ROTHENBUHLER ENGINEERING®

REMOTE FIRING DEVICE

OPERATION MANUAL

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ROTHENBUHLER ENGINEERING
P.O. BOX 708
524 RHODES ROAD
SEDRO WOOLLEY, WA 98284

1678-A16C
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SPECIAL NOTICE

WARNING TO USERS AND AFFECTED PERSONS

The Remote Firing Device (RFD) is designed to be used in blasting operations. Explosives used in connection with the RFD may be extremely powerful. Improper use of explosives with or without the RFD or improper safety precautions taken with respect to personnel or property may result in death, serious personal injury, or property damage. Other manufacturers' equipment that may not be in compliance with frequency coordination may inadvertently interfere with the operation of the RFD. Be aware of other operations within the receiving range of the RFD.

The literature accompanying this warning contains information of a general nature for users of the RFD based upon the manufacturer's experience in the design and manufacture of remote radio frequency devices. In addition, the manufacturer provides product literature and technical data sheets periodically which should be consulted for detailed information on the characteristics, specifications and recommendations for the RFD. The manufacturer does not purport to give information or advice on explosives or their use.

The RFD and related explosive devices are intended for use only by trained professionals having comprehensive knowledge of the RFD, the explosives being used, and the application together with all related safety precautions. The manufacturer of the RFD is responsible only for the proper performance of the RFD itself and is not responsible for the performance, safety, or specifications of the explosive used, nor the suitability of the RFD for any particular purpose other than that expressly described in the manufacturer's literature.

LIMITED WARRANTY

The manufacturer warrants the Model 1678 Remote Firing Device (RFD) to be free of defects in workmanship or materials for the period of one year from the date of purchase. In the event any RFD or component thereof is shown to be defective in workmanship or materials within one year, the system or component will be repaired or replaced without charge by the manufacturer at the manufacturer's place of business.

This warranty does not cover damage or injury to equipment resulting from abuse, neglect, or use in applications other than expressly described by the manufacturer as fit purposes for the RFD.

This Limited Warranty is given in lieu of all other legal warranties express or implied and neither the manufacturer nor its representatives shall be liable for any direct, incidental or consequential loss or damages arising out of any occurrence or accident involving the use of this product.

FCC NOTICE

This device complies with Part 15 of the FCC regulations. Operation is subject to the following two conditions: (1) That this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

RADIATION HAZARD WARNING

This radio shall only be used during the course of employment by individuals aware of the hazards of radio frequency (RF) radiation exposure, and the ways to minimize such hazards. This radio is not intended for use by the "General Population." Further, this radio must not be co-located or operated in conjunction with any other antenna or transmitter. User should not allow antennas to come within 20 cm (8 inches) of the body during use.

CANADA

**This Class B digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

These radio transmitters (IC: 2758A-166921, 2758A-16784, & 2758A-167801V2) have been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Antenna: ¼ wave whip, gain 2.15 dBi

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

Le présent émetteur radio (IC: 2758A-166921, 2758A-16784, & 2758A-167801V2) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Stabantenne: ¼ longueur d'onde, gain 2.15 dBi

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SAFETY INFORMATION

The following are WARNINGS and CAUTIONS, contained throughout this manual and are repeated here for emphasis. All personnel engaged in the handling, firing, and storage of the system covered in this manual must fully understand these WARNINGS and CAUTIONS, and procedures by which hazardous conditions are to be reduced or eliminated. Also listed are general safety precautions that are not related to any specific procedures and therefore don't appear elsewhere in this publication. These are recommended precautions that personnel must understand and apply during many phases of operation and maintenance.

WARNING Never rely on the equipment for your safety.

WARNING Use of this system and its components must be restricted to personnel qualified and experienced in the field of explosives and detonating devices. Under no circumstances shall untrained personnel attempt to use this manual as a text for self-teaching.

WARNING This system and its components should be stored in a secure area with no access to unauthorized personnel. This system can be used in conjunction with explosives as a deadly weapon.

WARNING These radios contain batteries. The potential for activation is always present whether or not antennas are attached to the units.

WARNING Employ standard blasting system safety standards when using this equipment with explosives.

WARNING Lightning induced energy, caused by electrical storms, can detonate explosives. In the interest of safety, blasting on land, water and underground should be suspended and all personnel should be evacuated to a safe distance from the blast area whenever lightning storms are in the vicinity. Dangerous levels of static electricity can build up in the atmosphere. These levels can be sufficient to detonate explosives.

WARNING Radio frequency energy of sufficient magnitude can cause blasting caps to detonate.

WARNING To eliminate long wire runs, and to make the "shoot" from a safe distance, the Remote Firing Device uses low energy level radio frequency transmissions.

WARNING Do not connect a blasting cap to a Remote Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

WARNING Ensure that blasting caps are not connected to any of the Remote Units during bench testing.

WARNING This is a sensitive electronic radio system and it may be damaged.

WARNING Do not use the Controller within 100 feet (30 meters) of explosives, blasting caps, or wires leading to them. The Controller signal is 5 watts, which can cause detonation of caps if within 100 feet. The 5 watt Controller complies with the Recommended Table of Distances established by the Institute for the Makers of Explosives (IME) when placed beyond 100 feet of explosives.

WARNING Do not engage in RFD communications with the Remote Units when they are connected to explosive charges until the shot is prepared and all personnel are clear. The Remote Unit complies with the Recommended Table of Distances established by the Institute for the Makers of Explosives (IME) when placed 25 feet (8 meters) or more from blasting caps or wires leading to them. For further information, refer to the Institute for the Makers of Explosives Publication no. 20, Part II, Section (1).

WARNING Do not touch the Shock Tube Tip Jacks on the top of the Remote Shock Tube Initiator (RSTI) when armed or firing. Lethal voltages may be present.

CAUTION Do not assume the DISARM command has been received by the Remote Unit unless disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. If distance appears to be the problem, move closer to the Remote Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Remote Unit is approached. Maintain a safe distance from the Remote Unit. Do not approach the Remote Unit until disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Controller closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

CAUTION All units must be thoroughly tested and the batteries fully charged prior to operational use.

CAUTION Unequal air pressure inside the Controller may affect the operation of membrane switch keypad. Extreme pressure differentials may irreversibly damage the keypad and/or cases.

CAUTION Vents in all units should be momentarily opened and closed immediately before use.

CAUTION Do not open a vent if there is water on or near the vent. Keep the vents closed when the relative humidity is above 90%. Take necessary precautions to ensure moisture does not enter the unit case.

CAUTION Do not use any component that is damaged, suspected of being damaged, or is not able to operate as designed. The safety of the operation could be compromised.

1. INTRODUCTION

1.1. PURPOSE

1.1.1. The primary purpose of this manual is to provide descriptive information, operational information, instructions in assembly, and instructions in testing and preparation for operational or training use of the Remote Firing Device (RFD).

1.1.2. The Remote Firing Device (RFD) is used to activate electric and non-electric detonator devices. The System is strictly an electronic device, containing no explosive. The Controller or Mini Controller Unit shall be operated from 100 feet (30 meters) to five miles (8 km) from the explosive. The Electric Remote Unit shall be placed at the explosive site, with a two-conductor firing line running to the explosive. The Remote Shock Tube Initiator (RSTI) is placed at the explosive site, with non-electric shock tube running to the explosive. The Controller or Mini Controller Unit communicates to the Remote Units through a two-way RF transmitter data link, for a typical distance greater than 5 miles (8 km). The Remote Unit can typically return communication for a distance greater than 1 mile (1.6 km). Actual communication range is dependant upon a variety of factors such as terrain, obstacles, antenna height, and local interference.

1.1.3. Throughout this manual, the term “Controller” is a generic term that is used whenever applicable for both the Controller Unit and for the Mini Controller Unit.

1.1.4. Throughout this manual, the term “Remote Unit” is a generic term that is used whenever applicable for both the Electric Remote Unit and for the RSTI.

1.2. ENVIRONMENTAL CONSIDERATIONS

1.2.1. The Controller and Remote Unit have manual operated vents. The vents should always be CLOSED during air transport, underwater transport, storage and operational use to prevent moisture intake. The operator should momentarily open and close the vent after the unit has been subjected to changes in elevation, depth, or temperature. This equalizes pressure within the case to the outside environment. DO NOT open the vent if there is water on or near the vent or if the relative humidity is above 90%. Towel dry vents prior to opening. The vents should be OPEN whenever the unit is stored in a dry hot environment.

1.2.2. The Controller and Remote Units (with vents closed) are airtight to an altitude of 30,000 feet (9,000 meters) and watertight to a depth of 100 feet (30 meters).

1.2.3. The Controller and Remote Units are shock resistant, drop tested from 5 feet onto 3 inches of steel plate backed by concrete.

1.2.4. The battery pack and unit electronics are electrically isolated from the unit case.

1.2.5. The Controller and Remote Units have a operation temperature range from -22 ºF to +140 ºF (-30 ºC to +60 ºC).

1.3. COMPLIANCE STANDARDS

- MIL-STD-810F, Method 501.4, Procedure II, High Temperature Test
- MIL-STD-810F, Method 502.4, Procedure II, Low Temperature Test
- MIL-STD-331C, A4.1, 5 feet (1.5 meter) Drop Test
- MIL-STD-331C, Test C7, Thermal Shock
- MIL-STD-331C, B1.6.2.2b, Loose Cargo / Vibration
- MIL-STD-331C, Test C4 modified to 100 feet (30 meters), Water Immersion

2. INTRODUCTION TO RFD SYSTEM COMPONENTS

2.1. SYSTEM

2.1.1. The RFD is a battery powered, hand held, radio remote controlled system to be used on land as a primary firing mechanism to detonate explosive charges. The RFD system consists of a either a Controller Unit or a Mini Controller Unit and up to either eight Remote Units (Controller Unit) or four Remote Units (Mini Controller). Any combination of Electric Remotes and RSTIs may be used.

2.1.2. The Controller and Remote Units in one system will not operate with units from another system.

2.1.3. The system has two modes of operation. The two modes are one-way, and the two-way mode.

2.1.3.1. Range for one-way mode is greater than 5 miles (8 km) typically.

2.1.3.2. Range for two-way mode is greater than 1 mile (1.5 km) typically.

2.1.4. The RFD System consists of the component parts in Table 2-1 and Figure 2-1.

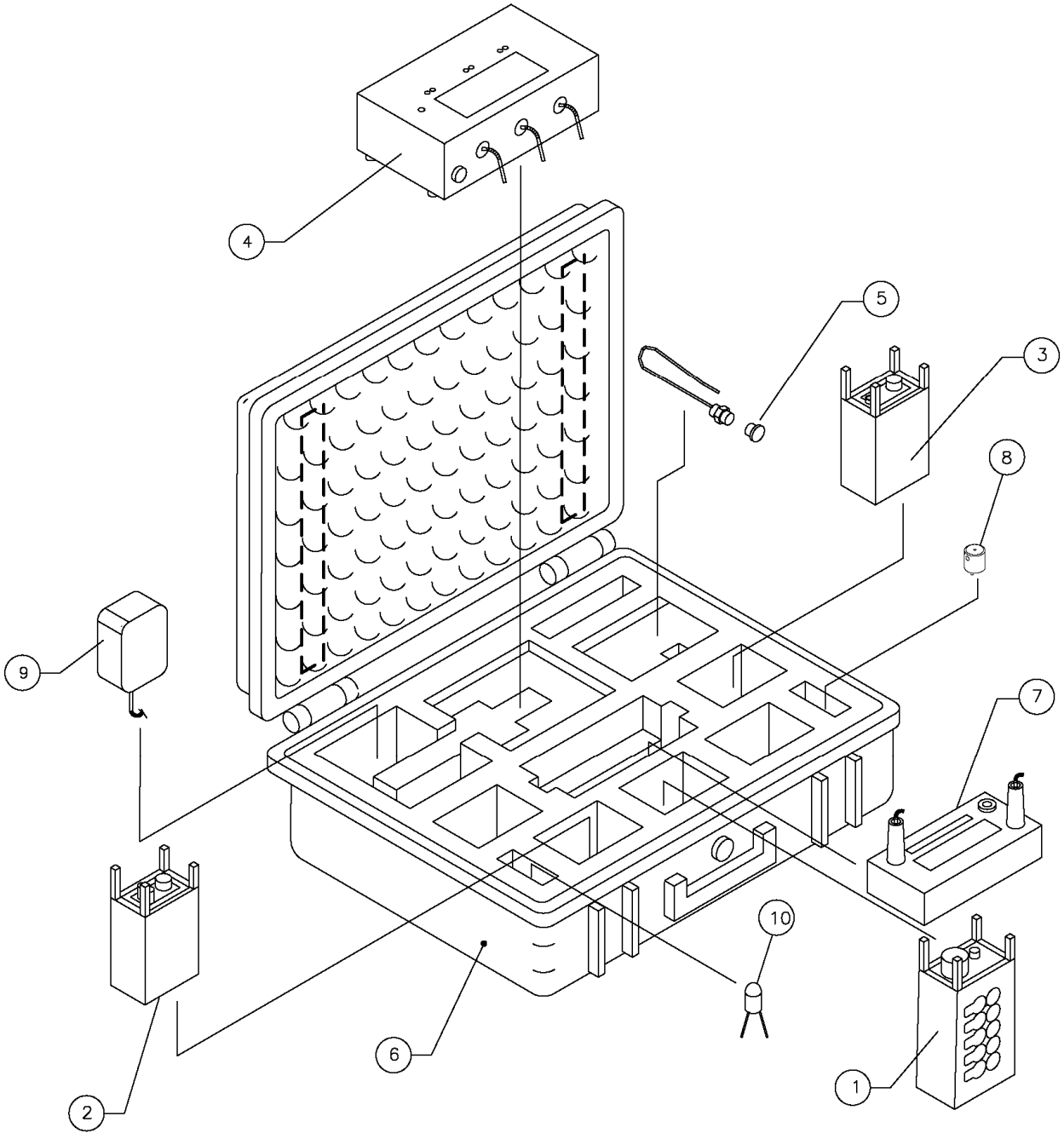


Figure 2-1 RFD 4-Remote Case System

Table 2-1 RFD 4-Remote Case System

Figure	Index No.	Description	Units per System
Figure 2-1	1	Mini Controller Unit	1*
Figure 2-1	2	Remote Unit, Electric	Up to 4 or 8**
Figure 2-1	3	Remote Unit, RSTI	Up to 4 or 8**
Figure 2-1	4	Battery Charger	See note ***
Figure 2-1	5	Antenna Assembly	1 for each Unit
Figure 2-1	6	Carrying Case Assembly	1
Figure 2-1	7	Test Box	See note ****
Figure 2-1	8	Shock Tube Igniter Tip	2 for each RSTI
Figure 2-1	9	Power Supply	1 for each Charger and for each Test Box
Figure 2-1	10	Test Light	1 for each Electric Remote

* The system is available with either a Controller (up to 8 Remotes) or a Mini Controller (up to 4 Remotes).

** Any combination of Electric Remotes and Remote Shock Tube Initiators (RSTIs) can be configured for a maximum total of 8 Remotes for a Controller or 4 Remotes for a Mini Controller.

*** The system is available with a 3 Position Charger or may come with a 5 Position Charger & Conditioner.

**** The Test Box is optional.

2.2. CONTROLLER UNIT

2.2.1. Figure 2-2 shows the external features of the Controller Unit. The Controller is sealed at the manufacturer and should not be opened during field activity. The user interface features a keypad and intensity adjustable LED display panel.

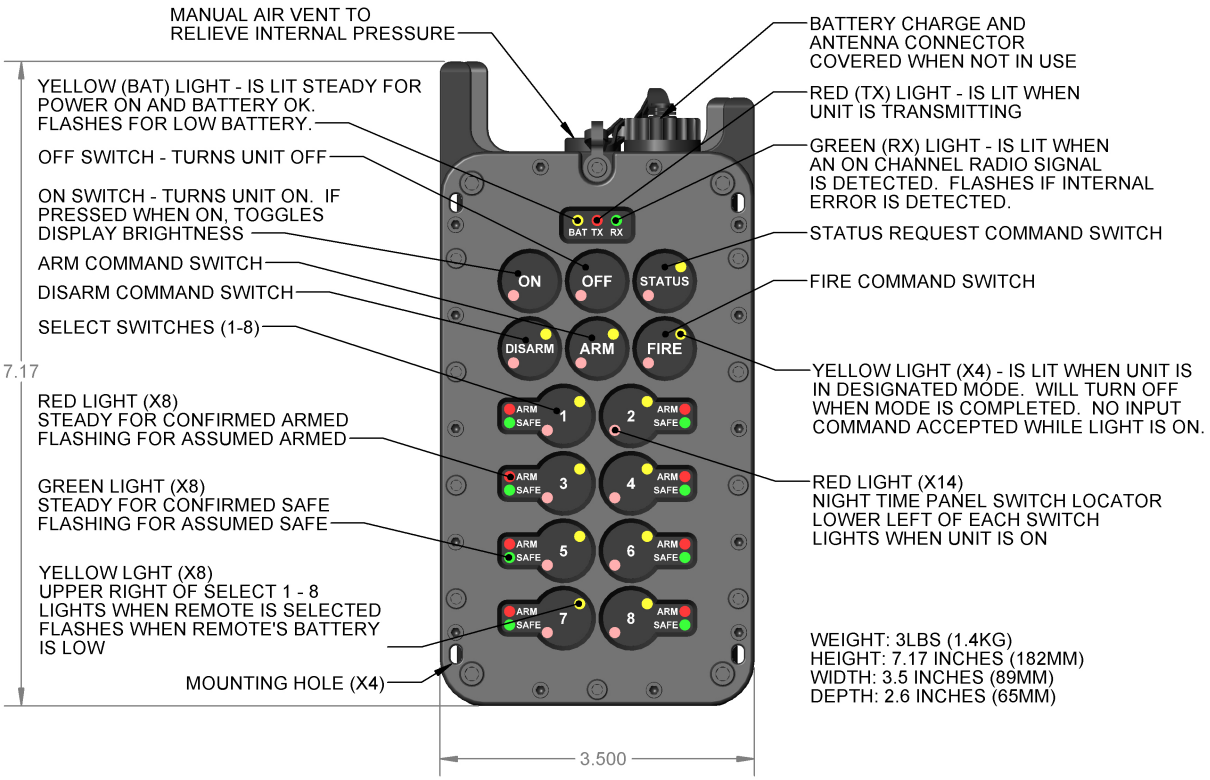


Figure 2-2 Controller Unit

2.3. MINI CONTROLLER UNIT

2.3.1. Figure 2-3 shows the external features of the Mini Controller Unit. The Mini Controller is sealed at the manufacturer and should not be opened during field activity. The user interface features a keypad and intensity adjustable LED display panel.

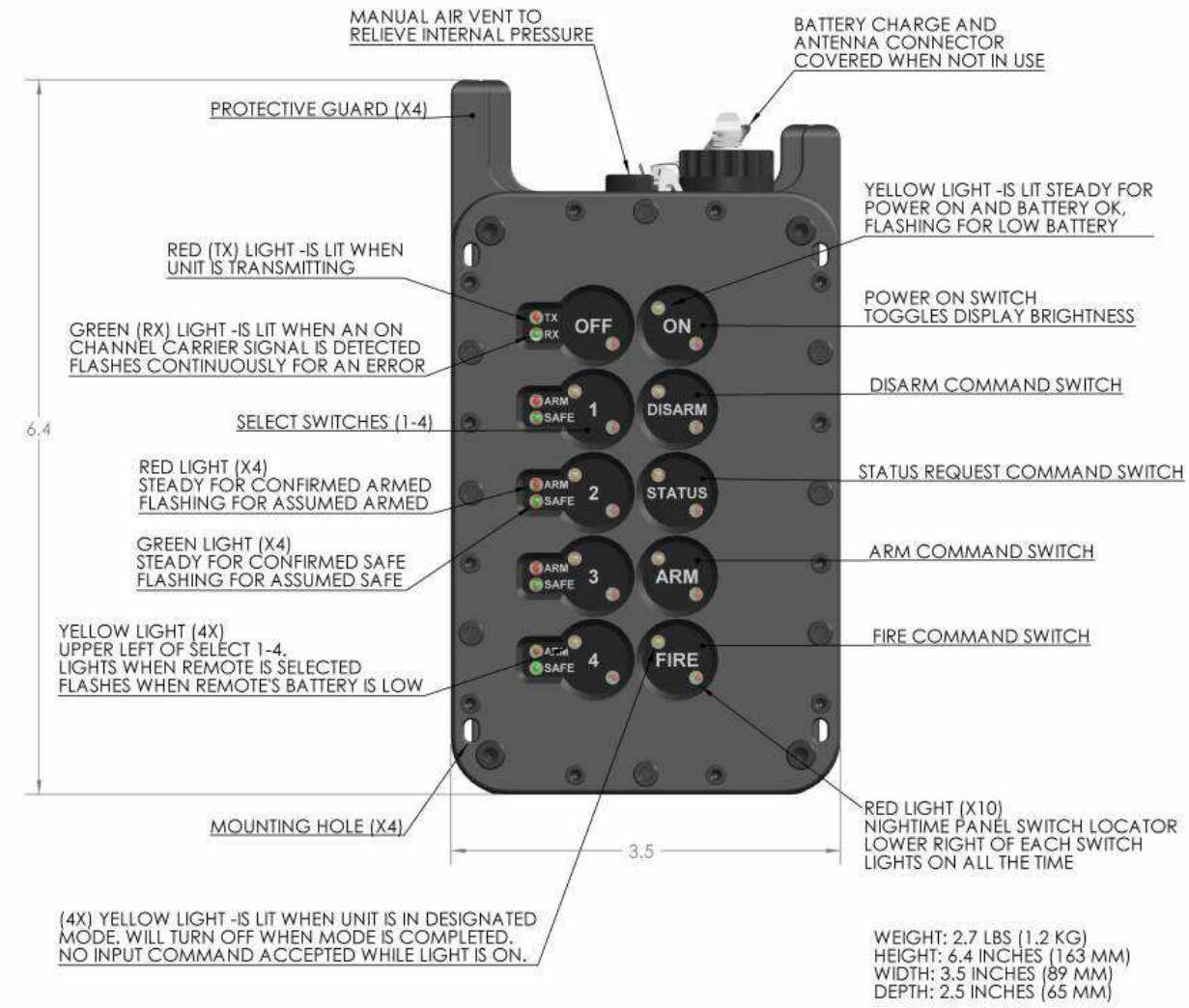


Figure 2-3 Mini Controller Unit

2.4. CONTROLLER SWITCH OPERATION

2.4.1. The Controller Unit and Mini Controller operate in a very similar manner. The difference being the maximum number of Remote Units each can control. Unless otherwise noted, the following descriptions apply to both the Controller Unit and the Mini Controller.

2.4.2. **Unit Power Control:** Depress the “ON” switch for one second to turn the power on to the Controller when the Antenna is attached. The yellow light in the upper left quadrant of the Mini Controller Unit’s “ON” switch will turn on. The yellow “BAT” light at the top of the Controller Unit will turn on. Depress the “OFF” switch to turn the power off to the Controller.

2.4.3. **Power ON Self Test:** Upon installing the antenna and pressing the “ON” switch, a rigorous self test is initiated. If a failure of the self test occurs, the green receive light (RX) will blink continuously and it will not be possible to operate the unit. Contact the Manufacturer for service. Do not attempt to use a failing unit.

2.4.4. **Display Panel Light Dimmer Circuit**: With the unit powered on, Repress the ‘ON’ switch briefly to toggle the LED display light’s intensity between bright and dim. When the unit is turned on, the last chosen intensity setting is restored.

2.4.5. **Select Remote Units:** Depress the Select Switches “1” through “4” or “8” to select independently the Remote Units that will communicate with the Controller. Any combination of the four or eight Remote Units may be selected. The yellow SELECT light on the switch indicates if the Remote Unit programmed for that switch is selected. Press the switch again and the yellow SELECT light for that Remote Unit will be turned off indicating the Remote Unit is not selected.

