ROTHENBUHLER ENGINEERING®

REMOTE FIRING DEVICE

OPERATION MANUAL

The information contained in this document is subject to change without notice. In no event shall Rothenbuhler Engineering Company be liable for errors contained herein or for special, indirect, or consequential damages or injuries of any nature resulting from use of information in this document.

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

1678-A16 {Draft}
5/12/2011

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.

This radio transmitters (IC: 2758A-166921 and 2758A-16784) 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 and 2758A-16784) 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

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

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 Mini Controller Unit within 100 feet (30 meters) of explosives, blasting caps, or wires leading to them. The Mini Controller signal is 5 watts, which can cause detonation of caps if within 100 feet. The 5 watt Mini 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 side 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 DISARMED light for that Remote Unit on the Mini Controller Unit 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 DISARMED light for that Remote Unit on the Mini Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Mini Controller Unit 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 Mini Controller Unit 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 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 3mm non-electric shock tube running to the explosive. The Mini Controller Unit communicates to the Remote Units through a two-way RF transmitter data link, for a typical distance greater than **Error! Reference source not found.** (8 km). The Remote Unit can typically return communication for a distance greater than **Error! Reference source not found.** (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 tem “Remote Unit” is a generic term that is used for both the Electric Remote Unit and for the RSTI.

1.2. STORAGE AND ENVIRONMENTAL CONDITIONS

1.2.1. The Mini Controller Unit 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 or depth. 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, when stored in a dry hot environment.

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

1.2.3. The Mini Controller Unit and Remote Unit is 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 Mini Controller Unit and Electric Remote Unit have a temperature operation from -22 ºF to +140 ºF (-30 ºC to +60 ºC). The RSTI has a temperature

operation range from -15 ºF to +140 ºF (-26 ºC to +60 ºC).

1.3. MAINTENANCE

1.3.1. Batteries within the RFD require periodic charging and discharging to maintain health and service life.

1.3.2. The battery packs within the RFD should be replaced every 3 years or 300 charge cycles, whichever comes first. Battery packs can be replaced by the user following strict procedures to maintain case sealing. It is recommended the battery packs be replaced by the manufacturer or by an authorized service center. Contact the manufacturer for details.

1.3.3. Corrective maintenance shall be accomplished at the manufacturer or authorized service depot. Replacement of parts or disassembly by any other entity could result in the unsafe operation of the RFD and will void the manufacturer's warranty.

1.3.4. In case of failure of a component of the RFD System, the system will need to be shipped to the manufacturer or authorized service depot.

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 Mini Controller Unit and up to four Remote Units (any combination for Electric Remotes and RSTIs up to a total of four).

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

2.1.3. The RFD is transportable over land, underwater to a depth of 100 feet (30 meters), and in the air to an altitude of 30,000 feet (9,100 meters). The units are shock resistant to a 5 foot (1.5 meter) drop and impervious to static discharge.

2.1.4. The Mini Controller and Electric Remote Units will operate in a temperature range of -22 ºF to + 140 ºF (-30 ºC to +60 ºC). The RSTI will operate in a temperature range of -15 ºF to +140 ºF (-26 ºC to +60 ºC).

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

2.1.5.1. Range for one-way mode is greater than **Error! Reference source not found.** (8 km) typically.

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

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

Table 2-1 RFD 4-Remote Case System

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

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

** The system is available with one or two 3-Position Chargers. Included with each Charger is a +12V power supply.

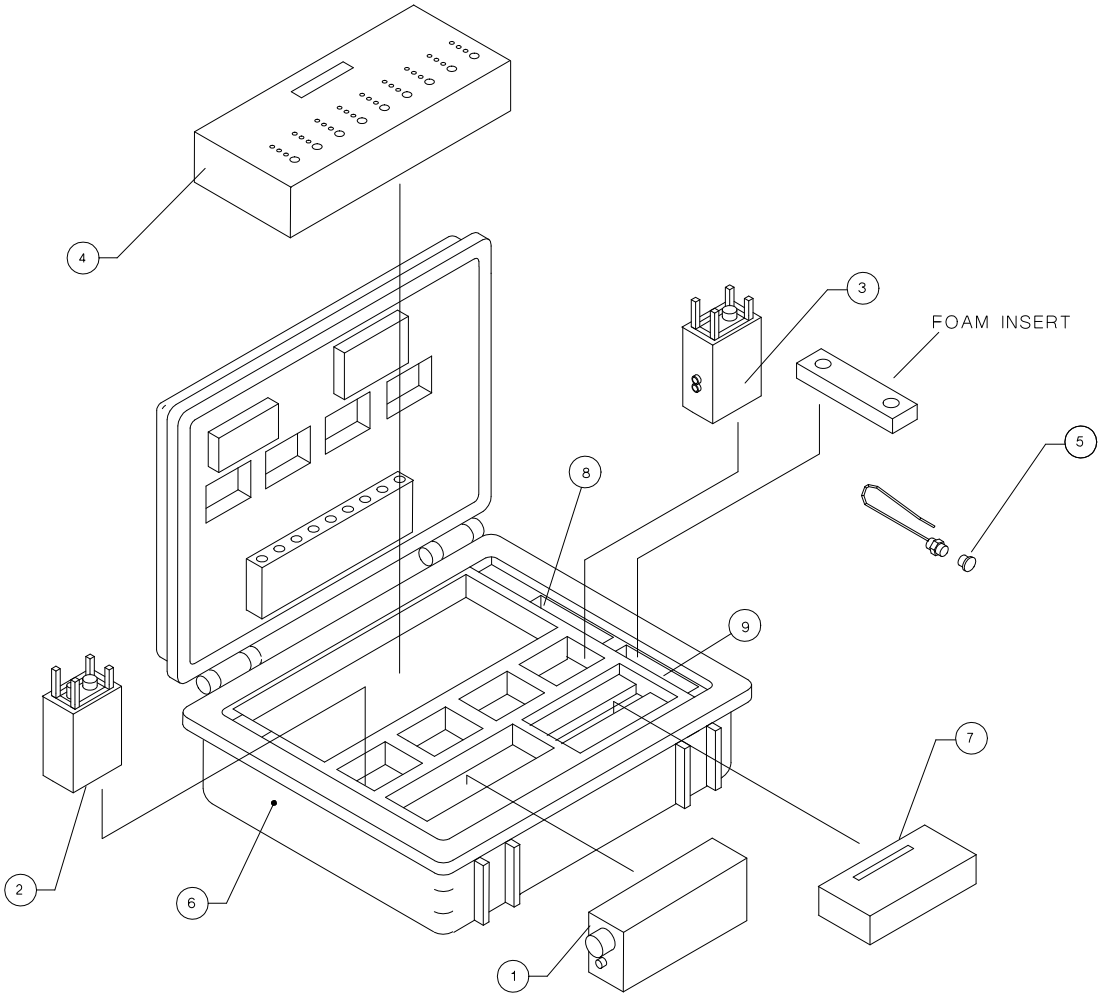


Figure 2-1 RFD 4-Remote Case System

2.2. MINI CONTROLLER UNIT

2.2.1. Figure 2-2 shows the external features of the Mini Controller Unit. The unit is sealed at the manufacturer and/or service depot and should not be opened during field activity.

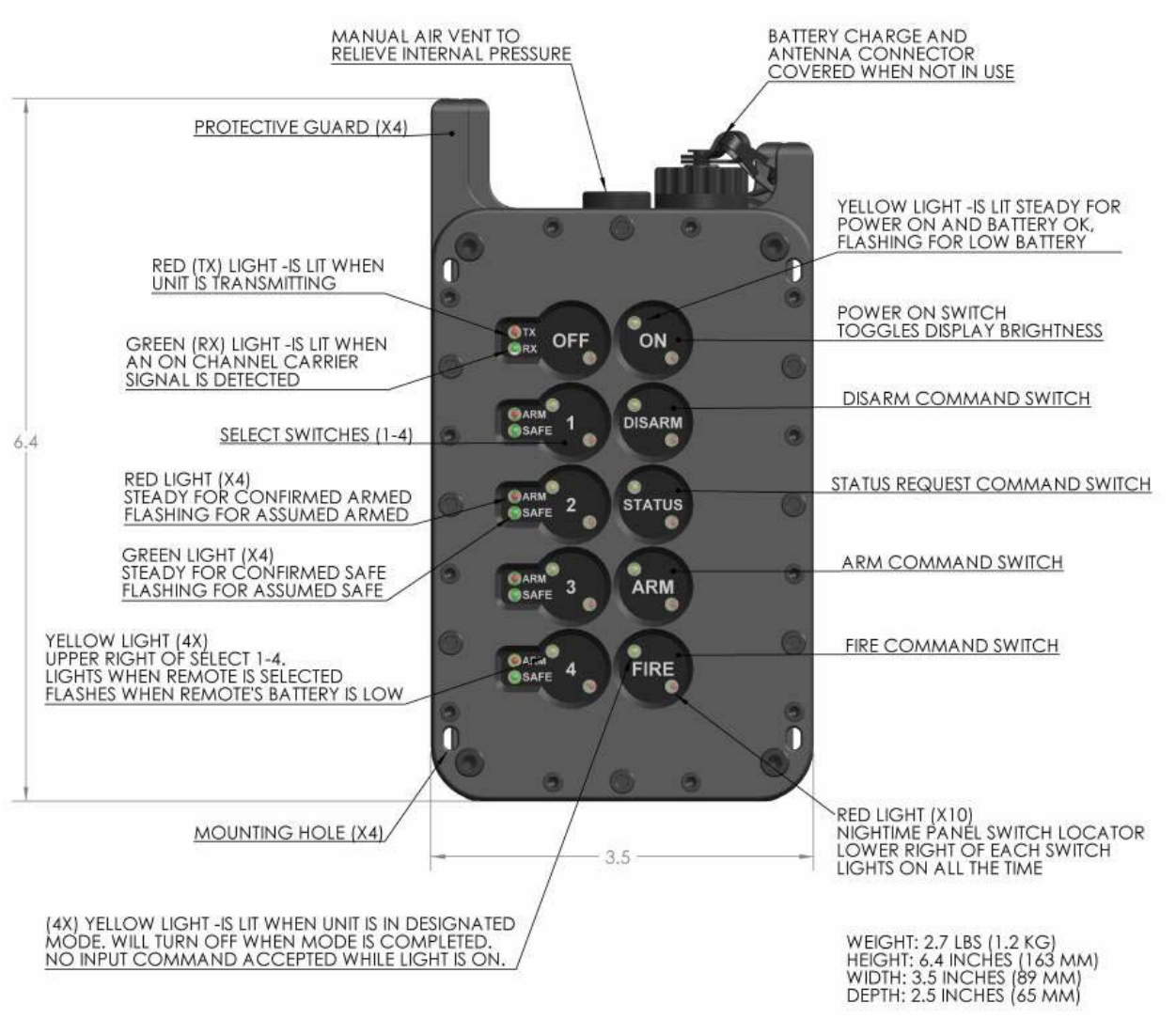


Figure 2-2 Mini Controller Unit

2.3. MINI CONTROLLER UNIT SWITCH OPERATION

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

2.3.2. **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, it will not be possible to activate the unit. The unit must be returned to the Manufacturer for service. Do not attempt to use a failing unit.

2.3.3. **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.

2.3.4. **Select Remote Units:** Depress the Select Switches “1” through “4” to select independently the Remote Units that will communicate with the Mini Controller Unit. Any combination of the four 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.

2.3.5. **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 Mini Controller Unit. If none of the Remote Units are selected, the Mini Controller Unit will request status from all four Remote Units. Any answering Remote Units will be selected automatically. If the Mini Controller Unit 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 Mini Controller Unit 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.

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

2.3.7. **Disarm the Remote Unit:** Depress the “DISARM” switch. The Mini Controller Unit 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 DISARMED light for selected Remote Units will begin to flash on the Mini Controller Unit display panel. The Mini Controller Unit will then request status of selected Remote Units. If the Mini Controller Unit is within range of the selected Remote Unit transmitter, the green DISARMED light for that Remote Unit will turn to steady on the Mini Controller Unit display panel. If the Mini Controller Unit is out of range of the selected Remote Unit transmitter, the green DISARMED light for that Remote Unit will continue to flash on the Mini Controller Unit display panel. If the Fire command is not sent within the Arm Time Period, the system will disarm automatically.

CAUTION Do not assume the Disarm command has been received by the Remote Unit unless DISARMED status is confirmed with a steady DISARMED light for that Remote Unit on the Mini Controller Unit 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 DISARMED light for that Remote Unit on the Mini Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Mini Controller Unit closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

2.3.8. **Activate the Remote Unit Firing Circuit:** Depress the “FIRE” switch for 1/2 second and the Mini Controller Unit will transmit the Fire command to selected Remote Units. The Mini Controller Unit 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 DISARMED light for each selected Remote Unit will begin to flash on the Mini Controller Unit display panel. The Mini Controller Unit will then request status from the selected Remote Units. If the Mini Controller Unit is within range of the selected Remote Unit transmitter, the DISARMED green light for that Remote Unit will turn to steady on the Mini Controller Unit display panel. If the Mini Controller Unit is out of range of the selected Remote Unit transmitter, the green DISARMED light for that Remote Unit will continue to flash on the Mini Controller Unit display panel.

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

- Depress “1” though “4” switches.
- Depress “ARM” switch – all four 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.

2.3.10. **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.

2.4. MINI CONTROLLER UNIT DISPLAY OPERATION

2.4.1. **Nighttime Panel Switch Locator:** There are ten red lights used for backlighting the Mini Controller Unit switches. When the Mini Controller is powered on, the lights turn on to help locate the switch positions.

2.4.2. **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.

2.4.3. **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.

2.4.4. **Remote Unit Battery Status:** The yellow select light at each of the “1” through “4” 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 Mini Controller Unit 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.

2.4.5. **Remote Unit Safe:** A green light next to each of the “1” though “4” 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 Mini Controller Unit and it is disarmed. If the Remote Unit transmitter is out of range of the Mini Controller Unit, the light will flash after a Disarm command has been sent.

2.4.6. **Remote Unit Armed:** A red light next to each of the “1” though “4” 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 Mini Controller Unit is within range of the selected Remote Unit's transmitter. If the Remote Unit transmitter is out of range of the Mini Controller Unit, the ARMED light will continue to flash.

2.4.7. **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.

2.4.8. **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.

2.4.9. **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.

2.4.10. **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.

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

2.4.12. **“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.

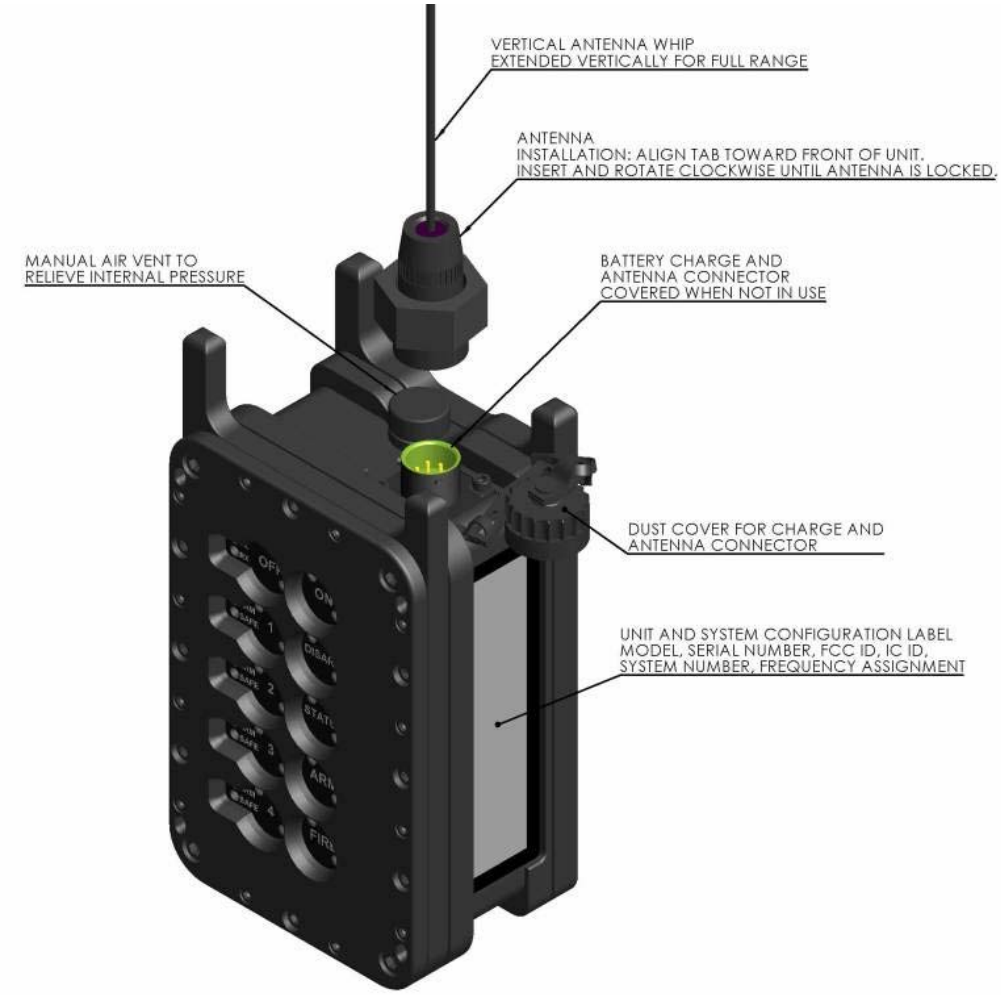


Figure 2-3 Mini Controller Isometric View with Antenna

2.4.13. Figure 2-3 shows an isometric view to further illustrate the exterior features of the Mini Controller.

2.4.14. **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.

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

2.4.16. **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.

