

INSTRUCTION MANUAL

R.C. SYSTEMS CO. INC.

**MODEL ST-95 WIRELESS RELAY & REPEATER
(With RF Wireless Interface)
(Revision 1.0; Firmwares 1.00 and later)**



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

Users are responsible for correct translations of this manual into their native language

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SECTION 1 – SAFETY INFORMATION

1.1 Safety Information – Read Before Installation & Applying Power

IMPORTANT

Users should have a detailed understanding of ST-95 operating and maintenance procedures. Use the ST-95 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 ST-48RF monitors that communicate to the ST-95 with a known value at start-up and check on a regular schedule, at least every 90 days.
- Do not use the ST-95 if its enclosure is damaged or cracked or has missing components.
- Make sure the cover, internal PCB's and antenna connections are securely in place before operation.
- Periodically test for correct operation of the system's alarm events by exposing the monitor to a known value above the High Alarm setpoint.
- Do not expose the ST-95 to electrical shock or continuous severe mechanical shock.
- Protect the ST-95 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.

1.2 Contacting R. C. Systems Co. Inc.

To contact R. C. Systems Co. 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 World Wide Web: www.rcsystemsco.com

SECTION 2 – GENERAL DESCRIPTION


2.1 Introduction

The [ST-95](#) functions on license free 900MHZ (specify **ST-95/900**) or 2.4GHZ (specify **ST-95/2400**) wireless Client / Server networks and may be user configured to receive wireless transmissions from as many as sixteen [ST-48RF](#) wireless sensor transmitters. ST-95 typical applications include providing local relays *and/or* repeating transmissions from ST-48RF's out of range of their destination ST-71 or ST-90/QUAD Controllers. Controllers must be equipped with the matching RF wireless modem and appropriate antenna to receive transmissions. Wireless networks requiring more than sixteen ST-48's, or relays in several locations, may utilize multiple ST-95's to achieve the desired goal. ST-95's must be continuously powered by an external 10-30VDC power source and are ideally suited for 12 solar power supplies.

Three of the ST-95's four relays are user configurable and non-volatile memory retains all configuration data during power interruptions. The 4th relay is dedicated to ST-48RF FAULT / Communication Error conditions and is always failsafe ("failsafe" means contacts indicate alarm event during loss of power because relay coil is energized with no alarm).


ST-95's only receive transmissions from ST-48RF Sensor Transmitters and are incompatible with other wireless devices. Each ST-48RF transmission includes monitored value, 3.6 volt battery voltage and a status byte containing alarm, cal mode and warm up status.

Additional features include:

- Magnetic keypad allows operator interface without opening the enclosure.
- Rx icon “” flashes at top left corner of each readout when an ST-48RF wireless message is received by the ST-95 (see left Readout in Figure 2-1). “Server In Range” or “Server Out of Range” and “ST-48 Low Battery” conditions are also indicated.
- All user configuration is with menus accessed via the LCD / magnetic keypad operator interface without opening the enclosure.
- New ST-48 ALARM 1, ALARM 2, ALARM 3, and FAULT events are indicated at the ST-95 by flashing front panel LED lights. Acknowledged (see section 4.5.1) alarm events are indicated at the ST-95 by steady front panel LED lights.
- ST-48 alarms, communication errors, CAL MODE, low battery, and warm up are indicated by the ST-95 LCD readout.
- Modular design affords efficient installation and troubleshooting.

2.1.1 ST-95 LCD Readouts

Figure 2-1 shows the ST-95's three LCD readout screens for displaying values and alarms from up to sixteen ST-48 sensor transmitters. Readouts in Figure 2-1 simulate a five channel system with an imaginary facility's ST-48RF locations identified as **NE Fence**, **Load Dock**, **East Fence**, **Ani Shelter** and **North Fence**. Eleven characters are available for users to identify each ST-48RF name/location/tag #, by ST-95 channel, on the LCD. Lower channel numbers (1-16) are displayed on top. If the quantity of alarm events requires additional screen pages, the ST-95 will scroll each alarm onto the LCD and highlight the lowest channel # with an arrow. As operators watch alarm events scroll past, they know they have seen all events when the arrow shows again.

An message received “Rx” icon “” flashes at top left of the LCD each time any ST-48 data packet is received by the ST-95.

