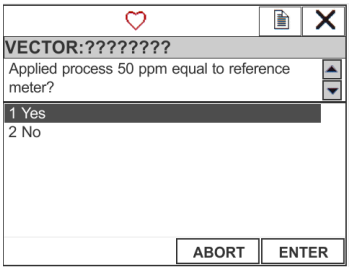


Figure 5-26: Span Calibration Confirm

Step 12:

This display will appear only if a 2 gas span calibration was selected.

If the mid-span calibration was successful (displayed concentration matches mid-span gas concentration), select "Yes". The calibration sequence will proceed. If not, select "No". The mid-span calibration will be repeated

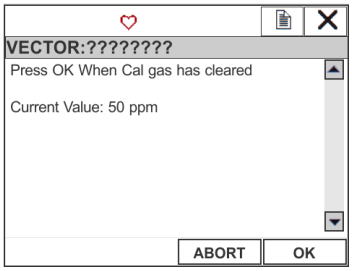


Figure 5-27: Calibration Exit

Step 13:

Calibration Exit

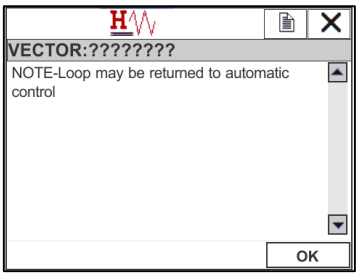


Figure 5-16: Warning Message

Warning Message:

Any alarms or devices controlled by the gas sensor output may be re-enabled at this time.

6.2 Calibrate the Analog Output Loop

The analog output loops may be calibrated by one of two methods:

- ESP Commander using the Modbus RTU interface
- HART Communicator

Analog Output Loop Calibration using ESP Commander

When the output current of the Vector FCU varies ±0.010 mA from the reference meter readings, calibration of the analog output loop is necessary. Trim or adjustment of the analog output loop of the Vector FCU may be performed using ESP Commander. This procedure is not intended to be performed in the field. Field trim of the analog output loop is accomplished using a HART communicator.

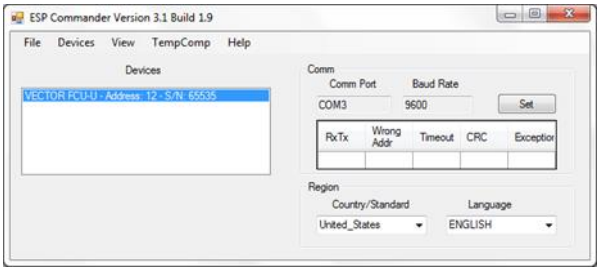


Figure 5-8: Main ESP Commander Form

On the *Devices* list of the main ESP Commander form, double click on the Vector FCU to be calibrated. This will open the form for the selected Vector FCU.

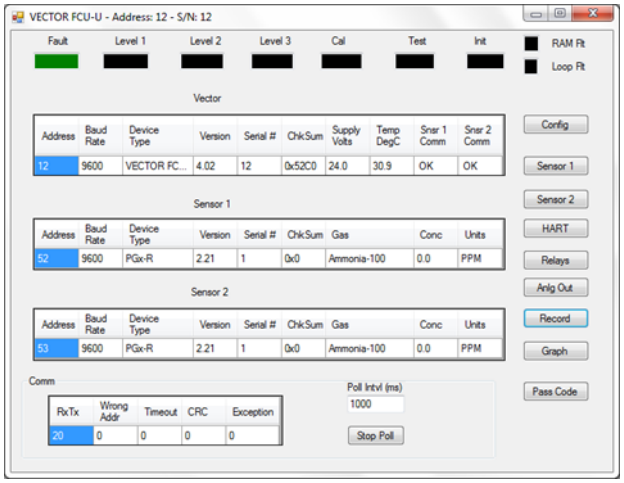


Figure 5–28: Vector Main Form

Press the button marked “Anlg Out” to open the Vector analog output form.

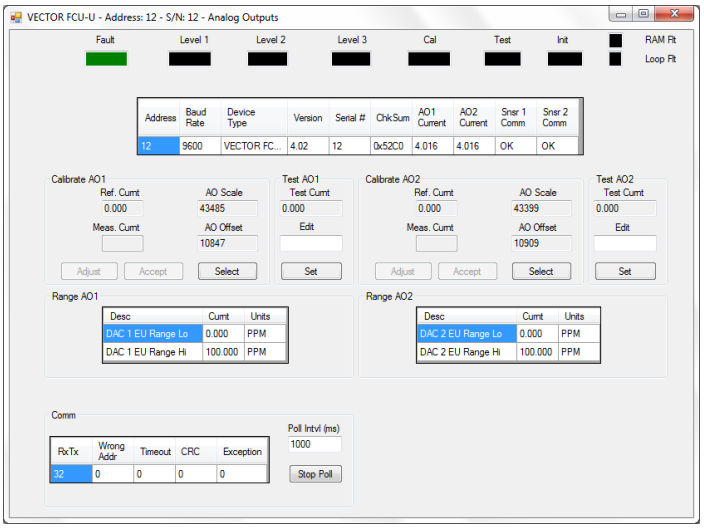


Figure 5–29: Vector Analog Output Form

Note the panels in the middle of the form marked “Calibrate AO1” and “Calibrate AO2”.
The example below shows the steps required to calibrate output loop 1

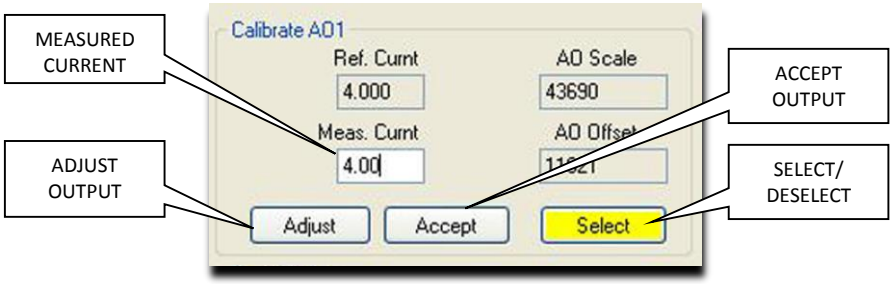


Figure 5–30: Analog loop calibrate panel

Step 1
Connect a reference current meter in the output loop being calibrated. This meter should be able to read DC current with an accuracy of 0.1 % or better.

Step 2
Press the *Select/Deselect* button to start the calibration sequence. The button will change color to indicate that calibration is in progress.

Step 3
The Vector FCU will output a reference current of 4.000 mA.

Step 4
Observe the current reading on the reference meter. If the measured value is 4.00 mA ±0.010 mA, press the (3) *Accept* button

Step 5
If the measured value is not 4.00mA (±0.010mA), enter the measured current from the reference meter in the Measured Current box and press the (2) *Adjust Output* button. The AO Offset value and measured current should change to reflect this adjustment.

Step 6
Repeat this adjustment step until a measured current of 4.00 mA ±0.01 mA is obtained. Then press the *Accept* button.

Step 7
Once the *Accept* button is pressed, the Vector FCU will change its output current to a value of 20.000 mA

Step 8
Observe the current reading on the reference meter. If the measured value is 20.00 mA ±0.01 mA, press the (3*)* *Accept* button

Step 9

If not, enter the measured current from the reference meter in the Measured Current box and press the (2) *Adjust Output* button. The AO Scale value and measured current should change to reflect this adjustment.

Step 10

Repeat this adjustment step until a measured current of 20.00 mA ±0.01 mA is obtained. Then press the (3) *Accept* button.

Step 11

The calibration sequence will exit.

Analog Output Loop Calibration using a HART Communicator

Refer to Appendix 3, HART Communicator Menu Tree, for an overview of the HART functions.

Navigate to the Analog Output display.

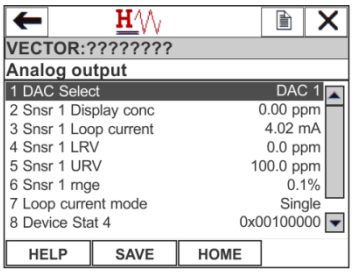


Figure 5-31: Analog Output Display

Step 1:

Highlight the DAC Select item. Then select it to select the output to be calibrated: DAC 1 or DAC 2

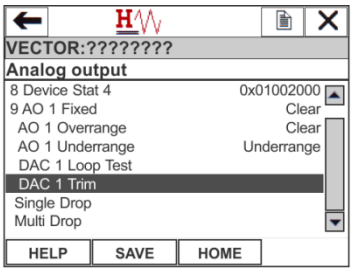


Figure 5-32: Analog Output Display

Step 2:

Highlight the DAC Trim item. Then select it to initiate the calibration sequence

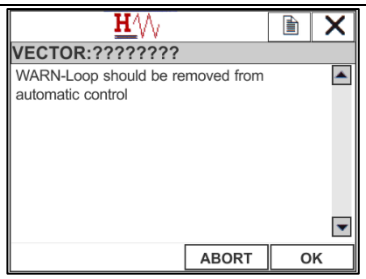


Figure 5-13: Warning Message

Warning Message:

Note the warning message. As a safety precaution, any alarms or devices controlled by the gas sensor output should be disabled at this time.

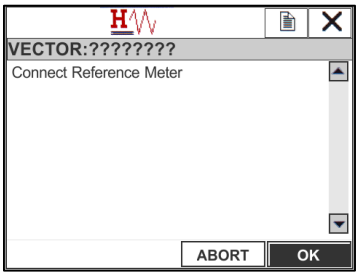


Figure 5-33: Connect Reference Meter

Step 3:

Connect a reference current meter in the output loop being calibrated. This meter should be able to read dc current with an accuracy of 0.1 % or better.

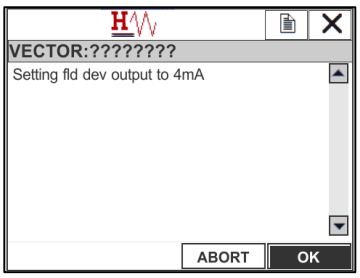


Figure 5-34: Setting Output to 4mA

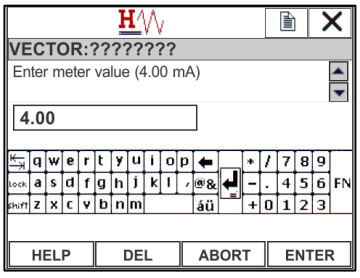


Figure 5-35: Enter Measured Current

Step 4:
Press “OK” to continue.

