

3.0 RFD DESCRIPTION

ETI developed the RFD to be a reusable device for remote initiation of shock tube and electric detonators, powered by commercially available batteries. The RFD is capable of remotely initiating either electric detonators or shock tube devices by radio from a safe distance. Each RFD set consists of one transmitter and multiple receivers. Both transmitter and receiver include a rotary switch to select one of five available channels. Receivers may all be set to fire on one channel, each on a different channel, or in any combination thereof. Under ideal line-of-sight conditions, functional ranges of 1,000 meters are possible.

This system is intended for use by qualified law enforcement agencies, military units, and professional demolition personnel. All personnel engaged, whether directly or indirectly, in the operation of the RFD should thoroughly review and understand this manual prior to using it.

3.1 Definition of Terms

The following terms are applicable to RFD operations.

Explosive Ordnance Disposal (EOD) - The detection, identification, field evaluation, rendering safe, recovering, evacuation, disposal, and reporting of explosive ordinance or improvised explosive devices that have been fired, dropped, launched, projected, or placed as to constitute a hazard to operations, installations, personnel, or material. EOD also includes the rendering safe and/or disposal of items that have become hazardous or unserviceable by damage or deterioration when the disposal of such items is beyond the capabilities of personnel normally assigned the responsibility for routine disposition.

Electric Cap - Caps which are electrically initiated, including both conventional electric blasting caps, and exploding bridgewire (EBW) caps.

3.2 RFD Controls and Indicators

This section describes the controls and indicators for both the RFD receiver and transmitter units. Procedures for operating the transmitter and receiver are separately described later in this chapter.