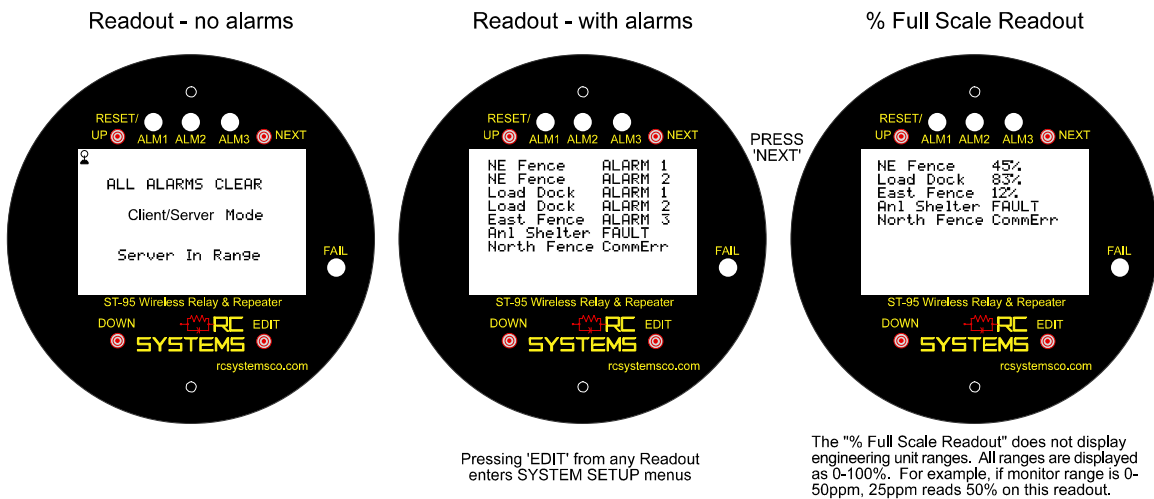


Figure 2-1: Readout Screens

2.2 Description of ST-95 & 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. The wireless network's Server transmits a beacon at the beginning of every frequency hop (50 times per second). Client transceivers with the same **Hop Channel** and **System ID** listen for this beacon and upon receiving it synchronize their hopping with the Server. Since ST-95 radios are always powered they may be user configured for Client or Server operation.

Multiple [ST-71](#), [ST-90/QUAD](#), & [ST-95](#) controllers may receive the same ST-48RF transmissions but only one controller per wireless network may be configured as the Server. All devices on a wireless network must receive the Server's beacons to have successful communication.

Therefore, if there are numerous controllers the most centrally located is typically the Server. If an ST-95 is utilized as a "repeater" (see section 4.4), to improve reception from remote ST-48's, it is generally configured as Server to ensure beacons are received at both ends of the network.

Each transceiver on a wireless network must have its **RADIO SETUP** menus configured to share the same **Hop Channel** (0-32) and **System ID** (0-255) in order to communicate (see section 4.3).

IMPORTANT! There should never be two servers with the same **Hop Channel / System ID** settings in the same coverage area because interference between the two servers will severely hinder RF communications.

Correct planning and design of wireless systems are imperative for ensuring a successful installation. It is highly recommended that a site drawing indicating location of monitors and base station, line of site obstructions, and sources of RF interference be submitted when requesting a quotation.

2.2.1 ST-48RF Communication Cycle and Conserving ST-48 Battery Life

The following list identifies each of the conditions that cause ST-48RF's to transmit:

- Every 5-minutes when there is no A1 or A2 alarm. Important since the receiving ST-95 reports "Comm Error" if the ST-48RF message is not received for periods of greater than 18-minutes. ST-48RF A3 and FAIL alarms do not increase radio transmission rates.
- Every 6-seconds if there is an A1 or A2 level alarm (A3 alarms do not increase rate to 6-seconds).
- Upon entry into CAL MODE a 75 counts value (-15.6% FS) is transmitted. Receivers indicate "IN CAL" when 75 counts is the input for a channel (200 to 1000 counts represents 0 to 100% of full scale).
- Upon ENTRY into CAL PURGE a 200 counts value (0% FS) is transmitted. NOTE: To prevent A1 & A2 low trip alarms, oxygen ranges transmit 20.9% readings upon entry into CAL PURGE.
- Holding the magnet to the UP key for >8 seconds forces a transmission of the current reading value.