Step 5:
Enter the current measured on the reference meter. Press “ENTER” to continue.

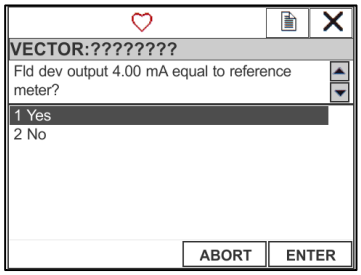


Figure 5-36: Current Calibration Confirm 4mA

Step 6:
If the calibration was successful (measured current matches reference current (4.0 mA), select “Yes”. The calibration sequence will proceed. If not, select “No”. The calibration will be repeated.

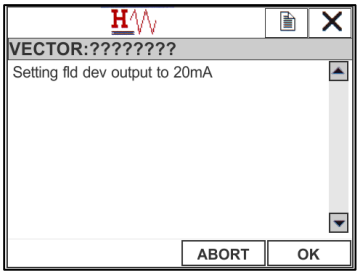


Figure 5-37: Setting Output to 4mA

Step 7:
Press “OK” to continue.

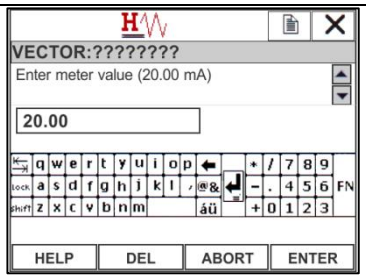


Figure 5-38: Enter Measured Current 20mA

Step 8:

Enter the current measured on the reference meter. Press "ENTER" to continue.

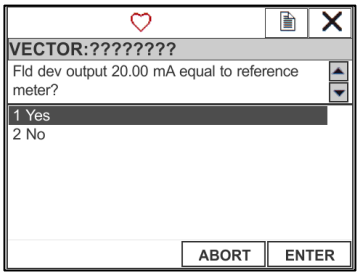
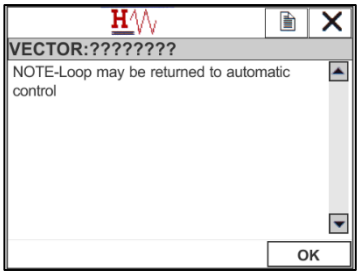


Figure 5-39: Current Calibration Confirm 20mA

Step 9:

If the calibration was successful (measured current matches reference current (20.0 mA), select "Yes". The calibration sequence will proceed. If not, select "No". The calibration will be repeated.



Step 10:

Any alarms or devices controlled by the gas sensor output may be re-enabled at this time.

7.0 Troubleshooting

Table 7.1—Troubleshooting Guide - Display Faults

Fault Condition	Description	Solution
FAULT message on Display	Attached sensor/detector in fault	Inspect the attached detector for damage. Consult the external detector operating manual for troubleshooting procedures. Verify the voltage supplied to the Vector is within specifications (24VDC nominal (+18 to 32VDC)).
NO SIG message on Display	Attached sensor/detector not communicating	Ensure power and RS485 connections are secure and correct polarity at Vector and detector/sensor.
CHKSM error on Display	ROM checksum error	Return to the factory.
PSVLT error on Display	Instrument supply voltage less than 18V or greater than 32V instrument supply voltage	Verify the voltage supplied to the Vector is within specifications (24VDC nominal (+18 to 32VDC)).
NOCFG error on Display	Sensor configuration table not loaded	Contact the factory for further instructions.
OVRNG error on Display	Sensor over ranged	Verify gas level is normal. Perform a functional test and calibrate if neccesary.
OLED screen and Power Fault LED off	Not powering up	Ensure input voltage of 18-32VDC is connected (Note voltage less than 18VDC will be indicated on OLED display).
		Ensure the control assembly is seated correctly.
Sensor/detector calibration error	Inaccurate gas values	Perform calibration if required.
Output current out of tolerance ±0.010mA	Unit output current does not match measured current from reference meter	Calibrate analog output current with ESP Commander or HART.
Output current zero	Unit 4-20mA output is zero.	Verify the voltage supplied to the Vector is within specifications (24VDC nominal (+18 to 32VDC). Contact the factory for further instructions.
UNDRG error On Display	Sensor under ranged	Perform a functional test and calibrate if necessary
RAMCK error On Display	RAM read/write error	Return to the factory

The Vector FCU does not contain any user-serviceable parts. Any repair of the Vector FCU should be performed by ESP Safety personnel. Any attempt to repair or service the Vector FCU by unauthorized personnel will void the product warranty.

Le Vector FCU ne contient aucune pièce entretenue par l'utilisateur. Toute réparation du FCU Vector doit être effectuée par le personnel ESP Safety. Toute tentative de réparation ou entretenir le FCU Vector par du personnel non autorisé annulera la garantie du produit.

8.0 Maintenance

Before testing, be sure to switch off all output loads normally activated by the gas detection system. This prevents inappropriate activation.

Avant le test, assurez-vous d'éteindre toutes les charges de sorties normalement activés par le système de détection de gaz. Ceci empêche une activation inappropriée.

Periodic Maintenance

This section describes maintenance activities to be performed on the Vector FCU

- Visual examination
- Cleaning
- Checking the grounding and explosion-protection system

Maintenance Activities

The Vector Field Control Unit needs very little routine maintenance; but periodic checks for proper system function and calibration are strongly advised. The frequency of these checks should be determined by the specific installation.

Although the fault-detection circuitry continuously monitors for various problems, it does not monitor external response equipment or wiring. These devices must be checked periodically in the Normal mode to ensure proper functioning.

9.0 Warranties

ESP Safety, Inc. (“ESP”) warrants the Vector Field Control Unit to be free from defects in material and workmanship under normal use and service for a period of five (5) 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. ESP’s warranty obligation is limited, at ESP’s option, to refund of the purchase price, repair, or replacement of a defective product or a component thereof, to the extent that the product is properly returned to ESP within the warranty period.

This warranty does not include:

a) fuses, disposable batteries or the routine replacement of parts due to the normal wear and tear of the product arising from use;
b) any product or component which in ESP’s opinion, has been misused, altered, abused, tampered with, improperly maintained or used, neglected or otherwise damaged by accident or abnormal conditions of operation, handling or use, or to have deteriorated due to aging of any component made of rubber or any other elastomer; or
c) any damage or defect attributable to repair of the product by any person other than an authorized dealer, 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 ESP;

b) the buyer promptly notifying ESP of any defect and, if required, promptly making the product available for correction. No goods shall be returned to ESP until receipt by buyer of shipping instructions from ESP. A return authorization number must be obtained from ESP prior to shipment; and

c) all warranty returns being shipped directly to ESP Safety, Inc.;

d) the right of ESP 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. ESP SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES. ESP WILL NOT BE LIABLE FOR LOSS OR DAMAGE OF ANY KIND CONNECTED TO THE USE OF ITS PRODUCTS OR FAILURE OF ITS PRODUCTS TO FUNCTION OR OPERATE PROPERLY. IN NO EVENT SHALL ESP’S LIABILITY HEREUNDER EXCEED THE PURCHASE PRICE ACTUALLY PAID BY THE BUYER FOR THE PRODUCT.

To the extent any provision of this warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision.

10.0 Repair and Return

Field Repair

The Vector is not intended to be repaired in the field. If a problem should develop, refer to the Troubleshooting section of this manual (Section 7.0). Please return the device to the factory for repair or replacement.

Return Material Authorization (RMA) Number

Contact ESP Safety Inc. at +1-408-886-9746 to obtain a Return Material Authorization (RMA) number. Please provide the following information during your call:
-Your Company Name
-Product Type
-Serial Number
-Date of Shipment
-Brief explanation of malfunction

Pack the unit properly to ensure that no shipping damage occurs and ship to:
ESP Safety, Inc.
555 North First Street
San Jose, CA 95112 USA

Write the RMA number on the front of the shipping carton.

ESP Safety, Inc. recommends that an inventory of spare detectors be kept on hand to enable rapid field replacement and minimize downtime.

ESP Safety, Inc. recommande qu'un inventaire des détecteurs de rechange conserver sous la main pour permettre le remplacement rapidement sur le terrain et de minimiser les temps d'arrêt.

11.0 Parts Ordering Information

The following items for the Vector may be ordered:

Vector

Vector Field Control Unit	–	100-0027

Accessories:

Calibration Magnet (magnetic wand)	–	611-0005
USB to RS422/RS485 Converter	–	120-0054
HART Field Communicator	–	120-0042

Detectors:

TGAES Open Path Detector	–	Various gasses	–	100-0023-xx
SGOES Gas Detector	–	Various gasses	–	100-0001-xx
PGU Gas Detector	–	Methane	–	100-0015-C1
PGU Gas Detector	–	Propane	–	100-0015-C3
PGU Gas Detector	–	Carbon Monoxide	–	100-0015-CO
PGU Gas Detector	–	Carbon Dioxide	–	100-0015-CO2
PGU Gas Detector	–	Hydrogen	–	100-0015-H2
PGU Gas Detector	–	Hydrogen Sulfide	–	100-0015-H2S
PGU Gas Detector	–	Ammonia	–	100-0015-NH3
PGU Gas Detector	–	Oxygen	–	100-0015-O2
PGU Gas Detector	–	Sulphur Dioxide	–	100-0015-SO
PGU Gas Detector	–	Isobutylene	–	100-0015-01
PGU Gas Detector	–	Nitrogen Dioxide	–	100-0015-02

For applications not listed above, please contact ESP Safety.

