TRIMMARK 3 Radio Modem

User Guide

Part Number: 44104-10

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Safety. Exposure to RF energy is an important safety consideration. The FCC has adopted a safety standard for human exposure to radio frequency electromagnetic energy emitted by FCC regulated equipment as a result of its actions in General Docket 79-144 on March 13, 1986. Proper use of this radio modem results in exposure below government limits. The following precautions are recommended:

DO NOT operate the transmitter when someone is within two feet (0.6 meter) of the antenna.

DO NOT operate the transmitter unless all RF connectors are secure and any open connectors are properly terminated.

DO NOT operate the equipment near electrical blasting caps or in an explosive atmosphere.

All equipment must be properly grounded according to Trimble installation instructions for safe operation.

All equipment should be serviced only by a qualified technician.

Class A Computing Device—Information to User. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Prior to operating these radio modems, users are legally required to obtain frequency licenses, as required by the country-of-use. Please contact your local communications governing agency for the licensing requirements for each of these radio modems.

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1. Improper or inadequate maintenance by the buyer
2. Buyer-supplied software or interfacing
3. Unauthorized modification or misuse
4. Operation outside of the environmental specifications of the product
5. Improper installation, where applicable
6. Lightning or other electrical discharge
7. Fresh or salt water immersion or spray
8. Normal wear and tear on consumable parts (for example, batteries)

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Preface

Welcome to the *TRIMMARK*™ 3 *User Guide*. This manual describes the TRIMMARK 3 Radio Modem for use in real-time differential and real-time kinematic GPS applications. The radio modem, when used with a Trimble rover GPS receiver with an internal radio modem, provides a high-speed wireless data link between base and rover GPS receivers.

Scope and Audience

We recommend that you spend some time reading this manual. The following section provides you with a guide to this manual, as well as to other documentation you have received with this product.

Organization

This manual contains the following chapters and appendices:

- Chapter 1, Overview - provides a brief overview and physical description of the TRIMMARK 3 radio modem.
- Chapter 2, Operation - contains configuration and installation instructions for the TRIMMARK 3 radio modem.

- Chapter 3, Characteristics and Specifications - summarizes performance characteristics and specifications of the TRIMMARK 3 Radio Modem and Antennas.
- Chapter 4, Troubleshooting - radio status messages and troubleshooting tips.
- Chapter 5, Regulations and Safety - contains regulation and safety information.
- Appendix A, Using Radio Communications Systems with GPS Surveying Receivers - general information on the use of with GPS.

Related Information

This manual contains system-wide, general information on the TRIMMARK 3 radio modem. Other sources of information are discussed in the following sections.

Update Notes

You will find a Warranty Activation Sheet with your TRIMMARK 3 radio modem. By sending in your Warranty Activation Sheet, you are automatically sent update notes as they become available. When you receive these packages, read them. They contain important information about software and hardware changes. **Contact your local Trimble Dealer** for more information about support agreement contracts for software and firmware, and extended warranty programs for hardware.

Other Information

This section lists sources that provide other useful information.

World Wide Web (WWW) Site

For more information about Trimble, visit our site on the World Wide Web:

- www.trimble.com

Technical Assistance

If you have a problem and cannot find the information you need in the product documentation, ***contact your local Trimble dealer***. Alternatively, request technical support using the Trimble World Wide Web site:

- www.trimble.com/support/support.htm.

Document Conventions

Italics identify software menus, menu commands, dialog boxes, and the dialog box fields.

SMALL CAPITALS identify DOS commands, directories, filenames, and filename extensions.

`Courier` represents messages printed on the screen.

`Courier Bold` represents information that you must type in a software screen or window.

Helvetica Bold identifies a software command button.

[Ctrl] is an example of a hardware function key that you must press on a personal computer (PC). If you must press more than one of these at the same time, this is represented by a plus sign, for example, [Ctrl] + [C].

Warnings, Cautions, Notes, and Tips

Warnings, cautions, notes, and tips draw attention to important information and indicate its nature and purpose.

Warning – Warnings alert you to situations that could cause personal injury or unrecoverable data loss.

Caution – Cautions alert you to situations that could cause hardware damage or software error.

Note – Notes give additional significant information about the subject to increase your knowledge, or guide your actions.

Tip – Tips indicate a shortcut or other time- or labor-saving hint that can help you make better use of the product.