2.4.6. **Request Remote Unit Status:** Depress the “STATUS” switch to transmit a status request signal to the selected Remote Units. The selected Remote Units will transmit their current status to the Controller. If none of the Remote Units are selected, the Controller will request status from all of the Remote Units. Any answering Remote Units will be selected automatically. If the Controller is within range of the Remote Unit transmitter, the status of the selected Remote Unit will be presented on the display panel with a steady light. If the Controller is out of range of the Remote Unit transmitter, the status will be assumed from the last command sent to that Remote Unit. In that case the assumed status of the Remote Unit will flash on the display panel.

2.4.7. **Arm the Remote Unit:** Depress the “ARM” switch for 1/2 second and the Controller will transmit the Arm command to the selected Remote Units. The red ARMED light at the selected Remote Units will flash on the Controller display panel until the firing capacitor charging time is completed. The Controller then requests status of the selected Remote Units. If the Controller is within range of the selected Remote Unit transmitter, the ARMED red light for that Remote Unit will be on steady on the Controller display panel. If the Controller is out of range of the selected Remote Unit transmitter, the red ARMED light for that Remote Unit will continue to flash on the Controller display panel. If the Fire command is not sent within the Arm Time Period, the system will disarm automatically.

2.4.8. **Disarm the Remote Unit:** Depress the “DISARM” switch. The Controller will transmit the Disarm command to selected Remote Units. Selected Remote Units will internally discharge their firing capacitor. Selected Remote Units that receive the Disarm command will become disarmed within 3 seconds of receiving the command. The green SAFE light for selected Remote Units will begin to flash on the Controller display panel. The Controller will then request status of selected Remote Units. If the Controller is within range of the selected Remote Unit transmitter, the green SAFE light for that Remote Unit will turn to steady on the Controller display panel. If the Controller is out of range of the selected Remote Unit transmitter, the green SAFE light for that Remote Unit will continue to flash on the Controller display panel. The Fire command must be sent during the Arm Time Period. Once the Arm Time Period has expired, the Auto Disarm feature will disarm the system automatically.

CAUTION Do not assume the DISARM command has been received by the Remote Unit unless disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. If distance appears to be the problem, move closer to the Remote Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Remote Unit is approached. Maintain a safe distance from the Remote Unit. Do not approach the Remote Unit until disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Controller closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

2.4.9. **Activate the Remote Unit Firing Circuit:** Depress the “FIRE” switch for 1/2 second and the Controller will transmit the Fire command to selected Remote Units. The Controller will only transmit the Fire command to selected Remote Units whose status is Armed. The selected Remote Units will be placed in Fire Mode and discharge the firing capacitor across the binding posts. The red ARMED light will turn off and the green SAFE light for each selected Remote Unit will begin to flash on the Controller display panel. The Controller will then request status from the selected Remote Units. If the Controller is within range of the selected Remote Unit transmitter, the green SAFE light for that Remote Unit will turn to steady on the Controller display panel. If the Controller is out of range of the selected Remote Unit transmitter, the green SAFE light for that Remote Unit will continue to flash on the Controller display panel.

2.4.10. **Multistage Firing of Remote Units:** Multistage firing provides the ability to arm all Remote Units at one time, and select any combination of the Remote Units to fire at different intervals within the Arm Time Period (prior to Auto Disarm). The procedure for multistage firing is:

- Depress “1” though “4” or “8” switches.

- Depress “ARM” switch – all Remote Units will arm.
- Depress the switches for the Remote Units that will not be fired initially.
- Depress the “FIRE” switch. Only Remote Units still selected will fire.
- Depress the switches for the Remote Units that were just fired.
- Depress the switches for Remote Units to be fired next.
- Depress the “FIRE” switch. Only Remote Units still selected will fire.
- Repeat as necessary. Remote Units will automatically disarm if not fired within the Arm Time Period.

2.4.11. **Misfires:** If a Remote Unit does not fire when the Fire command is sent, repeat the fire sequence up to 3 times. If the Remote Unit continues not to fire, then a thirty-minute wait prior to approaching is mandatory. Follow your standard operating procedures for misfires.

2.5. CONTROLLER DISPLAY OPERATION

2.5.1. **Night time Panel Switch Locator:** There are 10 or 14 red lights used for backlighting the Controller switches. When the Controller is powered on, the lights turn on to help locate the switch positions.

2.5.2. **Display Panel Dimmer Circuit:** Repressing the ‘ON’ switch toggles the LED display light’s intensity between bright and dim. When the unit is turned on, the last chosen intensity setting is restored.

2.5.3. **Mini Controller Unit Battery Status:** The yellow light at the “ON” switch displays the Mini Controller Unit BATTERY status. If the Mini Controller Unit battery is low, the yellow light at the “ON” switch will flash. Otherwise this light will be on steady.

2.5.4. **Controller Unit Battery Status:** The yellow “BAT” light at the top of the Controller display panel displays the Controller Unit BATTERY status. If the Controller Unit battery is low, the yellow light “BAT” will flash. Otherwise this light will be on steady.

2.5.5. **Remote Unit Battery Status:** The yellow select light at each of the “1” through “4” or “8” switches will indicate the selected Remote Units’ battery status after a status request command is issued. If the selected Remote Unit transmitter is within range of the Controller and Remote Unit's battery is low, the yellow select light for that Remote Unit will flash. Else, the select light will be on steady.

2.5.6. **Remote Unit Safe:** A green light next to each of the “1” though “4” or “8” switches is used to indicate when the corresponding Remote Unit is safe/disarmed. The light will be on steady when the Remote Unit transmitter is within range of the Controller and it is disarmed. If the Remote Unit transmitter is out of range of the Controller, the light will flash after a Disarm command has been sent.

2.5.7. **Remote Unit Armed:** A red light next to each of the “1” though “4” or “8” switches is used to indicate when the corresponding Remote Unit is armed. The ARMED light for selected Remote Units will flash after the Arm command is sent to the selected Remote Units. The ARMED light will go to steady after the firing capacitor charge time if the Controller is within range of the selected Remote Unit's transmitter. If the Remote Unit transmitter is out of range of the Controller, the ARMED light will continue to flash.

2.5.8. **Status:** A yellow light at the “STATUS” switch lights when the “STATUS” switch is pressed. The light remains on until the display panel has been updated with results of the status request. All new commands are blocked while this light is on.

2.5.9. **Arm:** A yellow light at the “ARM” switch lights when the “ARM” switch is pressed. This light will stay on for the firing capacitor charge time.

2.5.10. **Disarm:** A yellow light at the “DISARM” switch lights when the “DISARM” switch is pressed. This light will stay on until the display panel is updated for the Disarm command. Other commands will not be sent until this light is turned off.

2.5.11. **Fire:** A yellow light at the “FIRE” switch lights when the “FIRE” switch is pressed. This light will stay on until the display panel is updated for the Fire command. Other commands will not be sent until this light is turned off.

2.5.12. **“TX” (Transmit):** A red light at the “TX” position lights while Controller is transmitting. Switch presses (DISARM, STATUS, ARM, FIRE, and 1- 4 or 8) are not recognized while the Controller is transmitting.

2.5.13. **“RX” (Receive):** During operation the green “RX” light turns on while receiving a status response from a Remote Unit. The RX light will also turn on in the presence of another on channel radio signal or from background radio noise. Blinking continuously indicates a self-test failure has occurred.

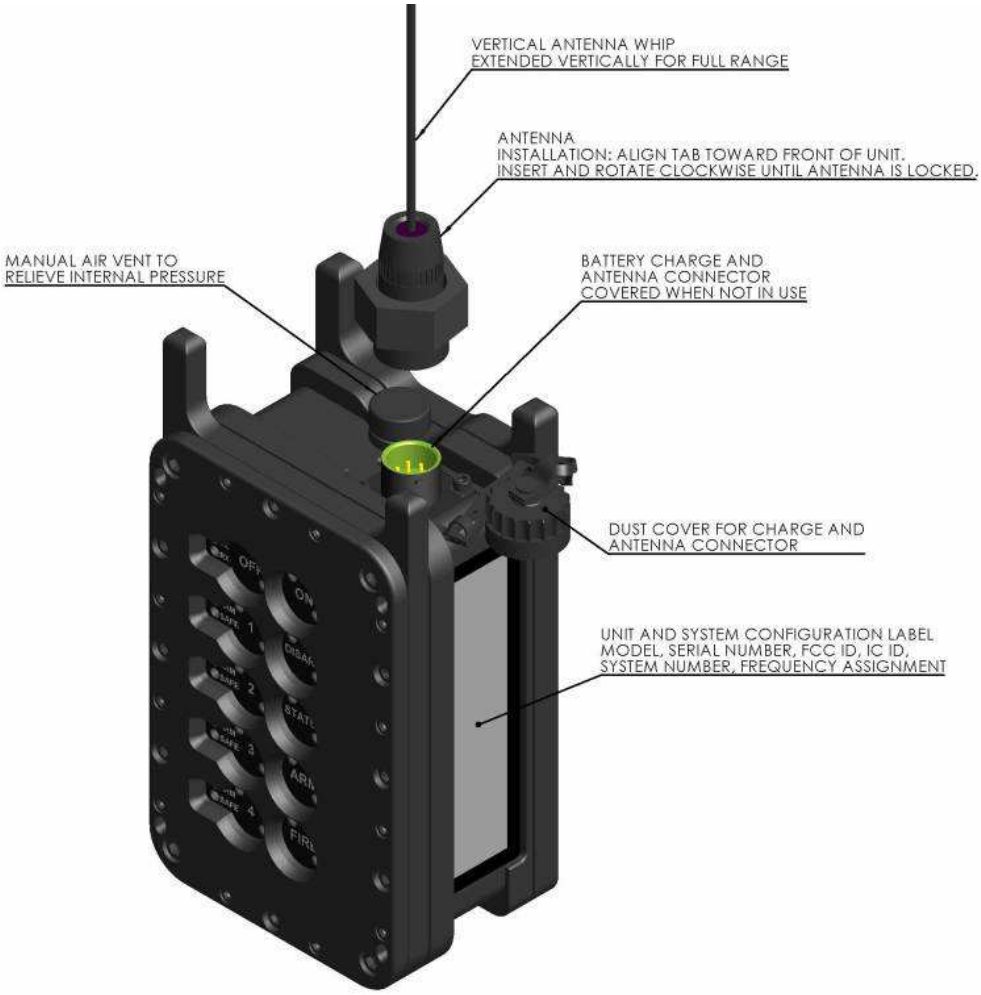


Figure 2-4 Mini Controller Isometric View with Antenna

2.5.14. Figure 2-4 shows an isometric view to further illustrate the exterior features of the Mini Controller.

2.5.15. **Manual Air Vent:** A manual vent is located on top of the unit. The vent is used to relieve any internal pressure that has accumulated within the unit as a result of temperature or altitude. The vent is opened when charging to release any gasses or pressures accumulated during charging. The vent is closed during normal use or when the unit is exposed to moisture.

2.5.16. **Battery Compartment:** In the back of the unit is a compartment which stores the rechargeable battery pack. The battery compartment is isolated from the unit's electronics.

2.5.17. **System Configuration Label:** The System Configuration Label contains information related to the settings of the unit within the system it operates. The information displayed on this label may be considered semi-permanent.

2.6. ELECTRIC REMOTE UNIT

2.6.1. Figure 2-5 shows the external features of the Electric Remote Unit. The unit is sealed at the manufacturer or service depot and should not be opened during field activity.

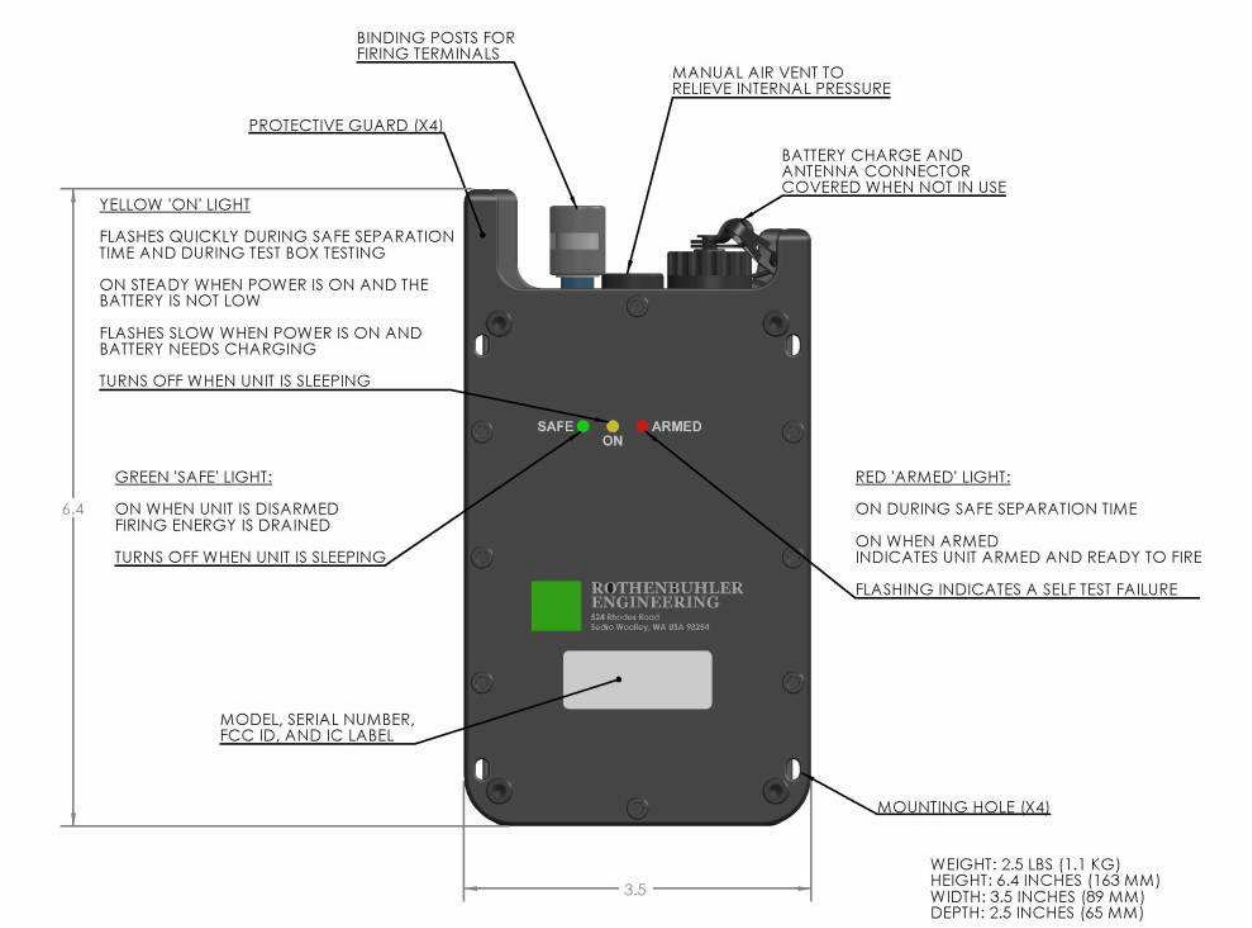


Figure 2-5 Electric Remote Unit

2.6.2. **Power ON Self Test:** Immediately after the Electric Remote is turned on by installing the Antenna, a rigorous self-test is performed. If a failure is detected, the red ARMED light will blink continuously and all other lights will be extinguished. It is not possible to use the unit once an error has been detected. The unit must be returned to the Manufacturer for service. Do not attempt to use a failing unit.

2.6.3. **Safe Separation Time:** Upon the installation of the Antenna, a safe separation countdown timer is initiated. During the safe separation time, the SAFE and ARMED lights will be on steady, while the ON light blinks rapidly. During the safe separation time, the unit will not accept any radio commands (i.e. Status, Arm, Disarm, or Fire). This is to provide a short but highly safe window of time for the user to exit the immediate vicinity of the blast area. After the safe separation time is complete, the unit may still be considered safe as long as it does not receive an Arm or a Fire radio command from the system's mated Controller. Thus, it is recommended that the mated Controller be rendered unusable while personnel are within the hazard area. This can be accomplished by the removal of the Controller's antenna and its secure storage until ready for use. The default Safe Separation Time is 15 seconds.

2.6.4. **Green SAFE Light:** After the Safe Separation Time is complete, the green SAFE light turns on to indicate that the unit is disarmed; the internal firing capacitor is fully discharged, and that the unit is operating correctly. The SAFE light will be extinguished when the unit has entered Sleep Mode (See 2.6.7).

2.6.5. **Yellow ON Light:** After the unit is activated and has completed its Safe Separation Time, the yellow ON light will remain illuminated. The ON light will blink slowly to indicate that its battery needs to be recharged before use. The ON light will be extinguished when the unit has entered Sleep Mode (See 2.6.7).

2.6.6. **Red ARMED Light:** After the Safe Separation Time is complete, the red ARMED light indicates that the unit is armed; the capacitor is charged and the unit is ready to fire. Appropriate caution of the unit should be observed when the unit is armed.

2.6.7. **Sleep Mode:** When enabled, the Electric Remote Unit operates in a sleep mode to extend the battery's run time during periods of inactivity. To enter sleep mode, the unit must be disarmed (safe and capacitor discharged) and the battery must not be low. Approximately one minute after activity (power on or a radio command), the unit will enter sleep mode. In sleep mode, the display lights extinguish and all non-essential functions are suspended. Sleep mode can be exited by sending the unit a radio command from its mated Controller. Upon receipt of a radio command, the unit will be immediately awakened and ready for operation. While in sleep mode, units may run for 200+ hours. Actual sleep mode run time is affected by a variety of factors such as the sleep mode setting of your system, the state of charge of the battery, the health of the battery, and the ambient temperatures the unit will be exposed to.

2.6.8. Figure 2-6 provides an angled view of the Electric Remote to show the System Configuration Label as well as the Battery Compartment Lid. Also illustrated are various hardware items such as the Binding Posts, Manual Air Vent, and the labels.

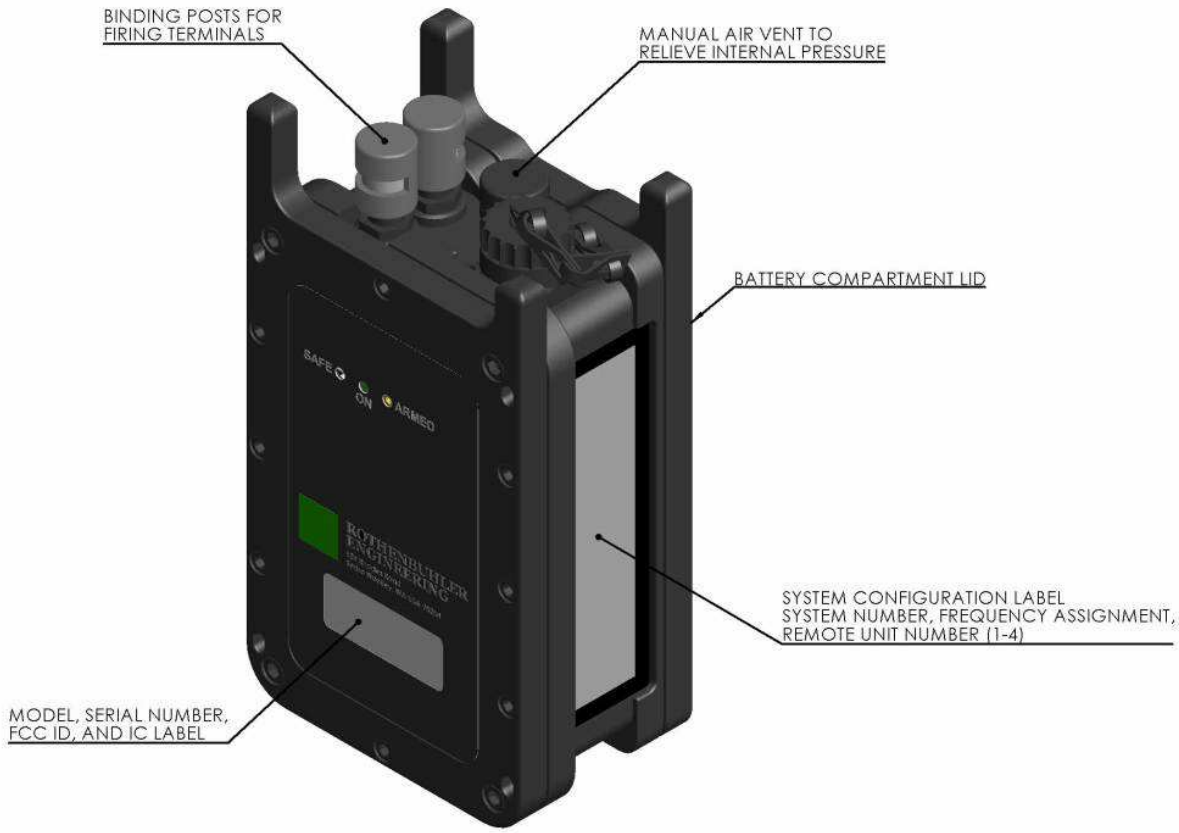


Figure 2-6 Electric Remote Unit Angled View

2.6.9. **Binding Posts:** The Binding Posts located on top of the Electric Remote Unit allow the firing cable to attach to the firing terminals. The insulation at the ends of the firing cable must be removed prior to attachment. One at a time, depress the top of the binding posts and insert a leg of the firing cable. Release the binding post, causing it to grab the lead.

2.6.10. **Manual Air Vent:** A manual vent is located on top of the unit. The vent is used to relieve any internal pressure that has accumulated within the unit as a result of temperature or altitude. The vent is opened when charging to release any gasses or pressures accumulated during charging. The vent is closed during normal use, transport, or when the unit is exposed to moisture.

2.6.11. **Battery Compartment:** In the back of the unit is a compartment which stores the rechargeable battery pack. The battery compartment is isolated from the unit's electronics.

2.6.12. **System Configuration Label:** The System Configuration Label contains information related to the settings of the unit within the system it operates. The information displayed on this label may be considered semi-permanent.

2.6.13. **Model, Serial Number, FCC ID, and IC Label:** The information displayed in this label is permanently assigned by the factory.

2.7. REMOTE SHOCK TUBE INITIATOR (RSTI)

2.7.1. Figure 2-7 shows the external features of the RSTI. The unit is sealed at the manufacturer or service depot and should not be opened during field activity.

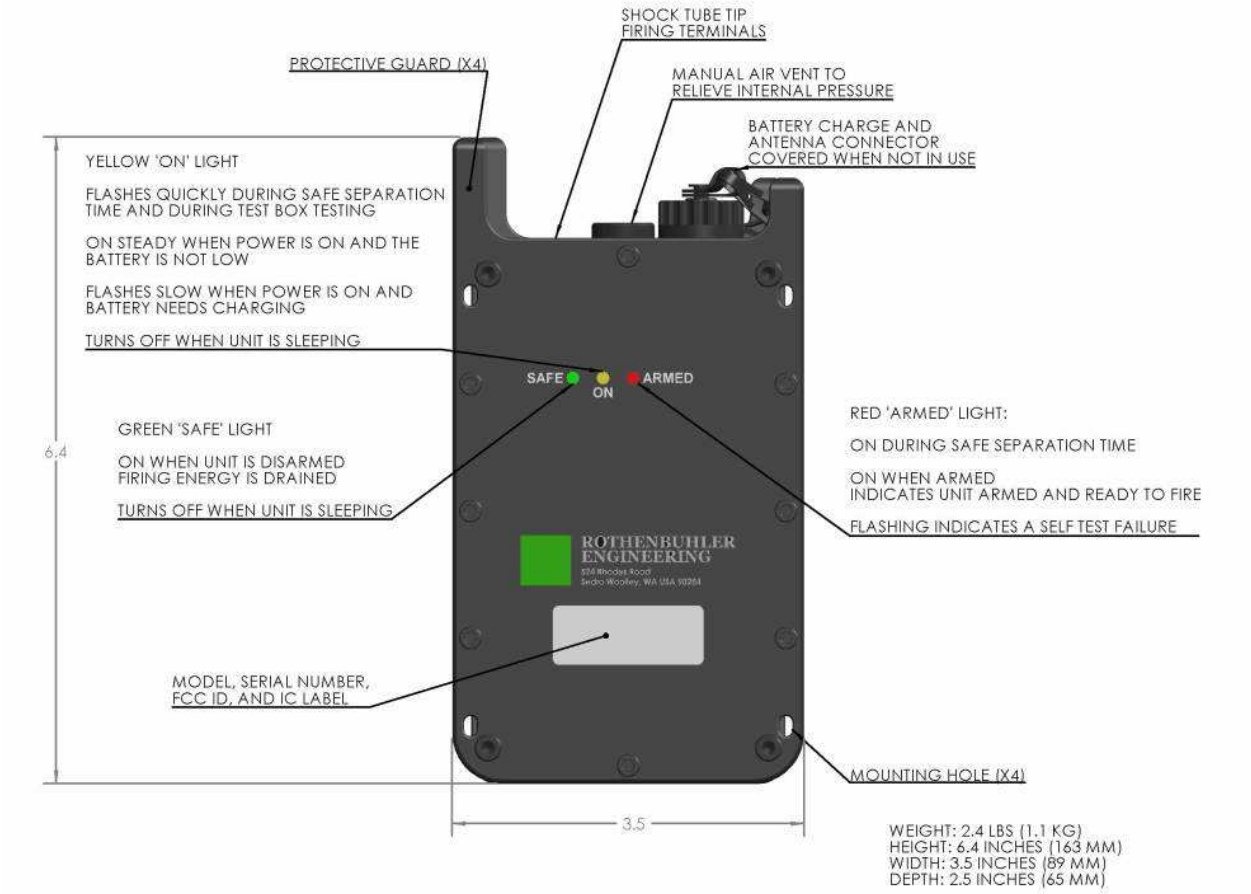


Figure 2-7 Remote Shock Tube Initiator (RSTI)

2.7.2. The RSTI operates similar to the Electric Remote Unit as described in Section 2.6, but initiates non-electric tubing instead of electric detonators. The RSTI develops 2,500V at the Shock Tube Tip Firing Terminals when firing.