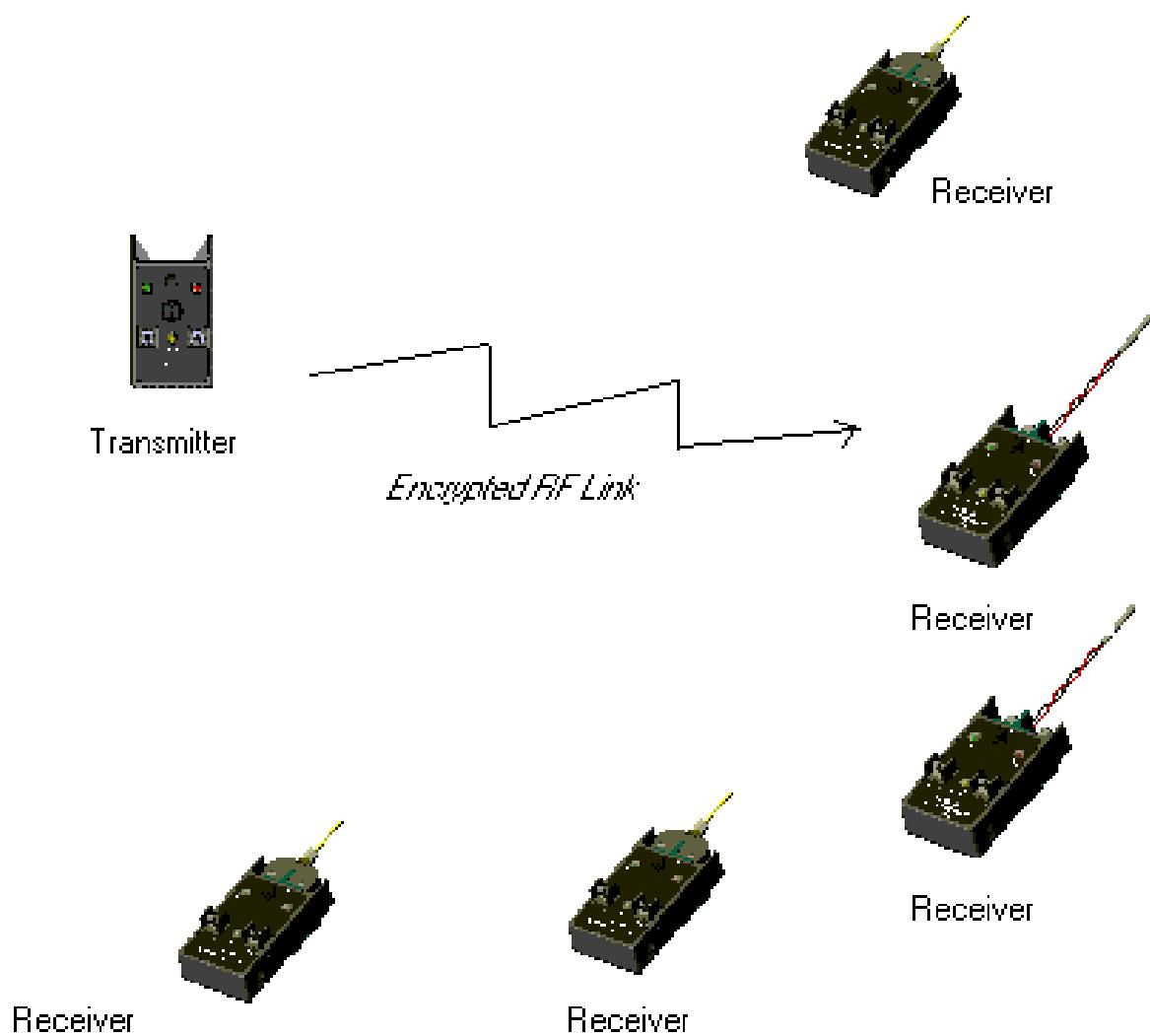


Figure 1. Radio Frequency Remote Firing Device transmitter and receivers.

3.2.1 Receiver Unit Controls and Indicators.

The receiver is shown below.



Figure 2. RFD receiver unit controls and indicators.

The receiver is clearly distinguishable from the transmitter by the bright yellow background on the receiver faceplate. The transmitter faceplate is red. Preprinted adhesive labels are provided with each kit to allow the user to assign each receiver with a numerical identifier. This is helpful in operations employing multiple receivers.

Each receiver has three control switches/knobs and three Light Emitting Diode (LED) status indicators. The switches on the receiver are:

- 1) POWER toggle switch. Applies power to the unit.
- 2) CHANNEL SELECT rotary switch. Selects one of five communication channels for the receiver. Available channels are 1-5.

NOTE

The unit reads the CHANNEL SELECT switch at the **beginning** of the safe separation period. Changing the setting of this switch after the ARM switch is engaged will not affect the channel setting.

- 3) ARM/SAFE toggle switch. Arms the unit.

The three status indicators are:

- 1) A red ARM STATUS LED
- 2) A green POWER ON LED
- 3) A yellow LOW BATTERY LED

The green POWER ON LED is lit whenever power is applied to the unit (i.e., the power switch is in the ON position).

The yellow BATTERY STATUS LED indicates the energy level of the batteries

The red ARM STATUS LED indicates the current armed state of the RFD receiver

Table 1 indicates possible combinations of the yellow BATTERY STATUS and red ARM STATUS LEDs.

Table 1. RFD Receiver BATTERY STATUS and ARM LED Status Indications.

ARM STATUS LED	BATTERY STATUS LED	CONDITION
OFF	ON	Batteries are very weak. Further operation is inhibited until the batteries are replaced.
OFF	FLASHING	Batteries should be replaced soon. Further operation is permitted.
FLASHING Short blink once every two seconds.	ANY	Arm switch has been placed in armed position. Receiver will start to generate and store firing energy in two minutes.
FLASHING Longer flash once every two seconds	ANY	Beginning two minutes after arm switch has been placed into ARM position. Unit has begun to generate and store firing energy.
ON	OFF or FLASHING	Beginning 5 minutes after receiver placed in ARM mode, unit is armed and awaiting a FIRE command.
FLASHING Four times per second.	ANY	Unit has received a valid FIRE command.
ON	ON	A fault condition has been detected. See section 3.7 for troubleshooting procedures.

NOTE

The RFD supplies its own energy. No external input power is required.

NOTE

A flashing BATTERY STATUS LED indicates at least one hour of operation is guaranteed, but batteries should be replaced immediately if practical. A fresh set of batteries provides up to six hours of receiver operation.