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1 Overview

The rugged TRIMMARK 3 radio modem is designed to operate in harsh environments, such as those associated with seismic and mining surveys. Used with a Trimble rover GPS receiver with an internal radio modem the TRIMMARK 3 provides a convenient, versatile means of establishing a robust wireless data broadcast network for real-time differential and real-time kinematic GPS applications.

1.1 Features

The TRIMMARK 3 has the following standard features:

- 20 channel capability
- Selectable 2, 10 and 25 Watts Transmit Power
- Narrowband UHF technology, available in three UHF bands: (410-420 Mhz, 430-450 Mhz, 450-470 Mhz)
- Wireless data rate of 4800, 9600 or 19200 bps
- Interfaces with all Trimble survey-grade GPS receivers
- Channel Sharing (carrier detect)
- Supports up to two repeaters in a single network
- Rugged, weatherproof construction
- Two line, 16-character VFD display
- Trimble CMR and RTCM SC-104 Version 2.x compatible

- Operational parameters configured through *WinFLASH* utility, handheld controller or front panel.
- Configured as Base, Repeater or Rover
- Compatible with TRIMTALK 450S, TRIMMARK II & IIe, SiteNet 450 external radios and 4700, 4800 and 5700 internal radios

Note – As used in this manual, CMR as well as CMR Plus formats are both represented by CMR.

1.2 Use and Care

The TRIMMARK 3 as a base or repeater is programmable in 2, 10 and 25 Watt output modes. As a rover the unit will receive only. When the unit is configured as a base or rover it can be connected to most Trimble survey-grade GPS receivers through a single cable for serial I/O and a separate cable for power. When used as a repeater the TRIMMARK 3 unit operates autonomously and requires only a power and antenna connection, with no connection to the serial port.

To achieve line-of-sight (LOS) coverage to all points in a survey area, a TRIMMARK 3 radio modem network can include up to two repeaters, depending on data format and output data rate. The repeaters retransmit data packets according to a simple time-sharing scheme to avoid mutual interference, and their operation is transparent to the rovers. The rovers will use the data packet from the base or repeater, whichever the rover detects first.

The TRIMMARK 3 unit is designed to withstand rough treatment typical of equipment used in the field. However, the unit is a precision electronic instrument and should be treated with reasonable care. The radio modem operates in temperatures ranging from -40°C to +65°C (–40°F to 149°F). The enclosure is sealed and weatherproof.

Warning – Operating or storing your TRIMMARK 3 radio modem outside the specified temperature range can damage the instrument.

1.3 Equipment Sets

The TRIMMARK 3 is available as a stand-alone product or in one of two standard equipment sets, base or repeater. These standard equipment sets are designed for use with GPS receivers such as the Trimble 4700, 4800 and 5700. The equipment sets contains the accessories required to operate the radio modems including cables, mounts, and antennas.

TRIMMARK 3 Radio only (P/N 44100-10-xx)[1]

The TRIMMARK 3 Radio only configuration consists of the following components:

- TRIMMARK 3 Radio Modem (P/N 46000-xx)[1]
- Power Cable (P/N 40356)
- Programming Cable (P/N 32960)
- TRIMMARK 3 CD, (P/N 47085-00)

TRIMMARK 3 Repeater Equipment Set (P/N 44100-20-xx)[1]

The standard TRIMMARK 3 Repeater Equipment Set consists of the following components:

- TRIMMARK 3 Radio Modem (P/N 46000-xx)[1]
- TRIMMARK 3 Transport Case (P/N 44072-00)
- Power Cable (P/N 40356)
- Programming Cable (P/N 32960)
- TRIMMARK 3 CD (P/N 47085-00)

- Mounting Pole (P/N 44091-00)
- Antenna Mounting Pole Plate (P/N 44092)
- Antenna & Pole Carry Pouch (P/N 44098-00)
- Whip Antenna Kit, 0dB/5dB (P/N 44075-xx)

  (includes antenna mount and cable, P/N 22720-10)

TRIMMARK 3 Base Equipment Set (44100-30-xx)[1]

The standard TRIMMARK 3 Base Equipment Set consists of the following components:

- TRIMMARK 3 Radio Modem (P/N 46000-xx)[1]
- TRIMMARK 3 Transport Case (P/N 44072-00)
- Power Cable (P/N 40356)
- Programming Cable (P/N 32960)
- TRIMMARK 3 CD (P/N 47085-00)
- Antenna Mounting Pole (P/N 44091-00)
- Antenna Mounting Pole Plate (P/N 44092)
- Antenna & Pole Carry Pouch (P/N 44098-00)
- Whip Antenna Kit, 0dB/5dB (P/N 44075-xx)

  (includes antenna mount and cable, P/N 22720-10)
- 8 meter (25 foot) Data I/O Cable, (P/N 31288-08)

[1]xx = 42, Frequency Band is 410-420 Mhz

[1]xx = 44, Frequency Band is 430-450 Mhz

[1]xx = 46, Frequency Band is 450-470 Mhz

Note – The standard base and repeater equipment sets are designed for use with GPS receivers such as the Trimble 4700, 4800 and 5700. Contact your local Trimble representative for information about connecting to other GPS receivers.

1.4 Optional Accessories

The following accessories may be purchased in addition to the standard system.

- 18AH Battery with Carry Pouch (P/N 44103-18)
- Battery Charger, 18AH (P/N 44111-00)

1.5 TRIMMARK 3 Description

The TRIMMARK 3 radio modem is packaged in a weatherproof housing. The front panel, see Figure 1-1, has a VFD display to indicate channel frequency, radio status and error messages. There are seven main menus available through the front panel:

- CHANNEL: Channel number and operating frequency
- MODE: Base, Repeater or Rover modes
- CHANNEL SHARING: Carrier Detect settings
- TRANSMIT POWER: 2,10 or 25 Watts
- WIRELESS MODE: Over-the-air data rate settings
- DATA PORT CONFIG: Data port baud rate settings
- DEVICE STATUS: Radio programming information

The default menu on power-up is the CHANNEL menu, with the additional menus selectable through the front panel control keys. The front panel keys are as follows:

- SPEAKER
- UP
- DOWN
- NEXT

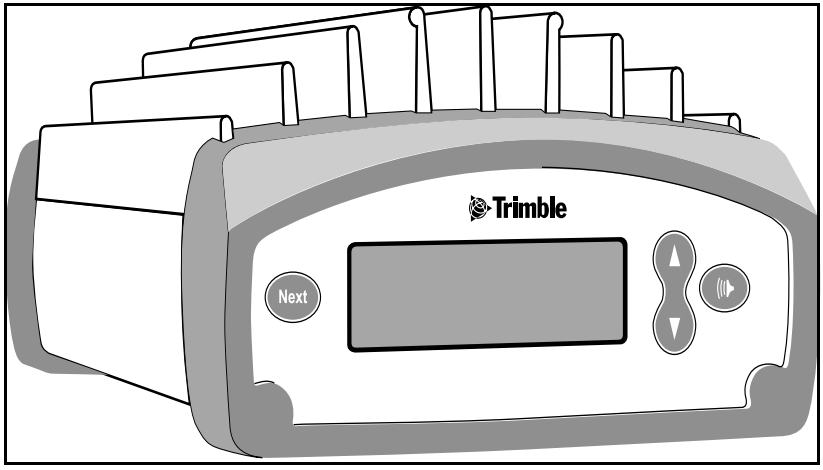

Figure 1-1 TRIMMARK 3 Front Panel

The SPEAKER button on right side the radio front panel controls the volume of the received audio signal on the currently selected channel. If traffic is present, you will hear the traffic if the volume is adjusted high enough.

The UP and DOWN buttons scroll through the various items within the individual menus.

The NEXT button is used to browse though the various menu screens.

Table 1-1 details the main menu items and the various selections within the main menus. Certain items displayed on the front panel will differ according to your units settings.

Main Menu	Menu Selection					
Channel	1 461.025	2 461.075	3 461.100	4 462.125	5 462.375	(up to 20 channels)
Mode	Base w/ No Rpt	Base w/ One Rpt	Base w/ Two Rpt	Repeater 1	Repeater 2	Rover
Channel Sharing	Off	Avoid Weak Sig	Avoid Strong Sig			
Transmit Power	Low Power 2 W	Med Power 10 W	High Power 25 W			
Wireless Mode	TM II 4800 bps	TT450S 9600 bps	TT450S 4800 bps	TM3 19200 bps		
Data Port Config	38400 8-none-1	38400 8-odd-1	9600 8-none-1	9600 8-odd-1		
Devices Status	Call Sign (On/Off)	CS: (call sign)	Ser: (unit serial #)	Ch Spacing (12.5/25 kHz)		

Table 1-1 TRIMMARK 3 Menu Hierarchy

Note – Certain standard features may be disabled in you unit to comply with your country-of -use regulations.