Gas Calibration Kits:

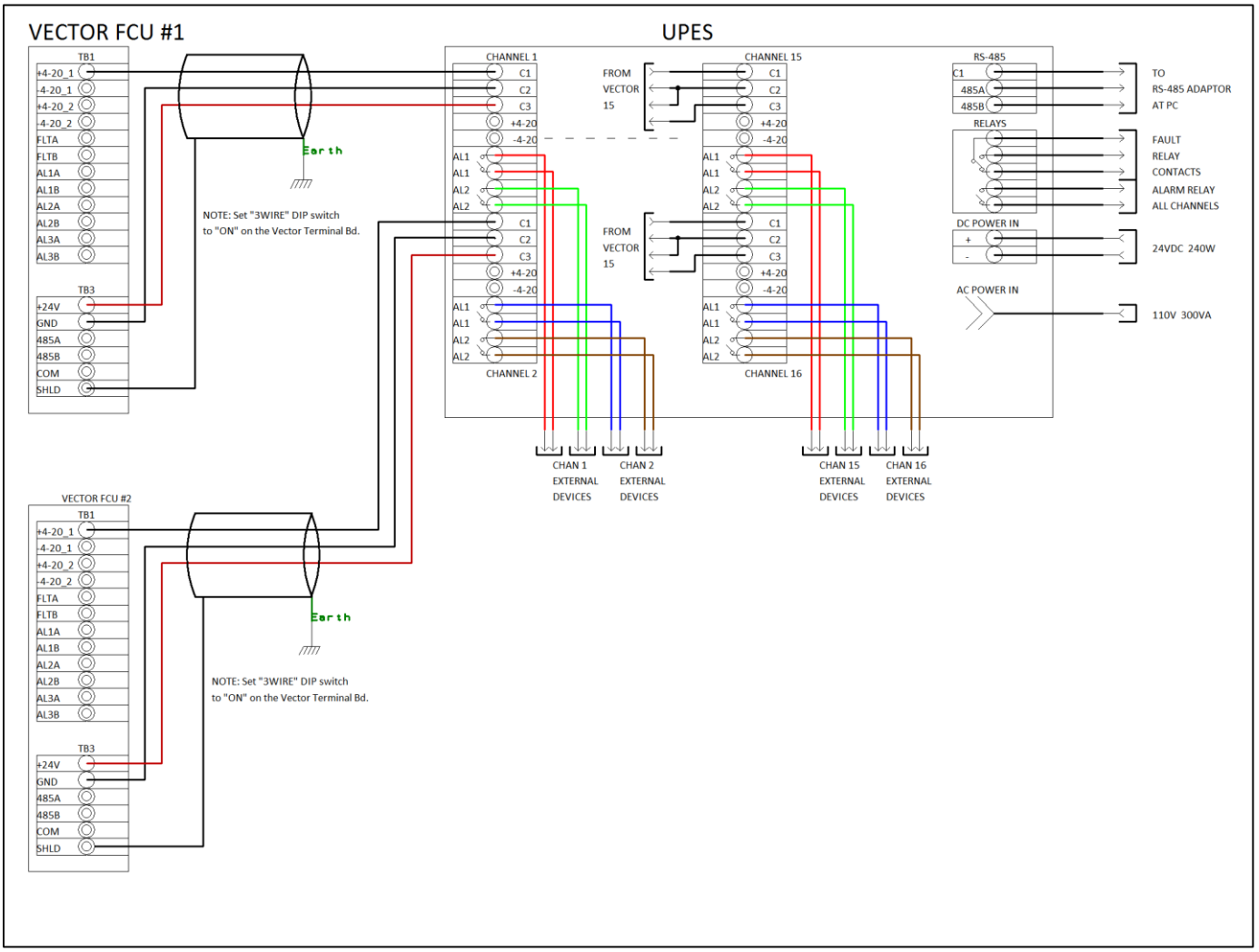
Calibration kits are available for various gases. Kits are available for Span and/or Mid-Span gas concentrations and include gas cylinders, regulators, tubing, and carrying cases. Please contact ESP Safety for details.

Order from:

ESP Safety Inc.
555 North First Street
San Jose, CA 95112
USA
Ph: 408-886-9746
Fax: 408-886-9757
Website: www.espsafetyinc.com
Email: info@espsafetyinc.com

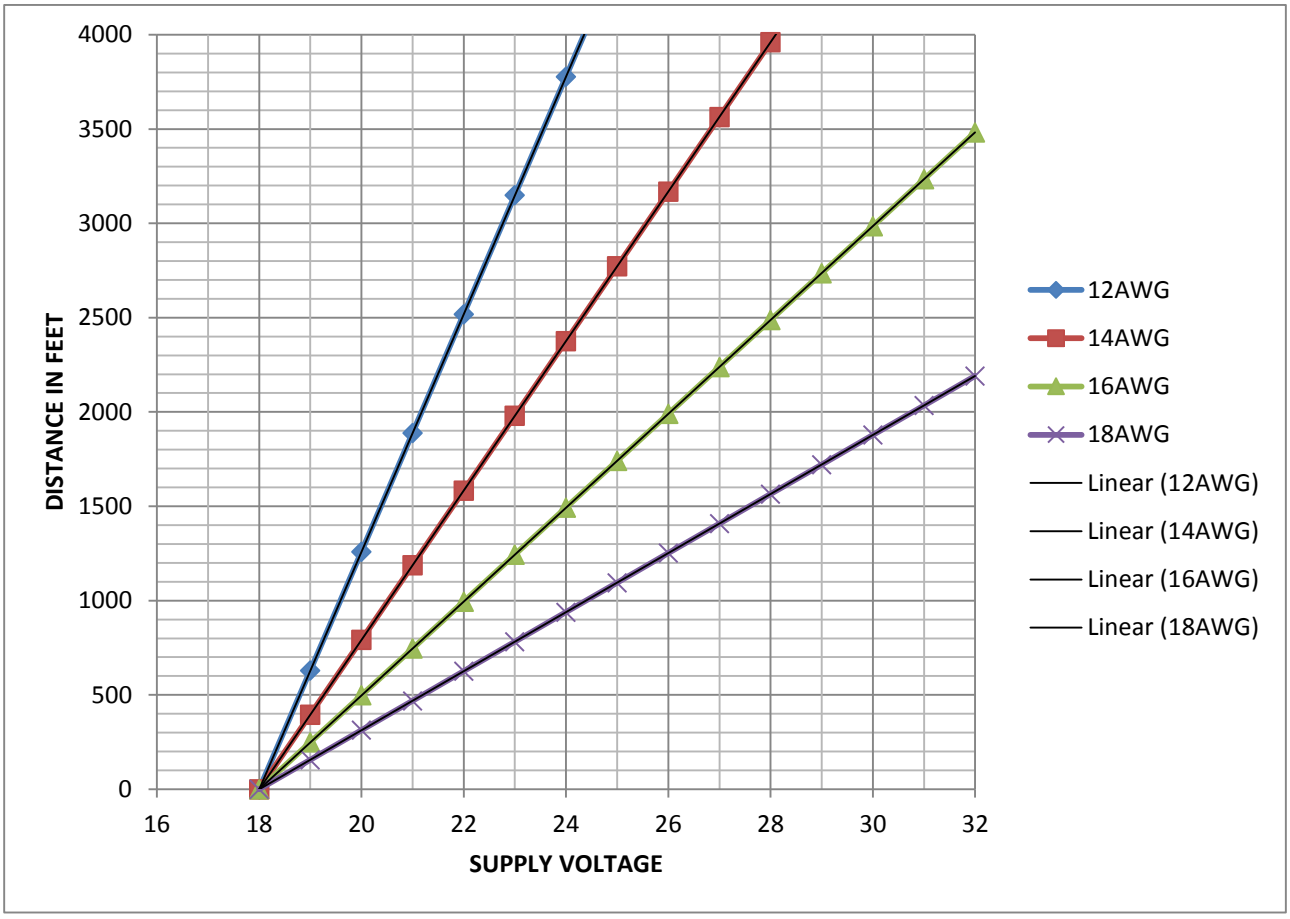
Please note that shipping charges will be added to your order.

Appendix 1 – Vector UPES Connections



Appendix 2 – Vector with PGU Sensor Wire Size Chart

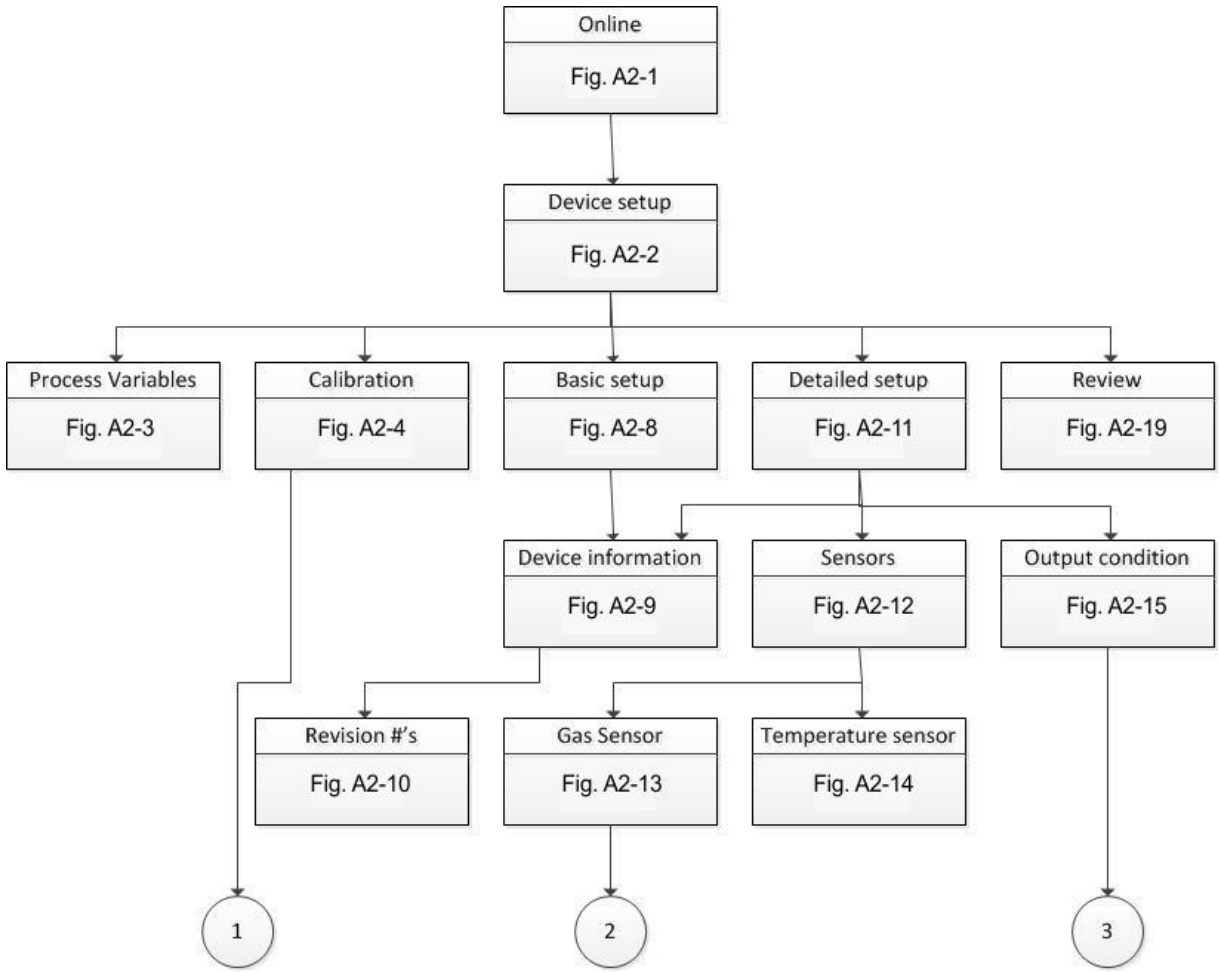
Wire Size Chart for Vector with REMOTE PGU Sensor