2.5. ELECTRIC REMOTE UNIT

2.5.1. Figure 2-4 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.

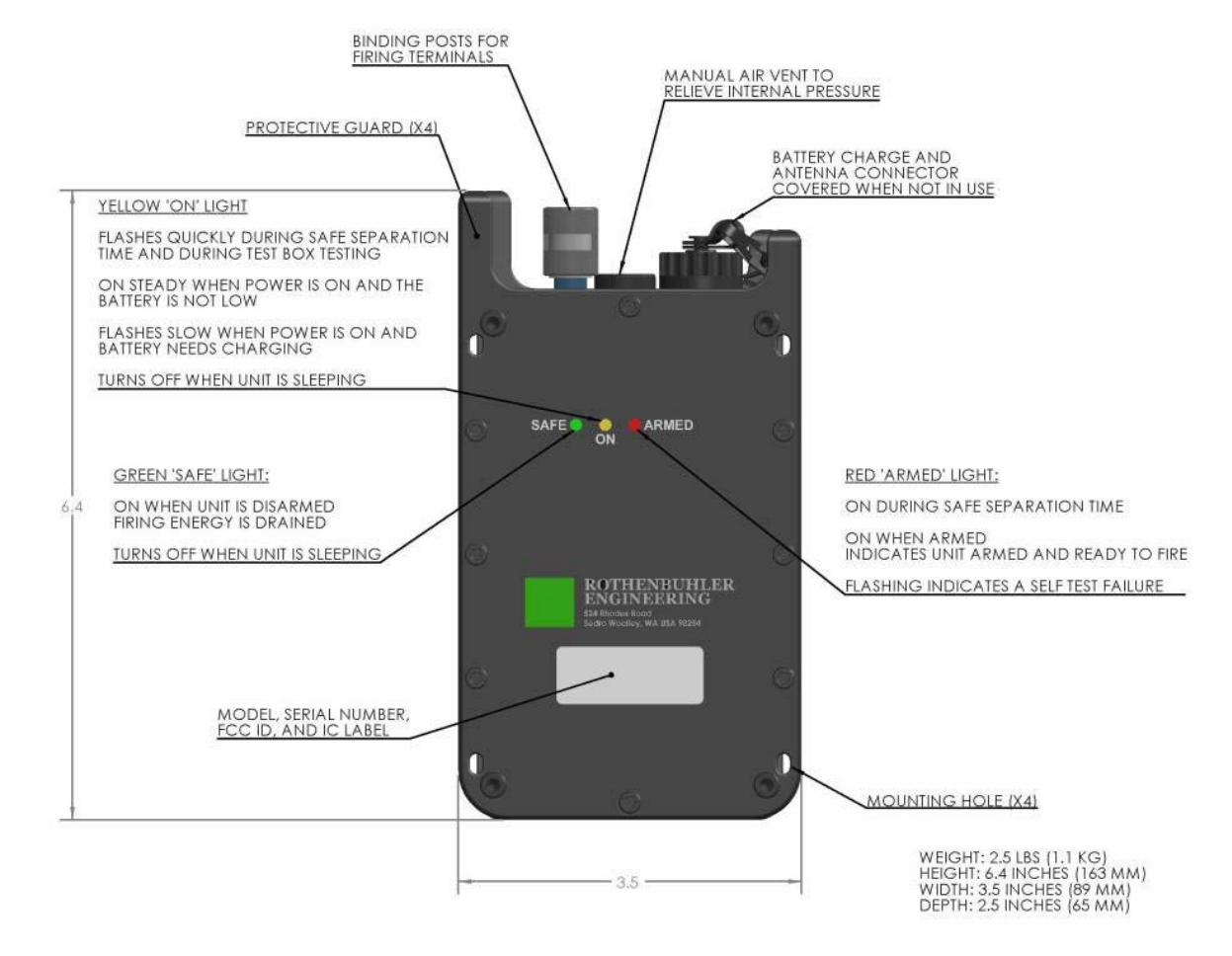


Figure 2-4 Electric Remote Unit

2.5.2. **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.

2.5.3. **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 Mini Controller. Thus, it is recommended that the mated Mini Controller be rendered unusable while personnel are within the hazard area. This can be accomplished by the removal of the Mini Controller's antenna and its secure storage until ready for use. The default Safe Separation Time is 15 seconds.

2.5.4. **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 2.5.7).

2.5.5. **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 2.5.7).

2.5.6. **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.

2.5.7. **Sleep Mode:** 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 Mini 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.

2.5.8. Figure 2-5 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.

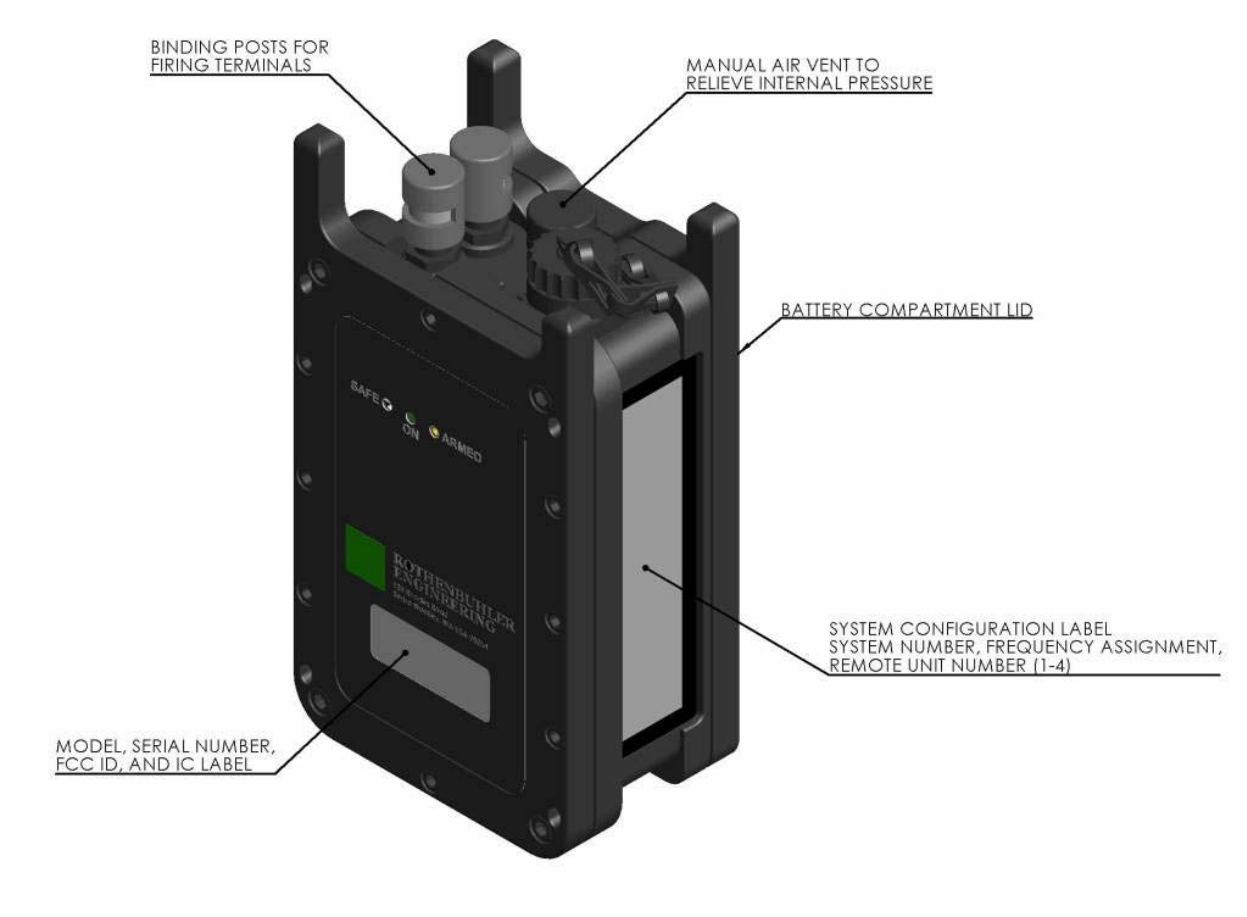


Figure 2-5 Electric Remote Unit Angled View

2.5.9. **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.

2.5.10. **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 or when the unit is exposed to moisture.

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

2.5.12. **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.

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

2.6. REMOTE SHOCK TUBE INITIATOR (RSTI)

2.6.1. Figure 2-6 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.

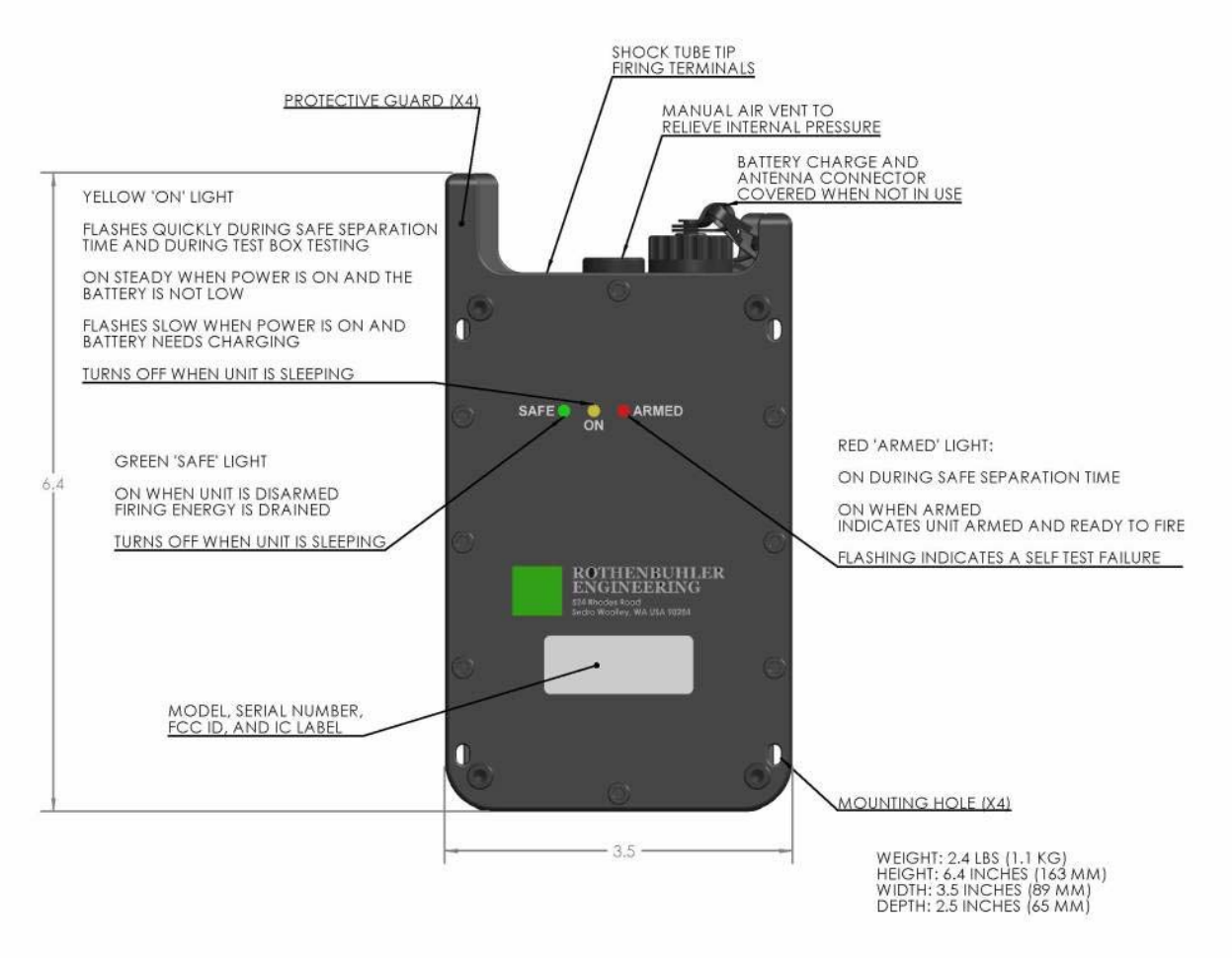


Figure 2-6 Remote Shock Tube Initiator (RSTI)

2.6.2. The RSTI operates similar to the Electric Remote Unit as described in Section 2.5, but initiates non-electric tubing instead of electric detonators. The RSTI develops 2,500V at the Shock Tube Tip Firing Terminals when firing.

Figure 2-7 RSTI Angled View with Shock Tube Spark Tip

2.6.3. Figure 2-7 shows the installation of the Shock Tube Firing Tip onto the Firing Terminals on the RSTI.

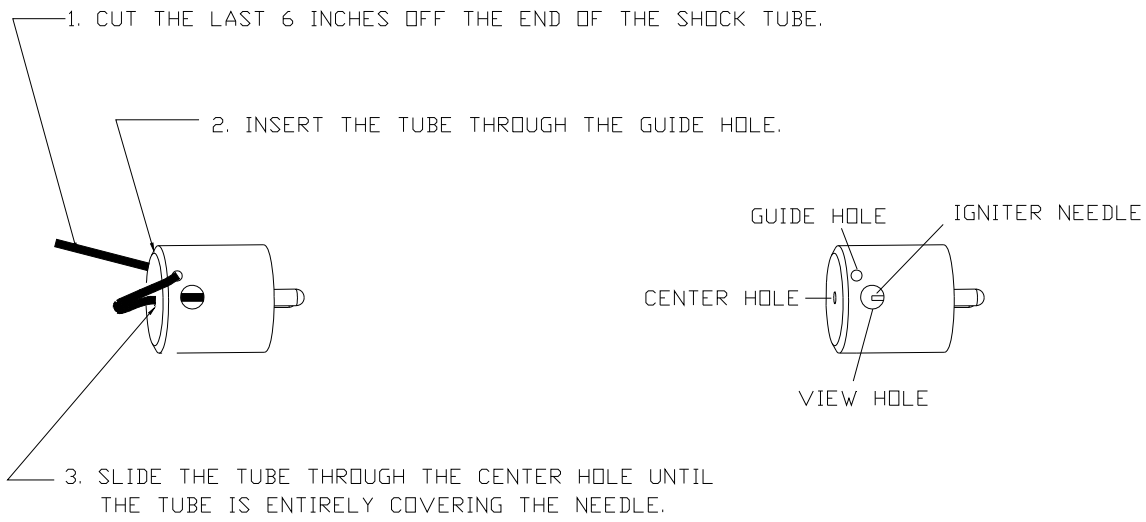


Figure 2-8 Shock Tube Tip

2.6.4. Figure 2-8 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 2-8. 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.

2.7. 3 POSITION BATTERY CHARGER

2.7.1. Figure 2-9 shows the 3 Position Charger that is used in some of the 1678 RFD Kits. The 3 Position Charger provides a basic 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 unit is sealed at the manufacturer or repair depot and should not be opened during field activity. The 3 Position Charger comes with an AC adapter that can be configured for use internationally.

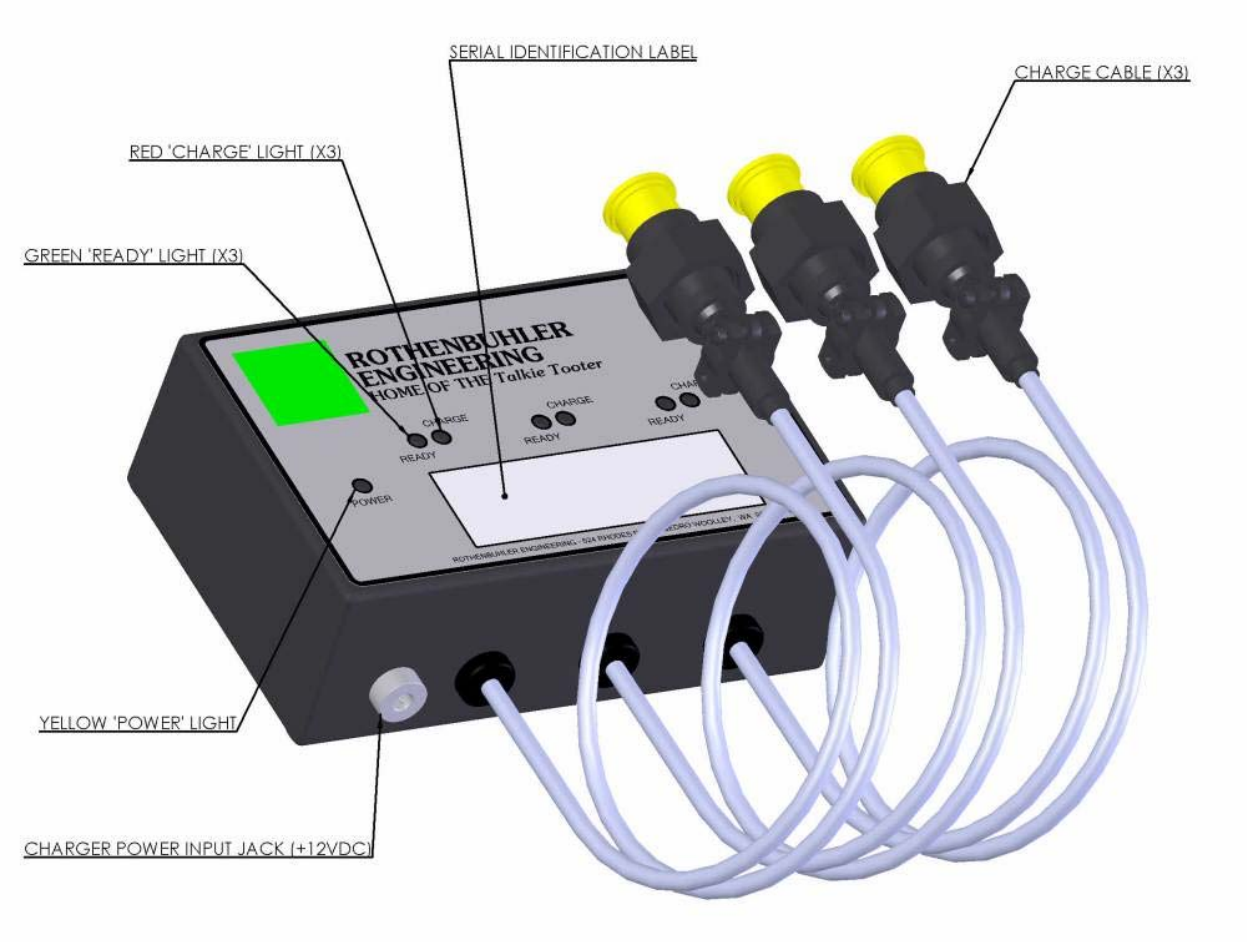


Figure 2-9 3 POSITION CHARGER

2.8. TEST BOX

2.8.1. Figure 2-10 provides a drawing of the Test Box. The Test Box is used to display information from and to evaluate the performance of the Mini Controller and Electric Remote Units and RSTIs. The Test Box can also be used to change settings and parameters of the units with certain restrictions.

2.8.2. **Serial Communications Port:** The Test Box can be connected to a serial RS-232 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.

Figure 2-10 Test Box

2.8.3. **Test Probe:** The Test Probe connects to the antenna/charge connector on the top of the 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.