The rear panel, see Figure 1-3, has three electrical connectors:

- POWER connector (two-pin LEMO)
- DATA connector (seven-pin LEMO, 0-shell)
- ANTENNA connector (female TNC)
-

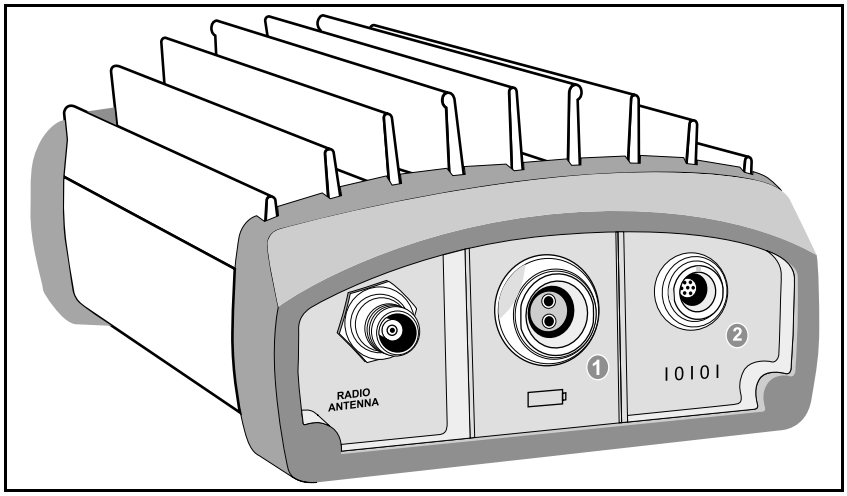

Figure 1-2 TRIMMARK 3 Rear Panel

1.5.1 Power and I/O Cables

The TRIMMARK 3 base equipment set comes with a radio to receiver I/O cable (not provided in the repeater equipment set), an antenna cable with integrated antenna mount, a power cable and a configuration cable (PC to radio modem). The configuration cable allows you to modify the radio modem configuration using the Trimble *WinFLASH* utility. See figure 1-4 for the cable connection diagram.

When configured as a base, the radio modem receives data at the DATA connector through a single LEMO-to-LEMO cable that plugs into a Trimble GPS receiver. When the unit is configured as a repeater, the data connection is not required.

Power is connected to the unit at the POWER connector from a suitable power source, either a stable DC power supply or a battery.

1.5.2 Defaults

The TRIMMARK 3 radio modem is shipped from the factory with the following default settings.

- CHANNEL: Channel 1
- MODE: Base with No Repeater
- CHANNEL SHARING: Off
- TRANSMIT POWER: Low Power 2 Watts
- WIRELESS MODE: TMII 4800 bps
- DATA PORT CONFIG: 38400 8-None-1
- DEVICE STATUS: Call Sign Off

Note – Prior to use of your TRIMMARK 3, you should change the radio settings to meet your specific requirements using the WinFLASH utility provided on the TRIMMARK 3 CD. Please refer to Chapter 2 for installation and configuration information.

1.6 Standard Omnidirectional Antennas

Each radio modem, when purchased as part of a base or repeater equipment set, is supplied with a standard omnidirectional antenna. The omnidirectional antenna provided is a 5dB gain UHF antenna with an interchangeable 0dB tip.This antenna can be used with a unit configured as a base or repeater. The antenna threads onto an integrated antenna mount and cable. The integrated antenna mount attaches to the antenna mounting pole on top of a tripod using a tripod mounting plate.

2 Operation

The TRIMMARK 3 radio modem contains both a data modem and a radio. It can be used in a variety of configurations to form a complete wireless data network. A typical configuration is as a base radio modem broadcasting directly to a Trimble 4700, 4800 or 5700 Rover GPS receiver that contains an internal radio modem. Alternatively, the TRIMMARK 3 may also operate as a repeater.

2.1 Configuration

Each TRIMMARK 3 radio modem comes from the factory programmed with default settings as defined in Chapter one of this manual. The factory default parameters are stored in nonvolatile memory and serve as the initial power-up settings for the radio modems. The unit retrieves the parameters stored in non-volatile memory at each power-up. The power-up settings can be reconfigured as often as necessary using the WinFLASH Utility. Certain parameters may also be changed using the front panel menus

2.1.1 Configuring the Serial I/O Port

Note – The BAUD RATE, FORMAT, and CTS parameters for the GPS receiver must be configured to properly transfer data between the receiver and the radio modem. BAUD RATE must be set to match the maximum serial I/O rate of the radio modem (38400 bps) and is always set to 8-NONE-1. CTS flow control is disabled.

The radio modem must be connected to a computer running Microsoft Windows 95/98 or Windows NT to run the *WinFLASH* utility. Perform the following procedures to connect the unit to your computer, install the WinFLASH Utility under Windows, and set up the serial I/O parameters. Alternatively, the serial port communication parameters may be configured from the front panel in the Data Port Config menu.

Note – Your computer must be able to support a 38400 bps serial port data rate.

Connecting to a Computer

Connect the radio modem programming cable (P/N 32960) to the serial COM port on the computer and the I/O port on the radio. Connect power cable (P/N 40356) to the POWER connector from a suitable power source.

2.1.2 Getting Started with WinFLASH

WinFLASH is a communications setup utility used to configure the TRIMMARK 3. You need Microsoft Windows 95/98/2000 or Windows NT to run *WinFLASH* on your computer. Read the README.TXT file provided on the *WinFLASH* diskette or use the Microsoft Windows documentation for information on the installation of *WinFLASH* and an icon on your desktop.

Using WinFLASH

To use *WinFLASH*, do the following:

1. Select and open the *WinFLASH* icon to start *WinFLASH*. The *WinFLASH* main window will be displayed as shown in Figure 2-1.

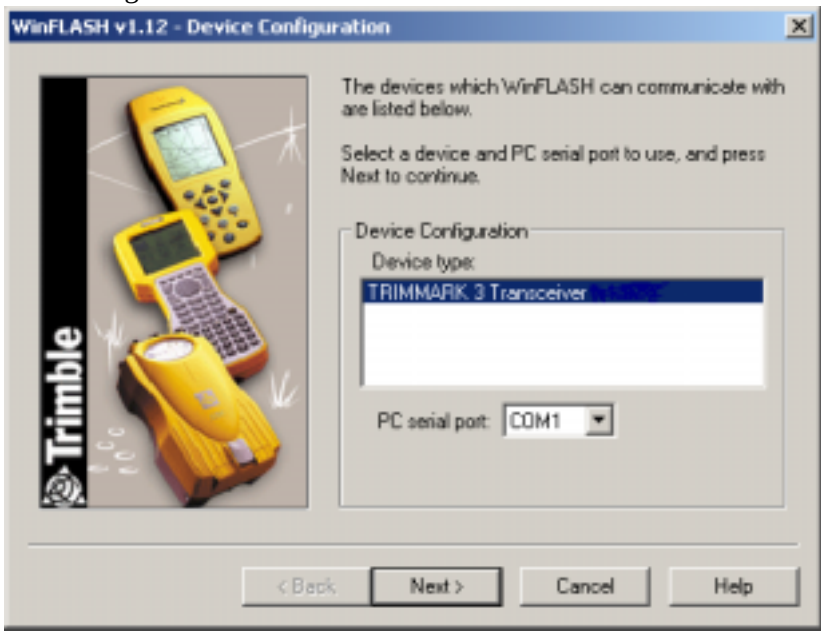

Figure 2-1 WinFLASH Main Window

2. Follow the directions in the *WinFLASH* window to make a logical connection to the radio modem.

   a. Select the appropriate *PC serial port* (COM port).

   b. Select the appropriate device, TRIMMARK 3 Transceiver and Press [Next}.

   The Operation Selection Window as shown in Figure 2-2 appears.