NOTE

After the ARM/SAFE switch is placed in the ARM position, the red ARM STATUS LED will blink once every two seconds for the first two minutes of the 5 minute safe wait period. During this initial two minutes the receiver is in standby and not generating and storing any firing energy to the firing circuit. After the initial 2 minutes of the 5 minute safe wait the LED will flash for a longer duration as the receiver begins to store firing energy to the firing capacitor until the full 300 volts of firing energy is stored. At this point the receiver will maintain the firing energy until the safe separation time of five minutes has expired. After that, the ARM STATUS LED will remain ON.

NOTE

The red ARM STATUS LED will blink four times per second once a valid FIRE command has been received. The LED will continue to blink at this rate until power is lost or the receiver turned off.

Two spring-loaded binding posts are located at the top of the receiver. The binding posts are designed to connect to either electric caps, or to the STInger shock-tube adapter included with each receiver.

To use shock tube, the STInger shock tube adapter (see figure 3) must be attached to the receiver. The STInger is attached to the receiver's binding posts by pressing the spring clips on the rear of the STInger onto the binding posts. No screws are required. Figure 4 is a receiver unit with STInger attached.

If shock tube to be employed the following procedure should be followed to connect the shock tube to the STInger adapter.

- a. Trim ends of shock tube.
- b. Loosen the plastic knob (turn counter-clockwise).
- c. Insert cut length of shock tube through the hole in the plastic knob until fully seated.
- d. Tighten the plastic knob (turn clockwise). Tug on tubing to insure that the attachment is secure.
- e. Once the unit has fired, loosen plastic nut and remove fired tubing.

NOTE

The white shock tube compression nut shown in figure 3 accepts shock tube that is nominally 0.120 inches in diameter (with a maximum diameter of 0.128 inches). Larger diameter shock tube (0.150 nominally) used by some military agencies will not interface with the STInger with the standard white compression fitting. ETI has a green colored compression fitting suited to this larger diameter shock tube which has been included in your kit.

CAUTION

The retaining nut should be finger-tightened only. Over-tightening the retaining nut may damage the unit.

