SenSmart 7000 WIRELESS SENSOR TRANSMITTER

Warning: Read & understand contents of this manual prior to operation. Failure to do so could result in serious injury or death.

Chapter 1 – SAFETY INFORMATION

1.1 SAFETY INFORMATION – READ BEFORE INSTALLATION & APPLYING POWER

IMPORTANT

The WaveNet Wireless Monitoring system described in this manual consists of anywhere from 1 to 32 SenSmart 7000s wirelessly sending data to any number of WaveLink Receivers (WLR) and/or WaveNet Relayers (WNR). Users should have a detailed understanding of WaveNet operating and maintenance procedures. Use the WaveNet system only as specified in this manual, or detection of gases and the resulting protection provided may be impaired. Read the following **WARNINGS** prior to use:

WARNINGS

- Calibrate SenSmart 7000 gas monitors that communicate to the WaveNet with a known value at start-up and check calibration on a regular schedule, at least every 90 days. More frequent inspections are encouraged to spot problems such as dirt, oil, paint, grease or other foreign materials on the sensor head.
- Do not paint the sensor assembly or any part of the SenSmart 7000.
- Do not use the WaveNet if any enclosure is damaged or cracked or has missing components.
- Make sure covers, internal PCBs and antenna connections are securely in place before operation.
- Use only a sensor assembly compatible with the SenSmart 7000 and approved for the monitor.
- Periodically test for correct operation of the system's alarm events by exposing the monitor to a known value above the High Alarm set-point.
- Do not expose WaveNet devices to electrical shock or continuous severe mechanical shock.
- Protect WaveNet devices from dripping liquids and high power sprays.
- Use only for applications described within this manual.

CAUTION: FOR SAFETY REASONS THIS EQUIPMENT MUST BE OPERATED AND SERVICED BY QUALIFIED PERSONNEL ONLY. READ AND UNDERSTAND INSTRUCTION MANUAL COMPLETELY BEFORE OPERATING OR SERVICING.

ATTENTION: POUR DES RAISONS DE SÉCURITÉ, CET ÉQUIPEMENT DOIT ÊTRE UTILISÉ, ENTRETENU ET RÉPARÉ UNIQUEMENT PAR UN PERSONNEL QUALIFIÉ. ÉTUDIER LE MANUE D'INSTRUCTIONS EN ENTIER AVANT D'UTILISER, D'ENTRETENIR OU DE RÉPARER L'ÉQUIPEMENT.

WARNING - EXPLOSION HAZARD
SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
BATTERIES MUST ONLY BE CHANGED IN AN AREA KNOWN TO BE NON-HAZARDOUS.

AVERTISSEMENT - RISQUE D'EXPLOSION
LA SUBSTITUTIOND E COMPOSANTSP EUTR ENDRE CE MATERIEL NACCEPTABLE POUR LES EMPLACEMENTS DE CLASSE I, DIVISION 2;
AFIN D'EVITER TOUT RISQUE D'EXPLOSION, S'ASSURER QUE L'EMPLACEMENT EST DESIGNE NON DANGEREUX AVANT DE CHANGER LA BATTERIE.

1.2 CONTACTING R. C. SYSTEMS CO. INC.

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

Chapter 2 – GENERAL DESCRIPTION

2.1 INTRODUCTION

R.C. Systems WaveNet is a Frequency Hopping Spread Spectrum (FHSS) **Client/Server** wireless monitoring system offered with integral 900 MHz or 2.4 GHz radio modules. Each WaveNet system may have between 1-32 battery-powered SenSmart 7000s (SenSmart 7000s), which are always "**Clients**". SenSmart 7000s may be equipped with single or dual gas sensors and transmit two of the 32 maximum channel values to the WaveLink Receiver (WLR) and/or WaveNet Relayer (WNR). There must also be at least one WaveLink Receiver (WLR) configured as the network's "**Server**". Since it is often desirable to indicate readings and alarms in more than one location, multiple WLRs configured as "Clients" are easily added to the same wireless network, but only one may be configured as the "Server". WaveNet radio configuration allows up to 26 separate FHSS hopping patterns and therefore as many as 26 separate WaveNet systems may be collocated into the same area. Each network's Server transmits Hopping Pattern and System ID settings only to Clients assigned to its network.
900MHz model's transmit power is adjustable between 10mW and 1W (0-30dBm EIRP; 2dBi gain antenna) and 2.4GHz model's power is fixed at 125mW (21dBm; conducted).
SenSmart 7000s are low power devices powered by an integral lithium D cell battery. WLRs must be continuously powered by an external power source (85-240VAC or 10-30VDC) and are ideally suited for 12VDC solar power supplies.

Additional features include:

- On screen radio status icons indicate "Server In-Range", "Server Out-of-Range", "Server Previously Out-of-Range" and "Low Battery" conditions.
- No potentiometer or jumper settings required. Cycling of power and configuration is with menus accessed via the LCD / magnetic keypad operator interface without opening the enclosure.
- "Smart Sensor" technology keeps gas type, range, calibration, temperature compensation and other sensor related parameters on the sensor module.
- If a sensor must be replaced, new smart sensors are recognized by the SenSmart 7000 and prompts users to either upload new configuration data or continue with data from the previous smart sensor.
- Missing sensors trip the FAIL alarm.
- Smart sensors are industry proven for fast response and long life.
- Field adjustable alarm levels flash front panel LED indicators for HIGH, WARN, FAIL conditions. Alarm relays are not available on the SenSmart 7000s with this low power model, but WLRs come equipped with 8 programmable relays and WNRs come equipped with four programmable relays.
- CAL MODE provides on-screen prompts when to apply calibration gas during calibrations.
- "Sensor life" bar-graph updates after each SPAN calibration indicating when to replace old sensors.
- One hour trend screen shows rate of change of gas exposures.
- Modular design affords efficient installation and plug in sensors allow changing target gases even after installation.

2.2 DESCRIPTION OF WAVENET CLIENT / SERVER WIRELESS NETWORKS

All R. C. Systems wireless devices utilize a FHSS (Frequency Hopping Spread Spectrum) Client / Server network where multiple **Clients** synchronize their frequency hopping to a single **Server**. Each network's **Server** transmits a beacon at the beginning of every frequency hop. **Clients** with the same **Hop Channel** and **System ID** menu settings listen for the **Server's** beacon and upon receiving it, synchronize their hopping with the **Server**. WLR may be user configured as either **Clients** or **Servers** since many installations require more than one WLR, but only one Server is allowed per network. Battery powered SenSmart 7000 are always **Clients** because their radio is usually powered down and therefore unable to continuously broadcast beacons as required by the **Server**. When there are multiple

WLR's on the same network, the most centrally located is usually designated as the Server. Multiple WNRs may be added to any WaveNet system in order to provide additional alarms, and/or function as repeaters for the alarm states of the SenSmart 7000s in the WaveNet network.

Each device on a WaveNet network must have its **NETWORK ID** menus configured to share the same **Hop Channel** and **Systems ID**. To simplify this setup, SenSmart 7000s, WLRs and WNRs are limited to 26 unique **Hop Channel** and **System ID** settings entered as "A" through "Z" in the **NETWORK ID** menu. All devices must have the same **Network ID** letter designated to communicate with each other (see Section 8.1.1*).* This also means it is possible to collocate multiple FHSS networks within the same coverage area without interference.

IMPORTANT! There should never be two servers with the same network settings within the same coverage area because interference between the two servers will severely hinder RF communication!

Correct planning and design of wireless systems are imperative for ensuring a successful installation.

SenSmart 7000

Chapter 3 – SenSmart 7000 DESCRIPTION

WARNING - EXPLOSION HAZARD
SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2;
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3.1 SenSmart 7000 LCD READOUTS

Figure 3-1 shows the primary data display screens for displaying sensor readings, radio status and current alarm conditions. The Single Channel **Engineering Unit** and **One-Hour Trend** screens on the left side of Figure 3-1 are available even if the SenSmart 7000 (SenSmart 7000) is equipped with Dual Sensors but there is two of each. The **Engineering Unit(Eunits)** screen has a large digital value with Eunits, a bar graph with Alarm 1, Alarm 2 and Alarm 3 levels indicated across the bar and a 16 character Measurement Name field for user ID of this measurement location. The NEXT key toggles to the **One-Hour Trend** screen which indicates the alarms levels horizontally across the screen and trends the most recent one hour of readings. The right screen shows the **Dual Monitor** readout available only when two smart sensors are enabled. Single Channel screens are also available in the Dual mode which totals 5 data displays for dual channel units.

3.1.1 SenSmart 7000 LCD STATUS ICONS – ZZz,SNIFF,RNG, , , , LoBat

The upper left LCD corner displays current status of the SenSmart 7000, and provides an indication of general health of the wireless network over time. These status icons and the COM LED are useful tools for evaluating RF communication and the current state of the SenSmart 7000.

The Zzz icon indicates the sensor is asleep and saving power. Every six seconds it awakes, reads the gas sensor's signal, and updates the displayed gas value. This is called a "sniff" and is indicated by the SNIFF icon, which flashes on the screen every 6 seconds. Following a sniff, if conditions described in Section 3.2 have been met, the SenSmart 7000 will wake up the radio and broadcast gas value and alarms over the airwaves to the WaveLink Receiver (WLR) and/or WaveNet Relayer(WNR). The sniff icon may be replaced by other status icons to indicate problems as described below:

- - **Server Out-of-Range** icon appears if the server's beacon was not received at the most recent attempt to broadcast.
- The **RNG** icon appears briefly at the beginning of each broadcast attempt to indicate the radio is awaiting the Server's beacon. If the beacon is not received after a few seconds the broadcast is terminated unsuccessfully and the icon is displayed at each sniff instead of the sniff icon. If a subsequent attempt receives the beacon and broadcasts successfully, the - **Server Previously Out-of-Range** icon will appear.

- The (Server Previously Out of Range) icon is very useful in determining if intermittent communication failures are a result of this SenSmart 7000 having problems receiving the Server's beacon as opposed to the WLR not receiving the SenSmart 7000 broadcast packet. The duration and frequency of "out-of-range" conditions are stored in the WLR Event Log table described in Section 10.9.
- When the 3.6 volt lithium battery is near end of life the LoBat - **Low Battery** icon is displayed during sniffs.

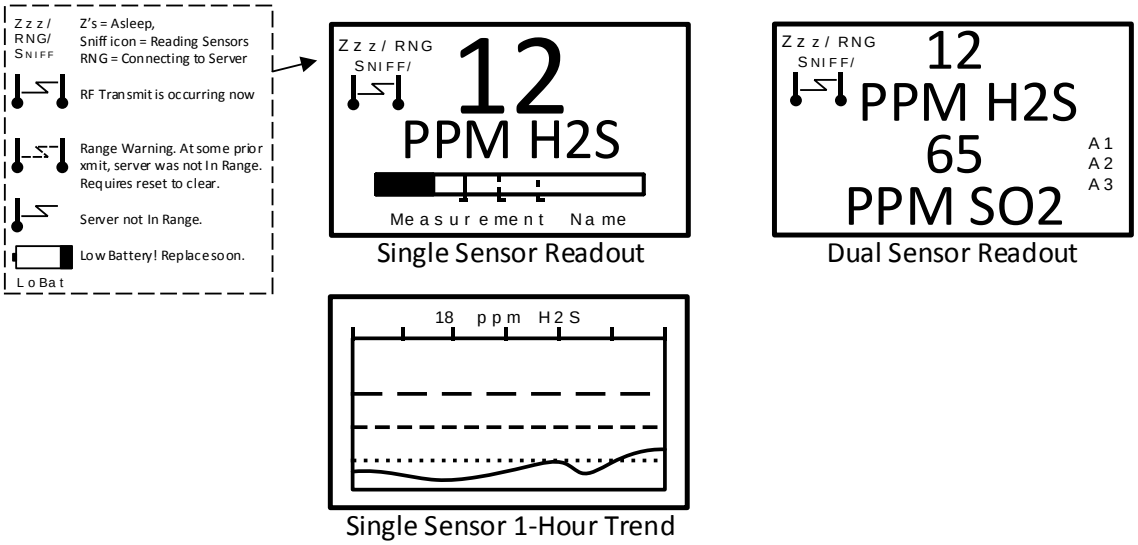


Figure 3-1 Readout Screen

3.2 SenSmart 7000 RF BROADCAST CYCLE AND CONSERVING BATTERY LIFE

Most SenSmart 7000 battery power is consumed as the radio communicates to the wireless network. Each Broadcast cycle consists of the following operations: Power up the radio; listen for the Server's beacon; synchronize to the Server's hopping pattern to become "In Range ", transmit data packet out of the antenna and return to sleep mode. This sequence takes from .25 to 1 second to complete. If the SenSmart 7000 radio fails to synchronize hopping with the Server upon the initial attempt it waits 6 seconds and tries again, then waits 6 seconds and tries once more. If the third attempt fails an "Out of Range " icon is displayed and the SenSmart 7000 goes to sleep and the scheduled Broadcast cycle repeats. Transmit power levels are adjustable (900MHZ models only) and the lower the power setting the longer the battery will last (see Section 4.4).

Every 6 seconds, the monitor performs a "sniff test" to detect level of target gas present at the sensor. At each "sniff test", the **Zzz**'s "Sleep Mode" icon is briefly replaced by a status icon as described above in Section 3.1.1. At this time, the LCD readout updates to indicate gas value measured during the sniff test. The radio stays OFF and no Broadcast occurs unless the gas value trips A1, A2 or A3 alarms, the ***Wakeup Timer*** expires (maximum of 5-minutes) or the conditions shown below are met. The following list identifies each of the conditions that cause the SenSmart 7000 radio to Broadcast over the airwaves:

- A Broadcast occurs every time the ***Wakeup Timer*** menu expires (see Section 8.1.3). This is important since the WLR reports "Comm Error" for channels when no data is received after [***Wakeup Timer*** X 5]. For example, if the SenSmart 7000 ***Wakeup Timer*** is set to broadcast every 5 minutes, the WLR will indicate a Comm Error alarm for this channel if data is not received after approximately 25 minutes.

- Broadcasts occur after each 6 second sniff test if there is an A1, A2 or A3 alarm. "FAIL" alarms do not increase radio broadcast rates.
- A Broadcast occurs upon entry into CAL MODE, upon entry into CAL PURGE and again upon completion of the CAL PURGE. A status bit in the broadcast packet advises WaveLink Receivers(WLR) and WaveNet Relayers(WNR) this SenSmart 7000 channel is being calibrated and alarms are inhibited. NOTE: Oxygen sensors cause 20.9% WLR readings during CAL MODE while all others cause zero readings (see CAL MODE Section 5.3).
- A Broadcast occurs if the reading rises or falls by >2% of full scale since the most recent Broadcast. This is to ensure a live reading at the WLR and/or WNR even though the ***Wakeup Timer*** might be set for a longer interval (5 minutes max).
- A Broadcast may be forced manually by holding the UP key for several seconds until the icon appears then RELEASING THE UP KEY.
- A Broadcast occurs at the end of a Warm Up interval (see Section 8.2.1).
- A Broadcast occurs as menu items are edited and again upon returning the LCD to the readings display.

3.3 SenSmart 7000 10-0407 BATTERY / I/O PCB

SenSmart 7000 electronics consist of the lower 10-0407 Battery / I/O PCB shown in Figure 3-2, connected by a cable to the upper 10-0404-C Display / Radio PCB shown in Figure 3-3. The 10-2465 3.6 volt lithium 'D' cell battery will continuously power the unit for up to one year and may be replaced by following the procedure in Figure 3-2.

Connectors S1 and S2 are for connecting 10-0247 Sensor Heads directly to the 10-0407 Battery / I/O PCB. Terminal blocks TB1 and TB2 are for connecting to the 10-0411 "Sensor Separation Kit" with a 15' data cable (see Section 5.5.1).

IMPORTANT: Do not turn Power ON to the SenSmart 7000 until the controller designated as Server is fully operational and ready to communicate to the SenSmart 7000s. Battery life is reduced if the SenSmart 7000 is on for long periods while unable to communicate to the Server.

IMPORTANT: DO NOT ATTEMPT TO CHARGE THIS BATTERY OR REPLACE WITH ANY OTHER THAN PART # 10-2465 FROM R. C. SYSTEMS INC.

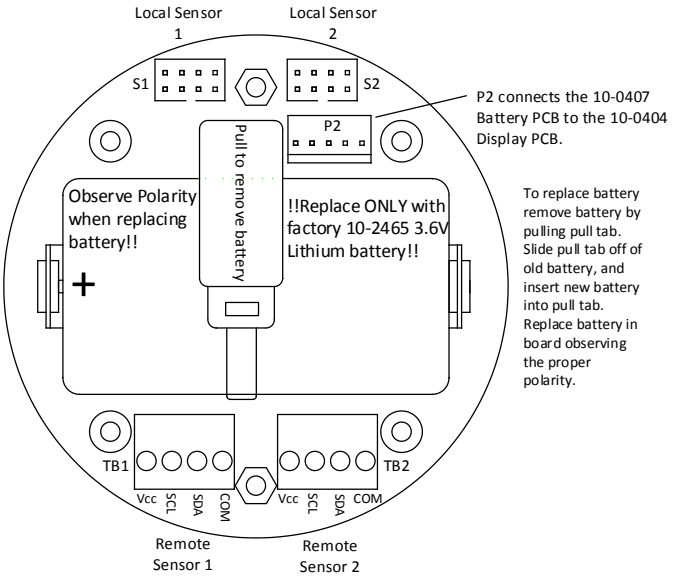


Figure 3-2 10-0407 Battery / I/O PCB

3.4 SenSmart 7000 10-0404-C DISPLAY / RADIO PCB

WaveNet systems support both 900MHz and 2.4GHz FHSS networks determined by the radio module mounted to the 10-0404-C Display / Radio PCB. The 1000-2188 900 MHz radio module mounts to the back of the 10-0404-C Display assembly as shown in Figure 3-3. Its MMCX RF connector attaches to the coax pigtail of the 10-0400 antenna fitting required for 900 MHz models.

The 1000-2454 2.4GHz radio module also mounts to the back of the 10-0404-C Display assembly as shown in Figure 3-3. Its u.FL RF connector attaches to the coax pigtail of the 10-0401 antenna fitting required for 2.4 GHz models.

A slender 5 conductor cable connects between the 10-0404-C and the 10-0407 Battery / I/O PCB bolted to the bottom of the enclosure.

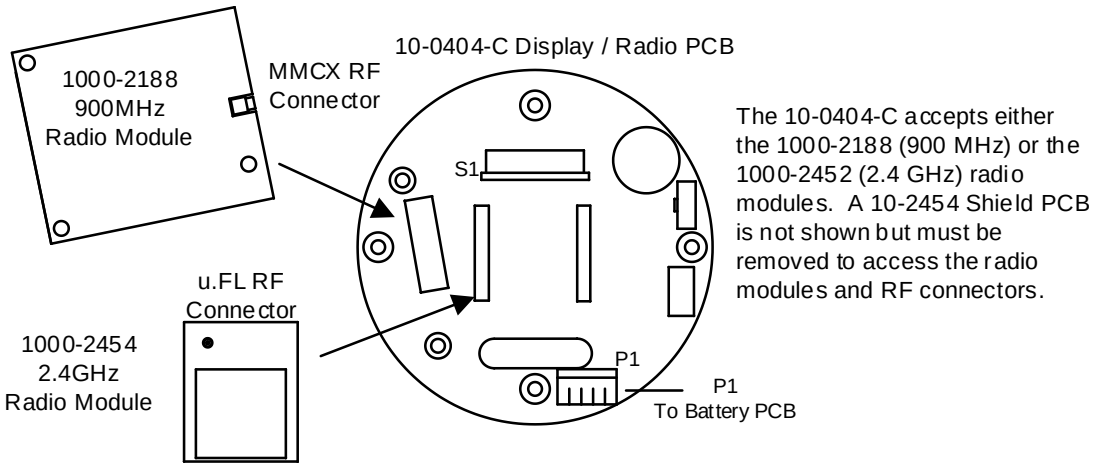


Figure 3-3 10-0404-C Display / Radio PCB

Chapter 4 - SenSmart 7000 INSTALLATION INSTRUCTIONS

4.1 RATINGS AND CERTIFICATIONS

The enclosure is NRTL certified for Division 1 hazardous area installations for explosion-proof Class 1 Groups A, B, C, D (see Figure 4-1). The SenSmart 7000 (SenSmart 7000) is designed to meet ISA 92.0.01 Part 1 for Toxic Monitors. The standard 10-0295 antenna fitting has an RP-TNC connector and is suitable for Division 2 classified areas. An optional explosion-proof dipole antenna is also available for Division 1 classified areas. Figure 4-2 shows both antenna styles.

4.2 SENSOR 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 monitors mounted 12 – 18 inches (30 – 45 centimeters) above the potential gas leak and heavier than air gases should be this distance below. Even though the SenSmart 7000 is designed for rugged service, sensors should be protected from environmental damage from water, snow, shock, vibration and dirt.

4.3 MOUNTING THE ENCLOSURE

The SenSmart 7000 standard enclosures are the cast aluminum explosion-proof (NEMA 7) enclosure as shown in Figure 4-1 and the polycarbonate enclosure shown in Figure 4-2. Modular design simplifies the installation of the SenSmart 7000. The SenSmart 7000 antenna should typically be mounted with line-of-site access to the WaveLink Receiver's (WLR's) and/or WaveNet Relayer's (WNR's) antenna. If a good line-of-site angle is not possible the SenSmart 7000s will usually still function properly at ranges up to 1500 feet. However, obstructions should still be kept to a minimum.

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. Install the SenSmart 7000 to a wall or bracket using the pre-drilled mounting flanges with I.D. 0.3 on 5.0 inch centers (Figure 4-1).

CAUTION: The sensor head (not shown in Figure 4-1) should never be installed pointing upwards.

4.3.1 SenSmart 7000 10-0322 MAGNETIC MOUNT OPTION

R. C. Systems offers a magnetic mounting option (10-0322) which includes two magnets affixed to the pre-drilled mounting holes securely attaching the assembly to a solid steel structure.

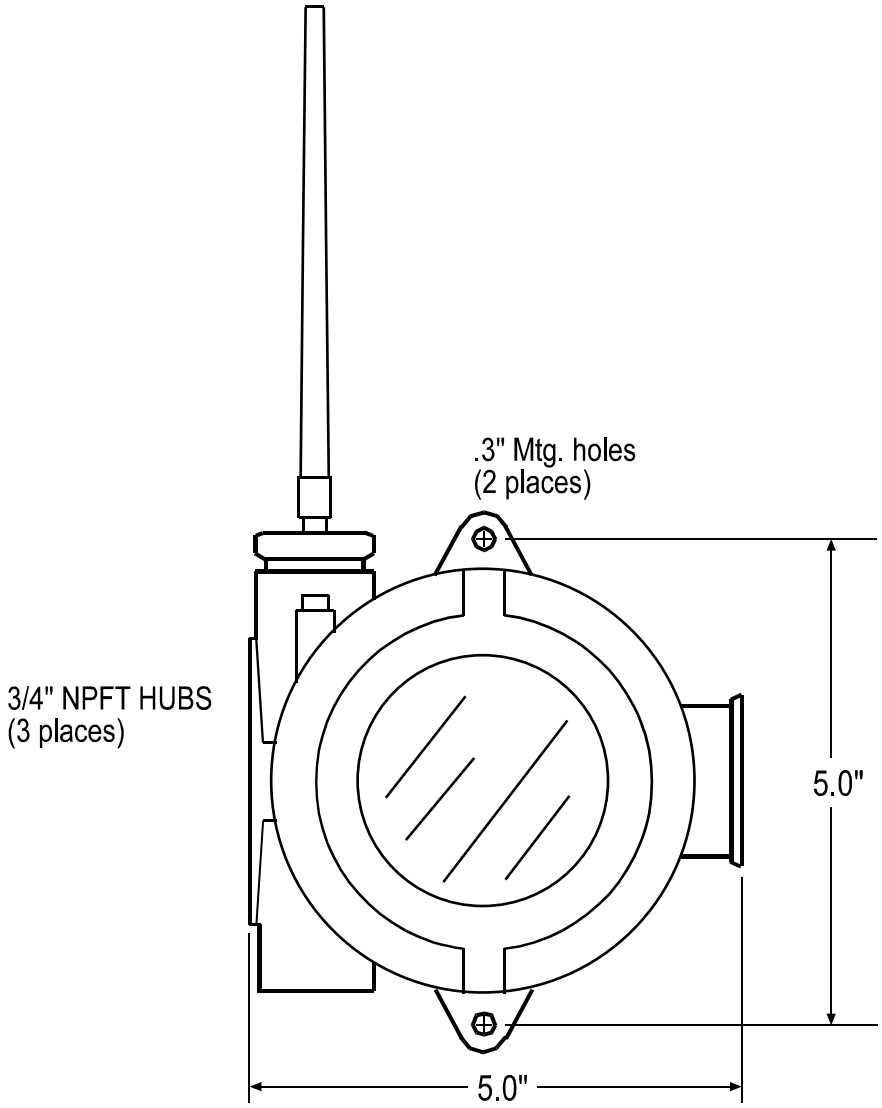


Figure 4-1 SenSmart 7000 NEMA 7 Explosion-Proof Enclosure

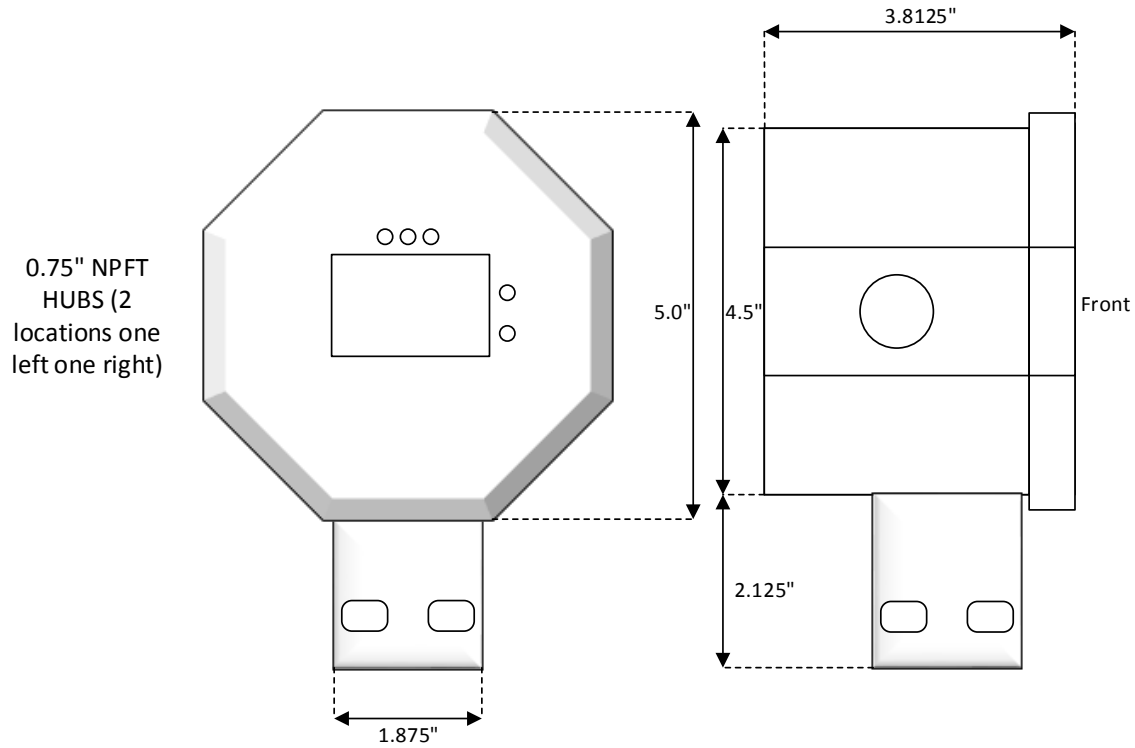


Figure 4-2 SenSmart 7000 Polycarbonate Enclosure

4.4 SPECIFICATIONS

4.4.1 POWER SUPPLY

Integral non-rechargeable 3.6 volt 19AH Lithium D-cell battery. Replacement part # 10-2465.

4.4.2 POWER CONSUMPTION

900MHz Models:
2mA during "sleep" mode, 40mA while receiving beacon, up to 1 amp during 1 watt "transmit" mode. Transmit power may be set from 10mW to 1 watt (see Section 8.1.9)

Note: 1 watt operation is not recommended or necessary for most applications as it can cause an unnecessary load on the battery thereby significantly reducing battery life.

2.4GHz Models:
2mA during "sleep" mode, 170mA during 125mW broadcasts.

4.4.3 MAXIMUM TRANSMIT (TX) POWER

900MHz Models (EIRP; 2dBi gain antenna):
30dBm at highest 1W power setting. Transmit power may be set from 10mW, 200mW, 400mW and 1 watt (see Section 8.1.9)

Note: 1 watt operation is not recommended or necessary for most applications as it can cause an unnecessary load on the battery thereby significantly reducing battery life.

2.4GHz Models (Conducted; no antenna):
Transmit power is fixed at 125mW (21dBm)

4.4.4 RECEIVE (RX) SENSITIVITY

900MHz Models:
100 dBm

2.4GHz Models:
95 dBm

4.4.5 RADIO FREQUENCY

900MHz Models:
Hopping occurs between 902 – 928 MHz.

2.4GHz Models:
Hopping occurs between 2400 – 2483.5 MHz.

4.4.6 MEMORY:

Non-volatile E2 memory retains configuration values in the event of power outages.

4.5 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.

Dist. between ant's	Fresnel zone diameter	Freespace loss (dB)
1000 ft (300 m)	16 ft (4.9 m)	81
1 Mile (1.6 km)	32 ft (9.7 m)	96
5 miles (8 km)	68 ft (20.7 m)	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 zone clear. In practice, however, there are many losses in the system besides just Free-space and it is 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.

4.5.1 ANTENNA SELECTION & LOCATION

A site survey using test radios is highly recommended.

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 as shown in Figure 4-2. Distances up to 2 miles may be achieved by equipping the SenSmart 7000s with YAGI directional antennas aimed towards a mast mounted fiberglass omnidirectional antenna at the WLR/WNR base station. Always minimize obstructions between the SenSmart 7000 and the WLR/WNR base station antenna.

Figure 4-3 Local Antennas

4.5.2 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 such as 3M 23 (order # 1000-2314), with a final layer of adhesive PVC tape (see Figure 4-3).

Figure 4-4 Water Proofing Antenna Connections

4.5.3 SYSTEM GROUNDING

Direct grounding of the SenSmart 7000 enclosure via a good electrical connection to a well-designed grounding system is essential. This will protect your system, reduce the damage that can occur during lightning strikes and reduce noise.

Chapter 5 – SenSmart 7000 ROUTINE OPERATING INSTRUCTIONS

5.1 USING THE MAGNETIC KEYPAD

Each SenSmart 7000 (SenSmart 7000) is supplied with a 1000-0078 magnetic wand for operating the non-intrusive magnetic keypad. Keys are identified as UP, DOWN, NEXT and EDIT and function similar to touch keys except a "swiping" motion of the magnet is used instead of pressing a key. In this manual, a "swipe" means: hold the magnet directly over the key's target, close to the enclosure's glass cover, and in the same motion move the magnet away from the target. Each "swipe" equals one press of the key, and swipes may be done rapidly to move through fields with many options. It is ok to touch the glass with the magnet but be careful not to "swipe" too close to one of the other keys and activate it by mistake.

Modify a menu item by pointing to it, press the EDIT key to display the cursor, press UP / DOWN to change that character, press NEXT to move the cursor, then press EDIT again to load the new item and remove the cursor. Press NEXT to reverse out of the sub-menu.

Figure 5-1 1000-0078 Magnetic Wand

5.2 CYCLING SenSmart 7000 POWER ON/OFF

It is not necessary to remove the instrument enclosure's cover to cycle power ON or OFF. If the LCD readout is blank the SenSmart 7000 is OFF. Apply power by holding the magnet over the UP key in the upper left front panel for a few seconds. When the LCD shows **Release Key**, pull the magnet away and power will remain ON. Turn the SenSmart 7000 OFF by either using the Power Off menu (see Section 8.5) or by holding the magnet over the NEXT key in the upper right front panel. When the LCD shows **EDIT to Accept**, swipe the magnet over the EDIT key and power will turn off.

5.3 CAL MODE – ROUTINE CALIBRATIONS

Calibration is the most important function for ensuring correct gas readings at the SenSmart 7000. The CAL MODE (flow chart shown in Figure 5-3) is designed to make calibration quick, easy and error free. A successful ZERO and SPAN calibration requires only four keystrokes. CAL MODE is always followed by an adjustable CAL PURGE time period (see Section 8.2.2). CAL PURGE holds the output at a safe value to prevent alarms being tripped by the upscale span calibration gas.

Follow these SenSmart 7000 calibration guidelines:

- Calibration accuracy is only as good as the calibration gas accuracy. R. C. Systems recommends calibration gases with NIST (National Institute of Standards and Technology) traceable accuracy to increase the validity of the calibration.
- Do not use a gas cylinder beyond its expiration date.
- Calibrate a new sensor before use.
- Allow the sensor to stabilize before starting calibration.

- Calibrate on a regular schedule. (R. C. Systems recommends once every 3 months, depending on use and sensor exposure to poisons and contaminants.)
- Calibrate only in a clean atmosphere, which is free of background gas.

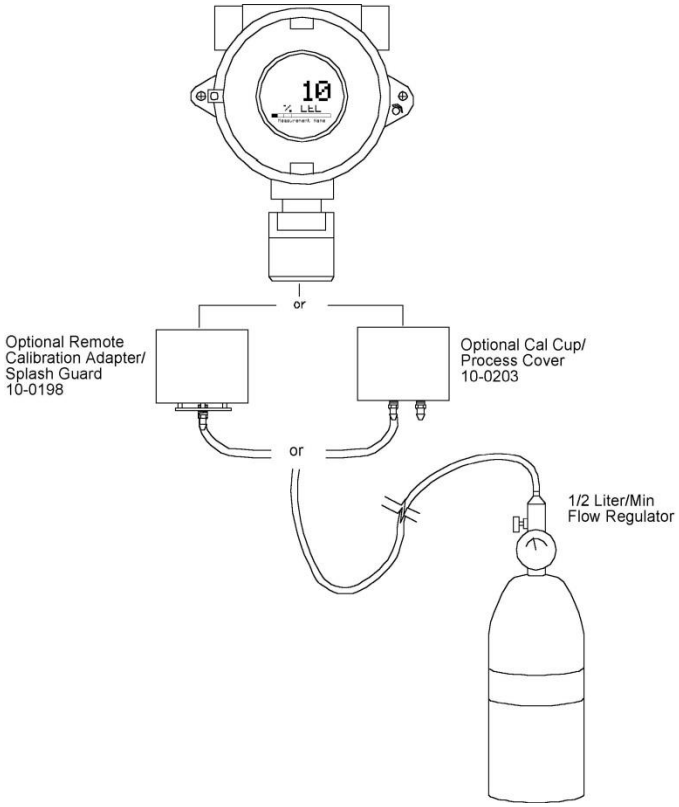


Figure 5-2 Calibration Gas Input

Use the following step-by-step procedure to perform ZERO and SPAN calibrations.

1. To enter the CAL MODE from the data displays, swipe the CAL / DOWN key and within 5 seconds swipe the EDIT key. **Note**: During SenSmart 7000 calibrations, alarms are inhibited and "CAL MODE" is displayed on the WaveLink Receiver (WLR).

2. Using the Cal-Cup (order # 10-0203) apply a clean ZERO gas or be sure there is no background target gas in the monitored area. After the reading is stable swipe the EDIT key to perform a ZERO calibration.

3. If the ZERO calibration is successful, swipe the NEXT key to proceed to the SPAN check.

4. Apply the **correct** SPAN gas at .5 liters/min. After the reading is stable swipe the EDIT key to perform a SPAN calibration.

   WARNING: The SPAN gas used must match the value specified since this is what the SenSmart 7000 will indicate after a successful SPAN calibration. The ***Cal Span Value*** may be edited if it becomes necessary to apply a different gas concentration (see Section 7.2.6).

5. If the SPAN calibration is successful, the display flashes "REMOVE CAL GAS" and starts the CAL PURGE delay (see Section 8.2.2). **Note**: During CAL PURGE, toxic monitors transmit 0% FS to the WLR to prevent alarms by residual upscale SPAN values. Oxygen monitors transmit a 20.9% oxygen reading during CAL PURGE to avoid tripping low oxygen alarms.

6. CAL MODE is complete after the end of the CAL PURGE delay.

The flow chart in Figure 5-3 illustrates the above procedure from left to right. UP, CAL, NEXT & EDIT labels indicate keystrokes using the magnetic wand. The CAL MODE information screen (top of the chart) is available for advanced users to see Offset / Gain calibration constants and live analog to digital converter (A/D) counts. Span Gas calibration values may also be edited from this screen. Holding the UP key, for 5 seconds during CAL MODE, displays this screen.

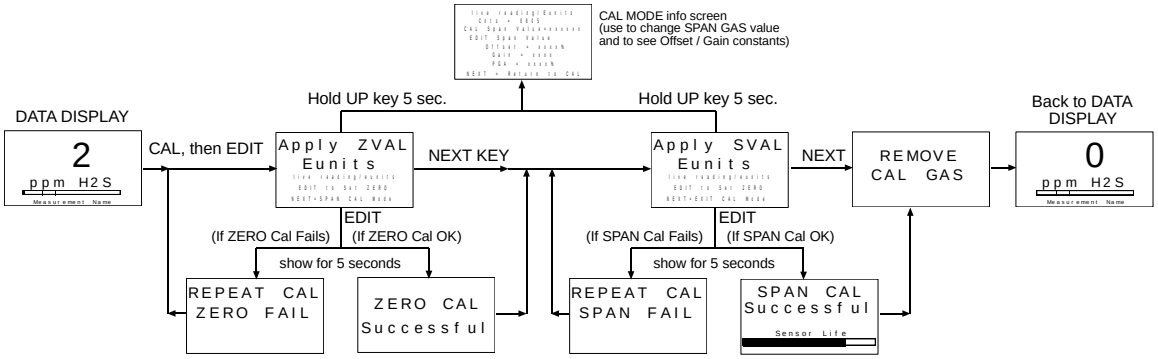


Figure 5-3 Cal-Mode Flow Chart and Menus

5.4 ALARM OPERATION

All alarm decision making is done by the SenSmart 7000 with the results broadcast to the WLR/WNR. SenSmart 7000s have five front panel LEDs to indicate Alarm 1, Alarm 2 and Alarm 3, FAIL and COM (Broadcast). Alarm LEDs only flash during alarm events to conserve battery life. **Low Battery** is indicated by an icon on the LCD and by flashing the FAIL LED. **ONLY LEVEL ALARMS (A1, A2, A3) INCREASE WIRELESS BROADCASTS TO EVERY 6 SECONDS**! Alarms may be set to trip upon increasing and decreasing readings (see Section 7.3.3).

5.4.1 UNDERSTANDING FAIL ALARM OPERATION

The **FAIL** alarm indicates system related problems such as missing sensor, sensor failures, inability to synchronize to the Server and excessive negative readings. The Fault alarm menu described in Section 7.3 allows setting how far below zero (negative) the reading may fall prior to tripping the FAIL alarm. The FAIL ALARM WILL ALSO TRIP WITH MISSING OR FAILED SENSORS REGARDLESS OF THE READING!
CAUTION: Missing or failed sensors always trip the FAIL alarm. FAIL alarm conditions DO NOT cause the radio broadcast rate to increase to 6 seconds.

5.4.2 LOW BATTERY CONDITION

The nominal battery voltage is 3.6 volts, and SenSmart 7000s trip their **Low Batt** alarm at < 3.3 volts. This causes the **Low Batt** icon to appear in the upper left hand corner of the display and the **Fail** LED to flash. At 3.2 volts the SenSmart 7000 enters the replace battery mode. In this mode, there may be insufficient power to transmit a signal to the WLR/WNR it is connected to which will most likely result in a Comm Error (Section 3.2). In this mode, the SenSmart 7000 will alternate, every six seconds, between the Replace Battery Screen (Figure 5-4) and the screen which was previously being monitored. It will continue in this manner until the battery is replaced (Section 3.3) or the battery no longer carries a sufficient voltage to power the unit.

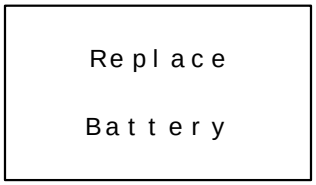


Figure 5-4 Replace Battery Screen

5.5 SMART SENSOR MODULES

Each SenSmart 7000 may be supplied with either one, or two, "Smart Sensor" gas sensor modules mounted locally to the SenSmart 7000 enclosure, or up 15 feet away with the 10-0411 "Sensor Separation Kit". "Smart Sensors" utilize a unique ***Smart Sensor Interface*** to transfer necessary configuration parameters from the Smart Sensor's memory to the SenSmart 7000 whenever a new sensor is installed. The "Smart Sensor Info" screen appears at power up and anytime a sensor module is removed and installed again. If a sensor is installed that does not match gas type of the previous sensor, the operator must manually approve the new sensor in order for the SenSmart 7000 to accept the new gas type (Figure 5-4).

Local sensor heads have a *Smart Sensor* cable connected to S1 (Channel 1) and/or S2 (Channel 2) of the 10-0407 Battery / I/O PCB (see Figure 3-2).

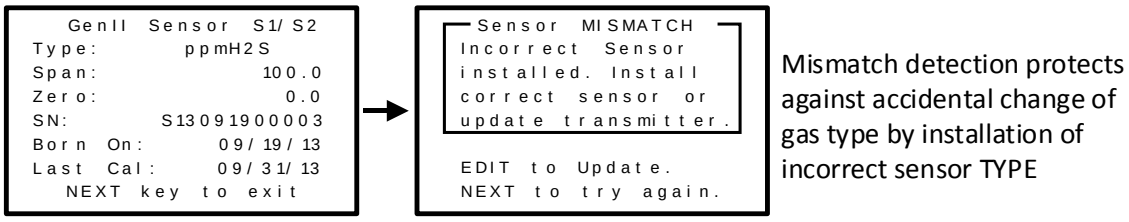


Figure 5-5 Smart Sensor Info / ERROR Screens

5.5.1 SenSmart 7000 10-0411 SENSOR SEPARATION KIT

Smart Sensor heads may be remote mounted up to 15 feet using the 10-0411 sensor separation kit connected to TB1 or TB2 of the 10-0407 Battery / I/O PCB (see Figure 3-2). The 10-0411 Sensor Separation Kit comes with 15 feet of data cable (1000-2730) and assures proper communication over the **Smart Sensor Interface**. Alternate cable types and longer distances are not approved and may result in poor performance.

Figure 5-6 Sensor Separation Kit 10-0411

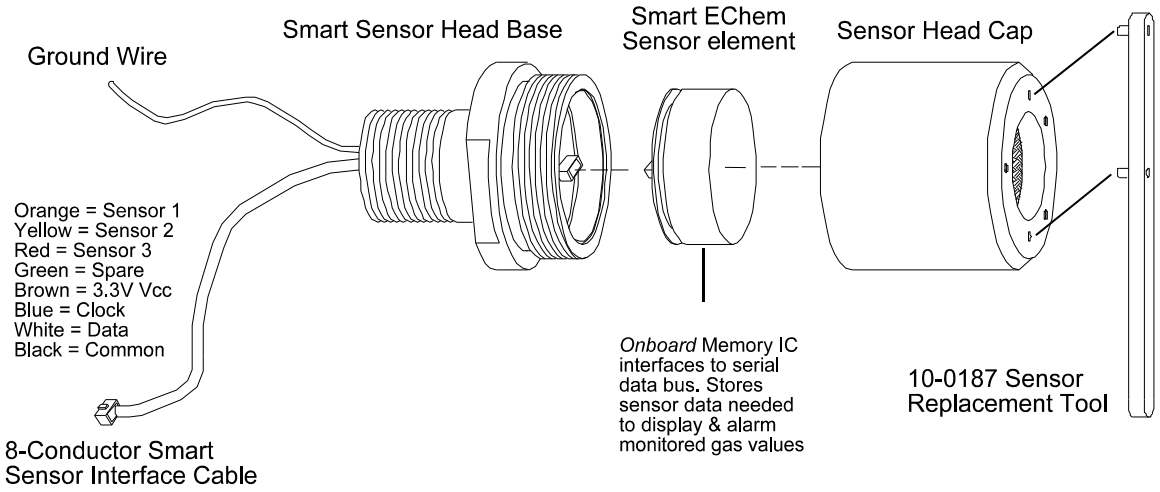


Figure 5-7 10-0247 Smart Sensor Head Assembly

Chapter 6 – SenSmart 7000 SETUP MENUS

6.1 MENU STRUCTURES

SenSmart 7000 (SenSmart 7000) configuration parameters are stored in its non-volatile menu database. Menus are accessed by swiping the EDIT key from any data display. This displays the **MAIN MENU** with a path to **Channel 1**, **Channel 2, Device Setup** and **Help** menus. **Channel 1** and **Channel 2** have two separate but identical menu structures which determine how readings and alarms function for each channel. Menus contain nominal default values from the factory which may be edited by the operator to better match the particular application. Section 7 is dedicated to describing **Channel** menus.

Device Setup contains menus not pertaining to either channel but to the unit as a whole. These include Security, Clock/Calendar, Delays, and how the SenSmart 7000 communicates to the wireless network. Section 8 is dedicated to describing **Device Setup** menus.

6.2 MAIN MENU

The **MAIN MENU** setup screen is shown in Figure 6-1. The UP / DOWN keys maneuver the pointer while EDIT enters sub-levels of menu items. All **MAIN MENU** items have at least one page of sub-menus indicated by the > symbol (right hand pointing arrow) at the end of each line. Change a menu item by:

1. Select UP/DOWN key so that the arrow on the left is pointing to the desired menu item.
2. Select the EDIT key to display the cursor.
3. Select UP / DOWN to change that character.
4. Select NEXT to advance the cursor.
5. Select EDIT again to load the new item, and remove the cursor.
6. Select NEXT to reverse out of the sub-menu.

The MAIN MENU is the pathway to **CHANNEL 1 / 2** menus, **Device Setup** menus and the **Help** pages. A channel should only be activated if it has a sensor connected to the 10-0407 Battery / I/O board. The **Device Setup** group (see Section 8) contains parameters affecting the entire SenSmart 7000 regardless of channel.

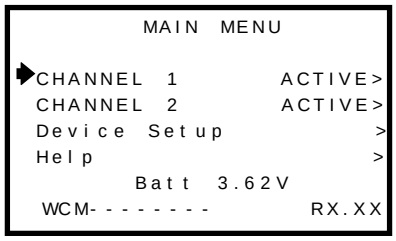


Figure 6-1 Main Menu Entry

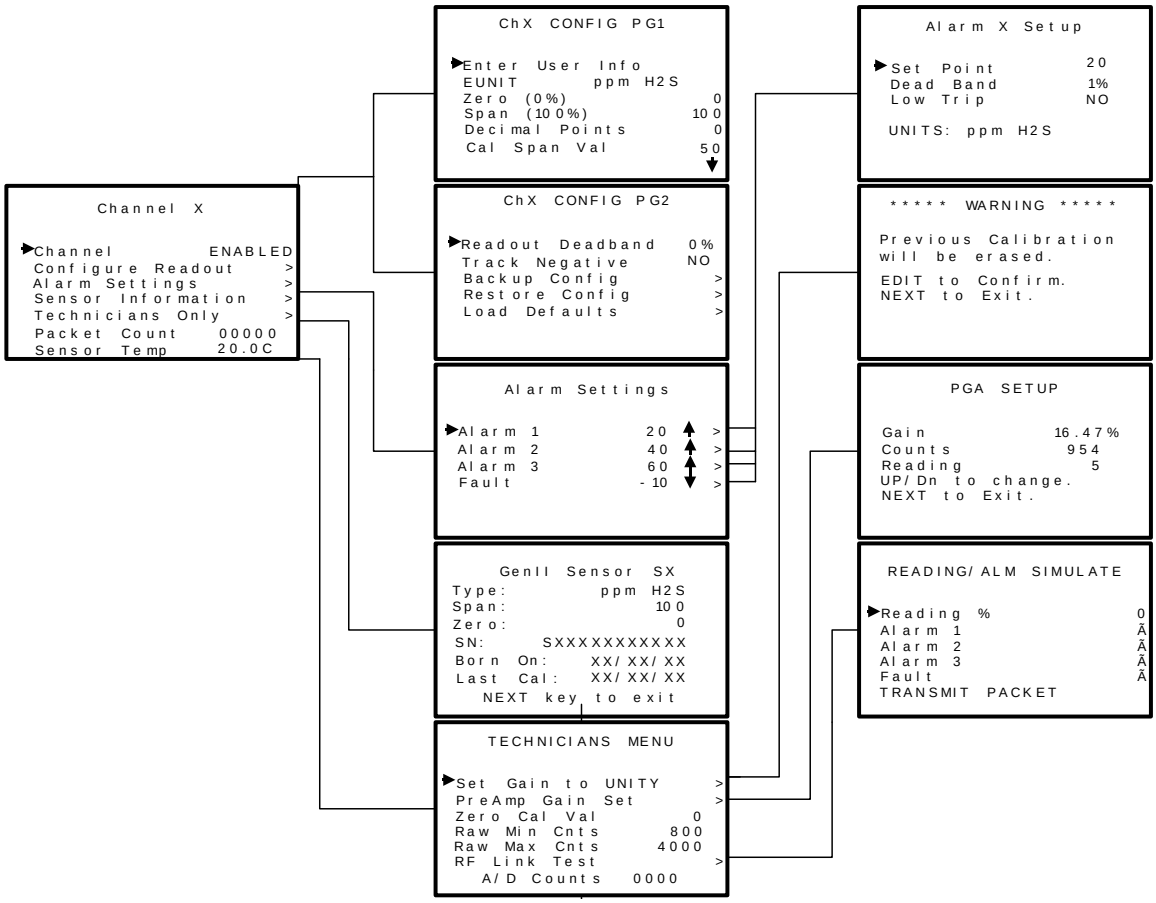


Figure 6-2 SenSmart 7000 Channel Configuration Menu Tree

Chapter 7 – SenSmart 7000 CHANNEL SETUP MENUS

The CHANNEL 1 / CHANNEL 2 menus accessed from the MAIN MENU are shown in Figure 7-1.

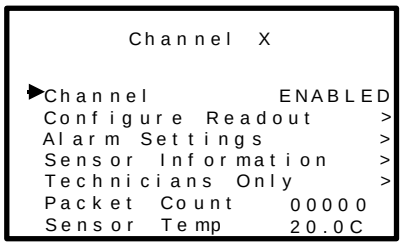


Figure 7-1 Channel Setup Menus

7.1 CHANNEL ENABLE / INACTIVE

Use the top menu in the group to make this channel either "ENABLED" or "INACTIVE". Channels should only be activated if a sensor is connected (see Section 5.5).

7.2 CONFIGURE READOUT

The Configure Readout group shown in Figure 7-2 has 2 pages of menus for controlling how sensor signals are displayed and alarms are activated for this channel.

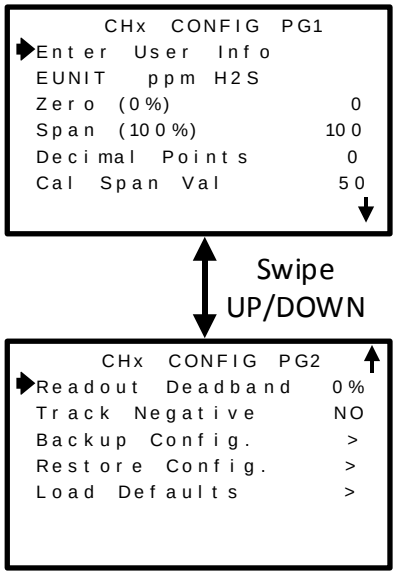


Figure 7-2 Configure Readout Setup Menus

7.2.1 MEASURMENT NAME

The **Measurement Name** field may be edited to contain virtually any 16-character ASCII string. It is typically used to describe the monitored point by user tag # or other familiar terminology.

7.2.2 EUNIT

Eunit (engineering unit) may have up to a 10 character ASCII field and is used to clearly identify the target gas and units of measure such as %, ppm or ppb.

7.2.3 ZERO (0%)

Zero (0%) defines the reading to be displayed when the monitored value = 0% of full scale.

7.2.4 SPAN (100%)

Span (100%) defines the reading to be displayed when the signal = 100% of full scale. The highest numeric reading allowed is 9999 including negative polarity sign and one decimal point. Polarity is only indicated for negative readings.

7.2.5 DECIMAL POINTS

Decimal Points determine the resolution of the LCD readings, and may be set to 0, 1 or 2 decimal points. Example: ZERO readings for 0, 1 & 2 DPs respectively are 0, 0.0 and 0.00.

7.2.6 CAL SPAN VAL

Cal Span Val sets the upscale gas value that must be applied when performing Span calibrations. This is typically at least 50% of the full scale range. Calibration accuracy is dependent on this setting matching the value of target gas in the span gas cylinder used during routine Span calibrations (see Section 5.3).

7.2.7 READOUT DEAD BAND

Readout Dead band allows forcing low readings to continue to read zero. This is useful when there are very small, safe, levels of background target gas that cause fluctuating readouts above zero. The highest amount of dead band allowed is 5% of the full scale range. Example: If the range is 0 – 10.0 ppm, setting **Dead band** to 3% would mean the readout continues to display 0.0 until the value exceeds .3 ppm.

7.2.8 TRACK NEGATIVE

Track Negative, set to NO, causes negative values to read the ***Zero (0%)*** value in data displays. The CAL MODE readout will display negative values regardless of this setting. Negative values below the Fault set point will still cause the Fault alarm to trip (see Section 5.4.1).

7.2.9 BACKUP CONFIG

Backup Config allows users to store the **CHANNEL** menu parameters into non-volatile memory for restoration later, if incorrect values are accidentally entered or uploaded.

7.2.10 RESTORE CONFIG

Restore Config restores the **CHANNEL** menu database to the values from the most recent **Backup Config** the special keystroke sequence of 4 consecutive UP keys is required to perform the **Restore** operations.

7.2.11 LOAD DEFAULTS

Users are encouraged to modify the **Channel** parameters described in this section when it helps tailor the SenSmart 7000 to their project. However, at some point it may be desirable to return all of these settings to their original factory defaults values. Each smart sensor has a protected database containing a copy of the original factory default values which the SenSmart 7000 user cannot modify. The **Load Defaults** menu retrieves these original factory default values from the smart sensor and repopulates all **Channel** menus to match.

7.3 ALARM SETTINGS

The **Alarm Settings** page includes the **Alarm 1, 2, 3** and **Fault** menus shown in Figure 7-3. Alarm conditions are indicated by "A1", "A2", "A3" and "FAULT" LCD icons on data displays and by flashing the A1, A2, A3 and FAIL LED's. The FAIL LED also flashes if the SenSmart 7000 detects a missing or defective sensor. Up or Down pointing arrows indicate if the alarm is set for a high or low trip respectively.

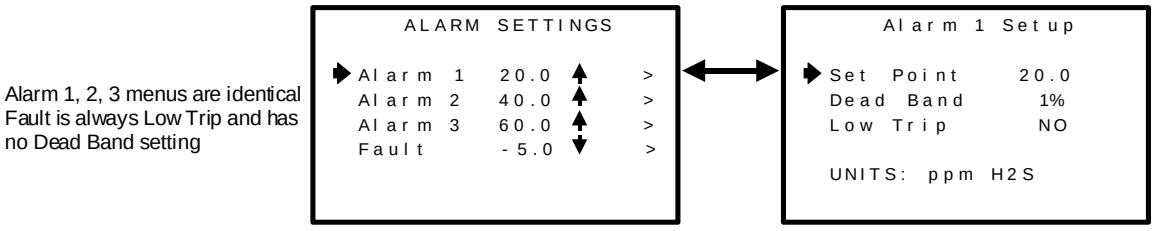


Figure 7-3 Alarm Settings Menus

7.3.1 SET POINT

Set Point enters the **Eunit** value where the alarm trips. The Fault Set Point may only be set for negative values between 0% and -10% of range and is always Low Trip. This makes it function as a FAULT alarm and trip when the monitored value is out-of-range negative.

7.3.2 DEAD BAND

Dead Band for A1, A2 and A3 have a minimum value of 1% and a maximum value of 10%. **Dead Band** is useful for preventing alarm cycling when the monitored value is hovering around the set point. EXAMPLE: With a range of 0-100 ppm, if Dead-Band equals 5% and the set point is 20 ppm, after tripping at 20 ppm the value must drop below 15 ppm to reset. **Dead Band** for the Fault alarm is fixed at 1%.

7.3.3 LOW TRIP

Low Trip for A1, A2 and A3 set to YES causes the alarm to trip as the value falls below the set point. The Fault alarm is always a **Low Trip.**

7.4 SENSOR INFORMATION

The **Sensor Information** page shown in Figure 7-4 displays important values for the Smart Sensor installed. The SenSmart 7000 Smart Sensor interface automatically detects new Smart Sensors and updates this page any time a new sensor is installed.

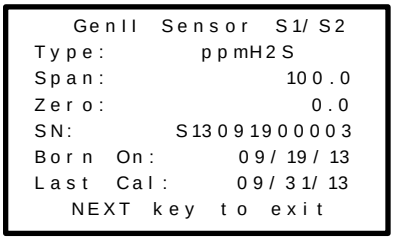


Figure 7-4 Smart Sensor Information Screen

Type, Span, Zero, SN (Serial Number) and **Born On Date** are set at the factory and may not be modified. **Last Cal** date updates each time the CAL MODE is performed (see Section 5.3). **Type** indicates what kind of sensor is plugged into this SenSmart 7000 channel. **Span / Zero** indicate the nominal gas range for this sensor but not necessarily what the user's range must be. For example, the nominal Span of an H2S sensor might be 100 ppm but the user may decide to set his SenSmart 7000 Span for only 50 ppm. See **Preamp Gain** Section 7.5.2 to learn how to set the SenSmart 7000 span for a different range than the Smart Sensor's nominal Span. **Born On Date** shows when the sensor was originally configured at the factory.

7.5 TECHNICIANS ONLY

WARNING! Users of these menus must have a detailed understanding of their functions. Monitoring of target gases, processing of alarms and wireless communications should not be relied upon while editing these menus! **Back-up the current configuration prior to altering any Technician menus in case Restore is required later (see Section 7.2.10).**

The **TECHNICIAN ONLY** menu group in Figure 7-5 contains items that are **factory configured** depending upon the type of sensor input connected to the SenSmart 7000. They should not be tampered with after installation. If configured incorrectly, some items will prevent accurate monitoring of target gases. **Access requires a special key sequence of four consecutive UP keystrokes** to prevent accidental modification of critical items.

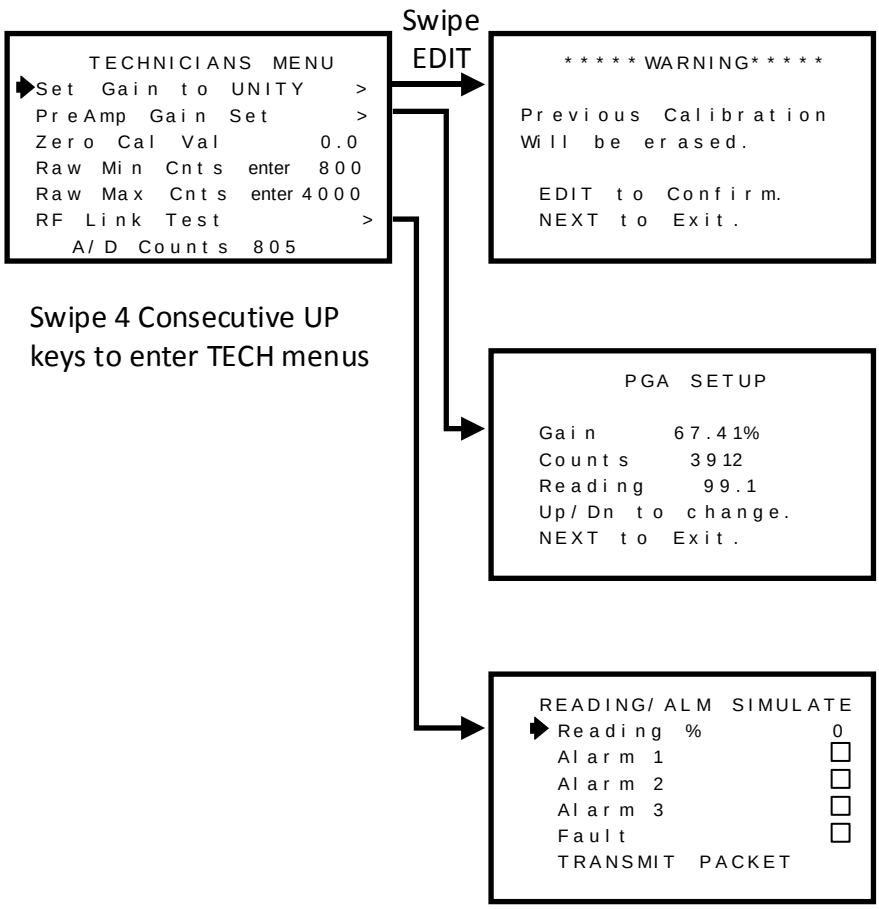


Figure 7-5 Technicians Menu Tree

7.5.1 SET GAIN TO UNITY (TECHNICIANS ONLY!)

Set Gain to UNITY allows resetting previous calibration OFFSET to zero and GAIN to one. This is the definition of UNITY. A calibration should be performed after setting UNITY (see Cal Mode Section 5.3).

7.5.2 PREAMP GAIN ADJUST (PGA) (TECHNICIANS ONLY!)

Gas sensors have a very wide output signal range, across the many gas types, and there are several full scale ranges for each type. **Preamp Gain** is the adjustment that matches the sensor element's signal range to the Smart Sensor's input signal conditioning circuits. The **Preamp Gain** value is saved into non-volatile memory on the Smart Sensor module. Altering the Preamp Gain automatically resets previous calibration OFFSET and GAIN values to UNITY as described in Section 7.5.1.

If it is determined the **Preamp Gain** value is incorrect, apply the desired up-scale target gas value to the sensor and use the UP / DOWN keys to obtain the correct **Reading** value. **Counts** are the 12-bit binary A/D value with an active range value of 800 – 4000 for 0-100% of full scale.

CAUTION: For standard installations this is a factory adjustment. Do not use the **Preamp Gain** menu for calibrating sensors. It should only be adjusted if a new measurement gas or input range is required.