2.8.4. **LCD Display:** The LCD displays information both from the Test Box itself during its power on sequence, and while reading and testing a 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.

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

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

2.9. ANTENNA ASSEMBLY

2.9.1. Figure 2-11 provides the physical size, technical requirements and view of the Antenna Assembly. The power to the Mini Controller Unit and Remote Unit is interrupted when the Antenna Assembly is not connected.

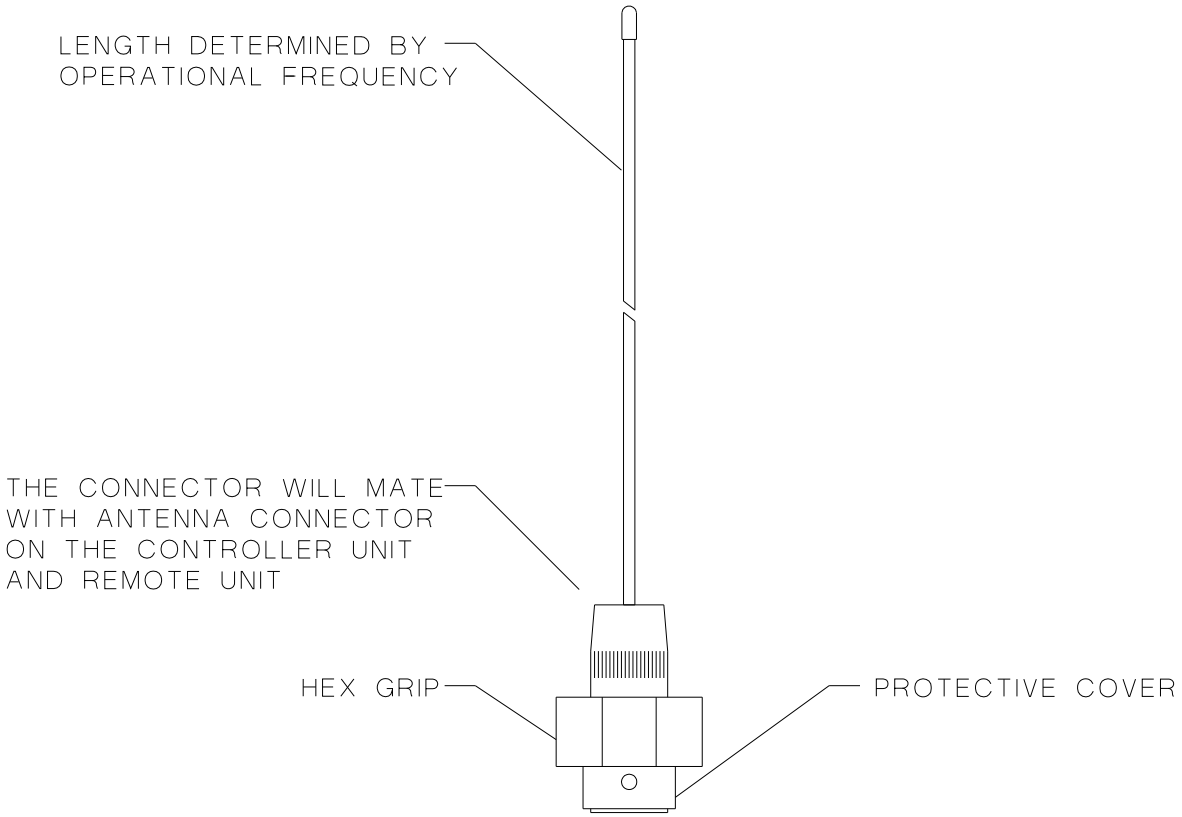


Figure 2-11 Antenna Assembly

2.10. CARRYING CASE

2.10.1. Figure 2-12 Carrying Case shows the full system Carrying Case and Figure 2-13 Carrying Case (Half Case)shows the Carrying Case (Half-Case). Shown are the physical sizes of the Carrying Cases and a view of the storage location for System assemblies in the Carrying Cases. The Carrying Cases have a pressure equalization vent near the handle. The vent operation is automatic.

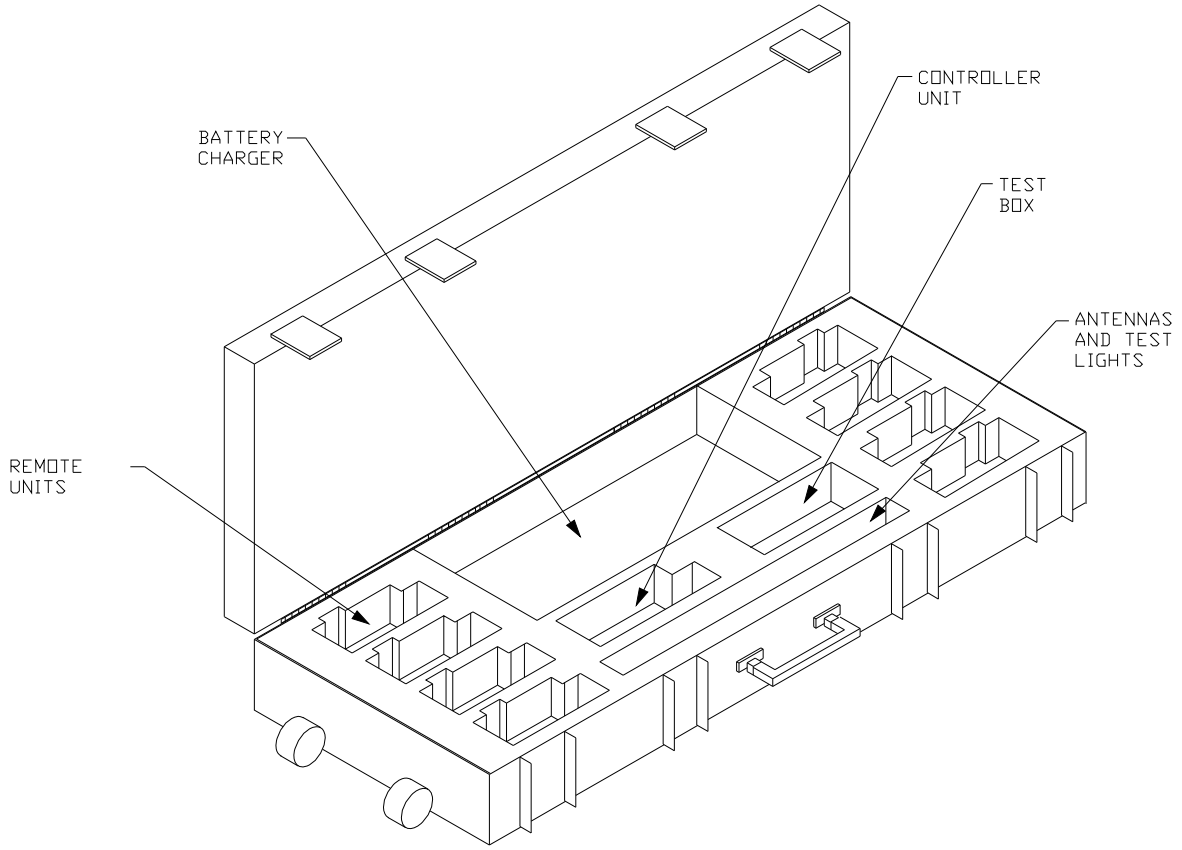


Figure 2-12 Carrying Case

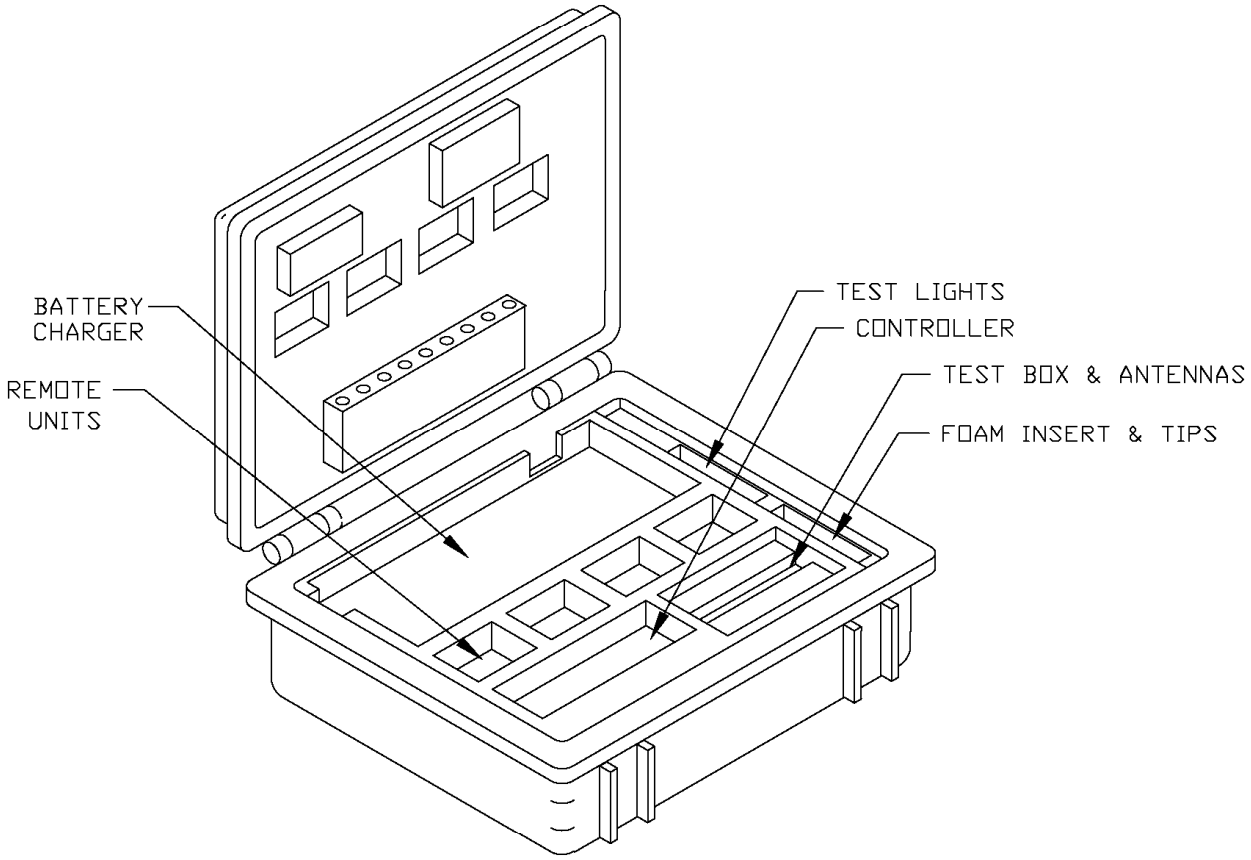


Figure 2-13 Carrying Case (Half Case)

2.11. VENT OPERATION

2.11.1. In Figure 2-14, 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.

CAUTION Unequal air pressure inside the Mini Controller Unit 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.

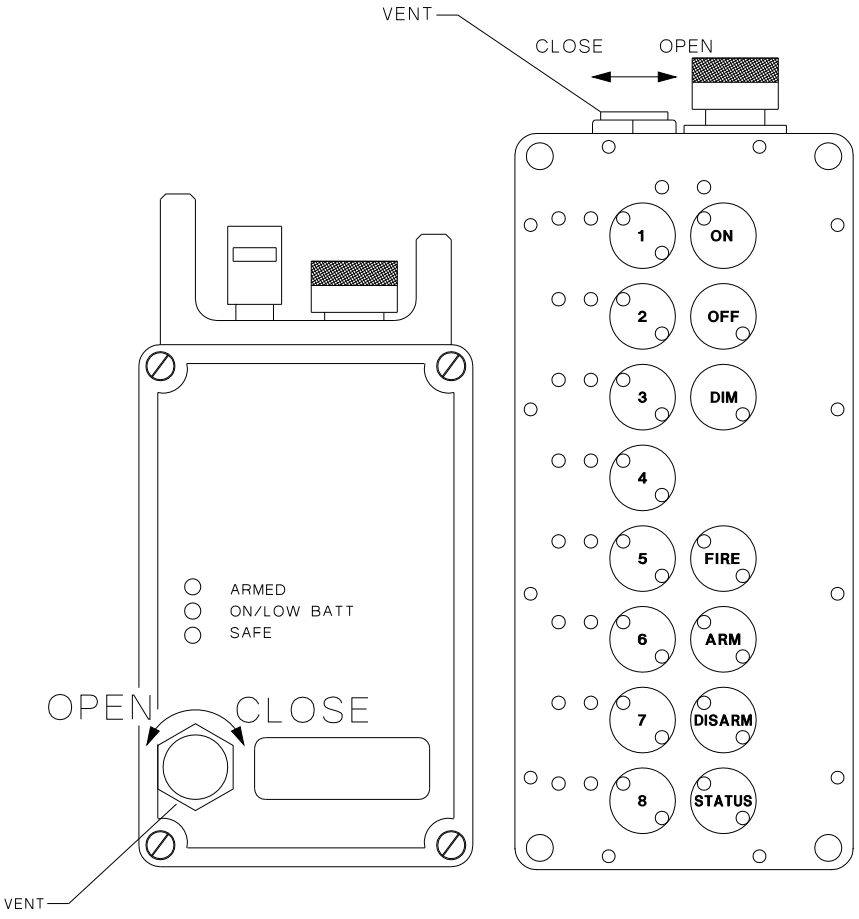


Figure 2-14 Vent Operation

2.12. ANTENNA / BATTERY CHARGER CONNECTOR

2.12.1. Figure 2-15 shows the connections when using the 3-Position Charger.

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

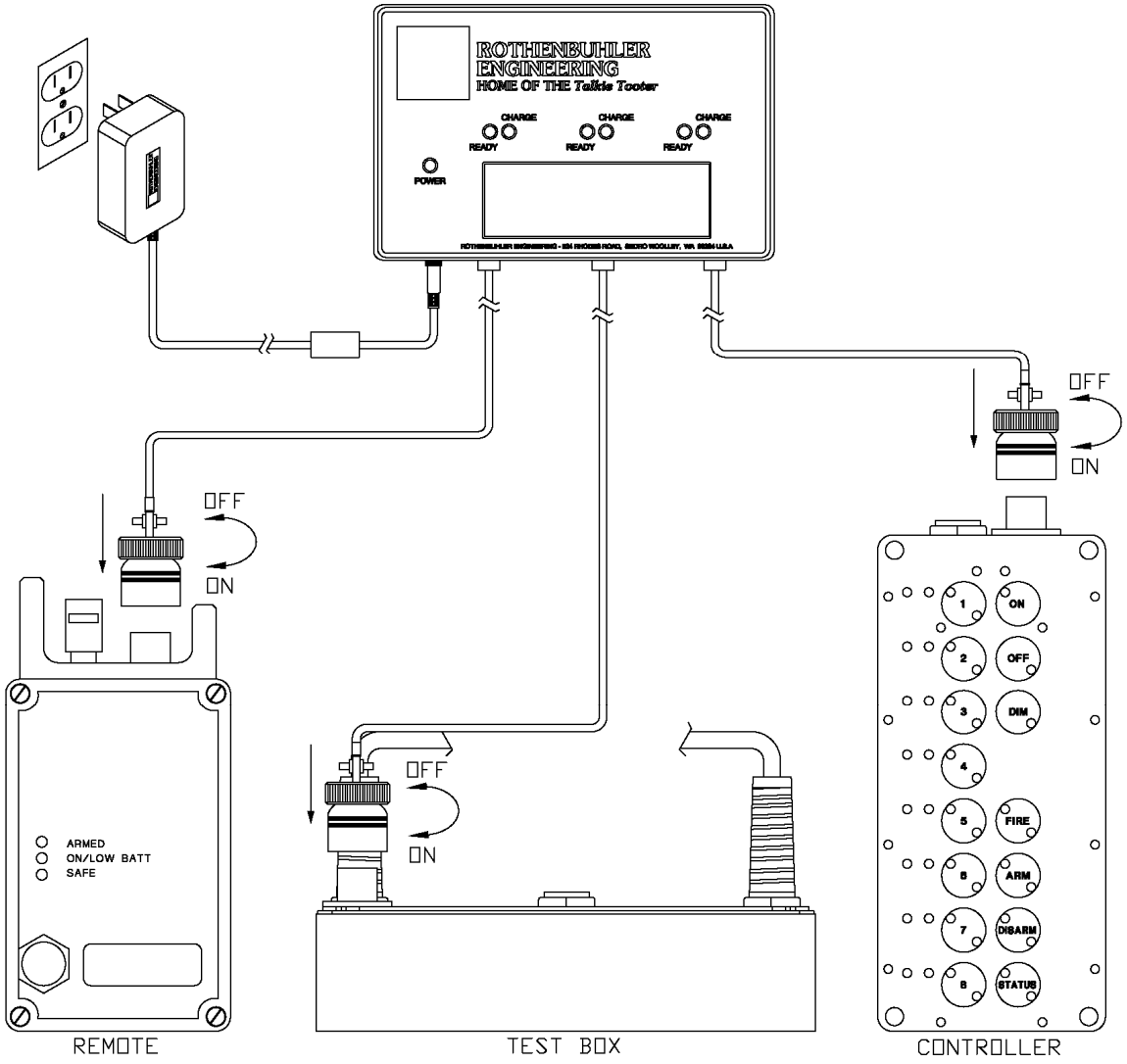


Figure 2-15 3-Position Charger Connection

2.13. CONNECTOR DUST COVER OPERATION

2.13.1. In Figure 2-16, the Mini Controller Unit and Remote Unit have an antenna / battery charger connector dust cover that protects the connector pins from shorting out and damage when the Antenna Assembly or Battery Charger Assembly is not connected. The connector dust cover should be connected to the connector when the connector is not in use.

