RC SYSTEMS

Universal Gas Detector Series

Operations Manual

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UM-1067
Revision A

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Chapter 1 Safety Information

1.1 Safety Information – Read Before Installation and Applying Power

The following symbols are used in this manual to alert the user of important instrument operating issues:

This symbol is intended to alert the user to the presence of important operating and maintenance (servicing) instructions.

This symbol is intended to alert the user to the presence of dangerous voltage within the instrument enclosure that may be sufficient magnitude to constitute a risk of electric shock.

WARNINGS:

- **WARNING- EXPLOSION HAZARD** - DO NOT REPLACE FUSE UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- **WARNING- EXPLOSION HAZARD** - DO NOT DISCONNECT EQUIPMENT UNLESS POWER HAS BEEN SWITCHED OFF OR THE AREA IS KNOWN TO BE NON-HAZARDOUS.
- Use a properly rated CERTIFIED AC power (mains) cable installed as per local or national codes
- A certified AC power (mains) disconnect or circuit breaker should be mounted near the controller and installed following applicable local and national codes. If a switch is used instead of a circuit breaker, a properly rate CERTIFIED fuse or current limiter is required to be installed as per local or national codes. Markings for positions of the switch or breaker should state (I) for on and (O) for off.
- Clean only with a damp cloth without solvents.
- Equipment not used as prescribed within this manual may impair overall safety.

1.2 Contacting RC Systems Inc.

To contact RC Systems Inc., call, fax, email or write:
409–986-9800 FAX 409-986-9880 Email: info@rcsystemsco.com
8621 Hwy. 6 Hitchcock, TX 77563
Or visit us on the Web at www.rcsystemsco.com

Chapter 2 General Description

The Universal Transmitter Series consists of a common processor board connected to various combinations of input output options. The models are based on wireless vs wired communications; and powering as follows:

SenSmart 4000

SenSmart 4000 – Low-power, 4-20mA loop powered gas detector for toxic and oxygen detection. Includes a 4-20mA output.

SenSmart 5000

SenSmart 5000 – 10-30VDC powered gas detector for toxic, oxygen, combustible, VOC and CO2 detection. This model adds a color backlit LCD display and has Modbus and/or 4-20mA communications and relays available.

SenSmart 8000 – Battery powered wireless gas detector for toxic, oxygen, combustible and CO2 detection. Available in either 900MHz or 2.4GHz models.

SenSmart 8000X – 10-30VDC powered wireless gas detector for toxic, oxygen, combustible and CO2 detection. This model adds a color backlit LCD display.

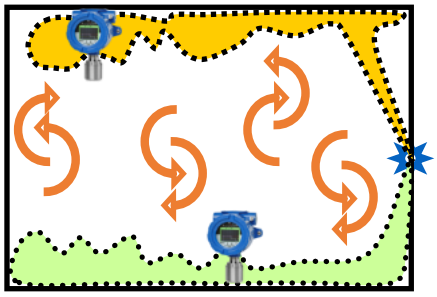
SenSmart 8000 and 8000X

All models use RC Systems latest Smart Sensor technology, providing smarter gas detection with simplified solutions.

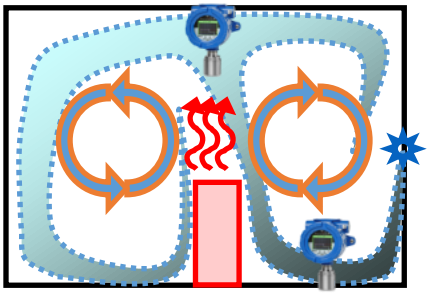
Chapter 3 Installation Instructions

3.1 Selecting a Location

Factors such as air movement, gas density in relation to air, emission sources and environmental variables affect correct sensor location.

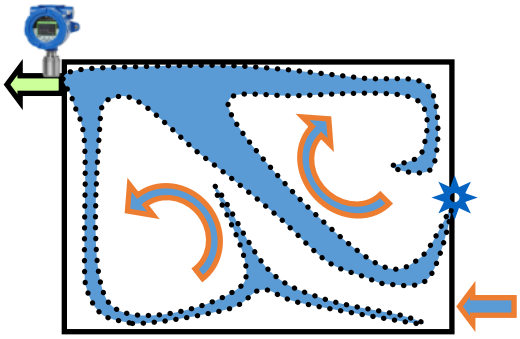


Air movement by fans, prevailing winds and convection should be carefully evaluated to determine if a leak is more likely to raise gas levels in certain areas within the facility.



Vapor density of a gas determines if it will rise or fall in air when there are no significant currents. Lighter than air gases should have the detector mounted 12 to 18 inches (30 to 45 cm) above the potential gas leak, and heavier than air gases should be this distance below the potential gas leak.

The Universal Series of gas detectors are designed for rugged service in the field. However, sensors should always be protected from environmental damage from water, snow, shock, vibration and dirt.



3.2 Mounting the Enclosure

Install the detector to a wall or bracket using the predrilled mounting flanges with I.D. 0.25 on 5-inch centers (*Figure 1*). If conduit is rigid and able to support the weight of the universal detector, the mounting bolts may be omitted.

After you have determined the appropriate location for your gas detector, it is important to securely mount the gas detector using the predrilled mounting flanges on the enclosure. Dimensions for the mounting holes can be found for both the aluminum and poly enclosures in Figure 3-1.

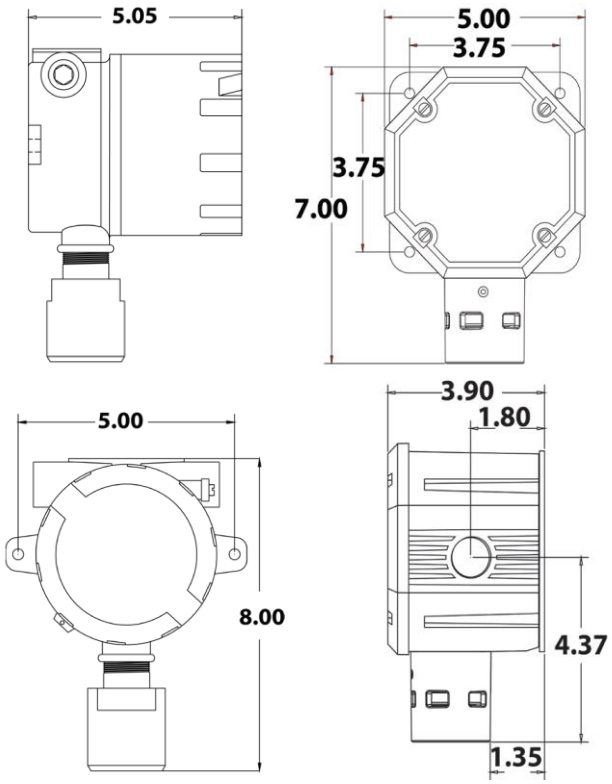


Figure 1 Mounting Dimensions

3.3 Power and Analog Outputs Wiring

WARNING: Qualified personnel should perform the installation according to applicable electrical codes, regulations and safety standards. Ensure correct cabling and sealing fitting practices are implemented. Do not aim the sensor pointing upward.

Modular design simplifies the installation of the universal gas detectors. A top display assembly is mounted with captive thumbscrews and is easily removed to access field-wiring terminals. Option

boards mount to the back of the display assembly, and power, input and output wires mount to the power supply board.

3.3.1 SenSmart 4000

The SenSmart 4000 is powered through a non-polar 4-20mA loop connected to TB2. Connect the +10-30VDC/4-20mA loop wires to TB2.1 and TB2.2 on the 2-wire 4-20mA Output Board (*Figure 2*).

TB2.1 - +10-30VDC/4-20mA (non-polar)

TB2.2 - +10-30VDC/4-20mA (non-polar)

Figure 2 SenSmart 4000

3.3.2 SenSmart 5000 and SenSmart 8000X

The SenSmart 5000 and SenSmart 8000X are 10-30VDC powered and have a dedicated 4-20mA output terminal. Connect the 10-30VDC Positive wire to terminal TB2.1. Connect the 10-30VDC Negative (Common) wire to terminal TB2.3. Connect the 4-20mA signal wire to terminal TB2.5 on the I/O Board (not necessary for SenSmart 8000X wireless communication) (*Figure 3*).

TB2.1 - 10 to 30VDC Positive (+)

TB2.3 - 10 to 30VDC Common (-)

TB2.5 - 4-20mA Output

Figure 3 SenSmart 5000 Wiring

3.4 Option Board Wiring

3.4.1 SenSmart 5000 RS 485 Option Board

The RS 485 Option (*Figure 4*) adds a single Modbus master port and a single Modbus slave port.

For the Modbus master port, connect your Modbus communication wires to terminals TB1.A and TB1.B, and connect your shield wire to TB1.SHLD.

For the Modbus slave port, connect your Modbus communication wires to terminals TB2.A and TB2.B, and connect your shield wire to TB2.SHLD. Note that there are two sets of terminals labeled TB2.A and TB2. B. This allows you to connect multiple SenSmart 5000 gas detectors in series. Each SenSmart 5000 represents an RS-485 slave and must have a unique Remote ID address (slave address). It is also important to note that wiring should be daisy chained as opposed to a star pattern for reliable operation. RC Systems recommends using shielded twisted pair cable such as Belden 3106A.

TB1 – RS485 Modbus Master Port

TB2 – RS485 Modbus Slave Port

Figure 4 SenSmart 5000 Modbus Option Wiring

3.4.2 SenSmart 5000 Relay Option

The SenSmart 5000 Relay option (*Figure 5*) includes three programmable relays and a single programmable RS 485 Modbus master or slave port. The relay labeled “FAILSAFE” is set up as a failsafe Fault relay by default but can be configured as a programmable relay in the **Relay Settings** menu. It is possible to use only the relays, only Modbus or both.

The relay terminals are labeled NO (Normally Open), NC (Normally Closed) or C (Common, or pole). These designators correspond to the shelf, or de-energized, state of the relays. When a relay is in Failsafe mode, it is energized when the alarm condition is not met, and therefore its action is reverse of the designators.

For the RS-485 Modbus master/slave port, connect your Modbus communication wires to terminals TB1.A and TB1.B, and connect your shield wire to TB1.SHLD.

TB1 – RS485 Modbus Master/ Slave Port

TB2 – Relay Terminals

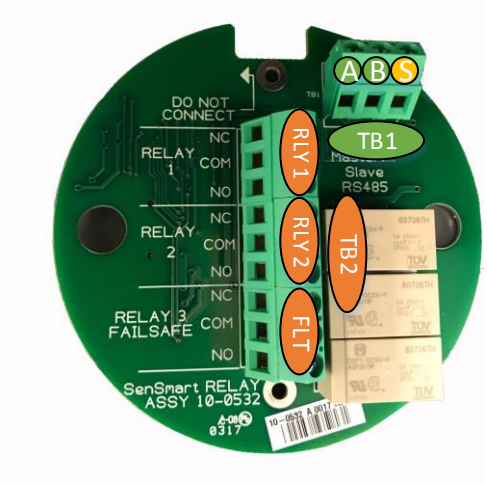


Figure 5 SenSmart 5000 Relay Option Wiring

3.5 Remote Sensor Installation

3.5.1 SenSmart 5000 Remote Sensor

Use of the Remote Sensor Option Board requires the SenSmart 5000 to be equipped with a RS 485 Option or Relay Option Board. The Remote Sensor Option Board communicates to the SenSmart 5000 by utilizing one of the RS-485 communication ports located on the option board.

Connect 24VDC and ground wires to the 24V and GND terminals on TB1 or TB2 of the Remote Sensor Option Board to supply the necessary 24V. Connect the A and B terminals of TB1 or TB2 of the Remote Sensor Option Board to the A and B Master Port terminals of the Relay/RS-485 Option Board.

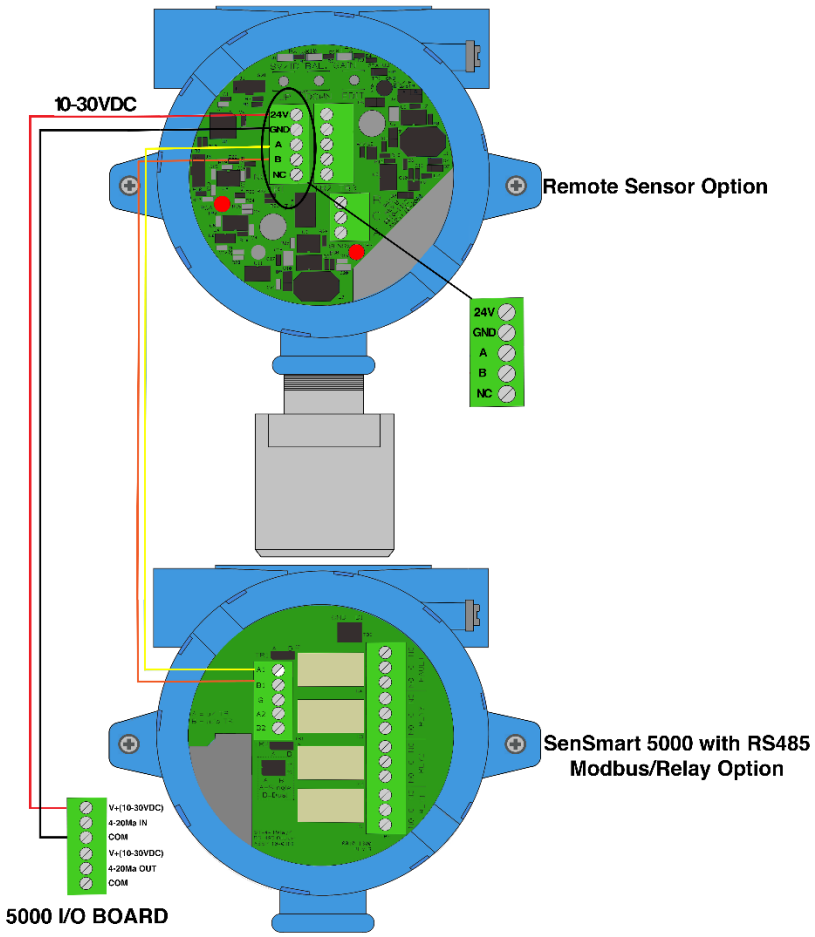


Figure 6 Remote Sensor Option

3.5.2 SenSmart 8000X Remote Sensor

The Remote Sensor Option Board communicates with the SenSmart 8000X via the Modbus master port located on the SenSmart 8000X's radio board.