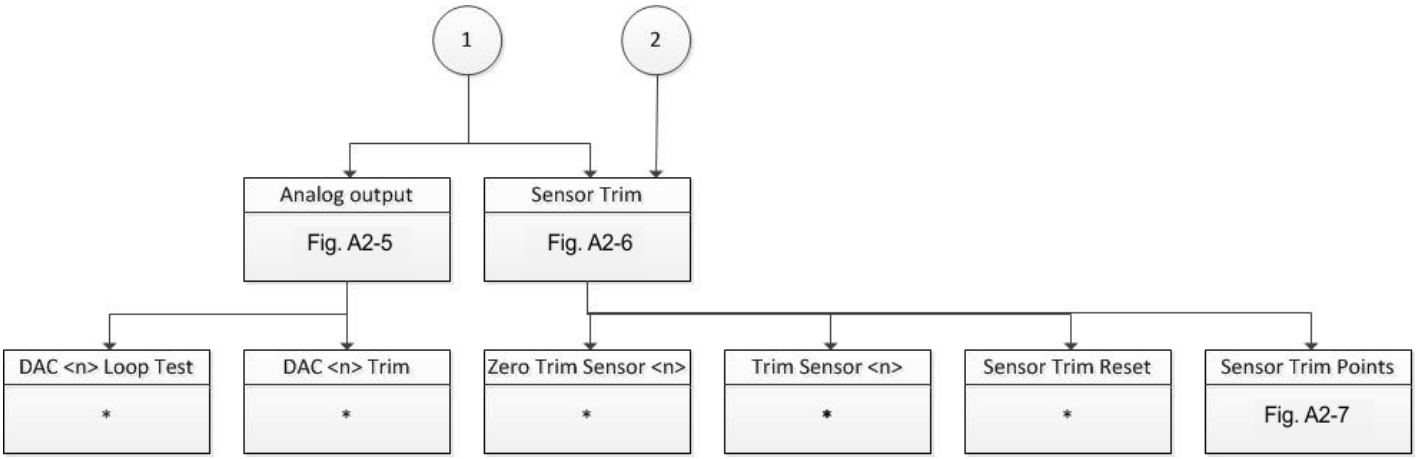


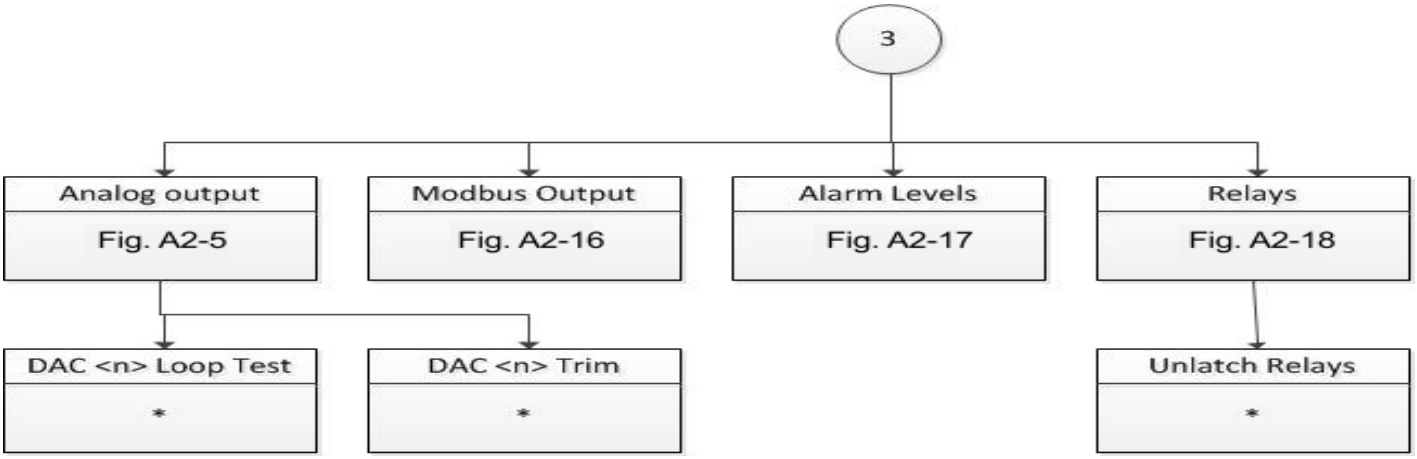
Appendix 3 – Vector HART Communicator Operations

While ESP Commander is the primary method of configuring a Vector FCU, many of the Vector configuration settings may also be set using a HART Communicator.

The following pages show the menu tree for Vector when using a HART Communicator. Menus containing a "*" are shown in more detail in the device calibration section. Note that the contents of the menus will change based on whether one or two sensors are configured. Only the configured sensor data will be shown.




1
2
Analog output
Fig. A2-5
Sensor Trim
Fig. A2-6
DAC <n> Loop Test
*
DAC <n> Trim
*
Zero Trim Sensor <n>
*
Trim Sensor <n>
*
Sensor Trim Reset
*
Sensor Trim Points
Fig. A2-7


3
Analog output
Fig. A2-5
Modbus Output
Fig. A2-16
Alarm Levels
Fig. A2-17
Relays
Fig. A2-18
DAC <n> Loop Test
*
DAC <n> Trim
*
Unlatch Relays
*

HART Communicator Operations

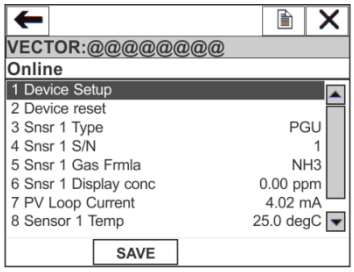


Figure A2-1: Online Menu

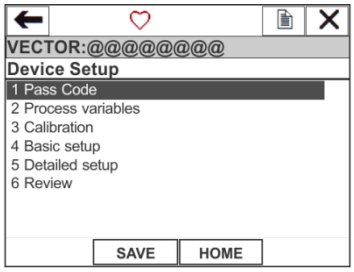


Figure A2-2: Device Setup Menu

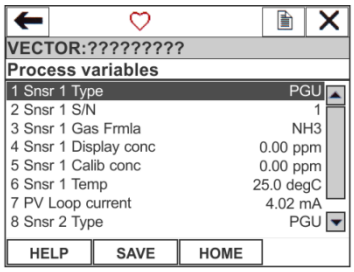


Figure A2-3: Process Variables Menu

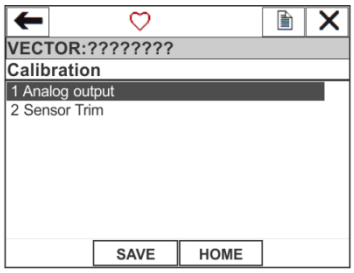


Figure A2-4: Calibration Menu

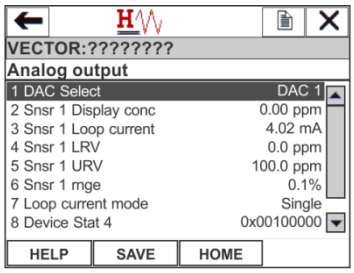


Figure A2-5: Analog Output Menu

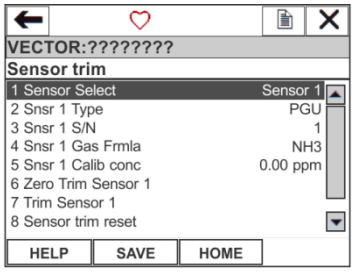


Figure A2-6: Sensor Trim Menu

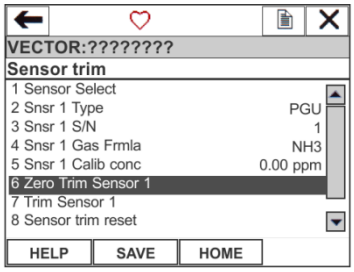


Figure A2-7: Sensor Trim Points Menu

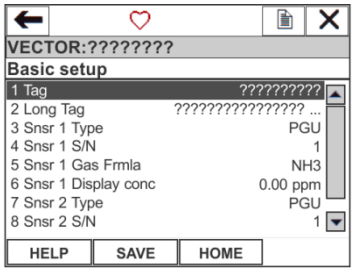


Figure A2-8: Basic Setup Menu

Sensor Trim Menu:
Select item 1 on the menu to specify the sensor to be configured. Refer to the calibration section of this manual for a description of menu items 6, Zero Trim Sensor, and menu item 7, Trim Sensor. Menu item 8, Sensor trim reset, may be used to reset the selected sensor to factory default settings.