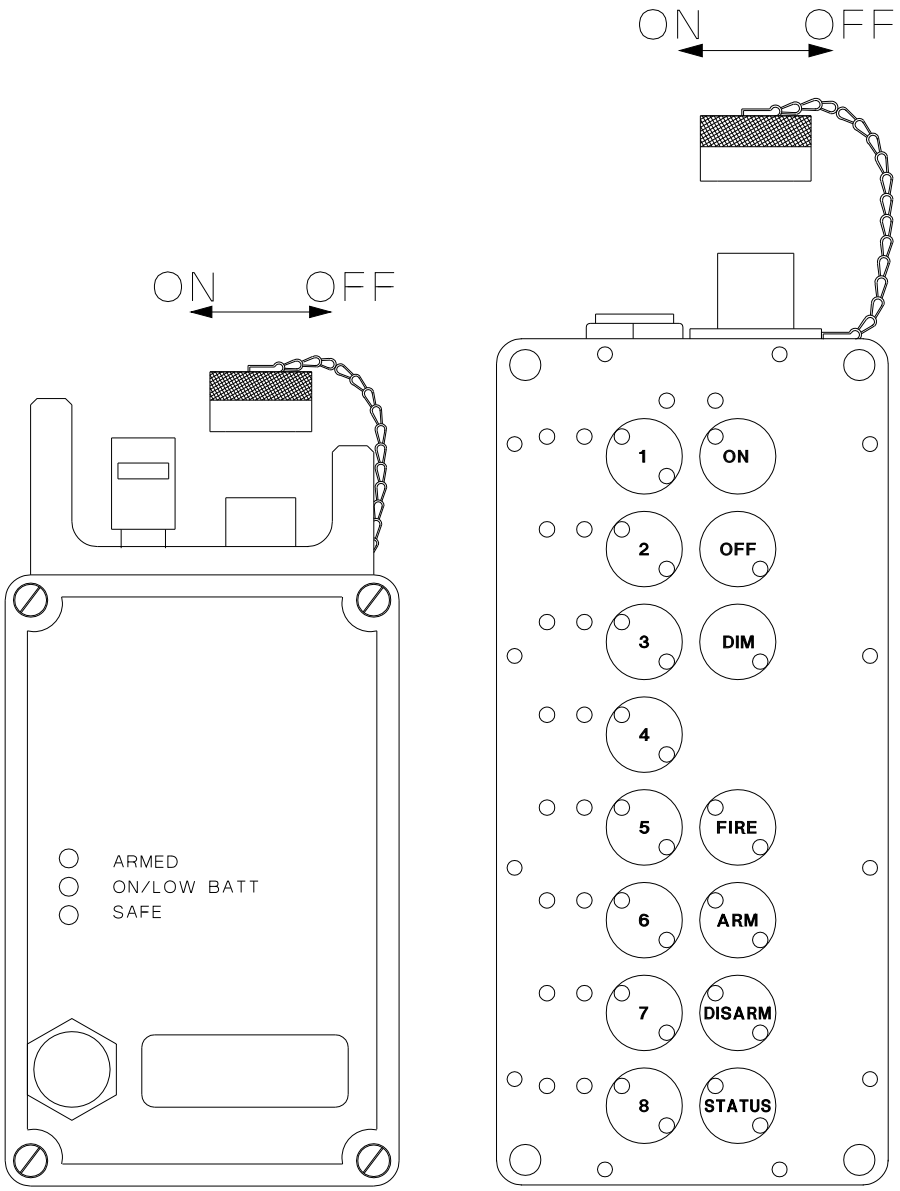


Figure 2-16 Connector Dust Cover Operation

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)
MINI CONTROLLER UNIT & TEST BOX		ELECTRIC REMOTE & RSTI	
FREQUENCY STABILITY	±2.5PPM OR (0.000025%)	FREQUENCY STABILITY	±2.5PPM OR (0.000025%)
MODULATION	11K2F3D (AFSK)	MODULATION	11K2F3D (AFSK)
TRANSMIT POWER	2-5 Watts (Mini Controller) 1 Watt (Test Box)	TRANSMIT POWER	2 Watts (Electric Remote) 2-5 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		Electric Remote Unit and RSTI	
SIZE (w/out antenna) (in)	8H x 3W x 2.5D	SIZE (w/out antenna)(in)	6H x 3W x 2.5D
SIZE (w/out antenna) (cm)	20.32H x 7.62W x 6.35D	SIZE (w/out antenna)(cm)	15.24H x 7.62W x 6.35D
WEIGHT (w/battery)	2.5 lbs., 1.14 kg	WEIGHT (w/battery)	2 lbs., 0.91 kg
CASE	Die cast aluminum	CASE	Die cast aluminum
COLOR	Black	COLOR	Black

3.3. BATTERY

Mini Controller Unit		Electric Remote Unit and RSTI	
BATTERY PACK	Rechargeable NiMH	BATTERY PACK	Rechargeable NiMH
BATTERY LIFE	6 Hours	BATTERY LIFE	Adjustable between 100-300 Hours Typical User Setting is 200 hours*
BATTERY RECHARGE	240 Min	BATTERY RECHARGE	240 Minutes
STANDBY CURRENT	110 milliamps	STANDBY CURRENT	80 milliamps
TRANSMIT CURRENT	2.5 Amp	TRANSMIT CURRENT	1-2.5 Amp

(*) At the end of the 200 hours, the Electric Remote Unit can detonate 13 (2-Ohm) blasting caps connected in series and attached to 100 feet (30 meters) of 18AWG firing cable.

3.4. TIMING

Mini Controller Unit ARM time:	1/2 ± 0.1 Seconds
Electric Remote Unit ARM time:	7 ± 0.5 Seconds
RSTI Unit ARM time:	4 ± 0.5 Seconds
Mini Controller Unit Arm Time Period:	1 – 60 Minutes (20 Minute Default) **
Remote Unit Arm Tim Period:	1 – 60 Minutes (20 Minute Default) **
Mini Controller Unit DISARM time:	3 ± 0.1 Seconds
Remote Unit DISARM time:	3 ± 0.1 Seconds
Mini Controller Unit FIRE time:	1 ± 0.1 Seconds
Remote Unit FIRE time:*	20 Milliseconds

*This is the delay after the Remote Unit receives the command signal from the Mini Controller Unit to Fire.

**The system's Arm Time Period is factory set. Consult Rothenbuhler Engineering for details.

3.5. DETONATE OUTPUT

The Remote Unit detonation output pulse is from a 2200 microfarad capacitor charged to 50 volts.

Stored Energy Level:	2.8 Joule (typical), 1.8 Joule (minimum)
Pulse Voltage Level:	50 VDC (typical), 45 VDC (minimum)
Maximum Firing Resistance:*	28Ω

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

The Remote Shock Tube Initiator (RSTI)'s output pulse is from a 0.15 microfarad capacitor charged to 2,500 volts.

Stored Energy Level:	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 Mini Controller Unit and Remote Unit is marked with an identification label. Figure 3-1 shows how the Mini Controller Unit identification label should be interpreted. Figure 3-2 shows the Remote Unit identification label. The Mini Controller Unit will only communicate with Remote Units from the same system.

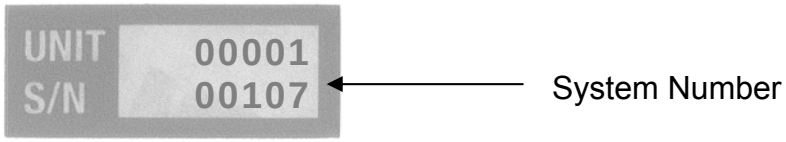


Figure 3-1 Mini Controller Unit Identification Label

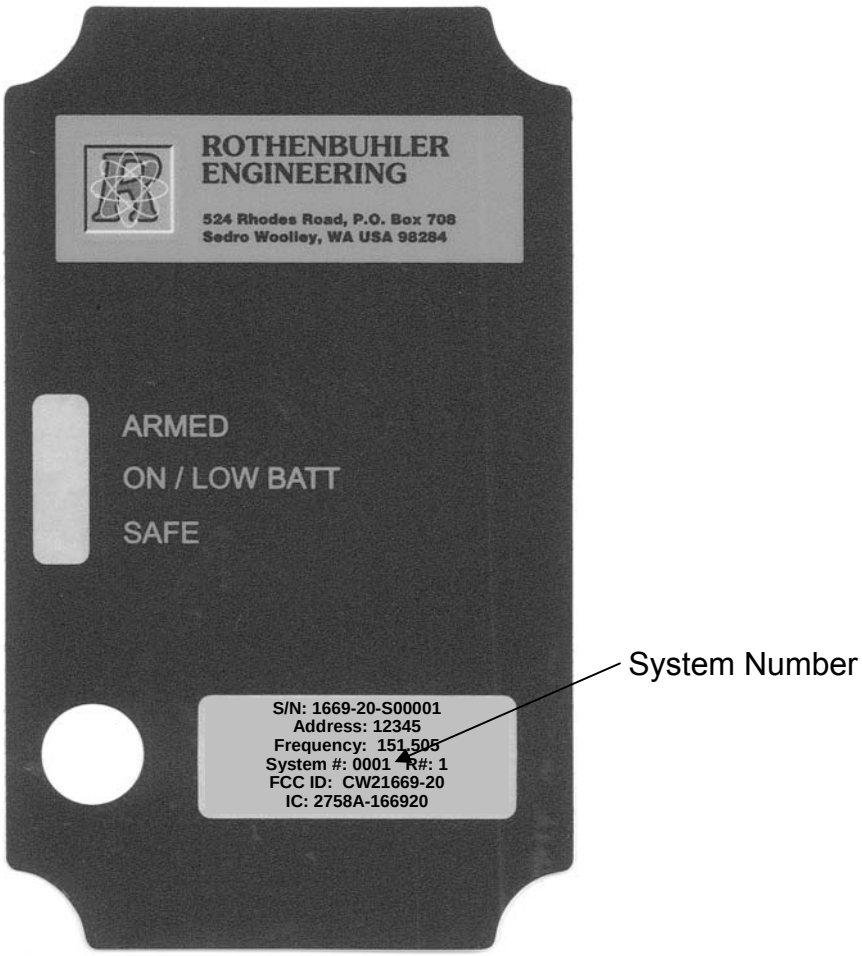


Figure 3-2 Remote Unit Front Identification Label

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 Mini Controller Unit 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 WITH THE 3-POSITION CHARGER

4.2.1. The battery packs in the Mini Controller Unit, Remote Unit and Test Box 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 to ensure reliable performance.

4.2.3. The battery pack in the Mini Controller Unit, Remote Units and Test Box should be charged before the system is used each time. The 3-Position Charger will charge the Mini Controller Unit, Remote Units and the Test Box in 240 minutes typically. 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.

4.2.4. 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.

4.2.5. 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.

4.2.6. 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.

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

4.2.8. Connect each unit to be charged to the 3-Position Charger. The charger does not discriminate between Mini Controller units, Remote units and Test Boxes; any unit may be connected to any of the 3 charge connectors.

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

4.2.10. 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.

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

4.2.12. 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.

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

4.2.14. 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.

4.2.15. 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.

4.2.16. Close the vent on each Remote Unit and the Mini Controller Unit

4.3. BENCH TESTING THE SYSTEM

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

4.3.1. 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.

4.3.2. 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.

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

4.3.4. 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 4.1.6.

4.3.5. Turn the Mini Controller Unit on by pressing the “ON” switch for 1 second. A yellow light located in the upper left quadrant of the “ON” switch will turn on steady. If the yellow light does not turn on steady, but flashes, this indicates a low battery for the Mini Controller Unit. Recharge the battery in accordance with section 4.1.6.

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

4.3.7. When the TX light stops flashing, the green DISARMED light will come on steady adjacent to the switches numbered “1” through “4”. A steady DISARMED light indicates that Remote Unit answered back with its status and it is disarmed. A flashing DISARMED light indicates the Mini Controller Unit 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.

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

4.3.9. Press the “ARM” switch for ½ second. The red ARMED light for each selected Remote Unit will flash on the Mini Controller Unit 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.

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

4.3.11. Re-Arm the Remote Units. Before the Arm Time Period expires, press the “DISARM” switch on the Mini Controller Unit. The Mini Controller Unit's ARMED light will be turned off. The DISARMED lights at the Mini Controller Unit 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.

4.3.12. If firing RSTI Units, proceed to 4.3.13. Connect a test bulb assembly to the binding posts of each Electric Remote Unit. Arm the Electric Remote Units. Press the “FIRE” switch on the Mini Controller Unit. The test bulb 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 Mini Controller Unit will change from ARMED to DISARMED. Proceed to 4.3.14.

4.3.13. 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 Mini Controller Unit. 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 Mini Controller Unit will change from ARMED to DISARMED.

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

Note: Refer to Section 2.6 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.

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

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

5. OPERATIONAL PROCEDURES

WARNING ***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. 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 Mini 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 Mini Controller Unit 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 Mini Controller Unit. Install the Antenna Assembly on to the antenna / battery charger connector. This will enable the keypad on the Mini Controller Unit.

WARNING Do not use the Mini Controller Unit within 100 feet (30 meters) of explosives, blasting caps, or wires leading to them. The Mini Controller signal is 5 watts, which can cause detonation of caps if within 100 feet. The 5 watt Mini 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 Mini Controller Unit on by pressing the "ON" switch for 1 second. A yellow light located in the upper left quadrant of the "ON" switch will turn on steady. If the yellow light does not turn on steady, but flashes, this indicates a low battery for the Mini Controller Unit. Recharge the battery in accordance with section 4.1.6.

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

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

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

5.1.8. Turn the Mini Controller Unit "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 **Error! Reference source not found.** 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 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 2.6. 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 **Error! Reference source not found.** of the Mini Controller Unit, refer to section 5.2.11.

5.2.10. If all Remote Units are located more **Error! Reference source not found.** than from the Mini Controller Unit, refer to section 5.3.11.

5.2.11. If some Remote Units are located within **Error! Reference source not found.** of the Mini Controller Unit, and other Remote Units are more than **Error! Reference source not found.** from the Mini Controller Unit, refer to section 5.4.11.

5.3. SYSTEM OPERATION – REMOTE UNITS WITHIN **ERROR! REFERENCE SOURCE NOT FOUND.** OF MINI CONTROLLER UNIT

Note: If the distance between the Mini Controller Unit and the Remote Units is in excess of **Error! Reference source not found.**, the Remote Units status transmissions may not be received by the Mini Controller Unit. The Mini Controller Unit will command the Remotes from a distance greater than **Error! Reference source not found.**, but the Remote Status may not be confirmed. The Mini Controller Unit performs just as it would when it is within **Error! Reference source not found.** of the Remote Units. The only difference is the method the status indications are displayed on the Mini Controller Unit display panel. The ARMED and DISARMED status lights for out of range Remote Units will flash on the Mini Controller Unit display panel to indicate the Mini Controller Unit 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 Mini Controller Unit on.

5.3.3. Press the “STATUS” switch. The Mini Controller Unit will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green DISARMED light on the Mini Controller Unit display panel will come on steady for the Remote Units that the Mini Controller Unit 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”. 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 DISARMED light for each selected Remote Unit will come on steady on the Mini Controller Unit display panel.

Note: When firing the RSTI with no tip or with a faulty tip, the green DISARMED light for that unit may not initially turn on following a FIRE operation. A subsequent press of the “STATUS” switch illuminates the green DISARMED 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 return to the DISARMED mode 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 DISARMED light for that Remote Unit on the Mini Controller Unit 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 DISARMED light for that Remote Unit on the Mini Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Mini Controller Unit closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.3.9. Turn off the Mini Controller Unit.

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 **ERROR! REFERENCE SOURCE NOT FOUND.** FROM MINI CONTROLLER UNIT

Note: If the distance between the Mini Controller Unit and the Remote Units is in excess of **Error! Reference source not found.**, the Remote Units status transmissions may not be received by the Mini Controller Unit. The Mini Controller Unit will command the Remotes from a distance greater than **Error! Reference source not found.**, but the Remote status may not be confirmed. The Mini Controller Unit performs just as it would when it is within **Error! Reference source not found.** of the Remote Units. The only difference is the method the status indications are displayed on the Mini Controller Unit display panel. The ARMED and DISARMED status lights for out of range Remote Units will flash on the Mini Controller Unit display panel to indicate the Mini Controller Unit 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 Mini Controller Unit on.

5.4.3. Press the “STATUS” switch. The Mini Controller Unit will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green DISARMED light on the Mini Controller Unit display panel will flash for all Remote Units that the Mini Controller Unit 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”. 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 DISARMED 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 return to the DISARMED mode 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 DISARMED light for that Remote Unit on the Mini Controller Unit 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 DISARMED light for that Remote Unit on the Mini Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Mini Controller Unit closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.4.9. Turn off the Mini Controller Unit.

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 **ERROR! REFERENCE SOURCE NOT FOUND.** AND LESS THAN **ERROR! REFERENCE SOURCE NOT FOUND.** FROM MINI CONTROLLER UNIT

Note: If the distance between the Mini Controller Unit and the Remote Units is in excess of **Error! Reference source not found.**, the Remote Units status transmissions may not be received by the Mini Controller Unit. The Mini Controller Unit will command the Remotes from a distance greater than **Error! Reference source not found.**, but the Remote status may not be confirmed. The Mini Controller Unit performs just as it would when it is within **Error! Reference source not found.** of the Remote Units. The only difference is the method the status indications are displayed on the Mini Controller Unit display panel. The ARMED and DISARMED status lights for out of range Remote Units will flash on the Mini Controller Unit display panel to indicate the Mini Controller Unit 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 to **Error! Reference source not found.**) and one-way mode (unconfirmed communications – range greater than **Error! Reference source not found.**).

5.5.2. If the Remotes are within **Error! Reference source not found.** of the Mini Controller Unit, the status of the Remote Units (ON/LOW BATT, ARMED, and SAFE) will be displayed with steady lights on the display panel of the Mini Controller Unit.

5.5.3. If one or more Remote Units are out of range of the Mini Controller Unit, the status of these Remote Units will be assumed and their status lights will flash on the Mini Controller Unit 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 Mini Controller Unit on.

5.5.6. Press the “STATUS” switch. The Mini Controller Unit will request status from all Remote Units. The red TX light will flash for approximately 5 seconds. The green DISARMED light on the Mini Controller Unit display panel will flash for all the Remote Units that the Mini Controller Unit 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”. 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 Mini Controller Unit 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 DISARMED light for each selected Remote Unit will flash on the Mini Controller Unit 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 return to the DISARMED mode 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 DISARMED light for that Remote Unit on the Mini Controller Unit 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 DISARMED light for that Remote Unit on the Mini Controller Unit display panel. Under no conditions should the “FIRE” switch be pressed as the Remote Unit is approached. DO NOT bring the Mini Controller Unit closer than 100 feet (30 meters) to blasting caps, wires connected to blasting caps, or other explosives.

5.5.12. Turn off the Mini Controller Unit.

5.5.13. Recover the fielded Remote Units.

5.5.14. Refer to Post Operational Procedures in chapter 5.5.14.

6. POST OPERATIONAL PROCEDURES

6.1. SECURING THE SYSTEM

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

6.1.2. Replace the dust cover on the antenna / battery charger connector on the Mini Controller Unit 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 Mini Controller Unit 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. MINI CONTROLLER UNIT

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) Mini Controller Unit battery needs to be recharged.

