INSTRUCTION MANUAL

DETECTION BUCKEYE SYSTEMS

BDS-NET

Wireless Relayer

BDS-NET Wireless Monitoring System
(With RF Wireless Interface)

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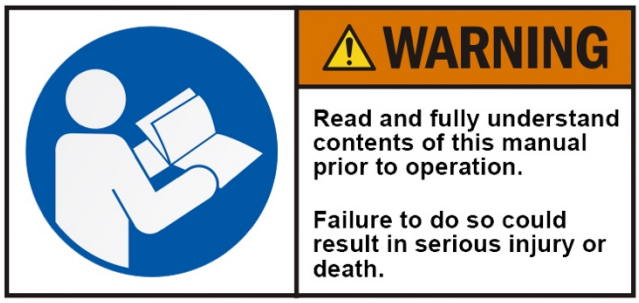

AVERTISSEMENT: Lire attentivement les instructions avant de metre en marche.

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

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CAUTION

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.

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Table of Contents

Chapter 1 – SAFETY INFORMATION

1.1 SAFETY INFORMATION – READ BEFORE INSTALLATION & APPLYING POWER

IMPORTANT
The BDS-NET Wireless Monitoring System described in this manual consists of anywhere from 1 to 32 BF-CAST Wireless Gas Monitors (Sensor Assemblies) sending data wirelessly to any number of BF-LINK Controllers and/or BFR Wireless Relayers. Users should have a detailed understanding of BDS-NET operating and maintenance procedures. Use the BDS-NET 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 sensor assemblies that communicate to the BDS-NET wireless monitoring system with a known value at start-up. 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 assembly.
- Do not paint any part of the sensor assembly or corresponding components.
- Do not use the sensor assembly 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 element compatible with the sensor assembly and approved for the sensor assembly.
- Periodically test for correct operation of the system's alarm events by exposing the sensor assembly to a known value above the High Alarm set-point.
- Do not expose BDS-NET devices to electrical shock or continuous severe mechanical shock.
- Protect BDS-NET devices from dripping liquids and high power sprays.
- Use only for applications described within this manual.

1.2 CONTACTING BUCKEYE DETECTION SYSTEMS

Buckeye Detection Systems
110 Kings Road
Kings Mountain, NC 28086
1-800-438-1028
bfec@buckeyef.com

Chapter 2 – GENERAL DESCRIPTION

2.1 INTRODUCTION

The BDS-NET is wireless monitoring system offered with integral 900 MHz or 2.4 GHz radio modules. Each BDS-NET system may have between 1 and 32 battery-powered BF-CAST wireless transmitters, which are always configured as “Clients”. BF-CAST wireless transmitters may be equipped with single or dual gas sensors which represent one channel with a single gas sensor or two channels as a dual gas sensor and transmits one or two of the 32 maximum channel values to the controller and/or wireless Relayer.

The Relayer has two modes of operation that can be used in individually or simultaneously. The Relayer can be used as device to receive wireless signals from the BF-CAST transmitters to then provide electromechanical relays to interface BF-CAST system alarms with strobes, horns, etc. The Relayer can also be used to serve as a Repeater to extend the wireless communication range to a BF-LINK controller. The Relayer can be used in multiple BDS-NET architecture configurations which provide system flexibility and enhance functionality of the BDS-NET wireless monitoring system.

- Figure 2-1: BF-CAST transmitters reporting to a BF-LINK controller configured as a “Server”.
- Figure 2-2: BF-CAST transmitters reporting to a BF-LINK controller with a Relayer providing local electromechanical relay interface of system alarms from BF-CAST transmitters.
- Figure 2-3: BF-CAST transmitters reporting to a BF-LINK controller with a Relayer configured to be a “Repeater” to repeat BF-CASTs to additional Relayers and/or BF-LINKs configured as “Clients”.
- Figure 2-4: BF-CAST transmitters reporting to a BF-LINK controller with a Relayer providing local electromechanical relay interface of system alarms from BF-CAST transmitters and configured to be a “Repeater” to repeat BF-CASTs to additional Relayers and/or BF-LINKs configured as “Clients”.
- Figure 2-5: BF-CAST transmitters reporting solely to a Relayer without a BF-LINK controller in the system providing local electromechanical relay interface of system alarms from BF-CAST transmitters.

If a Relayer is used in a BDS-NET system that has a BF-LINK /controller then the BF-LINK is configured as a “Server” and the Relayer is a client. If the Relayer is in a BDS-NET system without a BF-LINK / controller then the Relayer is configured as the “Server”. Since it is often desirable to indicate readings and alarms in more than one location, multiple BF-LINKs / controllers and Relayers are configured as Clients and are easily added to the same wireless network, but only one may be configured as the Server. BDS-NET radio configuration allows up to 26 separate FHSS hopping patterns and therefore as many as 26 separate BDS-NET 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.

NOTE: The Relayer should be setup to always be in range of the “Server”.

NOTE: When using multiple Relayers in a BDS-NET system in the “Repeater” mode, the system cannot handle multiple Relayers repeating the same BF-CAST channels as this will cause a communication loop between the Relayers, thus not extending the communications wireless range between the BF-CAST and the BF-LINK or a Relayer if the system receiver is a Relayer.

NOTE: RF Handshaking must be OFF if there is more than one BF-LINK controller and or Relayer receiving BF-CAST wireless broadcast.