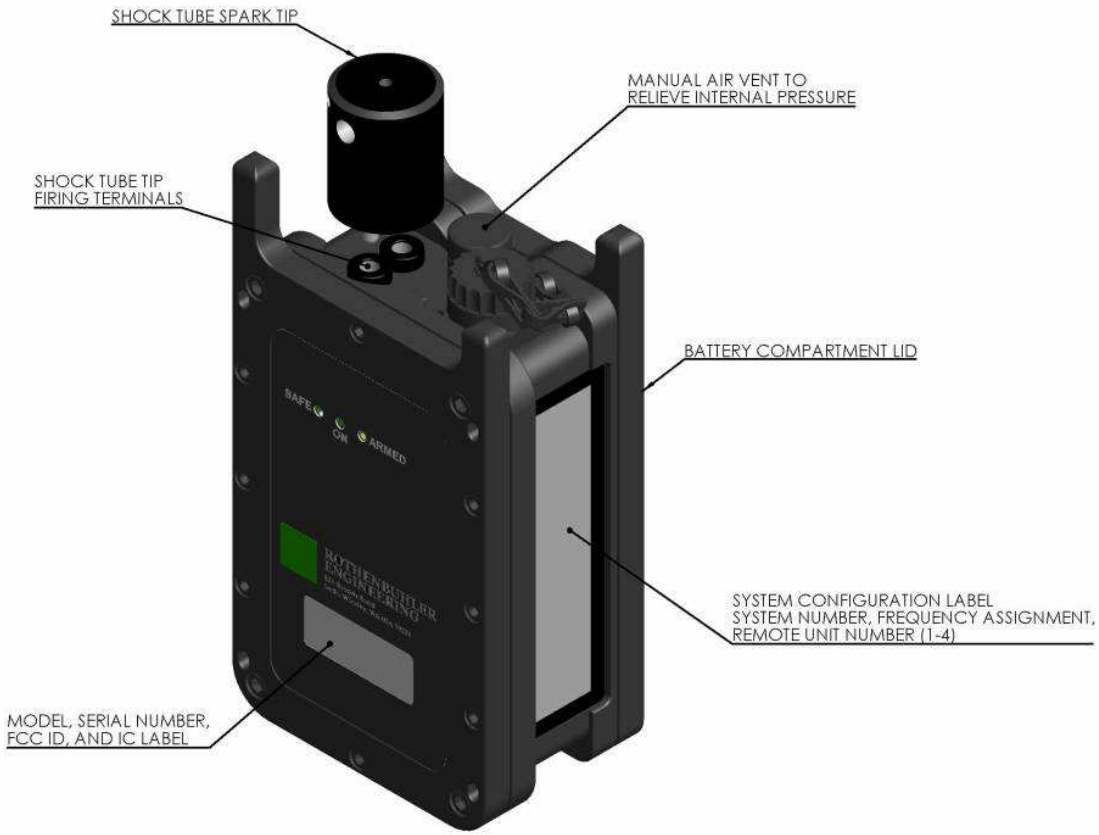


Figure 2-8 RSTI Angled View with Shock Tube Spark Tip

2.7.3. Figure 2-8 shows the installation of the Shock Tube Firing Tip onto the Firing Terminals on the RSTI.

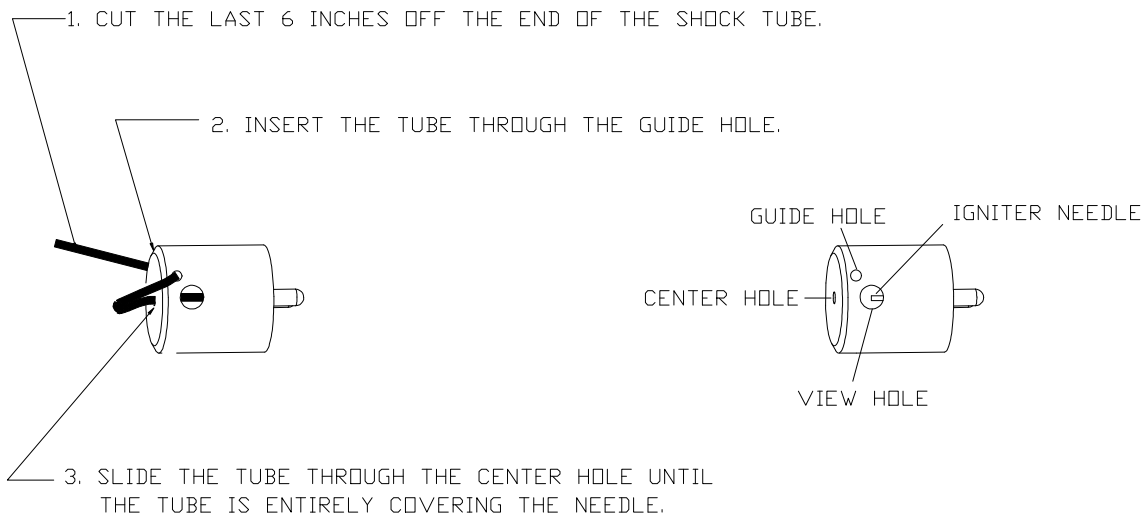


Figure 2-9 Shock Tube Tip

2.7.4. Figure 2-9 shows the installation of the shock tube onto the shock tube firing tip when preparing for use. Care should be taken when handling the shock tube to prevent the incursion of debris or moisture into the tube.

- Keep open tube ends capped during storage and transportation.
- Keep the tip needle clean and dry.
- Replace the tip every 200 shots or if misfiring occurs.

WARNING Do not touch the Shock Tube Tip Firing Terminals on the Remote Shock Tube Initiator (RSTI) when armed or firing. Lethal voltages may be present.

1. Make a fresh cut with a sharp knife removing the last 6 inches of shock tube.

2. Insert the shock tube through the guide hole on the tip as shown in Figure 2-9. The guide hole secures the tube to the tip and prevents pulling out.

3. Insert the tube into the center hole on the flat side. Feed the tube through the hole observing the side view hole. The tube should slide onto the igniter needle until the needle is no longer visible and the tube is resting against the plastic tip housing.

2.8. 3 POSITION BATTERY CHARGER

2.8.1. Figure 2-10 shows the 3 Position Charger that is configured with some 1678 RFD systems. The 3 Position Charger is a basic NiMH charger which provides a 3 to 4 hour recharge for up to three RFD units (e.g. one Mini Controller and two Remotes). It may be stored and used within the 1678 case/foam, or it can be stored and used as a stand-alone device. The 3 Position Charger comes with an AC adapter that can be configured for use internationally. The 3 Position Charges does not provide discharge or battery conditioning functions; these features are only available with the 5 Position Charger & Conditioner. The 3 Position Charger should be stored in a clean, dry place.

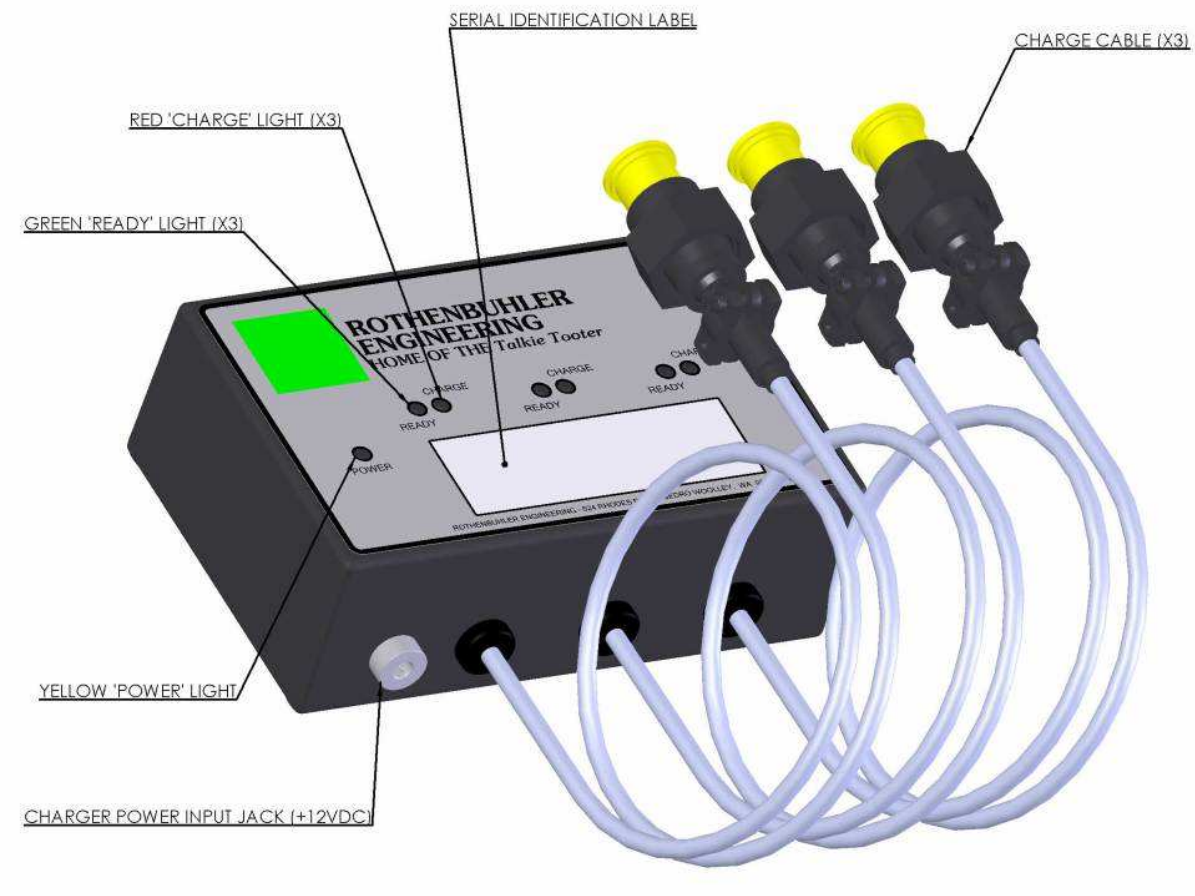


Figure 2-10 3 Position Charger

2.9. 5 POSITION CHARGER & CONDITIONER

2.9.1. Figure 2-10 shows the 5 Position Charger & Conditioner that is configured with some 1678 RFD systems. The 5 Position Charger & Conditioner charges 5 units of the 1678 RFD system in about 2 hours. The 5 Position Charger & Conditioner has advanced features that maximize the health and performance of the battery packs. It may be stored and used within the 1678 case/foam, or it can be stored and used as a stand-alone device. The 5 Position Charger & Conditioner comes with an AC adapter that can be configured for use internationally. The 5 Position Charger & Conditioner should be stored in a clean, dry place.

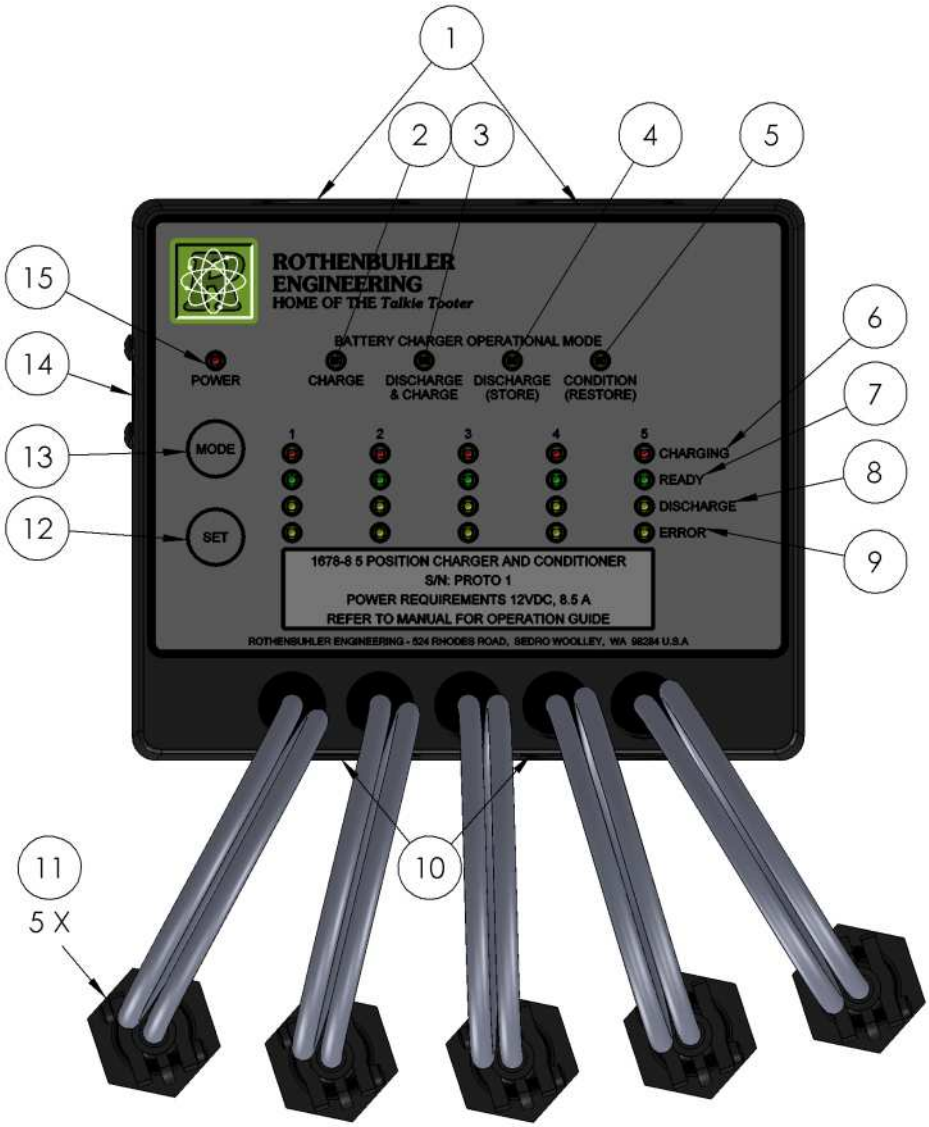


Figure 2-11 5 Position Charger & Conditioner

Table 2-2 RFD 5 Position Charger & Conditioner

Figure	Index No.	Description
Figure 2-11	1	Cooling air inlets (x2).
Figure 2-11	2	System Charge Mode Indicator (yellow). Indicates the attached units will be charged only (no discharge).
Figure 2-11	3	System Discharge then Charge Mode Indicator (yellow). Indicates the attached units will receive a discharge, and then a charge.
Figure 2-11	4	System Discharge Mode Indicator (yellow). This mode is used to discharge the batteries in preparation for storage.
Figure 2-11	5	System Condition Mode Indicator (yellow). This mode is used to restore batteries that have been in storage.
Figure 2-11	6	Unit Charge Indicator (red, x5). This indicator lights when the attached unit is charging.
Figure 2-11	7	Unit Ready Indicator (green, x5). This indicator lights when the attached unit has completed its charge cycle.
Figure 2-11	8	Unit Discharge Indicator (yellow, x5). This indicator lights when the attached unit is discharging.
Figure 2-11	9	Unit Error Indicator (yellow, x5). This indicator lights when the attached unit has experienced a fault when charging.
Figure 2-11	10	Cooling air outlets (x2).
Figure 2-11	11	Charge cables (x5).
Figure 2-11	12	Set Switch, used to set the charger to operate in the selected Mode.
Figure 2-11	13	Mode Switch, used to select the mode of operation for the charger.
Figure 2-11	14	Power Jack, +12V DC.

2.10. TEST BOX

2.10.1. Figure 2-12 provides a drawing of the Test Box. The Test Box is used to display information from and to evaluate the performance of the Controller, Mini Controller, Electric Remote Units and RSTIs. The Test Box can also be used to change settings and parameters of the units with certain restrictions.

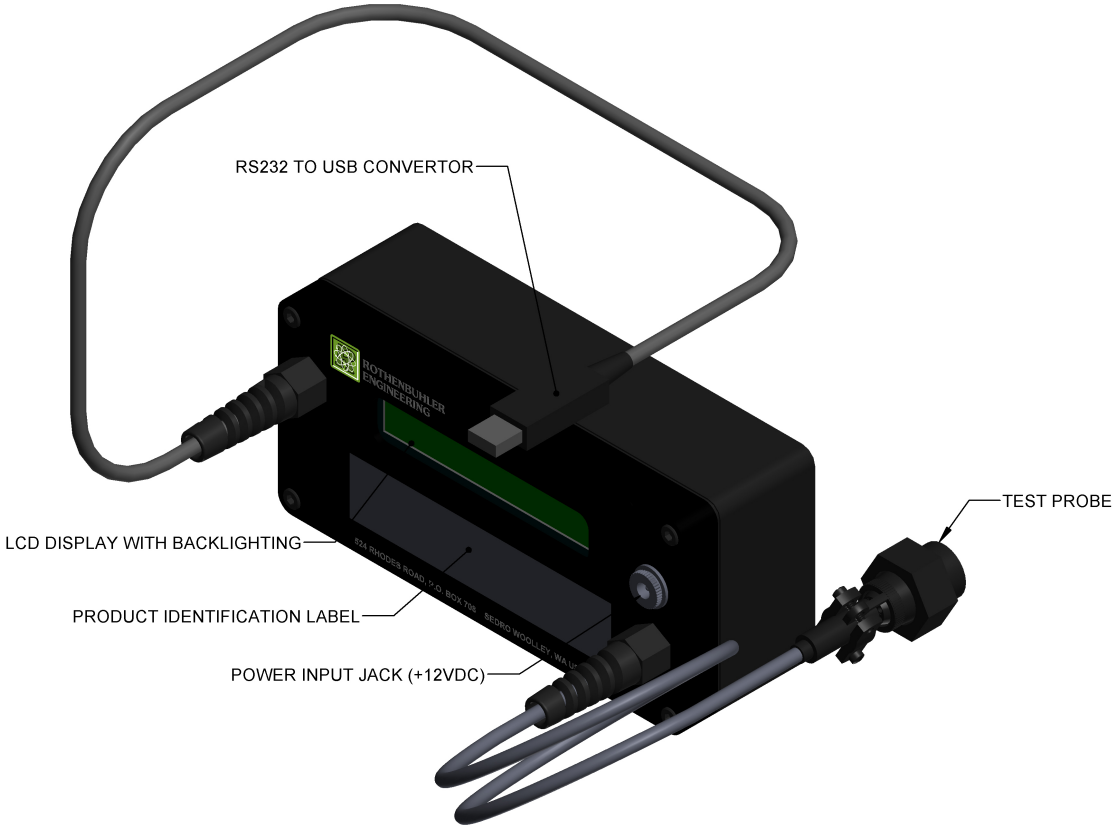


Figure 2-12 Test Box

2.10.2. **Serial Communications Port:** The Test Box can be connected to a USB port on a host PC. The connection can be used to log the results of the tests performed. The serial communications port is also used when performing parameter changes.

2.10.3. **Test Probe:** The Test Probe connects to the antenna/charge connector on the top of the Controller, Mini Controller, Electric Remote, or RSTI. Through the Test Probe, the Test Box communicates with the test unit to read the various settings, parameters, and to measure firing circuit and loaded battery voltages.

2.10.4. **LCD Display:** The LCD displays information both from the Test Box itself during its power on sequence, and while reading and testing a Controller, Mini Controller, Electric Remote, or RSTI. The LCD's backlighting will turn on while the unit is active. The information that may be displayed on the LCD is listed below:

- Serial Number
- Date of Manufacture
- System Number
- Unit ID
- Frequency Assignments
- Firmware Checksum and Version
- Battery Temperature and Charge Cycle Count
- Fire Count
- Battery voltage of unit under test while the battery is being loaded down.
- Electric Remote Units and RSTIs under test are armed and fired. The firing voltages are displayed.

2.10.5. **Power Input Jack:** The Test Box is powered from +12VDC from an AC adapter. The AC adapter is capable of international use.

2.10.6. **Serial Identification Label:** This label provides information such as the Model Number, Serial Number, System Number, Assigned Frequency, and certification numbers.

2.11. ANTENNA ASSEMBLY

2.11.1. Figure 2-13 provides the physical size, technical requirements and view of the Antenna Assembly. The power to the Controller and Remote Unit is interrupted when the Antenna Assembly is not connected.

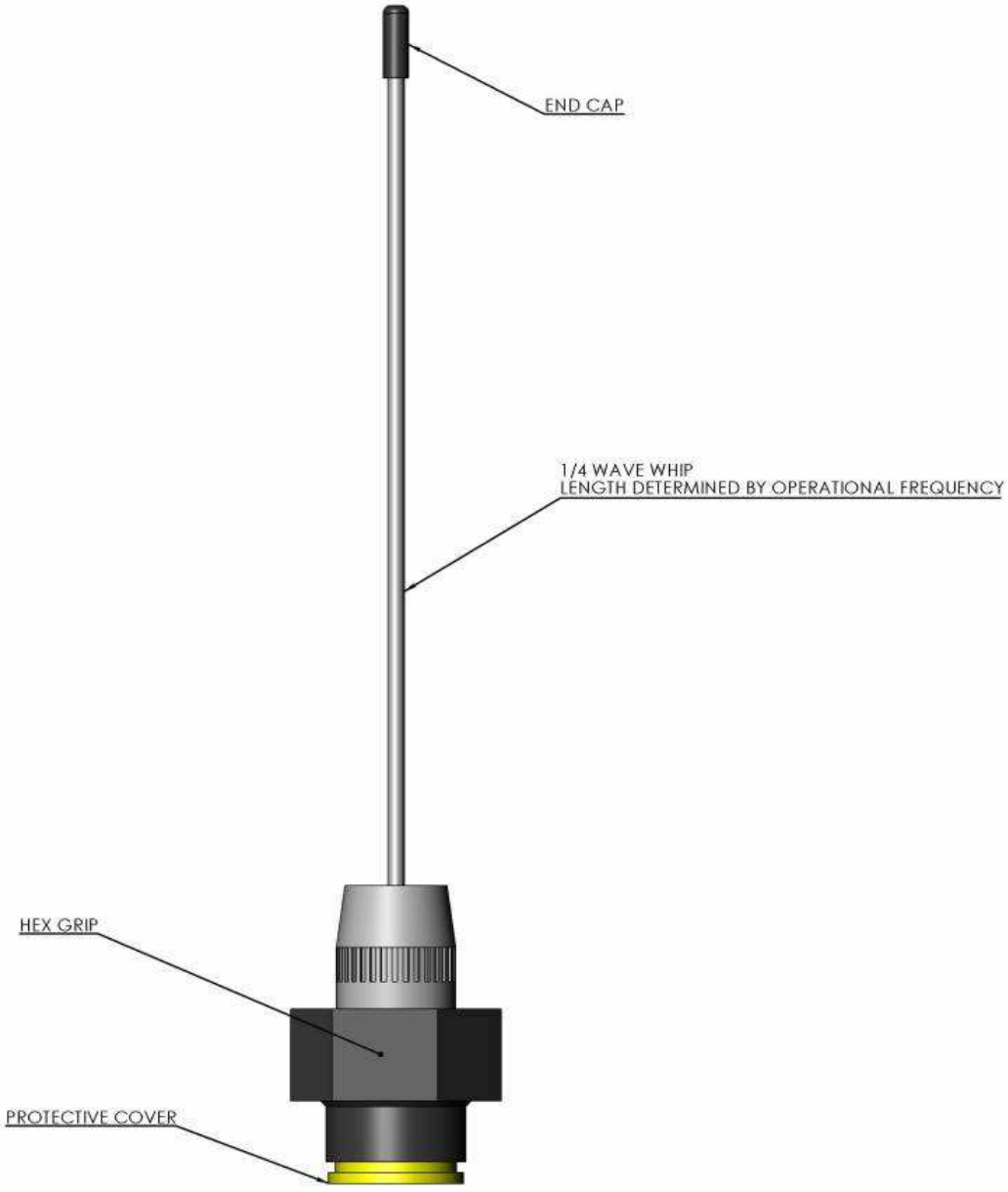


Figure 2-13 Antenna Assembly

2.12. CARRYING CASE

2.12.1. Figure 2-14 shows the Carrying Case, providing a view of the storage location for each system subassembly. The Carrying Case has a pressure equalization vent near the handle. The vent operation is automatic. There are foam inserts for the Battery Charger, depending on which model of charger the system is equipped.