7.2.2. Command receipt is not confirmed by Remote Unit.

a) Remote Unit is more than **Error! Reference source not found.** from Mini Controller Unit.

b) If the Remote Unit is less than **Error! Reference source not found.** away from the Mini Controller Unit.

Check for damage to Mini Controller Unit Antenna Assembly.

Try a different Antenna Assembly on the Mini Controller Unit.

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 Mini Controller Unit 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	**Error! Reference source not found.**
Dense Vegetation without Power Lines	**Error! Reference source not found.**
Open Land or Water without Power Lines	Greater than 5 Miles

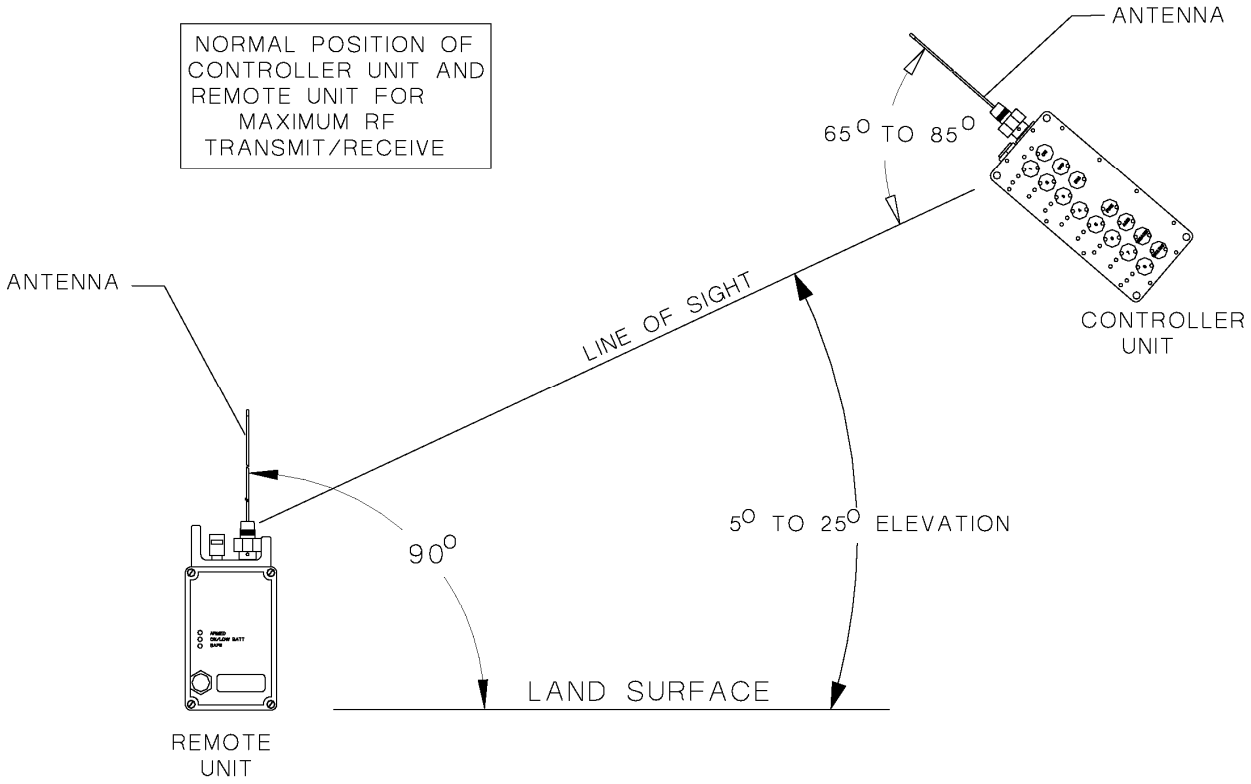


Figure 8-1 Unit Normal Transmission Location

8.1.2. If the Mini Controller Unit 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 Mini Controller Unit 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 Mini Controller Unit antenna and the Remote Unit antenna have the same radiant energy pattern as shown in Figure 8-4.

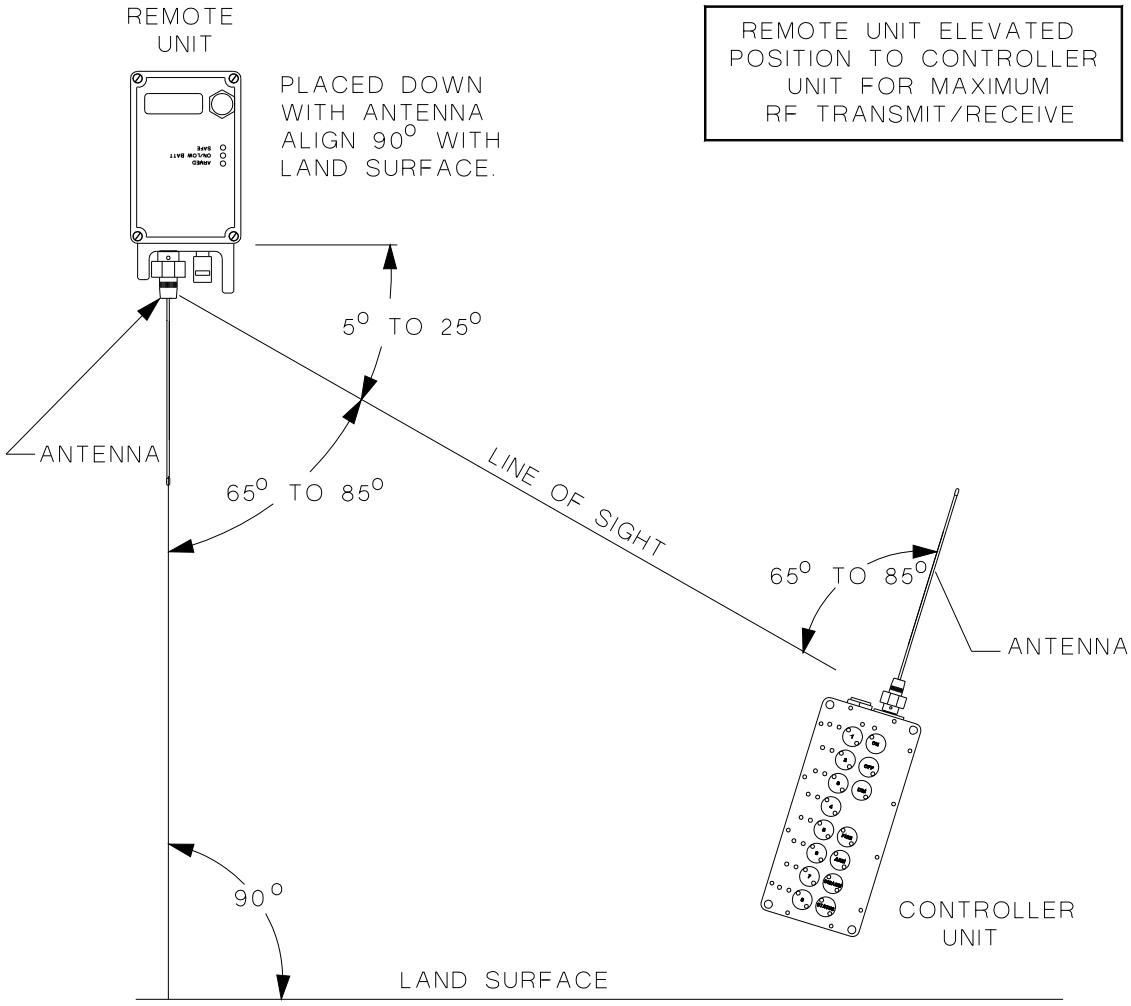


Figure 8-2 Remote Unit Elevated

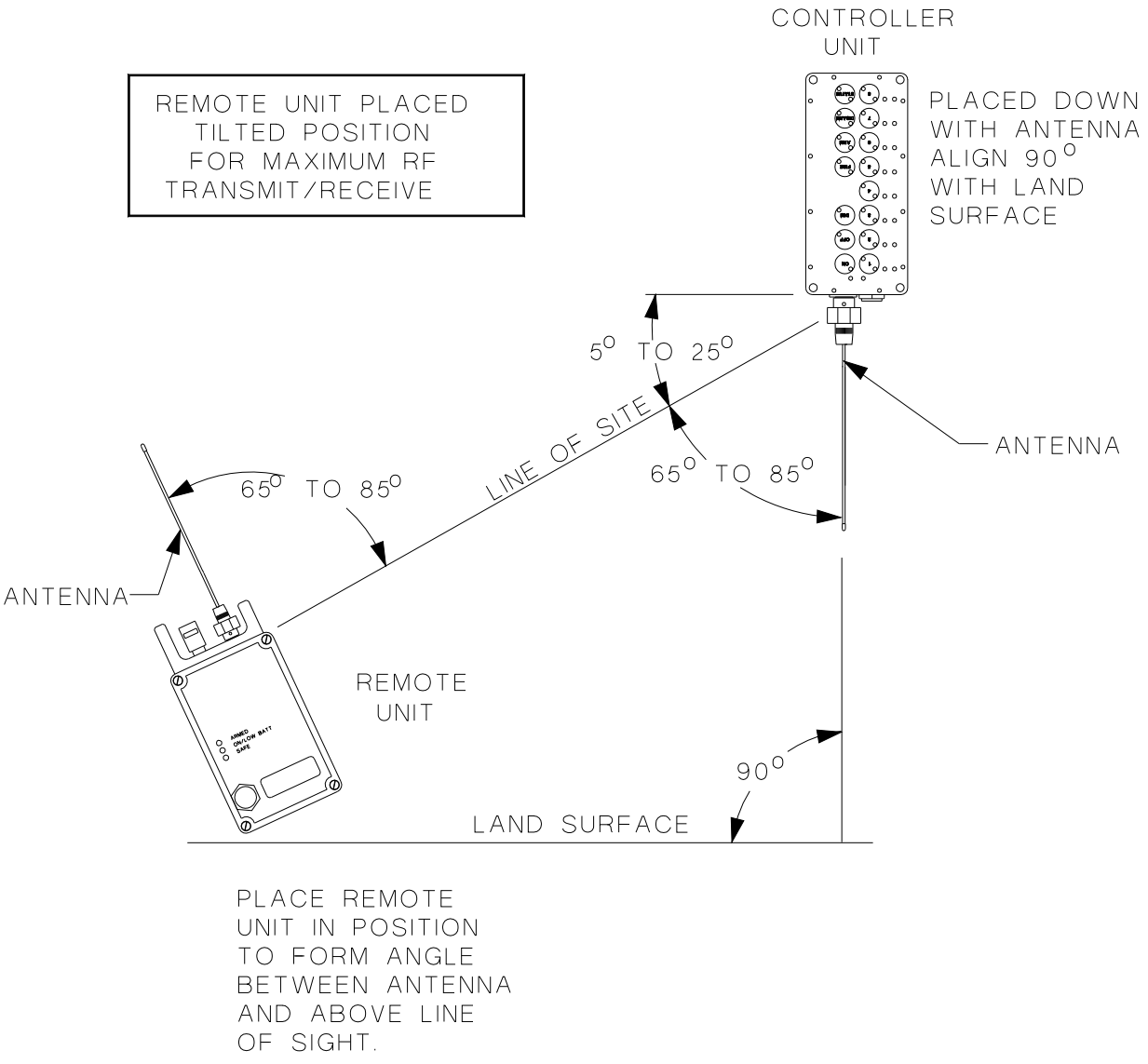


Figure 8-3 Mini Controller Unit Elevated

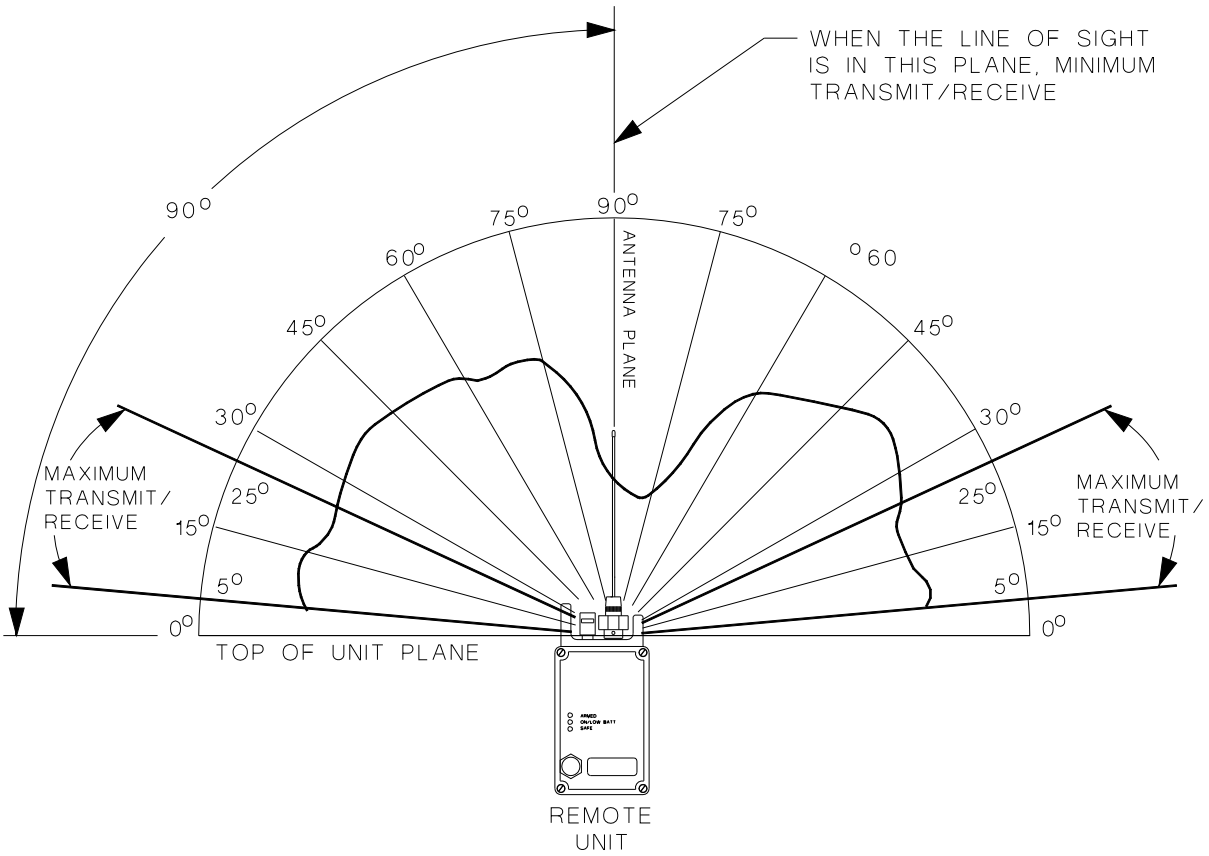


Figure 8-4 Antenna Radiation Pattern

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.

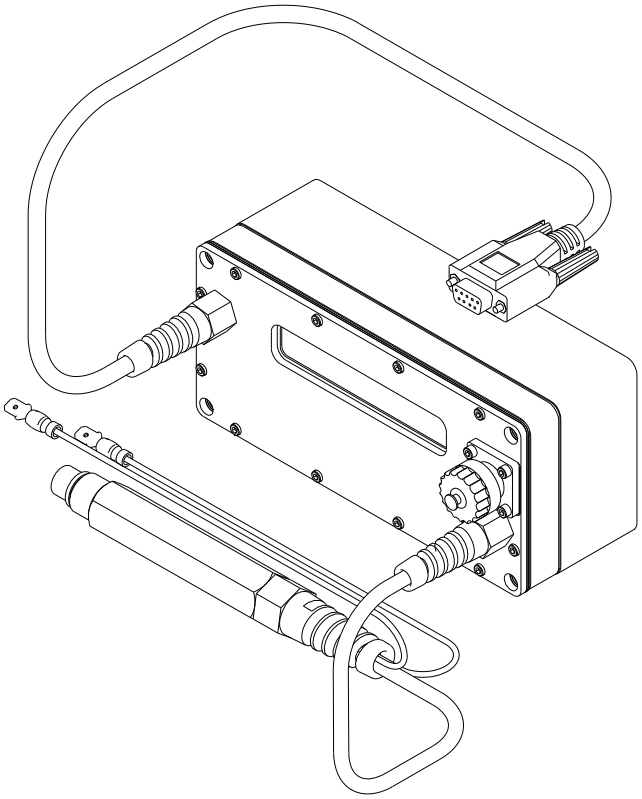


Figure 9-1 Test Box

9.1. TEST BOX DESCRIPTIONS

9.1.1. Power Supply/Connector:

The Test Box is powered from an external +12VDC wall adapter. The adapter can be configured for international use by choosing the correct power plug adapter. The default plug adapter for your country was supplied with your kit.

9.1.2. Probe:

The Test Box has a probe that plugs into the Remote or Mini Controller under test. The Test box communicates to the Unit under test through the probe and by using a radio transmitter that is internal to the Test Box.

9.1.3. Serial Connection:

A serial cable connects the Test Box to a computer serial port operating at 1200 baud. The serial cable must be connected to a computer when the Test Box is being used to program Mini Controller and Remote Units. The serial cable may also be used when the Test Box is in the test mode. While in the test mode, the Test Box transmits the information displayed on the Test Box screen out the serial cable. A terminal program such as Hyper Terminal may be set up to capture this information to a file. The file can then be saved and printed.

9.2. 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.

9.2.1. Test Box Messages

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

```
      1678 Test Box
    03/13/2011  Ver 3.0
```

The “1678 Test Box” part of the message identifies the system types that the Test Box is designed to operate with. “04/13/2011” 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
```

9.2.2. Testing the Mini Controller

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

```
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 Mini 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: 1400mAh 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 Mini Controller is assigned to and the Unit assigned to the Mini Controller (Default is Unit 1).

```
Address 0000000001
Unit 1
```

The next message displayed shows the assigned Frequency and the Message Number.

```
Frequency 174 MHz
Message Number 010000
```

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

```
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 Mini 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 following message is displayed.

```
    Testing Completed
```

9.2.3. 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 and the Message Number.

```
Frequency 174 MHz
Message Number 010000
```

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 1678-6
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 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, the following message is displayed.

```
     Testing Completed
```

9.2.4. 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 and the Message Number.