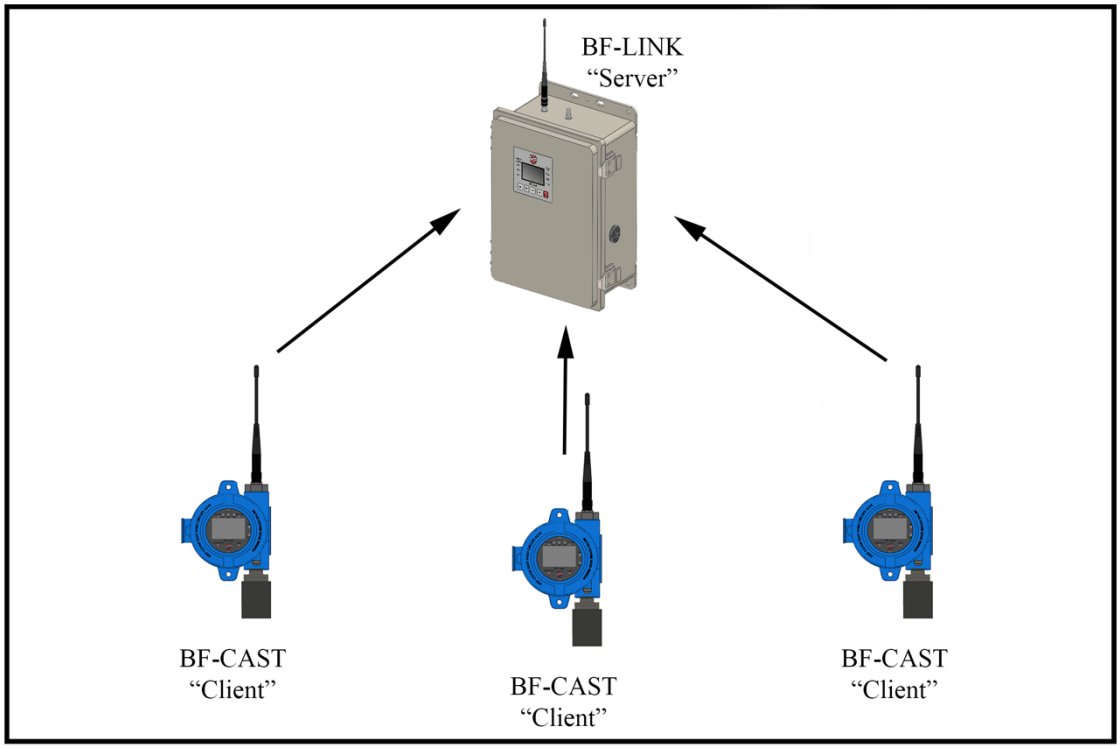

Figure 2-1 Standard BDS-NET System

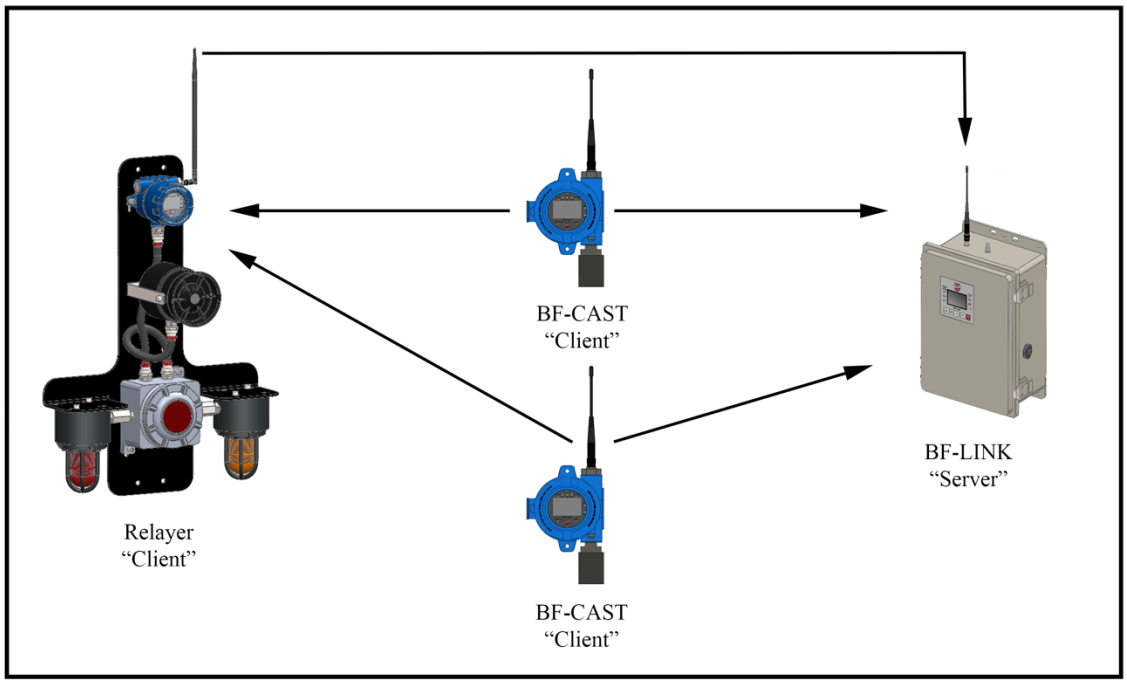

Figure 2-2 Relayer with Wireless Alarm Bar

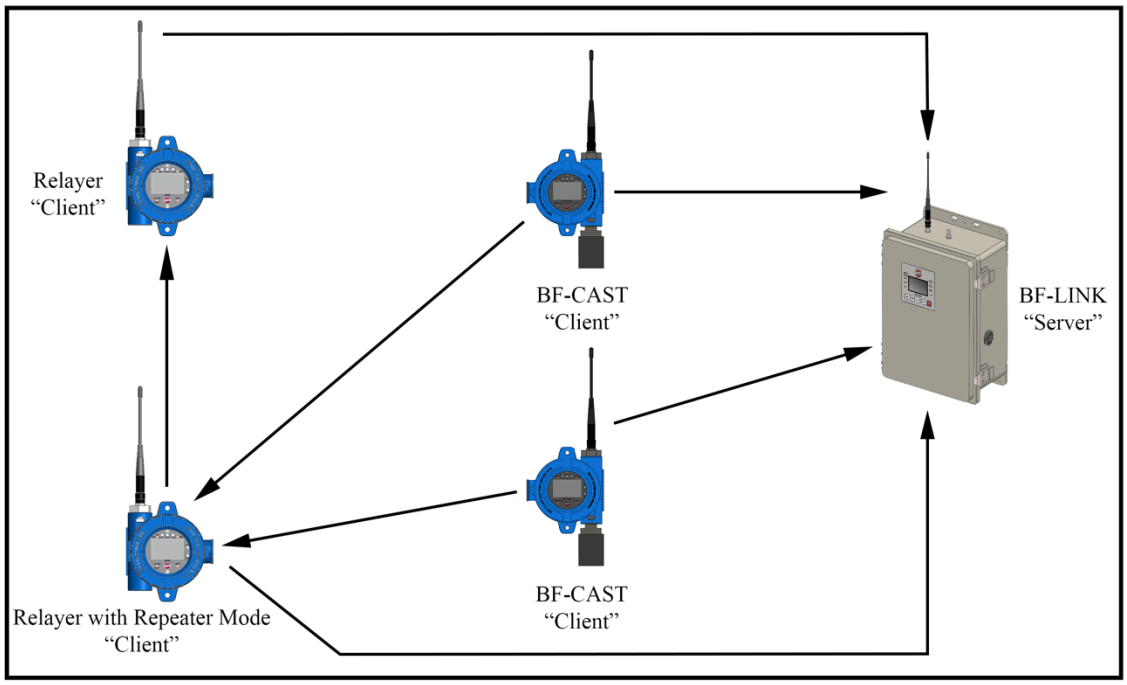

Figure 2-3 Relayer Acting as Repeater

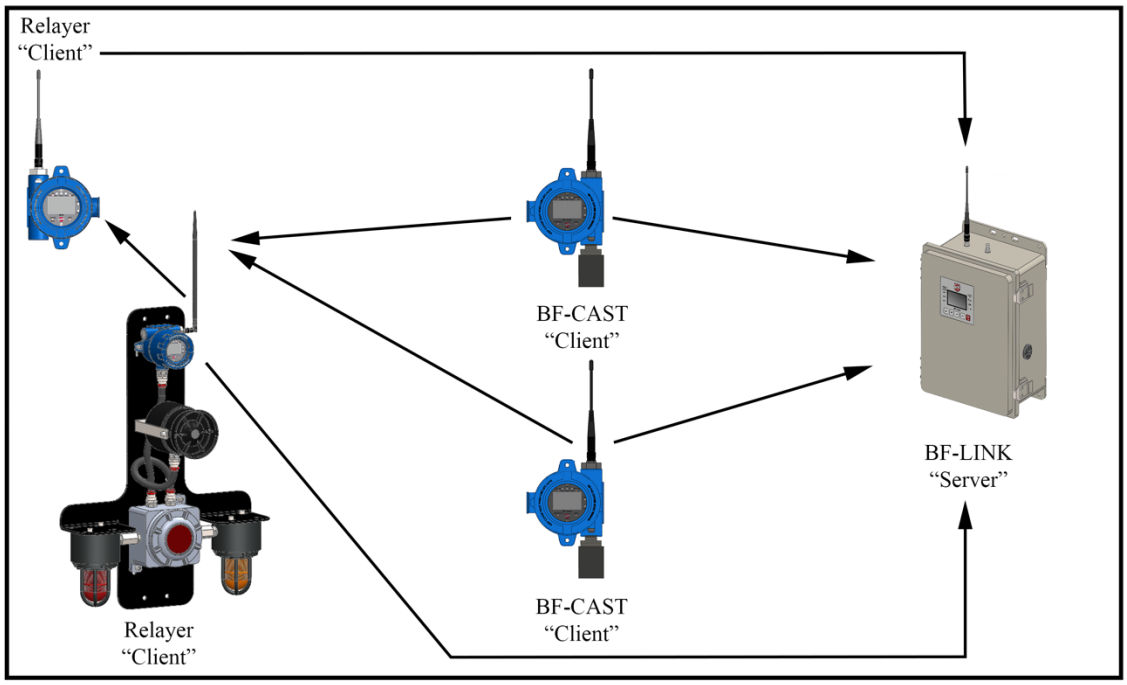

Figure 2-4 Relayer Acting as Repeater with Wireless Alarm Bar

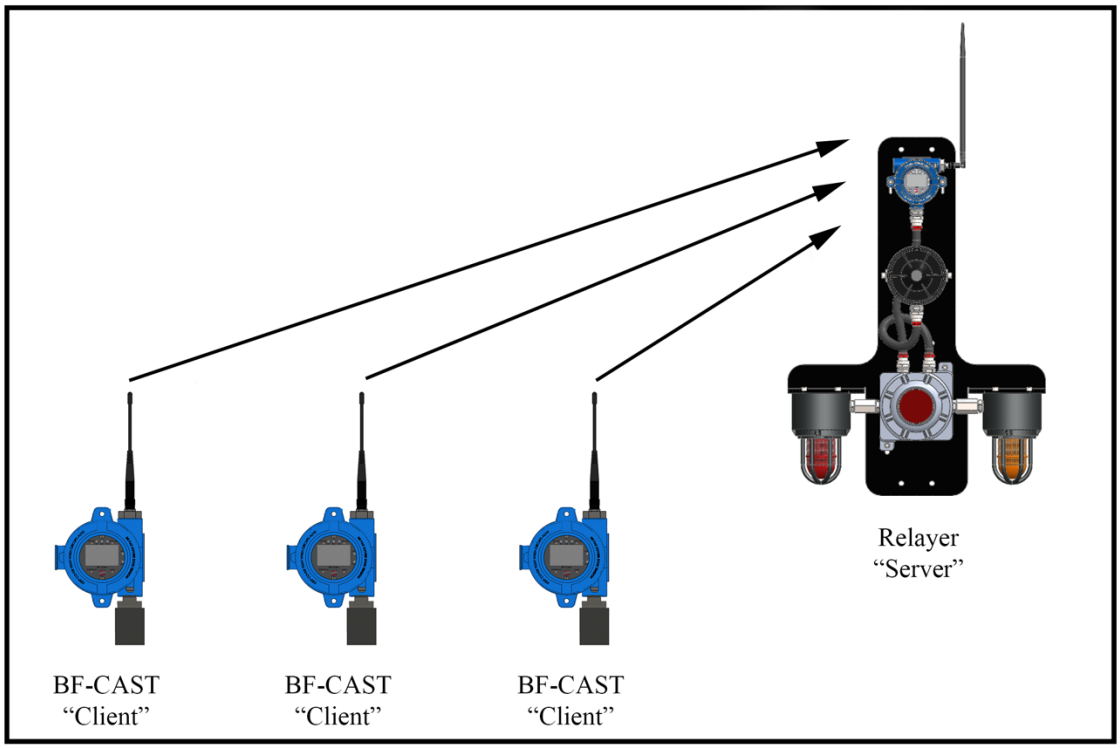

Figure 2-5 Transmitters with Wireless Alarms and No BF-LINK

Chapter 3 – PRODUCT DESCRIPTION

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.

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3.1 SYSTEM DIAGRAMS

Refer to the following diagrams for identification of system components that may be referred to in this manual.