7.5.3 ZERO CAL VALUE (TECHNICIANS ONLY!)

The **Zero Cal Value** menu entry allows the zero calibration value to be set for something other than a zero reading. In rare cases it may be necessary to perform Zero calibrations at some other engineering unit reading than zero. Do not exceed 25% of full scale.

7.5.4 RAW MIN / MAX COUNTS (TECHNICIANS ONLY!)

The **Raw Min / Max Counts** menus determine the range of 12-bit analog to digital (A/D) converter counts that define 0 and 100% of full scale. The default range is 800 – 4000 counts. **Raw Min A/D** counts create 0% readings, and **Raw Max A/D** counts create 100% readings. The corresponding **Zero 0%** and **Span 100%** readouts that appear on data displays are entered in the CHANNEL Configuration Menu describe in Sections 7.2.3 and 7.2.4. Live A/D count input values may be viewed on the **Preamp Gain** screen and the **CAL MODE** Information screens described Sections 7.5.2 and 5.3.

7.5.5 RF LINK TEST (TECHNICIANS ONLY!)

The **RF LINK TEST** shown in Figure 7-6 is a diagnostics tool which allows readings of 0%, 25%, 50%, 75% or 100% of the full scale range to be broadcast to any WaveLink Receiver(WLR) and/or WaveNet Relayer(WNR) on the same network. Alarms may also be sent by filling the check box. After the menu is ready, simply point to TRANSMIT PACKET menu and swipe the EDIT key. The broadcast is made every time the EDIT key is swiped. **RF LINK TEST** is very useful for troubleshooting and testing a new installation.

IMPORTANT! WLR/WNR relays do activate if alarms boxes are checked!

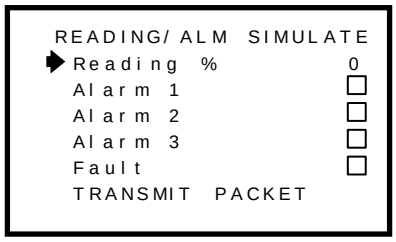


Figure 7-6 RF Link Test

7.5.6 SENSOR TEMP COMP TABLE (TECHNICIANS ONLY!)

Signals from electrochemical sensor elements used in SenSmart 7000 Smart Sensor modules may be affected by temperature extremes. SenSmart 7000 Smart Sensors are equipped with an on board temperature sensor which monitors temperature of the sensor element. Sensor types have a matching Temperature Compensation profile which is stored with each Smart sensor in the table shown in Figure 7-7. This TEMP COMP TABLE is a hidden menu but may be accessed from the TECHNICIANS MENU by holding the DOWN key until it appears.

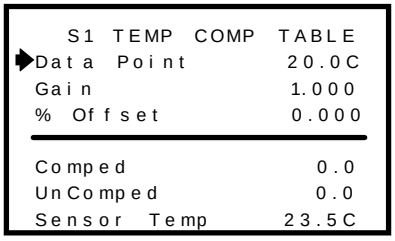


Figure 7-7 Temperature Compensation Table

The temperature **Data Points** scroll by in 10 degree C increments from -40C to + 60C with each swipe of the EDIT key. Each Data Point has an associated **Gain** and **Offset** value. Electrochemical sensors may be less sensitive to the target gas at lower temperatures than at higher temperatures and therefore require higher gain when cold and less gain when hot. To accomplish this, **Temp Comp Table Gain** is typically 1.000 at 20C and increases gradually at the colder Data Points and decreases at warmer. Some sensors may also have a shift in zero output at extreme temperatures. The **Offset** values add or subtract in % of full scale using the following formula: **Gain (Uncomped – Offset) = Comped**. Note that Offset values entered with a negative number actually add to the reading. **Sensor Temp** is a live readout from the current temperature of the sensor element.

7.6 PACKET COUNT

Packet Count appears at the bottom of Channel Setup menu, and is a 5 digit decimal number indicating the number of transmissions the SenSmart 7000 has transmitted since the last reset; up to 65,535 transmissions. This is a useful diagnostic tool for comparing how many times the SenSmart 7000 transmits to the number of transmissions received by receivers over a period of time

When the SenSmart 7000 is in dual channel mode each channel will display the number of transmissions for that channel independently, on its respective Channel Setup Menu (Figure 7-1).

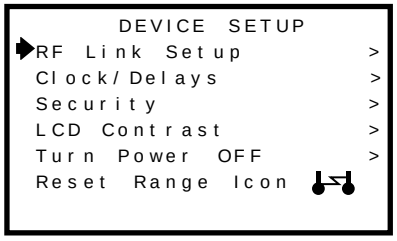
The TX Counter is reset by moving the cursor to the Packet Count line and selecting EDIT, or by cycling power to the SenSmart 7000.

7.7 SENSOR TEMP READING

The last item on the CHANNEL menus page is a live reading of the Smart Sensor's temperature. This reading is used if the sensor element requires temperature compensation (see Section 7.5.6).

Chapter 8 – SenSmart 7000 DEVICE SETUP MENUS

The **Device Setup** group shown in Figure 8-1 contains parameters affecting the entire SenSmart 7000 (SenSmart 7000) regardless of channel. These include Security, Clock/Calendar, Delays, and how the SenSmart 7000 communicates to the wireless network.



The "Reset Range Icon" menu only appears if the WCS was out of range of the Server during a previous broadcast attempt. To reset the Range Icon select the Reset Range Icon option.

Figure 8-1 Device Setup Menus

8.1 RF LINK SETUP

RF LINK SETUP provides access to a group of menus for configuring how the SenSmart 7000 broadcasts its data to the WaveNet wireless network. Items tagged with an asterisk affect power consumption and battery life.

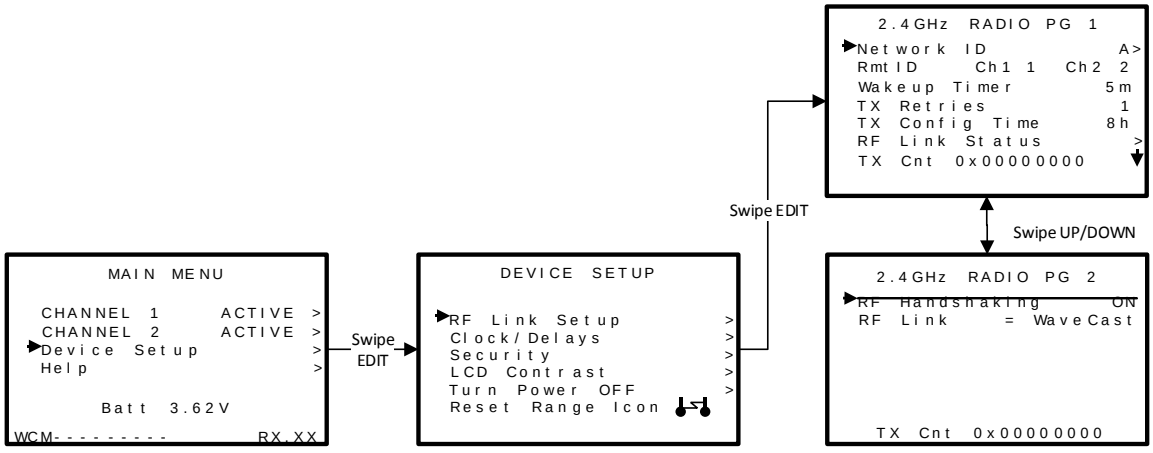


Figure 8-2 RF Link Setup Menu

8.1.1 NETWORK ID

WaveNet devices utilize the **Network ID** setting to assign up to 26 unique hopping patterns. To simplify system setup, **Network ID** is entered using letter designators "A" through "Z" where A = [Hop Channel 1, System ID 1] and Z = [Hop Channel 26, System ID 26]. A SenSmart 7000 will not indicate Server In-Range status or communicate with any WaveLink Receiver (WLR) and/or WaveNet Relayer (WNR) operating on a different **Network ID**. This feature allows multiple WaveNet wireless systems to be located within range of each other without interference.

Networks M through Z are encrypted networks. When one of these networks is selected the data will be encrypted via proprietary methods to ensure that only devices on that network, which hold the encryption key, will be able to decipher the data being transmitted.

IMPORTANT! Explore what frequencies are appropriate for the final location of any wireless system.

8.1.2 RMTID

WaveNet systems allow up to 32 SenSmart 7000 **RTU #s** per network. **IMPORTANT!** Dual sensor SenSmart 7000s have two **RTU #s** and they are always consecutive. For example, setting the **RTU #** of Sensor 1 to 5 automatically sets this SenSmart 7000's Sensor 2 **RTU #** to 6. The SenSmart 7000 **RTU #** is used by the WLR/WNR to control which channels the sensor readings are displayed on, and how its relays are tripped. It is not necessary for SenSmart 7000 **RTU #s** AND WLR/WNR CHANNEL NUMBERS TO MATCH. A separate WLR/WNR menu allows random matching of WLR/WNR Channel numbers to SenSmart 7000 **RTU #s**. This is useful for creating "zones" where monitors with the same gas type may be displayed on consecutive WLR/WNR channels.

*8.1.3 *WAKEUP TIMER*

The **Wakeup Timer** menu determines how often the SenSmart 7000 broadcasts its data when there is no A1, A2 or A3 LEVEL ALARM. Active A1, A2, A3 alarms override the **Wakeup Timer** and schedule broadcasts 6-seconds after each previous broadcast. The **Wakeup Timer** range is 1 minute – 5 minutes with 5 minutes being the default value.

Note: Broadcast intervals will actually be a few seconds longer than the value entered since the SenSmart 7000 radio module must be powered up and achieve Server In-Range status prior to broadcasting.

IMPORTANT: More frequent RF broadcasts deplete the battery faster!

*8.1.4 *TX RETRIES*

The **TX Retries** menu allows EVERY broadcast to be repeated up to 5 times with a 200mS delay between each repeated broadcast. Each repeated broadcast will appear as a separate blink of the SenSmart 7000's TX LED and the WLR/WNRs RX LED.

The default setting of 1 should only be increased if there is no other way to improve communications success. Increasing **TX Retries** may be a viable way to improve communications if there are other high power RF radiators near WaveNet antennas, and it is not possible to relocate the antennas. Power consumption increases with radio broadcasts, and battery life will be affected by raising the **TX Retries** setting.

Transmissions will perform as follows for the TX Retries settings:

1. **TX Retries** set to **1, 2 or 3**: the SenSmart 7000 automatically transmits one, two and three times respectively.
2. **TX Retries** set to **4**: the SenSmart 7000 transmits until an acknowledgement is received from the server or four times, whichever comes first.
3. **TX Retries** set to **5**: the SenSmart 7000 transmits until an acknowledgement is received from the server or five times, whichever comes first.