Connect 24VDC and ground wires to the 24V and GND terminals on TB1 or TB2 of the Remote Sensor Option Board to supply the necessary 24V. Connect the A and B terminals of TB1 or TB2 of the Remote Sensor Option Board to the A and B Master Port terminals of the radio board of the SenSmart 8000X.

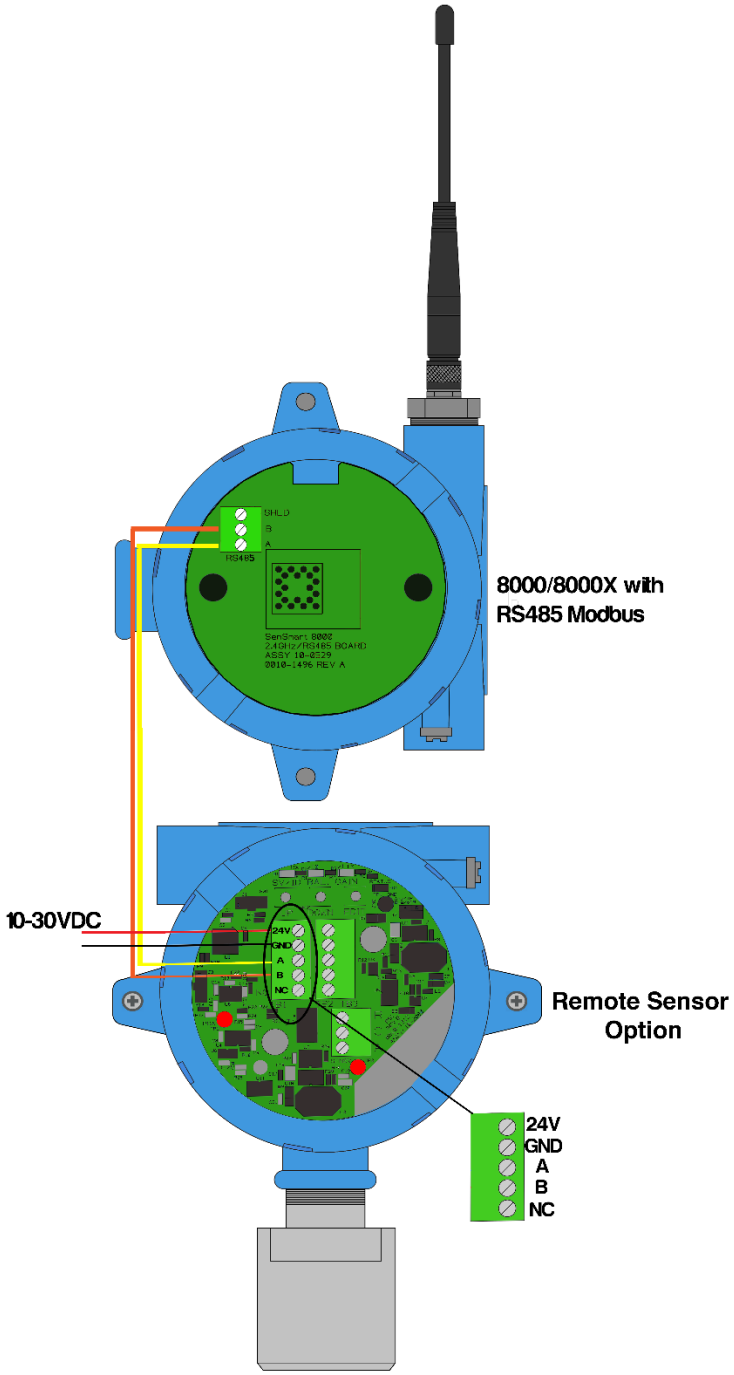


Figure 7 Wireless Remote Sensor Option

3.6 Sensor Installation and Replacement

The Universal Gas Detector series of monitors utilize RC Systems' Gen II Smart Sensors. These sensors come factory installed and provide our highest level of performance with increased accuracy and signal to noise ratio. The 8-conductor Smart Sensor interface connector attaches to the J1 connector on the base board, and the detector detects the type of sensor automatically. This makes it easier than ever to switch from any of our electrochemical Smart Sensors to any of our bridge (infrared, catalytic bead and PID) Smart Sensors without having to reconfigure wiring.

3.7 Smart Sensors

WARNING: Prior to performing sensor replacement ensure the area has been declassified.

To install a new sensor, simply remove the sensor head cap, remove the old sensor assembly and align the alignment arrows on the new sensor assembly with the sensor head body and press the sensor assembly toward the sensor head body until it has fully seated in the connector. The sensor board should be flush with the edge of the sensor head body when fully seated. Reinstall the sensor head cap and follow the on-screen prompts to upload the sensor settings into the gas detector.

Important: Sensor assembly must be **fully inserted** into the sensor head body when tightening the sensor head cap. Failure to do so could result in damage to the sensor and/or the sensor head body.

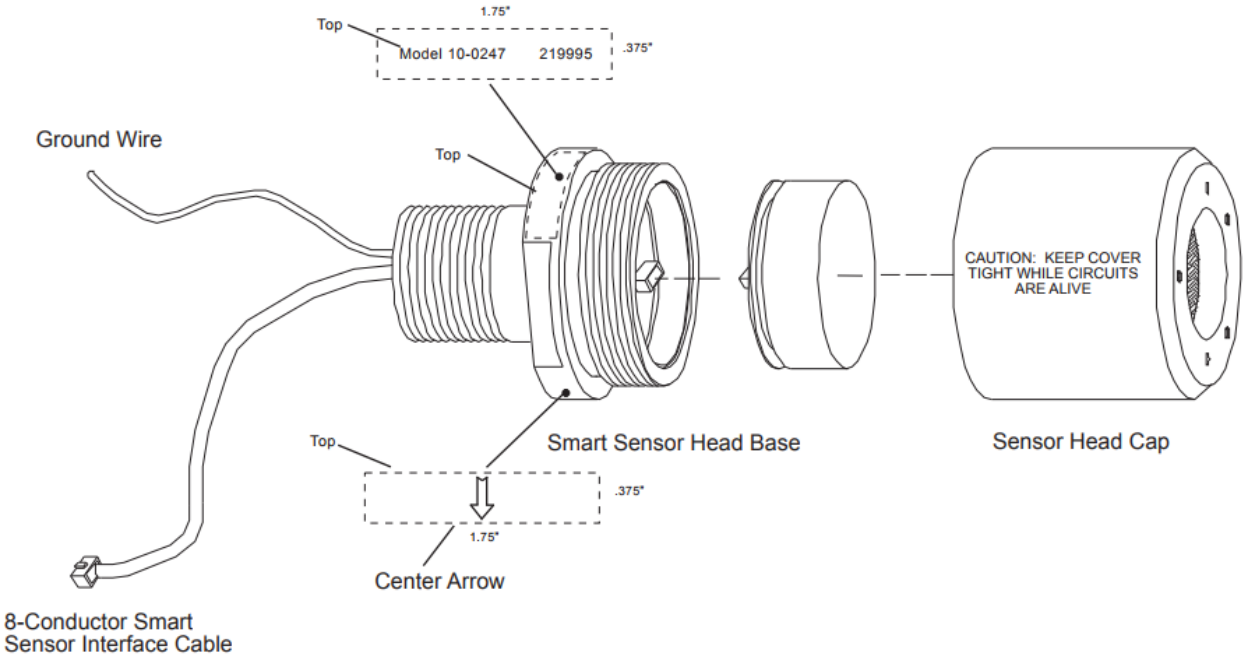


Figure 8 Stainless Steel Sensor Head

Chapter 4 General Operating Instructions

4.1 Introduction

Swiping a magnetic wand past the *Edit* key, from any of the **Data Display** screens, displays the **Main Menu**. The *Up* and *Down* keys maneuver the selection bar up and down and *Edit* selects the highlighted item to enter the sub-menus. All items with a sub-menu are indicated by a right facing arrow at the end of the line. To edit menu item values, swipe the *Edit* key, and use the *Up* and *Down* keys to edit the value. Once the desired value is entered, swipe the *Edit* key again to save the value. Swipe the *Next* key to reverse out of a sub-menu.

Important: Some values require a **Technician Sequence** to be entered to change their values. This is to prevent the operator from inadvertently changing the values. When prompted to "Enter technician sequence:" simply swipe the *Up* key four times to unlock the value for editing.

4.2 General Setup for SenSmart 4000 and SenSmart 5000

After ensuring proper installation perform the following steps:

1. Apply power to the gas detector
2. Verify the detector has begun startup.

Note: Once the detector is on the data screen, you may notice high or low values out of the full-scale range. These values should quickly return to the zero-gas value if no gas is present. No false alarms should be indicated at this time as the zero-gas value will be transmitted by the detector during the user-defined warmup delay period (up to 5 minutes).

3. Using the magnetic interface, navigate the menus to ensure:
   a) Alarm levels for Alarm 1, 2 and 3 are set to the desired value

Note: SenSmart 5000 series gas detectors have optional relays, which should also be set up at this time. When no relays are installed, alarms are indicated only by the display color and/or alarm LEDs.

   b) Time and date are set correctly
   c) Engineering units are set to the desired value
   d) Calibration span gas value is set to the value of the calibration gas that will be used to perform initial calibration
   e) Calibration marker is set to the desired value (this is the value the output will be held at during calibration and the calibration purge delay)
4. After sensor has stabilized, perform routine sensor calibration in accordance with Chapter 5.

4.3 Wireless Network Setup for SenSmart 8000 and SenSmart 8000X

The Universal Gas Detector series utilizes R.C. Systems' WaveNet wireless technology to make setup simplified with three easy steps.

1. Power on the SenSmart 8000/8000X (for the SenSmart 8000 hold a magnet over the *Up* key, for the SenSmart 8000X apply 10-30VDC to the power terminals).

Note: Once the detector is on the data screen, you may notice high or low values out of the full-scale range. These values should quickly return to the zero-gas value if no gas is present. No false alarms should be indicated at this time as the zero-gas value will be transmitted by the detector during the user-defined warmup delay period (up to 5 minutes).

2. Using the magnetic interface, navigate the menus to:
    a. Ensure the Network ID matches the Network ID of the controller.
    b. Set the RTU number to the desired number.
3. Verify proper operation by ensuring readings on gas detector and controller match.

4.4 Normal Operation

During normal operation the sensor data is displayed on one of three data display screens as shown below. To cycle through the data display screens, use a magnet and swipe the *Next* key until the desired screen is reached.

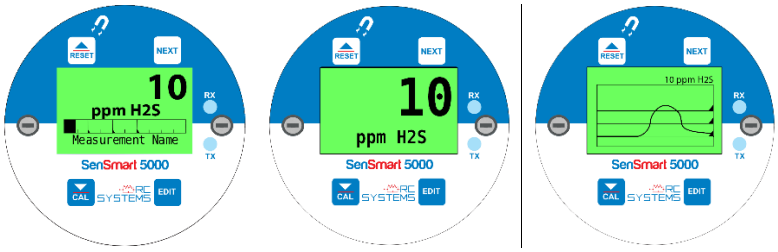


Figure 9 Universal Gas Detector Data Display Screens

4.5 Fault Condition

The Fault alarm is used to indicate a condition when there is a failure from the sensor or an out of range state has been reached. It is recommended to set the fault alarm level to -10% of the span value. For example, if an H2S sensor is installed with a span value of 100, the fault should be set at -10, or if an oxygen sensor is installed with a span value of 25, the fault setting should be -2.5.

If relays are installed, the Fault relay is always Failsafe. This is necessary for the relay to de-energize in the event there is a loss of power, so that a Fault will be indicated.

If relays are not installed, a Fault condition will only be indicated by the display color changing to red and/or the red Fault LED flashing.

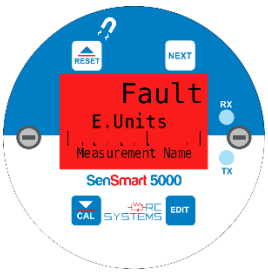


Figure 10 SenSmart 5000 Fault Screen

4.6 Alarm Conditions

4.6.1 SenSmart 4000

Alarm levels are user configured. When an alarm condition is met the alarm condition will be indicated by the alarm LED flashing.

4.6.2 SenSmart 5000 and SenSmart 8000X

The SenSmart 5000 and SenSmart 8000X allow the user to select the color associated with a certain alarm level. Options include yellow, orange, red, blue and purple. Alarm 1 is always set to yellow, and the Fault alarm is always set to Red.

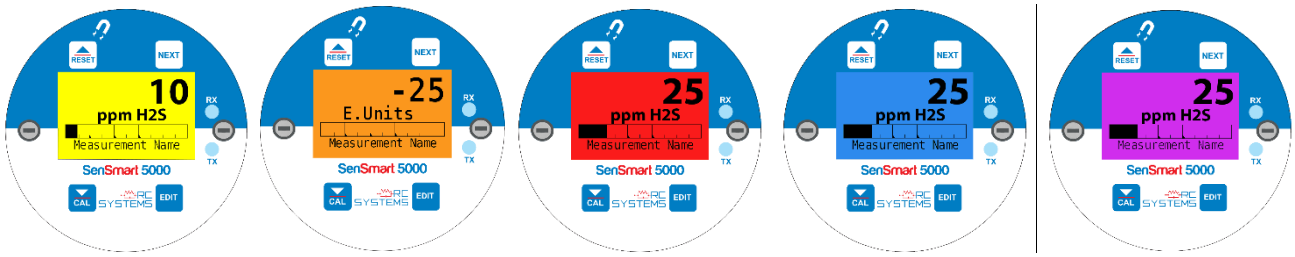


Figure 11 SenSmart 5000 and SenSmart 8000X Alarm Screens

When an alarm level is reached, the display will change to the user defined color and the alarm level will flash on the display. If Latching is turned on, the alarm will stay enabled until the user acknowledges the alarm, even if the alarm condition has cleared.