```
Frequency 174 MHz
Message Number 010000
```

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 4624
     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.

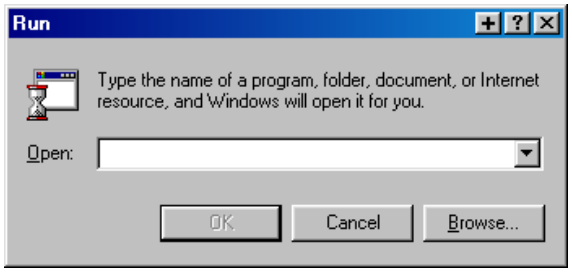
```
     Testing Completed
```

9.3. SAVING TEST BOX RESULTS TO A FILE USING HYPERTERMINAL

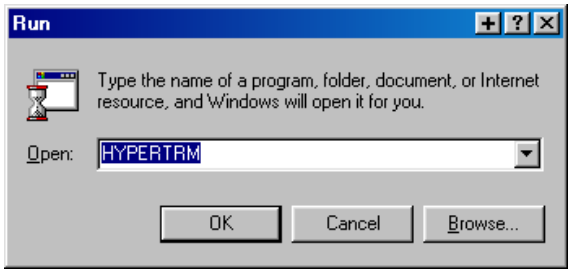
A situation might occur where the end users want to be able to record the Test Box results, but they may not be authorized to use the 'RFD Test Utility' program because of its capability of reprogramming. In that case the output of the Test Box serial cable can be captured to a terminal program such as HyperTerminal.

Click the Windows "Start" button, then click "Run…".

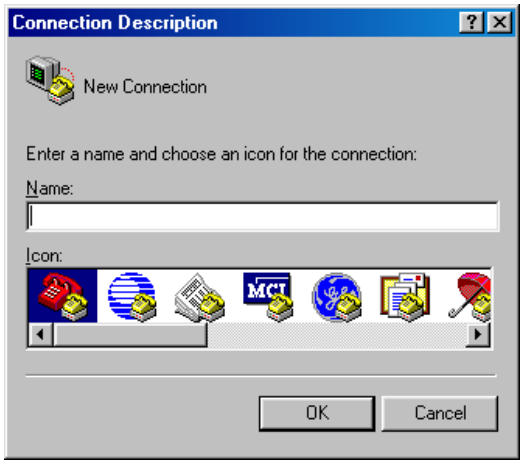
The dialog box shown below should appear.



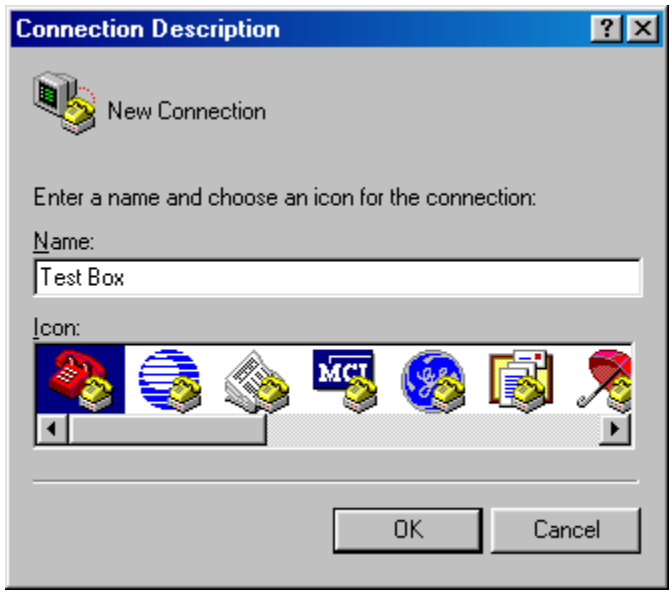
Type "HYPERTRM" in the open box (without the quote marks), and then click the "OK" button.



The dialog box shown below should appear.

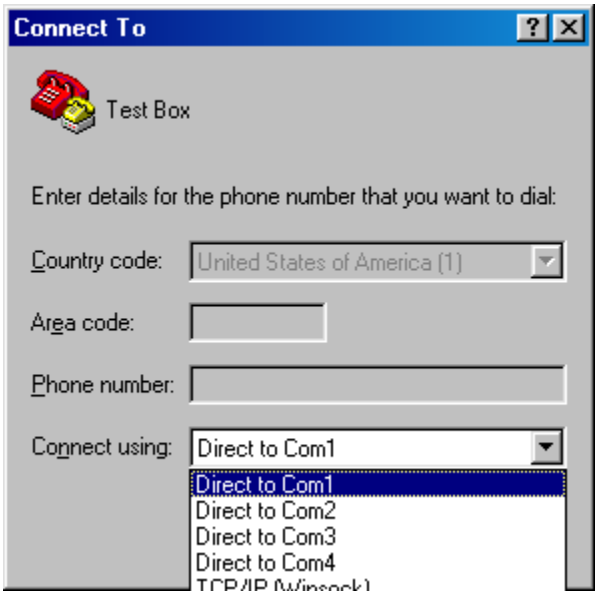


Enter a name and choose an icon for the connection. Click the “OK” button.

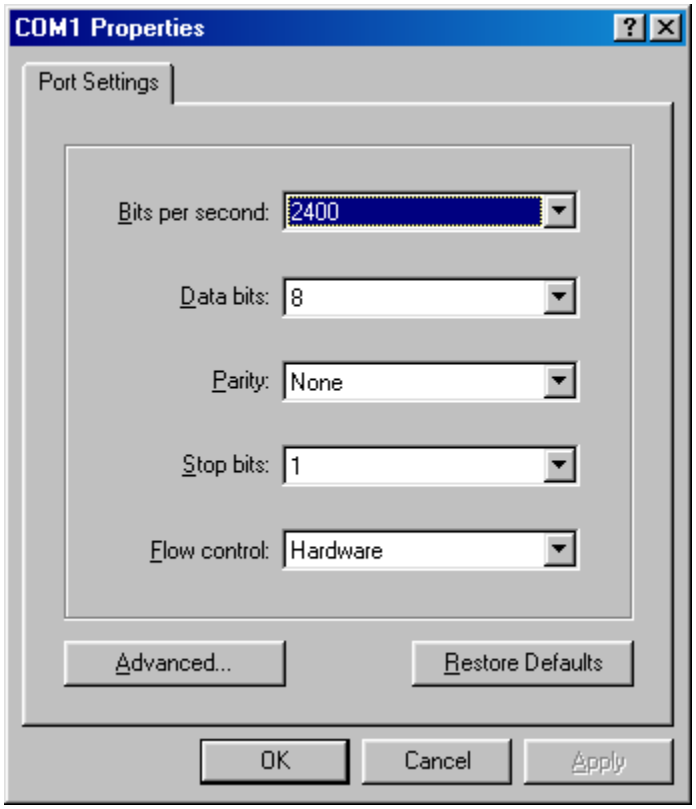


The dialog box shown below should appear.

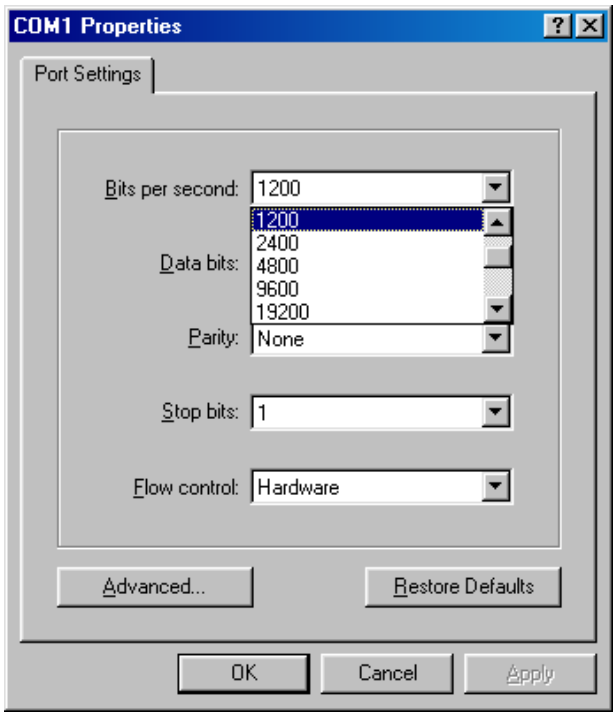
Click on the “Connect using:” list box and select either “Direct to Com1” or “Direct to Com2”. Select the one that corresponds with an unused serial port connector on the computer. Click the “OK” button.



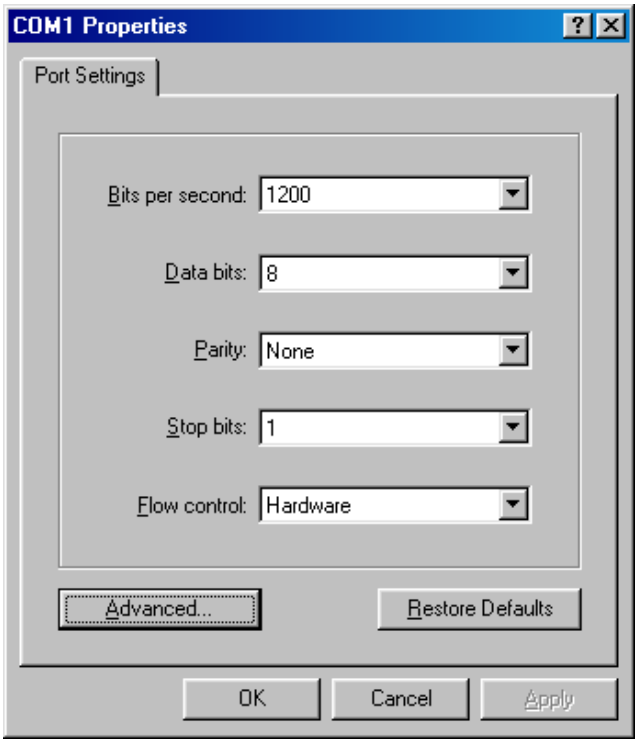
The dialog box shown below should appear.



Click on the “Bits per second:” list box and select 1200.

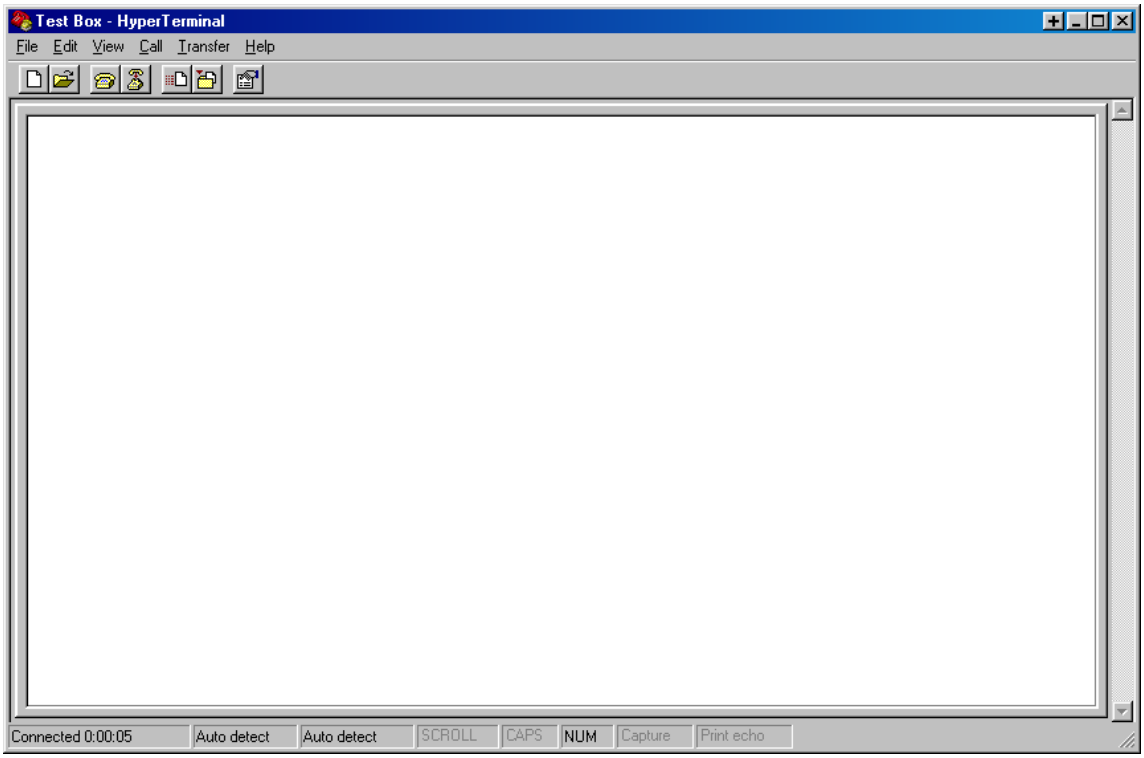


Leave the “Data bits:” set to ‘8’, “Parity:” set to ‘None’, “Stop bits:” set to ‘1’, and “Flow control:” set to ‘Hardware’ as shown in the following dialog box.

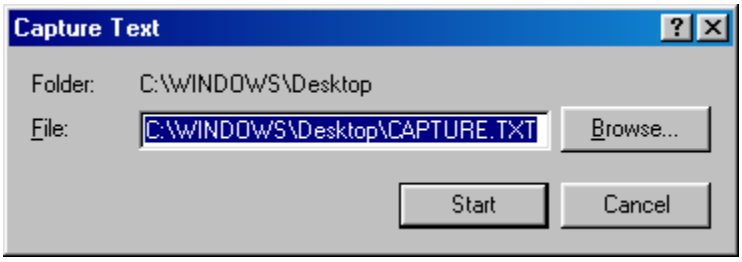


Click the “OK” button.

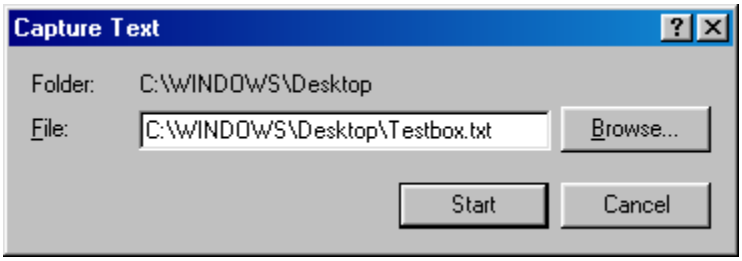
The dialog box shown below should appear.



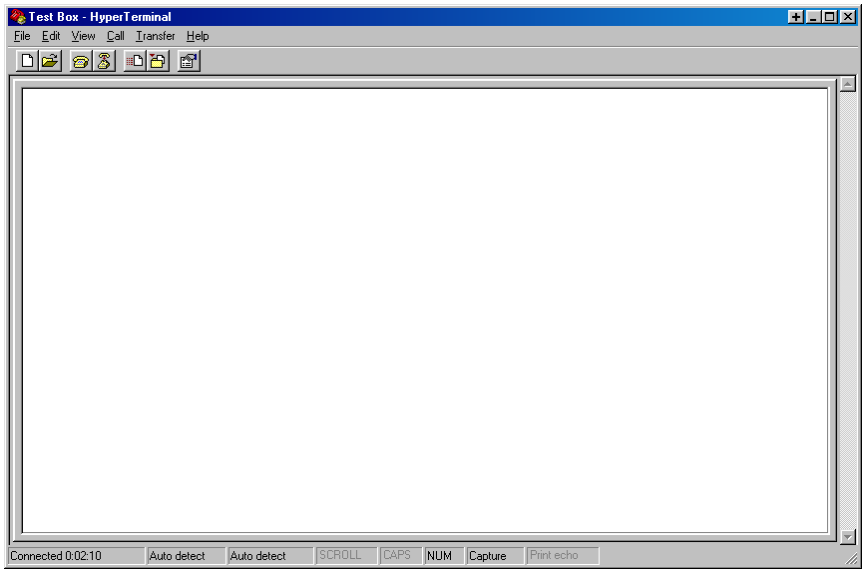
Click “Transfer” and then “Capture Text…”. The dialog box shown below should appear.



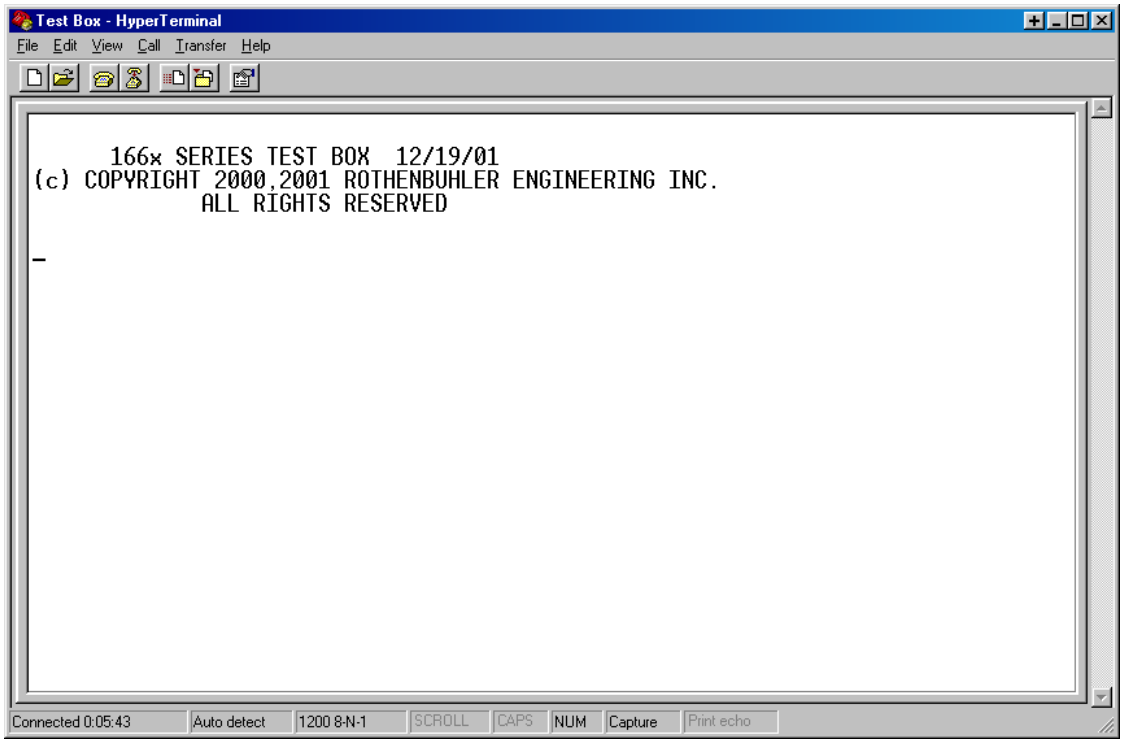
Enter a file name for the text output from the Test Box and click the “Start” button.



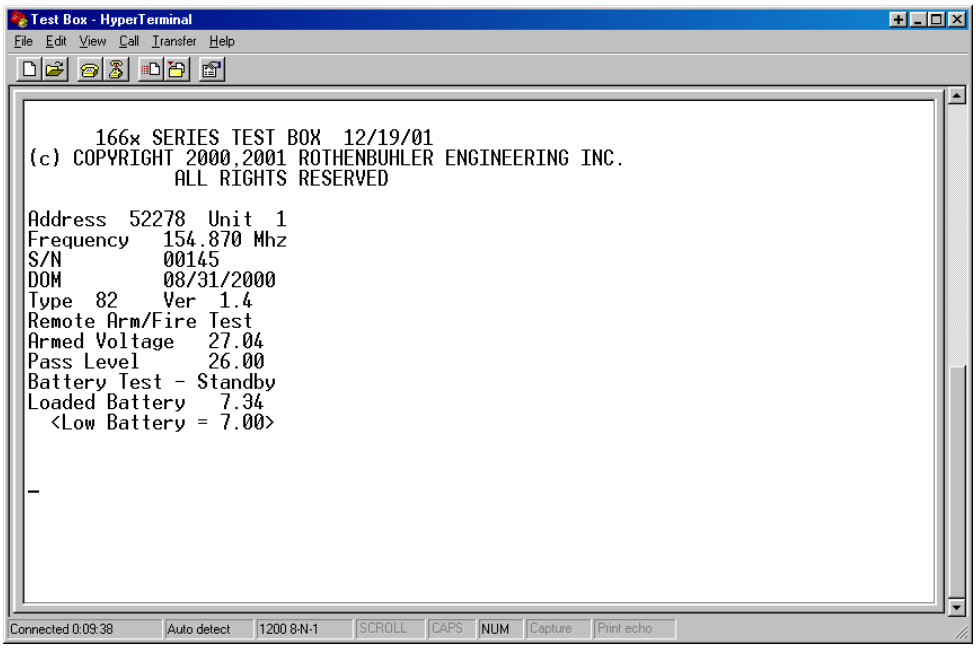
The dialog box shown below should appear.



Connect the Test Box serial cable to the serial port at the rear of the computer. This serial port must match up with the earlier selection of either “Direct to Com1” or “Direct to Com2”. Refer to documentation provided by computer manufacturer for more information on available serial ports. Turn the Test Box on by installing its antenna. The following text should appear in the window.



Proceed with testing the 1678 system.



The test results will be saved to a file. Select “File” and then “Print” to print the test results to the computer’s printer. Select “File” and then “Save” to save this configuration.

For future tests on the same computer, start HyperTerminal, Select “File” and then “Open”, select the configuration name. Select “Transfer” and then “Capture text…”. If the same capture file name is used, the new test results will be appended to the end of the previous test results.

Close the HyperTerminal window when the testing is completed.

If the above (or similar) text does not appear shortly after installing the Test Box antenna, check that the serial cable is connected from the Test Box to the computer correctly and that the selection under “Connect using:” matches the computer serial port number that the Test Box serial cable is connected to.

10. RFD PROGRAMMING GUIDE

10.1. PROGRAMMABLE PARAMETERS

10.1.1. Mini Controller Unit

- Operating frequency: Frequency is programmable, but if the new frequency is greater than 2MHz away from factory set frequency, the Mini Controller will have to be retuned at a factory authorized service center for optimum performance.

10.1.2. Remote Unit / RSTI

- Operating frequency: Frequency is programmable, but if the new frequency is greater than 2MHz away from factory set frequency, the Remote Unit or RSTI will have to be retuned at the factory for optimum performance.

- Unit ID: The Unit ID is a number from 1 to 4, and corresponds to the numbers on the Mini Controller Unit keypad.

- Address: This is the address for the system. Remotes can be moved from one system to another by matching up the system address and frequency.

10.2. REQUIRED EQUIPMENT

10.2.1. Test Box

10.2.2. A personal computer running Microsoft Windows® 95, 98, 2000, or XP and an available DB-9 RS-232 serial port.

10.2.3. The software utility ‘Setup RFD’ located on the CD at the back of this manual.

10.3. WINDOWS CONFIGURATION SOFTWARE OPERATION (SETUP RFD)

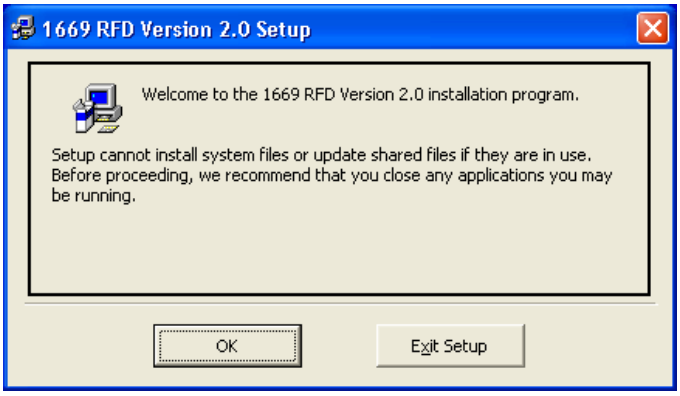