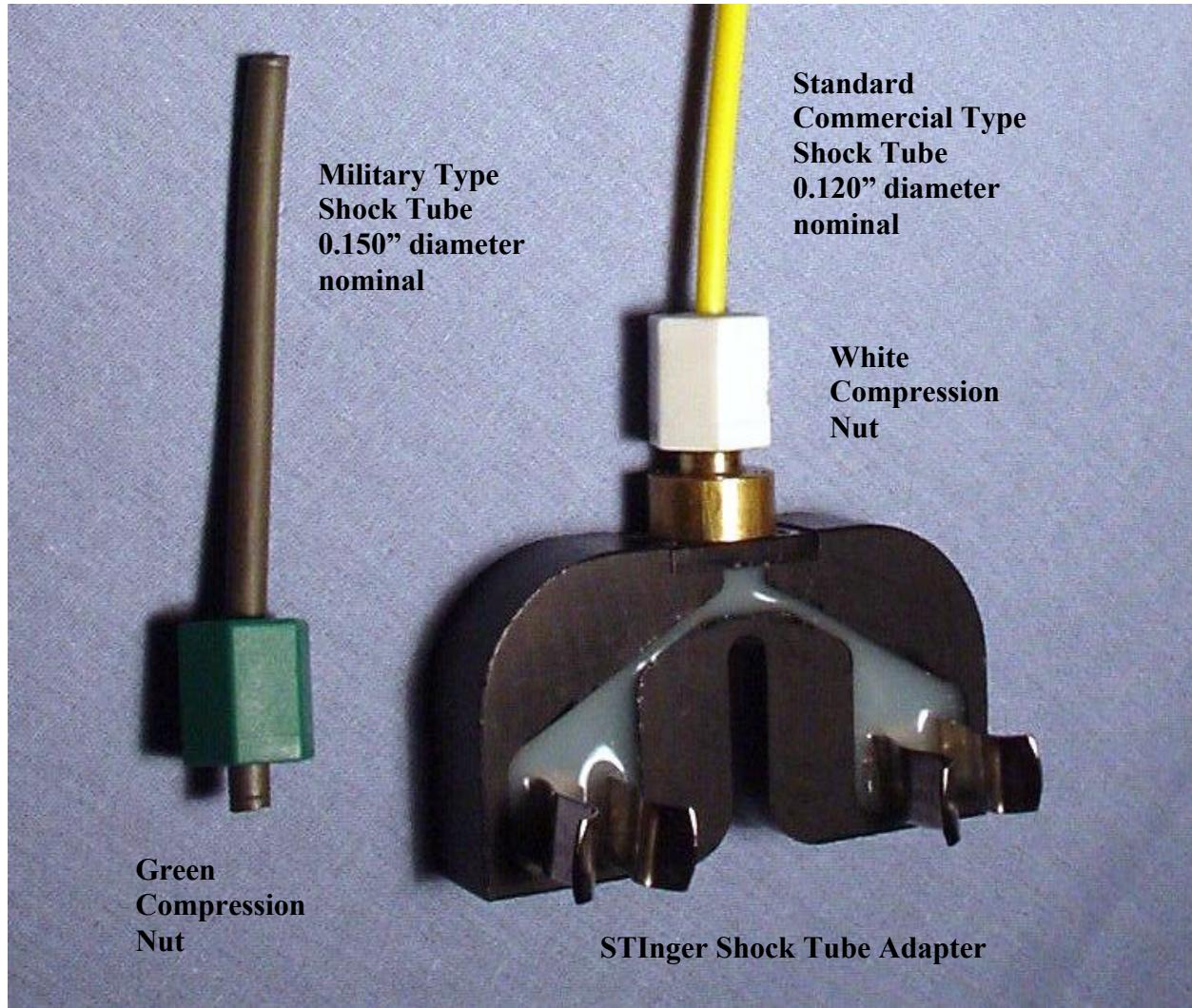


Figure 3. STInger shock tube adapter with plastic tubing fitting retaining nut.

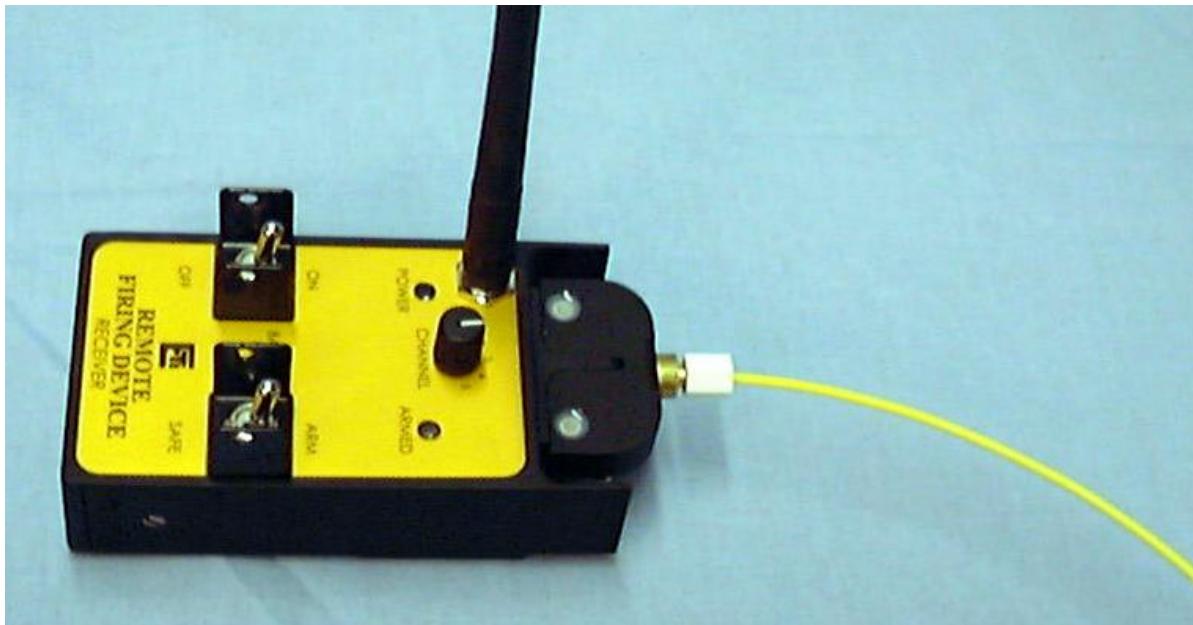


Figure 4. RFD receiver configured with STInger shock tube adapter.