Chapter 5 Calibration Procedure

5.1 Preparation

Calibration is the most important function for ensuring correct operation of the Universal Series of gas detectors. The CAL MODE is designed to make calibration quick, easy and error free, and a successful Zero and Span calibration requires only four keystrokes. The 4-20mA output transmits 3mA during the calibration, and 4mA during calibration purge to prevent alarms. After 5 minutes of inactivity the gas detector will exit calibration mode automatically.

- RC Systems recommends performing calibrations
  - ✓ Immediately prior to placing a gas detector in service
  - ✓ Any time a new sensor is installed
  - ✓ Every six months for routine calibrations (more often if sensor is known to have been exposed to gas for extended periods of time)
  - ✓ Periodic bump tests are recommended if detector has potentially been exposed to incompatible gases to ensure correct operation

- Follow these calibration guidelines to ensure proper operation of your RC Systems, Inc. gas detector:
  - ✓ Calibration accuracy is only as good as the calibration gas accuracy. RC Systems recommends calibration gases with National Institute of Standards and Technology (NIST) traceable accuracy to increase the validity of the calibration.
  - ✓ Do not use gas cylinders beyond their expiration date.
  - ✓ Calibrate a new sensor before it is put in use.
  - ✓ Allow the sensor to stabilize before starting calibration.
  - ✓ Calibrate on a regular schedule. RC Systems recommends once every 6 months, depending on use and sensor exposure to poisons and contaminants.
  - ✓ Calibrate only in a clean atmosphere, free of background gas.

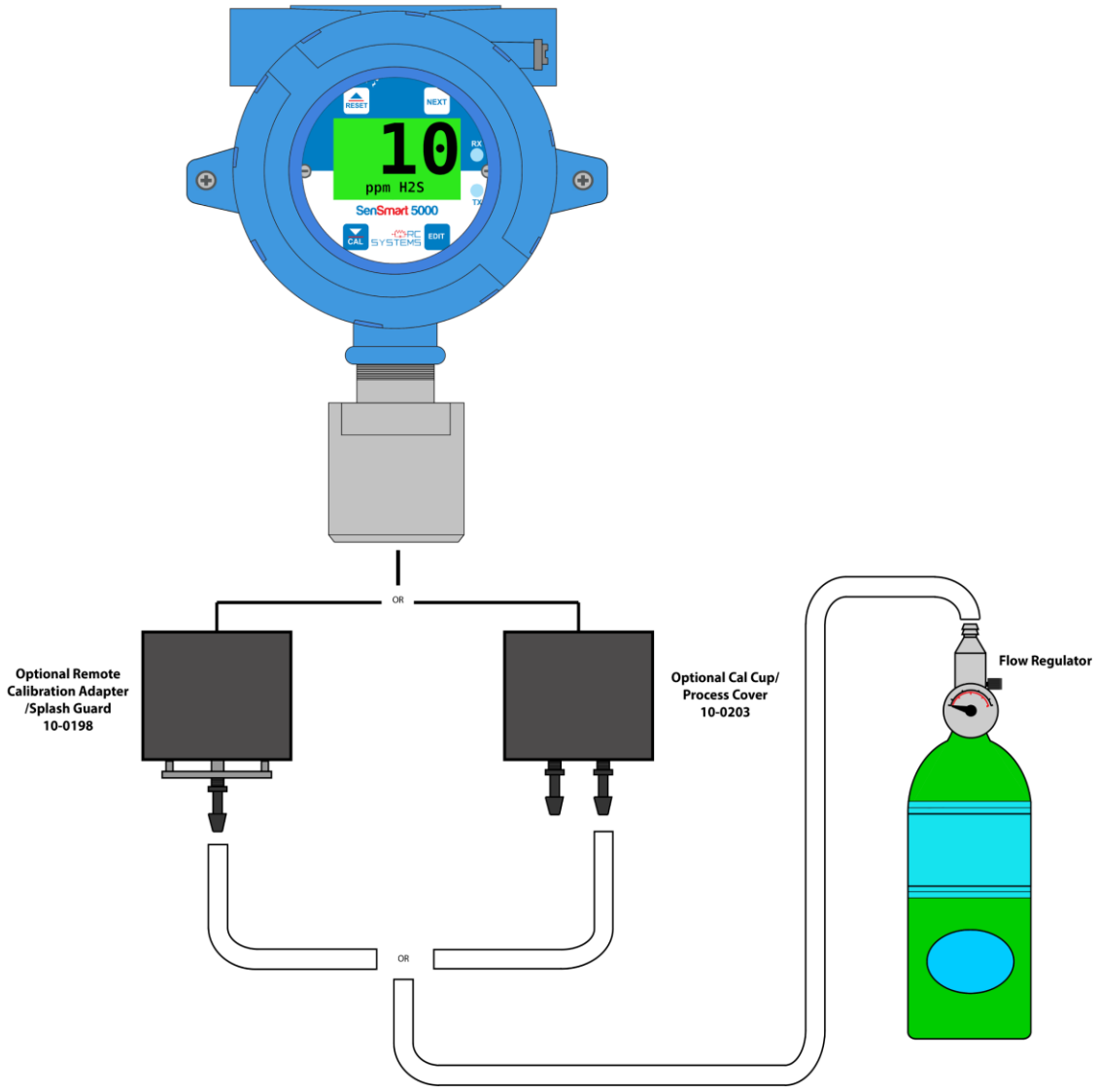


Figure 12 Calibration Diagram

Prior to beginning your calibration make sure you have the following items:

1. A cylinder of calibration gas with concentration equal to the SPAN GAS VALUE setting (RC Systems typically recommends choosing a value at 50% of full scale.)
2. A cylinder of Zero Air (unless you are confident there is no target gas potentially present in the area)
3. A flow regulator, a fixed flow of 0.5LPM is recommended for most applications, but some instances may require a 1.0LPM fixed flow regulator.
4. A Calibration Cup or Calibration Adaptor
5. Sufficient length of flexible tubing to connect the regulator to the calibration adaptor

5.2 Routine Calibration Procedure

Use the following step-by-step procedure to perform Zero and Span calibrations (Figure 1-2 may be used for reference to the Menus.):

Note: The first three steps must be performed before the timer in the bottom right corner expires, 15 seconds, otherwise the SenSmart 6000 will exit back to the Data Display Screen.

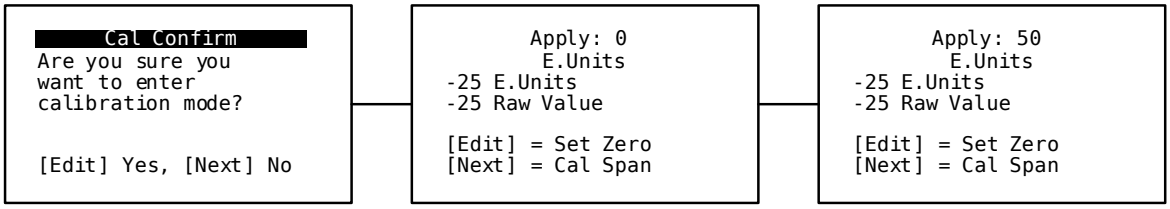


Figure 13 Calibration Menu Flowchart

1. Enter Calibration mode from any of the Data Display Screens by swiping the *Down/Cal* key.
2. Swipe the *Edit* key to enter Cal Mode.
3. Apply a clean Zero Gas (Figure 9), using the Calibration Cup or be sure there is no background target gas in the monitored area. After the reading is stable, swipe the *Edit* key to set the Zero Calibration. To skip the Zero calibration, and go to the Span calibration, swipe the *Next* key. Once a message that the Zero calibration was completed successfully has been displayed, proceed to the next step.
4. Apply the correct, as indicated, span gas (Figure 9). After the reading is stable, swipe the *Edit* key to set the Span Calibration. To skip the Span Calibration, swipe the *Next* key. When a message that the Span Calibration was completed successfully is displayed, the gas detector will exit back to the Data Display Screen.
5. Remove the calibration gas. Once the Cal Purge Delay has expired, normal alarm and relay functionality will be restored.

Calibration history records are logged and may be viewed in the Sensor Information.

5.3 Bump Test Procedure

Note: A bump test, when performed correctly, is meant to check both sensor and alarm functionality. This results in expected alarms, and proper precautions should be taken.

Also known as a functionality test, a bump test is not meant to test the accuracy of the detector, and no calibration settings are changed during the test.

To perform a bump test, briefly expose the sensor to a gas of known concentration (above the Low Alarm set point), and check to ensure the display reading increases to a value within tolerance of the concentration applied and check for alarm actuation. If the sensor does not perform as expected, RC Systems recommends performing a routine calibration and/or replacing the sensor. If the alarm does not perform as expected check the detector's alarm settings.

Chapter 6 Maintenance Procedure

6.1 Regular Maintenance

RC Systems recommends performing calibrations at regular intervals to ensure proper functionality of the Universal Gas Detector. During routine calibration, RC Systems recommends a visual inspection of sensor head, enclosure and conduit entries to check for cleanliness and physical integrity. Cleaning the detector is recommended when necessary but be aware that some cleaning compounds may be detected by an operational detector depending on the sensor type. So, proper precautions should be taken.

RC Systems recommends calibrations:

- ✓ Immediately prior to placing a gas detector in service
- ✓ Any time a new sensor is installed
- ✓ Every six months for routine calibrations (more often if sensor is known to have been exposed to gas for extended periods of time)
- ✓ Periodic bump tests are recommended if detector has potentially been exposed to incompatible gases to ensure correct operation

6.2 Sensor Replacement

When a sensor has reached its end of life, it is necessary to replace the sensor. For sensor replacement instructions, refer to Chapter 3.7.

Appendix 1 Gas Detector Specifications

	SenSmart 4000	SenSmart 5000
CERTIFICATIONS		
CSA Certification	Class I, Div 1, Groups A, B, C, D; Class I, Zone 1, Group IIC, T4 Class I, Div 2, Groups A, B, C, D; Class I, Zone 2, Group IIC, T4	
ENVIORNMENTAL		
Operating Temperature	-40°C to +60°C	
SPECIFICATIONS		
Power Supply	Loop Powered 10-30VDC at <.75 watt	10-30 VDC at <6.5 watts with relay board (all relay energized)
Display	2.1" x 1.2" (53.9 x 31mm) and 64 x 128 pixel LCD w/ 30-min trend, bar graph and engineering units	
Backlight	N/A	RGB Color Backlight for Alarm Indication
Standard Output	2-wire 4-20mA 600Ω Max with nominal 24VDC power supply	3-wire 4-20mA current source 750Ω Max with nominal 24VDC power supply
Optional Outputs	N/A	RS-485 MODBUS master/slave ports 3x programmable Form C (SPDT) 5A @30VDC(240~VAC) Resistive alarm relays
SENSOR SPECIFICATIONS		
Sensor Type	Electrochemical toxic and oxygen Low Power Combustible & CO2 IR	Electrochemical toxic and oxygen Catalytic Bead Infrared Photoionization Analog 4-20mA current input
INSTALLATION		
Housing	Aluminum with epoxy paint #316 stainless steel, Ul94 Poly Black Plastic Enclosure	
Wire Gauge	Screw type terminals (power and Modbus) 12AWG Spring type terminals 16AWG RS 485 cable recommendation = Belden 9841 (2-wire) Belden 9842 (4-wire) or equivalent	
Warranty	5 year limited warranty. For sensor warranty see sensor specifications sheet	
Dimensions	(Aluminum) W 5.4" (137 mm), H 8" (203 mm), D 5" (127 mm) Shipping weight 6.5 pounds (3 kg) (Stainless Steel) W 5.4" (137 mm), H 8" (203 mm), D 5" (127 mm) Shipping weight 9.5 pounds (4 kg) (Poly) W 5" (127 mm), H 7" (178 mm), D 4" (101 mm) Shipping weight 3 pounds (2 kg)	

Figure 14 SenSmart 4000 and SenSmart 5000 Specifications Table

	SenSmart 8000	SenSmart 8000X
CERTIFICATIONS		
CSA Certification	Class I, Div 2, Groups A, B, C, D; Class I, Zone 2, Group IIC, T4	
ENVIORNMENTAL		
Operating Temperature	-40°C to +60°C	
SPECIFICATIONS		
Power Supply	Replaceable internal D-cell lithium battery; 9 months Toxic/Oxygen and 6 months LEL operation	10-30 VDC at <0.6 watts
Display	2.1" x 1.2" (53.9 x 31mm) and 64 x 128 pixel LCD w/ 30-min trend, bar graph and engineering units	
Backlight	N/A	RGB Color Backlight for Alarm Indication
Standard Output	Frequency Hopping Spread Spectrum (FHSS) 900MHz and 2.4GHz Wireless	Frequency Hopping Spread Spectrum (FHSS) 900MHz and 2.4GHz Wireless and 3-wire 4-20mA current source 750Ω Max with nominal 24VDC power supply
SENSOR SPECIFICATIONS		
Sensor Type	Electrochemical toxic and oxygen Low Power Combustible & CO2 IR	Electrochemical toxic and oxygen Catalytic Bead Infrared Photoionization Analog 4-20mA current input
INSTALLATION		
Housing	Aluminum with epoxy paint #316 stainless steel, Ul94 Poly Black Plastic Enclosure	
Wire Gauge	Screw type terminals (power and Modbus) 12AWG Spring type terminals 16AWG RS 485 cable recommendation = Belden 9841 (2-wire) Belden 9842 (4-wire) or equivalent	
Warranty	5 year limited warranty. For sensor warranty see sensor specifications sheet	
Dimensions	(Aluminum) W 5.4" (137 mm), H 8" (203 mm), D 5" (127 mm) Shipping weight 6.5 pounds (3 kg) (Stainless Steel) W 5.4" (137 mm), H 8" (203 mm), D 5" (127 mm) Shipping weight 9.5 pounds (4 kg) (Poly) W 5" (127 mm), H 7" (178 mm), D 4" (101 mm) Shipping weight 3 pounds (2 kg)	