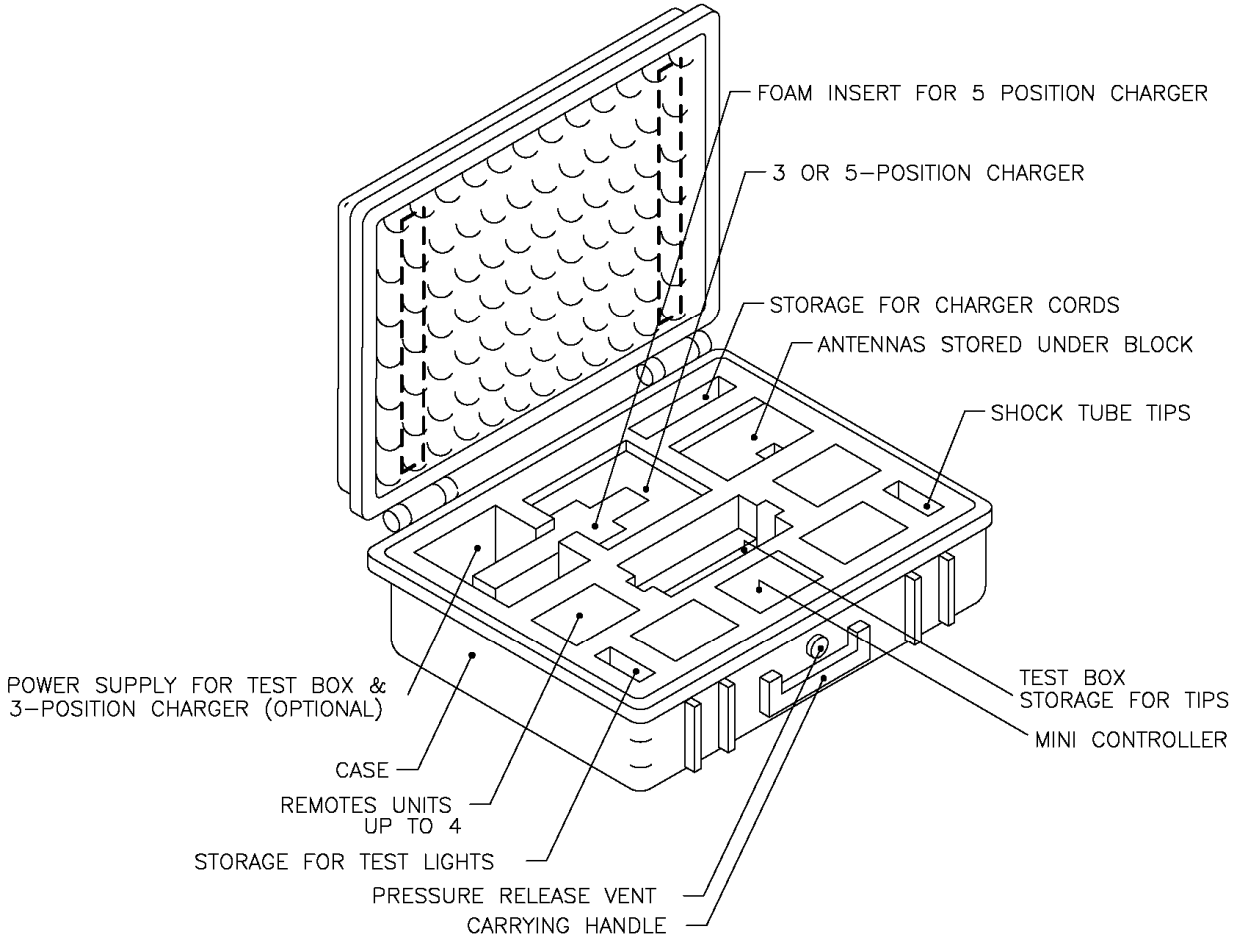


Figure 2-14 Carrying Case

2.13. VENT OPERATION

2.13.1. In Figure 2-15, the unit vents shown are manually operated and relieve internal pressure due to heat and altitude. When the vent is closed, it will not leak in 100 feet of water (30 meters) or up to 30,000 feet (9,100 meters) in altitude.

2.13.2. The vent is opened when charging to release any gasses or pressures accumulated during charging. The vent is closed during normal use or when the unit is exposed to moisture.

2.13.3. The vent is momentarily opened before use to equalize the case pressure.

2.13.4. To open vent, loosen the knob approximately one turn in the counter-clockwise direction. To close the vent, turn fully clockwise.

CAUTION Unequal air pressure inside the Controller may affect the operation of membrane switch keypad. Extreme pressure differentials may irreversibly damage the keypad and/or cases.

CAUTION Vents in all units should be momentarily opened and closed immediately before use.

CAUTION Do not open a vent if there is water on or near the vent. Keep the vents closed when the relative humidity is above 90%. Take necessary precautions to ensure moisture does not enter the unit case.

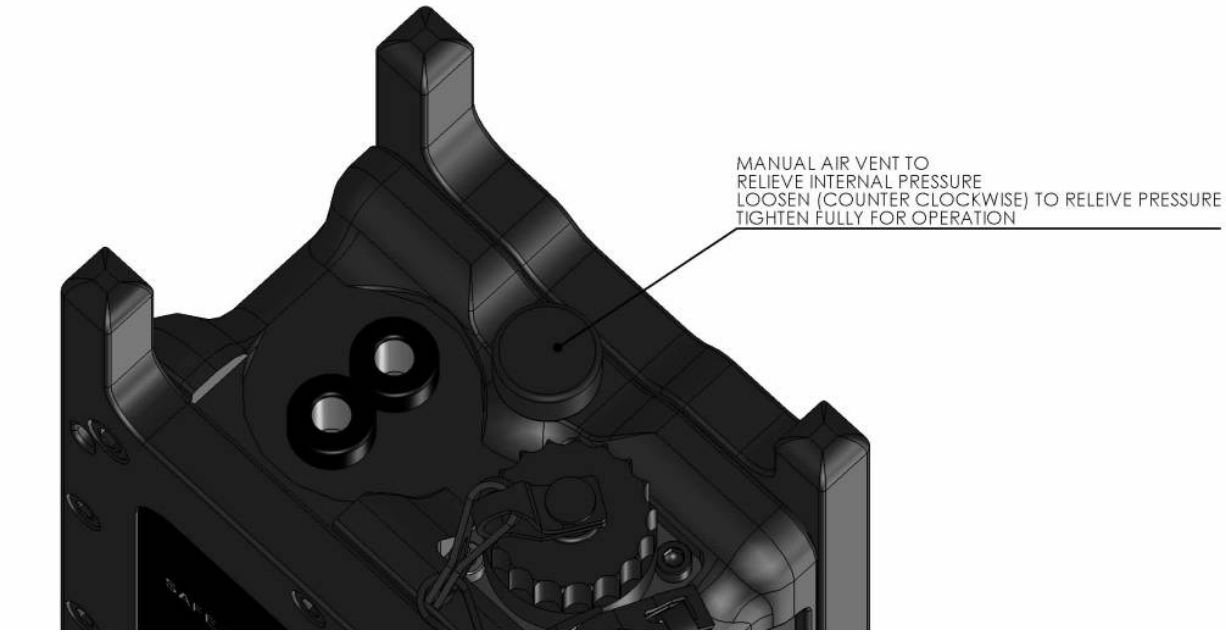


Figure 2-15 Vent Operation

2.14. ANTENNA / BATTERY CHARGER CONNECTOR

2.14.1. Figure 2-16 shows the connections when using the 3 Position Charger. The connections for the 5 Position Charger are similar.

2.14.2. The chargers do not discriminate between Controller and Remote units; any unit may be connected to any charge connector.

2.14.3. There is a key on the charge connector that must be aligned with a slot on the unit's charge connector. Align the key and insert. Turn clockwise until the connector locks into place.

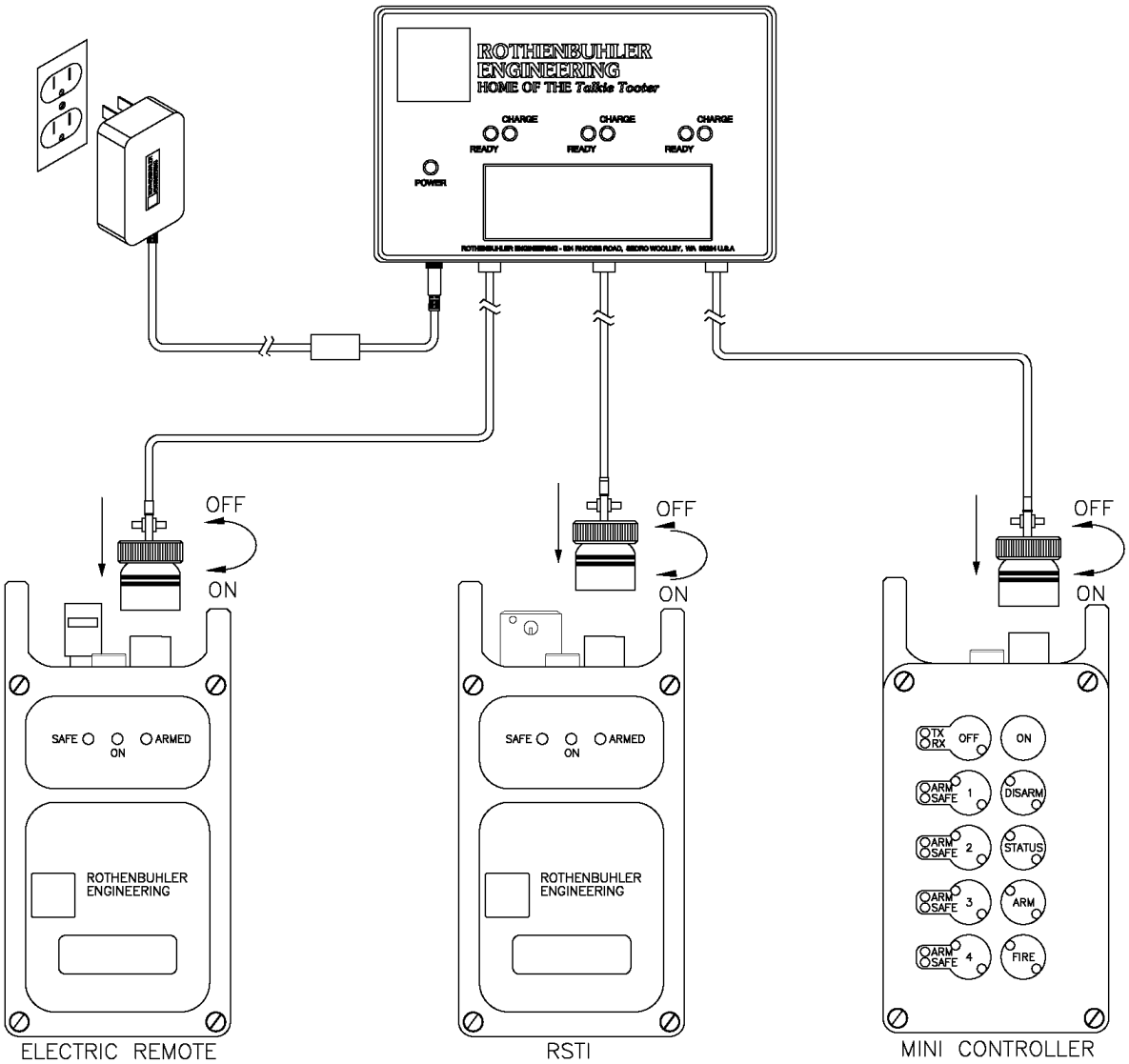


Figure 2-16 3 Position Charger Connection

3. SYSTEM SPECIFICATIONS

3.1. RADIO

CARRIER FREQUENCY	150 - 174 MHz	OPERATING TEMPERATURE RANGE	-30ºC to 60ºC -22ºF to 140ºF -26ºC to 60ºC (RSTI) -15ºF to 140ºF (RSTI)
FCC	Certified		<freq. diff. 800 HZ (±400)

CONTROLLER & TEST BOX		ELECTRIC REMOTE & RSTI	
FREQUENCY STABILITY	±2.5PPM OR (0.0000025%)	FREQUENCY STABILITY	±2.5PPM OR (0.0000025%)
MODULATION	11K2F3D (AFSK)	MODULATION	11K2F3D (AFSK)
MAXIMUM TRANSMIT POWER	5 Watts (Controller and Mini Controller) 3/4 Watt (Test Box)	MAXIMUM TRANSMIT POWER	2 Watts (Electric Remote) 5 Watts (RSTI)
OPERATING POWER	7.2 VDC	OPERATING POWER	7.2 VDC
TRANSMISSION RANGE (LOS)	5-12 Miles* 3 feet (Test Box)	TRANSMISSION RANGE (LOS)	1-12 miles*
RECEIVER SENSITIVITY	12 dB Sinad at 0.28uV	RECEIVER SENSITIVITY	12 dB Sinad at 0.28uV

(*) Range is specified as line-of sight. The typical transmission range is based on transmitter power, antenna gain, frequency used, local geography, and local radio interference.

3.2. PHYSICAL

Mini Controller Unit Controller Unit		Electric Remote Unit and RSTI	
SIZE (w/out antenna) (in)	6.4H x 3.5W x 2.6D 7.2H x 3.5W x 2.6D	SIZE (w/out antenna) (in)	6.4H x 3.5W x 2.4D
SIZE (w/out antenna) (cm)	16.3H x 8.9W x 6.6D 18.3H x 8.9W x 6.6D	SIZE (w/out antenna)(cm)	16.3H x 8.9W x 6.1D
WEIGHT (w/battery)	2.7 lbs., 1.2 kg 3 lbs., 1.4kg	WEIGHT (w/battery)	2.5 lbs., 1.1 kg
CASE	6061 Aluminum	CASE	6061 Aluminum
COLOR	Black	COLOR	Black
CASE FINISH	Hard Anodized	CASE FINISH	Hard Anodized

3.3. BATTERY

	Controller	Electric Remote Unit and RSTI
BATTERY PACK	Rechargeable NiMH	Rechargeable NiMH
RUN TIME PER CHARGE	12+ Hours	Adjustable between 12-300 Hours Typical User Setting is 200 hours*
BATTERY RECHARGE	1-4 Hours**	1-4 Hours**
BATTERY LIFE	Approximately 2 years or 300 charge cycles	Approximately 2 years or 300 charge cycles
STANDBY CURRENT	110 milliamps	80 milliamps
TRANSMIT CURRENT	1-2.5 Amp	1-2.5 Amp

(*) At the end of the 200 hours, the Electric Remote Unit can initiate 14 (2-Ohm) blasting caps connected in series and attached to 100 feet (30 meters) of 18AWG firing cable.

(**) Actual charge time depends on the model of charger used, initial charge of the battery, and the condition of the battery. This estimate does not include discharge or reconditioning operations.

3.4. TIMING

ARM TIME	4 ± 0.5 Seconds *
ARM TIME PERIOD (BEFORE AUTO DISARM)	1 – 60 Minutes (20 Minute Default) **
DISARM TIME	3 ± 0.1 Seconds *
ELECTRIC REMOTE FIRE TIME*	20 Milliseconds *
RSTI FIRE TIME*	225 ± 125 Milliseconds *

(*) This is the delay after the Remote Unit receives the command signal from the Controller.

(**) This is the amount of time the unit will remain Armed (ready to fire), before automatically returning to the disarmed state. This figure is normally set at 20 minutes but can be changed to other values.

3.5. DETONATE OUTPUT

The Electric Remote Unit's firing circuit has the following characteristics:

CAPACITOR	2,200µF Electrolytic
FIRING ENERGY	2.8 Joule (typical), 1.8 Joule (minimum)
PULSE VOLTAGE LEVEL	50 VDC (typical), 45 VDC (minimum)
MAX FIRING RESISTANCE*	28Ω

*This includes firing cables, detonators, & detonator leg wires.

The RSTI's firing circuit has the following characteristics:

FIRING ENERGY	0.470 Joule (typical), 0.350 Joule (minimum)
PULSE VOLTAGE LEVEL	2,500 VDC (typical), 2,250 VDC (minimum)

3.6. SYSTEM IDENTIFICATION

3.6.1. Each Unit within the RFD system is marked with an identification label.

3.6.2. Figure 3-1 shows the front label for the Electric Remote and RSTI Units. Provided on this label are the Model and Serial Numbers. Also shown are the FCC and Industry Canada Certification identifiers. Depending on the radio version, the FCC ID and Industry Canada identifiers may differ from those shown (CW21678-1-V2 & 2758A-167801V2 respectively).

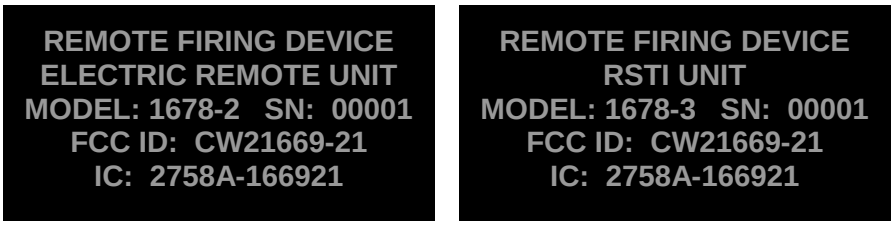


Figure 3-1 Electric Remote and RSTI Unit Front Label

3.6.3. Figure 3-2 shows the side labels of the Electric Remote and RSTI Units. The *System* number is shared by all the units of an RFD kit. Remote units and Controllers from other kits have different system numbers. Units with different system numbers cannot be operated together. *Frequency* is the assigned operation frequency of the unit. All units of a system share the same frequency. Individual *Unit* numbers are assigned to each Electric Remote and/or RSTI within a System, for a maximum of 4 or 8. The unit numbers distinguish each Electric Remote and/or RSTI unit from the other units within the system.

Figure 3-2 Electric Remote and RSTI Side System Labels

3.6.4. Figure 3-3 shows the identification label of the Mini Controller Unit located on the right side. The Mini Controller's label has the unit's *Model*, *System, S/N* (Serial Number), *Frequency*, and the *FCC* and *IC* (Industry Canada) certification numbers. Depending on the radio version, the FCC ID and Industry Canada identifiers may differ from those shown (CW21678-1-V2 & 2758A-167801V2 respectively).

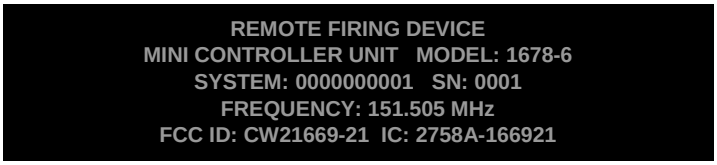


Figure 3-3 Mini Controller Side Label

3.6.5. Figure 3-4 shows the identification label of the Controller Unit located on the right side. The Controller's label has the unit's *Model*, *System, S/N* (Serial Number), *Frequency*, and the *FCC* and *IC* (Industry Canada) certification numbers.

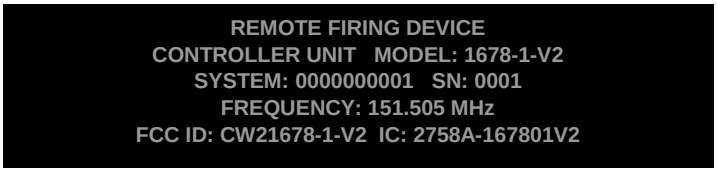


Figure 3-4 Controller Side Label

3.6.6. Figure 3-5 shows the identification label of the optional Test Box. The Test Box's label has the unit's *Model*, *System, S/N* (Serial Number), *Frequency*, and the *FCC* and *IC* (Industry Canada) certification numbers. Depending on the radio version, the FCC ID and Industry Canada identifiers may differ from those shown (CW21678-1-V2 & 2758A-167801V2 respectively).

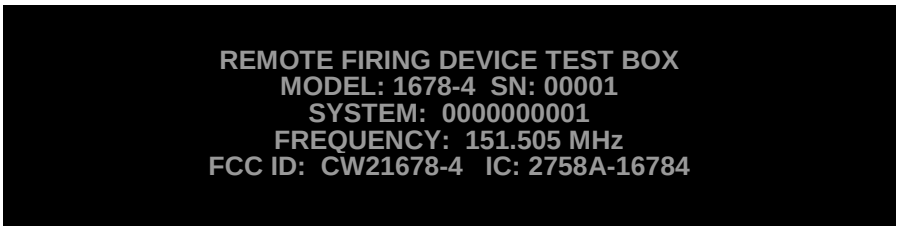


Figure 3-5 Test Box Identification Label

4. PRE-OPERATIONAL PROCEDURES

4.1. PHYSICAL INSPECTION

CAUTION Inspect all components for physical damage. Do not use any component that is damaged, suspected of being damaged, or is not able to operate as designed. The safety of the operation could be compromised.

4.1.1. Ensure the antenna / battery charger connector on the Controller and Remote Unit is not damaged.

4.1.2. Remove the antenna / battery charger connector dust cover and ensure the electrical pin area is clean and free of foreign material. Replace the dust cover.

4.1.3. Ensure the Antenna Assembly whip is not broken and that the whip has not separated from the sealing compound at the top of the connector.

4.1.4. Ensure that the spring-loaded binding posts on the Electric Remote Units are not damaged.

4.1.5. Ensure the Shock Tube Tip Jacks on the top of the RSTIs are clean and not damaged.

4.1.6. Remove the yellow dust cover from the Antenna Assembly and ensure that there is no foreign material in the electrical contact area. Replace the yellow dust cover.

4.2. BATTERY CHARGING

4.2.1. The battery packs in the Controller Unit, Remote Unit contain rechargeable NiMH batteries. The battery packs are recharged through the antenna / battery charger connector on each unit.

4.2.2. For each new battery charge cycle, the charger increments a charge cycle counter stored within the packs of each unit. The charge cycle count can be displayed using the Test Box. Battery pack replacement is recommended when the charge count reaches 300 charge cycles or when the battery is more than 3 years old to ensure reliable performance. For charging with the 5 Position Charger & Conditioner, proceed to Section 4.4.