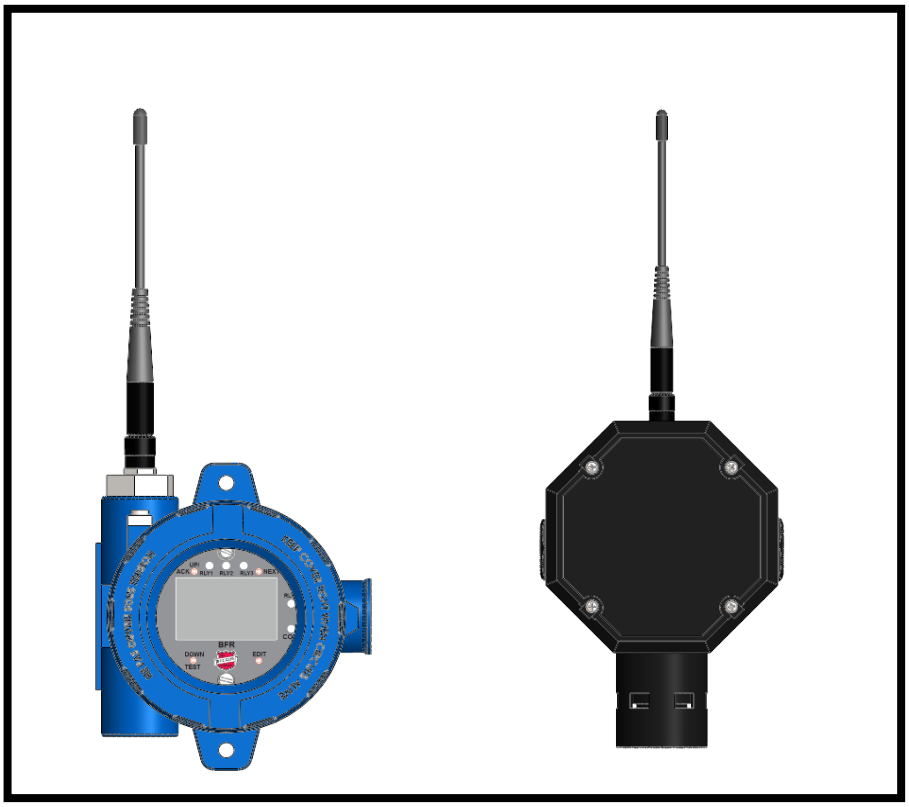


Figure 3-1 BDS-NET Relayer Explosion-Proof and Polycarbonate Versions

3.1.1 EXTERNAL SYSTEM DIAGRAM

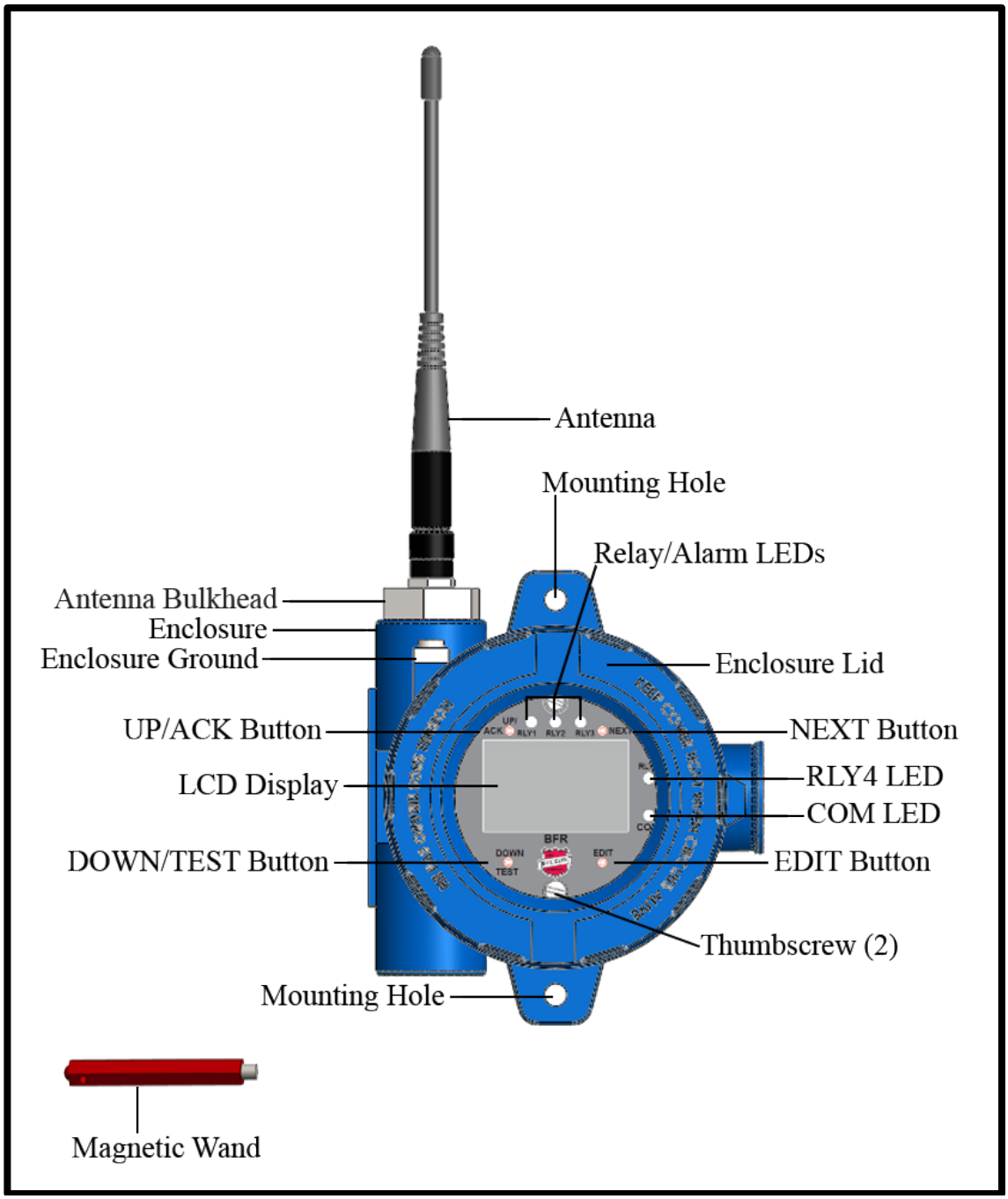


Figure 3-2 External System Diagram

3.1.2 INTERNAL SYSTEM DIAGRAMS

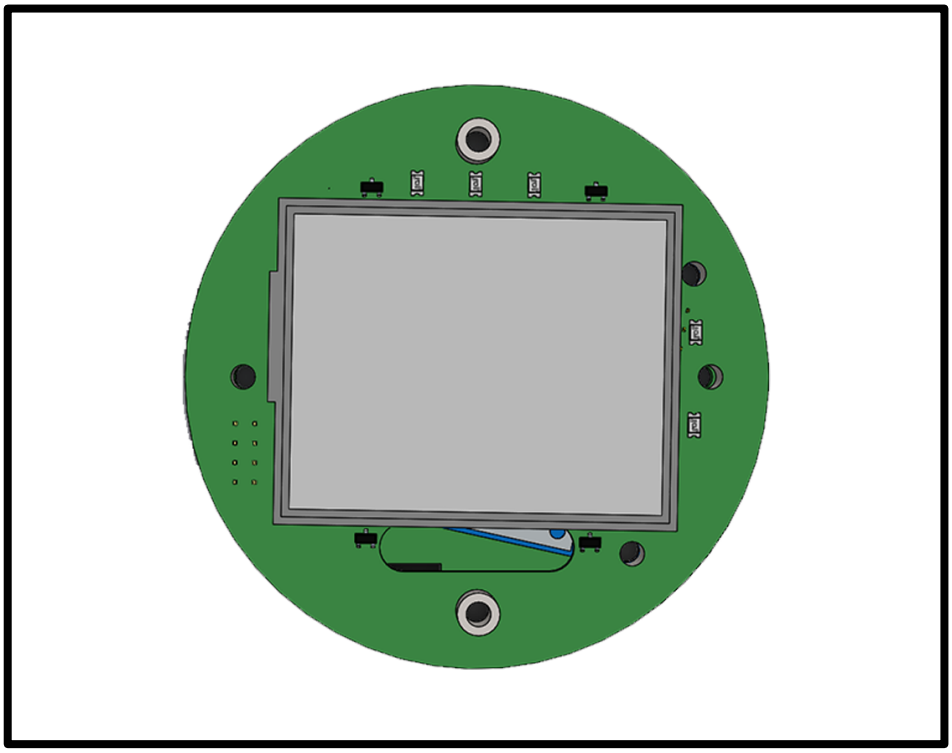


Figure 3-3 LCD Board (Front)

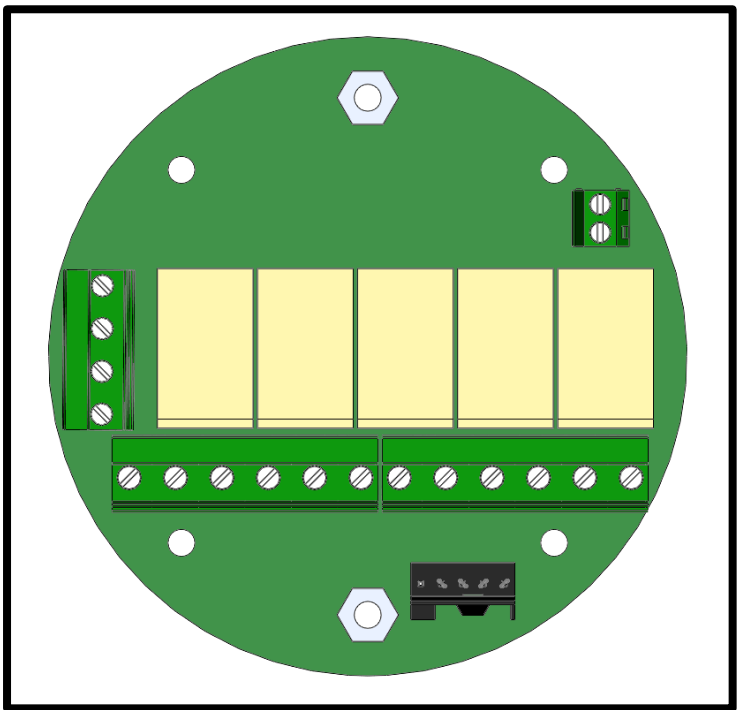


Figure 3-4 Power & Relay Board

3.1.3 ASSEMBLY DIAGRAM

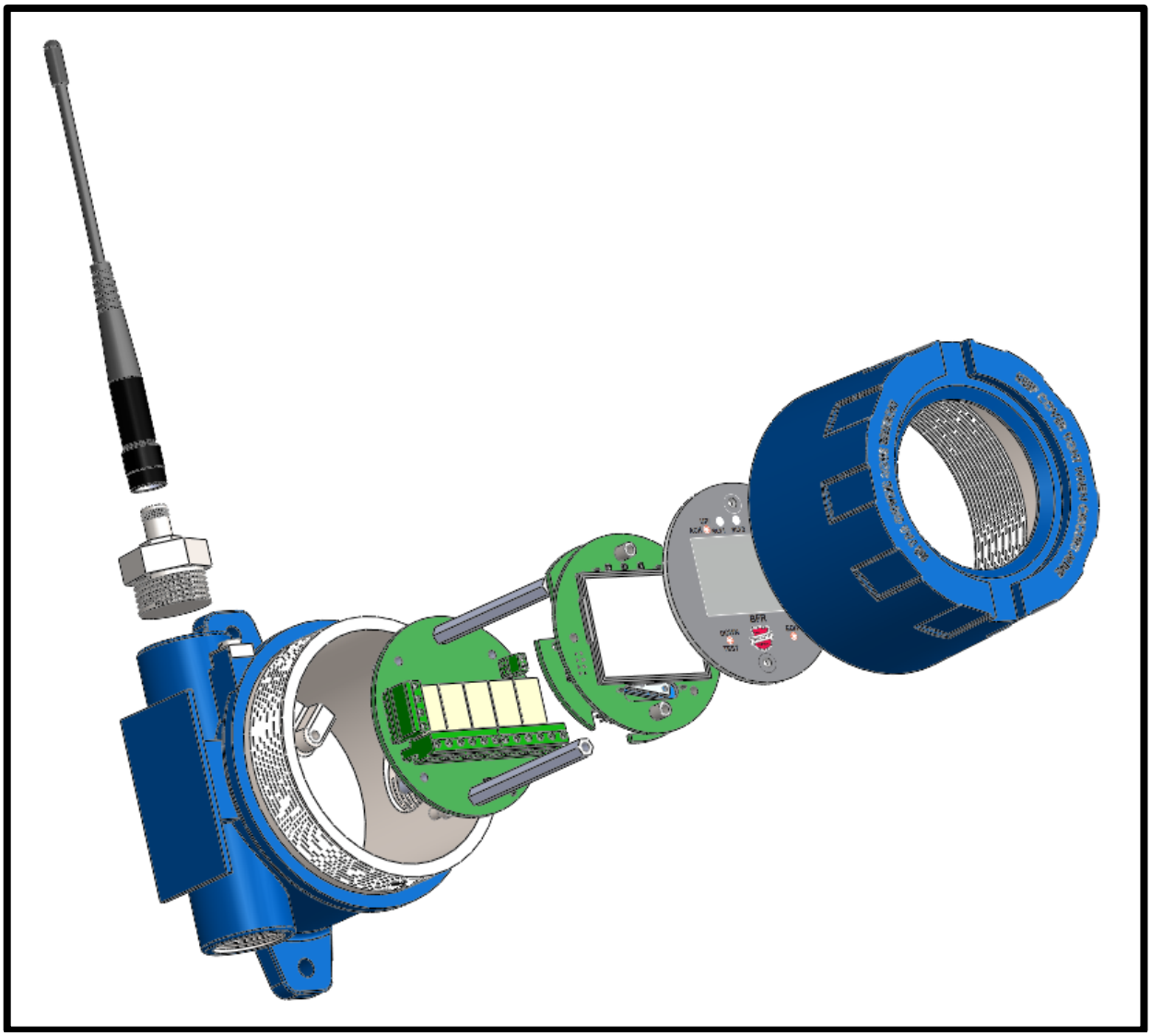


Figure 3-5 Assembly Diagram

3.2 BFR RELAYER DESCRIPTION

The Relayer is designed to control alarm event relay switching for up to 32 BF-CAST Sensor Assemblies. The Relayer receives Fail, Alarm 1, Alarm 2 and Alarm 3 signals from each sensor assembly, maps them to its four programmable relays, while adding features such as Failsafe, Alarm Acknowledge and Refresh. Four standard 5-amp alarm relays may be programmed to activate based upon various alarm combinations. These four programmable relays may then be mapped to a single dedicated horn drive which may be set to off, pulse or steady for each of the relays.