Figure 15 SenSmart 8000 and SenSmart 8000X Specifications Table

Appendix 2 Sensor Specifications

Target gas	Formula	Relateive Gas Density	TWA	IDLH	Min Span	Max Span
Acetaldehyde	C2H4O	1.5	200ppm	2000ppm (Ca)	30ppm	1500ppm
Acetylene	C2H2	0.91	--	asphyxiant	--	0-100% LEL
Ammonia	NH3	0.6	50ppm	300ppm	25ppm	1000ppm
Ammonia	NH3	0.6	50ppm	300ppm	1250ppm	5000ppm
Arsine	AsH3	2.69	0.5ppm	3ppm	--	0.5ppm
Arsine	AsH3	2.69	0.5ppm	3ppm	--	1ppm
Benzene	C6H6	2.6961	1ppm	500ppm	3ppm	25ppm
Butane	C3H8	1.55	1000ppm (pel)	2100ppm	--	0-100% LEL
Carbon Dioxide	CO2	1.53	5000ppm	40000ppm	--	0-100%vol
Carbon Dioxide	CO2	2.33	0.1ppm C	5ppm	--	5%/vol
Carbon Dioxide	CO2	1.53	5000ppm	40000ppm	--	5%/vol
Carbon Dioxide	CO2	1.53	5000ppm	40000ppm	--	1.5%/vol
Carbon Monoxide	CO	0.97	50ppm	1200ppm	40ppm	5000ppm
Chlorine	Cl2	2.47	1ppm C	10ppm	5ppm	20ppm
Chlorine Dioxide	ClO2	2.33	0.1ppm C	5ppm	2ppm	6ppm
Combustible	Hydrocarbons	varies	--	asphyxiant	--	100%LEL
Ethane	C2H6	1.07	--	asphyxiant	--	0-100% LEL
Ethanol	C2H6O	1.6	1000ppm	3300ppm	--	0-100% LEL
Ethylene	C2H4	0.98	200ppm	asphyxiant	--	0-100% LEL
Ethyl Alcohol	C2H6O	1.59	1000ppm	3300ppm	40ppm	3300ppm
Ethylene Oxide	C2H4O	1.49	<0.1ppm (Ca)	800ppm (Ca)	2ppm	100ppm
Flourine	F2	1.31	0.1ppm	25ppm	--	1ppm
Hexane	C6H14	2.97	500ppm	1100ppm	--	0-100% LEL
Hydrazine	N2H4	1.1	C 0.03ppm (Ca)	50ppm (Ca)	--	1ppm
Hydrogen	H2	0.07	--	asphyxiant	250ppm	5000ppm
Hydrogen	H2	0.07	--	asphyxiant	500ppm	10000ppm
Hydrogen	H2	0.07	--	asphyxiant	5000ppm	40000ppm or 100%LEL
Hydrogen Chloride	HCl	1.27	5ppm C	50ppm	20ppm	100ppm
Hydrogen Cyanide	HCN	0.94	ST 4.7ppm	50ppm	35ppm	100pm
Hydrogen Flouride	HF	0.69	3ppm	30ppm	10ppm	10ppm
Hydrogen Sulfide	H2S	1.19	20ppm	100ppm	5ppm	2000ppm
Methane	CH4	0.6	--	asphyxiant	5%/vol (100%LEL)	100%/vol
Methane	CH4	0.6	--	asphyxiant	--	0-100% LEL
Methane	CH4	0.6	--	asphyxiant	--	0-100% LEL
Nitric Oxide	NO	1.04	25ppm (pel)	100ppm	10ppm	250ppm
Nitric Oxide	NO	1.04	25ppm (pel)	100ppm	70ppm	500ppm
Nitrogen Dioxide	NO2	2.62	5ppm C	20ppm	15ppm	20ppm
Nitrogen Dioxide	NO2	2.62	5ppm C	20ppm	25ppm	200ppm
Oxygen	O2	1.1	--	19.50%	--	25%/vol
Ozone	O3	1.66	0.1ppm	10ppm	510ppb	2ppm
Pentane	C5H12	2.487	1000ppm	1500ppm	--	0-100% LEL
Phosphine	PH3	1.18	0.3ppm	50ppm	5ppm	10ppm
Propane	C3H8	1.55	1000ppm (pel)	2100ppm	--	
Propane	C3H8	1.55	1000ppm (pel)	2100ppm	--	0-100% LEL
Propane	C3H8	1.55	1000ppm (pel)	2100ppm	--	0-100% LEL
Propylene	C3H6	1.45	--	asphyxiant	--	0-100% LEL
Silane	SiH4	1.11	5ppm	asphyxiant	45ppm	50ppm
Sulfur Dioxide	SO2	2.26	5ppm	100ppm	10ppm	100ppm
Sulfur Dioxide	SO2	2.26	5ppm	100ppm	100ppm	2000ppm

TYPE	T50	T90	TEMP °F	Relative Humidity (non-condensing)	Application Notes	A1	A2	A3
PID	--	<3	-40° to 131°	0 to 99%		20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
EC	<20	<60	-4° to 104°	15 to 90%		20%	40%	60%
EC	<30	<90	-4° to 104°	15 to 90%		20%	40%	60%
EC	<20	<60	-4° to 104°	20 to 95%		20%	40%	60%
EC	--	<30	-4° to 104°	10 to 95%	Available with or without H2S filter	20%	40%	60%
PID	--	<3	-40° to 131°	0 to 99%		20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%		20%	40%	60%
IR	<15	<30	-4° to 122°	0 to 95%	Specify span when ordering	20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%	Low power IR in development	20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%	Low power IR	20%	40%	60%
EC	--	<30	-4° to 122°	15 to 90%		20%	40%	60%
EC	--	<60	-4° to 122°	15 to 90%		20%	40%	60%
EC	--	<60	-4° to 122°	15 to 90%		20%	40%	60%
CB	3	8	-4° to 158°	0 to 100%		20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
PID	--	<3	-40° to 131°	0 to 99%		20%	40%	60%
EC	--	<200	-22° to 122°	15 to 90%		20%	40%	60%
EC	<30	<80	14° to 104°	15 to 90%		20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
EC	<30	<120	14° to 104°	20 to 95%		20%	40%	60%
EC	--	<80	-22° to 122°	15 to 90%		20%	40%	60%
EC	<40	<70	-4° to 104°	16 to 90%		20%	40%	60%
EC	<40	<60	-4° to 104°	15 to 95%		20%	40%	60%
EC	--	<200	-22° to 122°	15 to 90%		20%	40%	60%
EC	--	<120	-22° to 122°	15 to 90%		20%	40%	60%
EC	--	<90	-4° to 104°	15 to 90%		20%	40%	60%
EC	--	<55	-22° to 122°	15 to 90%		20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%	Specify span when ordering	20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%	Low power IR	20%	40%	--
IR	<5	<10	-40° to 158°	0 to 99%	Millenium sensor	20%	40%	60%
EC	--	<30	-22° to 122°	15 to 90%		20%	40%	60%
EC	--	<75	-22° to 122°	15 to 90%		20%	40%	60%
EC	--	<60	-22° to 104°	15 to 85%		20%	40%	60%
EC	--	<40	-4° to 122°	15 to 90%		20%	40%	60%
EC	--	<15	-22° to 131°	5 to 95%		19	18	17
EC	--	<150	-4° to 122°	15 to 90%		20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
EC	--	<20	-22° to 122°	15 to 90%		20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%		20%	40%	--
IR	<5	<10	-40° to 158°	0 to 99%	Millenium sensor	20%	40%	60%
IR	--	<30	-4° to 122°	0 to 95%	Low power IR	20%	40%	60%
IR	<5	<10	-40° to 158°	up to 99%	Millenium sensor	20%	40%	60%
EC	--	<60	-4° to 104°	10 to 95%		20%	40%	60%
EC	--	<40	-22° to 122°	15 to 90%		20%	40%	60%
EC	--	<30	-22° to 122°	16 to 90%		20%	40%	60%

Appendix 3 Modbus Table and Operations

The Universal Gas Detector series may be equipped with two optional (10-0388 Relay/RS-485 Modbus Option Board) RS-485 boards where the 10-0388 Relay board can be set up as master or slave, and the RS-485 Modbus Option board can be set up as master and slave (base 1).

The Modbus slave ports allow function code 3 (write coil), as well as function code 6, and 16 (write holding registers). These function codes can be used to write configuration parameters to the Universal Gas Detectors. Writing parameters that span multiple register (such as 32bit floating points) requires function code 16. All registers must be written at once.

The following table describes the Universal Gas Detector series Modbus slave database. Any portion of this data may be read by a Modbus master device such as a PC, PLC or DCS. Since the Modbus port is RS-485, multiple Universal Gas Detectors may be multi-dropped onto the same cable.

System Registers

Input Registers						
Tag	**Address**	**Type**	**Function Code to Read**	**Function Code to Write**	**Size**	**Notes**
Packed Status	31000	Unsigned Integer	4	N/A	1	0- OK 1- Alarm 1 2- Alarm2 3- Alarm3 4- Fault 5- Warmup 6- Inhibited 7- Zero Calibration 8- Calibration Span 9- Calibration Purge 10- Calibration Mode 11- Diagnostics Mode 12- Value Error (Calibration needed or Channel State Over range) 13- Sensor Error (Channel State Corrupted, Channel State Over range, Channel State Mismatch, Channel State No Sensor, Channel State Sensor Error, Channel State Comm Error, Channel state Scaling Error)
Analog Output	31001	Unsigned Integer	4	N/A	1	12-bit value; 800 = 4mA; 4000 = 20mA
Sensor Life	31009	Integer	4	N/A	1	16-bit signed integer 1 to 100 1 indicates Calibration Required
Temperature	31011	32-Bit Floating Point	4	N/A	2	16-bit integer 1 to 4095 scaled for - 55°C to +125°C
4-20mA(mA)	31210	32-Bit Floating Point	4	N/A	2	32-bit floating point
Bridge Supply(V)	31220	32-Bit Floating Point	4	N/A	2	32-bit floating point
Bridge Out(V)	31224	32-Bit Floating Point	4	N/A	2	32-bit floating point
Version	32002	Unsigned Integer	4	N/A	1	Factory use only

Boot Date	32006	Date	4	N/A	2	Last Power up date
Boot Time	32009	Time	4	N/A	2	Last Power up Time
Holding Registers						
Alarm Reset	40001	Command write 1 to activate	3	6	1	Write to acknowledge alarm
Set Unity	40002	Command write 1 to activate	3	6/16	1	
Start Inhibit	40003	Command write 1 to activate	3	6/16	1	
Stop Inhibit	40004	Command write 1 to activate	3	6/16	1	
Name	40010	Packed Character String	3	6/16	1	16-character ASCII text
Date	40020	Date	3	6/16	2	Current Data
Time	40023	Time	3	6/16	2	Current Time
Warmup Time	40027	Integer	3	6/16	1	Warm up delay (minutes)
Cal Purge Time	40028	Integer	3	6/16	1	Cal purge delay (minutes)
Block Negative	40029	Selection	3	6/16	1	0-Clear 1-Triggered 1 prohibits display of values < 0
Comm Mode	40030	Selection	3	6/16	1	0-Modbus slave 1-Remote sensor MODBUS serial port #1
Baud Rate	40031	Selection	3	6/16	1	0 -9600 1 - 19200 2 - 38400 3 - 57600 4 - 115200
Parity	40032	Selection	3	6/16	1	0- None 1- Even 2-Odd
Remote ID	40033	Integer	3	6/16	1	
Byte Order	40036	Selection	3	6/16	1	0-ABCD 1-CDAB 2-BADC 3-DCBA
Comm 1 LED Enable	40038	Selection	3	6/16	1	0-No 1-Yes
Comm 1 Term Resistor	40039	Selection	3	6/16	1	0-No 1-Yes

Comm 2 LED Enable	40048	Selection	3	6/16	1	0-No 1-Yes
Comm 2 Term Resistor	40049	Selection	3	6/16	1	0-No 1-Yes

Table 1 System Registers

Relay Registers

Input Registers						
Tag	**Address**	**Type**	**Function Code to Read**	**Function Code to Write**	**Size**	**Notes**
Standard Relay 1 State	32020	Selection	4	N/A	1	0-Clear 1-Triggered
Standard Relay 2 State	32021	Selection	4	N/A	1	0-Clear 1-Triggered
Standard Relay 3 State	32022	Selection	4	N/A	1	0-Clear 1-Triggered
Warmup	32025	Selection	4	N/A	1	0-No 1-Yes
Standard Relay 1 Flashing	32026	Selection	4	N/A	1	0-No 1-Yes
Standard Relay 2 Flashing	32027	Selection	4	N/A	1	0-No 1-Yes
Standard Relay 3 Flashing	32028	Selection	4	N/A	1	0-No 1-Yes
Holding Registers						
Relay 1 Source	40106	Selection	3	6/16	1	0-Alarm 1 1-Alarm 2 3-Alarm 3 3-Fault 4-Cal Mode 5-Cal Zero 6-Cal Span 7-Disabled
Relay 1 Acknowledge	40107	Selection	3	6/16	1	0-No 1-Yes
Relay 1 Failsafe	40108	Selection	3	6/16	1	0-No 1-Yes
Relay 1 Refresh Time	40109	Integer	3	6/16	1	

Relay 2 Source	40116	Selection	3	6/16	1	0-Alarm 1 1-Alarm 2 3-Alarm 3 3-Fault 4-Cal Mode 5-Cal Zero 6-Cal Span 7-Disabled
Relay 2 Acknowledge	40117	Selection	3	6/16	1	0-No 1-Yes
Relay 2 Failsafe	40118	Selection	3	6/16	1	0-No 1-Yes
Relay 2 Refresh Time	40119	Integer	3	6/16	1	
Relay 3 Source	40126	Selection	3	6/16	1	0-Alarm 1 1-Alarm 2 3-Alarm 3 3-Fault 4-Cal Mode 5-Cal Zero 6-Cal Span 7-Disabled
Relay 3 Acknowledge	40127	Selection	3	6/16	1	0-No 1-Yes
Relay 3 Failsafe	40128	Selection	3	6/16	1	0-No 1-Yes
Relay 3 Refresh Time	40129	Integer	3	6/16	1	