4.3. BATTERY CHARGING WITH THE 3 POSITION CHARGER

4.3.1. The battery pack in the Controller, Remote Units should be sufficiently charged before use. The 3 Position Charger will charge each unit in about 3-4 hours. It will take less time for units that are partially charged. Each 3 Position Charger has three independent charge stations. Each charge station has a CHARGE and a SLOW light. The 3 Position Charger has a single POWER light. The 3 Position Charger does not have a discharge function. Two 3 Position Chargers can be employed to charge all 6 units of the Half Case kit during one charge session.

4.3.2. The 3 Position Charger does not feature a discharge function. To condition the batteries of the units, they should periodically be left on until the low battery condition occurs before recharging. A full discharge will help to rejuvenate batteries that have been stored for extended periods or that may have developed a memory.

4.3.3. Plug the supplied AC Power Adapter into an AC outlet. The AC Power Adapter will operate from 100-240VAC, 50-60 Hz. The charger itself requires 11-14 VDC @ 2.5A which can also be supplied by an optional 12V auto accessory adapter.

4.3.4. Insert the DC plug from the AC Power Adapter into the power jack on the side of the charger. The POWER light will turn on.

CAUTION Do not open a vent if there is water on or near the vent. Keep the vents closed when the relative humidity is above 90%. Take necessary precautions to ensure moisture does not enter the unit case.

4.3.5. Open the vent on each unit to be charged.

4.3.6. Connect each unit to be charged to the 3 Position Charger. The charger does not discriminate between Controller and Remote Units; any unit may be connected to any of the 3 charge connectors.

4.3.7. The CHARGE light for each connected unit will flash for approximately 5 seconds. The flashing CHARGE light indicates that charging is pending.

4.3.8. In normal operation, the CHARGE light will be on steady (non-blinking) after 5 seconds has passed. The steady CHARGE light indicates that the battery is being charged.

4.3.9. The battery must be within the temperature range 32 ºF and 104 ºF (0 to +40 ºC) for fast charging to occur.

4.3.10. If the detected battery voltage is less than 6 volts, the battery will be slow charged until the voltage is high enough for rapid charge. If the battery pack is defective and the voltage does not rise to the correct level, or if an internal error is detected within the battery, the green SLOW light will blink continuously.

4.3.11. When rapid charging terminates, the green SLOW light will be on steady, and the CHARGE light will be turned off.

4.3.12. Rapid charging terminates when the charger detects the battery pack is charged. Rapid charging will also terminate after 4 hours, or if the battery pack's temperature is out of range.

4.3.13. If a unit is left turned on beyond the low battery point, the battery pack may not fully charge before the 4 hour rapid charge time limit expires. In that case, charge the battery pack again.

4.3.14. Close the vent on each Remote Unit and the Controller after charging is completed.

4.4. 5 POSITION CHARGER & CONDITIONER

4.4.1. The battery pack in the Controller, Remote Units should be sufficiently charged before use. Each 5 Position Charger & Conditioner has five independent charge stations. Full charge time is about 2 hours. It will take less time for units that are partially charged. Figure 4-1 and Table 4-1 provides details of the user interface.

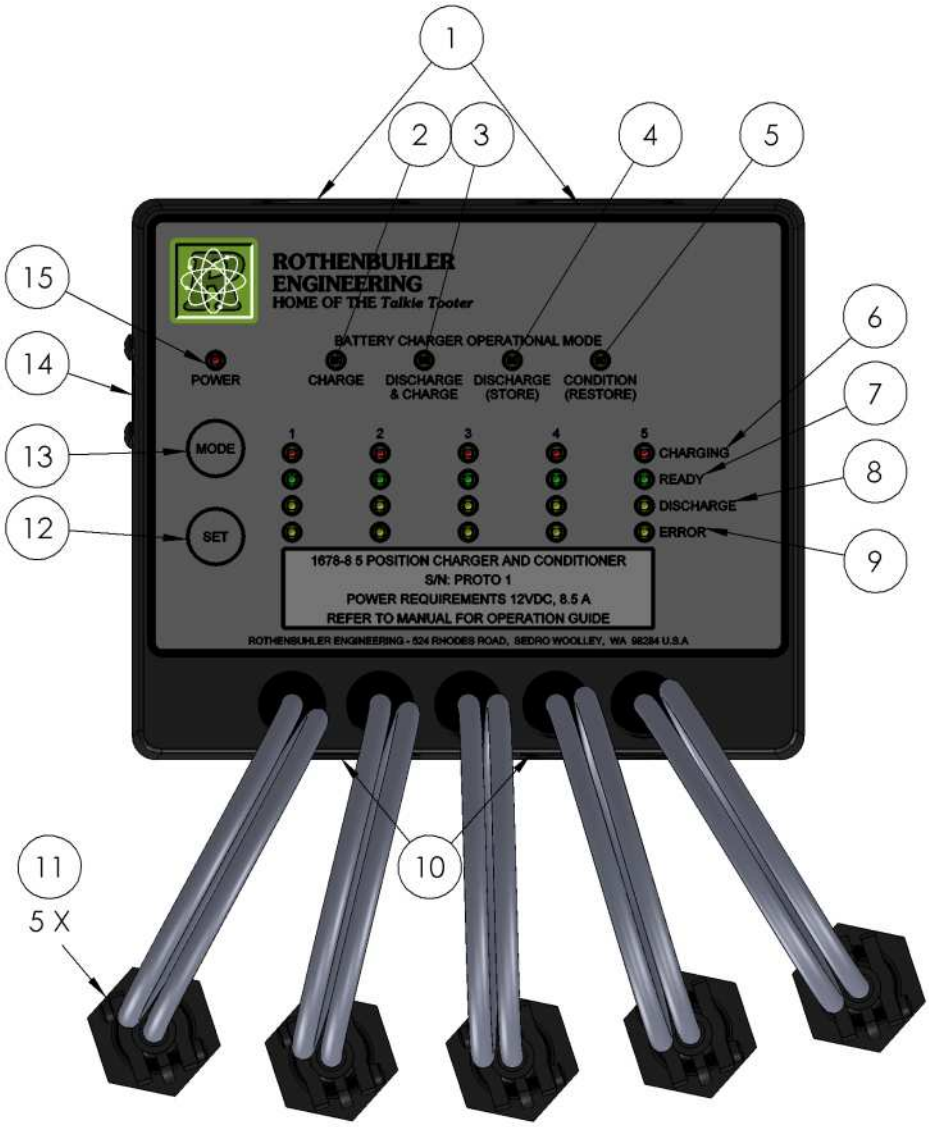


Figure 4-1 5 Position Charger & Conditioner

Table 4-1 RFD 5 Position Charger & Conditioner

Figure	Index No.	Description
Figure 2-11	1	Cooling air inlets (x2).
Figure 2-11	2	System Charge Mode Indicator (yellow). Indicates the attached units will be charged only (no discharge).
Figure 2-11	3	System Discharge then Charge Mode Indicator (yellow). Indicates the attached units will receive a discharge, and then a charge.
Figure 2-11	4	System Discharge Mode Indicator (yellow). This mode is used to discharge the batteries in preparation for storage.
Figure 2-11	5	System Condition Mode Indicator (yellow). This mode is used to restore batteries that have been in storage.
Figure 2-11	6	Unit Charge Indicator (red, x5). This indicator lights when the attached unit is charging.
Figure 2-11	7	Unit Ready Indicator (green, x5). This indicator lights when the attached unit has completed its charge cycle.
Figure 2-11	8	Unit Discharge Indicator (yellow, x5). This indicator lights when the attached unit is discharging.
Figure 2-11	9	Unit Error Indicator (yellow, x5). This indicator lights when the attached unit has experienced a fault when charging.
Figure 2-11	10	Cooling air outlets (x2).
Figure 2-11	11	Charge cables (x5).
Figure 2-11	12	Set Switch, used to set the charger to operate in the selected Mode.
Figure 2-11	13	Mode Switch, used to select the mode of operation for the charger.
Figure 2-11	14	Power Jack, +12V DC.

4.4.2. Charge Mode provides a charge only of the connected units. The charge time in Charge Mode is about 2 hours for fully discharged batteries. Less time is required for units that have a partial charge. Charge Mode is usually used when rapid deployment of the system is required.

4.4.3. Discharge & Charge Mode provides a full discharge of the connected units, followed by a complete charge. A full Discharge & Charge Mode cycle requires about 5 hours for completion. This mode is recommended for normal use to ensure full battery capacity and health.

4.4.4. Discharge (Store) Mode discharges the batteries down to a level that is recommended when long term storage is required. The Condition (Restore) Mode should be used to return units for use that have been stored.

4.4.5. Condition (Restore) Mode helps to rejuvenate batteries. The Condition (Restore) causes the battery to be discharged and charged repetitively until the battery has reached its maximum charge capability. The Condition (Restore) Mode is normally used to restore units from storage and to condition new batteries. The Condition (Restore) Mode is also recommended for occasional use when low capacity due to having developed a “battery memory” is suspected. The Condition (Restore) Mode may require up to 17 hours for full charge conditioning.

4.4.6. The red CHARGING indicators (x5) light as each respective unit is charged. When discharging, the yellow DISCHARGE indicators (x5) will light. As the units finish their selected charging modes, the green READY indicators will light to show completion. If a problem is detected during the charge process, the yellow ERROR light will turn on.

4.5. 5 POSITION CHARGE PROCEDURE

4.5.1. Plug the supplied AC Power Adapter into an AC outlet. The AC Power Adapter will operate from 100-240VAC, 50-60 Hz.

4.5.2. Insert the DC plug from the AC Power Adapter into the power jack on the side of the charger. The POWER light will turn on.

CAUTION Do not open a vent if there is water on or near the vent. Keep the vents closed when the relative humidity is above 90%. Take necessary precautions to ensure moisture does not enter the unit case.

4.5.3. Open the vent on each unit to be charged.

4.5.4. Select the desired charger Operation Mode using the MODE switch. The indicator for the chosen mode will blink.

4.5.5. Press the SET switch to set the chosen Operation Mode. The indicator for the set mode will turn on steady.

4.5.6. Connect each unit to be charged to the 5 Position Charger & Conditioner. The charger does not discriminate between Controller or Remote Units; any unit may be connected to any of the 5 charge connectors. The units will begin to execute the process for the Operation Mode that has been set.

4.5.7. At the beginning of a charge cycle, the red CHARGE light will blink briefly and then turn on steady.

4.5.8. While discharging the battery, the yellow DISCHARGE light will be on.

4.5.9. As each unit completes its Operation Mode cycle, the READY lights will illuminate.

4.5.10. If a problem is detected during the charge cycle, the yellow ERROR light will illuminate. Errors are used to indicate that the battery may be outside of its charge temperature range, a faulty battery, or when an interruption to the charge process has occurred.

4.5.11. The battery must be within the temperature range 32 ºF and 104 ºF (0 to +40 ºC) for fast charging to occur.

4.5.12. Close the vent on each Remote Unit and the Controller after charging has completed.

4.6. BENCH TESTING THE SYSTEM

WARNING Radio frequency energy of sufficient magnitude can cause blasting caps to detonate.

4.6.1. The System test must be conducted in an area that is at least 100 feet (30 meters) from the nearest blasting caps, wires connected to blasting caps, or other explosives.

4.6.2. All RFD System controls are described in detail in Section 2.

CAUTION All units must be thoroughly tested and the batteries fully charged prior to operational use.

4.6.3. Install the Antenna Assembly on the antenna / battery charger connector of the Controller. Ensure the Controller is off.

4.6.4. Install the Antenna Assemblies on the antenna / battery charger connectors of the Remote Units. The ON/LOW BATT and SAFE lights will come on steady. If the ON/LOW BATT light is flashing, the Remote Unit has a low battery. Recharge the battery in accordance with Section 4.2.

4.6.5. Turn the Controller on by pressing the “ON” switch for 1 second. A yellow light located in the upper left quadrant of the “ON” switch of the Mini Controller will turn on steady. The “BAT” yellow light at the top of the Controller Unit display panel will turn on. If the yellow light does not turn on steady, but flashes, this indicates a low battery for the Controller. Recharge the battery in accordance with Section 4.2.

4.6.6. Press the “STATUS” switch for 1 second. The red TX light on the Controller will start blinking for approximately 5 seconds. During that time the Controller is requesting status from the Remote Units.

4.6.7. When the TX light stops flashing, the green SAFE light will come on steady adjacent to the switches numbered “1” through “4” or “8”. A steady SAFE light indicates that Remote Unit answered back with its status and it is disarmed. A flashing SAFE light indicates the Controller did not receive the Remote Unit’s status transmission.

WARNING Ensure that blasting caps are not connected to any of the Remote Units during bench testing.

4.6.8. Select all of the Remote Units by pressing switches “1” through “4” or “8”. A yellow light will be lit in each switch to indicate the corresponding Remote Unit is selected.

4.6.9. Press the “ARM” switch for ½ second. The red ARMED light for each selected Remote Unit will flash on the Controller display panel for approximately 5 seconds and then come on steady. The ARMED light for each selected Remote Unit will grow brighter and then stay on steady. The Remote Units are now armed.

4.6.10. Observe the Controller and Remote Units. After the Arm Time Period expires, the Remote Units will automatically disarm. The ARMED lights at the Controller and Remote Units should turn off. The SAFE lights at the Controller and SAFE lights at the Remote Units should turn on.

4.6.11. Re-Arm the Remote Units. Before the Arm Time Period expires, press the “DISARM” switch on the Controller. The Controller's ARMED light will be turned off. The SAFE lights at the Controller should blink for approximately 3 seconds and then turn on steady. The ARMED lights at the Remote Units will turn off and the Remote Units’ SAFE lights will turn on.

4.6.12. If firing RSTI Units, proceed to 4.6.13. Connect a test light assembly to the binding posts of each Electric Remote Unit. Arm the Electric Remote Units. Press the “FIRE” switch on the Controller. The test bulbs should flash brightly. The ARMED light will turn off and the SAFE light will turn on at each Electric Remote Unit. The displayed status at the Controller will change from ARMED to SAFE. Proceed to 4.6.14.

4.6.13. Install the firing tip into the Shock Tube Tip Jacks on the top of each RSTI. Arm the RSTI Units. Press the “FIRE” switch on the Controller. Observe that bright sparks should be heard and seen on each unit. The ARMED light will turn off and the SAFE light will turn on at each RSTI. The displayed status at the Controller will change from ARMED to SAFE.

Note: When firing the RSTI with no tip or with a faulty tip, the green SAFE light for that unit may not initially turn on following a FIRE operation. A subsequent press of the “STATUS” switch illuminates the green SAFE light.

Note: Refer to Section 2.7 for details about the RSTI and the Shock Tube Igniter Tip handling and replacement. Never exceed 200 shots on your tip before replacement. If you notice the spark is weak or if misfires occur, the tip needs replacement. Always keep a spare tip as a backup. Keep the tip needle clean and dry. It is always recommended to perform a test fire of the RSTI before use.

4.6.14. Turn off the Controller by pressing the “OFF” switch. Turn off the Remote Units by removing their Antenna Assemblies.

4.6.15. The RFD system is now ready to use operationally.

5. OPERATIONAL PROCEDURES

WARNING Use of this system and its components must be restricted to personnel qualified and experienced in the field of explosives and detonating devices. Under no circumstances shall untrained personnel attempt to use this manual as a text for self-teaching.

WARNING Employ standard blasting system safety standards when using this equipment with explosives.

WARNING All units must be thoroughly tested and the batteries fully charged prior to operational use.

5.1. READY THE SYSTEM AT SITE

5.1.1. Remote Units. Select the number of Electric Remote Units or RSTIs required for the operation. Remove the dust cover from the antenna / battery charger connector. Install the Antenna Assembly on to the antenna / battery charger connector. This will turn on the Remote Unit. The yellow ON/LOW BATT light and green SAFE light will be turned on. The green SAFE light will be on for the first minute, whenever the Remote Unit is turned on and it is disarmed. In the disarmed state, the firing capacitor charge circuit is disabled, the firing terminals are electrically isolated from the firing capacitor, and the firing terminals are shunted to each other. If the yellow ON/LOW BATT light is flashing, the Remote Unit battery is low and should be recharged before use.

5.1.2. Remote Sleep Mode. If Sleep Mode is enabled, after 1 minute, the display lights on the Remote Units will extinguish. During this time, the Remote unit is in a low power ‘sleep’ state to conserve battery power. Sleep Mode can only be entered if the Remote Unit is disarmed. The Remote units are quickly awakened by the Controller’s radio signal when needed for use.

WARNING Do not connect a blasting cap to a Remote Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

5.1.3. Open and close the vent on each Remote Unit and the Controller to equalize the case pressure. Unscrew the vent, one revolution, to open.

5.1.4. Remove the dust cover from the antenna / battery charger connector of the Controller. Install the Antenna Assembly on to the antenna / battery charger connector. This will enable the keypad on the Controller.

WARNING Do not use the Controller within 100 feet (30 meters) of explosives, blasting caps, or wires leading to them. The Controller signal is 5 watts, which can cause detonation of caps if within 100 feet. The 5 watt Controller complies with the Recommended Table of Distances established by the Institute for the Makers of Explosives (IME) when placed beyond 100 feet of explosives.

5.1.5. Turn the Controller on by pressing the "ON" switch for 1 second. A yellow light located in the upper left quadrant of the Mini Controller's "ON" switch will turn on steady. The "BAT" yellow light at the top of the Controller Unit's display panel will turn on. If the yellow light does not turn on steady, but flashes, this indicates a low battery for the Controller. Recharge the battery in accordance with Section 4.2.

5.1.6. Adjust the intensity of the LED display on the Controller for the desired setting by repressing the 'ON' switch on the Controller.

5.1.7. Press the "STATUS" switch on the Controller. The red TX light will flash for approximately 5 seconds. The green SAFE light corresponding to each Remote Unit will come on steady if the Controller receives a status message from that Remote Unit. If the Controller does not receive a status message from a Remote Unit, the green SAFE light for that Remote Unit will flash on the Controller display panel.

Note: The Controller battery life is approximately 6 hours when in the "ON" condition. To conserve battery life, the Controller should be turned off when not being used.

5.1.8. Turn the Controller "OFF" until Remote Units are in place and wired to shoot.

5.2. PLACEMENT OF REMOTE UNITS

WARNING Do not connect a blasting cap to a Remote Unit unless the green SAFE light is on, the red ARMED light is off, and the yellow ON/LOW BATT light is on steady. This indicates there is no voltage on the binding posts, the binding posts are electically isolated from the firing capacitor, the binding posts are shunted to each other, and the battery is not low.

5.2.1. The range of the RFD is typically 5 miles under most conditions.

5.2.2. Place the Remote Units with the antenna in a vertical position and free from obstruction within 100 feet (30 meters) of the shot. Use sandbags or other suitable materials to protect the Remote Units from the shot.

5.2.3. Ensure that all Remote Units indicate a SAFE condition (green SAFE light on steady).

5.2.4. If using the RSTI, proceed to Section 5.2.7. After performing standard demolition circuit checks and before placing initiator into the main charge, depress the two spring-loaded binding posts on the Electric Remote Unit.

5.2.5. Insert one leg of the demolition wire in each binding post and allow the binding posts to close on the wire ends.

5.2.6. Ensure the wire is held securely by the binding posts and that the wire ends are not touching the Electric Remote's case or each other. Proceed to Section 5.2.8.

5.2.7. Install the non-electric shock tubing onto the Shock Tube Tip and mount the tip onto the RSTI according to Section 2.7. Take care to ensure no moisture or debris enter the shock tube or contact the Shock Tube Tip's needle.

5.2.8. Prepare the shot and return to the safe firing area.

5.2.9. If all Remote Units are located within 1 mile of the Controller, refer to Section 5.3.

5.2.10. If all Remote Units are located more than 1 mile from the Controller, refer to Section 5.4

5.2.11. If some Remote Units are located within 1 mile of the Controller, and other Remote Units are more than 1 mile from the Controller, refer to Section 5.5.

5.3. SYSTEM OPERATION – REMOTE UNITS WITHIN 1 MILE OF CONTROLLER

Note: If the distance between the Controller and the Remote Units is in excess of 1 mile, the Remote Units status transmissions may not be received by the Controller. The Controller will command the Remotes from a distance greater than 1 mile, but the Remote Status may not be confirmed. The Controller performs just as it would when it is within 1 mile of the Remote Units. The only difference is the method the status indications are displayed on the Controller display panel. The ARMED and SAFE status lights for out of range Remote Units will flash on the Controller display panel to indicate the Controller did not receive a status message from the Remote Unit. Once the Remote Units are set up for the shot, the operator must assume the Remote Units have received the command.

5.3.1. Ensure the area is clear.

5.3.2. Turn the Controller on.

5.3.3. Press the "STATUS" switch. The Controller will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green SAFE light on the Controller display panel will come on steady for the Remote Units that the Controller receives a disarmed status message from.

5.3.4. Select the Remote Units that are to be used in the shot by pressing the corresponding numbered switches "1" through "4" or "8". Press the numbered switches one at a time.

System Safety Feature Once armed, the Remote Units must be sent a Fire command within the Arm Time Period. If the Remote Units do not receive a Fire command within the Arm Time Period, they will automatically disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.3.5. To arm the selected Remote Units, press the "ARM" switch. The red ARMED light next to each selected Remote Unit switch will flash for approximately 5 seconds and then come on steady. The selected Remote Units are now ARMED!

5.3.6. To fire the Remote Units, press the "FIRE" switch and hold for 1 second. The operator should get an indication of shot initiation. The ARMED light will go out and the green SAFE light for each selected Remote Unit will come on steady on the Controller display panel.

Note: When firing the RSTI with no tip or with a faulty tip, the green SAFE light for that unit may not initially turn on following a FIRE operation. A subsequent press of the "STATUS" switch illuminates the green SAFE light.

5.3.7. If not all the Remote Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.3.8. To disarm any Remote Units that have been armed, select the Remote Units and press the "DISARM" switch. All selected Remote Units will disarm in approximately 3 seconds.

CAUTION Do not assume the DISARM command has been received by the Remote Unit unless disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. If distance appears to be the problem, move closer to the Remote Unit following standard procedures for this type of situation. The "STATUS" and/or "DISARM" switches may be pressed repeatedly as the Remote Unit is approached. Maintain a safe distance from the Remote Unit. Do not approach the Remote Unit until disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. Under no conditions should the "FIRE" switch be pressed as the Remote Unit is approached. DO NOT bring the Controller closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.3.9. Turn off the Controller.

5.3.10. Recover the fielded Remote Units.

5.3.11. Refer to Post Operational Procedures in chapter 5.5.14.

5.4. SYSTEM OPERATION – REMOTE UNITS MORE THAN 1 MILE BUT LESS THAN 5 MILES FROM CONTROLLER

Note: If the distance between the Controller and the Remote Units is in excess of 1 mile, the Remote Units status transmissions may not be received by the Controller. The Controller will command the Remotes from a distance greater than 1 mile, but the Remote status may not be confirmed. The Controller performs just as it would when it is within 1 mile of the Remote Units. The only difference is the method the status indications are displayed on the Controller display panel. The ARMED and SAFE status lights for out of range Remote Units will flash on the Controller display panel to indicate the Controller did not receive a status message from the Remote Unit. Once the Remote Units are set up for the shot, the operator must assume the Remote Units have received the command.

5.4.1. Ensure the area is clear.

5.4.2. Turn the Controller on.

5.4.3. Press the “STATUS” switch. The Controller will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green SAFE light on the Controller display panel will flash for all Remote Units that the Controller does not receive a status message from.

5.4.4. Select the Remote Units that are to be used in the shot by pressing the corresponding numbered switches “1” through “4” or “8”. Press the numbered switches one at a time.

System Safety Feature Once armed, the Remote Units must be sent a Fire command within the Arm Timeout Period. If the Remote Units do not receive a Fire command within the Arm Timeout Period, they will automatically disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.4.5. To arm the selected Remote Units, press the “ARM” switch. The red ARMED light next to each selected Remote Unit switch will flash for 5 seconds, then come on steady for two seconds, and then continue to flash. The selected Remote Units are now assumed to be ARMED!

5.4.6. To fire the Remote Units, press the “FIRE” switch. The operator should get an indication of shot initiation. The ARMED light will go out and the green SAFE light for each selected Remote Unit will flash on the Mini Controller Unit display panel.