2.2.2 #10-0324 ST-95 Relays / Power Supply PCB

ST-95 electronics consists of two PCB assemblies. The 10-0324 Relays / Power Supply PCB (Figure 2-2 right) is mounted to the bottom of the enclosure with four 4-40 screws and connects to the upper Display / Radio assembly (part # 10-0341 = 900MHZ and 10-0340 = 2.4GHZ; Figure 2-2 left) with a 4 conductor cable.

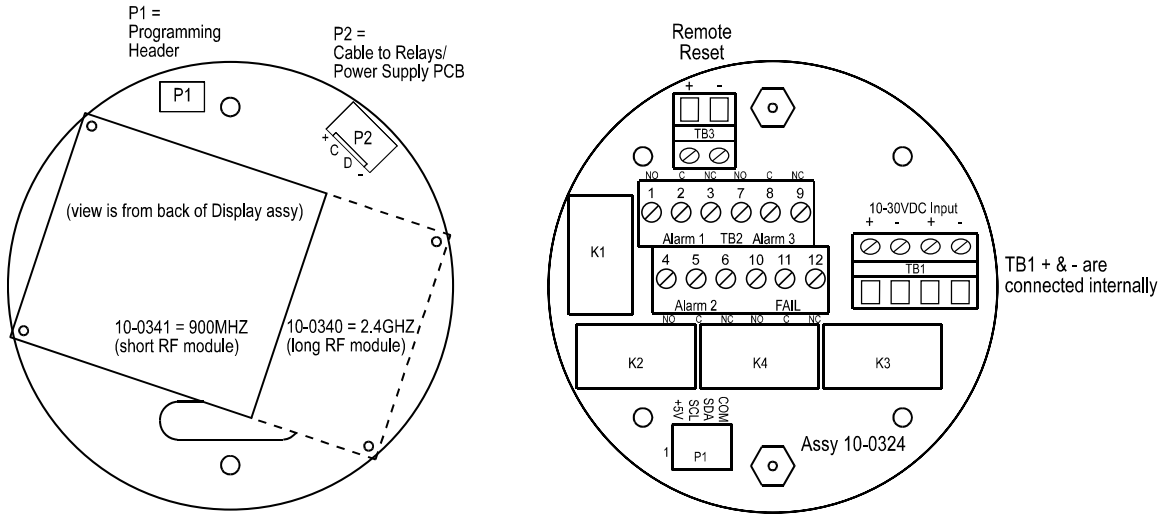


Figure 2-2: Display/Radio Assy & 10-0324 Relays/Power Supply Assy

SECTION 3 – INSTALLATION INSTRUCTIONS

3.1 Ratings and Certifications

The cast aluminum enclosure is NRTL certified for Division 1 hazardous area installations for explosion-proof Class 1 Groups B,C,D (see Figure 3-1). The 10-0295 antenna fitting has an RP-SMA connector and is suitable for Division 2 classified areas. An optional explosion-proof antenna is also available for Division 1 classified areas (order 1000-2193 for 900MHZ and 1000-2301 for 2.4GHZ). Figure 3-3 shows both antenna styles.

3.2 Location

Even though the ST-95 is designed for rugged service it should be protected from environmental damage from water, snow, shock, vibration and dirt. Minimize obstructions around the antenna.

3.3 Mounting the Enclosure

The ST-95 standard enclosure is a cast aluminum explosion-proof (NEMA 7) enclosure as shown in Figure 3-1. Modular design simplifies the installation of the ST-95 (Figure 3-2). The ST-95 antenna should typically be mounted with “line of site” access to the devices it communicates with. If a good “line of site” angle is not possible the ST-95’s will usually still function properly at ranges up to 1500 feet but obstructions should 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 ST-95 to a wall or bracket using the predrilled mounting flanges with I.D. 0.25 on 5.0 inch centers (Figure 3-1).

3.3.1 10-0322 Magnetic Mount Option

R. C. Systems offers square aluminum plate, with a magnet on each corner, to bolt to the back of the ST-95’s instrument enclosure. The 10-0322 Magnetic Mount securely attaches the assembly to solid steel structure that is at least 6 inches wide.

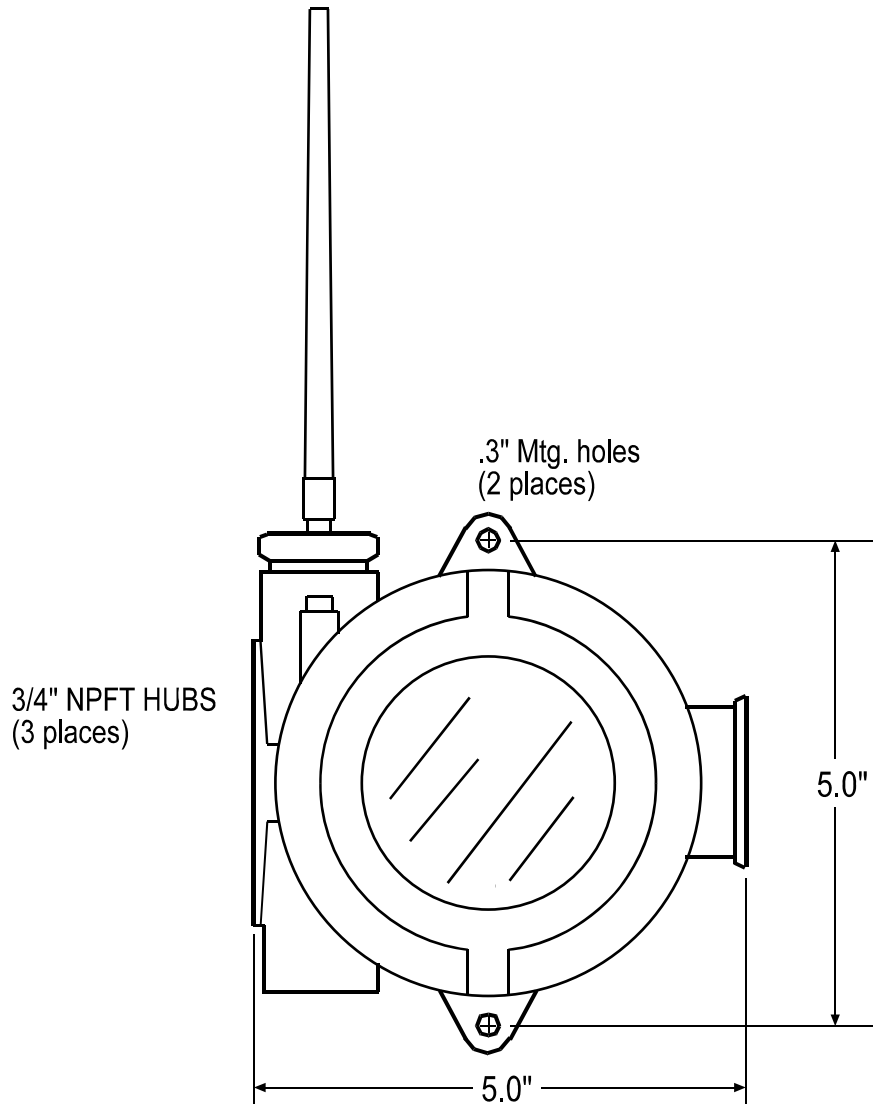


Figure 3-1: ST-95 Explosion-Proof Housing

3.4 Specifications

Power Supply:

10-30 VDC @ 3 watts max.

Transmit (TX) Power

30dBm at highest 1W power setting. Transmit power may be set from 10mW to 1 watt (see Section x-x)

Receive (RX) Sensitivity

-100 dBm

Radio Frequency

See section 4.3.

Memory:

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

3.5 Antenna Transmission Range

The distance radio signals can travel is dependent upon several factors including antenna design, transmitter power and Freespace losses. In order for a wireless link to work, the available system operating margin (**TX power - RX Sensitivity + Antenna gains**) must exceed the Freespace 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 (see below).

<u>Dist. between ant's</u>	<u>Fresnel zone diameter</u>	<u>Freespace loss (dB)</u>
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
10 miles (16 km)	95 ft (29 m)	116

Example:

The RF radio modem has the following parameters:

- Maximum RF TX power setting = 30 dBm (1 Watt)
- RF RX sensitivity = -100 dBm (this is a constant)
- Antenna gain (standard equipped dipole) = 2.1dBi x 2 = 4.2dBi

So the system operating margin is $30 - (-100) + 4.2 = 134.2$ dBm. This is enough to transmit 10 miles if freespace was the only loss in the system. For this to be the case, the antennas must be mounted with a combined height greater than 95ft above all obstructions (including the ground) to keep the fresnel zone clear. In practice however, there are many losses in the system besides just freespace 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 Site" (LOS) requires an increase of 6 dB.
- Doubling the range without good RF LOS requires an increase of 12 dB.

3.5.1 Antenna Selection & Location

A site survey using an RF spectrum analyzer and 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 900MHZ installations utilize locally mounted 1000-2189 dipole antennas as shown in Figure 3-2. An option is available for a 6 foot riser to increase the height of the antenna 6 feet above the ST-95. Minimize obstructions between the ST-95 and the devices it communicate with.

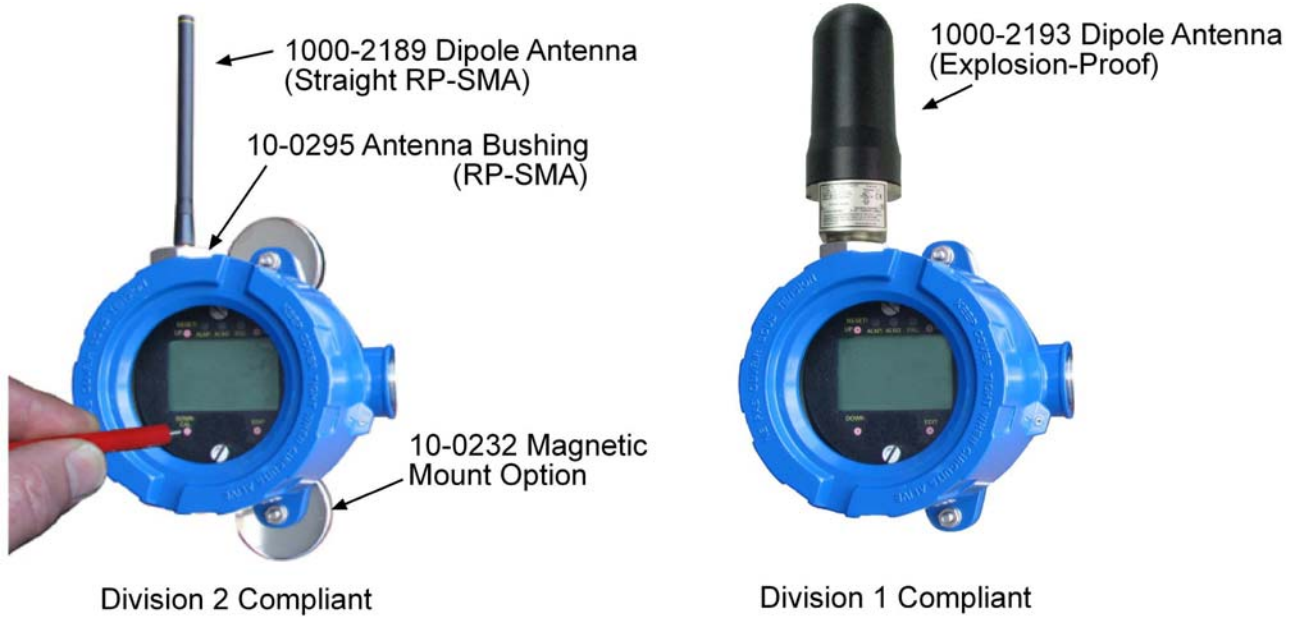


Figure 3-2: Local Antennas (900MHZ Shown)

3.5.2 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 3-3).

1. Attach antenna to RP-SMA fitting
2. Wrap 20-24" strip PVC electrical tape onto hub, nut & base of antenna
3. Wrap 20-24" strip 3M 23 tape (order # 1000-2314) onto PVC tape
4. Wrap 24-28" strip PVC electrical tape over all



Figure 3-3: Water Proofing Antenna Connections

3.5.3 System Grounding

Direct grounding of the ST-95 enclosure via a good electrical connection to a well designed grounding system is essential. This will protect your system, reduce damage that can occur during lightning strikes, and reduce noise.

SECTION 4 – SETUP MENU CONFIGURATION

4.1 Menus Database Configuration

All ST-95 configuration variables are stored in its non-volatile menu database. Upon installation, many menu items will contain default values from the factory and require changes to better match a user's particular application. ST-95 menus may be configured from the magnetic keypad in just

a few minutes per channel. The configuration menu tree is shown in Figure 4-1 and each menu's description follows.

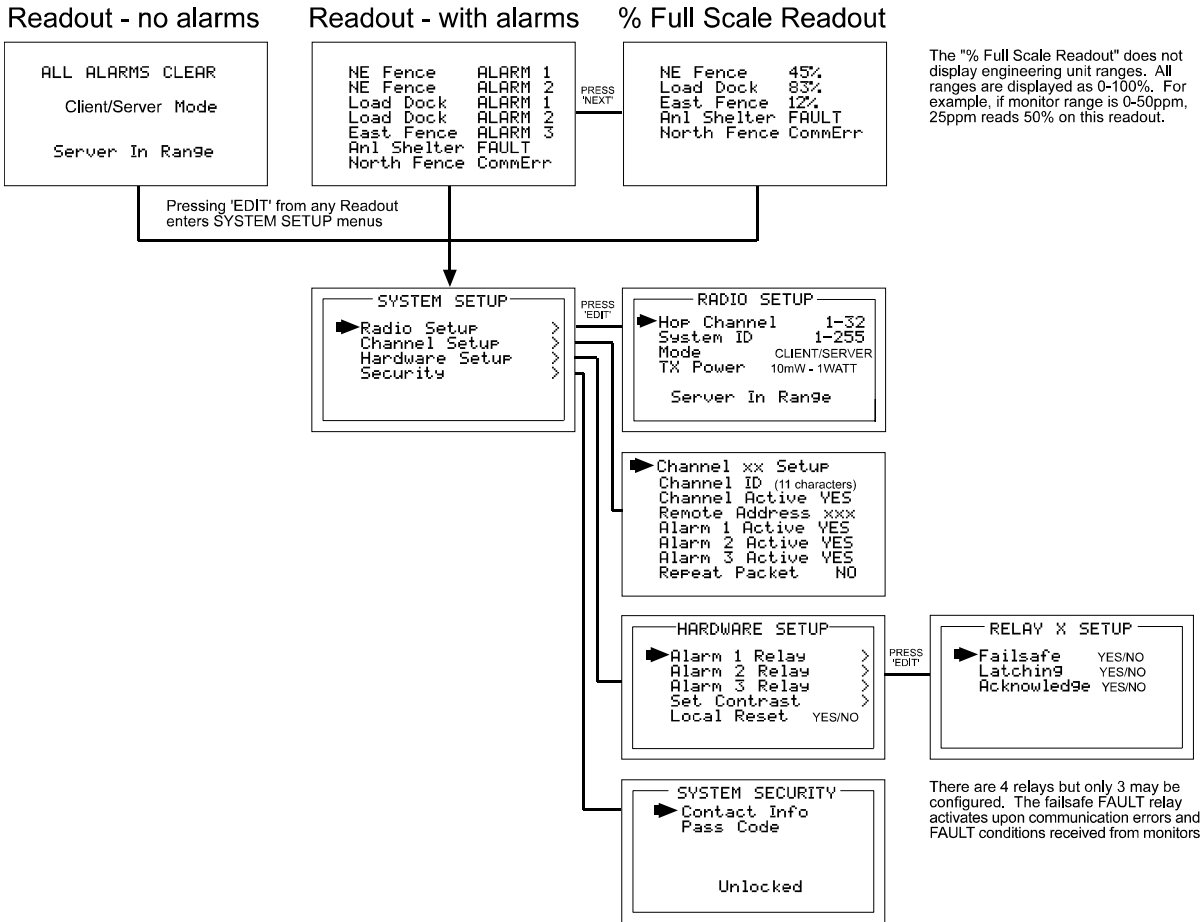


Figure 4-1: Configuration Menu Tree

4.2 SYSTEM SETUP Using the Magnetic Wand

Passing the magnetic wand over the EDIT key, from either data display, displays the **SYSTEM SETUP** screen as shown at bottom center in Figure 4-2. The UP / DOWN keys maneuver the pointer while EDIT enters sub-levels of menu items. All **SYSTEM SETUP** menu items have at least one page of sub-menus. Items with sub-menus are indicated by the > symbol (right hand pointing arrow) at the end of each line. Edit menu items by pointing to the item, 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.