Table 2 Relay Registers

Sensor Registers

Input Registers						
Tag	**Address**	**Type**	**Function Code to Read**	**Function Code to Write**	**Size**	**Notes**
Send Sensor Life	40153	Selection	3	6/16	1	0-No 1-Yes
Contact Info String	40160	Packed Character String	3	6/16	1	16 ASCII characters (2 per register)
Security	40182	Selection	3	6/16	1	0-Unlocked 1-Locked
Measurement Name	40401	Packed Character String	3	6/16	1	16 ASCII characters (2 per register)
E. Units	40423	Packed Character String	3	6/16	1	10 ASCII characters (2 per register)
PGA Gain	40433	Integer	3	6/16	1	Contact Factory
Zero Setpoint	42001	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Span Setpoint	42003	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Zero Value	42005	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Span Value	42007	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Fault Value	42009	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Alarm 1 Setpoint	42011	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Alarm 2 Setpoint	42013	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Alarm 3 Setpoint	42015	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Calibration Gain	42017	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt
Calibration Offset	42019	32-Bit Floating Point	3	6/16	2	Modbus 32-bit IEEE 754 Floating Pt

Table 3 Sensor Registers

Channel Registers

Input Registers						
Tag	**Address**	**Type**	**Function Code to Read**	**Function Code to Write**	**Size**	**Notes**
Alarm 1 Status	33017	Selection	4	N/A	1	0-No 1-Yes
Alarm 1 Flashing	33018	Selection	4	N/A	1	0-No 1-Yes
Alarm Status	33019	Selection	4	N/A	1	0-No 1-Yes
Alarm Flashing	33020	Selection	4	N/A	1	0-No 1-Yes
Alarm 3 Status	33021	Selection	4	N/A	1	0-No 1-Yes
Alarm 3 Flashing	33022	Selection	4	N/A	1	0-No 1-Yes
Fault Status	33023	Selection	4	N/A	1	0-No 1-Yes
Comm Error	33024	Selection	4	N/A	1	True if comm error
Config Error	33025	Selection	4	N/A	1	True if config error
I/O Error	33026	Selection	4	N/A	1	True if input/output error
Calibration Flag	33027	Selection	4	N/A	1	True if calibration in progress
Error Flashing	33030	Selection	4	N/A	1	True if channel error
Value	33065	32-Bit Floating Point	4	N/A	2	

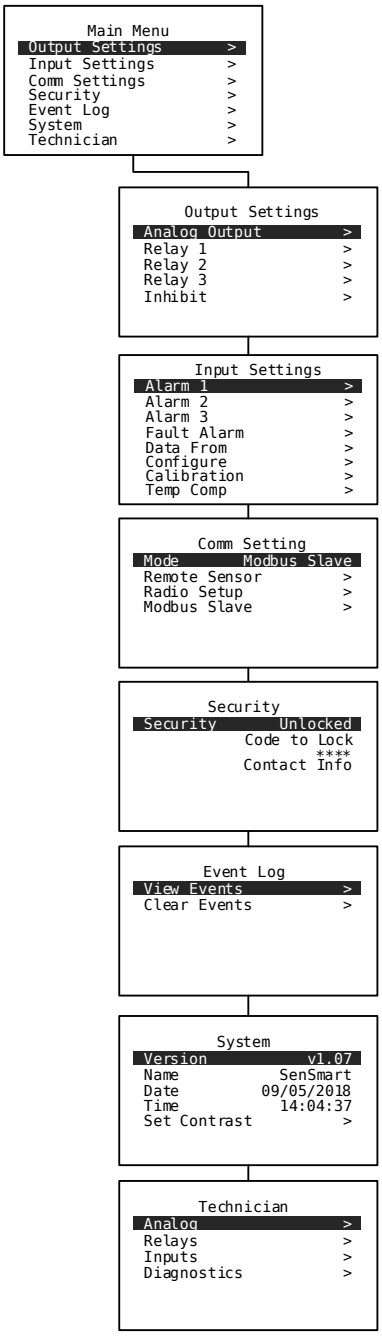
Holding Registers						
Tag	**Address**	**Type**	**Function Code to Read**	**Function Code to Write**	**Size**	**Notes**
Alarm 1 Latch	43001	Selection	3	6/16	1	0-No 1-Yes
Alarm 1 Trip	43002	Selection	3	6/16	1	0-High 1-Low
Alarm 1 On Delay	43003	Integer	3	6/16	1	Activation delay in seconds
Alarm 1 Off Delay	43004	Integer	3	6/16	1	Deactivation delay in minutes
Alarm 1 Deadband%	43005	Integer	3	6/16	1	Percent of scale
Alarm 2 Latch	43011	Selection	3	6/16	1	0-No 1-Yes

Alarm 2 Trip	43012	Selection	3	6/16	1	0-High 1-Low
Alarm 2 On Delay	43013	Integer	3	6/16	1	Activation delay in seconds
Alarm 2 Off Delay	43014	Integer	3	6/16	1	Deactivation delay in minutes
Alarm 2 Deadband%	43015	Integer	3	6/16	1	Percent of scale
Alarm 2 Color	43016	Selection	3	6/16	1	0-Red 1- Orange 2-Blue
Alarm 3 Latch	43021	Selection	3	6/16	1	0-No 1-Yes
Alarm 3 Trip	43022	Selection	3	6/16	1	0-High 1-Low
Alarm 3 On Delay	43023	Integer	3	6/16	1	Activation delay in seconds
Alarm 3 Off Delay	43024	Integer	3	6/16	1	Deactivation delay in minutes
Alarm 3 Deadband%	43025	Integer	3	6/16	1	Percent of scale
Alarm 3 Color	43026	Selection	3	6/16	1	0-Red 1- Orange 2-Blue
Alarm 3 Enabled	43027	Selection	3	6/16	1	0-No 1-Yes
Data From	43031	Selection	3	6/16	1	0-Sensor 1-Remote Sensor 2-4-20mA
Min Raw	43032	Unsigned Integer	3	6/16	1	Binary (800)
Max Raw	43033	Unsigned Integer	3	6/16	1	Binary (4000)
Remote ID	43034	Integer	3	6/16	1	Binary
Remote ID	43042	Integer	3		1	
Decimal Points	43079	Selection	3	6/16	1	Number of decimal points
Deadband(%)	43081	Integer	3	16	1	Modbus 32-bit IEEE 754 Floating Pt
Filter Count	43090	Integer	3	6/16	1	Binary ;0 to 60
Polarity	43092	Selection	3	6/16	1	Binary
Bridge Voltage	43093	32-Bit Floating Point	3	16	2	Modbus 32-bit IEEE 754 Floating Pt
Balance	43095	Integer	3	6/16	1	Binary
Heater Enabled	43096	Selection	3	6/16	1	0-No 1-Yes
Heater Setpoint	43097	32-Bit Floating Point	3	16	2	Modbus 32-bit IEEE 754 Floating Pt

Temp Comp -40C	43099	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp -30C	43103	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp -20C	43107	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp -10C	43111	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 0C	43115	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 10C	43119	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 20C	43123	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 30C	43127	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 40C	43131	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 50C	43135	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Temp Comp 60C	43139	Temperature Comp	3	16	4	32-bit FP Gain ;32-bit FP Offset
Sensor Type	43143	Selection	3	6/16	1	0-None, 1-EC, 2-Bridge, 3-Low Power IR
Cal mA Setting	43145	32-Bit Floating Point	3	16	2	Modbus 32-bit IEEE 754 Floating Pt

Table 4 Channel Registers

Appendix 4 Menu Navigation



Main Menus

- **Alarm Outputs**
  The Alarm Outputs Menu is accessed via the Main Menu, and is used to configure the mapping of the three programmable relays to the alarm setpoints, and relay configuration items such as Acknowledge, Failsafe and Override.

- **Input Settings**
  The Input Settings Menu provides access to user configurable input parameters. This includes Alarm settings for all three alarms, access to the data from menus (where you can adjust sensor settings for various types of sensors including sensor voltage for bridge type sensors), input configuration settings including tag name, engineering units and inCal mA, calibration span value, and the Temperature compensation table.

- **Com Settings**
  The Com Settings Menu provides access to the settings for the Modbus configuration, when installed.

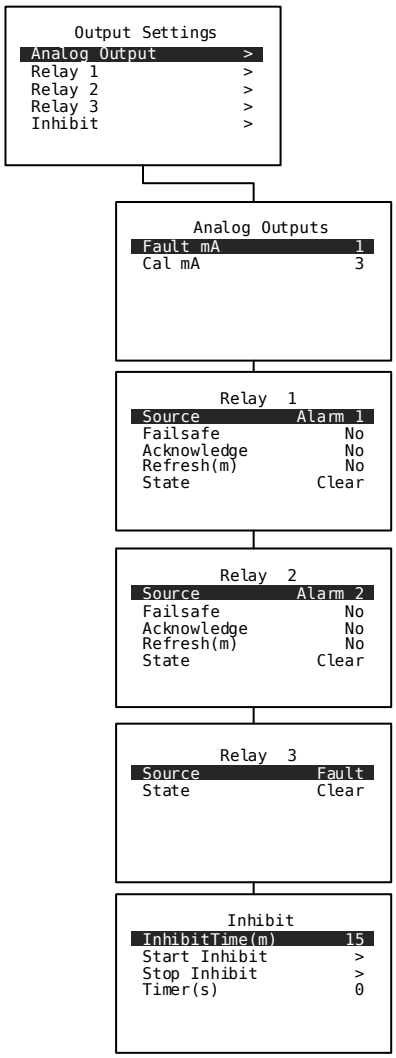
- **Security**
  Allows the user to enter a passcode to restrict access to some settings

- **Event Log**
  The Event Log allows the user to view a list of recent events logged in the transmitter, and to clear the log. Events are logged in a first in first out manner.

- **System**
  User adjustable items which effect the entire gas detector, and are not specific to either channel.

- **Technician**
  The Technician Menu provides access to a variety of useful troubleshooting screens to view ADC reading, Discrete I/O, Current input, Sensor life and access to the diagnostics mode for testing analog outputs, relay function and LED operation.

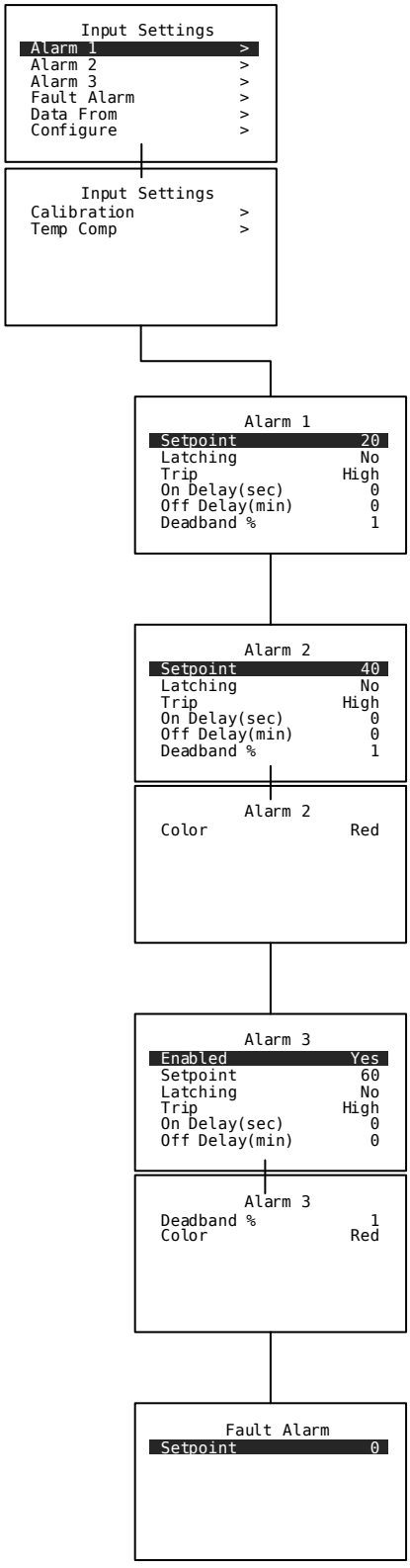
- **Help**
  The Help Menu provides a QR Code link to this manual



Output Settings

Output Settings Menus

- **Analog Outputs**
  - **Fault mA**
    Allows the user to configure the mA output when the detector is in the Fault condition. This is useful to indicate a fault condition on the connected control device.
  - Cal mA
    Allows the user to configure the mA output when the detector is in Cal Mode. This is useful to indicate a calibration condition on the connected control device.
- **Relay 1, 2, 3**
  - **Source**
    The Source setting can be set to Alarm 1, Alarm 2, Alarm 3, Fault, Cal Mode, Cal Zero, Cal Span or Disabled. This setting determines which condition must be met in order for the relay to actuate.
  - **Failsafe**
    When set to Yes, Failsafe means the relay de-energizes during alarm and energizes with no alarm. This is useful for signaling an alarm on a loss of power. The dedicated Fault relay is always Failsafe.
  - **Acknowledge**
    When set to Yes, Acknowledge means the *UP/RESET* key will set the relay to its normal state even if the alarm condition still exists. This can be useful for silencing audible devices driven from the relay.
  - **Refresh**
    When enabled, this feature refreshes the relay for acknowledged alarms if the indicated time elapses and the alarm condition still exists
  - **State**
    Indicates the current state of the relay
- **Inhibit**
  - **Fault mA**
    The inhibit feature allows the user to inhibit outputs during a designated time period. Once the timer has been started all outputs will be blocked until the time has expired.
  - **Start Inhibit**
    Starts the inhibit timer
  - **Stop Inhibit**
    Stops the inhibit timer
  - **Timer (s)**
    Indicates the time remaining on the inhibit timer in seconds



Input Settings Menus

- **Setpoint (Alarm 1, 2, 3 and Fault)**
  Setpoint enters the engineering unit value where the alarm will trip. It may be negative, and trip when monitored values fall out of range in this direction.