Setup RFD is a Windows program designed for depot personnel to determine system information, make permissible changes to the system, and create a log file of test results.

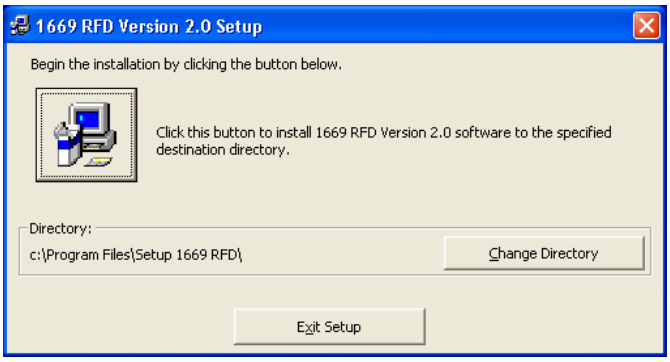
10.4. SETUP RFD INSTALLATION

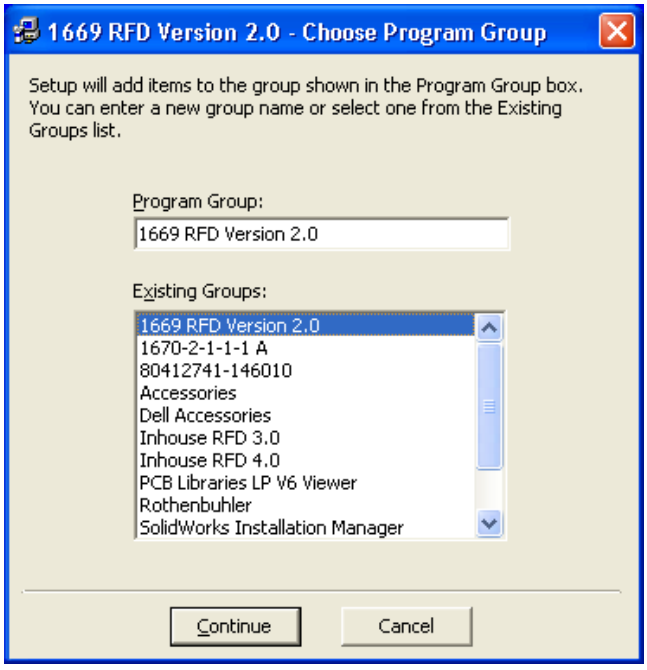
The Setup RFD install files are distributed on a CD. Follow the listed steps to install Setup RFD on a computer.

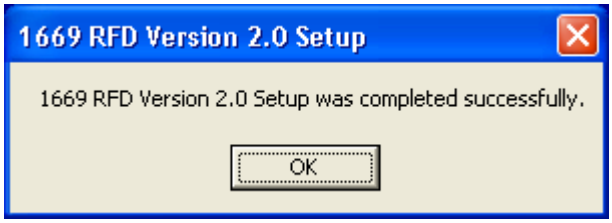
- Install the CD and browse to the file ‘Setup.exe’.

- Run the setup.exe file from the folder.
- Follow the prompts in the dialog boxes that appear. Typical dialog boxes are shown below.







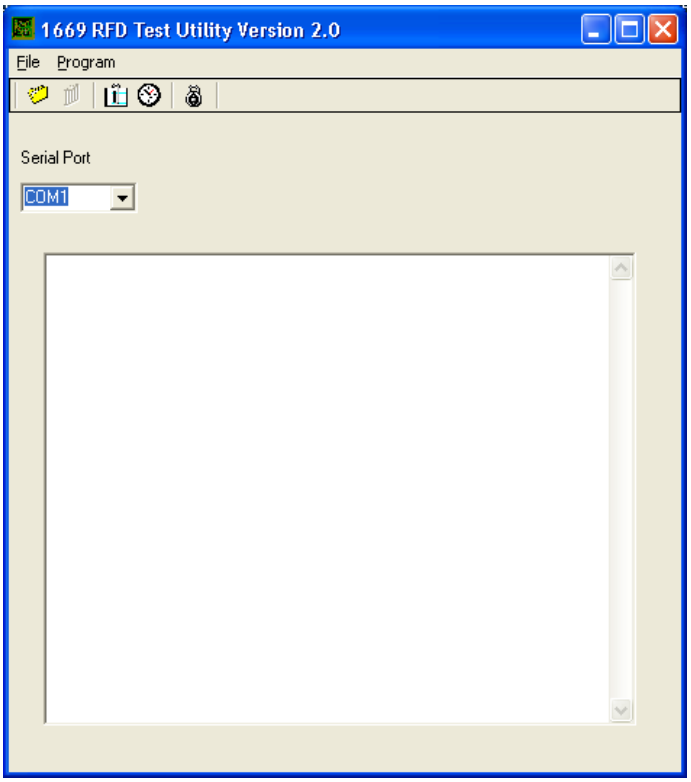


Setup 1669 RFD is now installed on the computer.

10.5. CONFIGURING SETUP RFD

Follow the listed instructions to configure Setup RFD.

- Click on the Windows “Start” button.



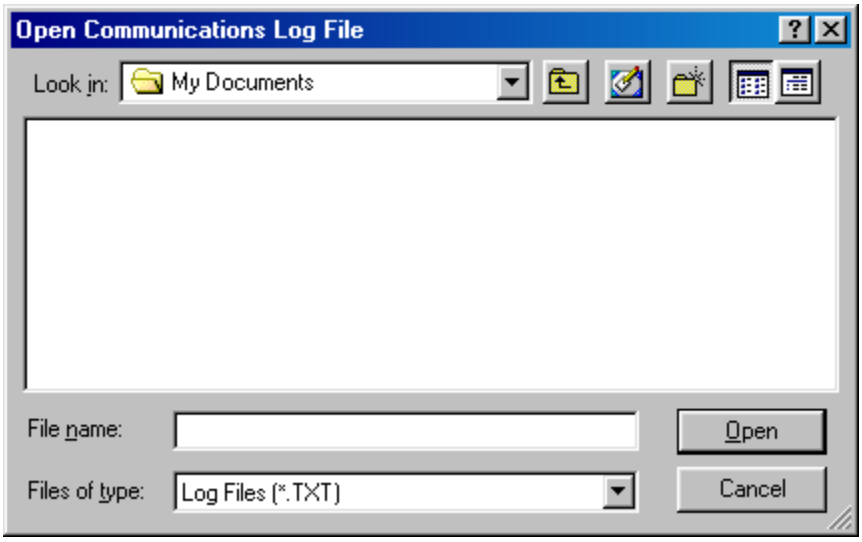
- Go to “Programs” then “Setup RFD” and then click on “Setup RFD”.
- The program will start and display the following dialog box.
- Click on the Serial Port list box and select the serial port that will be used with the 1678 Series RFD Test Box.
- The serial port selection will be retained for future sessions automatically.
- The Setup RFD program is now configured.

10.6. USING SETUP RFD TO TEST RFD UNITS

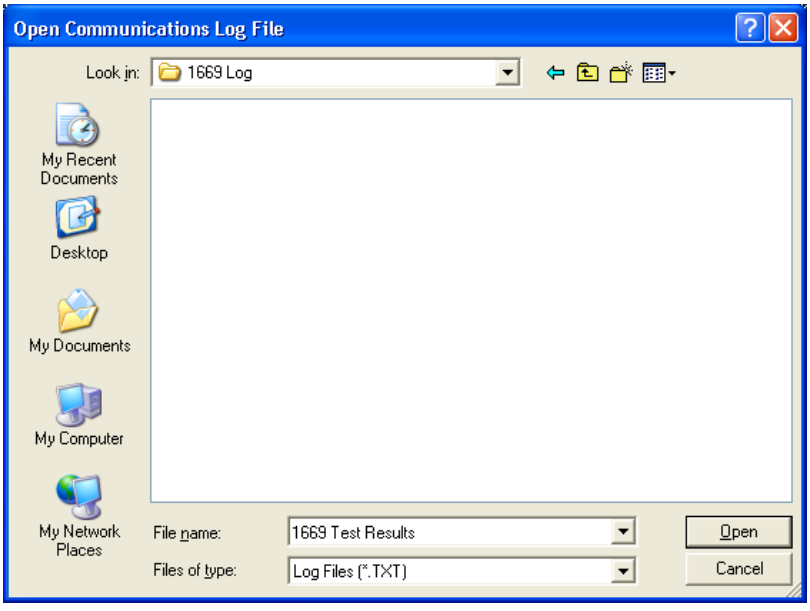
The Setup RFD program may be used with the 166x Series Test Box to test 166x Series Units and record the results of those tests.

10.6.1. Creating a Test Results Log File:

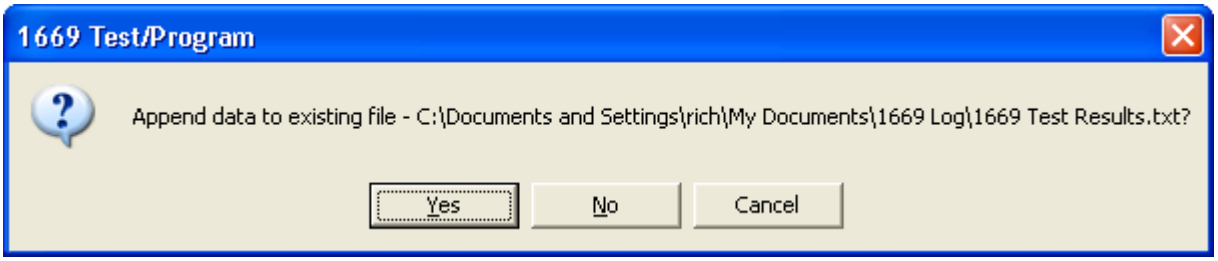
- If a log file of test results is desired, click "File" and then "Open Log File…". The following dialog box will appear.



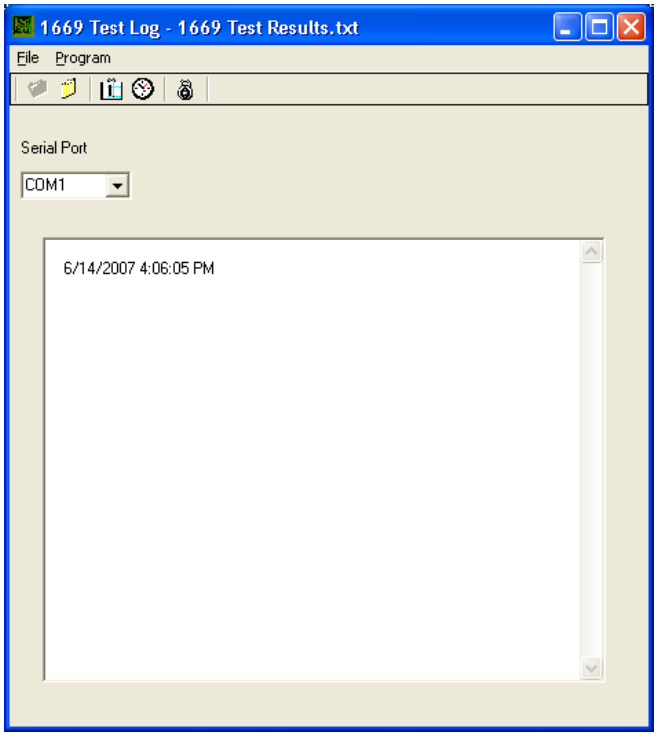
- Type in a file name for the log file or select an existing file to use. Click the "Open" button.



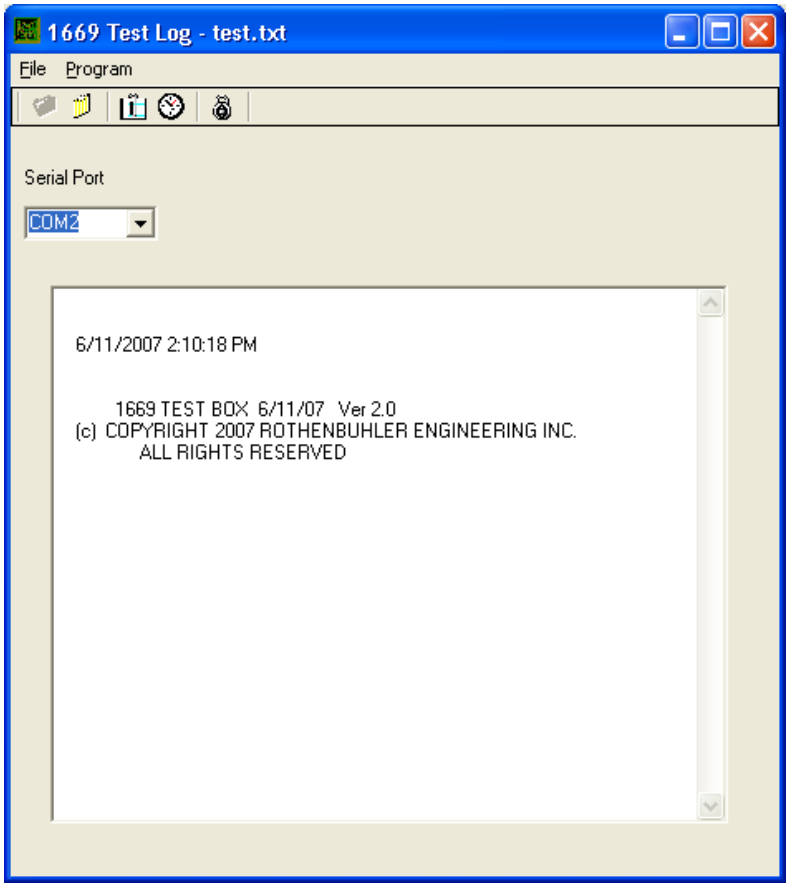
- If the file already exists, the following prompt appears.



- Click "Yes" to append (add to) existing data or "No" to overwrite the existing file.



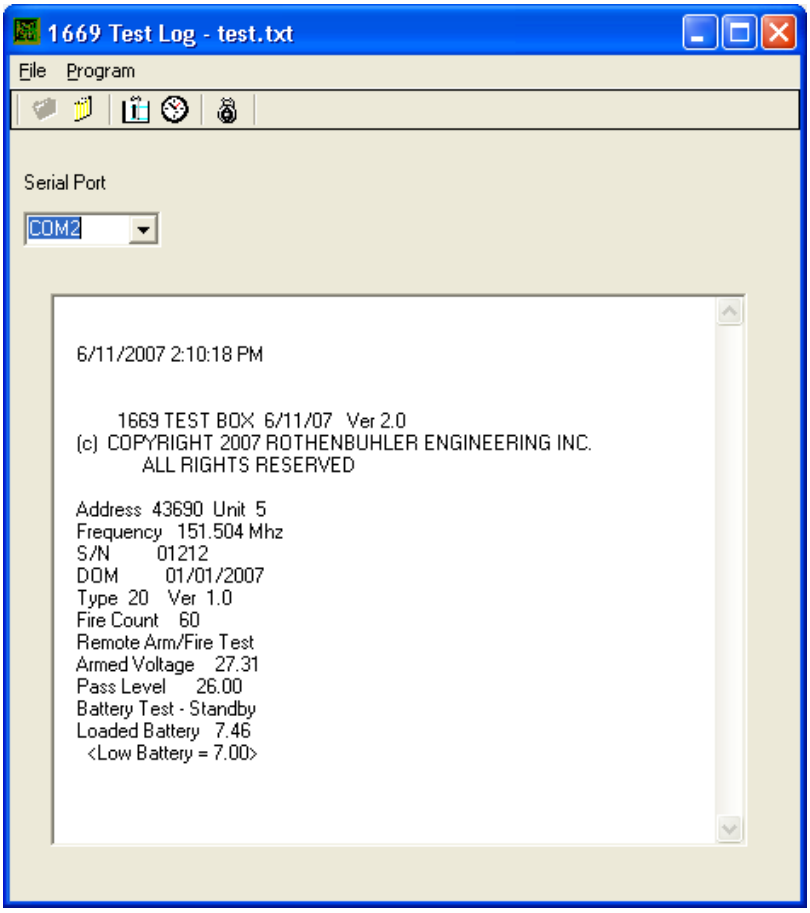
- The following window appears.
- A time and date stamp is added to the window.
- Notes can be added to the log file by clicking the note card icon and typing the note in the dialog box that appears. Multiple notes can be added as required.
- Connect the Test Box serial cable to the serial port selected in a previous step.
- Turn on the Test Box by installing its antenna. The following window is displayed.



- Connect the Test Box Probe to a Remote Unit.

- Connect the Test Box Probe Leads to the Remote Unit binding posts. It does not matter which lead goes to which binding post.

- The Test Box reads and displays the system information from the Remote Unit, and then executes an arm/fire test followed by a battery test. The results are displayed as shown in the next window.



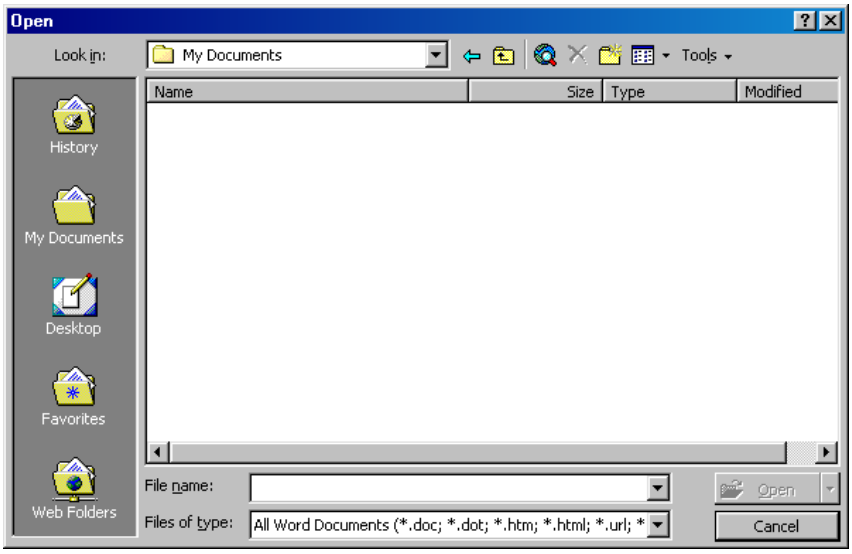
- To test the Remote Unit again, remove the Test Box Probe from the Remote Unit for a few seconds, and then reconnect the Test Box Probe to the Remote Unit.

- To end the testing and save the log file, click “File” and then “Close Log File…”

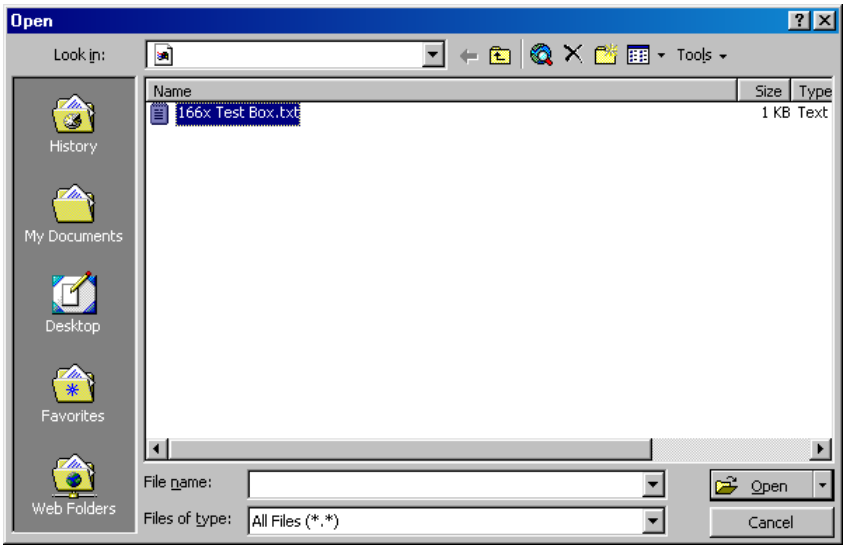
10.6.2. Printing Test Results to a Log File

- The log file must be printed from another Windows application such as Microsoft Word.

- Start Word, click “File” and then “Open”.



- Change the “Files of type:” list box to “All Files (*.*)”



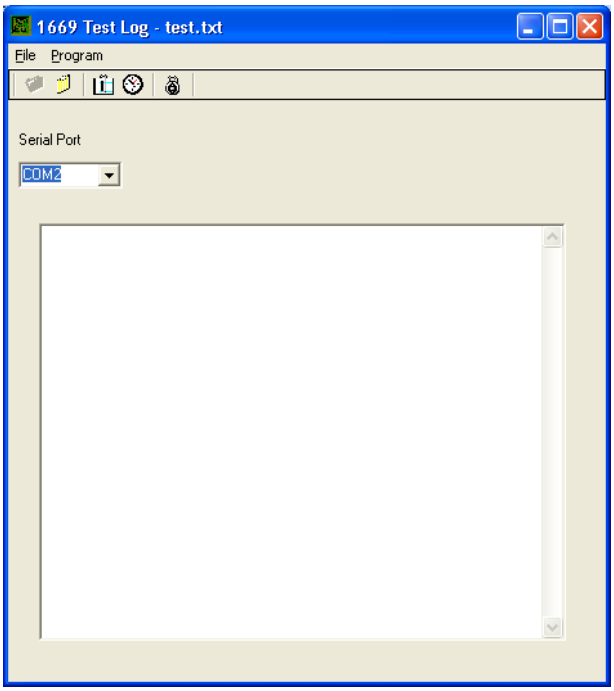
- Browse to the folder that contains the log file to print, and select the file.

- Print the file by clicking “File” and then “Print”.

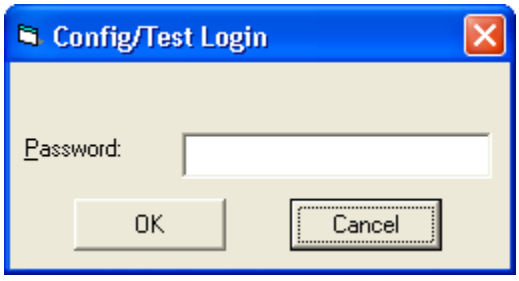
10.7. USING SETUP RFD TO PROGRAM RFD UNITS

Follow the listed instructions to use Setup RFD to Program RFD Units.

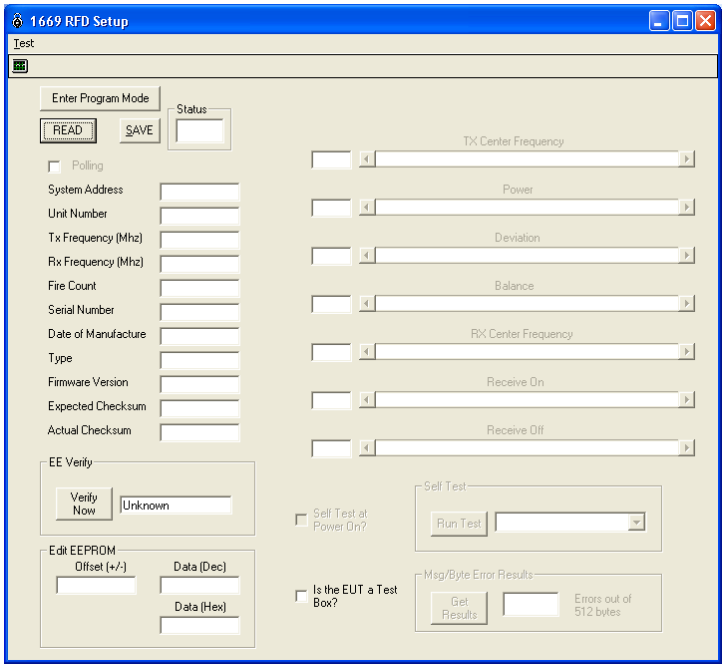
- Click on the Windows “Start” button.
- Go to “Programs” then “Setup RFD” and then click on “Setup RFD”.
- The program will start and display the following dialog box.



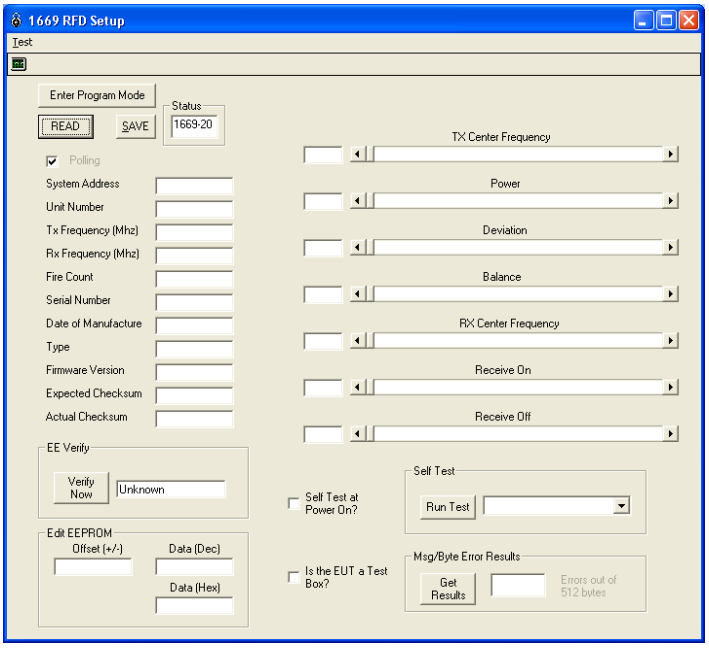
- Click on the Serial Port list box and select the serial port that will be used with the Series Test Box.
- Click on “Program” and the following window appears.



- For standard ‘User’ mode, click ‘Ok’. The password protected mode is for advanced features and the tune up mode. The following screen should appear.

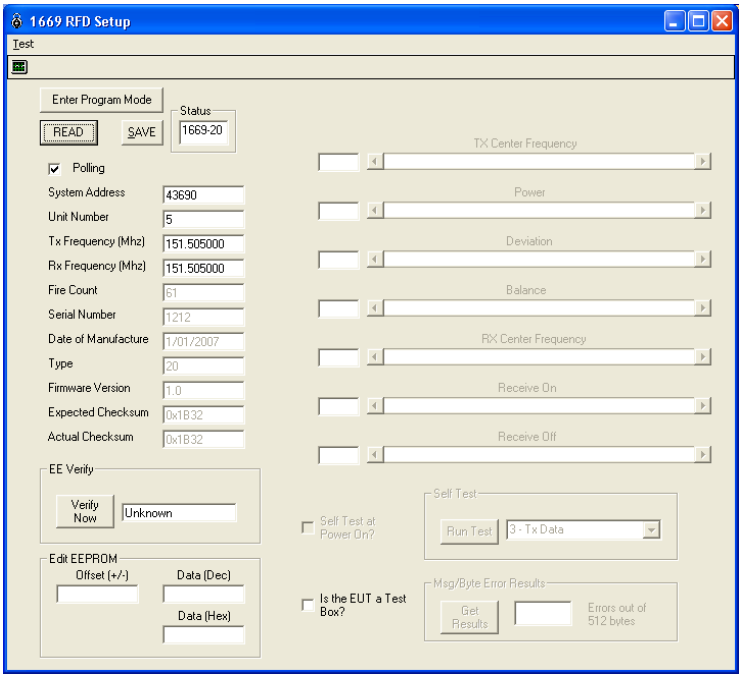


- Connect the Test Box Probe to the Unit to be programmed.



- The box labeled ‘Status’ updates automatically showing the type of unit connected. 1669-1 and 1669-21 designate Mini Controllers, 1669-2 and 1669-20 designate Remotes, 1669-14 and 1669-19 designate RSTIs.

- With ‘Polling’ checked, the program will automatically read and display the unit’s current settings.