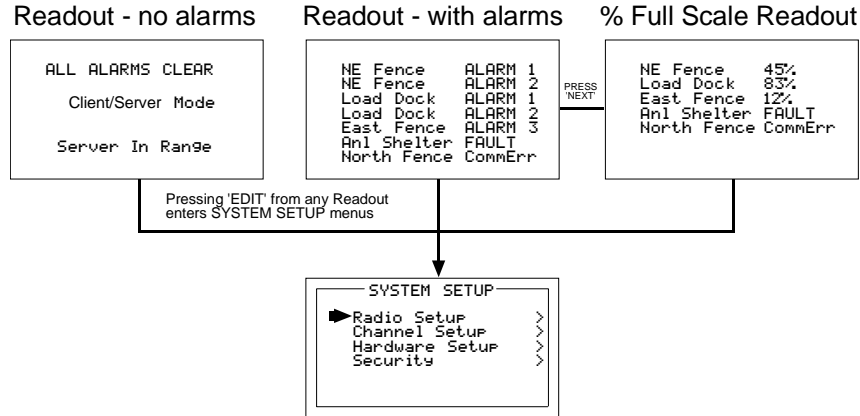


Figure 4-2: Setup Menu Entry

4.3 Radio Setup Menus

The **RADIO SETUP** group consists of four menu items as shown in Figure 4-3. This screen is also useful to confirm if the ST-95's wireless network server is in range. If this ST-95 is the network's server then the message will always display "Server In Range".

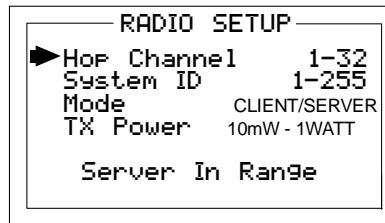


Figure 4-3: System Config. Menus

- **Hop Channel** may be set from 1-32 and assigns the pseudo-random radio frequency hopping pattern. A transceiver will not go In Range of or communicate with a transceiver operating on a different Hop Channel. Different Hop Channel designations may be used to prevent radios in one network from listening to transmissions of another. Installations with more than one Server network should also have different hop channels for each network.

2.4GHZ variation: Hop hannels on 2.4 GHZ models may be set between 0 and 39. Hop channels 0-19 includes EU "low band" frequencies 2406 – 2435MHZ. Hop channels 20-39 includes EU "high band" frequencies 2444 – 2472MHZ.

IMPORTANT!! IT IS THE USERS RESPONSIBILITY TO EXPLORE WHAT FREQUENCIES ARE APPROPRIATE FOR THE FINAL LOCATION OF ANY WIRELESS SYSTEM.

- **System ID** may be set from 1-255 and is similar to a password character or network number and makes network eavesdropping more difficult. A transceiver will not go in range of or communicate with a transceiver operating on a different **System ID**.
- **Mode** may be set for CLIENT or SERVER. For a single ST-95 communicating to up to sixteen ST-48/RF transceivers, **Mode** must = Server because ST-48/RF's may not be Servers. If an application calls for the ST-95 plus additional ST-71 or ST-90/QUAD locations, only one may be set for Server and all others must be Clients. This single Server transmits a beacon for each of this network's Clients to synchronize to.

- **TX Power** for 900MHZ models may be set to 10 mW, 200mW, 400mW and 1 watt. Since ST-90/QUAD's typically have power to spare, the recommended TX Power setting is 1 watt. **TX Power** is fixed at 50mW on 2.4GHZ models.

4.4 Channel Setup Menus

The **CHANNEL SETUP** group consists of eight menu items as shown in Figure 4-4.

IMPORTANT! This menu is used to configure all sixteen ST-95 channels so it is very important to pay close attention to the top "Channel xx Setup". THE "xx" FIELD DISPLAYS THE NUMBER OF THE CHANNEL BEING CONFIGURED.