The receiver unit may also be used with electric caps (see figure 5). The contact wires should be attached directly to the spring-loaded binding posts. Attach one contact wire to each spring-loaded binding post, as follows:

1. Press down on the spring-loaded binding posts to open the wire connection.
2. Insert the wire into the opening and release to clamp the wire. Approximately $\frac{1}{2}$ -inch of insulation should be removed from the end of the wire prior to making the connection to the spring-loaded binding posts.

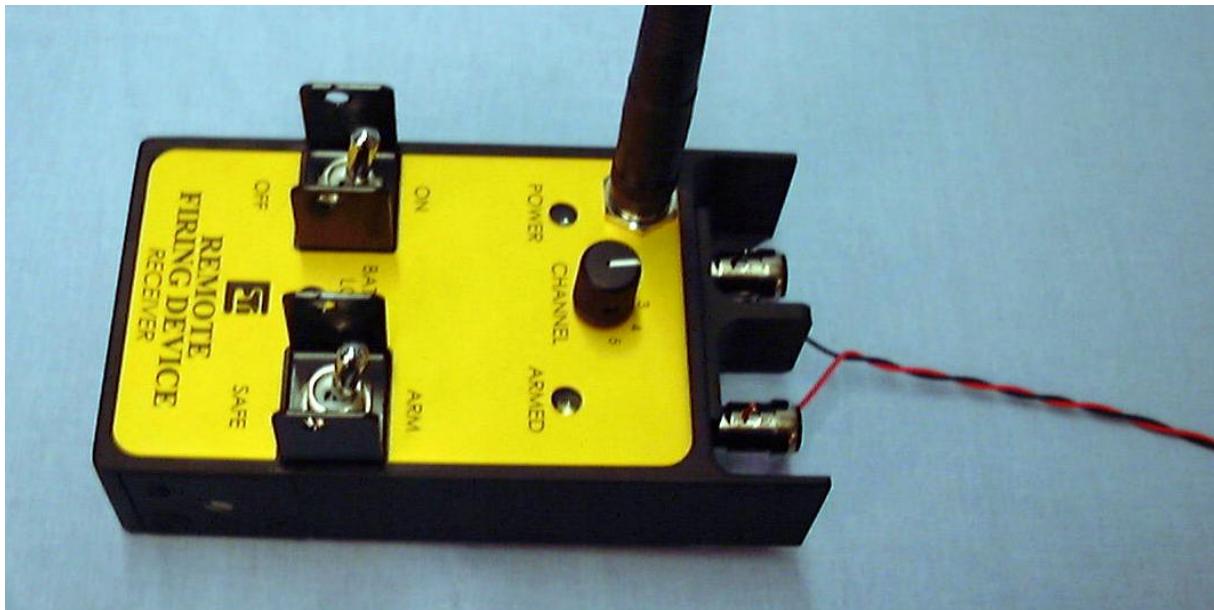


Figure 5. RFD receiver configured for use with electric caps.

3.2.2 Transmitter Unit Controls and Indicators



Figure 6. RFD transmitter unit controls and indicators.

The transmitter (red faceplate) has four control switches and three LED status indicators. The switches are:

- 1) POWER toggle switch. Applies power to the unit
- 2) CHANNEL SELECT rotary switch. Selects the communication channel for the transmitter. Channels 1-5 are available.
- 3) ARM key switch. Allows FIRE commands to be sent. The key should be removed as a safety measure while the receivers are being placed. The arm key is locked into the key switch when in the ARM position. Key may only be removed when switched to the SAFE position.
- 4) FIRE toggle switch. Sends FIRE commands to the receivers.

The three status indicators are:

- 1) A red ARM STATUS LED.
- 2) A green POWER ON LED.
- 3) A yellow BATTERY STATUS LED.

The green POWER ON LED is lit any time power is applied to the unit (i.e., the power switch is in the ON position).

The yellow BATTERY STATUS LED indicates the energy level of the batteries.

The red ARM STATUS LED indicates the current armed state of the RFD transmitter.

Table 2 indicates possible combinations of the yellow BATTERY STATUS and red ARM STATUS LEDs.

Table 2. RFD Transmitter ARM STATUS LED and BATTERY STATUS LED Indications.

ARM STATUS LED	BATTERY STATUS LED	CONDITION
OFF	ON	Batteries are very weak. Further operation is inhibited until the batteries are replaced.
OFF	FLASHING	Batteries should be replaced soon. Further operation is permitted.
FLASHING	ANY	Unit is transmitting a FIRE command.
ON	OFF or FLASHING	Unit is armed and ready to transmit a FIRE command.
ON	ON	A fault condition has been detected. See section 3.7 for troubleshooting procedures.

3.3 Method of Operation

A test firing should always be performed up range before an actual initiation. A typical test firing sequence is provided below. Live firing procedures are provided in paragraph 3.3.2.

3.3.1 Test Fire Procedures

Test fire procedures are generally specified by local agency policy and should always be completed before live firing the RFD. In the absence of local test firing procedures, use the following general procedure.

1. Remove transmitter and receivers from their containers and inspect for damage.
2. Insert batteries in transmitters and receivers.
3. Install antennas on transmitters and receivers.
4. Install STInger shock tube adapters on all receivers.
5. Set each receiver on a different channel.
6. Power each unit ON and ensure the battery light is not illuminated. If the battery light is illuminated, replace the batteries.
7. Set each receiver ARM/SAFE key switch to ARM. The key is locked into the key switch when in the ARM position.
8. Place each receiver in the order of channel selection (1 through 5), with each receiver antenna oriented vertically. Each unit should be no closer than 2 feet from any adjacent receiver and not less than 6 feet from the transmitter.
9. Wait until all receiver units ARM lights display solid red, indicating units are ready to fire.
10. Remove locking pins from transmitter unit and set transmitter to ARM. Move at least 6 feet away from the receiver(s).
11. Fire each receiver in channel selection order (one through five) and observe to ensure each STInger fires.

WARNING

In the event of a misfire, during test firing, do not use the failed receiver with live explosives. Follow troubleshooting procedures in paragraph 3.7 to determine the cause of the misfire.

3.3.2 Live Fire Procedures

1. Perform a site survey to determine positioning of the transmitter, receiver, detonator, and explosives.
2. Test fire the RFD according to local agency procedures. Do not use the RFD with live explosives until a test fire is successfully completed.

WARNING

The RFD should always be test fired up range, following local agency procedures, before using live explosives. An RFD which has not been test fired may malfunction, resulting in serious bodily injury or death. A typical test firing procedure is provided in paragraph 3.3.1.

3. Secure detonator by placing it in the ground or covering with sandbags. Ensure the detonator or tool is not in contact with explosive materials.

CAUTION

Protect the RFD from potential blast damage by distance, shielding, and cover. Units not adequately protected from blast may malfunction or fail completely.

4. At the receiver unit:

- Step 1: Ensure the power switch is turned OFF.
- Step 2: Attach the device (shock tube or electric caps) to be initiated.
- Step 3: Turn POWER switch to ON.
- Step 4: Set the CHANNEL SELECT switch to the desired channel ID.
- Step 5: When ready to fire, the receiver arming sequence may be started by placing the ARM/SAFE switch in the ARM position. The time should be recorded and a stopwatch started at this point, since the transmitter gives no indication of when the safe separation period is over.

Upon completion of step 5, the ARM STATUS LED will begin flashing and will continue to do so for five minutes. The flashing state is an indication that the unit is operating in the five-minute safe separation period. During this time, commands received over the radio link are ignored. At the completion of the safe separation period, the ARM STATUS LED goes to a steady ON state. Should a validated fire command be received from the transmitter, the unit fires, and the ARM STATUS LED flashes approximately four times per second. All indicators remain in this state until power is cycled (turned off, then back on) on the receiver.

At any time before firing, the ARM/SAFE switch may be placed into the SAFE position to immediately return the receiver unit to the SAFE condition. Restoring the switch to the ARM position starts a new five-minute safe separation period.

NOTE

If there is any possibility of the ARM or POWER switches being displaced prior to the firing of the receiver, (for example, due to vibrations from nearby detonations), the switches may be locked in the ON and ARM positions by inserting the supplied locking pins through the holes in the switch guards.

5. Prime the explosive charge.

WARNING

Do not touch the RFD receiver after the explosive charge has been primed.

NOTE

The RFD should not be relied on to function properly if left in an armed state for more than six hours.

6. At the transmitter unit:

- Step 1: Ensure the power switch is turned OFF and the ARM/SAFE switch key is removed.
- Step 2: Ensure all personnel are at a safe distance from the detonation area.
- Step 3: Turn the POWER switch to ON.
- Step 4: Set the rotary switch to the desired Channel ID.
- Step 5: Insert the key into the ARM/SAFE switch.
- Step 6: Place ARM/SAFE switch in the ARM position. The ARM STATUS LED will light.

7. When ready to fire:

- Step 7: Remove the locking pin from the FIRE switch guard.
- Step 8: To fire, momentarily push the FIRE switch to the FIRE position and hold, then release. The ARM STATUS LED will briefly flash during transmission of the FIRE command.

After step 8 has been completed, the rotary switch may be turned to a different channel and the FIRE switch pushed to fire any receiver(s) located on that channel. Channels may be re-selected only between FIRE commands. Wait for the ARM LED to stop flashing before pushing the FIRE switch again.

WARNING

In the event of a misfire, safe procedures must be followed. See paragraph 3.5 for misfire safe procedures.

3.4 Line-of-Sight/Radio Considerations

The RFD transmitter and receiver have been tested to operate at a separation distance of up to 1000 meters. Significantly longer distances may be possible under ideal conditions. This assumes a clear line-of-sight between transmitter and receiver, i.e., in a flat area, and with no obstructions between the two. One thousand meters may not be attainable in urban environments due to the presence of obstructions (such as RF-absorbing/reflecting walls and other surfaces) and extensive interference from RF emitting devices such as cellular telephones. There should also be a minimum of 6 feet separation between the transmitter and receiver, a distance of several wavelengths at to transmitter frequency. The RFD may not function reliably at distances of less than 6 feet.

NOTE

At distances of greater than 1000 meters, it may be necessary to elevate the receiver from the ground slightly to ensure good reception. Elevation of as little as one foot above the ground can often provide greater reliability at these longer distances.

NOTE

For maximum range, antennae for both transmitter and receiver should be vertically oriented (facing up).

3.5 Safe Procedures in the Event of Misfire

Procedures for handling a misfire are generally specified by agency policy and should be followed. General procedures in the event of a misfire are as follows:

- Step 1: On the transmitter, turn the ARM/SAFE key switch to the SAFE position and turn the transmitter POWER switch OFF.
- Step 2: Maintain a safe distance from the receiver for at least 30 minutes after the misfire.
- Step 3: After 30 minutes have elapsed since the misfire, approach the detonator. Do not touch the RFD.
- Step 4: Remove any sandbags or soil covering the detonator and detach the detonator from the main charge.
- Step 5: Remove the electric detonator wires or shock tube from the RFD.
- Step 6: The RFD may now be safely handled. Note the status of the ARM and POWER lights before powering the receiver OFF.

Step 7: Follow troubleshooting procedures in paragraph 3.7 to determine the cause of the misfire.

Step 8: If the cause of the misfire can be determined, correct the problem, then perform a test fire following the procedures in paragraph 3.3.1. If the cause of the misfire cannot be determined, use a different RFD, perform a test fire following the procedures in paragraph 3.3.1, replace the detonator or shock tube, and repeat the firing procedure in paragraph 3.2.2.