5.4.7. If not all the Remote Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.4.8. To disarm any Remote Units that have been armed, select the Remote Units and press the “DISARM” switch. All selected Remote Units will disarm in approximately 3 seconds.

CAUTION Do not assume the DISARM command has been received by the Remote Unit unless disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. If distance appears to be the problem, move closer to the Remote Unit following standard procedures for this type of situation. The "STATUS" and/or "DISARM" switches may be pressed repeatedly as the Remote Unit is approached. Maintain a safe distance from the Remote Unit. Do not approach the Remote Unit until disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. Under no conditions should the "FIRE" switch be pressed as the Remote Unit is approached. DO NOT bring the Controller closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.4.9. Turn off the Controller.

5.4.10. Recover the fielded Remote Units.

5.4.11. Refer to Post Operational Procedures in chapter 5.5.14.

5.5. SYSTEM OPERATION – REMOTE UNITS BOTH WITHIN AND IN EXCESS OF 1 MILE FROM CONTROLLER

Note: If the distance between the Controller and the Remote Units is in excess of 1 mile, the Remote Units status transmissions may not be received by the Controller. The Controller will command the Remotes from a distance greater than 1 mile, but the Remote status may not be confirmed. The Controller performs just as it would when it is within 1 mile of the Remote Units. The only difference is the method the status indications are displayed on the Controller display panel. The ARMED and SAFE status lights for out of range Remote Units will flash on the Controller display panel to indicate the Controller did not receive a status message from the Remote Unit. Once the Remote Units are set up for the shot, the operator must assume the Remote Units have received the command.

5.5.1. The RFD will operate in a two-way mode (confirmed communications – range less than 1 mile) and one-way mode (unconfirmed communications – range greater than 1 mile).

5.5.2. If the Remotes are within 1 mile of the Controller, the status of the Remote Units (ON/LOW BATT, ARMED, and SAFE) will be displayed with steady lights on the display panel of the Controller.

5.5.3. If one or more Remote Units are out of range of the Controller, the status of these Remote Units will be assumed and their status lights will flash on the Controller display panel to indicate unconfirmed status. Accordingly the operator must assume the following:

- Commands have been received by the Remote Units.

- The Remote Unit battery is sufficiently charged to activate the firing circuit.

- A DISARM command should not be assumed.

5.5.4. Ensure the area is clear.

5.5.5. Turn the Controller on.

5.5.6. Press the “STATUS” switch. The Controller will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green SAFE light on the Controller display panel will flash for all the Remote Units that the Controller does not receive a status message from.

5.5.7. Select the Remote Units that are to be used in the shot by pressing the corresponding numbered switches “1” through “4” or “8”. Press the numbered switches one at a time.

System Safety Feature Once armed, the Remote Units must be sent a Fire command within the Arm Time Period. If the Remote Units do not receive a Fire command within the Arm Time Period, they will automatically disarm. The firing capacitor will be safely internally discharged, the binding posts will remain isolated from the firing capacitor and the binding posts will remain shunted together.

5.5.8. To arm the selected Remote Units, press the “ARM” switch. The red ARMED light next to each selected Remote Unit switch will flash for 5 seconds, and then come on steady for two seconds. ARMED lights for selected Remote Units that the Controller did not receive a status message from will begin to flash again. The selected Remote Units are now assumed to be ARMED! For unconfirmed communications, count to 5 from when the "ARM" switch is pressed and assume the Remote Units are armed.

5.5.9. To fire the Remote Units, press the “FIRE” switch. The operator should get an indication of shot initiation. The ARMED light will go out and the green SAFE light for each selected Remote Unit will flash on the Controller display panel.

5.5.10. If not all the Remote Units were selected for the shot, repeat above steps to initiate the remaining shots.

5.5.11. To disarm any Remote Units that have been armed, select Remote Units and press the “DISARM” switch. All selected Remote Units will disarm in approximately 3 seconds.

CAUTION Do not assume the DISARM command has been received by the Remote Unit unless disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. If distance appears to be the problem, move closer to the Remote Unit following standard procedures for this type of situation. The “STATUS” and/or “DISARM” switches may be pressed repeatedly as the Remote Unit is approached. Maintain a safe distance from the Remote Unit. Do not approach the Remote Unit until disarmed status is confirmed with a steady SAFE light for that Remote Unit on the Controller display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Controller closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.5.12. Turn off the Controller.

5.5.13. Recover the fielded Remote Units.

5.5.14. Refer to Post Operational Procedures in chapter 6.

6. POST OPERATIONAL PROCEDURES

6.1. SECURING THE SYSTEM

6.1.1. Turn the Controller off and remove the Antenna Assembly. This action disables the Controller.

6.1.2. Replace the dust cover on the antenna / battery charger connector on the Controller and replace the plastic cap on the Antenna Assembly.

6.1.3. Remove the Antenna Assemblies from the Remote Units. This action turns off the Remote Units.

6.1.4. Replace the dust cover on the antenna / battery charger connector on the Remote Units and replace the plastic cap on the Antenna Assembly.

6.2. PHYSICAL INSPECTION

6.2.1. Inspect the Controller and Remote Units for physical damage.

6.2.2. Inspect the units for dirt or corrosion around/on connector pins and vent.

6.2.3. Replace any unit found to have damage. Return unit to manufacturer.

6.2.4. Clean units using a soft bristle brush.

6.2.5. If a unit cannot be cleaned by brushing, make sure the vent is closed securely and wash units in warm soapy water.

6.2.6. Rinse units with clean water and dry thoroughly.

6.2.7. Inspect units for damage. Replace as necessary.

6.3. PACKAGING

6.3.1. Re-package all components in carrying case.

6.4. MAINTENANCE & EQUIPMENT STORAGE

6.4.1. Periodic battery charging

6.4.2. Check for signs of corrosion around and on connector pins.

7. BASIC TROUBLESHOOTING IN THE FIELD

7.1. REMOTE UNITS

7.1.1. ON and SAFE lights do not illuminate when the Antenna Assembly is installed.

a) Check Antenna Assembly and make sure it is seated, “clicks” on to the connector.

b) Recharge the battery.

c) Try a different Antenna Assembly.

7.2. CONTROLLER

7.2.1. ON Light does not stay on.

a) Check Antenna Assembly and make sure it is seated, “clicks” on to the connector.

b) Press and hold the “ON” switch for 5 seconds.

c) Controller battery needs to be recharged.

7.2.2. Command receipt is not confirmed by Remote Unit.

a) Remote Unit is more than 1 mile from Controller.

b) If the Remote Unit is less than 1 mile away from the Controller:

Check for damage to Controller Antenna Assembly.

Try a different Antenna Assembly on the Controller.

Move at least 25 feet in any direction and try again.

Reposition the Remote Unit if:

- The antenna is not positioned vertically.
- The antenna is next to another radio antenna.
- The antenna is surrounded by metallic objects.
- Use optional magnetic mount antenna for improved gain. This antenna is available by special order only.

7.3. REMOTE SHOCK TUBE INITIATOR

7.3.1. Unit will not ignite the shock tube.

a) The Shock Tube Tip may be worn or damaged. Replace tip.

b) The shock tube may be damaged from moisture. Try a fresh cut or replace the tubing. Ensure the tube covers the entire needle. Ensure both the needle and the shock tube lead-in is dry when mating.

8. OPTIMIZING RANGE

8.1.1. When power lines are in the area, the radio transmission distance is reduced. The system can operate at the following distance, when the Controller is elevated to a maximum transmission location angle to the Remote Unit location (see Figure 8-1).

Over	Minimum Distance
Open Land or Water with Power Lines	1 mile
Dense Vegetation without Power Lines	1 mile
Open Land or Water without Power Lines	Greater than 5 Miles

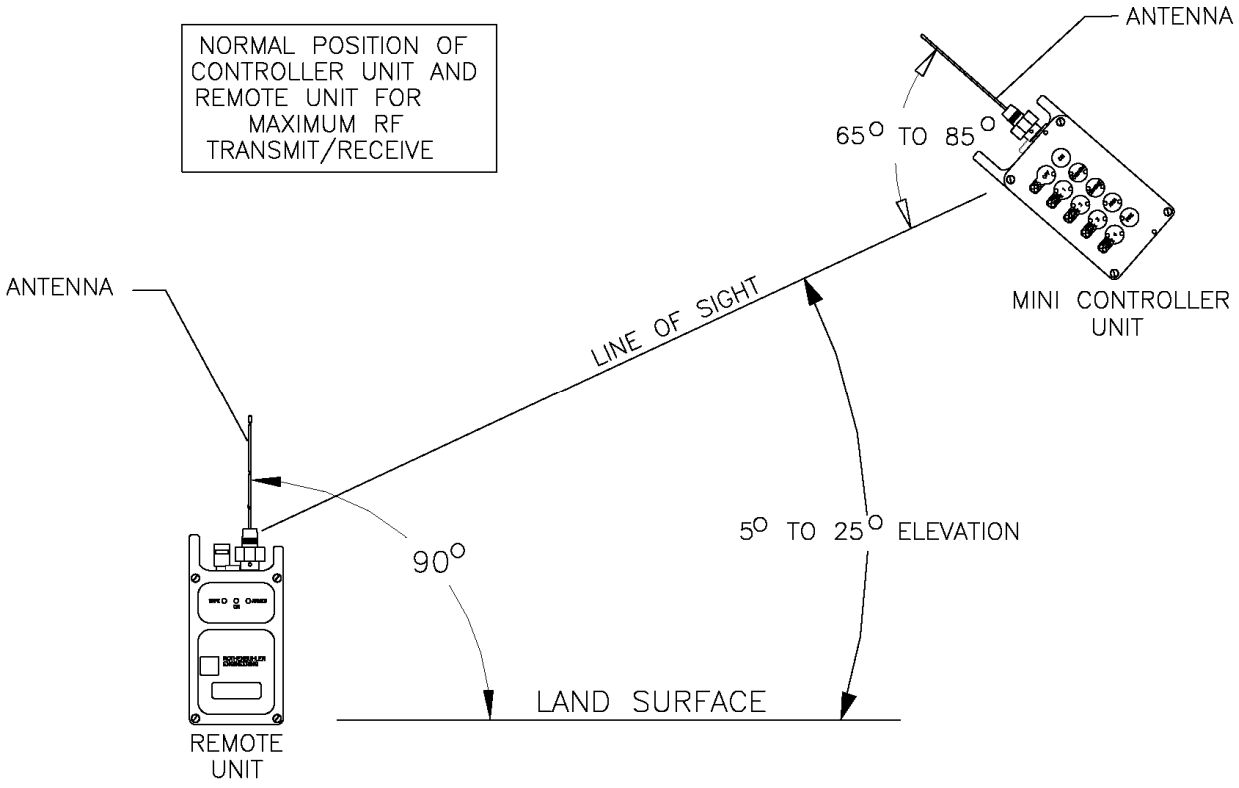


Figure 8-1 Unit Normal Transmission Location

8.1.2. If the Controller and Remote Unit must be placed in a position other than location in Figure 8-1, use Figure 8-2 or Figure 8-3. The minimum transmission will occur when the Controller antenna and the Remote Unit antenna are placed in the line of site. The maximum transmission occurs when the line of site lays in a path of 5 to 25 degrees above unit top plane perpendicular to the antenna. Both the Controller antenna and the Remote Unit antenna have the same radiant energy pattern as shown in Figure 8-4.

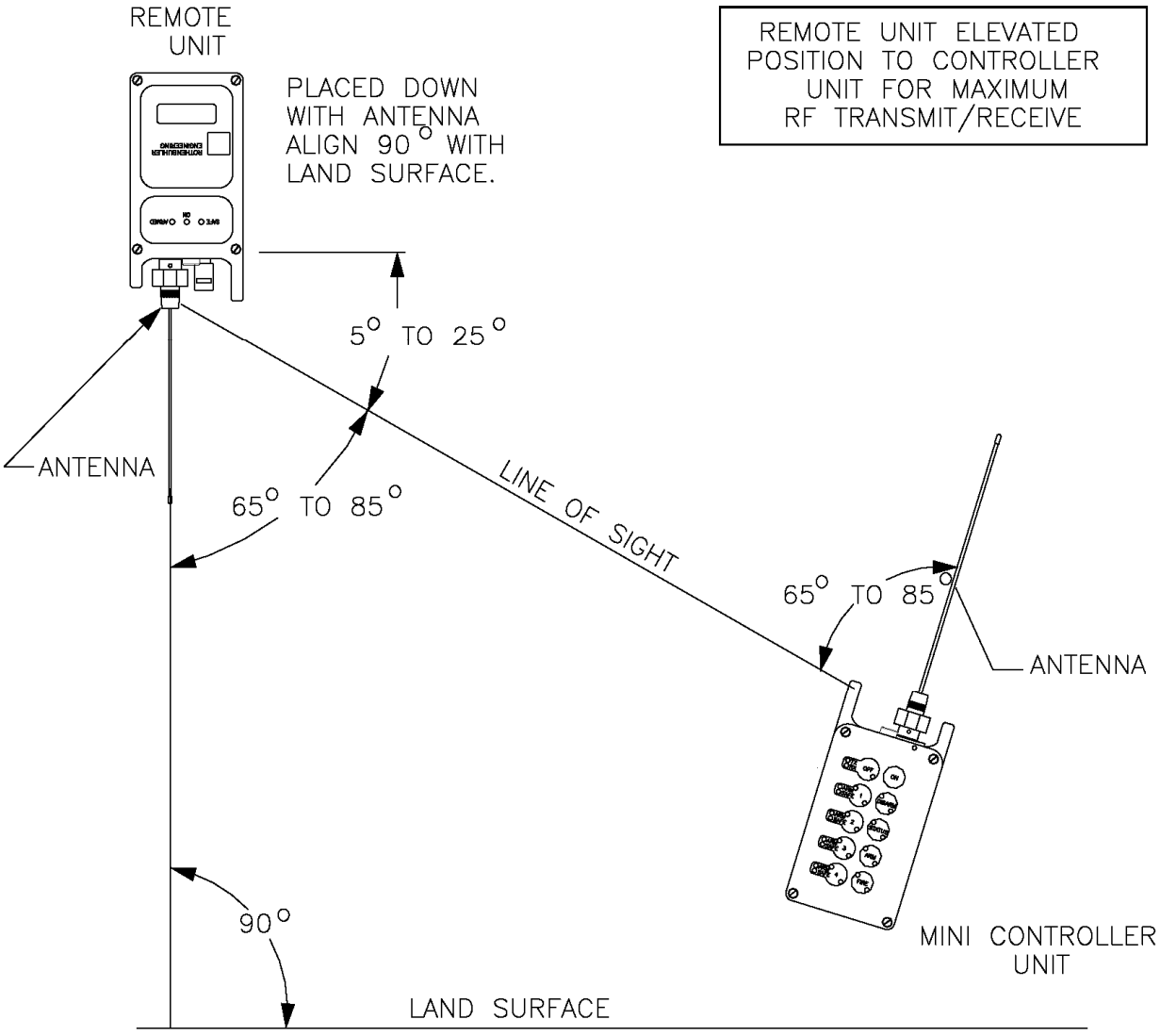


Figure 8-2 Remote Unit Elevated

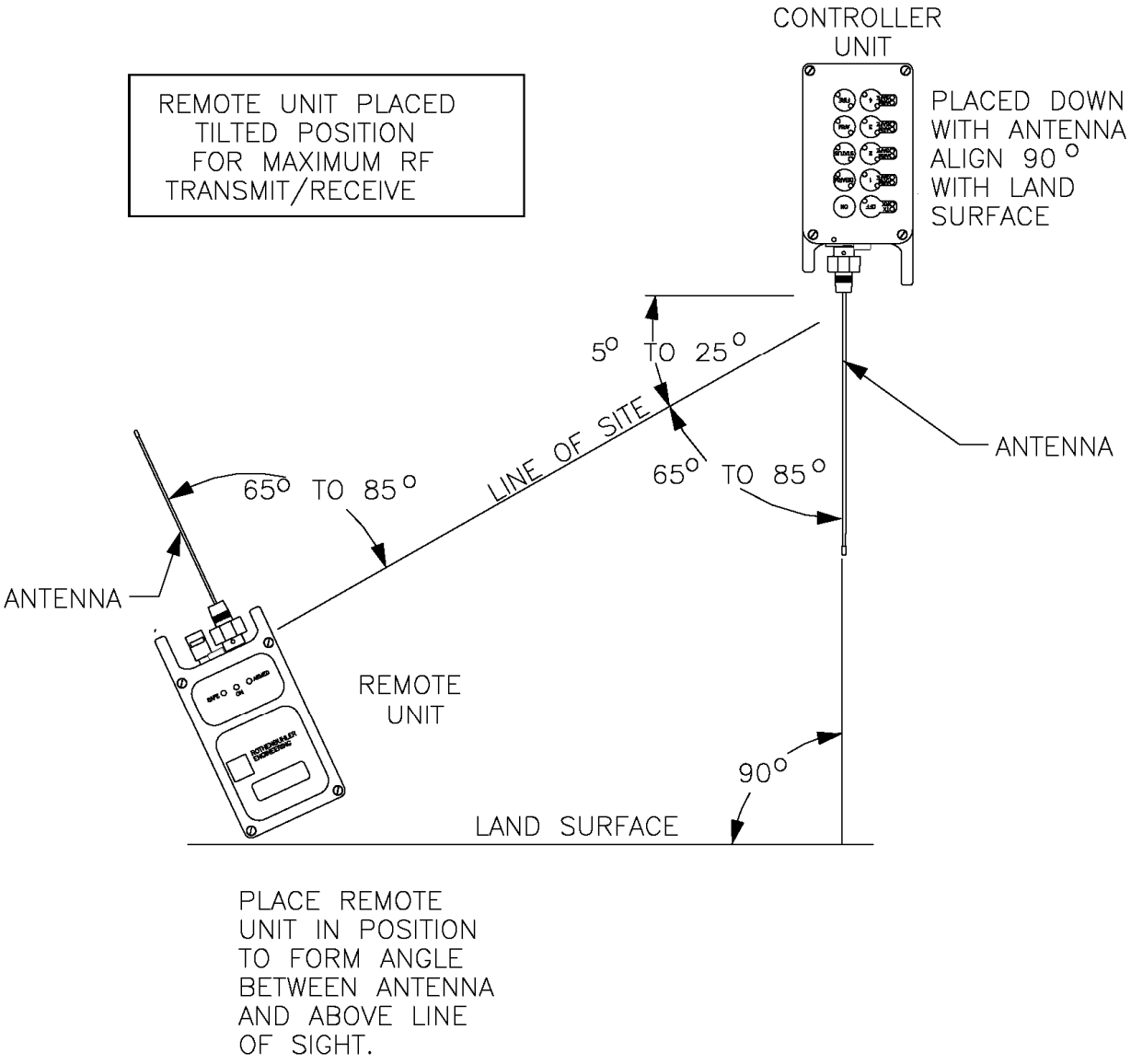


Figure 8-3 Mini Controller Unit Elevated

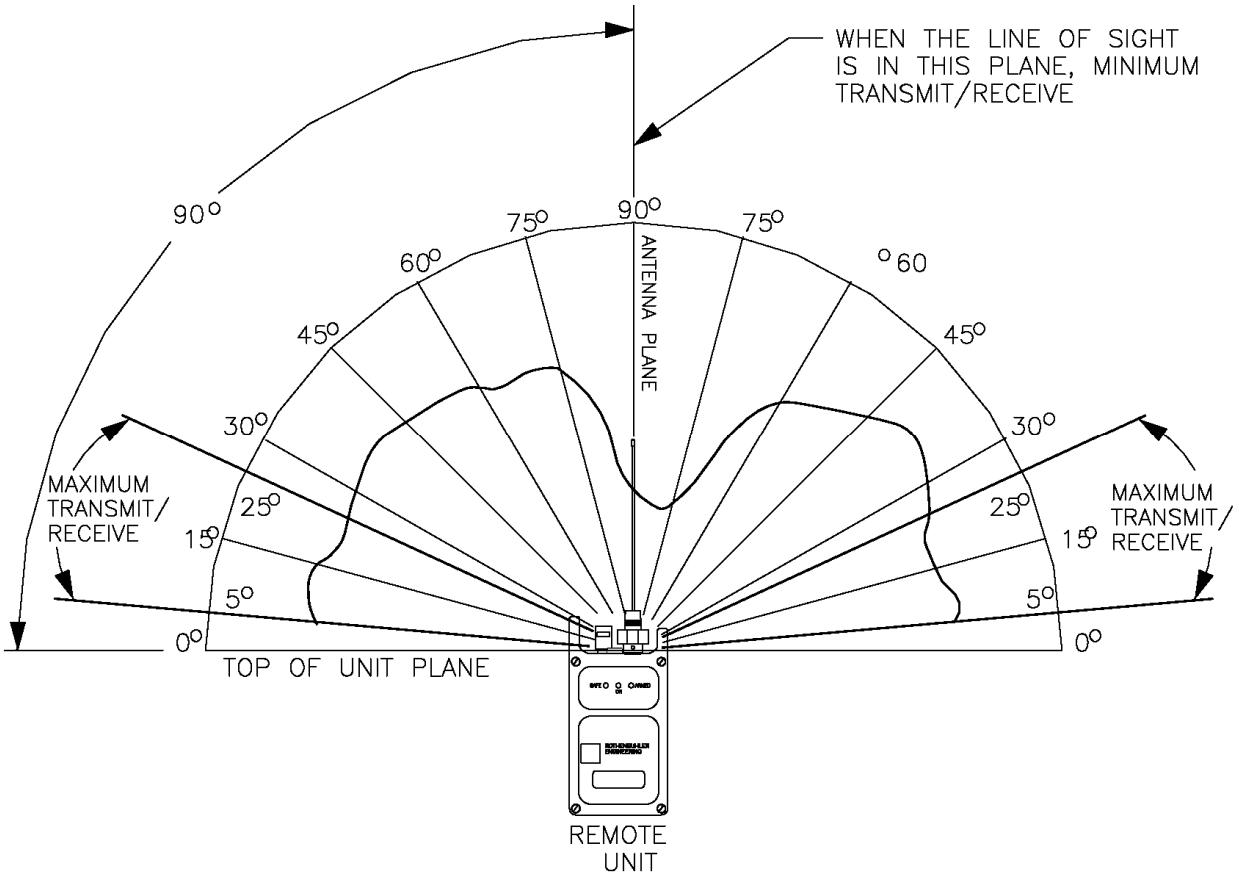


Figure 8-4 Antenna Radiation Pattern (All Units)

9. TEST BOX

The Test Box allows the user to test display system information of the Electric Remote, RSTI, and Mini Controller Units as well as perform diagnostic checks. The Test Box also serves as the programming interface between a computer and a RFD Unit.