A backlit graphic LCD and front LEDs clearly indicate the alarm status of monitored channels (Figure 3-2). When there are no channels with alarm conditions the Relayer displays **ALARMS STATUS CLEAR** as the Main Screen. However, when there are channels with alarms the **ALARMS STATUS CLEAR** screen is replaced by the **Channel Alarm Status** screen which displays any active channel in alarm, and followed by an alternating line which shows the channel's Measurement Name and the current alarm. To view the alarming details, enter the channel's Channel Setup Menu discussed in Section 3.3.2.

On the right side of the screen is found the range indicator. One of four indicators will be displayed vertically. When the Relayer has been out of range of the Server for at least 30 seconds the Previously Out of Range icon will be displayed:

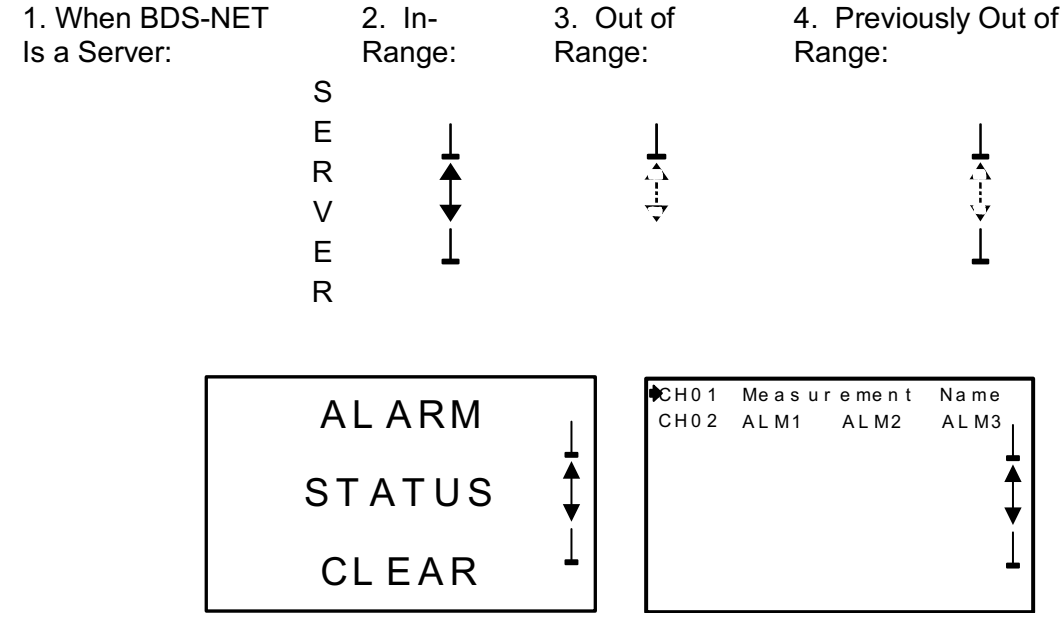


Figure 3-6 Main Screen

3.3 BDS-NET RELAYER MENUS

Below, in Figure 3.2, is the complete menu tree for the Relayer. To navigate the menus, use the magnetic keypad.

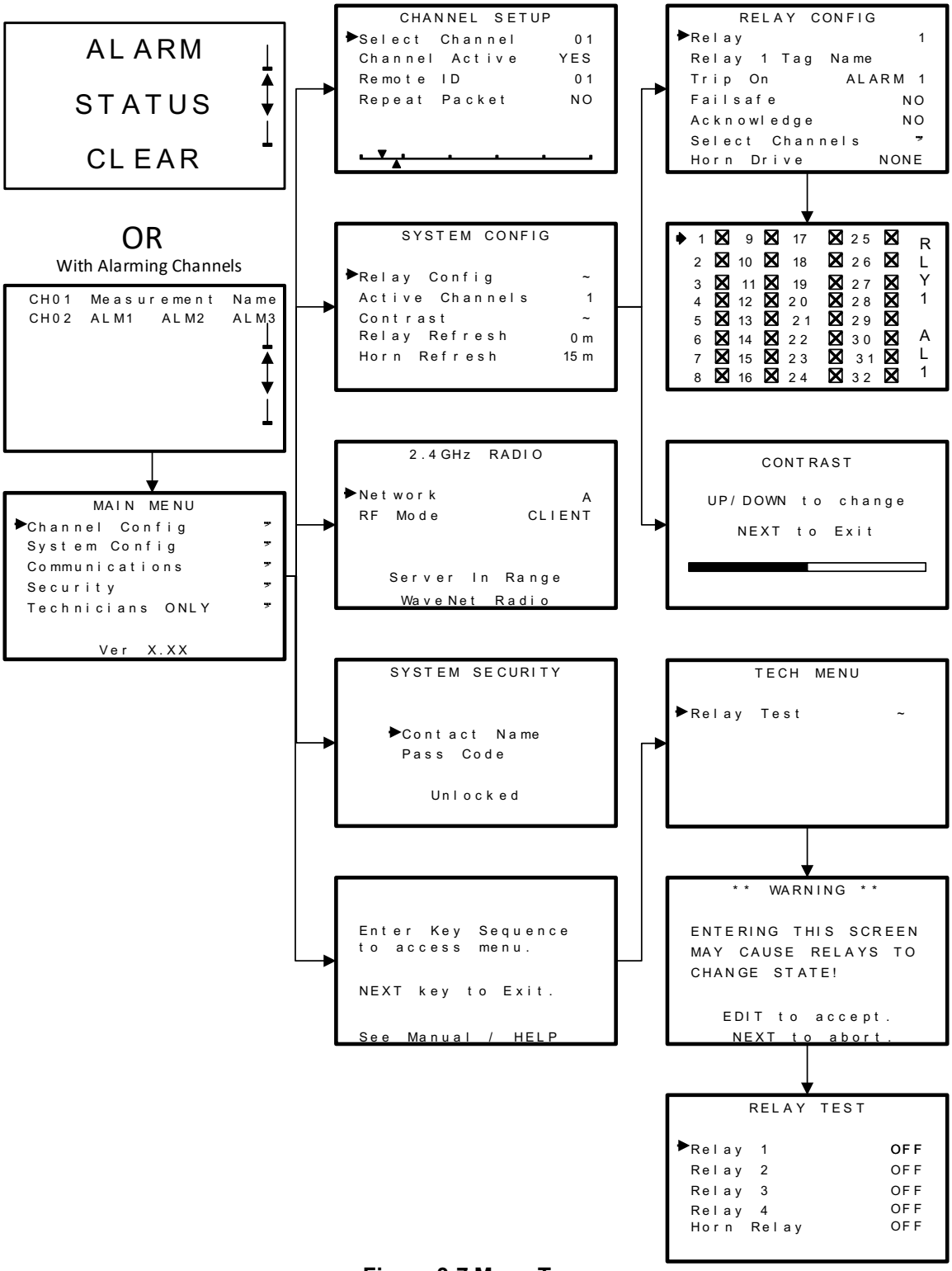


Figure 3-7 Menu Tree

3.3.1 MAIN MENU

The MAIN MENU group shown in Figure 3-8 below is reached by swiping the EDIT key while on the Home Screen. This is the entry-level screen to Channel Config, System Config, Communications, Security and Technicians ONLY menus, and displays the current firmware version. Use the UP/DOWN keys to move the pointer to the desired menu and swipe the EDIT key.

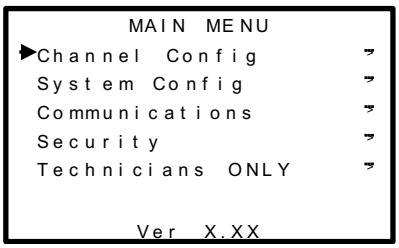


Figure 3-8 Main Menu

3.3.2 CHANNEL CONFIG MENU GROUP

The **CHANNEL CONFIG** menu shown in Figure 3-9 allows configuration of variables specific to the selected channel. The channel to be affected is selected by swiping the **EDIT** key. If the selected channel is in an alarm state, the Comm Error Timeline will be replaced by an indication of the type of alarm being received.