NOTE

Appendix B is a Malfunction Report Form. Please use this form to report malfunctions of the RFD to ETI.

3.6 Power

The RFD is powered by three internal alkaline, 1.5-volt, AA batteries. No external power supply is required. See paragraph 4.1 for battery replacement procedures.

3.7 Troubleshooting

Q: The indicator lights remain dark when the unit is powered up.

A: Check the batteries for correct orientation and try again. If this does not help, try replacing the batteries.

Q: The POWER, ARM/SAFE and BATTERY STATUS indicators all light and remain lit.

A: This indicates an internal failure has been discovered by the unit. Try cycling power. If this condition continues to occur, the unit should be replaced.

Q: A FIRE command was sent by the transmitter to the receiver and no detonation occurred.

A: Follow misfire safe procedures (see section 3.5). Before powering down the receiver, observe the state of the ARM STATUS indicator.

If the indicator is not flashing rapidly, check the CHANNEL SELECT switch to ensure the receiver and transmitter are both set to the same communication channel. Verify the antenna is securely attached to both transmitter and receiver. Also verify a clear line-of-sight is available for communication between the transmitter and receiver.

A rapidly flashing ARM STATUS indicator indicates communication between transmitter and receiver was successful, but something prevented energy from being supplied to the detonator. Check for good electrical contact being made between the binding posts and the device being initiated, whether through electric cap wires or the STInger. Check the batteries.

How the 900 SS MicroHopper Works

What is Spread Spectrum?

The 900 SS MicroHopper uses frequency-hopping signals instead of narrowband signals. The advantages of frequency hopping include traffic privacy, low probability of intercept, multiple access capability, and short synchronization time. With World Wireless Communication's Secure-Sync technology, the 900 SS MicroHopper provides fast, reliable and secure radio communication.

The 900 SS MicroHopper operates on 25 discrete frequencies within the ISM band; each frequency is about 400 kHz apart. Using a high-speed phase-locked loop synthesizer, the radio receiver is able to quickly acquire synchronization with the transmitter and receive the transmitted data.

Data is transported across the RF channel in a transparent, promiscuous mode. This means that data sent into the serial port on one radio will be presented out of the serial port on all other radios that are within range and have the same group code.

Connections

The Data Radio is connected to a host device using a 20-pin dual in-line header for TTL mode. The radio requires external DC power delivered through the 20-pin header, an RS485 adapter or RS-232/DB9 adapter board for supported serial communications modes. These connections provide the radio with the required DC power source and allow the Data Radio to be programmed and configured, while providing I/O lines for an RS-232 port.

Interference

The radio shares frequency spectrum with other services and other unlicensed devices using the 902 Mhz to 928 Mhz frequency band. Systems that are installed in rural areas will encounter the least amount of interference, but because of the frequency sharing some level of interference is expected. However, the Hopper's flexible design and hopping technology should allow adequate performance as long as care is taken in choosing site locations.

Specifications

Frequency Range:	902 to 928 MHz
Power Source:	5 VDC +/- 10%, 1.5 Watts
Current consumption:	<u>Receive</u> <u>Transmit</u> 35 mA 350 mA max
Antenna Impedance:	50 Ohms unbalanced
Antenna Connection:	Reverse Polarity SMA male
Operation Mode:	Frequency Hopping Spread Spectrum
Frequency Control:	PLL Synthesizer, 100 kHz step size
Operating Band:	ISM 902 MHz to 928 MHz
Channel Spacing:	400 kHz
Modulation System:	Direct FM
System Deviation:	100 kHz max
Sensitivity:	-103 dBm
FCC Compliance:	Part 15
Transport Protocol:	Transparent
Data Interface:	Asynchronous Serial – RS-232 or TTL, RS-485
RF Data Rates:	19,200 bps
Data Interface Rates:	2,400 to 19,200 bps
Data Protocols:	8 data bits, no parity, 1 stop bit, transparent (No protocol).
Operating Temperatures:	0 to 70C (Commercial temperature range)
Size:	Approximately 1.75" x 2.47" x 0.375"
Range (line of sight):	500 meters