- **Latching (Alarm 1, 2, 3)**
  Setting Latching to YES causes the alarm to remain active even after the condition is gone, and to reset only when the *UP/RESET* key is swiped from a data display.

- **Trip (Alarm 1, 2, 3)**
  Set Trip to HIGH to have the alarm trip when the value goes above the setpoint. Set to LOW to trip when the value falls below the setpoint.

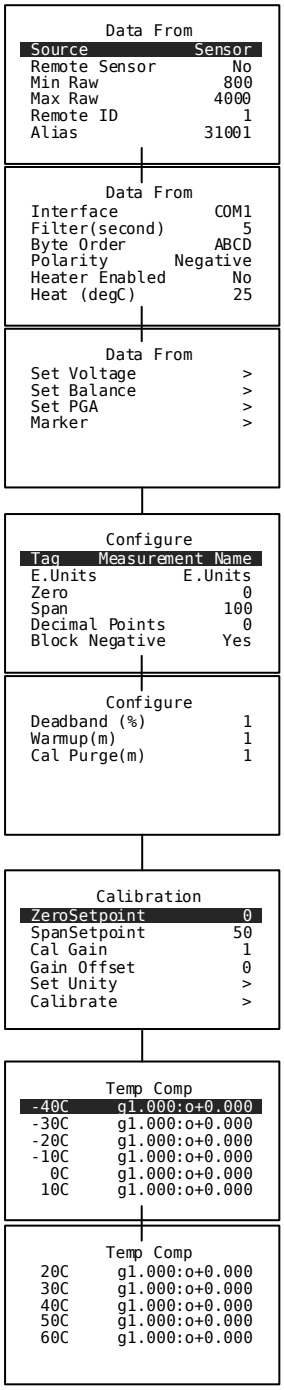
- **On Delay (sec) (Alarm 1, 2, 3)**
  On Delay allows entering a maximum 10 second delay before this alarm becomes active. This is useful for preventing spurious alarms by brief spikes beyond the alarm setpoint.

- **Off Delay (min) (Alarm 1, 2, 3)**
  Off Delay allows entering a maximum 120-minute delay before clearing an alarm after the alarm condition is gone. This is useful for continuing an alarm function, such as operation of an exhaust fan, for a period of time after the alarm condition clears.

- **Deadband % (Alarm 1, 2, 3)**
  Deadband allows forcing low values to continue to read zero. This is useful when there are small amounts of background gases that cause fluctuating readouts above zero. The highest amount of Deadband allowed is 5%.

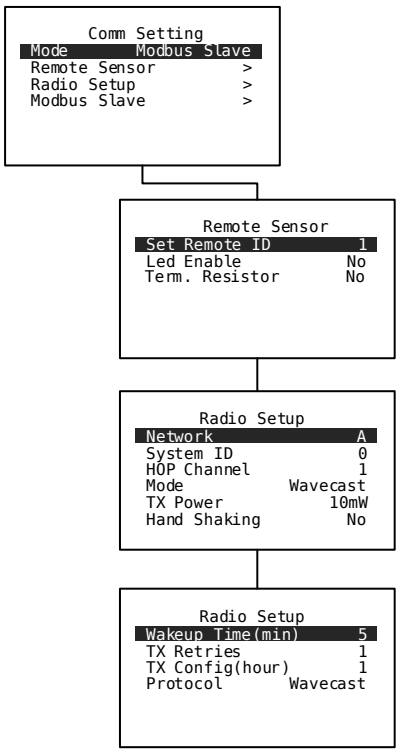
- **Color (Alarm 2, 3)**
  Selecting Color changes the color associated with the particular alarm. Options are Red, Blue, Purple and Orange.

- **Enabled (Alarm 3)**
  Set to YES to enable Alarm 3 and NO to disable.



Input Settings Menus (cont'd)

- **Data From (certain menu items only show up depending on the input type)**
  - **Source** determines the type of sensor installed in the detector. E.g. bridge, electrochemical, etc.
  - **Remote Sensor** set to Yes indicates that the sensor is installed remotely with Remote sensor option.
  - **Min and Max Raw** set the range of the input to the A/D converter. Normally set to 800/4000. Useful when the sensor's output doesn't provide a full range signal.
  - **Remote ID** is where the Modbus slave's ID number is entered
  - **Alias** is the register number which defines the location of the variable representing the input value of the Modbus data received through the communication ports
  - **Interface** assigns which communication port the Modbus slave is connected to and the detector will get its data from
  - **Filter (second)** sets the number of seconds over which samples are averaged
  - **Byte Order** determines WORD and BYTE alignment of data at the remote Modbus transmitter when sending this 4-byte IEEE floating point values
  - **Polarity** determines the polarity of the sensor
  - **Heater Enabled** determines if the sensor heater is turned on or off
  - **Heat (degC)** is the thermostat setting of the sensor
  - **Set Voltage** set's the voltage being supplied to bridge type sensors
  - **Set Balance** adjusts the balance of a catalytic bead sensor and must only be adjusted with ZERO gas on the sensor.
  - **Set PGA** is the adjustment that matches the input signal range to the detectors input signal conditioning circuits.
  - **Marker** used to detect special modes of operation from analog inputs, which some monitors use to indicate special modes of operation, such as calibration mode
- **Configure**
  - **Tag** is a 16-character ASCII field typically used to describe the monitored point by user tag number or other familiar terminology.
  - **E. Units** or engineering units may have up to 10 ASCII characters, and is usually factory configured based on sensor type.
  - **Zero** defines the reading to be displayed when the output is 4mA (0%)
  - **Span** defines the reading to be displayed when 20mA (100%) is the output.
  - **Decimal Points** sets the resolution of the displayed reading, and may best to zero, one or two.
  - **Block Negative** blocks negative values from being display (Displays 0).
  - **Deadband (%)** allows forcing low values to continue to read zero. This is useful when there are small amounts of background gases that cause fluctuating readouts above zero. The highest amount of Deadband allowed is 5%. Note: Deadband affects all outputs as well as the local reading.
  - **Warmup (m)** defines the time allotted for sensor warmup. During this time output s will be held at a zero value and relays will stay in their normal state.
  - **Cal Purge (m)** determines the amount of time the transmitter will stay in calibration mode after calibration is complete as the sensor returns to normal state.
- **Calibration**
  - **Zero Setpoint** is set to the zero value.
  - **Span Setpoint** is set to the calibration gas value, typically 50% of full scale.
  - **Cal Gain** reflects the change made when calibrating.
  - **Gain Offset** reflects the change made when calibrating.
  - **Gain Unity** is to reset the Gain and Offset back to default (1 and 0 respectively)
  - **Calibrate** is used to calibrate sensors.
- **Temp Comp** allows the user to adjust the gain and offset that is applied to sensors to compensate for temperature drift. Factory supplied sensors are preprogrammed with these values which are automatically uploaded from the Smart Sensor.



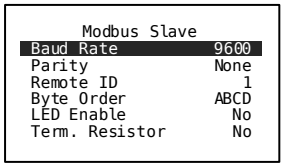
Comm Settings Menus

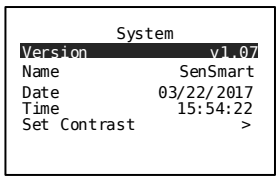
- **Mode**
  Determines the mode of operation for the communication port.

- **Remote Sensor**
  - **Set Remote ID** is where the Modbus slave's ID number is entered
  - **LED Enable** is to enable the serial communication LED.
  - **Term. Resistor** is to enable the terminating resistor.
- **Radio Setup**
  - **Network** is where the network is selected from A-Z.
  - **System ID** is to assign the device a unique ID
  - **Hop Channel** is set to match the server's Hop Channel
  - **Mode** is for switching between WaveCast and Legacy mode.
  - **Power** is the level of power for communicating with the selection of 10mW, 100mW, 200mW, 1W.
  - **Hand Shaking**
  - **Wakeup** is the amount of time set between normal transmitting
  - **TX Retries** is the amount of times the transmitter will try to transmit after failing to
  - **TX Config** is how often the transmitter will send the config information packet to the server
  - **Protocol** is for picking between the WaveCast and Legacy network protocol

Comm Settings Menus (cont'd)

- **Modbus Slave (when installed)**
  - **Baud Rate** allows users to set the data rate of the communication port. The options include 9600, 19200, 38400, 57600 and 115200.
  - **Parity** is a bit that is added to ensure that the number of bits with the value "1" in a set of bits is even or odd. Parity bits are used as the simplest form of error detecting within code. The default is None.
  - **Remote ID** is where the Modbus slave's ID number is entered
  - **Byte Order** determines WORD and BYTE alignment of data at the remote Modbus transmitter when sending this 4-byte IEEE floating point values
  - **LED Enable** enables the RX and TX LEDs to flash green on valid transmit and receive transmissions. For ports configured as master, the RX LED will flash red if there is a Comm Error or if an exception is received. Slave ports will cause the RX LED to flash red under the same conditions but can also cause the TX LED to flash red if an invalid function code is received or if the wrong register is given.





System Menus

- **Version**
  The version of firmware installed on the gas detector
- **Name**
  The user defined name of the gas detector. Swipe edit to change.
- **Date**
  Current Date. Swipe edit to change
- **Time**
  Current time on 24 hour clock. Swipe edit to change
- **Set Contrast**
  This menu allows the user to adjust the display's contrast to make it lighter or darker

Technician Menus

- **Analog**
  Selecting Analog displays the current output from the analog output terminals in mA.
- **Input**
  Displays the current input to the detector. Items displayed include input source, A/D counts, and display value.
- **Diagnostics**
  The Diagnostics Menu is entered by swiping the edit key, entering the technician's sequence (4 swipes of the UP key) and then swiping the edit key again.
  - **Analog Output**
    The Analog Output Diagnostics Menu is useful for troubleshooting the wiring of the analog output terminals. While in the menu, swipe the up and down keys to raise and lower the output from 0mA to 24mA.
  - **LED Test**
    Swiping Edit on the LED Test menu causes the two LEDs on the display to alternate on and off and change colors between red and green.

Appendix 5 Antenna Selection

Antenna Transmission Range

The distance radio signals can travel is dependent upon several factors including antenna design, transmitter power and free-space losses. In order for a wireless link to work, the available system operating margin **(TX power - RX Sensitivity + Antenna gains)** must exceed the free-space loss and all other losses in the system. For best RF line-of-site, the combined height of both antennas must exceed the Fresnel zone diameter.

Distance Between antennas	Fresnel Zone Diameter	Freespace Loss (dB)
1000ft (300m)	16ft (4.9m)	81
1 mile (1.6km)	32ft (9.7m)	96
5 miles (8km)	68ft (20.7m)	110

Example:

A 2.4GHz WaveNet system has following parameters:

- RF TX power setting = 21 dBm (125 mW)
- RF RX sensitivity = -95 dBm (this is a constant)
- Antenna gain (standard equipped rubber collinear) = 7dBi x 2 = 14dBi

So, the system operating margin is 21 - (-95) + 14 = 130 dBm. This is enough to transmit 5 miles if free-space was the only loss in the system. For this to be the case, the antennas must be mounted with a combined height greater than 68ft above all obstructions (including the ground) to keep the Fresnel recommended there be at least 20dB extra system operating margin.

RF “Rules of Thumb”:

- Doubling the range with good RF “Line of Sight” (LOS) requires an increase of 6 dB.
- Doubling the range without good RF LOS requires an increase of 12 dB.
- Doubling the power increases dBm by 3.

Antenna Selection and Location

The location of the antenna is very important. Ensure the area surrounding the proposed location is clear of objects such as other antennas, trees or power lines which may affect the antenna’s performance and efficiency. It is also vital that you ensure the support structure and mounting arrangement is adequate to support the antenna under all anticipated environmental conditions. The choice of appropriate mounting hardware is also important for both minimizing corrosion and maintaining site intermodulation performance.

Most installations with ranges under 1000 feet require only the standard equipped rubber antennas. Distances up to 2 miles may be achieved by using YAGI directional antennas aimed towards a mast

mounted fiberglass omnidirectional antenna at the base station. Always minimize obstructions between the gas detector and the base station antenna.

Water-proofing Antenna Connections

Waterproof all outdoor coax connectors using a three-layer sealing process of initial layer of adhesive PVC tape, followed by a second layer of self-vulcanizing weatherproofing tape, with a final layer of adhesive PVC tape.

Figure 14 Water-proofing Antenna Connections

Dipole and Collinear Antennas

These antennas are connected to the Radio via a length of coax cable. If the cable is larger than 6mm diameter (1/4 inch), be aware of sideways tension on the connection. Thick cables have large bending radii and sideways force on the connector can cause a poor connection.

The polarity of these antennas is the same as the main axis, and they are normally installed vertically. They can be mounted horizontally (horizontal polarity), however the antenna at the other end of the wireless link would need to be mounted perfectly parallel for optimum performance. This is very difficult to achieve over distance. If the antenna is mounted vertically, it is only necessary to mount the other antennas vertically for optimum "coupling" – this is easy to achieve.

Dipole and collinear antennas provide best performance when installed with at least 1 to 2 wavelengths clearance of walls or steelwork. The wavelength is based on the frequency:

Wavelength in meters = 300 / frequency in MHz

Wavelength in feet = 1000 / frequency in MHz

Therefore, 900 MHZ antennas require at least 2/3 meter (2 feet) and 2.4GHz 15 cm (6 inches). Antennas may be mounted with less clearance but radiation will be reduced. If the radio path is short this won't matter. It is important the antenna mounting bracket to well connected to "earth" or "ground" for good lightning surge protection.

Yagi Antennas

Yagi antennas are directional along the central beam of the antenna. The folded element is towards the back and the antenna should be pointed in the direction of the transmission. Yagi's should also be mounted with at least 1 to 2 wavelengths of clearance from other objects. The polarity of the antenna is the same as the direction of the orthogonal elements. For example, if the elements are vertical the Yagi transmits with vertical polarity.