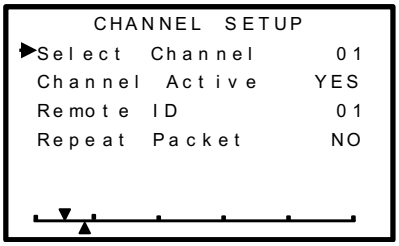


Figure 3-9 Channel Config Menu

3.3.2.1 CHANNEL ACTIVE

Channel Active is a YES/NO field that allows temporarily deactivating channels. Channels that may be deactivated are limited to the number of **Total Channels** designated in the System Config menu group (see Section 3.3.3.2). If a channel is to be permanently removed, then **Total Channels** should be adjusted down to reflect the number of sensor assemblies communicating to this Relayer.

3.3.2.2 REMOTE ID

The **Remote ID** menu determines which sensor assembly RTU number is assigned to this Relayer channel. RTU numbers are limited to 1-32, but any of these may be assigned to any of the 32 Relayer channels. This is useful for arranging which Relayer channels are used to relay specific sensor assembly information. For example, dual BF-CAST sensor assemblies have consecutive RTU numbers. It might be desirable to separate these at the Relayer in order to keep same gas types together.

3.3.2.3 REPEAT PACKET

By turning the Repeat Packet option on, any received packet by the Relayer will automatically be re-transmitted on the current hopping frequency. This is useful to ensure that distant sensor assembly transmissions will reach all of the controller and Relayer receivers.

NOTE: If two Relayers are in range of one another, both should not be set to repeat.

3.3.2.4 COMM ERROR TIMELINE

The horizontal Comm Error Time Line on the bottom of this screen is divided into five segments, from left to right. Each segment equals one BF-CAST sensor assembly Wakeup Timer interval from the sensor assembly providing data to this Relayer channel (see BF-CAST sensor assembly manual). Therefore, the entire time line is equal to 5 times the Wakeup Timer value.

The arrow on the top side of the Time Line slides across the line as time goes by for the current channel being observed. However, every time the broadcast packet is received on this channel, the pointer resets to the left of the time line. If the pointer reaches the right of the time line the Relayer will raise a comm error for this channel. For example, if the Wakeup Timer is set for the maximum 5 minutes it requires 25 minutes without a broadcast to raise the Comm Error alarm for the channel. If the wireless link between the BF-CAST sensor assembly and this channel is functioning properly the pointer should never exceed the 1st Wakeup Timer line segment.

The arrow on the bottom side of the Time Line slides across the line as time goes by in a similar manner to the other arrow. However, this arrow represents the channel which is furthest along it's time line for all of the monitored channels. This is useful in determining if any channels have missed a transmission without having to cycle through observing all of the channels. If the arrow on the bottom side has not passed the first segment, all of the monitored channels have received their latest transmission.

3.3.3 SYSTEM CONFIG MENU GROUP

The **SYSTEM CONFIG** menus shown in Figure 3-10 allows configuration of variables for the Relayer unrelated to any specific channel. This includes editing how the relays function, total number of channels, contrast and relay refresh time.

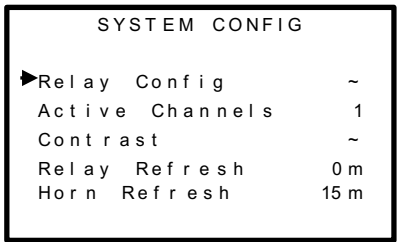


Figure 3-10 System Config Menu

3.3.3.1 RELAY CONFIG

The **RELAY CONFIG** screen shown in Figure 3-11 allows sophisticated programming of each of the four programmable relays. Select the relay to be configured by pointing to the Relay menu and swiping **EDIT**.

NOTE: The fifth relay, the dedicated Horn Relay, is enabled by the Horn Drive setting for each of the four programmable relays.

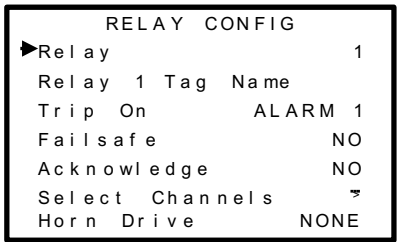


Figure 3-11 Configure Relays Menu

- **Tag Name** may be edited to give the selected relay a name, which will help identify which BF-CAST sensor assemblies are connected to that relay or the type of alarm associated with that relay or any name of the user's choosing.
- **Trip On** controls what conditions will cause the relay to activate. These may be **A1, A2, A3, FAULT/COMM** or **Any Alarm** (from a sensor assembly).
- **Failsafe** is an ON/OFF field where ON causes the relay to energize when the condition is not present. When the **Trip On** condition becomes true the relay de-energizes. **Failsafe** is often utilized when it is desirable for loss of power to indicate the alarm condition.
- **Acknowledge** is an ON/OFF field with ON typically used when the relay controls an audible device and it is desirable to silence the horn audible while troubleshooting the alarm. Applying an Alarm Reset causes the relay to return to its inactive state even though the alarm condition remains in effect. The **Relay Refresh** menu (see Section 3.3.3.4) may be used to re-activate acknowledged relays.
- **Select Channels** brings up a Check Box (Figure 3-12) screen for assigning which of the Active Channels are assigned to this relay. This allows creating Zones among the active channels.

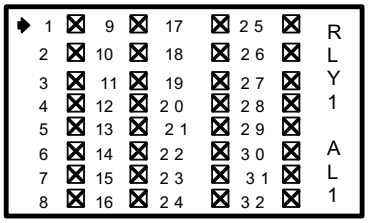


Figure 3-12 Select Channels Menu

- **Horn Drive** controls the operation of the horn drive in relation to any of the four programmable relays. **Horn Drive** selects how the horn drive will function for the relay selected. Select one of three options:
  - **None – no horn**
  - **Pulse**
  - **Steady**

  NOTE: Steady overrides the pulse condition.

  When the alarm condition is present for the selected relay the relay will energize along with the horn drive in the manner selected.

3.3.3.2 ACTIVE CHANNELS

Active Channels may be set from 1 to 32 and limits the maximum number of active channels. For example, if this menu is set for 10, then only 10 channels are available in the CHANNEL CONFIG menus discussed in Section 3.3.2.

3.3.3.3 CONTRAST

LCD Contrast Adj. may be set for optimum viewing using the menu shown in Figure 3-13. Swipe the UP/DOWN keys to adjust the contrast and NEXT to save the changes.

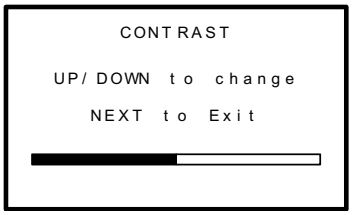


Figure 3-13 LCD Contrast Adjust

3.3.3.4 RELAY REFRESH

Relay Refresh may be set from 0 to 120 minutes with 0 turning the Refresh function OFF. Each relay may be set to allow **Acknowledge** (see Section 3.3.3.1) which means an **Alarm Reset** deactivates the relay even though the alarm condition still exists. **Refresh** will re-activate the relay after this timer expires. This feature is useful for silencing audible devices, and then automatically activating them again if the alarm condition remains after a period of time.

3.3.3.5 HORN REFRESH

Horn Refresh may be set from 0 to 120 minutes with 0 turning the Refresh function OFF. The horn relay may be set to allow **Acknowledge** (see Section 3.3.3.1) which means an **Alarm Reset** deactivates the relay even though the alarm condition still exists. **Refresh** will re-activate the relay after this timer expires. This feature is useful for silencing audible devices, and then automatically activating them again if the alarm condition remains after a period of time.

3.3.4 COMMUNICATIONS

The **Communications Menu** shown below in Figure 3-14 allow setting the *Network ID* and *RF Mode*.

For 900MHz models the power level option is also available from this screen.

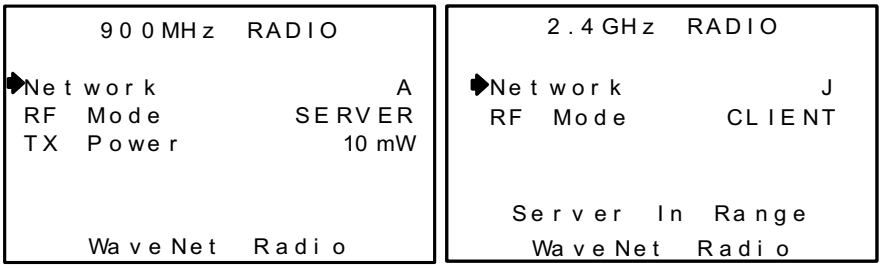


Figure 3-14 Communications Menu

3.3.4.1 NETWORK

BDS-NET Relayer devices utilize the **Network** setting to assign up to 26 unique hopping patterns. To simplify system setup, **Network** 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 Relayer will not indicate Server In-Range status or communicate with any device operating on a different **Network ID**. This feature allows multiple 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.

2.4GHZ used in EU countries: Hop channels on 2.4 GHZ models may be set between 1 and 26. Hop channels A-R include EU “low band” frequencies 2406 – 2435MHZ. Hop channels S-Z include EU “high band” frequencies 2444 – 2483.5MHZ.

IMPORTANT: EXPLORE WHAT FREQUENCIES ARE APPROPRIATE FOR THE FINAL LOCATION OF ANY WIRELESS SYSTEM.

3.3.4.2 RF MODE

RF Mode determines if the BDS-NET Relayer is a Server or a Client. ONLY ONE SERVER IS ALLOWED PER WIRELESS NETWORK. Numerous Relayers may share the same Network, but only

one may be the Server. Networks with multiple Relayers should have the most centrally located unit designated as the Server (see Section 2.2).

3.3.4.3 TX POWER

The **TX Power** menu is only available on 900MHz systems, and allows the setting of the **TX Power** for the radio. The settings for this are 10mW, 200mW, 400mW and 1W.

3.3.5 SECURITY

The **SECURITY** menu in Figure 3-15 requires the 4-digit **Pass Code** prior to altering menus. Entering a Pass Code and locking the menu locks the entire menu database until the correct **Pass Code** is entered. **Contact Name** is a 12 character ASCII field available for displaying a phone # or name of personal who know 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.

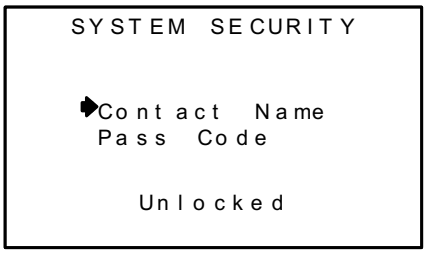


Figure 3-15 Security Menu

3.3.6 TECHNICIANS ONLY

WARNING: USERS OF THESE MENUS MUST HAVE A DETAILED UNDERSTANDING OF THEIR FUNCTIONS. PROCESSING OF ALARMS AND WIRELESS COMMUNICATIONS SHOULD NOT BE RELIED UPON WHILE EDITING THESE MENUS.

The **TECHNICIAN ONLY** menu group access requires a special key sequence of four consecutive **UP** keystrokes to prevent accidental modification of critical items. The **TECHNICIANS ONLY** menu tree is shown in Figure 3-16.

The **TECHNICIAN ONLY** menu group contains a **Relay Test** function which allows the user to stimulate the five relay outputs to ensure proper operation. Use the UP/DOWN keys to highlight the desired relay and select using **EDIT** to energize the relay.

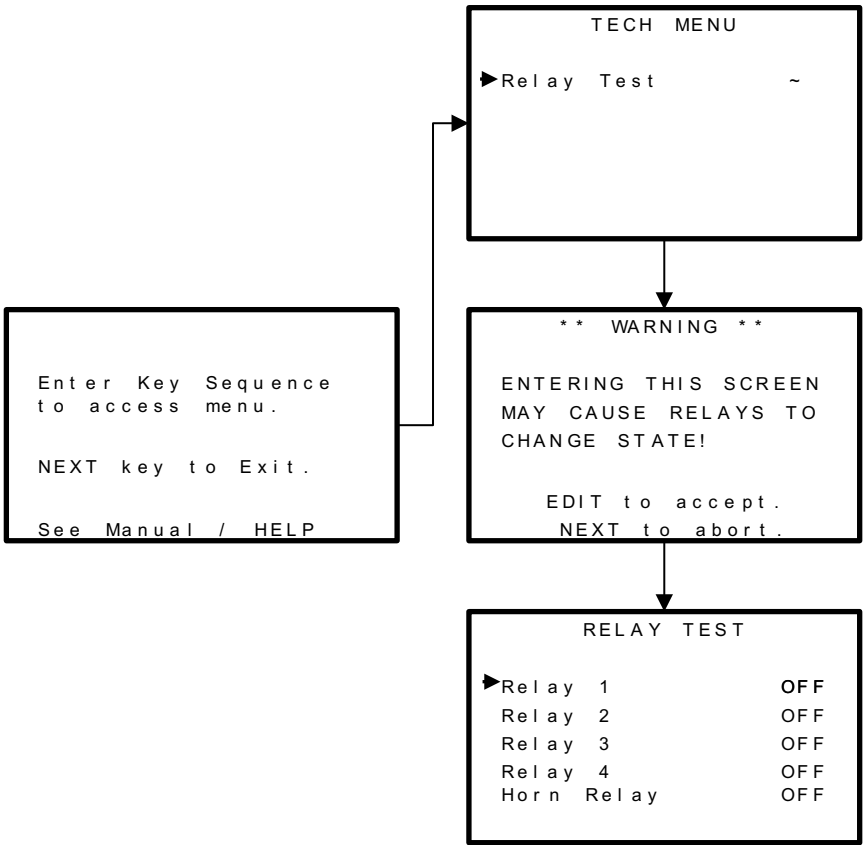


Figure 3-16 TECHNICIANS ONLY Menu Tree

3.4 BDS-NET RELAYER PCBS

3.4.1 BWT10-0404 DISPLAY / RADIO PCB

BDS-NET systems support both 900 MHz and 2.4 GHz FHSS networks determined by the radio module mounted to the BWT10-0404 Display / Radio PCB. The BWT1000-2455 900 MHz radio module mounts to the back of the BWT10-0404 Display assembly as shown in Figure 3-17. Its MMCX RF connector attaches to the coax pigtail of the BWS10-0400 antenna fitting required for 900 MHz models.

The BWT1000-2454 2.4 GHz radio module also mounts to the back of the BWT10-0404 Display assembly as shown in Figure 3-17. Its u.FL RF connector attaches to the coax pigtail of the BWS10-0401 antenna fitting required for 2.4 GHz models.

A slender 5 conductor cable connects between the BWT10-0404 and the BWT10-0407 Battery / I/O DC Power Board bolted to the bottom of the enclosure.

NOTE: The BWT10-0404 accepts either the BWT1000-2455 (900 MHz) or BWT1000-2455 (2.4 GHz) radio module. A Shield PCB is not shown but must be removed to access the radio modules and RF connectors.

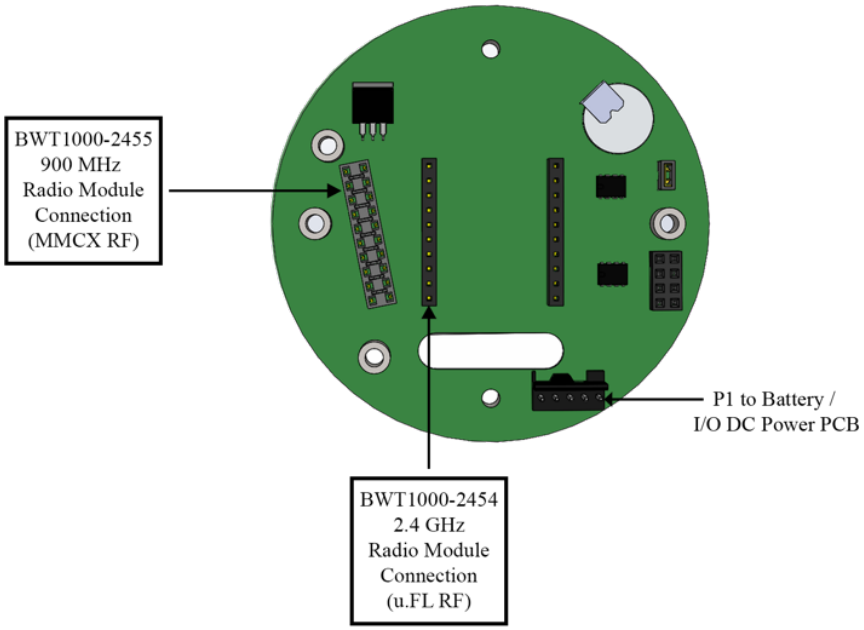


Figure 3-17 BWT10-0404 Display / Radio PCB

3.4.2 BDS-NET RELAYER BWT10-0425 POWER SUPPLY/RELAY PCB

CAUTION: Alarm relays have dry contacts and power must be supplied from an external source. If this power source exceeds 3 amps users should consider fusing relay wiring with 3 amp fuses. Contacts are rated for **RESISTIVE** loads! Inductive loads, such as contactor coils or motors, may cause contact arcing, which shortens life and emits RFI into the sensor signals. Use appropriate arcing snubbers and MOV's across inductive loads and keep wiring away from signal wires. External wiring to TB3 (Remote Alarm Reset) should be shielded and protected from noise spikes to prevent false Alarm Reset.