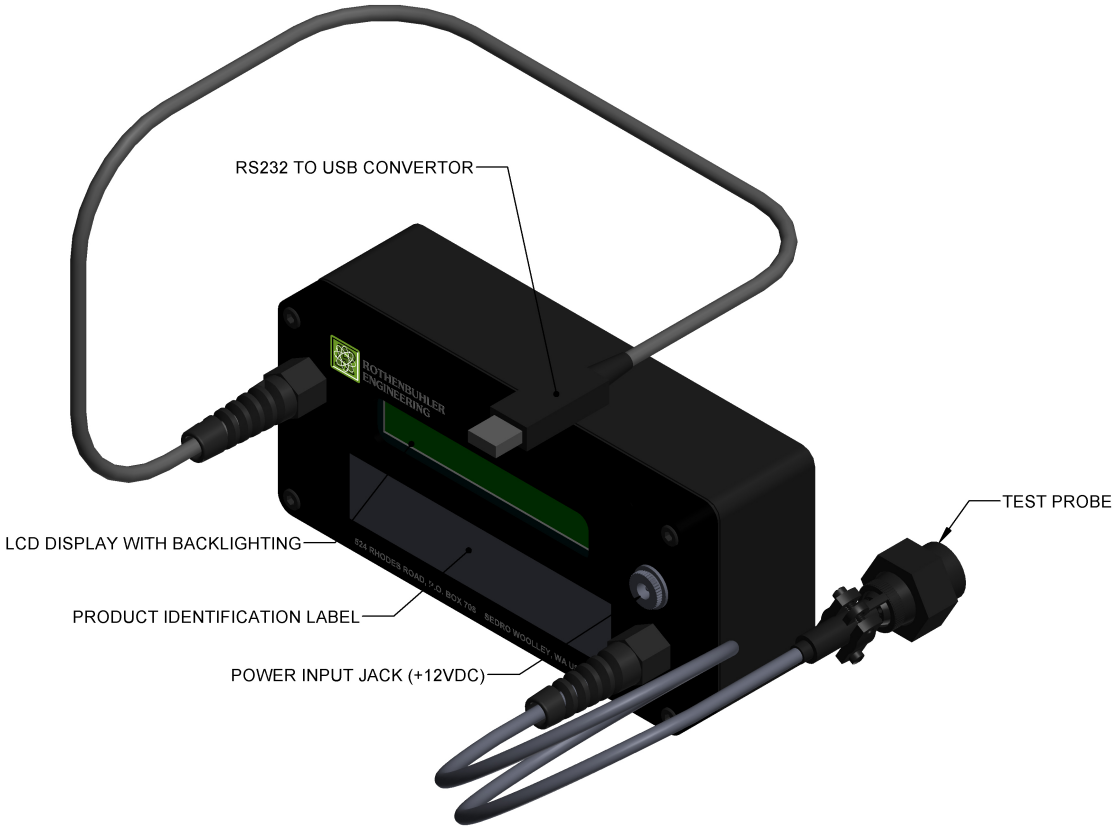


Figure 9-1 Test Box

9.1. TEST BOX OPERATION

WARNING Do not touch the firing terminals of the Remote units while testing. A potentially lethal voltage is present during the Fire test.

9.1.1. Test Box Messages

When the Test Box is turned on, the following message is displayed.

```
    1678 Test Box
  01/13/2011  Ver 3.0
```

The “1678 Test Box” part of the message identifies the system types that the Test Box is designed to operate with. “01/13/2011” is the date of the Test Box firmware. “Ver 3.0” is the version of the Test Box firmware. The Test Box will automatically step to the next message “Connect Unit to Test”.

```
Connect Unit to Test
```

9.1.2. Testing the Controller

To test a Controller, plug the Test Box probe into the top connector on the Controller. Then press the ‘ON’ Switch while pressing the Select ‘3’ switch. The Controller turns on with the yellow light next to the Select ‘3’ switch illuminated. The Test Box will display the following message. The actual message will depend on the model of Controller.

```
Mini Controller Detected
```

Next the Test Box will display the Battery Charge Count as shown below. This is the number of charge cycles the battery within the Controller has experienced.

```
Battery Charge Count
          83
```

Next the Test Box displays the current battery’s temperature (+22C +72F) and chemistry type (NiMH).

```
Battery Temp +22C +72F
Battery Type: 1650mAh NiMH
```

The next message shows the battery serial number (Battery SN 0001) and the battery’s date of manufacture (Battery DOM 02/03/2011).

```
Battery SN 0001
Battery DOM 02/03/2011
```

The next message displayed shows the System Number or Address (0000000001) that the Controller is assigned to and the Unit assigned to the Controller (Default is Unit 1).

```
Address 0000000001
Unit 1
```

The next message displayed shows the assigned Frequency.

```
Frequency 174 MHz
```

The next message displayed is the Controller's serial number (S/N), unit Type (Model) date of manufacture (DOM), firmware version (Ver). The actual message will depend on the model of Controller.

```
S/N 00101 Type 1678-6
DOM 06/29/2010 Ver 1.0
```

The next message displayed is the firmware Checksum and the Fire Count.

```
    Checksum 4C42
    Fire Count 87
```

Next the Controller begins a Battery Test.

```
Battery Test – Standby
          30
```

The Battery Test places a load on the battery and a countdown timer is started. At the end of the test, the loaded battery voltage is displayed along with the test limit of (7.00).

```
Loaded Battery 7.24
<Low Battery = 7.00>
```

After testing is complete, the Controller's loaded battery voltage is displayed.

```
Battery Voltage 7.24
```

9.1.3. Testing the Electric Remote

WARNING Do not touch the firing terminals of the Remote units while testing. A potentially lethal voltage is present during the Fire test.

To test an Electric Remote, plug the Test Box probe into the top connector on the Electric Remote. The Electric Remote turns on with the yellow light fast blinking and the green light on. The Test Box will display the following message.

```
Electric Remote Detected
```

Next the Test Box will display the Battery Charge Count as shown below. This is the number of charge cycles the battery within the Electric Remote has experienced.

```
Battery Charge Count
          83
```

Next the Test Box displays the current battery's temperature (+22C +72F) and chemistry type (NiMH).

```
Battery Temp +22C +72F
Battery Type: 1650mAh NiMH
```

The next message shows the battery serial number (Battery SN 0001) and the battery's date of manufacture (Battery DOM 02/03/2011).

```
Battery SN 0001
Battery DOM 02/03/2011
```

The next message displayed shows the System Number or Address (0000000001) and the Unit number assigned to the Electric Remote.

```
Address 0000000001
Unit 2
```

The next message displayed shows the assigned Frequency.

```
Frequency 174 MHz
```

The next message displayed is the Electric Remote's serial number (S/N), unit Type (Model) date of manufacture (DOM), firmware version (Ver).

```
S/N 00101 Type 1678-2
DOM 06/29/2010 Ver 1.0
```

The next message displayed is the firmware Checksum and the Fire Count.

```
    Checksum 7061
    Fire Count 87
```

Next the Electric Remote begins the Electric Arm/Fire Test. The Test Box Arms the Electric Remote and begins 5 second countdown.

```
Electric Arm/Fire Test
          05
```

At the end of the countdown the Electric Remote is fired. The firing voltage and pass level is shown.

```
Arm/Fire Voltage 50.23
 <Pass Level = 45.00>
```

Next the Electric Remote begins a Battery Test.

```
Battery Test – Standby
          30
```

The Battery Test places a load on the battery and a countdown timer is started. At the end of the test, the loaded battery voltage is displayed along with the test limit of (7.00).

```
   Loaded Battery 7.24
  <Low Battery = 7.00>
```

After testing is complete, Electric Remote's loaded battery voltage and firing voltage are displayed.

```
Battery Voltage 7.24
Firing Voltage 51.54
```

9.1.4. Testing the RSTI

WARNING Do not touch the firing terminals of the Remote units while testing. A potentially lethal voltage is present during the Fire test.

To test an RSTI, install the firing tip on the top of the RSTI and plug the Test Box probe into the top connector on the RSTI. The RSTI turns on with the yellow light fast blinking and the green light on. The Test Box will display the following message.

```
    RSTI Detected
```

Next the Test Box will display the Battery Charge Count as shown below. This is the number of charge cycles the battery within the RSTI has experienced.

```
Battery Charge Count
         83
```

Next the Test Box displays the current battery's temperature (+22C +72F) and chemistry type (NiMH).

```
Battery Temp +22C +72F
Battery Type: 1650mAh NiMH
```

The next message shows the battery serial number (Battery SN 0001) and the battery's date of manufacture (Battery DOM 02/03/2011).

```
Battery SN 0001
Battery DOM 02/03/2011
```

The next message displayed shows the System Number or Address (0000000001) and the Unit that the RSTI is assigned to.

```
Address 0000000001
Unit 3
```

The next message displayed shows the assigned Frequency.

```
Frequency 174 MHz
```

The next messages displayed are the serial number (S/N), unit Type (Model) date of manufacture (DOM), firmware version (Ver).

```
 S/N 00101 Type 1678-3
 DOM 06/29/2010 Ver 1.0
```

The next message displayed is the firmware Checksum and the Fire Count.

```
     Checksum 56c4
     Fire Count 87
```

Next the RSTI begins the Arm/Fire Test. The Test Box Arms the RSTI and begins 5 second countdown.

```
RSTI Arm/Fire Test
        05
```

At the end of the countdown, the RSTI fires resulting in the formation of a spark at the tip. The firing voltage and pass level is shown.

```
Firing Voltage 2652
<Pass Level = 2250>
```

Next the RSTI begins a Battery Test.

```
Battery Test – Standby
        30
```

The Battery Test places a load on the battery and a countdown timer is started. At the end of the test, the loaded battery voltage is displayed along with the test limit of (7.00).

```
Loaded Battery 7.24
<Low Battery = 7.00>
```

After testing is complete, the following message is displayed.

```
Battery Voltage 7.24
Firing Voltage 2652
```

RFD Programming Guide

9.2. PROGRAMMABLE PARAMETERS

9.3. REQUIRED EQUIPMENT

9.3.1. 1678 Test Box

9.3.2. A personal computer running Microsoft Windows® 95, 98, 2000, or XP and an available USB port.

9.3.3. The software utility ‘RFD HS Terminal Utility’ located on the CD at the back of this manual.

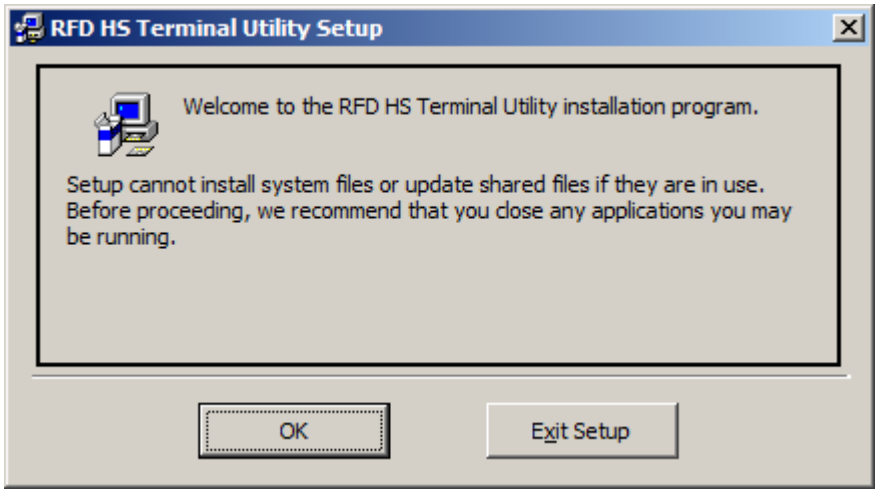
9.4. WINDOWS CONFIGURATION SOFTWARE (RFD HS TERMINAL UTILITY)

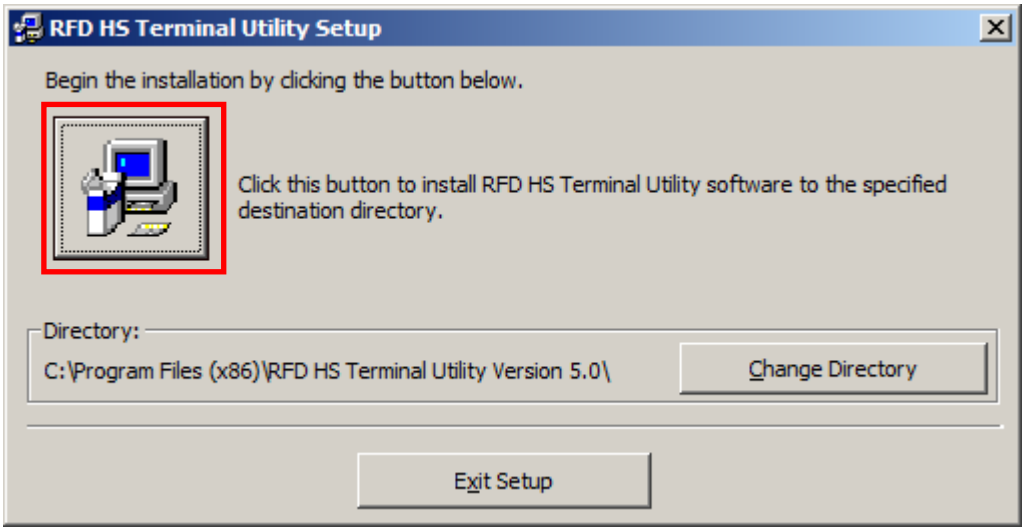
RFD HS Terminal Utility is a Windows program which allows users to log the test results from the Text Box into a PC.

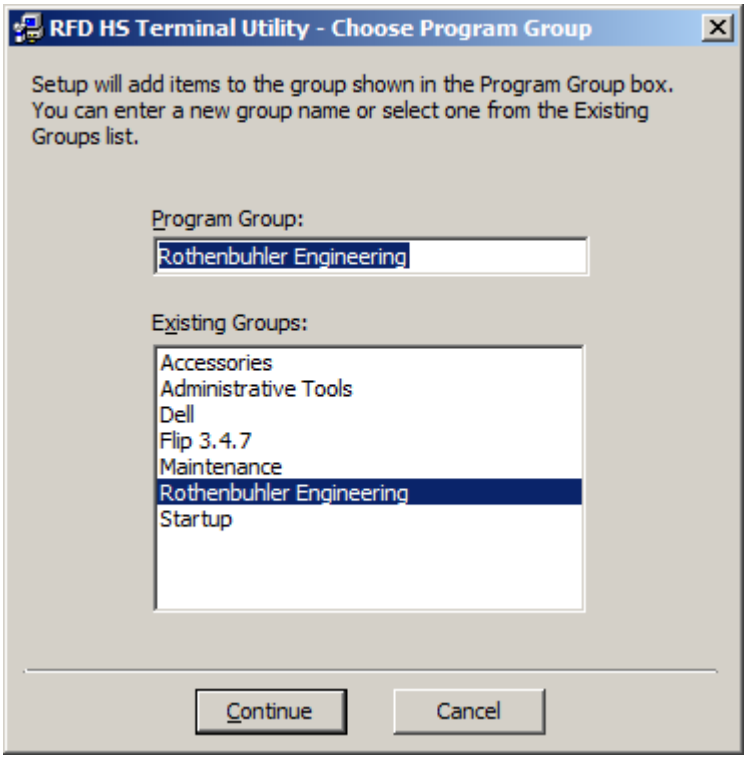
9.5. RFD HS TERMINAL UTILITY INSTALLATION

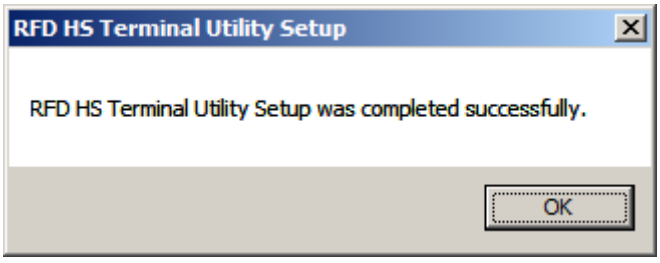
The RFD HS Terminal Utility install files are distributed on a CD. Follow the listed steps to install RFD HS Terminal Utility on a computer.

- Install the CD and browse to the file ‘Setup.exe’.
- Run the setup.exe file from the folder.
- Follow the prompts in the dialog boxes that appear. Typical dialog boxes are shown below.







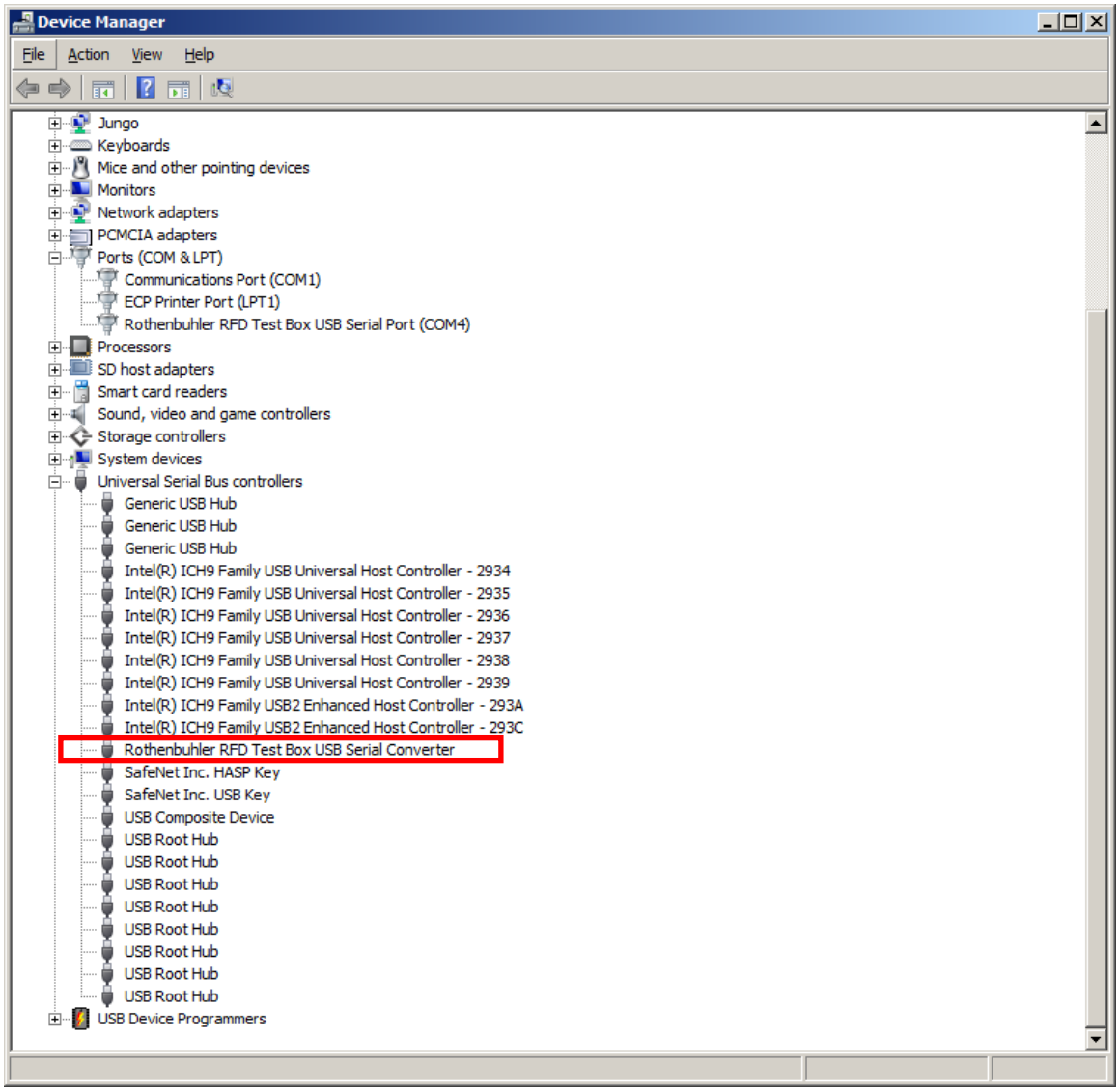


RFD Terminal Utility is now installed on the computer.

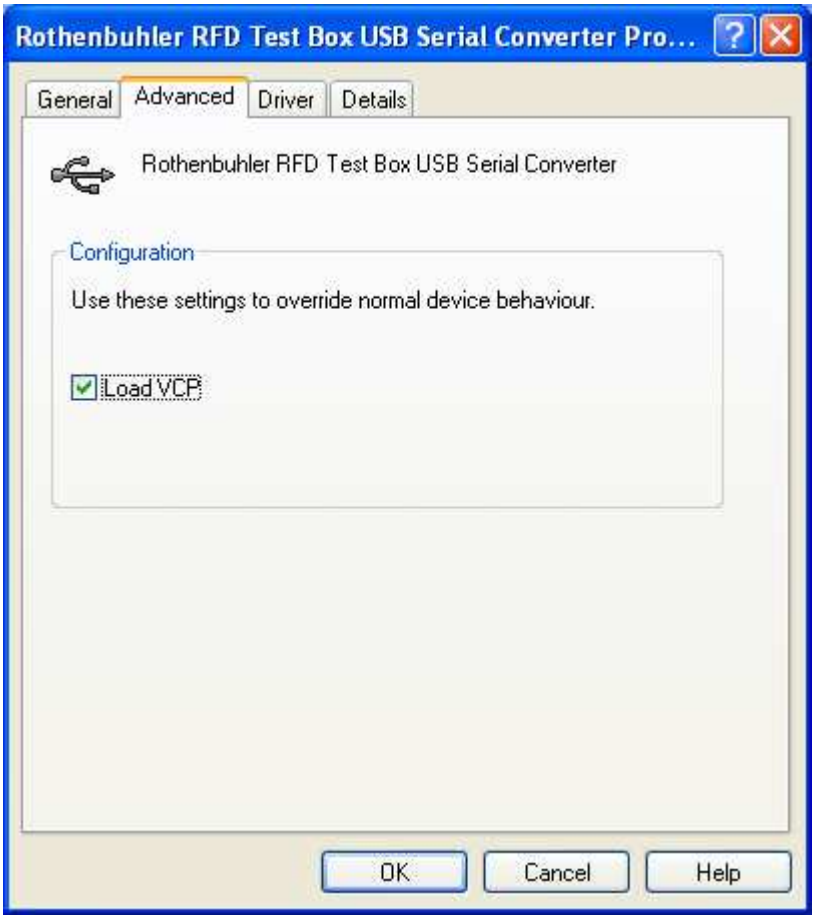
9.6. INSTALLING TEST BOX USB CABLE DRIVERS

1. Connect the USB cable from the 1678-4 RFD Test Box to a USB port on the PC.
2. If the automatic installation takes place there is no need to continue with the procedure outlined below. If the automatic installation does not find the USB drivers, browse to the RFD HS Terminal Utility install disk and then the “Rothenbuhler USB Drivers” folder. The folder contains the required drivers and the automatic installation should then be able to complete.
3. After installation is completed, press the Windows start button to bring up the start menu and right click on My Computer.
4. Select Properties.

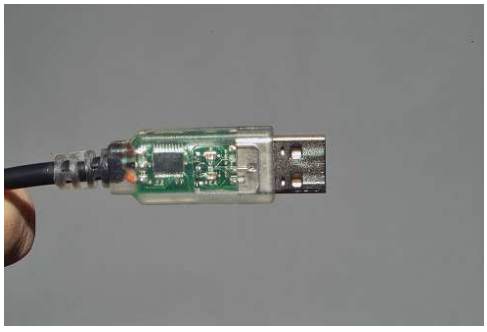
5. Select the Hardware Tab, and click on Device manager.
6. A Rothenbuhler RFD Test Box USB Serial Port should be listed under Ports (COM & LPT). Make a note of the COM number assigned to the Test Box.
7. If the Rothenbuhler RFD Test Box USB Serial port is not listed under PORTS (COM & LPT) then expand the Universal Serial Bus Controllers tab.