In networks spread over wide areas, it is common for a central unit to have an omni-directional antenna and the remote units to have Yagi antennas. In this case, as the omni-directional antenna will be mounted with vertical polarity, then the Yagi's must also have vertical polarity. Care needs to be taken to ensure the Yagi is aligned correctly to achieve optimum performance.

Two Yagi's can be used for a point-to-point link. In this case they can be mounted with the elements horizontally to give horizontal polarity. There is a large degree of RF isolation between horizontal and vertical polarity (approx. –30dB) so this installation method is a good idea if there is a large amount of interference from another system close by transmitting vertical polarity.

An important mounting tip – if a Yagi has drainage holes in the dipole element, do not mount the antenna with the drainage.

Mounting Near other Antennas

Avoid mounting your network's antenna near any other antenna even when the other antenna is transmitting on a different radio band. High RF energy of the transmission from a close antenna can deafen a receiver. This is a common cause of problems with wireless systems.

Because antennas are designed to transmit parallel to the ground rather than up or down, vertical separation between antennas is a lot more effective than horizontal separation. If mounting near another antenna cannot be avoided, mounting it beneath or above the other antenna is better than mounting beside it. Using different polarity to the other antenna (if possible) will also help to isolate the RF coupling.

Coax Cables

If a coax cable connects to the antenna via connectors, it is very important to weatherproof the connection using our 1000-2314 or equivalent sealing tape. Moisture ingress into a coax cable connection is the most common cause of problems with antenna installations. A three-layer sealing process is recommended – an initial layer of electrical PVC tape, followed by a second layer of self-vulcanizing weatherproofing tape (1000-2314), with a final layer of electrical PVC tape (see Section 4.5.2).

Allowing a drip "U loop" of cable before the connection is also a good idea. The loop allows water to drip off the bottom of the U instead of into the connection, reduces installation strain and provides

spare cable length in case later the original connectors need to be removed, the cable can be cut back and new connectors fitted.

Avoid installing coax cables together in long parallel paths. Leakage from one cable to another has a similar effect as mounting an antenna near another antenna.

Surge Protection and Grounding

Voltage surges can enter the WaveNet System via the antenna connections, power supply connections, connections to other equipment and even the earth or ground connection. Surges are electrical energy following a path to earth and the best protection is achieved by draining the surge energy to earth via an alternate path. Wireless devices need to have a solid connection to earth via a ground stake or ground grid if the soil has poor conductivity. Solid connection means a large capacity conductor (not a small wire) with no coils or sharp bends. All other devices connected to the WLR need to be grounded to the same ground point. There can be significant resistance between different ground points leading to very large voltage differences during lightning activity. As many wireless units are damaged by earth potential surges due to incorrect grounding as direct surge voltage.

It is very difficult to protect against direct lightning strikes but the probability of a direct strike at any one location is very small. Unfortunately, power line surges and electromagnetic energy in the air can induce high voltage surges from lightning activity several miles away.

Antenna Grounding

Electromagnetic energy in the air will be drained to ground via any and every earth path. An earth path exists between the antenna and the WaveNet, and to protect against damage this earth path current must be kept as small as possible. This is achieved by providing better alternate earth paths. It is important to ground the antenna to the same ground point as the WaveNet. Antennas are normally mounted to a metal bracket which should be grounded to the WaveNet earth connection. Surge energy induced into the antenna will be drained first by the mount's ground connection, second by the outside shield of the coax cable to the ground connection on the radio and third by the internal conductor of the coax cable via the radio electronics. This third earth path causes damage unless the other two paths provide a better earth connection allowing surge energy to bypass the electronics.

When an antenna is located outside of a building and outside of an industrial plant environment, external coax surge diverters are recommended to further minimize the effect of surge current in the inner conductor of the coax cable.

Coax surge diverters have gas-discharge element which breaks down in the presence of high surge voltage and diverts any current directly to a ground connection. A surge diverter is not normally required when the antenna is within a plant or factory environment, as the plant steelwork provides multiple parallel ground paths and good earth grounding will provide adequate protection without a surge diverter.

Connections to other Equipment

Surges can enter the wireless unit from connected devices, via I/O, serial or Ethernet connections. Other data devices connected to the wireless unit should be well grounded to the same ground point as the wireless unit.

Special care needs to be taken where the connected data device is remote from the wireless unit requiring a long data cable. As the data device and the wireless unit cannot be connected to the same ground point, different earth potentials can exist during surge conditions.

There is also the possibility of surge voltages being induced on long lengths of wire from nearby power cables. Surge diverters can be fitted to the data cable to protect against surges entering the wireless unit.

The same principle applies to I/O device is not close to the wireless unit, the risk of surge increases. Surge diverters for I/O wiring are available to protect the wireless unit.

Appendix 6 Ordering Information

(To configure your custom gas detector visit www.rcsystemsco.com)

Part Number	Description	Reference
10-0517	SenSmart 4/5/8000 CPU Board	
10-0519	SenSmart 4000 and SenSmart 5000 Shield Board	
10-0529	SenSmart 8000 and SenSmart 8000X 2.4GHz Wireless Board	
10-0530	SenSmart 8000 and SenSmart 8000X 900MHz Wireless Board	
10-0531	SenSmart 5000 RS-485 Modbus Option Board	6
10-0532	SenSmart Relay and RS-485 Modbus Option Board	7
10-0533	SenSmart 5000 and SenSmart 8000X I/O Board	5
10-0534	SenSmart 8000 Battery Board	
10-0535	SenSmart 4000 Current Out Board	5
Accessories		
10-0198	Sensor Head Splash Guard with Remote Cal Port	
10-0203	Sensor Head Calibration Adaptor	
10-0270	Stainless Steel Duct Mount	
10-0379	PVC Duct Mount	
1000-2498	Gas Detector Stand	
1000-2499	Transmitter Pole Mount Bracket 1.5”	
10-0322	Magnetic Mounting Kit for Aluminum Enclosure	
10-0480	Magnetic Mounting Kit for Poly Enclosure	

Appendix 7 Frequently Asked Questions

How do I perform a calibration?

- To perform a calibration, please refer to Chapter 5. RC Systems recommends performing calibrations
    - ✓ Immediately prior to placing a gas detector in service
    - ✓ Any time a new sensor is installed
    - ✓ Every six months for routine calibrations (more often if sensor may have been exposed to gas for extended periods of time)
    - ✓ Periodic bump tests are recommended if detector has potentially been exposed to incompatible gases to ensure correct operation

Is there a Quick Start Guide available?

- Yes, visit www.rcsystemsco.com/downloads for a complete list of all of our product materials available for download.

My universal gas detector is not responding to Modbus queries.

- Verify the Slave ID is correct (Appendix 4).
- Verify the Modbus master is polling the correct alias (Appendix 4).
- Verify Modbus wires are connected to the correct terminals (Chapter 3.4).

My universal gas detector is responding to gas but the controller is in fault.

- Verify the analog signal wire is connected to the correct terminal at the monitor (Chapter 3.3).
- Verify the analog signal wire is connected to the correct terminal at the controller. For RC Systems controllers the HI terminal on the analog input board is where the signal wire connects.
- Verify monitor's 4-20 mA output by disconnecting the signal wire and measure across 4-20 output (+) and common (-) (Chapter 3.3).

My universal gas detector is reading NO SENSOR.

- Remove senor head cover and verify the Smart Sensor module is fully engaged in the Smart Sensor connector (Chapter 3.6).
- Verify the Smart Sensor connector is fully plugged into the Smart Sensor connection on the I/O board.

I can't loosen the XP enclosure cover.

- Make sure the set screw has been loosened.

My universal gas detector is failing calibration.

- Make sure the calibration gas is the proper concentration and gas type.

- Be sure to follow the calibration procedure.

For Technical Support call **409-986-9800 x160** or email support@rcsystemsco.com.

Appendix 8 Channel States

Priority	Channel State	Screen Color	Description
1	MFG	Green	State when performing manufacturers checkout process
2	Diagnostic	White	Not visible since it is a menu item
3	Inhibit	Green	Used in PGA/Balance/Voltage screens
4	Corrupted	Red	Sensor Memory is corrupted
5	Sensor Error	Red	Sensor is found/valid, but failed to read information from the sensor
6	Type Error	Red	Sensor mismatch, and user failed to accept the sensor
7	No Sensor	Red	Sensor is not found
8	Cal Needed	Red	A calibration of the sensor is required
9	Comm Error	Red	Indicates timeout or invalid reply from Modbus or wireless device
10	I/O Error	Red	Indicates a failure to communicate between I/O board electronics
11	Config Error	Red	Indicates interface for Modbus/wireless is configured for something else
12	Warmup	Green	Indicates the detector is in the user defined warmup time period
13	Overrange	Current Alarm Color	Indicates the sensor is reading over the maximum allowable range
14	Cal Zero	Pink	Indicates calibration mode
15	Cal Span	Pink	Indicates calibration mode
16	Cal Purge	Pink	Indicates the detector is in the user defined cal purge time period
17	Fault	Red	Indicates a fault condition exists
18	Alarm 3	User Programmed	Indicates the Alarm 3 condition exists
19	Alarm 2	User Programmed	Indicates the Alarm 2 condition exists
20	Alarm 1	Yellow	Indicates the Alarm 1 condition exists