Relay terminals are labeled NO (normally open), NC (normally closed) and COM (common). These designators correspond to the shelf, or de-energized, state of the relays.

AC or DC power supplies to relays on the BWT10-0425 Power Supply/Relay PCB must be the same for each relay. Example: 24VDC should not be the power switched by one relay and 115VAC by others as the common pole is common to all relays.

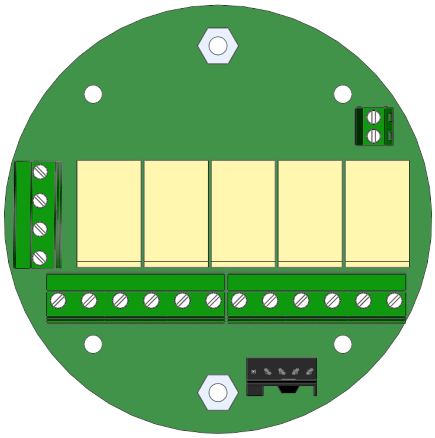


Figure 3-18 BWT10-0425 Power Supply/Relay PCB

Chapter 4 – BDS-NET RELAYER 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 Relayer is designed to meet ISA 92.0.01 Part 1 for Toxic Monitors. The standard BWS10-0295 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.

4.2 MOUNTING THE ENCLOSURE

The Relayer standard enclosure is a cast aluminum explosion-proof (NEMA 7) enclosure as shown in Figure 4-1. Modular design simplifies the installation of the Relayer. The BF-CAST sensor assembly antenna should typically be mounted with line-of-site access to the controller and/or Relayer's antenna(s). If a quality line-of-site angle is not possible, the BF-CAST sensor assembly will usually still function properly at the following ranges–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 WNR TO A WALL OR BRACKET USING THE PRE-DRILLED MOUNTING FLANGES WITH I.D. 0.3 ON 5.0 INCH CENTERS (FIGURE 4-1).

4.2.1 BANM-L2 MAGNETIC MOUNT OPTION

Buckeye Detection Systems offers a magnetic mounting option (BANM-L2) which includes two magnets affixed to the pre-drilled mounting holes securely attaching the assembly to a solid steel structure.

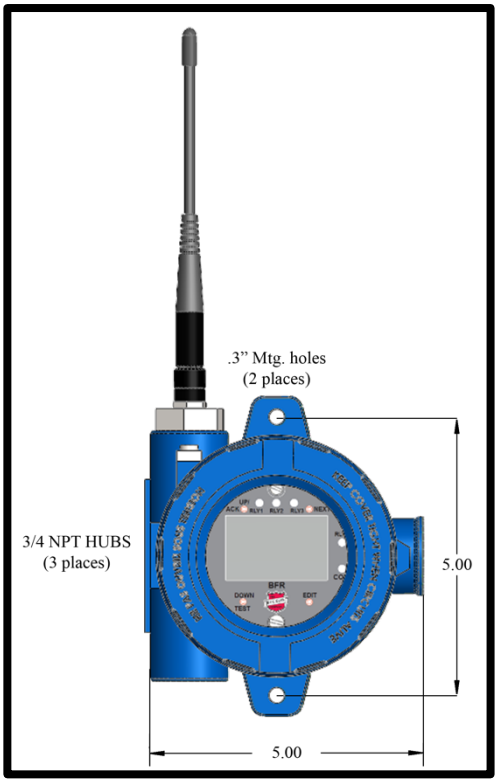


Figure 4-1 Explosion-Proof Housing

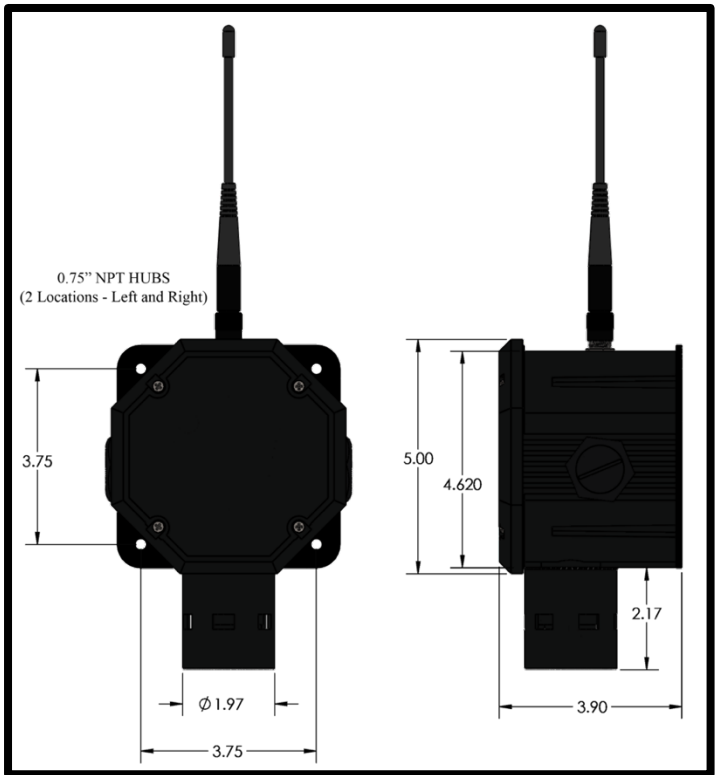


Figure 4-2 Polycarbonate Enclosure

4.3 SPECIFICATIONS

4.3.1 POWER SUPPLY

10-30 VDC @ 3 watts max.

4.3.2 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.

2.4GHz Models:
2mA during “sleep” mode, 170mA during 125mW Broadcasts.

4.3.3 MAXIMUM TRANSMIT (TX) POWER

900MHz Models (EIRP; 2dBi gain antenna):
Maximum transmit power is 30dBm at highest 1W power setting. Transmit power may be set from 10mW, 100mW, 400mW and 1 watt.

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

4.3.4 RECEIVE (RX) SENSITIVITY

900MHz Models:
-100 dBm

2.4GHz Models:
-95 dBm

4.3.5 RADIO FREQUENCY

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

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

4.3.6 MEMORY

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

4.4 ANTENNA TRANSMISSION RANGE

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

Distance Between Antennas	Fresnel Zone Diameter	Freespace Loss (dB)
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 2.4 GHz BDS-NET 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.

Chapter 5 – BDS-NET ANTENNA SELECTION

5.1 ANTENNA SELECTION

5.1.1 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.

5.1.2 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.

IMPORTANT: A YAGI HAS DRAINAGE HOLES IN THE DIPOLE ELEMENT, DO NOT MOUNT THE ANTENNA WITH THE DRAINAGE.

5.1.3 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.

5.1.4 COAX CABLES

If a coax cable connects to the antenna via connectors, it is very important to weatherproof the connection using our 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 with a final layer of electrical PVC tape.

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.

5.2 SURGE PROTECTION & GROUNDING

Voltage surges can enter the Relayer 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 controller 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.

5.2.1 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 sensor assembly, 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 sensor assembly. Antennas are normally mounted to a metal bracket which should be grounded to the sensor assembly 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.

5.2.2 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.

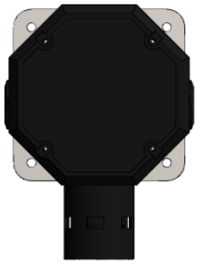
There is also the possibility of surge voltages being induced on long lengths of wire from nearby power cables. Surge diverters can be fitted to the data cable to protect against surges entering the wireless unit.

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 7 – OPTIONAL ADD-ONS

Explosion-Proof Antenna

Polycarbonate Enclosure



Chapter 8 – TABLE OF FIGURES

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