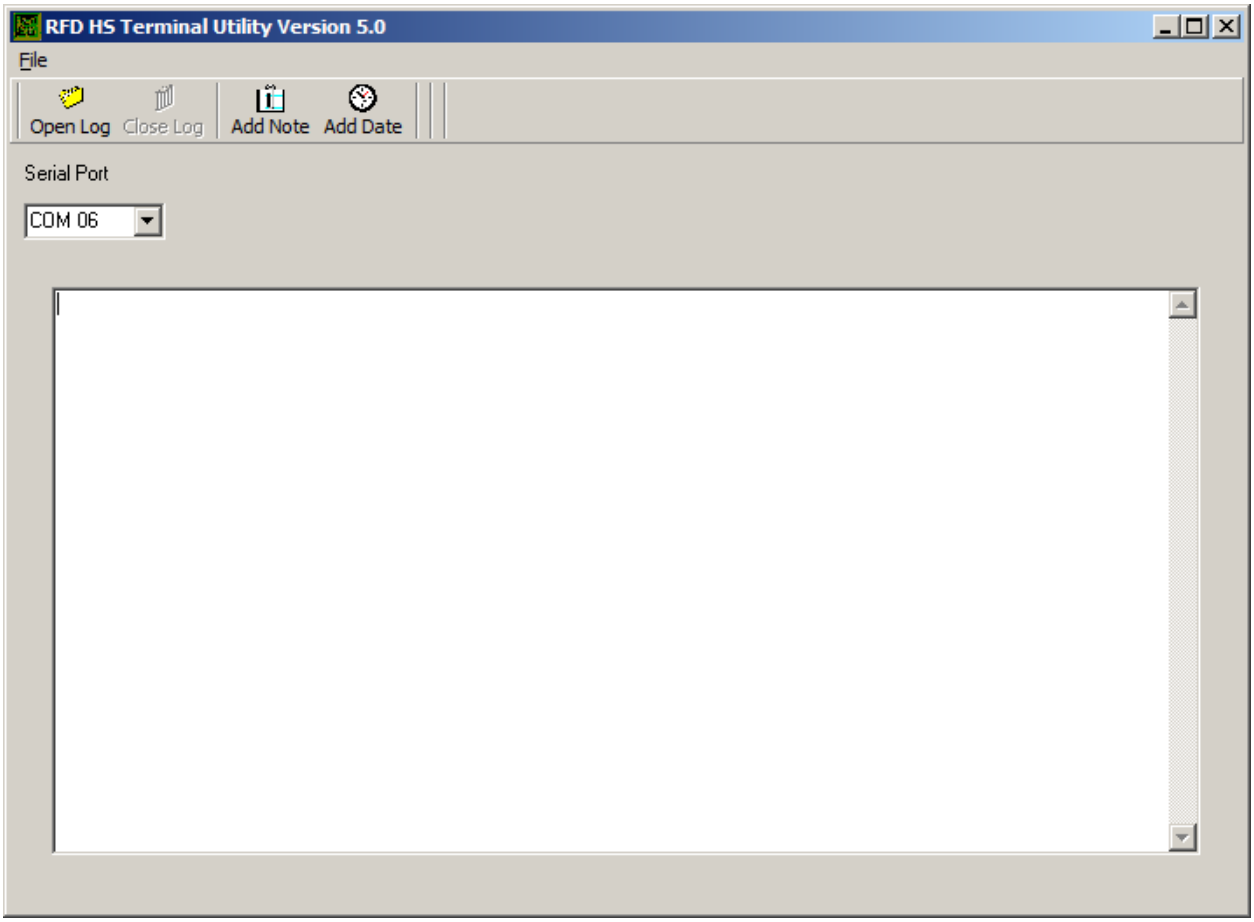
8. Select the Rothenbuhler RFD Test Box USB Serial Convertor, and right click to open its properties.



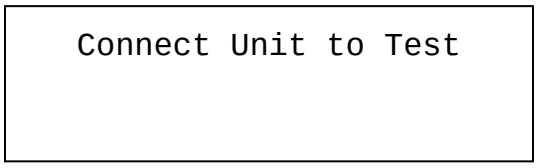
9. Open the Advanced tab and make sure the Load VCP box is checked. It maybe necessary to disconnect and reconnect the USB cable to refresh the list.
10. Note the COM number that has been assigned to the Test Box. The COM number will be necessary when connecting to the RFD HS Terminal Utility Software.
11. Note that the COM port assigned to the Test Box may change if the USB cable is plugged into a different USB port on the computer.
12. Before starting the RFD HS Terminal Utility, connect the USB cable from the 1678-4 RFD Test Box to a USB port on the PC.

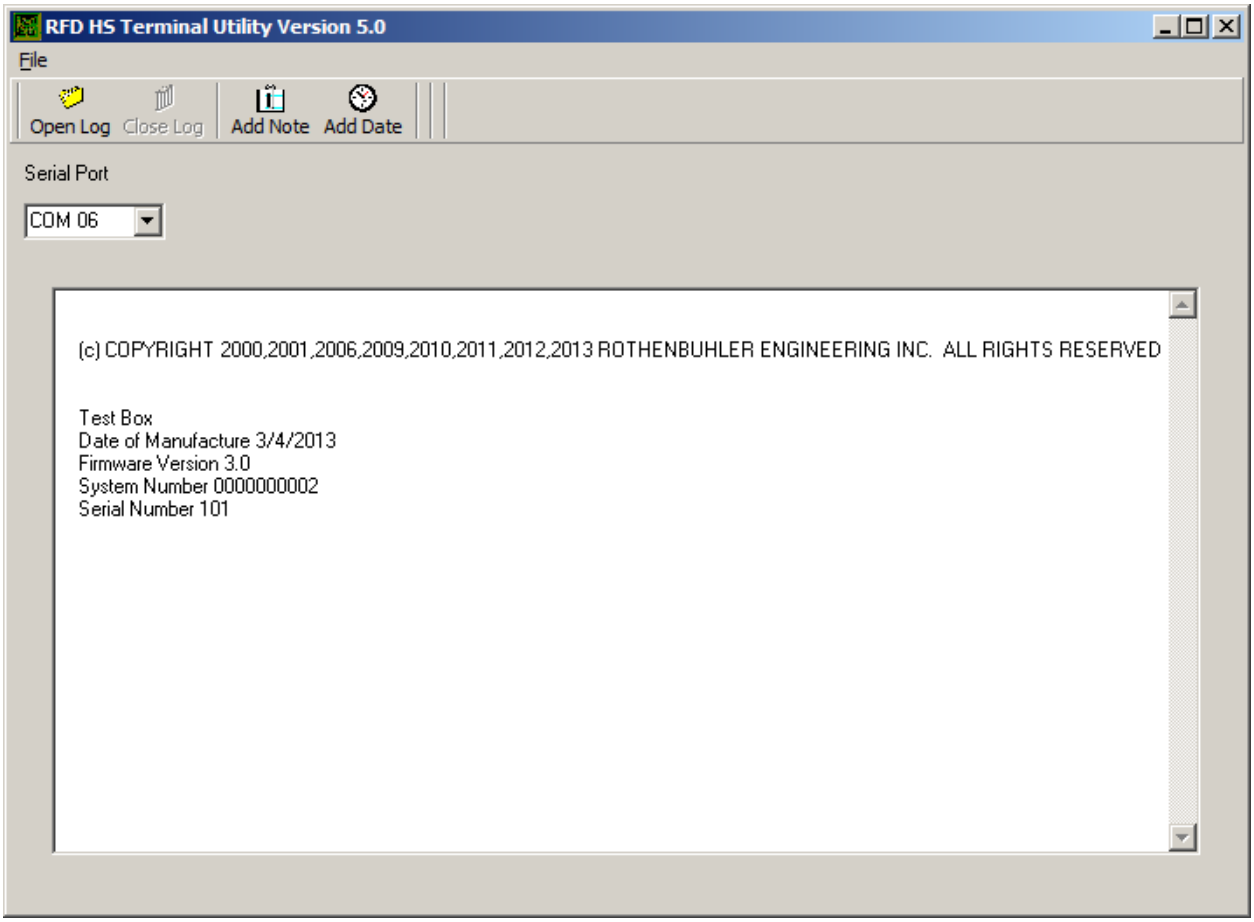


13. Open the RFD HS Terminal Utility program and select the COM Port that was assigned by the computer's Hardware Manager to the Test Box.



14. Plug in the power input jack on the top right of the Test Box. Observe the display on the Test Box. It should read “Connect Unit to Test.”





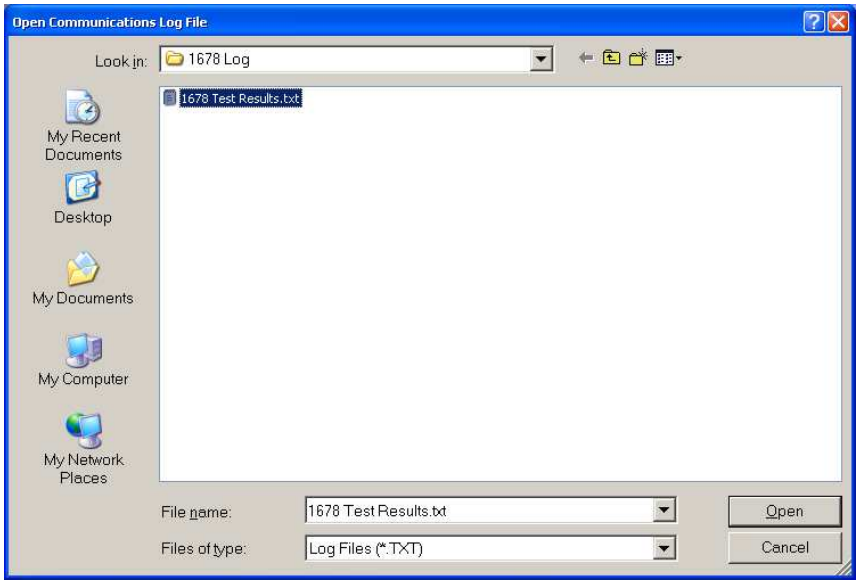
15. The information from the Test Box should be displayed in the Terminal window.

9.7. USING RFD HS TERMINAL UTILITY TO TEST RFD UNITS

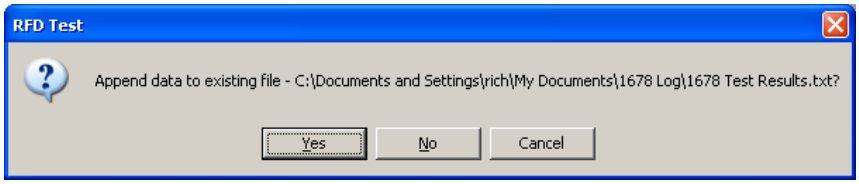
The RFD HS Terminal Utility program may be used with the 1678-4-V2 Test Boxes for recording test results. It is also compatible with 1678-4 Test Boxes with a firmware version of 3.0 or greater.

Creating a Test Results Log File:

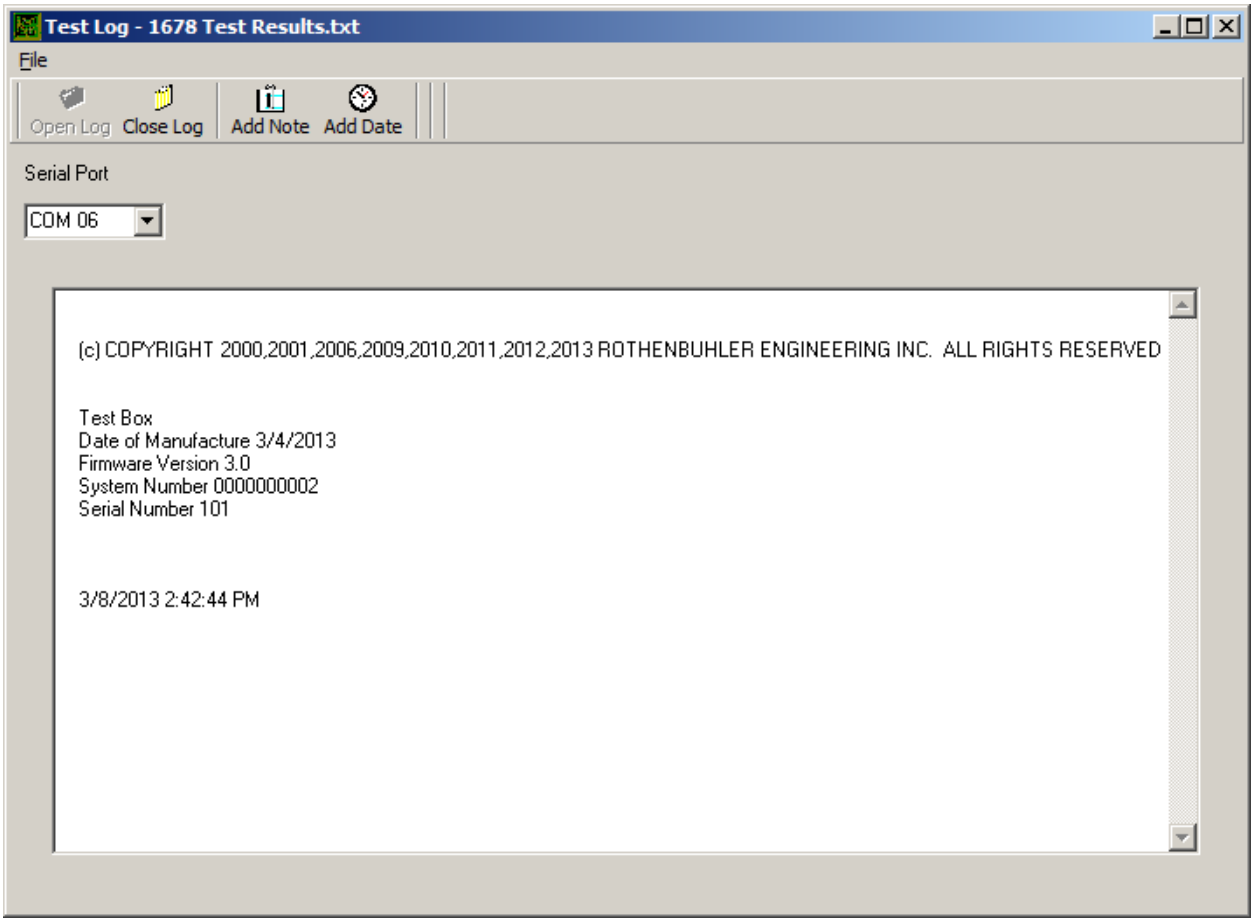
- If a log file of test results is desired, click “File” and then “Open Log File…”. The following dialog box will appear.



- Type in a file name for the log file or select an existing file to use. Click the "Open" button.
- If the file already exists, the following prompt appears.



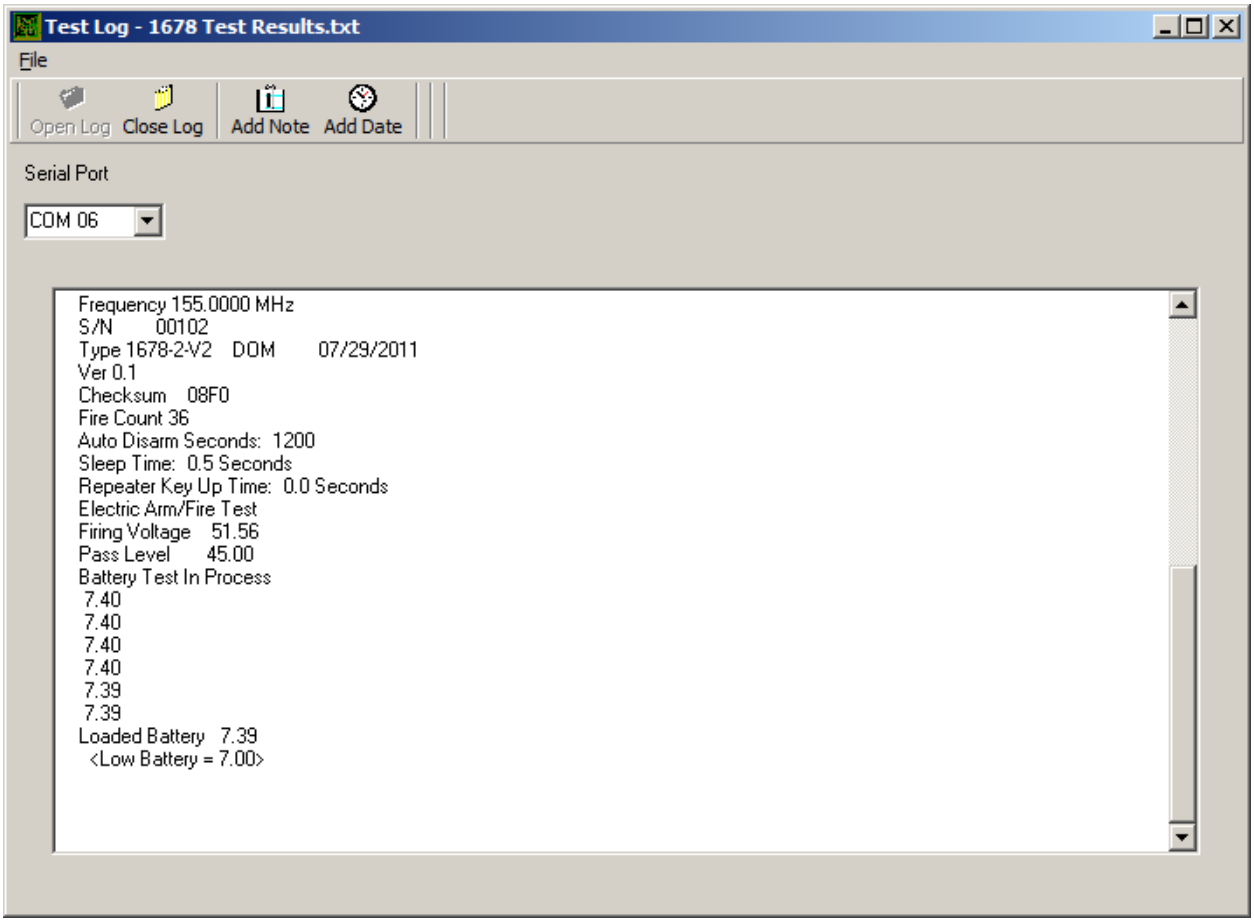
- Click "Yes" to append (add to) existing data or "No" to overwrite the existing file.
- A time and date stamp is added to the window.



- Notes can be added to the log file by clicking the note card icon and typing the note in the dialog box that appears. Multiple notes can be added as required.

- Connect the Test Box Probe to an Electric Remote Unit, RSTI, or Controller.
- If testing the Controller, place the unit in Program mode by turning the unit on while holding the select switch for #3.

- The Test Box reads and displays the system information from the unit connected both on the LCD display of the Test Box, and on the RFD HS Terminal Utility window. The Electric Remote and RSTI will begin reading and displaying unit parameters automatically and then will conduct an ARM/FIRE test. The Controller displays unit parameters. All units then execute a loaded battery test voltage test. The results are displayed as shown in the next window.



- Changes to unit parameters and settings are not permitted with RFD HS Terminal Utility. Advanced user software is available which allows some system parameter changes to be made. Advanced user software permits changes to the Unit ID# and System number assignments of the Electric Remote & RSTIs as well as sleep mode settings and repeater delays. Please contact the factory to discuss your application if you feel that advanced user software may be required.

10. MAINTENANCE

The units will provide optimum performance and maximum life when the following recommendations are adhered to.

10.1. SCHEDULED SERVICING

It is recommended that you return your RFD System to the manufacturer or an authorized service shop every 2-3 years for service. During servicing, each unit is evaluated and adjusted to maintain optimal performance. The hardware of the unit is checked and replaced as needed. Additionally, general updates and service bulletins are included with no additional cost. It is also recommended that the battery packs be replaced at this time.

10.2. BATTERY CHARGING INFORMATION

10.2.1. Battery Temperature

For maximum efficiency, charge the batteries when they are at temperatures between 50˚F and 86˚F (10˚C and 30˚C). DO NOT attempt to charge batteries that are below 32˚F (0˚C) or above 104˚F (40˚C). Permanent damage to batteries and or equipment may result.

10.2.2. Pre-operation

Use the Battery Charger Assembly to discharge and then charge the battery of each unit.

10.2.3. Periodic

3 Position Charger: For optimal battery health, perform two or more full charge cycles per month on each unit. Allow the units to discharge to a low battery level before recharging.

5 Position Charger Conditioner: For optimal battery health, use the Discharge & Charge Mode when recharging is required. Condition the battery every 6 months using the Condition (Restore) Mode.

10.3. BATTERY PACK REPLACEMENT

It is recommended that the battery packs contained in each unit should be replaced every 300 charge / discharge cycles. This number can be read and displayed with the optional RFD Test Box. If a Test Box is not available, this number can be estimated by your typical usage. It is recommended that the battery pack is replaced by the factory so that the case seals can be fully tested prior to re-deployment. For this reason, it may be desirable to arrange battery pack replacement with Scheduled Service of the RFD system. To ensure quality and safety, only OEM battery packs can be used in the RFD units.

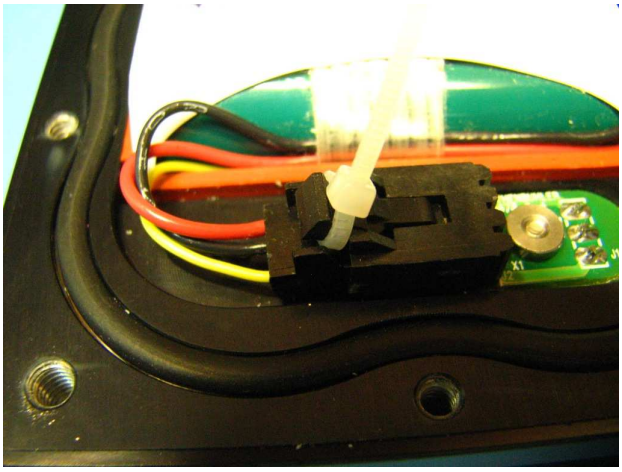
Battery Pack Replacement Procedure

10.3.1. Battery pack placement may be performed by the user under certain conditions. Battery packs replacement should only be performed indoors in a dry, clean, dust-free work environment. Replacement should only be performed by persons having sufficient skills and tools to perform the work described below. The use of non OEM battery packs is not allowed.

1. Loosen and remove the 9 or 13 smaller machine screws on the backside of the unit using a 7/64 Allen wrench. Then loosen and remove the four larger machine screws using a 9/64 Allen wrench.

2. Separate the lid from the main body exposing the battery.

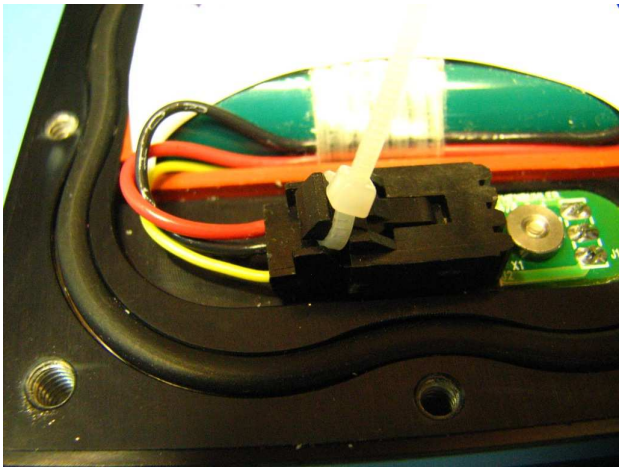
3. A black plastic connector housing at the bottom of the case attaches to the 3-wire battery connector plug. Carefully cut the white nylon cable tie from the clip on the battery pack and remove.



4. Push the tab on the 3-wire battery connector plug and gently pull to release it from the receptacle.

5. Gently pry the battery pack from the main body.

6. Replace battery pack with the new pack. Carefully route the wires to the inside of the seal wall to prevent pinching when the case is closed. Snap the battery pack's 3-wire plug into the connector housing. Install the cable tie as shown to ensure the battery pack does not detach under mechanical stress. Trim the excess portion of the cable tie.



7. Replace the seal using the new seal supplied in the kit. Ensure the seal groove and the battery lid's sealing surfaces are clean and dry. The seam in the seal should be oriented toward the straight part of the case at the top.

8. Restore the lid and screws. Tighten screws in a criss-cross pattern. Torque all screws to 10 inch-lbs.

9. Charge the battery before use. If the 5 Position Charger Conditioner is available, perform a Condition (Restore) operation to maximize the batteries useable capacity.

10.4. EXTENDED NON-USE

3 Position Charger: For optimal storage life, store units with their batteries discharged to a low battery. Several full charge/discharge cycles may be necessary before the battery's capacity is restored to full. Units should be stored without the antennas attached.

5 Position Charger Conditioner: For optimal battery health, use the Discharge (Store) function to discharge the battery before storage. Use the Condition (Restore) function prior to use. Units should be stored without the antennas attached.

Do not exceed the storage temperature guidelines below. Storage outside of this range may reduce battery capacity and/or cause physical deterioration of battery components.

Storage Time	Storage Temperature
<30 days	-4 to 122°F (-20 to +50°C)
30 - 90 days	-4 to 104°F (-20 to +40°C)
>90 days	-4 to 86 °F (-20 to +30°C)

Revision History:

Rev A, January 31, 2012: Added instruction to install and use the virtual USB Software.

Rev B, March, 5, 2012: Updated Figure 2-1 and Figure 2-13 to show the new case foam and decals.

Rev C, March 8, 2013: Added 1678-1-V2 Controller Unit. Made references to Controllers be more generic where possible. Updated Test Box photo and Windows RFD Terminal Utility screen captures.