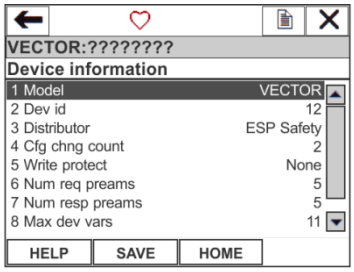


Figure A2-9: Device Information Menu

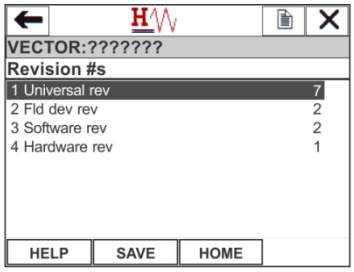


Figure A2-10: Revision Number Menu

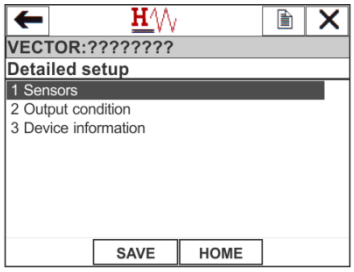


Figure A2-11: Detailed Setup Menu

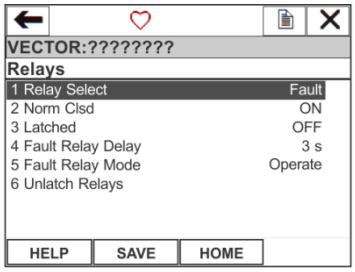


Figure A2-18: Relays Menu

Relays Menu:
This menu may be used to specify the configuration of the output relays. Select item 1 on the menu to specify which relay is to be configured.

Note that in order to comply with Factory Mutual requirements, a relay may be fixed in latched mode. Relays may be configured to be in one of four modes:

Operate	Relay responds to process conditions
Closed	Relay is closed until it times out or is set to another mode
Open	Relay is open until it times out or is set to another mode
Disabled	Relay is disabled (open)

Menu item 6, Unlatch Relays, may be used to clear latched relays that were previously set due to process alarm conditions

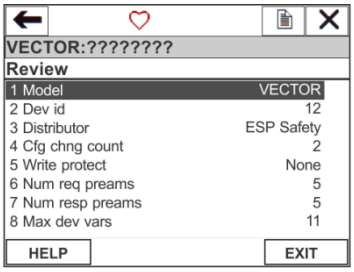


Figure A2-19: Review Menu

Review Menu:
This menu provides a summary of the key configuration settings of the device.

Appendix 4 – Vector Modbus Register Map

Vector Field Control Unit
Modbus Register Assignments
For firmware version 4.02

Name	Addr	R/W	Format	Description
Address	1	R/W	U16	Address
BaudRate	2	R/W	U16	Host Port Baud Rate/1200
Relay Normal	3	R/(W)	Bits	Normal State: B3: 0 open, 1 closed Alarm relay 3 B2: 0 open, 1 closed Alarm relay 2 B1: 0 open, 1 closed Alarm relay 1 B0: 0 open, 1 closed Fault relay
Relay HiLo	4	R/(W)	Bits	Alarm State: B3: 0 low, 1 high Alarm relay 3 B2: 0 low, 1 high Alarm relay 2 B1: 0 low, 1 high Alarm relay 1 B0: Reserved
Relay Delay 0	5	R/(W)	U16	Operate Delay for Fault Relay (seconds)
Relay Delay 1	6	R/(W)	U16	Operate Delay for Alarm relay 1 (seconds)
Relay Delay 2	7	R/(W)	U16	Operate Delay for Alarm relay 2 (seconds)
Relay Delay 3	8	R/(W)	U16	Operate Delay for Alarm relay 3 (seconds)
Relay Latch	9	R/(W)	Bits	Latching Mode: B3: 0 unlatched, 1 latched Alarm relay 3 B2: 0 unlatched, 1 latched Alarm relay 2 B1: 0 unlatched, 1 latched Alarm relay 1 B0: Reserved
Relay Test	10	R/(W)	Bits	Relay Test: 00-relay disable 01-open 10 close 11-normal B6-7: Alarm relay 3 B4-5: Alarm relay 2 B2-3: Alarm relay 1 B0-1: Fault Relay Writing 0xffff resets the latching function on all relays – This function does not require a password.
Serial Number	11	R/(W)	U16	Serial number of Vector – Note 1
Firmware Version	12	R	2-U8	MSB: Major version LSB: Minor version
Device Type	13	R	2-U8	MSB: Device type LSB: Model
PCB Number	14	R/(W)	U16	PCB identifier – Note 1
LED Test	15	R/(W)	Bits	Added at version 3.03 LED Test: 00-undefined 01-off 10 on 11-normal B8-9: Fault LED B6-7: Level 3 LED B4-5: Level 2 LED B2-3: Level 1 LED B0-1: Cal LED Writing 0xffff starts the LED test function. This function does not require a password.

Name	Addr	R/W	Format	Description
LED Test	15	R/(W)	Bits	Added at version 3.03 LED Test: 00-undefined 01-off 10 on 11-normal B8-9: Fault LED B6-7: Level 3 LED B4-5: Level 2 LED B2-3: Level 1 LED B0-1: Cal LED Writing 0xffff starts the LED test function. This function does not require a password.
Factory Test	16	R/(W)	U16	Added at version 3.03 Factory Test Modes: 0 – Normal (Run) 1 – Display pixels off 2 – Display pixels on 3 – Hall switch test 4 – Set default gas to Ammonia 100 ppm
Pswd	17	R/W	U16	Password sent by user Always reads zero (0).
Restart Device	18	W	N/A	Restart device – including sensors
Set Fac Default	19	W	N/A	Restore factory defaults – Vector Only
Firmware Chksum	20	R	U16	Firmware checksum
Language ID	21	R/(W)	U16	0 – English 1 – Russian 2 – French 3 – German 4 – Spanish 5 – Portuguese
Country ID	22	R/(W)	U16	0-US, 1 - Russia
Set Pswd	23	R/(W)	U16	Sets password to be used by device Always reads zero(0).
Cal Timeout	24	R/(W)	U16	Calibration timeout in seconds
File Timeout	25	R/(W)	U16	File lock timeout in seconds
Modbus Timeout	26	R/(W)	U16	Modbus interface timeout in seconds
HART Timeout	27	R/(W)	U16	HART interface timeout in seconds
Display Timeout	28	R/(W)	U16	Display interface in seconds
SnsrBaudRate	29	R/(W)	U16	Sensor Port Baud Rate/1200
WriteLockFile	30	R/W	U16	File number of file to be locked – 0xffff to unlock Added at version 3.04
NbrSensors	31	R/(W)	U16	Number of sensors configured
Reset Comm Stats	32	W	N/A	Reset sensor communications statistics
Alarm1Enable	33	R/(W)	Bits	Alarm 1 Enable: Bn = 1 operation of Relay 1/LED 1 depends on Limit 1 of nth sensor
Alarm2Enable	34	R/(W)	Bits	Alarm 2 Enable: Bn = 1 operation of Relay 2/LED 2 depends on Limit 2 of nth sensor
Alarm3Enable	35	R/(W)	Bits	Alarm 3 Enable: Bn = 1 operation of Relay 3/LED 3 depends on Limit 3 of nth sensor
FaultAlarmEnable	36	R/(W)	Bits	Fault Alarm Enable: Bn = 1 operation of Fault Relay/Fault LED depends on Fault output of nth sensor
ShortFrameAddr	37	R/W	U8	HART short frame address (0-63)

Name	Addr	R/W	Format	Description
ShortTag	38-41	R/W	ASC	HART short tag (8 chars)
LongTag	42-57	R/W	ASC	HART long tag (32 chars)
Descriptor	58-65	R/W	ASC	HART descriptor (16 chars)
Message	66-81	R/W	ASC	HART message (32 chars)
FinalAssyNbrH	82	R/W	U32-MSW	HART final assembly number (8 bits)
FinalAssyNbrL	83	R/W	U32-LSW	HART final assembly number (16 bits)
PVSelect	84	R	U16	Device variable code for primary variable
SVSelect	85	R	U16	Device variable code for secondary variable
TVSelect	86	R	U16	Device variable code for ternary variable
QVSelect	87	R	U16	Device variable code for quatenary variable
AO Enable	88	R/(W)	U8	AO1 signaling enable (0 disabled, 1 enabled)
AO Enable	88	R/(W)	U8	AO1 signaling enable (0 disabled, 1 enabled)
AO1 Scale	89	R/(W)	U16	AO1 Scale Coeff (2731 cnts/mA)
AO1 Offset	90	R/(W)	U16	AO1 Offset Coeff(2731 cnts/mA)
AO1 Lwr RangeH	91	R/(W)	F-MSW	AO1 Lower Range Value - MSW
AO1 Lwr RangeL	92	R/(W)	F-LSW	AO1 Lower Range Value - LSW
AO1 Upr RangeH	93	R/(W)	F-MSW	AO1 Upper Range Value - MSW
AO1 Upr RangeL	94	R/(W)	F-LSW	AO1 Upper Range Value - LSW
AO1TestCurnt_H	95	R/(W)	F-MSW	AO1 Test Current (mA). 0.0 to disable
AO1TestCurnt_L	96	R/(W)	F-LSW	AO1 Test Current (mA). 0.0 to disable
AO1Zero_H	97	R/(W)	F-MSW	AO1 Zero Cal (mA) at 4. mA
AO1Zero_L	98	R/(W)	F-LSW	AO1 Zero Cal (mA) at 4. mA
AO1Span_H	99	R/(W)	F-MSW	AO1 Span Cal (mA) at 20. mA
AO1Span_L	100	R/(W)	F-LSW	AO1 Span Cal (mA) at 20. mA
AO2 Scale	101	R/(W)	U16	AO2 Scale Coeff (2731 cnts/mA)
AO2 Offset	102	R/(W)	U16	AO2 Offset Coeff(2731 cnts/mA)
AO2 Lwr RangeH	103	R/(W)	F-MSW	AO2 Lower Range Value - MSW
AO2 Lwr RangeL	104	R/(W)	F-LSW	AO2 Lower Range Value - LSW
AO2 Upr RangeH	105	R/(W)	F-MSW	AO2 Upper Range Value - MSW
AO2 Upr RangeL	106	R/(W)	F-LSW	AO2 Upper Range Value - LSW
AO2TestCurnt_H	107	R/(W)	F-MSW	AO2 Test Current (mA). 0.0 to disable
AO2TestCurnt_L	108	R/(W)	F-LSW	AO2 Test Current (mA). 0.0 to disable
AO2Zero_H	109	R/(W)	F-MSW	AO2 Zero Cal (mA) at 4. mA
AO2Zero_L	110	R/(W)	F-LSW	AO2 Zero Cal (mA) at 4. mA
AO2Span_H	111	R/(W)	F-MSW	AO2 Span Cal (mA) at 20. mA
AO2Span_L	112	R/(W)	F-LSW	AO2 Span Cal (mA) at 20. mA
AO Cal Mode	113	R/(W)	2-U8	MSB: Sensor Nbr –AO1 = 248; AO2 = 249 LSB: Mode select 0 – Exit Calibration Mode 3 – Select Zero Calibration 4 – Select Span Calibration
DSTEnable	114	R/(W)	U16	Daylight Savings Time (1 = enable, 0 = disable)
	115-118			Reserved