*8.1.5 *TX CONFIG TIME*

TX CONFIG TIME may be set from 0 to 18 hours and determines how often the SenSmart 7000 broadcasts all of the CHANNEL CONFIG parameters to the WLR/WNR. Broadcasts normally include only monitored gas values and alarm status, but at least hourly, all configuration is sent to the WLRs to assure identical readings at all locations. The configuration data is also broadcast whenever any menu containing these parameters is edited or manually by holding the UP key for 5 seconds. This longer broadcast takes approximately 1 second to complete.

Setting TX Config Time to 0 means that the SenSmart 7000 will not send all of the Channel Config parameters to the WLR/WNR automatically, and these parameters must be sent by holding the UP key for 5 seconds.

8.1.6 RF LINK STATUS

RF Link Status opens another screen that shows if the SenSmart 7000 is In-Range of the Server and what the battery voltage is currently. The radio remains active during this screen so the range status is displayed in real time. Battery voltage is also displayed on the MAIN MENU.

**** TX Multiples(900MHz and 2.4GHz)***, ***RF Handshaking(900MHz)*** and ***TX Power(900MHz)*** menu settings are available to improve communications reliability by increasing the quantity and power of wireless broadcasts.

IMPORTANT! Ensure proper selection and location of antennas before increasing ***TX Multiples*** and ***TX Power*** settings. Battery life will be reduced by increasing these settings. Proper selection and location of antennas is more important to successful communications and will not sacrifice battery life.

*8.1.7 *RF HANDSHAKING (900MHZ MODELS ONLY)*

RF Handshaking must be OFF if there is more than one WLR/WNR receiving SenSmart 7000 broadcasts. The default OFF setting causes every SenSmart 7000 broadcast to repeat 3 times in rapid succession (these appear as a single blink of the TX LED and are unrelated to **TX Multiples**). The ON setting requests an Acknowledge, or, "Handshake" from the Server. With **RF Handshaking** = ON, the SenSmart 7000 broadcasts only once if the Acknowledge is received, and up to 3 times if an Acknowledge is not received.

IMPORTANT! The ON setting allows more efficient communications but must only be utilized when broadcasting to a single WLR/WNR configured as Server. Multiple WLRs/WNRs, listening on the same **NETWORK ID,** will have acknowledge data collisions if the SenSmart 7000 **RF Handshaking** = ON.

RF HANDSHAKING = OFF may be used for any application, but is required when broadcasting to a WLR/WNR Server and other WLR/WNR Clients.

*8.1.8 *RF LINK*

RF Link will change the mode in which the SenSmart 7000 will communicate. The default setting is the WaveCast mode which is discussed in detail in Section 8. By selecting **RF Link** the mode may be changed to Legacy Mode, which is discussed in Chapter 10.

*8.1.9 *TX POWER (900MHZ MODELS ONLY)*

TX Power (900MHz models only) may be set for 10mW, 200mW and 400mW (EIRP based upon a 2 dBi antenna). Since SenSmart 7000s are battery powered the **TX Power** setting should be as low as possible to sustain reliable communication. The maximum **TX Power** setting is 30db (1 watt) and each time TX power is reduced by half, antenna transmit power is reduced by 3dB.

Note: 1 watt operation is not recommended or necessary for most applications as it can cause an unnecessary load on the battery thereby significantly reducing battery life.

Under normal operations the SenSmart 7000 cannot be set to 1 watt. In order to set the SenSmart 7000 to 1 watt hold the up key for 5 seconds while at the bottom of the radio menu. A1 and A3 LEDs will flash to indicate the change, and now 1 watt is an available option under TX Power.

2.4GHZ variation: The TX Power menu is not available in 2.4GHZ models and is fixed at 125mW conducted.

8.1.10 TX CNT (TRANSMIT COUNTER)

TX Cnt. (Transmit Counter) appears at the bottom of the RF LINK page and is an 8 digit hexadecimal counter that appears as 0x00000000. The highest count would be 0xFFFFFFFF, or 4,294,967,295 decimal. It is useful as a diagnostic tool for counting how many times the SenSmart 7000 broadcasts over any given period of time. To reset the TX Cnt hold the CAL/DOWN key when on the RF Link Setup menu.

When in dual channel mode this number combines the transmissions from each channel.

8.2 CLOCK, WARM-UP and CAL PURGE DELAYS

The SenSmart 7000 is equipped with a Real Time Clock and Calendar so **Time** and **Date** must be set to correctly match its location. They are set at the factory in a 24 hour format but may require adjustment to match the location's time and date after shipment. **Warm Up** and **Cal Purge** time delays are also available to prevent unwanted alarm trips. Figure 8-3 shows the menu for these items.

8.2.1 WARM UP TIMER

The **WARM UP** timer is has a default setting of 60 seconds but may be between 0 – 254 seconds. The primary purpose of the warm up timer is to allow sensor stabilization after power up.

8.2.2 CAL PURGE TIMER

The **CAL PURGE** timer has a default setting of 60 seconds, but may be set between 0 – 254 seconds. The primary purpose is to allow sensor stabilization after a Span calibration (see Section 5.3). A purge interval is needed after the span calibration, because up-scale readings will linger until the span gas exits the sensor head. Alarms are inhibited during the **CAL PURGE** interval.

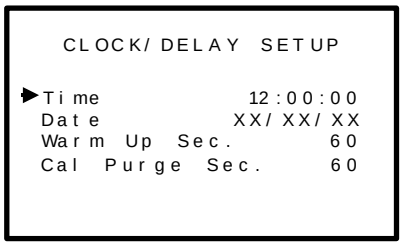


Figure 8-3 Clock & Calendar / Delay Timer Menu

8.3 SYSTEM SECURITY

The **SYSTEM SECURITY** menu in Figure 8-4 offers two levels of protection. A **LOW** level allows CAL MODE sensor calibrations, but requires the 4-digit **Pass Code** prior to altering menus. **HIGH** level locks the entire menu database, plus CAL Mode, until the correct **Pass Code** is entered. **LOW** and **HIGH** security levels always allow

viewing of configuration menus but they may not be modified. **Contact Name** is a 12 character ASCII field available for displaying a phone #, or name, of personnel who manage the **Pass Code**.

Lost **Pass Codes** may be recovered by entering the locked security menu and holding the UP key for 5 seconds. The 4-digit code appears near the bottom of the screen.

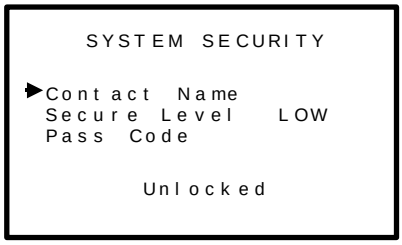


Figure 8-4 System Security Menu

8.4 LCD CONTRAST ADJUST

LCD Contrast Adj. may be set for optimum viewing using the menu shown in Figure 8-5. To adjust swipe the UP/DOWN keys, and swipe next to save and exit.

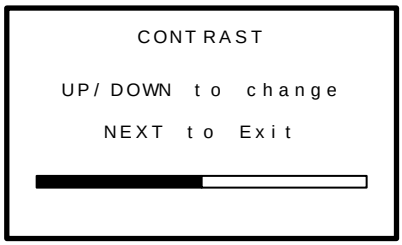


Figure 8-5 LCD Contrast Adjust Menu

8.5 TURN POWER OFF

There are three ways to power down the SenSmart 7000. Use this menu in the DEVICE SETUP group, or, with any **Data Display** on the screen hold the NEXT key for several seconds. The final way, which should only be used if the unit is not responding to any key swipes, is to hold the EDIT key until the unit powers down. Power should be turned off prior to replacing the battery. Otherwise, a large storage capacitor will keep the SenSmart 7000 powered for up to 10 minutes even after the battery is removed.

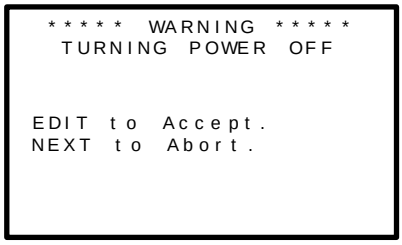


Figure 8-6 Turn Power OFF Menu

8.6 RESET RANGE ICON

The **Reset Range Icon** menu only appears if the SenSmart 7000 has experienced an Out-of-Range () condition, but later recovered to achieve Server In-Range status. In this case, the SenSmart 7000 latches the Server Previously Out-of-Range condition and displays the associated icon () on readouts to indicate a potential problem with communications to this SenSmart 7000. It is important to Reset the unit back to the desired Server In-Range icon () either by using this menu or by cycling SenSmart 7000 power.

Following is a description how to use the range icons as wireless network troubleshooting tools:

The SenSmart 7000 displays one of three RANGE ICONS ( ,,) to indicate if its radio has been achieving the Server In-Range status necessary to broadcast its data.

- is desired since it indicates **every** attempt to broadcast since power up has been successful.
- indicates, during the **most recent** attempt, the Server could not be found.
- indicates the most recent attempt was successful, however, an earlier attempt was unsuccessful.

If the WLR is experiencing comm errors there are two probable causes:

1. The SenSmart 7000 is not achieving “Server In-Range” status and therefore not broadcasting.
2. The SenSmart 7000 broadcasts but the data is not received by the WLR.

SenSmart 7000 range icons help isolate #1 or #2 since if the desired is displayed, #2 must be the problem. However, if intermittent WLR comm errors occur, and is displayed it is likely the SenSmart 7000 is not reliably achieving a Server In-Range status.

Chapter 9 – WAVENET ANTENNA SELECTION

9.1 ANTENNA SELECTION

9.1.1 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.

9.1.2 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. Yagis 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 Yagis 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.

9.1.3 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.

9.1.4 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.

9.2 SURGE PROTECTION & 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.

9.2.1 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.

9.2.2 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.

Chapter 10 - WAVENET LEGACY MODE

WaveLink Recievers (WLRs) are not compatible with SenSmart 7000s in legacy mode.

When using a SenSmart 7000 (SenSmart 7000) with other R. C. Systems controllers, such as the ST-72, ST-90, ST-71, Rig Protector or other legacy type controllers, it is necessary to operate wirelessly in Legacy Mode.

To enter Legacy mode enter the **RF Link Menu** discussed in Section 8.1.8. To switch from WaveCast mode to Legacy mode select RF Link and enter the special key sequence of four **UP** keystrokes. Once in Legacy mode it is necessary to enter the appropriate **Hop Channel** and **System ID** in accordance with your **Server's Network Configuration**. All other SenSmart 7000 settings function as discussed in Section 8.1.

Chapter 11 - TABLE OF FIGURES