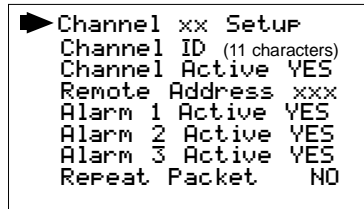


Figure 4-4: Alarm Settings Menus

- **Channel "xx" Setup** scrolls through all sixteen channels by pressing the EDIT key. Point to this menu and scroll to select channel to be configured. Use UP/DOWN keys to maneuver to other items.
- **Channel ID** is an eleven character field provided to identify each channel in user terminology. Use for tag #'s or other descriptive information to distinguish each channel. This field appears on readouts when displaying alarm status and other information related to the channel.
- **Channel Active** may be set for YES or NO. NO should be entered only if this channel is not receiving data from an ST-48RF sensor transmitter.
- **Remote Address** must match the **Remote ID** setting in the ST-48RF sensor transmitter providing input data to this ST-95 channel. The remote address value determines order of channels on the LCD readouts with lowest on top and highest on bottom.
- **Alarm 1, Alarm 2, Alarm 3 Active** menus determine if these ST-48 alarm events are processed by the ST-95. Some applications may require only a single event such as activation of an **Alarm 2** horn. In this case flashing the other alarm LED's might be confusing and therefore may be disabled using this menu.
- **Repeat Packet** set to YES causes transmissions received from this ST-95 channel's ST-48RF to be retransmitted by the ST-95. This feature is useful if ST-48RF's are too far from the final destination base station controller for reliable communication. In most cases it is necessary to designate this midpoint ST-95 as the network's Server to also ensure reliable receipt of beacons by the ST-48RF. This is due to the likelihood if ST-48RF transmissions are not reaching its destination controller, then server beacons from that controller also will not reach the ST-48RF.

4.5 Hardware Setup

The **HARDWARE SETUP** group consists of five menu items as shown in Figure 4-5.

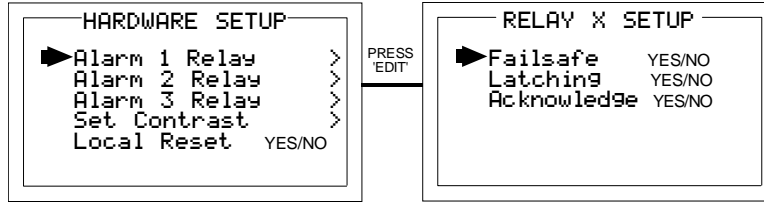


Figure 4-5: Sensor Information Menus

4.5.1 Alarm 1, Alarm 2, Alarm 3 Relays Setup

Alarm 1, Alarm 2, Alarm 3 Relay menus determine how these ST-48RF alarm events affect their associated ST-95 relays.

- **Failsafe** may be set for YES or NO for each relay. NO is default and causes relays to energize when the alarm is present. YES causes the relay to energize when the alarm is not present. **Failsafe** is normally only used when in addition to the relay contacts sending notification an alarm exists, they must also indicate loss of power conditions.
- **Latching** may be set for YES or NO for each relay. NO is default and causes the relay to automatically reset to the “no alarm” state when the alarm clears. YES causes relays to require a manual reset from the ST-95 front panel before returning to the “no alarm” state. Latching is useful when an inspection is required after alarm events.
- **Acknowledge** may be set for YES or NO for each relay. YES causes the relay to reset to the “no alarm” state even while the alarm is active. The Acknowledge feature is useful when the relay drives a loud audible device that must be silenced to effectively work in the area. It should only be used in applications where other relays drive light indicators that may not be acknowledged.

4.5.2 Set LCD Contrast

The **Contrast** menu shown in Figure 4-6 allows adjusting of the LCD contrast to ambient lighting conditions and user preferences.

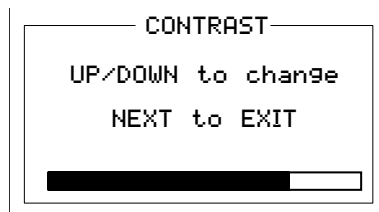


Figure 4-6: LCD Contrast Adjust Menu

4.5.3 Local Reset YES/NO

The **Local Reset** menu allows disabling of the ST-95's local Alarm Reset front panel control. “No” prevents the ability to deactivate relays while the alarm condition exists (such as silencing of audible alarms during alarm events). **DO NOT DISABLE LOCAL RESET IF ANY RELAYS ARE LATCHING BECAUSE THEY WILL REMAIN LATCHED AFTER ALARM EVENTS WITH NO WAY TO RESET!**

4.6 Security

The **Security** menu in Figure 4-7 allows locking of all configuration variables by requiring a 4-digit **Pass Code** prior to altering menus. **Contact Info** is a 15 character ASCII field available for displaying a phone # or name of personal in possession of 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.

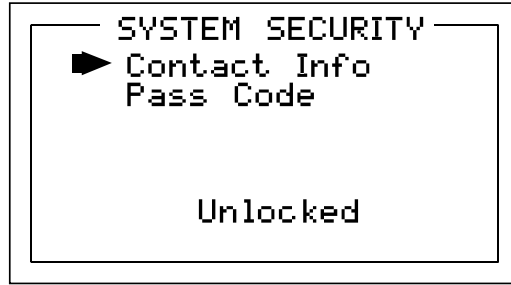


Figure 4-7: System Security Menu