Name	Addr	R/W	Format	Description
DeviceStatus2	119	R	Bits	B15: Test Mode B14: Init Mode B13: Cal Mode B6-12: Not Used B5: AO Loop Fault B4: RAM Fault B3: 0 Std time, 1 DST (V3.05) B2: 0 normal, 1 Time Invalid B1: 0 normal, 1 Checksum Error B0: 0 normal, 1 Lo Supply Voltage ********** Bits removed at V3.05 B10: 0 normal, 1 Snsr 1 Find sensor B9: 0 normal, 1 Snsr 0 Find sensor B8: 0 normal, 1 Snsr 1 No Configuration B7: 0 normal, 1 Snsr 0 No Configuration B6: 0 normal, 1 Snsr 1Overrange B5: 0 normal, 1 Snsr0 Overrange B4: 0 normal, 1 Snsr 1 Underrange B3: 0 normal, 1 Snsr 0 Underrange
AO1Current_H	120	R	F-MSW	AO1 current (mA)
AO1Current_L	121	R	F-LSW	AO1 current (mA)
AO2Current_H	122	R	F-MSW	AO2 current (mA)
AO2Current_L	123	R	F-LSW	AO2 current (mA)
Date	124	R/(W)	Bits	B9-B15 Year – Base 2000 B5-B8 Month – 1-12 B0-B4 Day of month – 1-31
Time	125	R/(W)	U16	seconds after midnight (1 count = 2 seconds)
DeviceStatus	126	R	Bits	Device status: B15: 0 normal, 1 AO2 in cal mode (V3.05) B14: 0 normal, 1 AO2 current in fixed mode B13: 0 normal, 1 AO2 current over limit B12: 0 normal, 1 AO2 current under limit B11: 0 normal, 1 AO1 in cal mode (V3.05) B10: 0 normal, 1 AO1 current in fixed mode B9: 0 normal, 1 AO1 current over limit B8: 0 normal, 1 AO1 current under limit B7: Alm 3 Rly, 0 Open, 1 Closed B6: Alm 2 Rly, 0 Open, 1 Closed B5: Alm 1 Rly, 0 Open, 1 Closed B4: Fault Rly, 0 Open 1 Closed B3: 0 normal, 1 Alarm 3 active B2: 0 normal, 1 Alarm 2 active B1: 0 normal, 1 Alarm 1 active B0: 0 normal, 1 Fault
TL	127	R	S16	SSS903M temperature (deg C * 10)
VSupply	128	R	S16	SSS903 Supply Voltage (Volts * 10)
SnsrCalMode	129	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor is in cal mode
SnsrCommFail	130	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor comm. fail
SnsrLimit1	131	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor limit reached
SnsrLimit2	132	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor limit reached

Name	Addr	R/W	Format	Description
SnsrLimit3	133	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor limit reached
SnsrFault	134	R	Bits	Removed at version 3.05 Bn = 1 indicates corresponding sensor faulted
EventLogSize	135	R	U16	Event log size in words
EventLogStart	136	R	U16	Event log start position in words
EventLogSnap	137	W	N/A	Takes snapshot of event log
EventLogClear	138	(W)	N/A	Clear event log – Note 1
FlashRefresh	139	(W)	N/A	Refresh (rewrite) flash memory – Note 1
FlashInit	140	(W)	N/A	Reinitialize flash – Note 1
	141-192			Reserved
Snsr0DisplayConcH	193	R	F-MSW	Sensor 0 display concentration - MSW
Snsr0DisplayConcL	194	R	F-LSW	Sensor 0 display concentration - LSW
Snsr0DisplayUnits	195	R	U16	Sensor 0 display concentration engineering units (enum)
Snsr0Msg Cnt	196	R	U16	Sensor 0 Total message count
Snsr0CRC Errs	197	R	U16	Sensor 0 CRC error count
Snsr0Timeouts	198	R	U16	Sensor 0 Comm timeout count
Snsr0Wrong Addr	199	R	U16	Sensor 0 Wrong address count
Snsr0Exceptn	200	R	U16	Sensor 0 Exception message count
Snsr0Status	201	R	Bits	Added at version 3.05 Sensor 0 Status: B9: 0 normal, 1 Snsr 0 Find sensor B8: 0 normal, 1 Snsr 0 Limit 3 Active B7: 0 normal, 1 Snsr 0 Limit 2 Active B6: 0 normal, 1 Snsr 0 Limit 1 Active B5: 0 normal, 1 Snsr 0 Cal Mode B4: 0 normal, 1 Snsr0 Overrange B3: 0 normal, 1 Snsr 0 Underrange B2: 0 normal, 1 Snsr 0 No Configuration B1: 0 normal, 1 Snsr 0 Comm Fail B0: 0 normal, 1 Snsr 0 Fault
	202-208			Reserved
Snsr1DisplayConcH	209	R	F-MSW	Sensor 1 display concentration - MSW
Snsr1DisplayConcL	210	R	F-LSW	Sensor 1 display concentration - LSW
Snsr1DisplayUnits	211	R	U16	Sensor 1 display concentration engineering units (enum)
Snsr1Msg Cnt	212	R	U16	Sensor 1 Total message count
Snsr1CRC Errs	213	R	U16	Sensor 1 CRC error count
Snsr1Timeouts	214	R	U16	Sensor 1 Comm timeout count
Snsr1Wrong Addr	215	R	U16	Sensor 1 Wrong address count
Snsr1Exceptn	216	R	U16	Sensor 1 Exception message count
Snsr1Status	217	R	Bits	Added at version 3.05 Sensor 1 Status: B9: 0 normal, 1 Snsr 1 Find sensor B8: 0 normal, 1 Snsr 1 Limit 3 Active B7: 0 normal, 1 Snsr 1 Limit 2 Active B6: 0 normal, 1 Snsr 1 Limit 1 Active B5: 0 normal, 1 Snsr 1 Cal Mode B4: 0 normal, 1 Snsr1 Overrange B3: 0 normal, 1 Snsr 1 Underrange B2: 0 normal, 1 Snsr 1 No Configuration B1: 0 normal, 1 Snsr 1 Comm Fail B0: 0 normal, 1 Snsr 1 Fault

Name	Addr	R/W	Format	Description
	218-224			Reserved
Snsr0DisplaySelect	225	R/(W)	U16	Sensor 0 range displayed (0-2)
Snsr0DisplayFormat	226	R/(W)	2-U8	Sensor 0 Display Width(H) & Precision(L)
Snsr0Limit1H	227	R/(W)	F-MSW	Sensor 0 Alarm Limit 1 - MSW
Snsr0Limit1L	228	R/(W)	F-LSW	Sensor 0 Alarm Limit 1 - LSW
Snsr0Limit2H	229	R/(W)	F-MSW	Sensor 0 Alarm Limit 2 - MSW
Snsr0Limit2L	230	R/(W)	F-LSW	Sensor 0 Alarm Limit 2 - LSW
Snsr0Limit3H	231	R/(W)	F-MSW	Sensor 0 Alarm Limit 3 - MSW
Snsr0Limit3L	232	R/(W)	F-LSW	Sensor 0 Alarm Limit 3 - LSW
Snsr0Address	233	R/(W)	U8	Sensor 0 Modbus address (1-247)
Snsr0BaudRate	234	R	U8	Sensor 0 Baud Rate/1200
Snsr0DevType	235	R	U16	Sensor 0 Device Type: 0 = None 1 = Unknown 2 = PGU 3 = SGOES 4 = SGOES-M 5 = TGAES 6 = VGU 7 = Open Path
Snsr0SerialNbr	236	R	U16	Sensor 0 Serial number
Snsr0Version	237	R	U16	Sensor 0 Firmware version: H- Major, L – Minor
Snsr0Chksum	238	R	U16	Sensor 0 Firmware checksum
Snsr0Gas	239	R	U16	Sensor 0 Gas identifier
Snsr0Cal1H	240	R/(W)	F-MSW	Sensor 0 Mid-span gas conc (2 gas) - MSW
Snsr0Cal1L	241	R/(W)	F-LSW	Sensor 0 Mid-span gas conc (2 gas) - LSW
Snsr0Cal2H	242	R/(W)	F-MSW	Sensor 0 Span gas conc (2 gas) - MSW
Snsr0Cal2L	243	R/(W)	F-LSW	Sensor 0 Span gas conc (2 gas) - LSW
Snsr0Cal3H	244	R/(W)	F-MSW	Sensor 0 Span gas conc (1 gas) - MSW
Snsr0Cal3L	245	R/(W)	F-LSW	Sensor 0 Span gas conc (1 gas) - LSW
Snsr0Pswd	246	R/(W)	U16	Sensor 0 parameters password Always reads 0
Snsr0Factory	247	R/(W)	U16	Sensor 0 factory password Always reads 0
	248-256			Reserved
Snsr1DisplaySelect	257	R/(W)	U16	Sensor 1 range displayed (0-2)
Snsr1DisplayFormat	258	R/(W)	2-U8	Sensor 1 Display Width(H) & Precision(L)
Snsr1Limit1H	259	R/(W)	F-MSW	Sensor 1 Alarm Limit 1 - MSW
Snsr1Limit1L	260	R/(W)	F-LSW	Sensor 1 Alarm Limit 1 - LSW
Snsr1Limit2H	261	R/(W)	F-MSW	Sensor 1 Alarm Limit 2 - MSW
Snsr1Limit2L	262	R/(W)	F-LSW	Sensor 1 Alarm Limit 2 - LSW
Snsr1Limit3H	263	R/(W)	F-MSW	Sensor 1 Alarm Limit 3 - MSW
Snsr1Limit3L	264	R/(W)	F-LSW	Sensor 1 Alarm Limit 3 - LSW
Snsr1Address	265	R/(W)	U8	Sensor 1 Modbus address (1-247)
Snsr1BaudRate	266	R	U8	Sensor 1 Baud Rate/1200
Snsr1DevType	267	R	U16	Sensor 1 Device Type: 0 = None 1 = Unknown 2 = PGU 3 = SGOES 4 = SGOES-M 5 = TGAES 6 = VGU 7 = Open Path
Snsr1SerialNbr	268	R	U16	Sensor 1 Serial number

Name	Addr	R/W	Format	Description
Snsr1Version	269	R	U16	Sensor 1 Firmware version: H- Major, L – Minor
Snsr1Chksum	270	R	U16	Sensor 1 Firmware checksum
Snsr1Gas	271	R	U16	Sensor 1 Gas identifier
Snsr1Cal1H	272	R/(W)	F-MSW	Sensor 1 Mid-span gas conc (2 gas) - MSW
Snsr1Cal1L	273	R/(W)	F-LSW	Sensor 1 Mid-span gas conc (2 gas) - LSW
Snsr1Cal2H	274	R/(W)	F-MSW	Sensor 1 Span gas conc (2 gas) - MSW
Snsr1Cal2L	275	R/(W)	F-LSW	Sensor 1 Span gas conc (2 gas) - LSW
Snsr1Cal3H	276	R/(W)	F-MSW	Sensor 1 Span gas conc (1 gas) - MSW
Snsr1Cal3L	277	R/(W)	F-LSW	Sensor 1 Span gas conc (1 gas) - LSW
Snsr1Pswd	278	R/(W)	U16	Sensor 1 parameters password Always reads 0
Snsr1Factory	279	R/(W)	U16	Sensor 1 factory password Always reads 0
	280-288			Reserved

Notes:

1. Registers containing the notation "(W)" in the R/W column require that the password register, register 17, be written with the password value, prior to writing the specified register. The default password value is zero (0).

Data Format Descriptions	
Value	Description
ASC	ASCII/ISO 8859-1 8 bit character (2 per register)
Bits	Bit flags (16 bits wide)
F-MSW	32 bit IEEE floating point value – Most significant word
F-LSW	32 bit IEEE floating point value – Least significant word
N/A	Value has no meaning (write only)
U8	Unsigned 8 bit value – high byte ignored
2-U8	Two unsigned 8 bit values
U16	Unsigned 16 bit value
U32-MSW	Unsigned 32 bit value – Most significant word
U32-LSW	Unsigned 32 bit value – Least significant word

Engineering Units Enumerations	
Value	Description
0	Not valid
1	Volume Percent
2	Percent LEL
3	ppm
4	Mg/M3
5	Percentage Exposure Limit
6	LEL-Meters

Gas Codes for SGOES	
Value	Description
523	Methane
552	Cyclohexane
525	Hexane
526	Butane
527	Isobutane

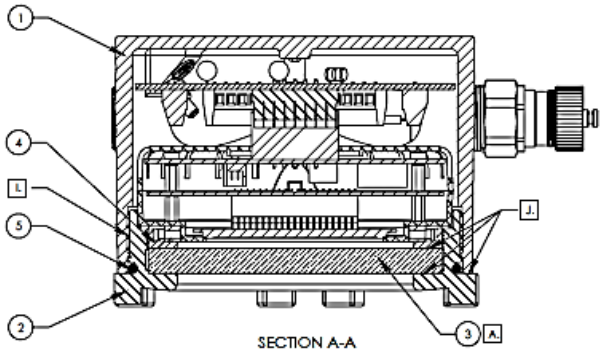
528	Pentane
529	Cyclopentane
530	Ethanol
531	Not used
532	Methanol
533	Propylene (NEW)
534	Benzene (NEW)
535	Ethane (NEW)
536	Acetone (NEW)
537	Toluene (NEW)
538	MTBE (NEW)
539	Ethylene (NEW)
540	Oil (NEW)
541	Natural Gas (NEW)
542	Gasoline (NEW)
543	Kerosene (NEW)
544	White Spirit (NEW)
545	Diesel Oil (NEW)
546	Petroleum (NEW)
547	p-Xylene (NEW)
548	o-Xylene (NEW)
549	Heptane (NEW)
550	IsoPropanol (NEW)
552	Cyclohexane
551	Ethyl Benzene (NEW)
552	Cyclohexane
553	Butadiene
554	Styrene
555	Methyl Chloride
556	Methylene Chloride
557	Butyl Acetate
558	Ethyl Acetate
559	Butanone
560	Cyclohexanone
561	Propanol
562	Butanol
563	Octane

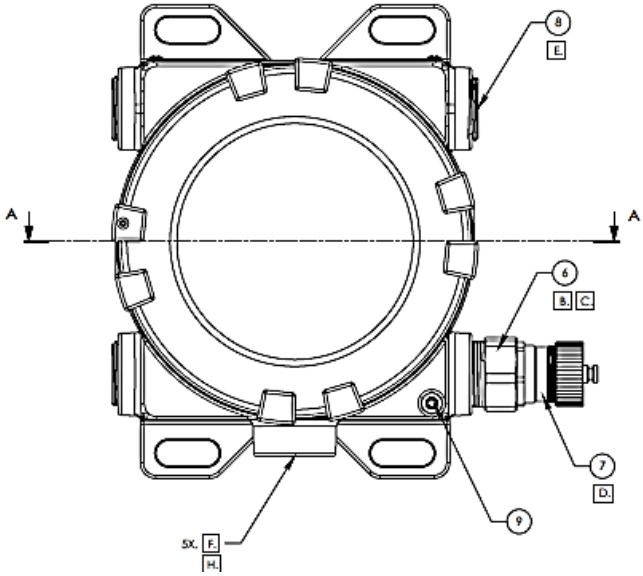
Gas Codes for PGU	
Value	Description
0	None
1	Methane
2	Propane
3	Hexane
4	Butane (Not used)
5	Isobutane (Not used)
6	Pentane (Not used)
7	Cyclopentane (Not used)
8	Ethanol (Not used)
9	CO2-2
10	CO2-5
11	Methanol
12	Isobutylene 20
13	Isobutylene 200
14	Ethylene
15	Benzene
16	H2

17	O2
18	CO
19	H2S 45
20	H2S 85
21	NO2
22	SO2
23	Ammonia 100
24	Ammonia 1000
25	Cl2
26	HCl
27	HF
28	H2S 10
29	Ethane (Not used)
30	Acetone (Not used)
31	Toluene(Not used)
32	MTBE (Not used)
33	Acetylene
34	IsoButylene 2000
35	Methyl Mercaptan
36	Ethyl Mercaptan
37	Propylene (NEW)
38	Oil (NEW)
39	Natural Gas
40	Gasoline
41	Kerosene
42	White spirit
43	Diesel Oil
44	Petrochemical
45	Formaldehyde
46	Vinyl acetate
47	Heptane
48	Orthoxylene
49	Paraxylene
50	Isopropanol
51	Cyclohexane
52	Ethylbenzene
53	Petroleum

Gas Codes for TGAES	
Value	Description
523	Methane
524	Propane
525	Ethylene

Appendix 5 – Vector Explosion Protection Drawing





NOTES: UNLESS OTHERWISE SPECIFIED,

A. EPOXY COMPOUND APPLIED ON TOP, BOTTOM & SIDE OF WINDOW SURFACES FOR SEALING; MINIMUM JOINT LENGTH = 10MM.

B. THE HART ADAPTER FITTING WITH 3/4-14 NPT THREADS (18MM LONG) CONNECT TO VECTOR HOUSING AND FEMALE END FITTING WITH PG 13.5 THREADS TO COUPLE WITH BINDER CONNECTOR.

C. HART ADAPTER FILLED WITH EPOXY COMPOUND; MINIMUM LENGTH OF SEAL = 26MM.

D. BINDER CONNECTOR POTTED IN EPOXY COMPOUND.

E. PIPE FITTINGS AND PORT PLUGS USE 3/4-14 NPT THREADS WITH PIPE SEALANT.

F. FIVE THREADED 3/4-14 NPT FEMALE CONDUIT OPENINGS ARE PROVIDED IN THE HOUSING FOR SENSOR MOUNTING AND WIRING.

G. VECTOR SURFACE ARE COATED WITH ELECTROPOLISH PER ASTM B912. FOR EXPLOSION PROOFING; NO MECHANICAL DAMAGE SUCH AS CRACKS, DENTS, SCRATCHES ARE ALLOWED.

H. 3/4-14 NPT CONDUIT OPENINGS SHALL PROVIDE FOR NOMINAL 4-1/2 THREADS AT FULL ENGAGEMENT AND SHALL BE 1/2 TO 2 TURNS DEEPER THAN NOMINAL.

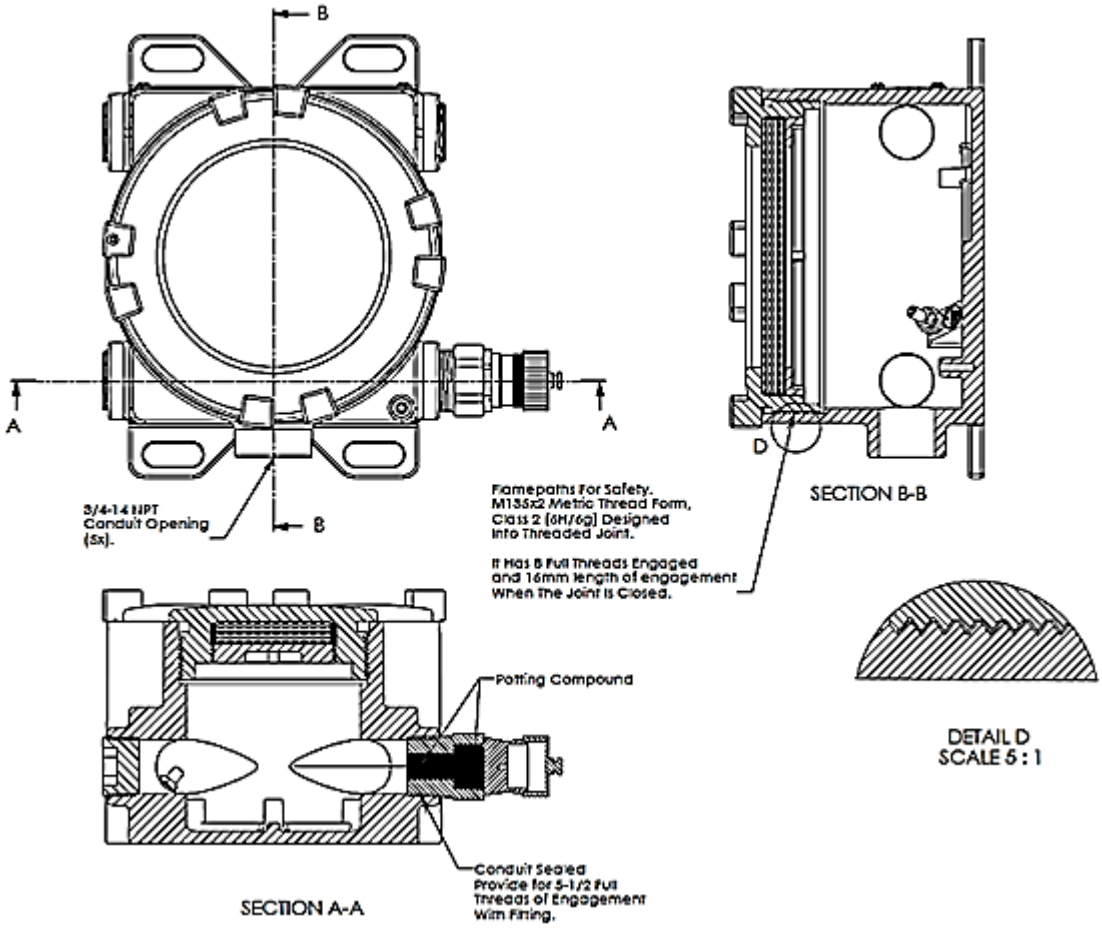
I. M135x2 THREADED JOINT, 8 FULL THREADS ENGAGED.

J. MATING SURFACES FINISH NOT ROUGHER THAN $\sqrt{}$.

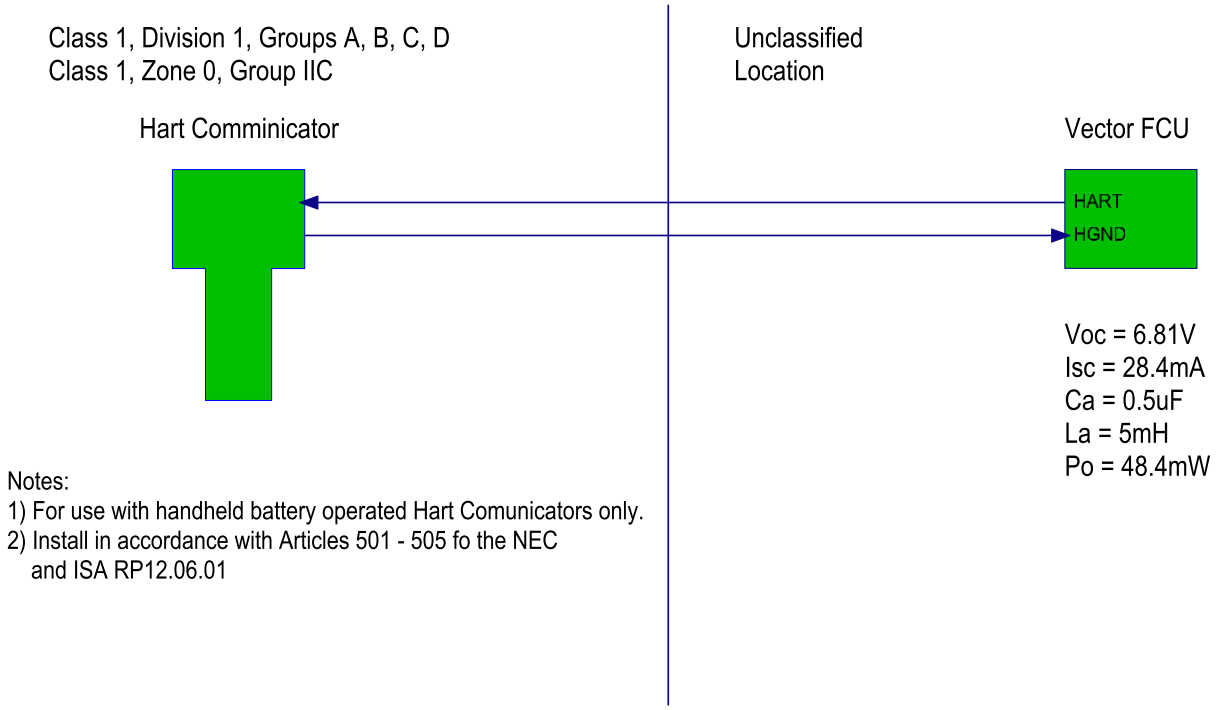
MATERIALS OF CONSTRUCTION

ITEM#	DESCRIPTION	MATERIAL	
1	VECTOR, HOUSING	CAST 316 SS ASTM A351 CF8M	
2	VECTOR, CAP	CAST 316 SS ASTM A351 CF8M	
3	VECTOR, WINDOW GLASS	CLEAR SODA LIME GLASS	
4	COLLAR	316 SS	
5	O-RING	SILICONE, AS-568-250, 70A DUR., -65 TO +230C	
6	HART ADAPTER	316 SS	
7	BINDER CONNECTOR	BINDER 99-4638-20-06, IP67 RATED	
8	CONDUIT ACCESS PORT PLUG	316 SS	
9	EXTERNAL EARTH GROUND CONNECTION	M5 SET SCR., LOCK & FLAT WASHER AND NUTS	

Appendix 6 – Vector Flame Paths

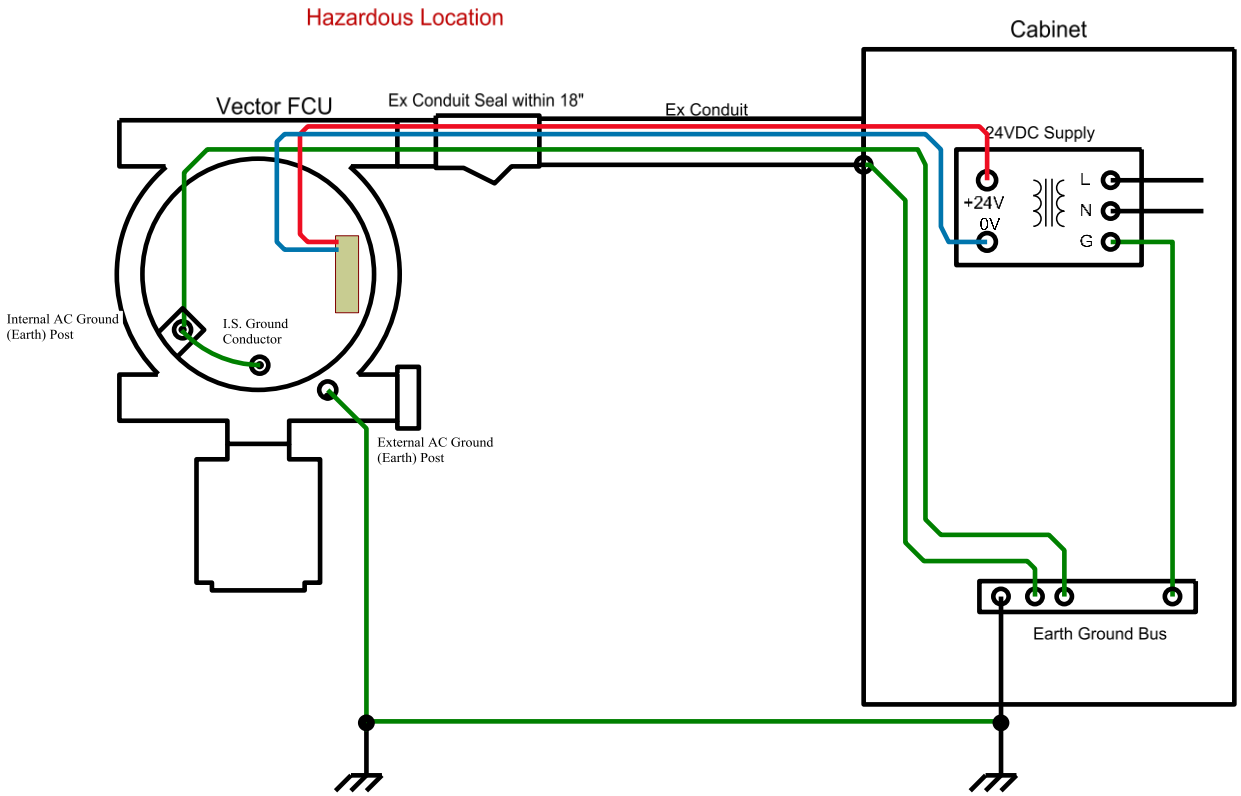


Appendix 7 – Vector Intrinsically Safe Apparatus Control Drawing



Notes:
1) For use with handheld battery operated Hart Comunicators only.
2) Install in accordance with Articles 501 - 505 fo the NEC
and ISA RP12.06.01

Appendix 8 – Vector Protective Grounding



Ground in accordance with applicable section of
Canadian Electrical Code, Part I, CSA C22.1
National Electrical Code, NFPA 70 Articles 250, 500 - 517
Standard for Electrical Installations, NOM-001-SEDE
EN60079-14 clause 4.7
DIN VDE 0100 Part 410, DIN VDE 0100 P t ar 540