Appendix 9 Drawings

Drawings

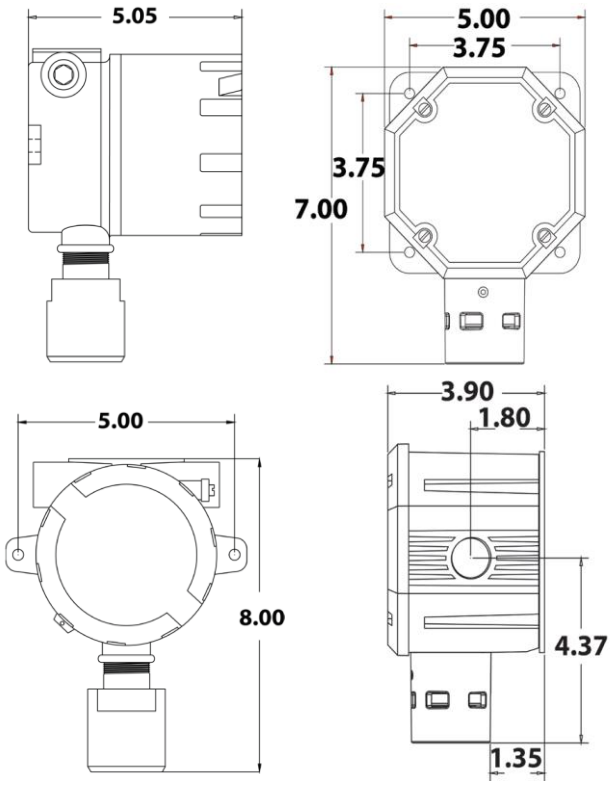


Figure 15 Mounting Dimensions

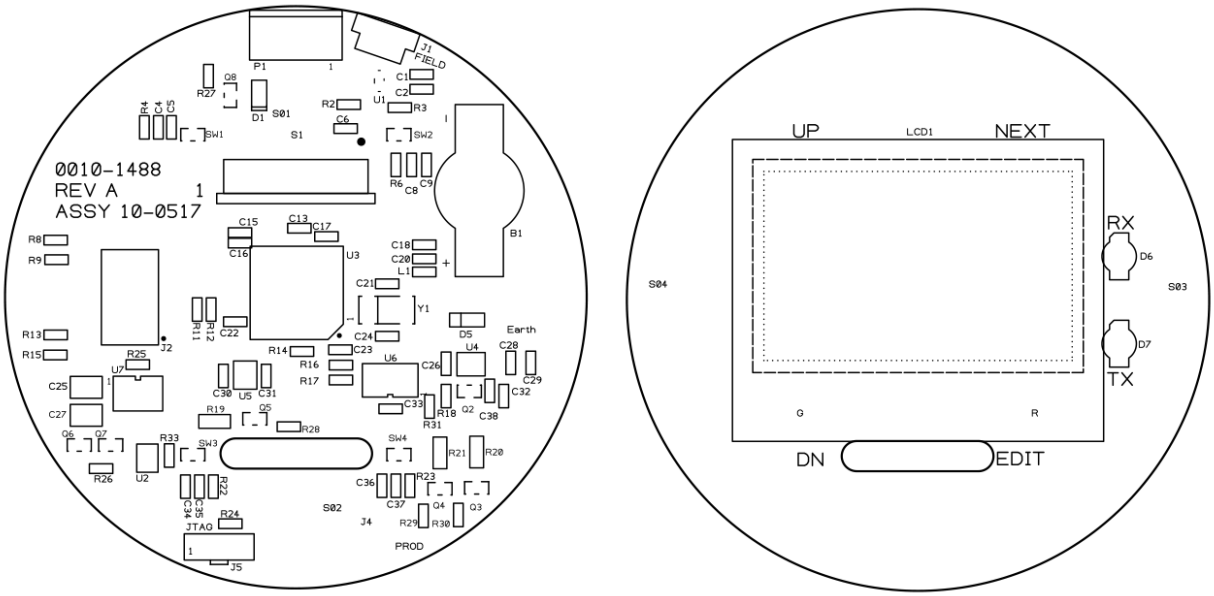


Figure 16 10-0517 CPU Board

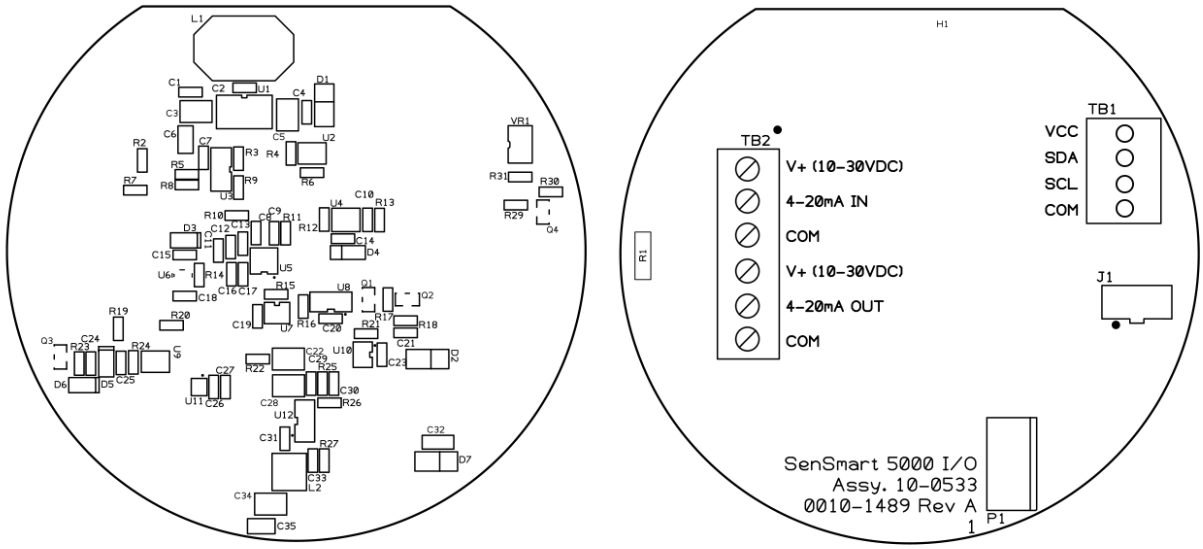


Figure 17 10-0533 I/O Board

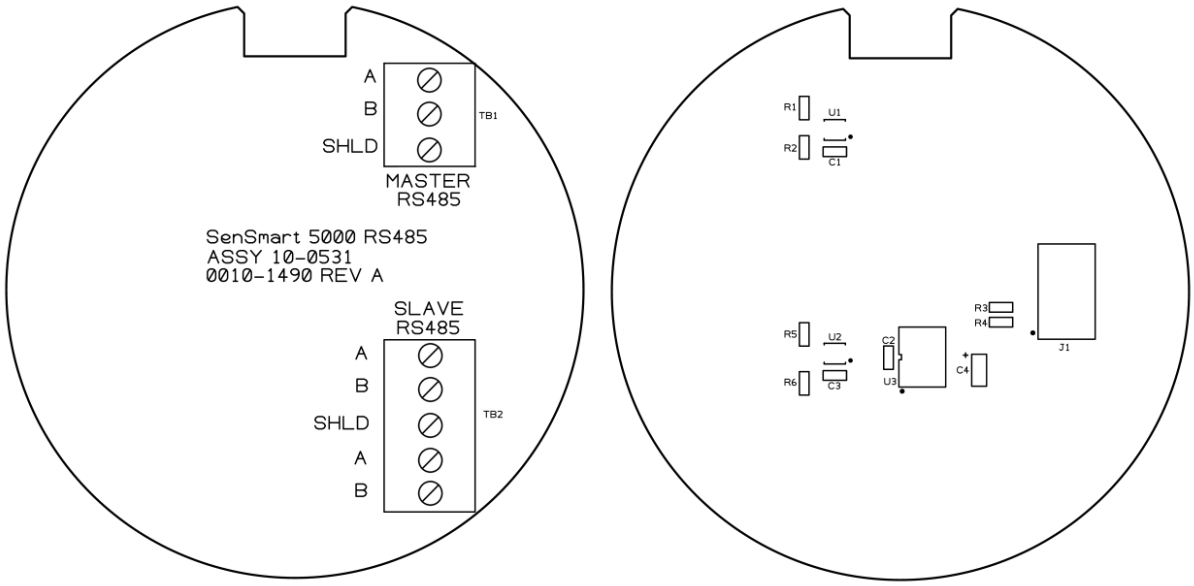


Figure 18 10-0531 Modbus Board

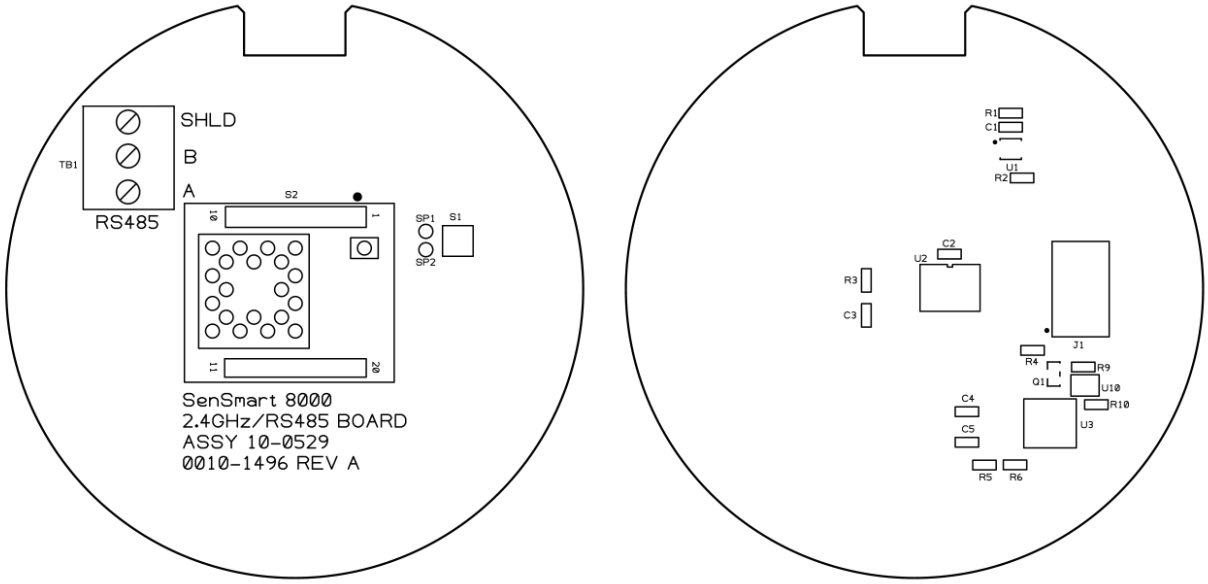


Figure 19 10-0529 2.4 GHz Board

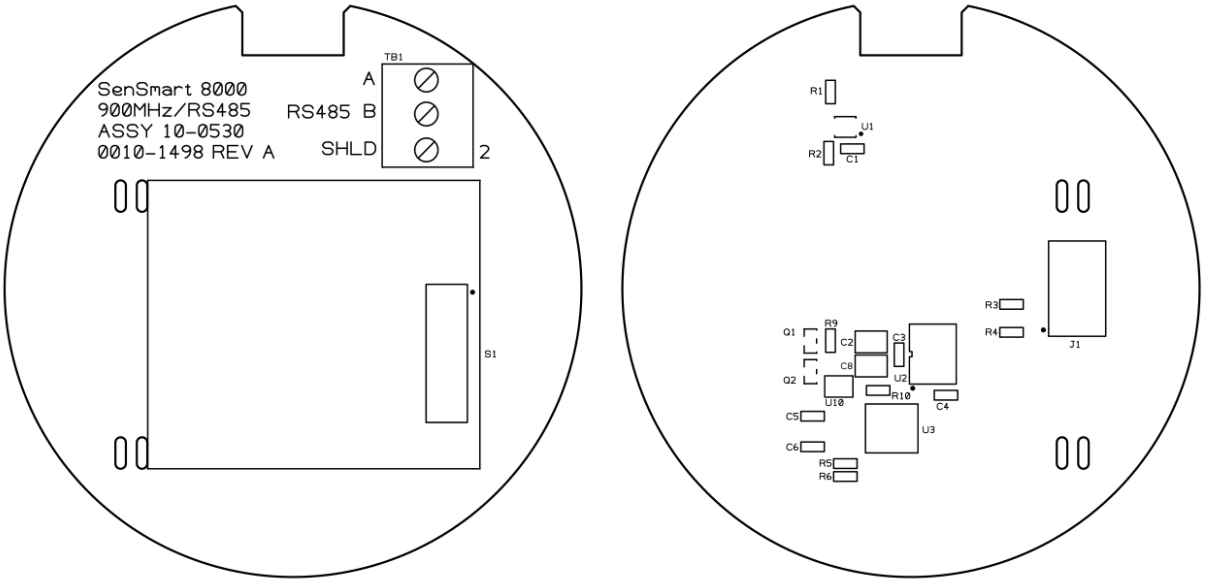


Figure 20 10-0530 900 MHz Board

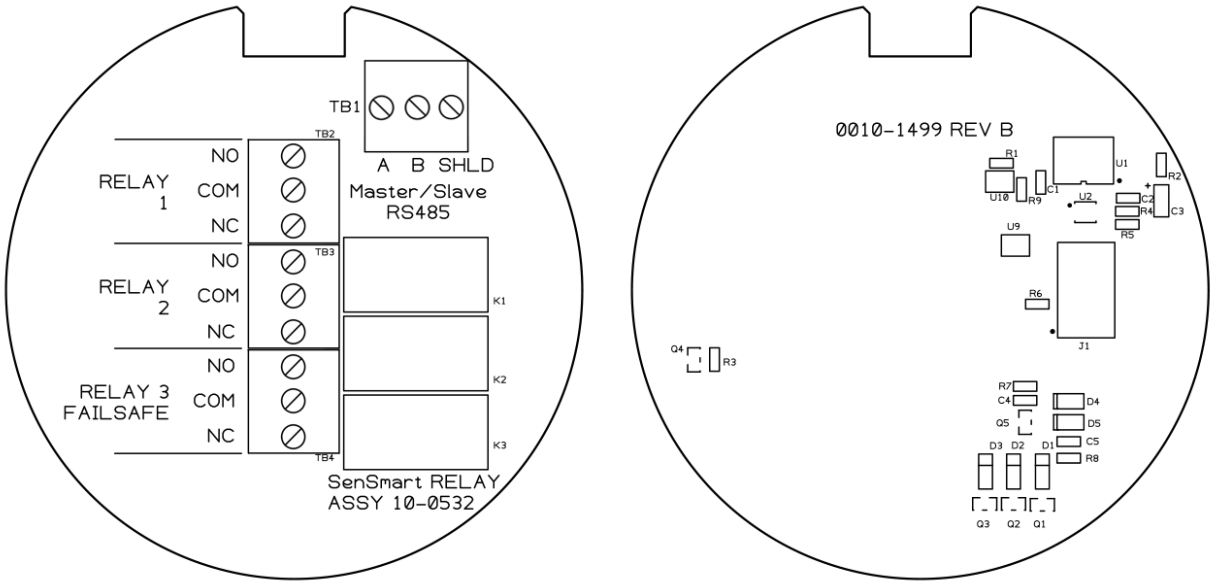


Figure 21 10-0532 Modbus/Relay Board

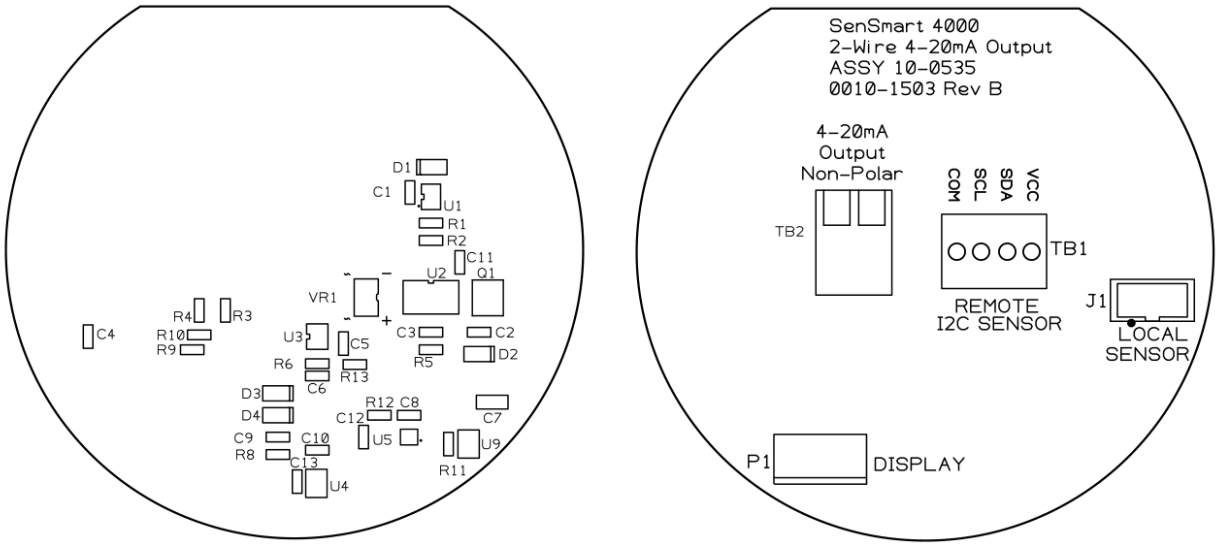


Figure 22 10-0535 4-20mA Output

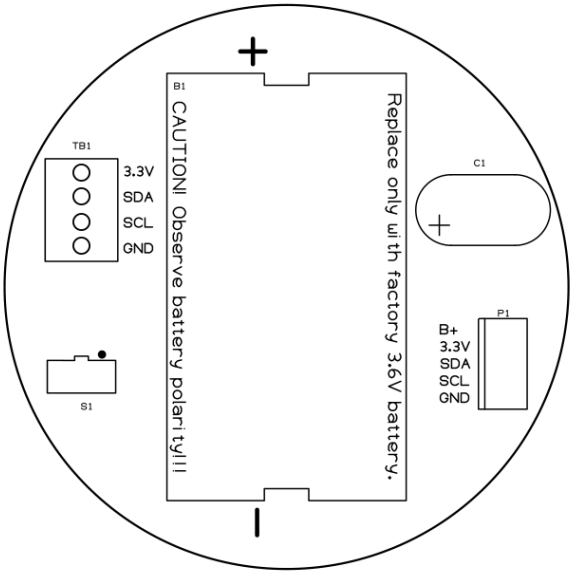


Figure 23 10-0534 Battery Board