- The “System Address” box displays the system address for the Unit. This number is unique to each system.

- The “Unit Number” box displays the number for the Unit within the system. Remotes will be 1 through 8 and the Mini Controller will be Unit 0.

- The “Frequency (MHz)” box displays the transmitter and receiver frequencies, in Mega Hertz, for the Unit.

- The “Fire Count” box displays the number of times the Remote has been fired.

- The “Serial Number” box displays the Manufacturer’s serial number for the Unit.

- The “Date of Manufacture” box displays when the Unit was manufactured.

- The “Type” box displays the Manufacture’s type code for the Unit.

- The “Firmware Version” box displays the version of firmware that is programmed into the Unit.

- Boxes that are displayed in gray are not programmable and are for information purposes only.

10.7.1. Changing the System Address

The System Address is programmable only on Remote and RSTI Units. It may not be changed on Mini Controller Units. The System Address should only be changed by personnel having that authority. A possible scenario for changing the System Address is that a Remote Unit in system 12345 has become unserviceable. A Remote Unit from another system may be reprogrammed to have a System Address of 12345 to complete the system. The Unit Number for the replacement Remote Unit should be reprogrammed to match the Unit Number of the Remote Unit it is replacing.

To change the System Address follow the listed steps.

- Click on the “System Address” box and then type the desired System Address in the box. Allowable entries are in the range of 1 to 65535.
- Press the “Enter” Key or click the mouse to another box.
- Click the “Read” button to re-read the Unit information and confirm that the desired System Address was accepted.

10.7.2. Changing the Unit Number

The Unit Number is used to assign a unique ID to each Remote Unit within a system. The same Unit Number should not be assigned to more than one Remote Unit within a system.

To change the Unit Number follow the listed steps.

- Click on the “Unit Number” box and then type the desired Unit Number in the box. Allowable entries are in the range of 1 to 8.
- Press the “Enter” Key or click the mouse to another box.
- Click the “Read” button to re-read the Unit information and confirm that the desired Unit Number was accepted.

10.7.3. Changing the Frequency

The Frequency is the radio frequency that the Mini Controller Unit, Remote Units, RSTIs, and RFD Test Box use to communicate with each other. All Units within a system must have the same Frequency.

To change the Frequency, follow the listed steps.

- Click on the “Frequency (MHz)” box and then type the desired Frequency in Mega Hertz in the box for both the transmit (TX) and receive (RX) boxes. Allowable entries are in the range of 150 to 174 Mega Hertz.

CAUTION Changes to the TX operating frequency by more than 2 MHz on either side of the original frequency require retuning and must be performed by an authorized service center.

- Press the “Enter” Key or click the mouse to another box.

- Click the “Read” button to re-read the Unit information and confirm that the desired frequency was accepted.

- To change the frequency of the RFD Text Box (Version 2.0 or later), click the box “Is EUT a Test Box” and perform the steps outlined above.

10.7.4. End of Programming

- When programming has been completed, perform a “Read” operation and confirm all of the fields are entered as intended.

- Press the “Verify” button. This causes the unit to verify the integrity of all the data stored in the unit’s memory. Reprogram any fields that fail and re-verify.

- When all the changes are confirmed and verified, test the system by following the Bench Test Procedure in Section 4.3.

11. BATTERY MAINTENANCE

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

11.1. BATTERY TEMPERATURE

For maximum efficiency charge batteries when they are between 10 and 30 degrees Celsius. DO NOT attempt to CHARGE BATTERIES that are BELOW 0 degrees or ABOVE 40 degrees Celsius. Permanent damage to batteries and or equipment may result.

11.2. PRE-OPERATION

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

11.3. PERIODIC

Every two months perform two discharge and then charge cycles using the Battery Charger Assembly on the battery of each unit.

11.4. ANNUAL

Have the battery packs replaced every 3 years or 300 charge / discharge cycles, whichever comes first.

11.5. EXTENDED NON-USE

If the battery has not been discharged and charged within four months, repeat the discharge / charge cycle four times and check the battery capacity prior to operational use. Do not exceed storage temperature guidelines as it 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: