Vector Field Control Unit
Operating Manual

810-0001

ESP SAFETY INC

Technology of the Future...Protection for today

Vector Field Control Unit
Operating Manual
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ESP Safety, Inc.
555 North First Street
San Jose, CA 95112
408-886-9746

Date	Revision	Description	Approval/ECO
04/04/14	01	Initial Draft	A. Burgos
05/01/14	02	Add relay contact specs; clarity	140501A
07/15/14	03	Update wiring diagramsp	140715A

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.

1.0 Introduction

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 1) 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
- Tri-color status LED indicates operational mode, fault, gas presence, calibration mode, and alarm level

ESP Safety, Inc. Contact Information

Contact ESP Safety for application assistance or order placement.

ESP Safety, Inc.
555 North First Street
San Jose, CA 95112
USA
Telephone: 408-886-9746
FAX: 408-886-9757
website: www.espsafetyinc.com
email: info@espsafetyinc.com

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.

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.

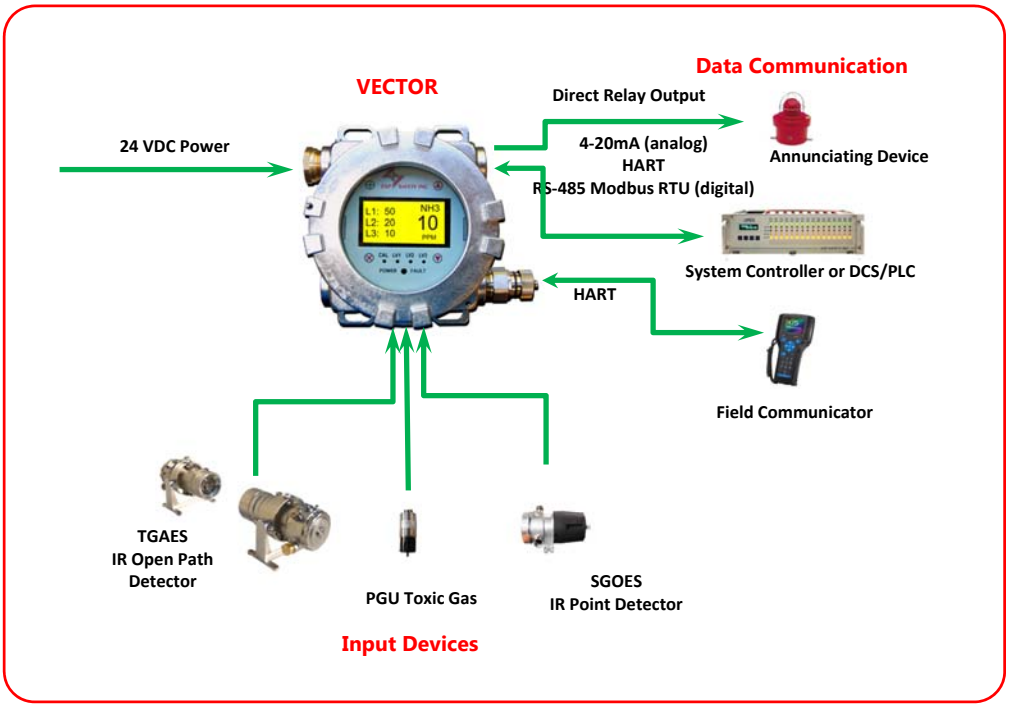


Figure 1-1: Vector Communications

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/USB communication port (3/4" NPT), x1
F. LED Indicators
G. Magnetic keypad, x4

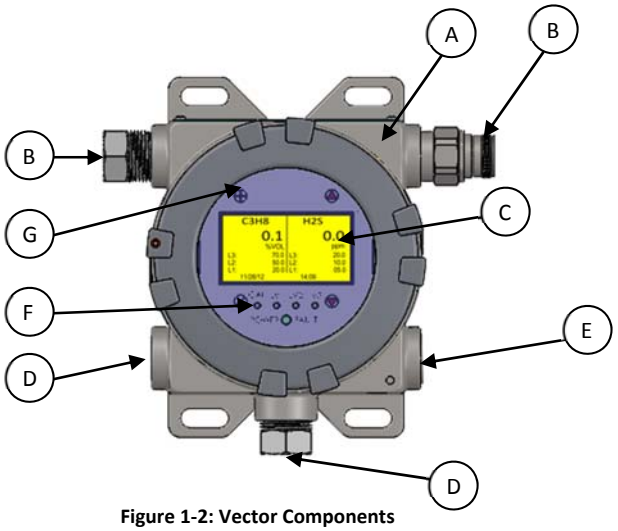


Figure 1-2: Vector Components

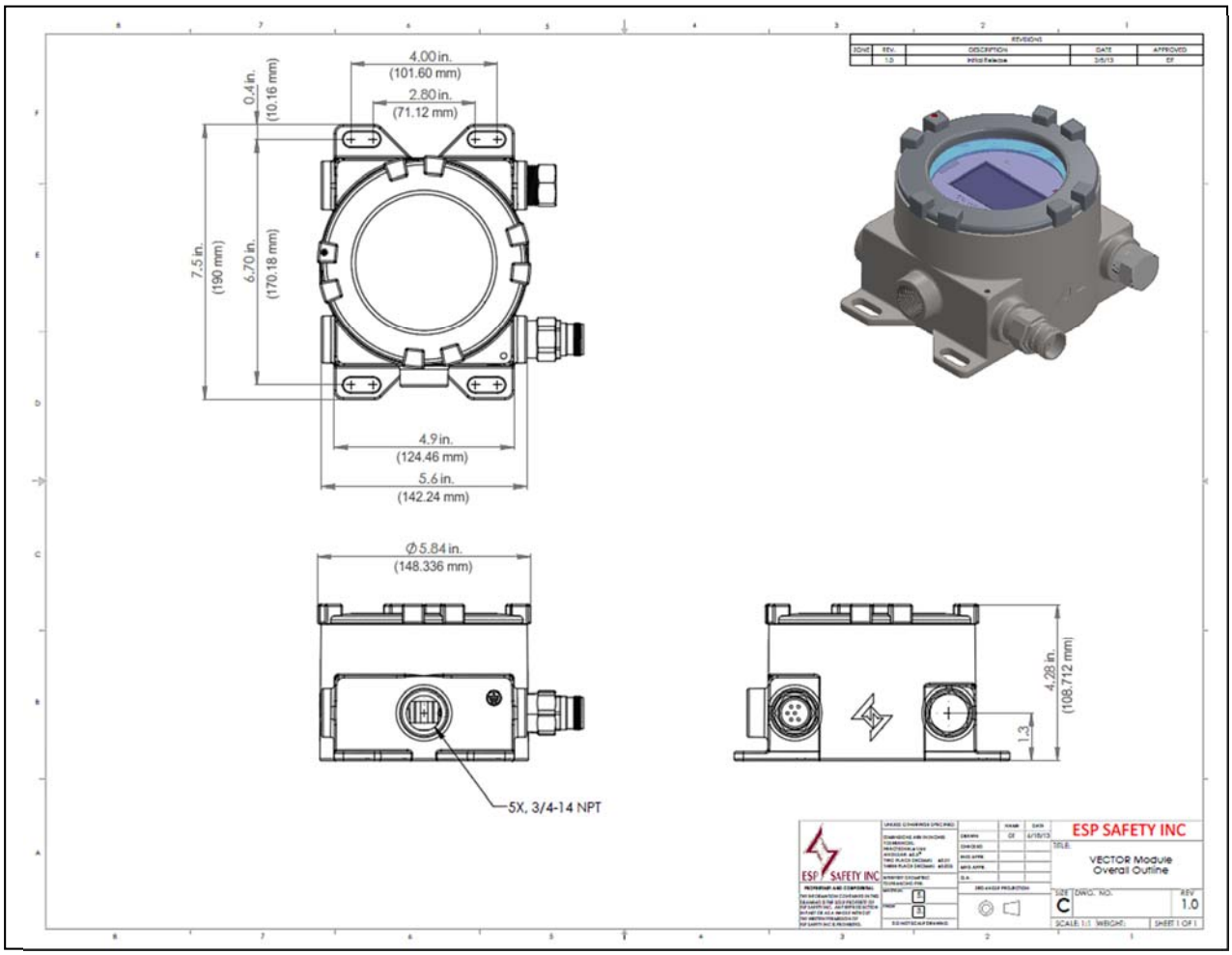


Figure 1-3: Vector Dimensions

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 1 connection for HART/USB
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 Digital RS-485 Modbus RTU
Alarm Relays	Contacts rating Form 1A 0-60V, 1.0A AC/2.0A DC 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
Sensor Types / Model	Electrochemical: PGU-E Infrared: PGU-IR Infrared (point): SGOES Infrared (open path): TGAES Photo Ionized: PGU-P 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)
Ingress Protection	IP67
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. Tri-color status LED indicates operational mode, fault, and gas presence. 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 3 minutes

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

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

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:

1. Start – selects a function to be performed
2. Back – cancel a pending function or exit the current function
3. Scroll Up – selects the item above the current one, or may be used to increase a numeric digit by one
4. Scroll Down – selects the item below the current one, or may be used to decrease a numeric digit by one

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.

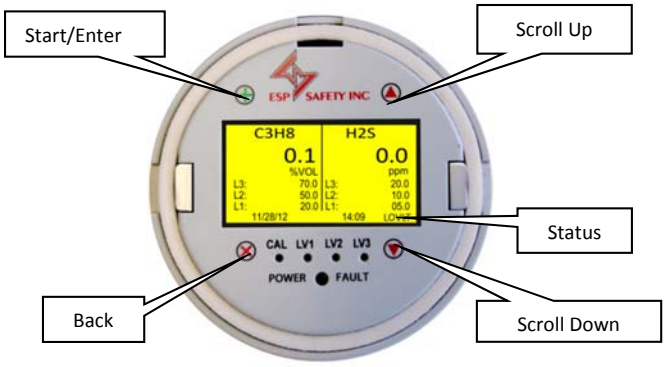


Figure 2-1: Touch Wand Points

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)

Status Code Conditions:

CHKSM – ROM checksum error
LOVLT – instrument supply voltage less than 18 volts
NOCFG – Sensor configuration table not loaded
OVRNG – sensor over ranged
UNDRG – sensor under ranged
USBER – USB write error
USBOK – USB write complete
USBWR – USB write in progress

Vector Display Menu Structure

Those menus that contain a "*" are shown in more detail in the Calibration section of this document. The alarm reset function is used to reset the alarm relays when they are operating in latching mode. This function does not have a specific display associated with it.

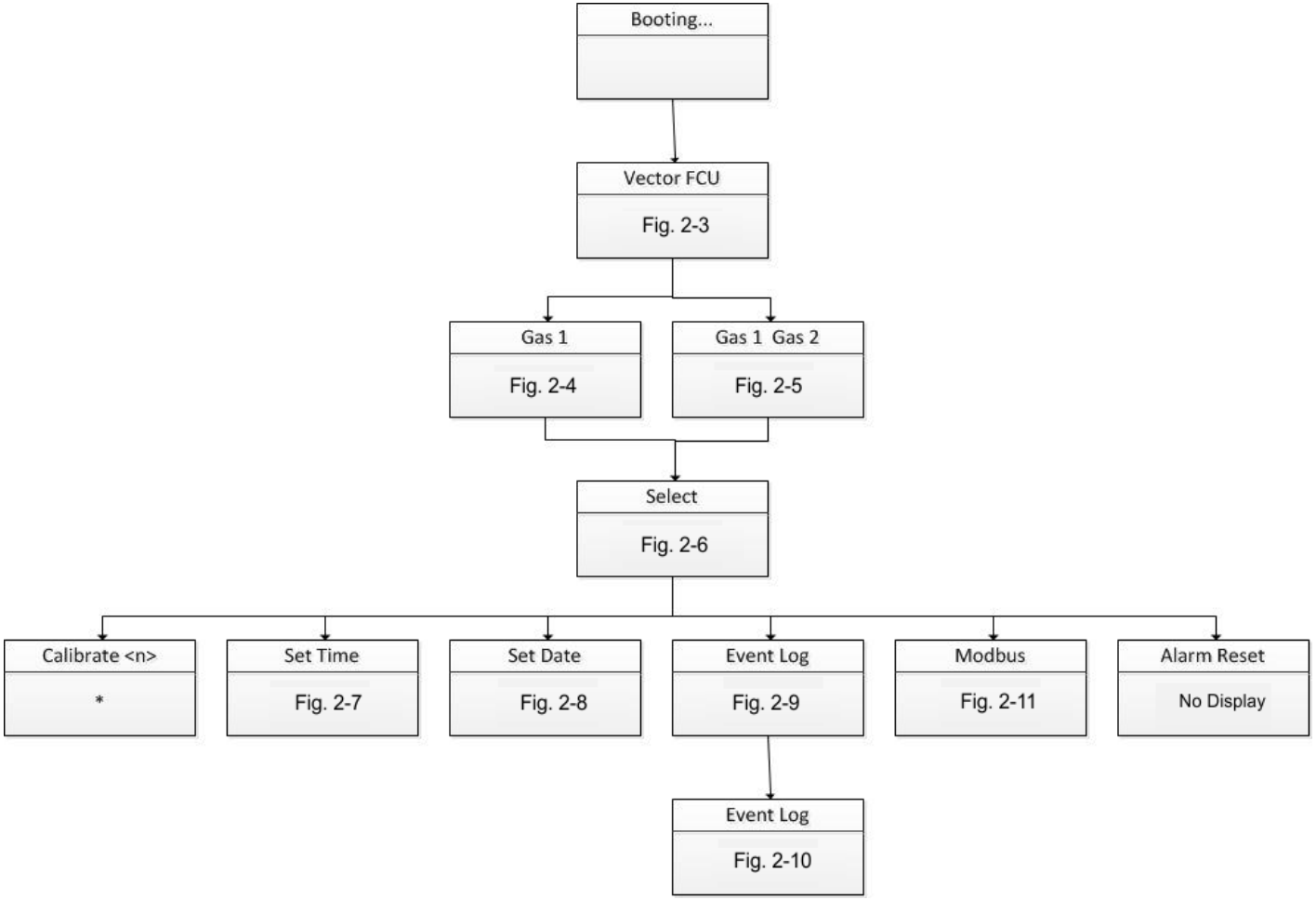


Figure 2-2: Vector Menu Structure

Vector Display Operations

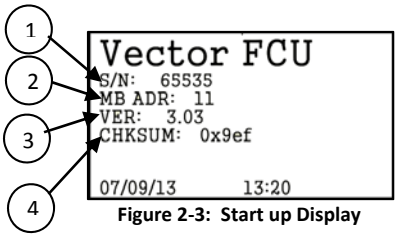


Figure 2-3: Start up Display

Start Up Display Information:

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

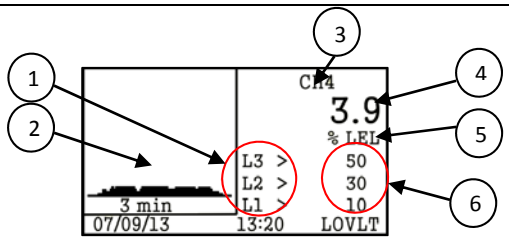


Figure 2-4: Single Gas Display

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 values lower than the specified limit value 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. Typically, this is the chemical formula for gas concentration being displayed.
4. Measured gas concentration.
5. Engineering units for gas concentration.

Value of Alarm Limits 1-3. Units are the same as those for the measured gas concentration

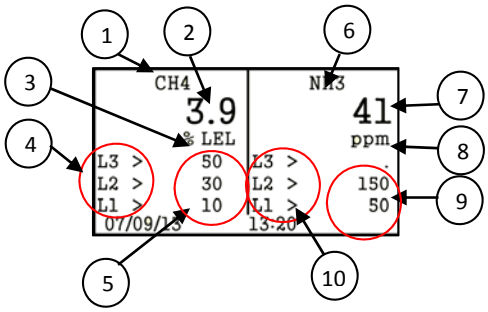


Figure 2-5: Two Gas Display

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 values lower than the specified limit value will be considered to be in alarm.

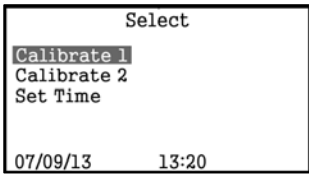


Figure 2-6: Function Select Display

Function Select Display:

Use the UP/DOWN scroll points to move through the available functions. Touch the START point to activate the function. The BACK point will return to the gas display.

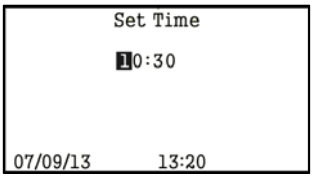


Figure 2-7: Set Time Display

Set Time Display:

The time is displayed in HH:MM. Touch the UP/DOWN scroll points to cycle through the digits. Touch the START point to advance to the next digit.

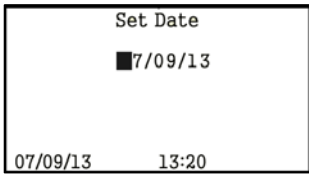


Figure 2-8: Set Date Display

Set Date Display:

The date is displayed in month, day, and year format – MM/DD/YY. Touch the UP/DOWN scroll points to cycle through the digits. Touch the START point to advance to the next digit.

Figure 2-9: Event Select Display

Event Select Display:

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.

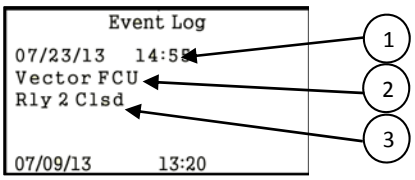


Figure 2-10: Event Log Display 2

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.

The ESP Commander program can also retrieve event logs for display on a PC. Additional information will be displayed about the event when using this feature.

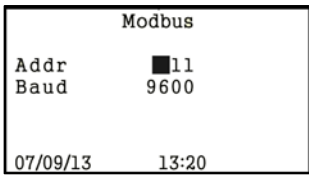


Figure 2-11: Modbus Display

Modbus Display:

The Modbus display may be used to configure the communications parameters of the host port. Use the UP/DOWN scroll points to select the value of each digit. Use the START point to advance to the next digit.

Valid slave addresses for Modbus devices is 1 through 247.

While the baud rate is configurable to one of the standard baud rates, the following communications settings are fixed: 8 data bits, no parity, two stop bits

Certifications

FM C US APPROVED	Explosion Proof Intrinsically Safe (XPIS): Class 1; Division 1; Group A, B, C, D; Temp T5 AEx d[ia]: Zone 2; Group IIC, Temp Class T5 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-12.13.01-2002, ANSI/ISA-12.13.04-2007, ANSI/ISA-920001, ANSI/NEMA 250, ANSI/IEC 60529
CSA®	Explosion Proof Intrinsically Safe (XPIS): Class 1; Division 1; Group B, C, D; Temp T5 Ex d[ia]: Zone 1; Group IIC, Temp Class T5 Enclosure Type 4X; IP Rating IP67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: CSA C22.2 Nos. 0.4., 0.5, 30, 94, 142, 152, 157, 60529, CAN/CSA 60079-0, CAN/CSA 60079-1, CAN/CSA 60079-11
ATEX IEC Ex CE 94/9/EC	CE 0470 Ex II 2/1 G Ex d[ia] IIC T5 IP 67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: EN60079-0, EN60079-1, EN60079-29-1-2007, EN 50270, EN 50271, EN 60529
IEC IECEx	Ex d [ia] IIC T5 IP 67 Temperature Range: -50°C ≤ Ta ≤ 75°C Standards: IEC 60079-0, IEC 60079-1, IEC 60079-11, IEC 60079-29-1, IEC 60079-29-4, IEC 60529

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.

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.
- Vector wiring should comply with all governing electrical codes, standards and regulations.
- Never operate the Vector if the casing is damaged.
- Do not open the Vector case when the unit is energized.
- Perform regular testing and maintenance as outlined in the Maintenance section.
- 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.

Also see the individual sections in this manual for relevant specific safety guidelines.

Explosion Protection Means

The table below describes the Vector explosion protection design features. Refer to Appendix 4 for additional details.

Feature	Protection Means
Enclosure of Current Carrying Parts	The casing includes spigot joints with controlled gaps to meet explosion-proof requirements for installation in Class I, Division I, Group B, C and D, and T5 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 and FM 3615.
Manufacturing Control Of Casing	Important parameters include: • Maximum width and minimum length of spigot 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 212°F (100°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 is protection class IP 67 in accordance with IEC 60529-004.
Sealing Cables at Conduit Entry	Use approved hazardous location sealed conduit fittings. For outdoor installations, ensure sealing meets IP67 requirements.

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, P/N 100-0008-xx
- 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.

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

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 PGU sensor(s)
- 2mm “Flat Head” screwdriver for protective cover lock screw and wire terminal block clamps
- Phillips head screwdriver for ground connector
- Allen wrench set
- Ferrule crimper (up to 12ga)
- Two (2) slotted, flared-tip screwdrivers (75mm x 2.5mm)

Mounting

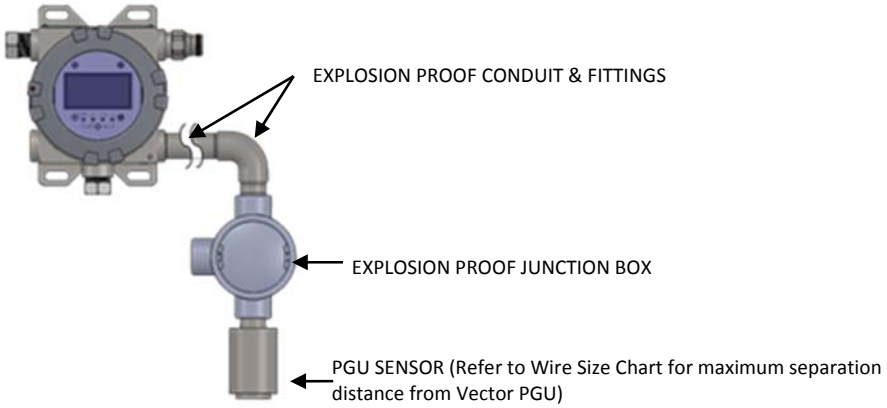
Mount the Vector Field Control Unit housing with the faceplate oriented at a vertical plane to reduce the possibility of dirt and dust building up on the window.

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 cable to the detector. All connections require explosion proof and sealed cable glands.

FIGURE 4-1: REMOTE CONFIGURATION



Earth Grounding

The enclosure of the Vector Field Control Unit must be earth grounded for electrical safety and to limit the effects of radio frequency interference. An earth/ground point is provided on the outside of the Vector Field Control Unit Explosion Proof enclosure.

The Vector FCU must be earth grounded in order to operate properly. Refer to Appendix 5, Vector FCU with External Bonding Jumper for grounding details

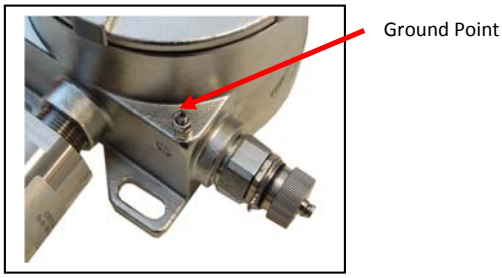


Figure 4-2: Ground Point

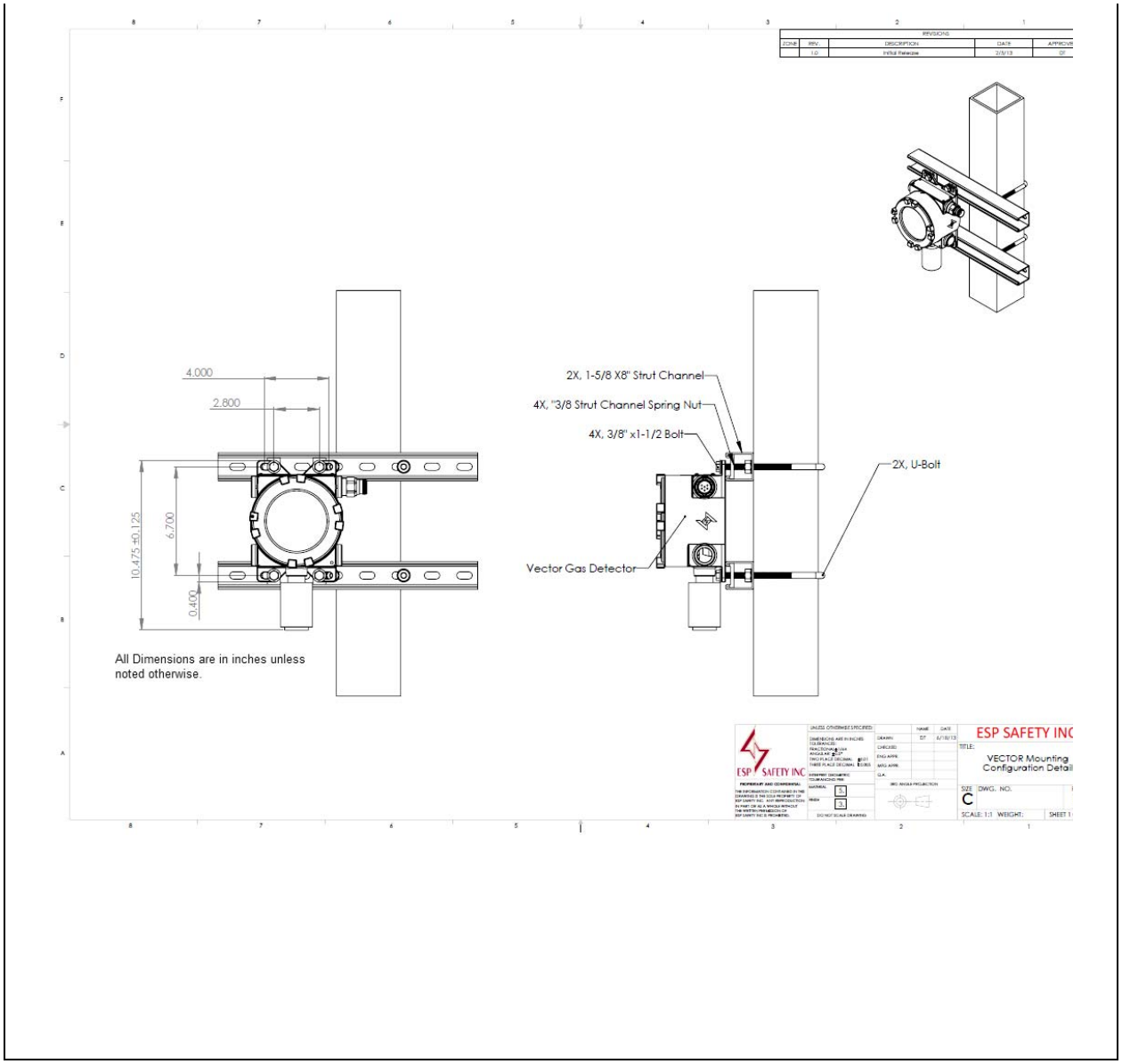


Figure 4-3: Suggested Mounting Configurations

General Wiring Requirements

Caution: All cable/conduit entries must be sealed with an appropriate and certified sealing plug and cable gland. The use of industrial grade, armored field cable is recommended. If installing the sensor in a hazardous area using a remote configuration, armored cabling is required for the detector connection to the Vector FCU.

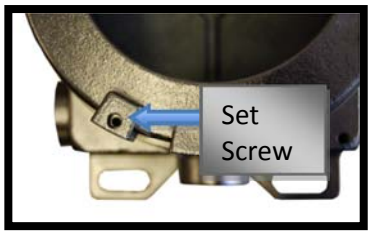
- If installing connection cables in an explosion proof conduit, do not use the same conduit to carry wiring for any other purpose or equipment.
- If installing the remote sensor in a hazardous area, armored cabling is required for the sensor connection to the Vector FCU.
- Minimum 14 AWG (2.08 mm^2) 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 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 removal tabs.



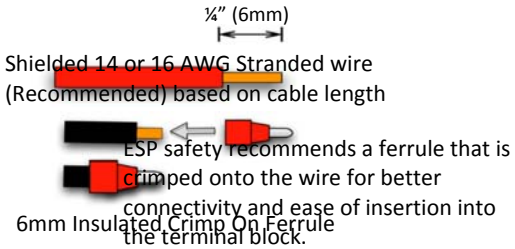
cover

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- Wire Preparation **Figure 4-6: Wire Prep**	Use a stripping tool for the selected wire gauge to remove ¼-inch (6mm) of the insulating jacket for each conductor to be inserted in the terminal blocks of the Connector PCBA. 
Step 4- 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 5- 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 must be sealed with an appropriate and certified sealing plug and cable gland. The use of industrial grade, armored field cable is recommended. If installing the remote sensor in a hazardous area using remote configuration, armored cabling is required for the Sensor connection to the Vector Field Control Unit.

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 1-B 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.

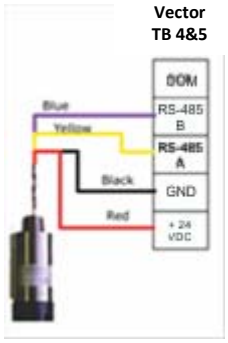


Figure 4-8: PGU Connection to Terminal Block TB-4 & TB-5

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 RTU connection
TB2-4	RS485B	RS-485B RTU connection
TB2-5	COM	RS-485 common
TB2-6	SHLD	Shield

Connection	Label	Function
TB3-1	+24V	+24VDC Power In
TB3-2	+24RTN	+24VDC Supply return (common/GND)
TB3-3	RS485A	RS-485A RTU connection
TB3-4	RS485B	RS-485B RTU 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 comm port

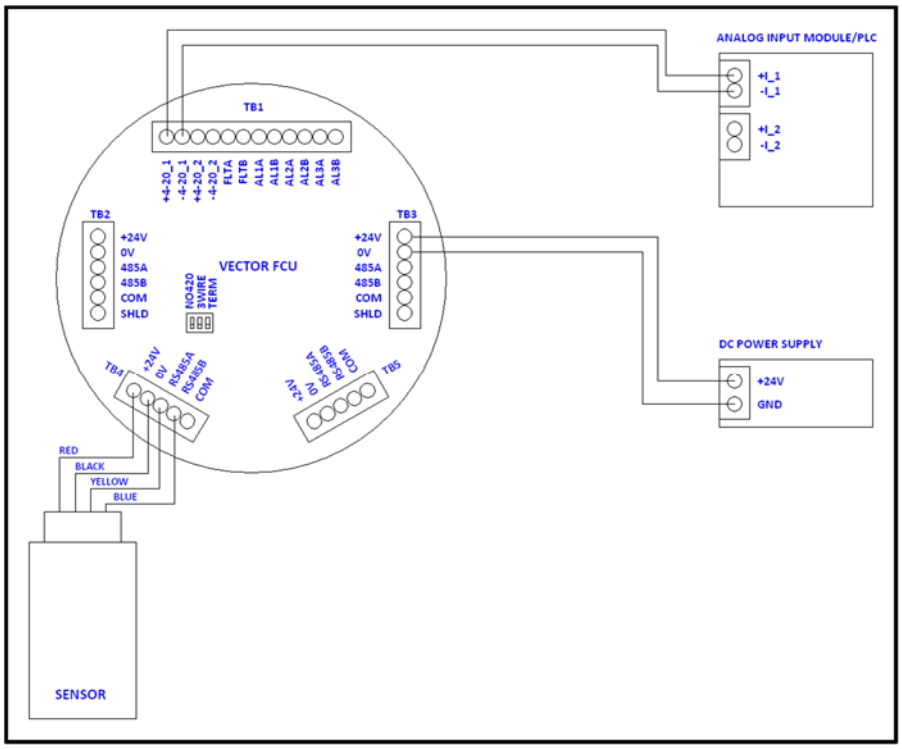


Figure 4-10: Vector wiring to analog input module with current inputs and single sensor

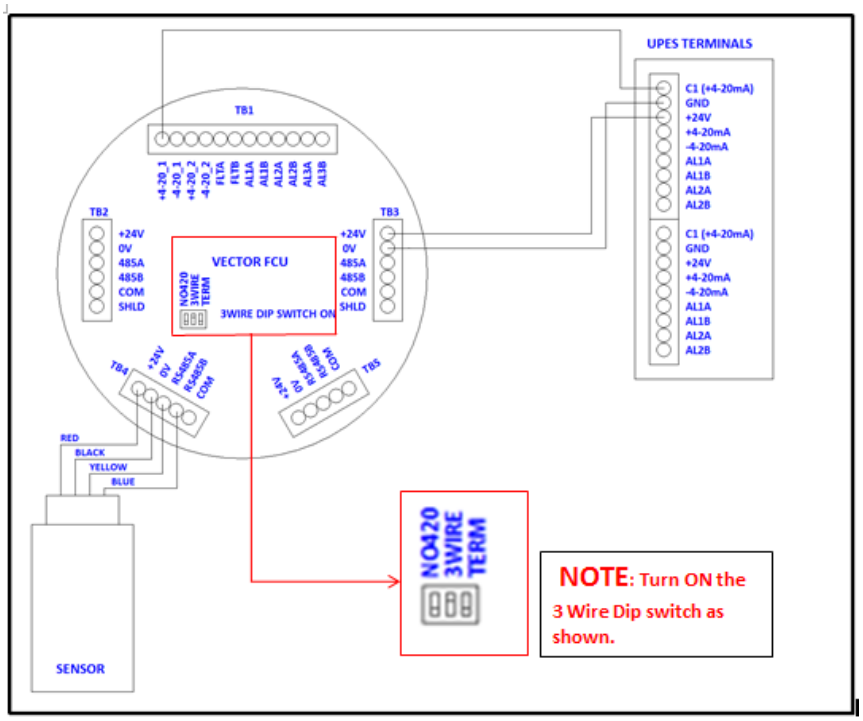


Figure 4-11: Vector FCU to UPES Controller wiring

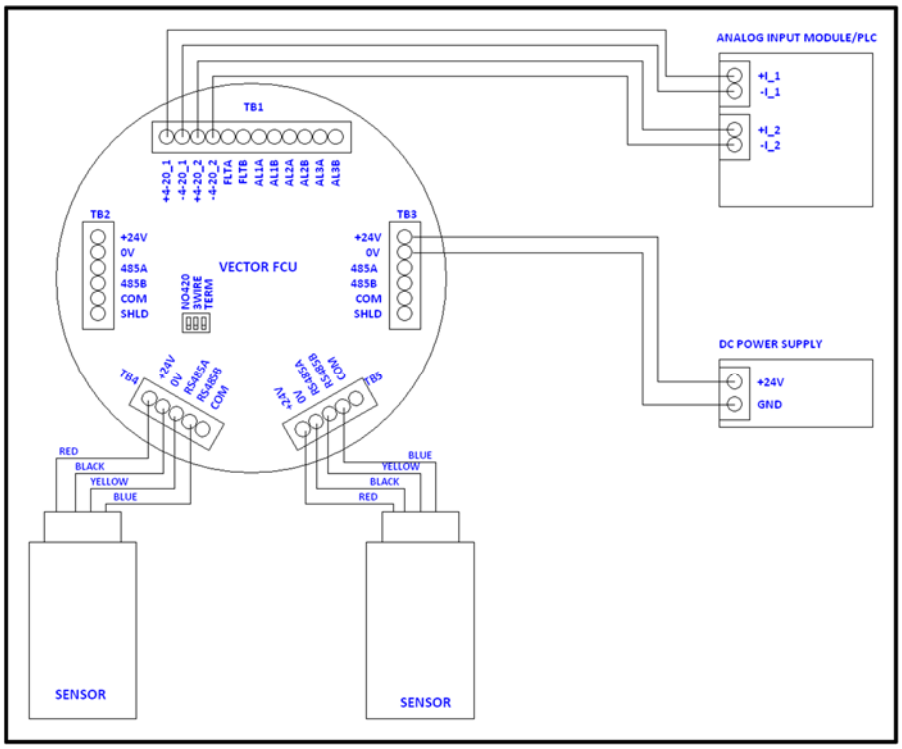


Figure 4-12: Vector wiring to analog input module with current inputs and two sensors

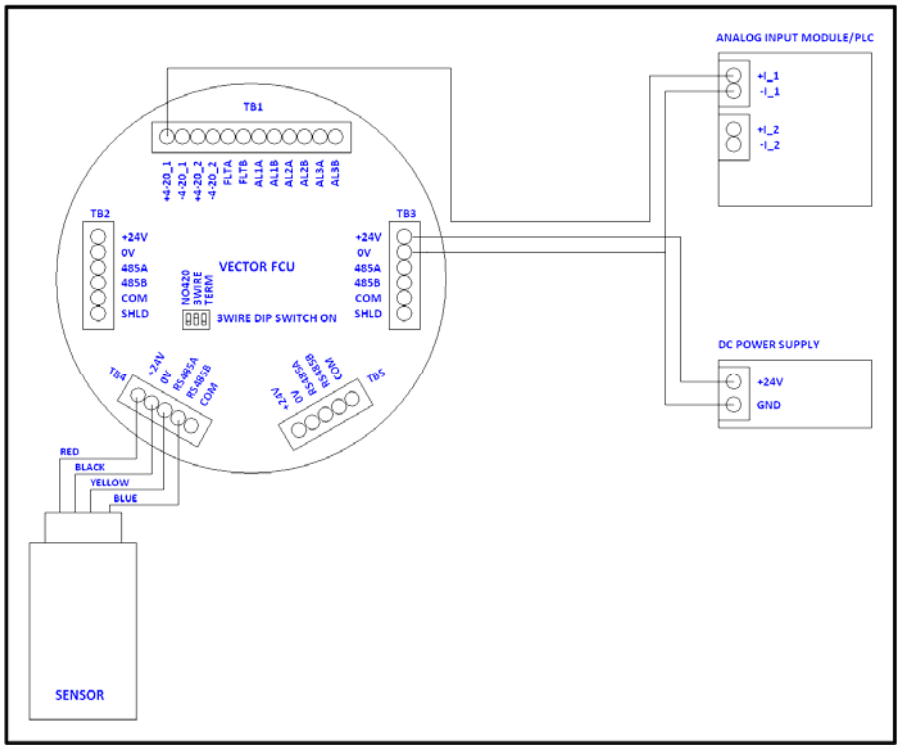


Figure 4-13: Legacy 3-wire 4-20mA connection to Vector FCU

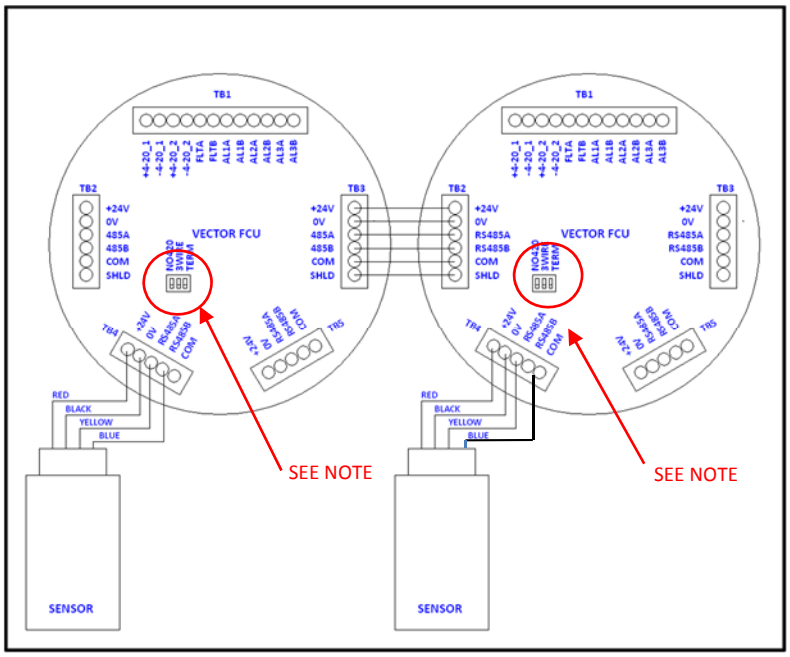


Figure 4-14: Two Vector FCUs with daisy-chained RS-485 communications

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.

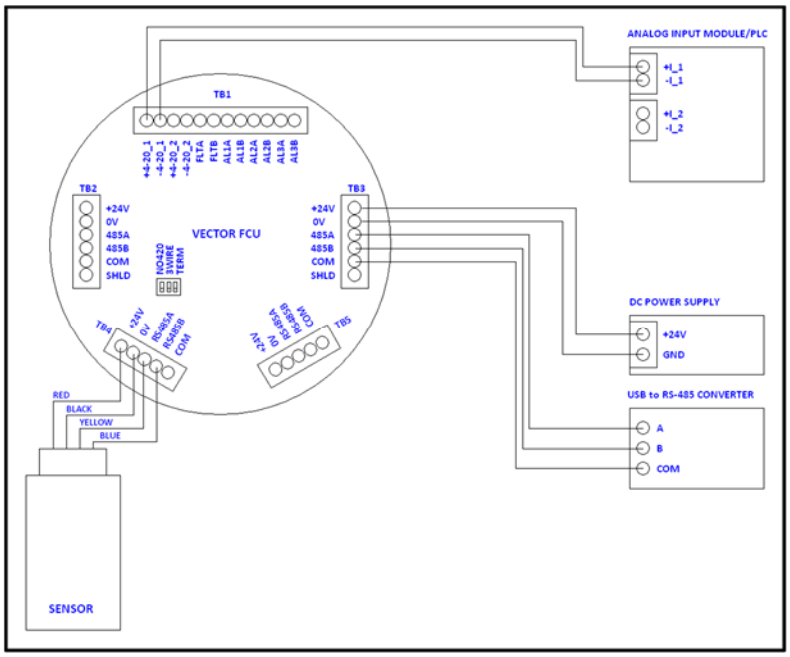


Figure 4-15: Vector wiring to RS-485 to ESP Commander or SCADA

- 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.

Power up and Stand Alone Operation of the VECTOR

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.
- 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 Calibration Procedures

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

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

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

- 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 Section 3, Display Operations, 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.

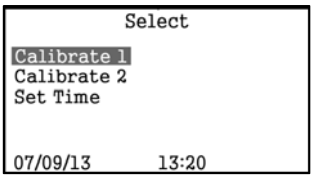


Figure 5-1: Function Select Display

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).

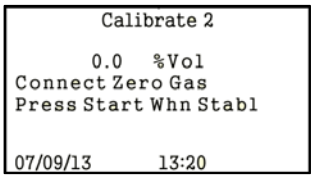


Figure 5-2: Zero Calibration Screen

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.

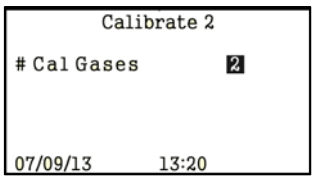


Figure 5-3: Calibration Gas Count Selection

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.

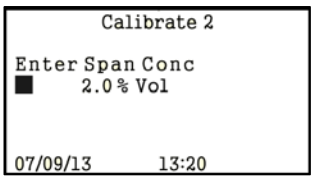


Figure 5-4: Span Gas Concentration Entry

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: 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.

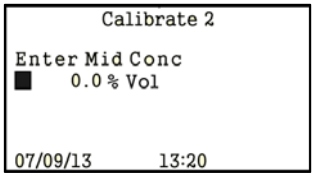


Figure 5-5: Mid-Span Gas Concentration Entry

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.

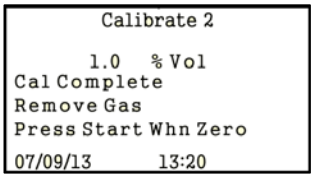


Figure 5-7: Calibration Complete

Step 8

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.

Touch the "BACK" point to exit the Function Select display and return to the process value display.

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.

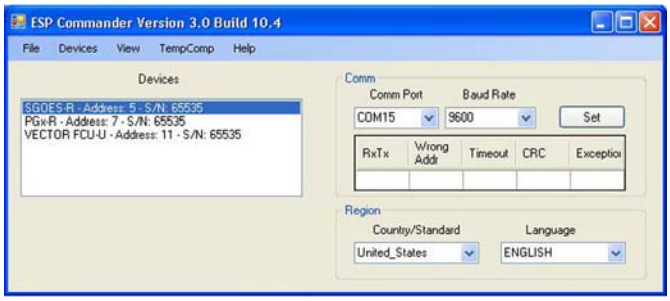


Figure 5-8: Main ESP Commander Form

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.

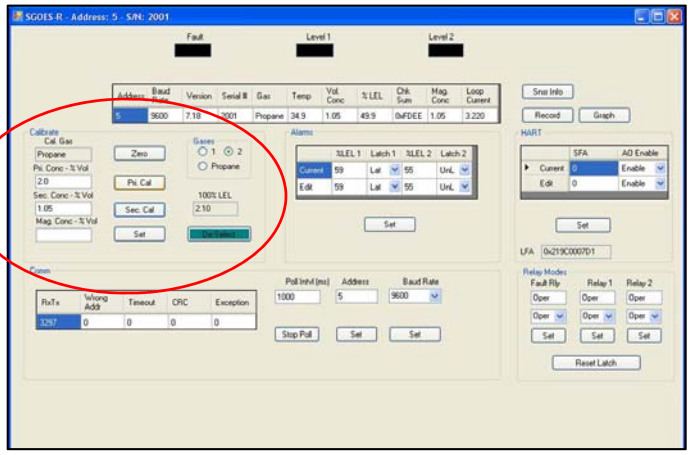


Figure 5-9: SGOES Form

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.

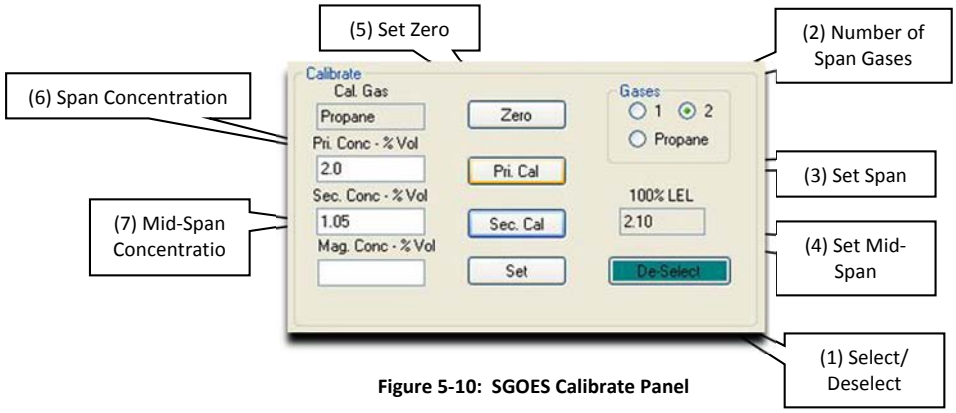


Figure 5-10: SGOES Calibrate Panel

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 2, 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.

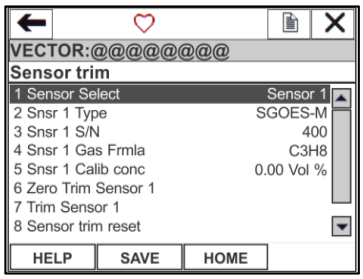


Figure 5-11: Sensor Select Display

Step 1:

Navigate to the Sensor Trim display.

Highlight the 1 Sensor Select item. Then select it to select the sensor to be calibrated: Sensor 1 or Sensor2

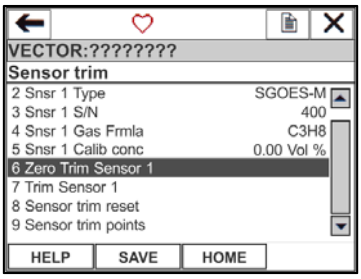


Figure 5-12: Sensor Trim Display (Zero)

Step 2:

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

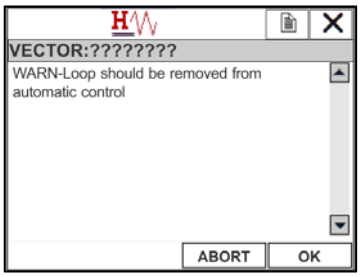


Figure 5-13: Warning Message

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.

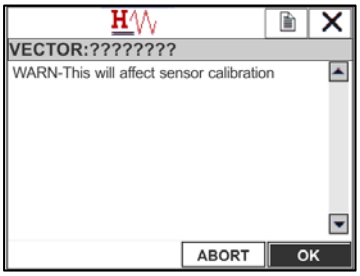


Figure 5-14: Warning Message 2

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.

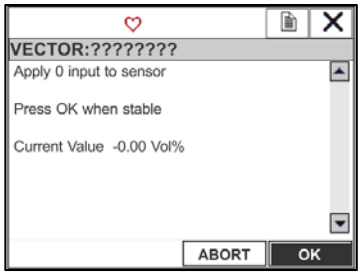


Figure 5-15: Sensor Zero Calibration

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.

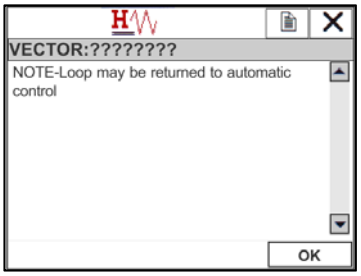


Figure 5-16: Warning Message

Warning Message 3:

Note the warning message.

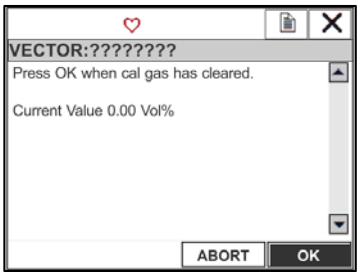


Figure 5-17: Zero Calibration Exit

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.

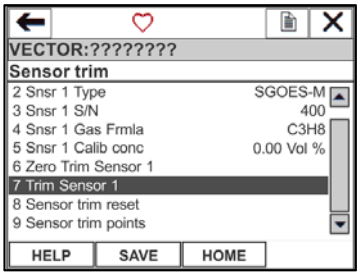


Figure 5-18: Sensor Trim Display (Span)

Step 5:

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

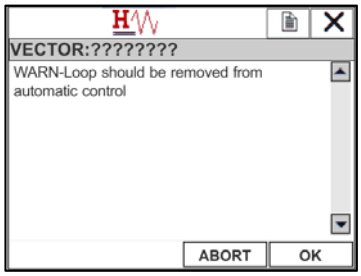


Figure 5-19: Warning Message

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.

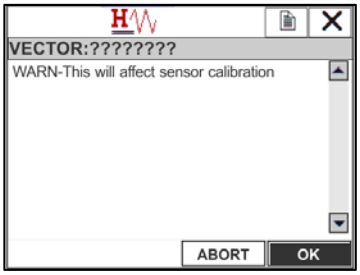


Figure 5-14: Zero Calibration Exit

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.

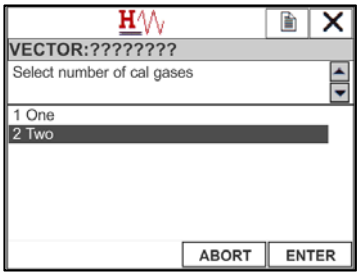


Figure 5-20: Span Gas Count Select

Step 6

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

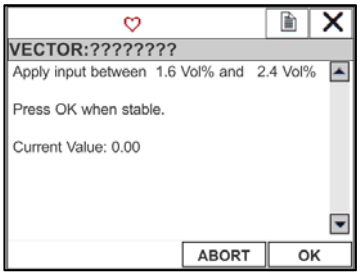


Figure 5-21: Span Gas Calibration

Step 7:

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

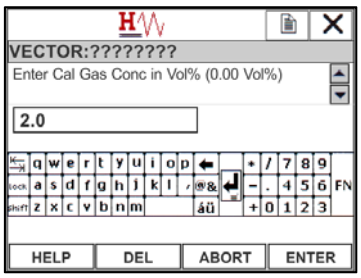


Figure 5-22: Span Gas Concentration Data Entry

Step 8:

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

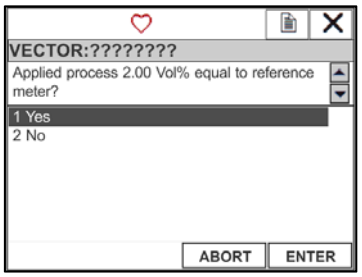


Figure 5-23: Span Calibration Confirm

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.

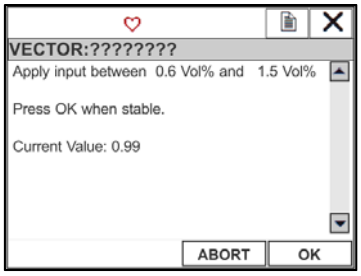


Figure 5-24: Mid-Span Gas Calibration

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.

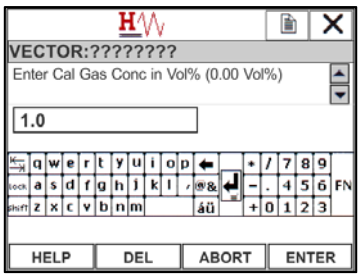


Figure 5-25: Mid-Span Gas Concentration Data Entry

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.

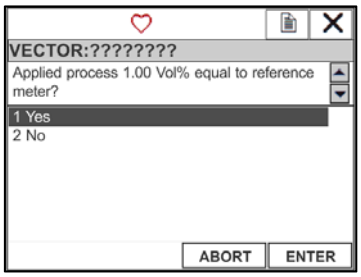


Figure 5-26: Span Calibration Confirm

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

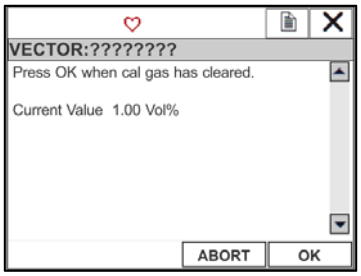


Figure 5-27: Calibration Exit

Step 13:

Calibration Exit

not, select "No". The mid-span calibration will be repeated

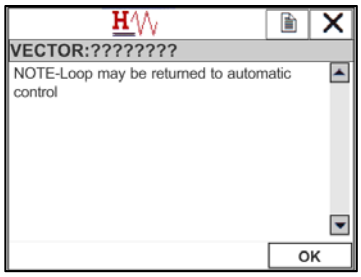


Figure 5-16: Warning Message

Warning Message:

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

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.

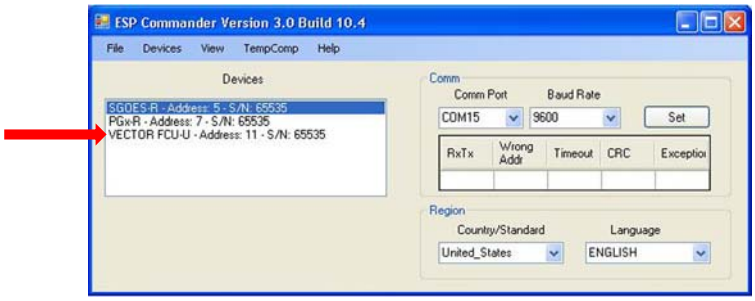


Figure 5-8: Main ESP Commander Form

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.

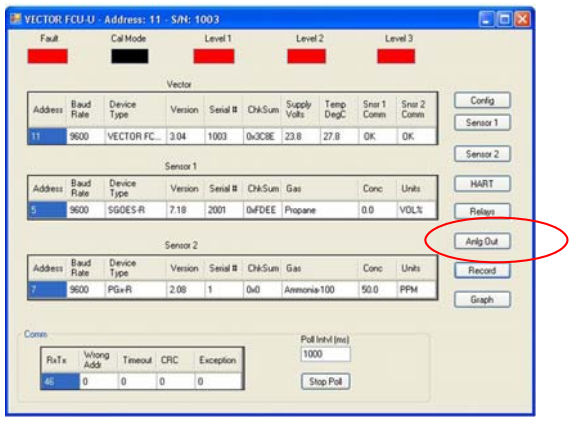


Figure 5–28: Vector Main Form

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

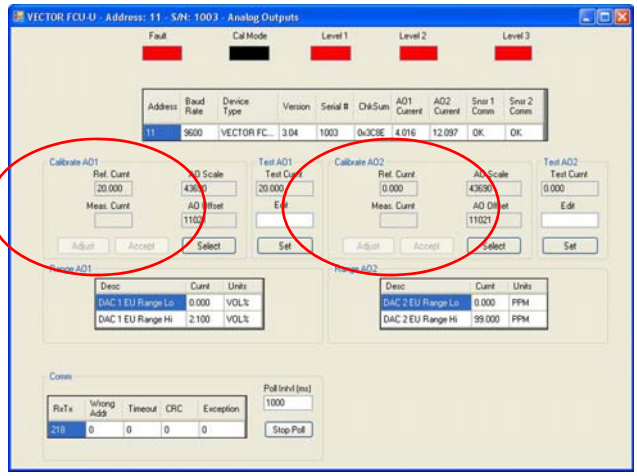


Figure 5–29: Vector Analog Output Form

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

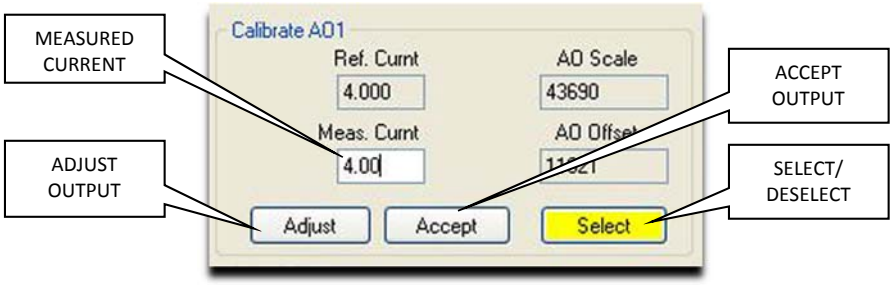


Figure 5–30: Analog loop calibrate panel

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 (4) *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 (1) 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 (3) *Accept* button.

Calibrate Output Loop (cont'd)

Step 7
Once the (3*) 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 (1) 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 2, HART Communicator Menu Tree, for an overview of the HART functions.

Navigate to the Analog Output display.

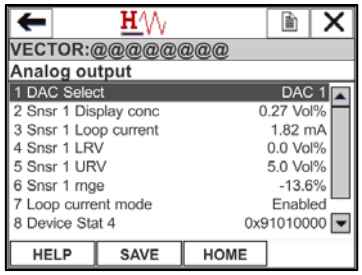


Figure 5-31: Analog Output Display

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

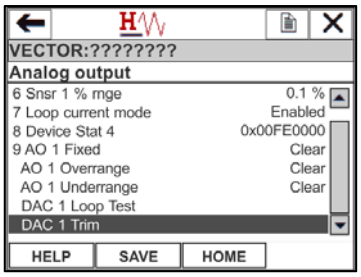


Figure 5-32: Analog Output Display

Step 2:
Highlight the DAC Trim item. Then select it to initiate the calibration sequence

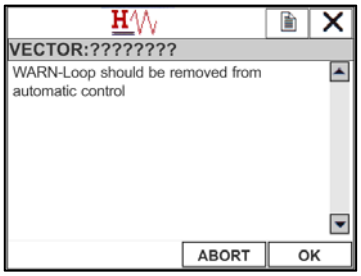


Figure 5-13: Warning Message

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.

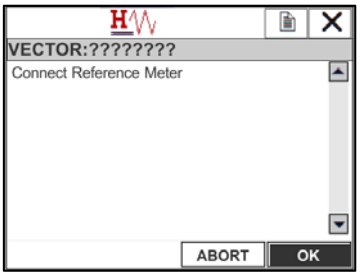


Figure 5-33: Connect Reference Meter

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.

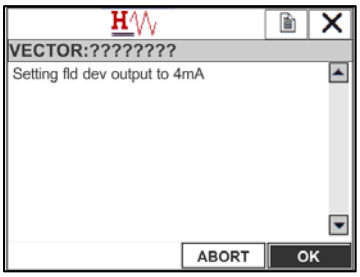


Figure 5-34: Setting Output to 4mA

Step 4:

Press "OK" to continue.

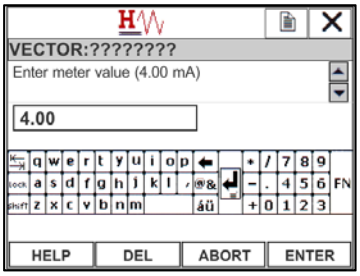


Figure 5-35: Enter Measured Current

Step 5:

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

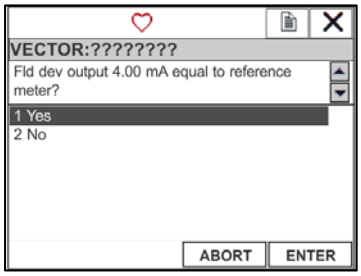


Figure 5-36: Current Calibration Confirm 4mA

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.

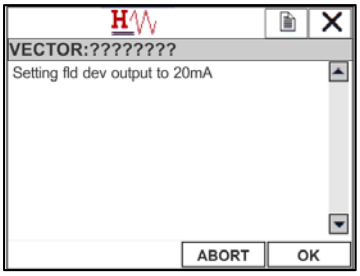


Figure 5-37: Setting Output to 4mA

Step 7:

Press "OK" to continue.

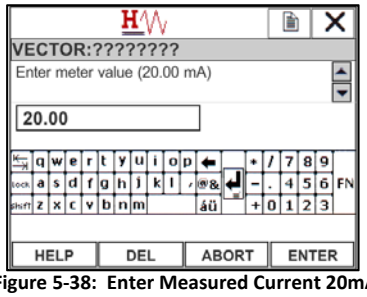


Figure 5-38: Enter Measured Current 20mA

Step 8:

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

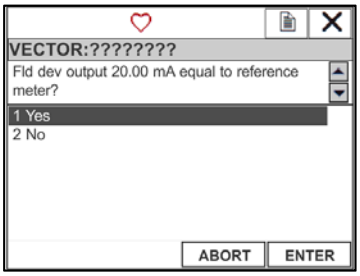
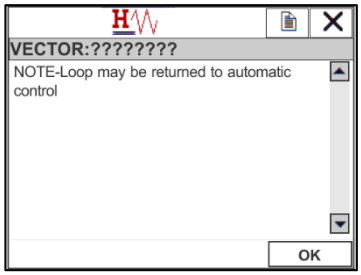


Figure 5-39: Current Calibration Confirm 20mA

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.

6.0 Troubleshooting

Table 6.1—Troubleshooting Guide - Display Faults

Fault Condition	Description	Solution
FAULT message on Display	Attached sensor/detector in fault	Inspect attached detector for damage. Consult the external detector operating manual for troubleshooting procedures
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 factory
LOVLT error on Display	Instrument supply voltage less than 18 volts	Check the supply voltage
NOCFG error on Display	Sensor configuration table not loaded	Contact the factory for further instructions
OVRNG error on Display	Sensor over ranged	Perform functional test and calibrate if neccesary.
UNDRG error on Display	Sensor under ranged	Perform functional test and calibrate if neccesary.
USBER error on Display	USB write error	Ensure USB socket is connected and green LED is illuminated. Ensure flash drive has adequate available memory. Attempt with a different drive.
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 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

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.

7.0 Maintenance

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

Periodic Maintenance

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

- Visual examination
- Cleaning
- Checking the grounding and explosion-protection systems
- Performance test.

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.

8.0 Warranties

ESP Safety, Inc. (“ESP”) warrants the Vector Field Control Unitto 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.

9.0 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 6.0). 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.

10.0 Parts Ordering Information

The following items for the Vector may be ordered:

Accessories:

Calibration Magnet (magnetic wand), P/N 611-0005

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

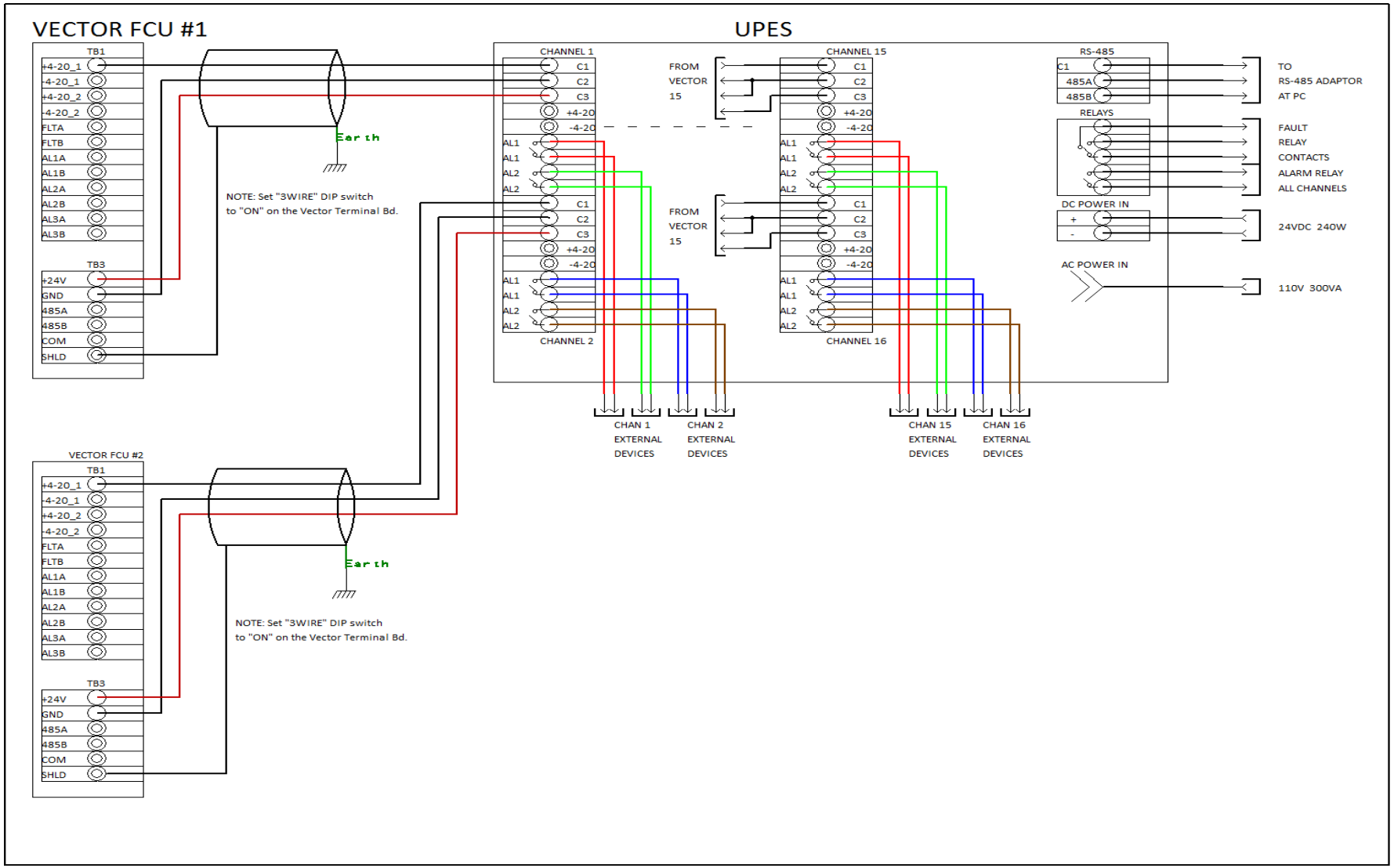
For applications not listed above, please contact ESP Safety.

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

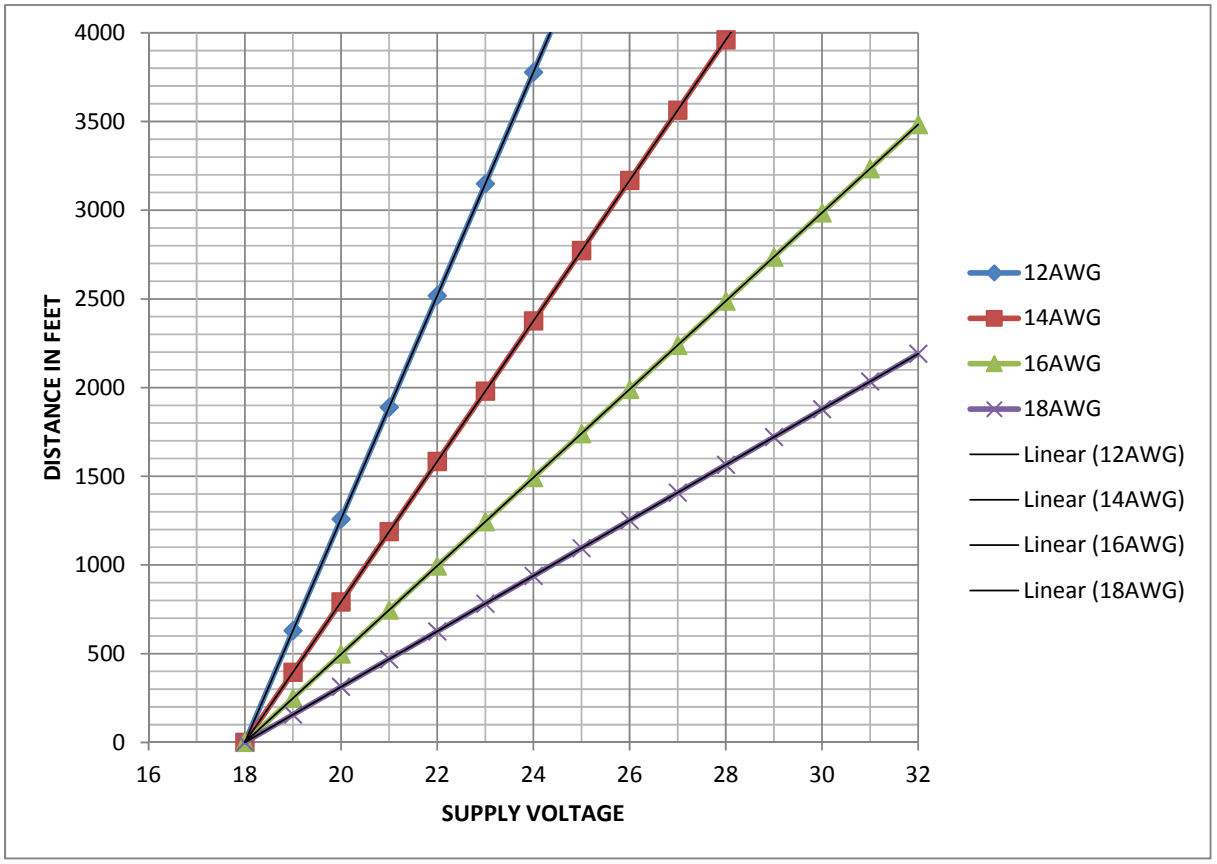
Please note that shipping charges will be added to your order.

Appendix 1A – UPES Connections



Appendix 1B – Vector with PGU Sensor

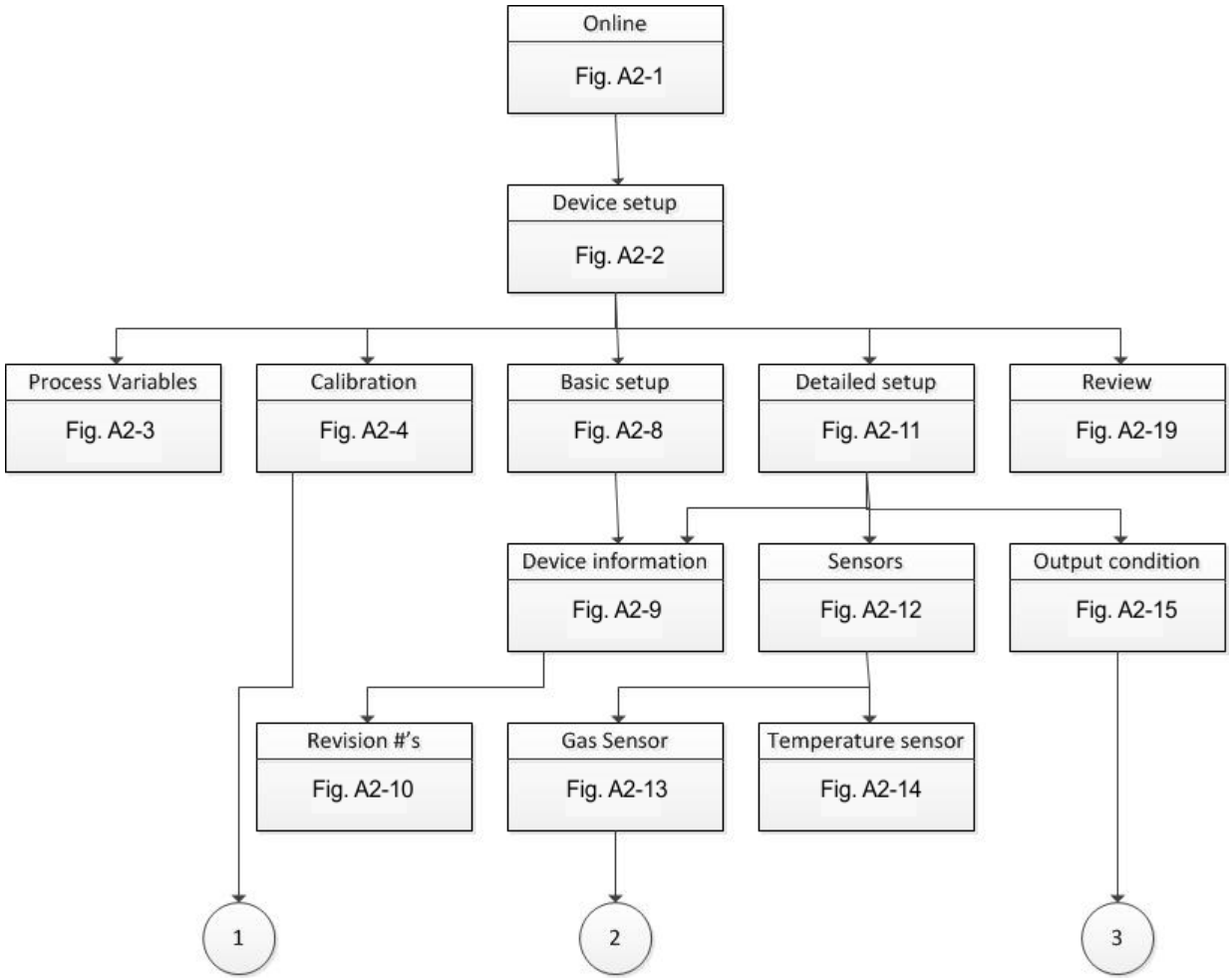
Wire Size Chart for Vector with REMOTE PGU Sensor

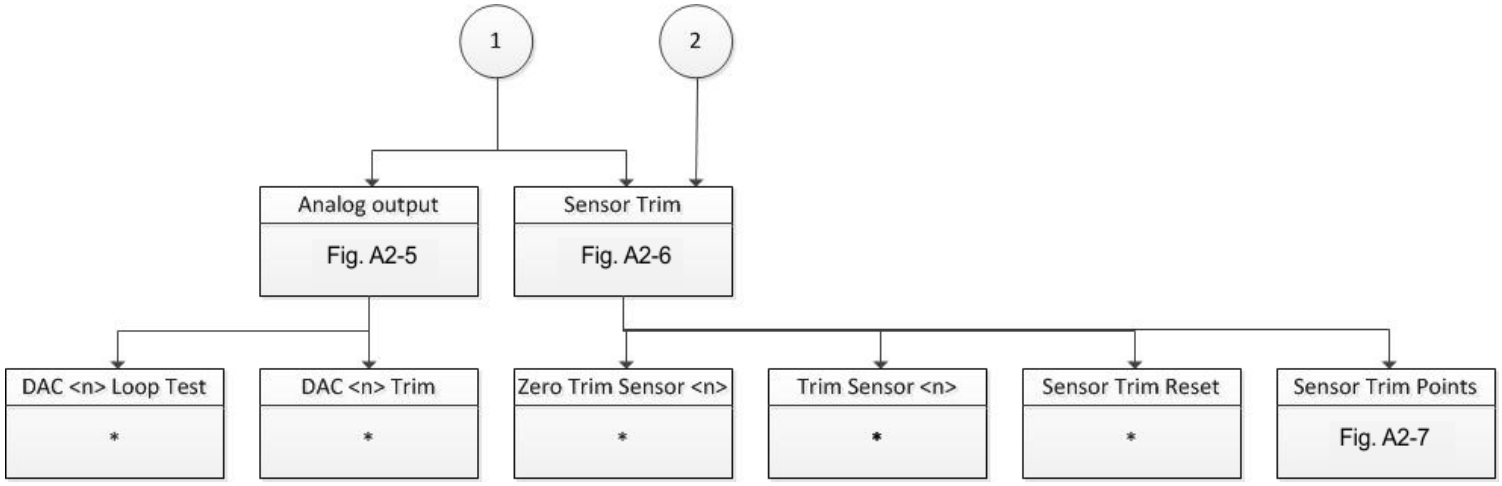


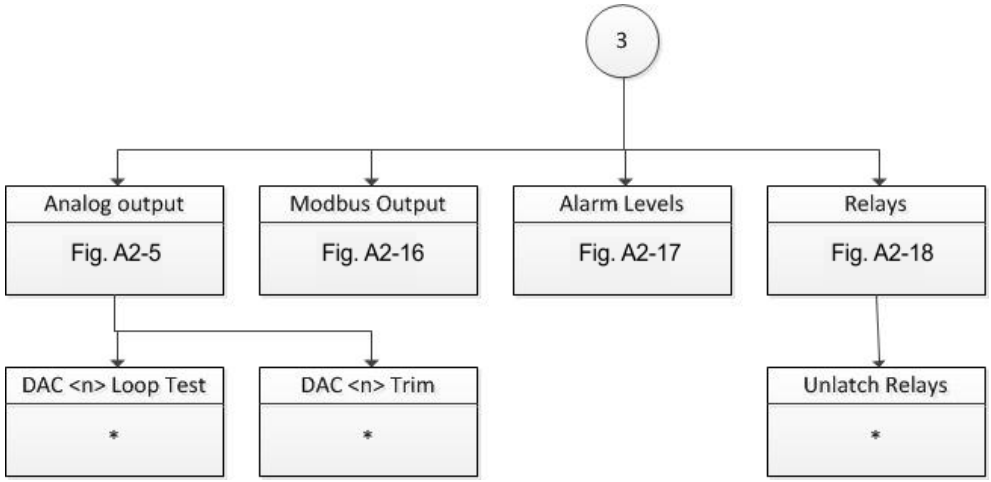
Appendix 2 – HART Communicator Operations

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.


Online
Fig. A2-1
Device setup
Fig. A2-2
Process Variables
Fig. A2-3
Calibration
Fig. A2-4
Basic setup
Fig. A2-8
Detailed setup
Fig. A2-11
Review
Fig. A2-19
Device information
Fig. A2-9
Sensors
Fig. A2-12
Output condition
Fig. A2-15
Revision #'s
Fig. A2-10
Gas Sensor
Fig. A2-13
Temperature sensor
Fig. A2-14
1
2
3


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

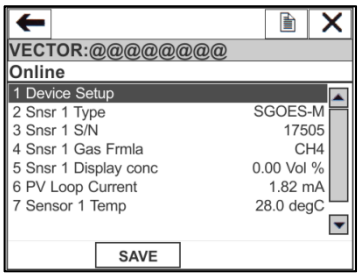


Figure A2-1: Online Menu

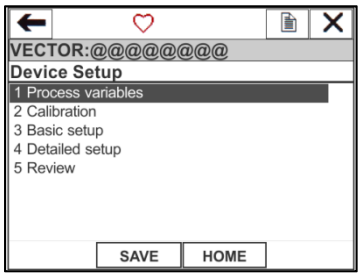


Figure A2-2: Device Setup Menu

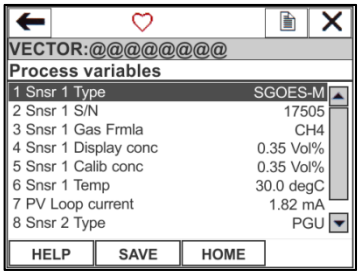


Figure A2-3: Process Variables Menu

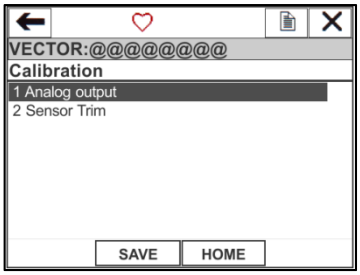


Figure A2-4: Calibration Menu

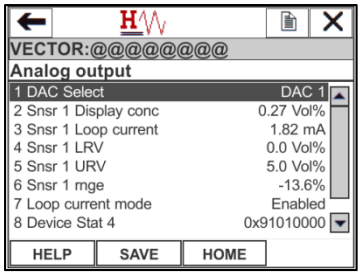


Figure A2-5: Analog Output Menu

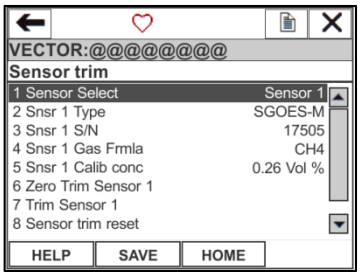


Figure A2-6: Sensor Trim Menu

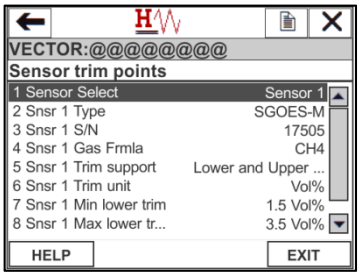


Figure A2-7: Sensor Trim Points Menu

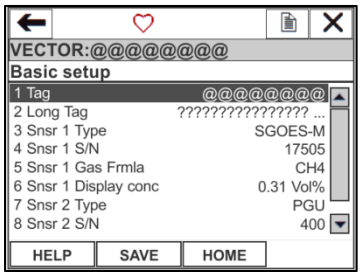


Figure A2-8: Basic Setup Menu

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.

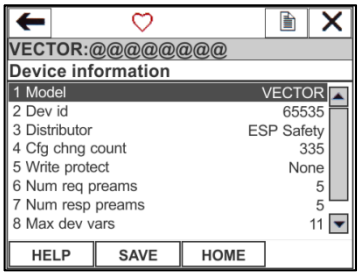


Figure A2-9: Device Information Menu

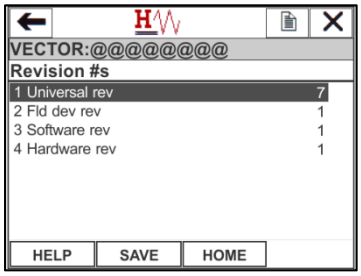


Figure A2-10: Revision Number Menu

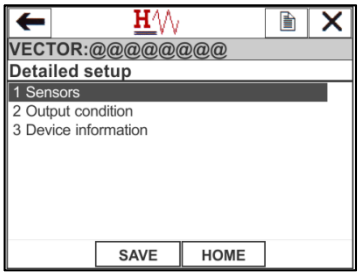


Figure A2-11: Detailed Setup Menu

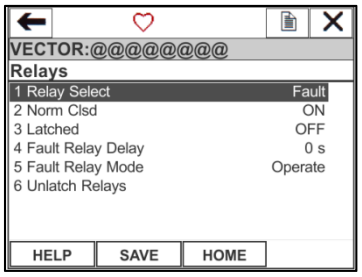


Figure A2-18: Relays Menu

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

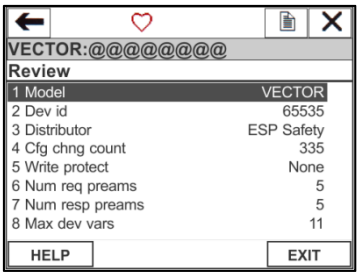


Figure A2-19: Review Menu

Review Menu:

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

Appendix 3 – Modbus Register Map

Vector Field Control Unit
Modbus Register Assignments
For firmware versions 3.0, 3.01, 3.02, 3.03, 3.04, 3.05

Name	Addr	R/W	Format	Description
Address	1	R/W	U16	Address
BaudRate	2	R/W	U16	Host Port Baud Rate/1200
	3-10			Reserved
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	0x0a01
	14-30			Reserved
NbrSensors	31	R/W	U16	Number of sensors configured
Reset Comm Stats	32	W	N/A	Reset sensor communications statistics
	33-118			Reserved
DeviceStatus2	119	R	U16	B4-15: Not used ********** 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 --- 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
	120-123			Reserved
Date	124	R/W	U16	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	U16	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)

Name	Addr	R/W	Format	Description
	129-140			Reserved
Snsr0DisplayConcH	141	R	F-MSW	Sensor 0 display concentration - MSW
Snsr0DisplayConcL	142	R	F-LSW	Sensor 0 display concentration - LSW
Snsr0DisplayUnits	143	R	U16	Sensor 0 display concentration engineering units (enum)
Snsr0Msg Cnt	144	R	U16	Sensor 0 Total message count
Snsr0CRC Errs	145	R	U16	Sensor 0 CRC error count
Snsr0Timeouts	146	R	U16	Sensor 0 Comm timeout count
Snsr0Wrong Addr	147	R	U16	Sensor 0 Wrong address count
Snsr0Exceptn	148	R	U16	Sensor 0 Exception message count
Snsr0Status	149	R	U16	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
	150			Reserved
Snsr1DisplayConcH	151	R	F-MSW	Sensor 1 display concentration - MSW
Snsr1DisplayConcL	152	R	F-LSW	Sensor 1 display concentration - LSW
Snsr1DisplayUnits	153	R	U16	Sensor 1 display concentration engineering units (enum)
Snsr1Msg Cnt	154	R	U16	Sensor 1 Total message count
Snsr1CRC Errs	155	R	U16	Sensor 1 CRC error count
Snsr1Timeouts	156	R	U16	Sensor 1 Comm timeout count
Snsr1Wrong Addr	157	R	U16	Sensor 1 Wrong address count
Snsr1Exceptn	158	R	U16	Sensor 1 Exception message count
Snsr1Status	159	R	U16	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
	160			Reserved
	161-228			Reserved
Snsr0Address	229	R/W	U8	Sensor 0 Modbus address (1-247)
Snsr0BaudRate	230	R	U8	Sensor 0 Baud Rate/1200
Snsr0DevType	231	R	U16	Sensor 0 Device Type: 0 = None 1 = Unknown 2 = PGU 3 = SGOES 4 = SGOES-M 5 = TGAES
Snsr0SerialNbr	232	R	U16	Sensor 0 Serial number
Snsr0Version	233	R	U16	Sensor 0 Firmware version: H- Major, L – Minor

Name	Addr	R/W	Format	Description
Snsr0Chksum	234	R	U16	Sensor 0 Firmware checksum
Snsr0Gas	235	R	U16	Sensor 0 Gas identifier
	236-244			Reserved
Snsr1Address	245	R/W	U8	Sensor 1 Modbus address (1-247)
Snsr1BaudRate	246	R	U8	Sensor 1 Baud Rate/1200
Snsr1DevType	247	R	U16	Sensor 1 Device Type: 0 = None 1 = Unknown 2 = PGU 3 = SGOES 4 = SGOES-M 5 = TGAES
Snsr1SerialNbr	248	R	U16	Sensor 1 Serial number
Snsr1Version	249	R	U16	Sensor 1 Firmware version: H- Major, L – Minor
Snsr1Chksum	250	R	U16	Sensor 1 Firmware checksum
Snsr1Gas	251	R	U16	Sensor 1 Gas identifier
	252			Reserved

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
524	Propane
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)

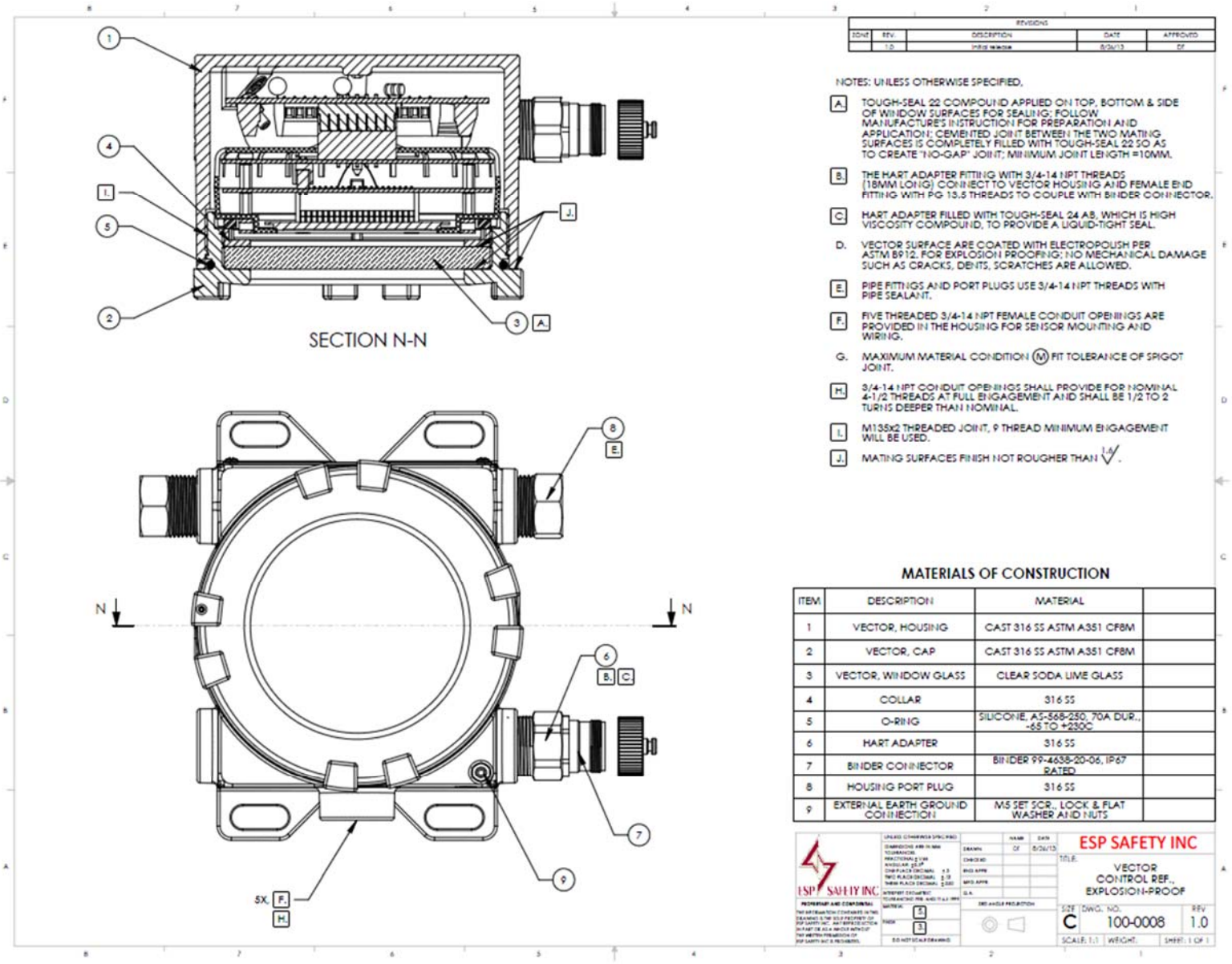
547	p-Xylene (NEW)
548	o-Xylene (NEW)
549	Heptane (NEW)
550	IsoPropanol (NEW)
551	Ethyl Benzene (NEW)
552	Cyclohexane

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 70
24	Ammonia 500
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
1001	Methane
1002	Propane
1003	Hexane
1004	Butane
1005	Isobutane
1006	Pentane
1007	Cyclopentane
1008	Ethanol
1009	CO2
1010	Methanol

Appendix 4 – Explosion Protection Drawing



REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
	1.0	INITIAL RELEASE	8/26/13	DT

NOTES: UNLESS OTHERWISE SPECIFIED.

A. TOUGH-SEAL 22 COMPOUND APPLIED ON TOP, BOTTOM & SIDE OF WINDOW SURFACES FOR SEALING; FOLLOW MANUFACTURE'S INSTRUCTION FOR PREPARATION AND APPLICATION; CEMENTED JOINT BETWEEN THE TWO MATING SURFACES IS COMPLETELY FILLED WITH TOUGH-SEAL 22 SO AS TO CREATE "NO-GAP" JOINT; 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 TOUGH-SEAL 24 AB, WHICH IS HIGH VISCOSITY COMPOUND, TO PROVIDE A LIQUID-TIGHT SEAL.

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

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. MAXIMUM MATERIAL CONDITION (M) FIT TOLERANCE OF SPIGOT JOINT.

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, 9 THREAD MINIMUM ENGAGEMENT WILL BE USED.

J. MATING SURFACES FINISH NOT ROUGHER THAN 1.6.

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	HOUSING PORT PLUG	316 SS	
9	EXTERNAL EARTH GROUND CONNECTION	M5 SET SCR., LOCK & FLAT WASHER AND NUTS	

ESP SAFETY INC

TITLE: VECTOR CONTROL REF., EXPLOSION-PROOF

SIZE C | DWG. NO. 100-0008 | REV 1.0

Appendix 5 – Vector FCU with External Bonding Jumper