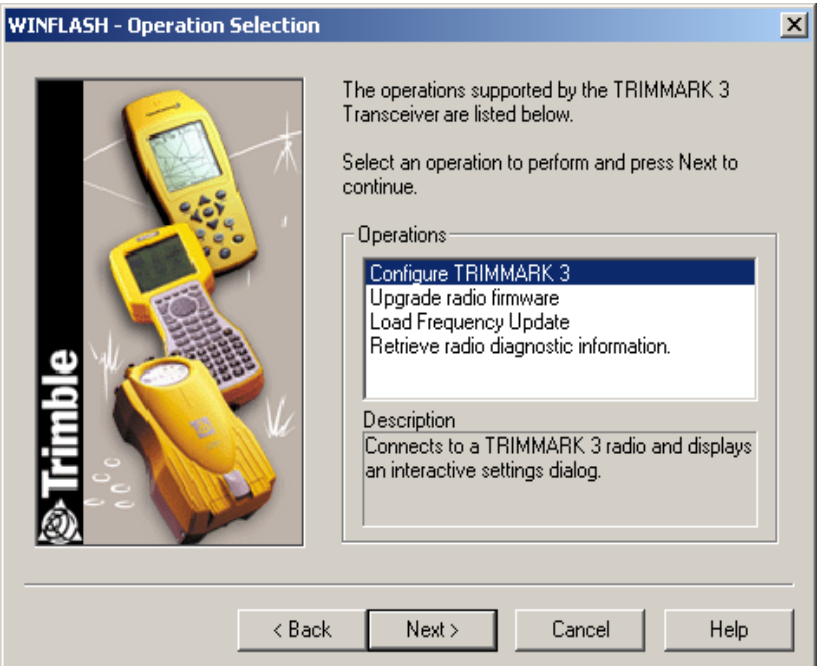

Figure 2-2 Operation Selection Window

3. Select the appropriate operation in the *Operations* window, Configure TRIMMARK 3, and Press [Next].

   a. The *Settings Review* window appears to confirm you selected operation, Press [Finish].

b. A connection status window appears, counts to 100%, and then displays the TRIMMARK 3 configuration menu.

When a successful connection is established, the *TRIMMARK 3 Configuration* window (Figure 2-3) replaces the *WinFLASH* window.

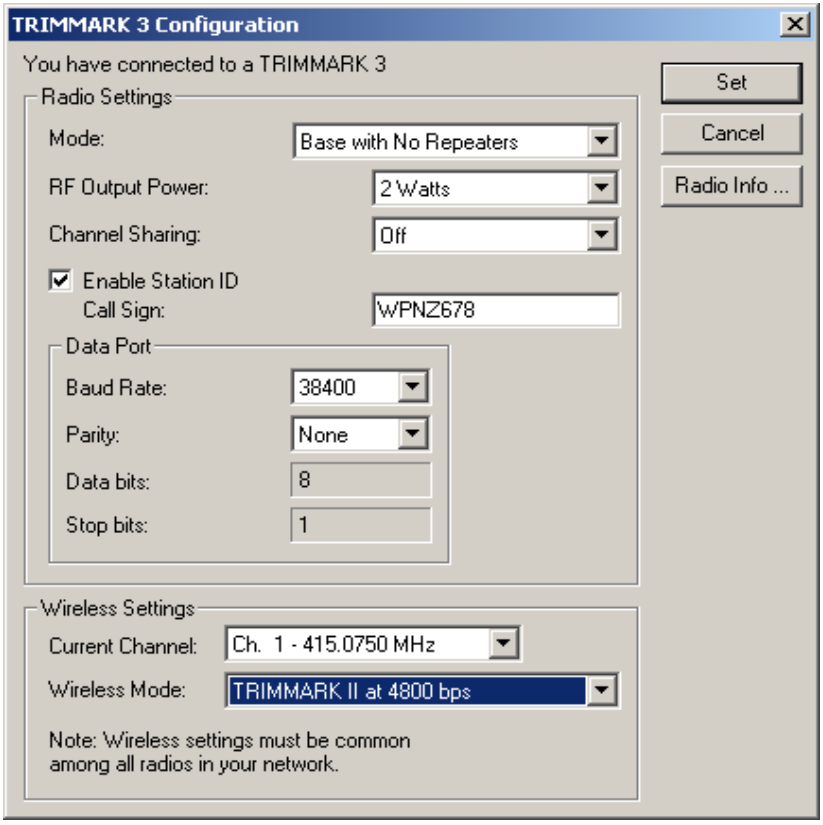

Figure 2-3 Configuration Window

Use the dialogs in the *TRIMMARK 3 Configuration* window to modify configuration parameters.

Perform the following steps to configure the TRIMMARK 3:

1. Select the appropriate operating ***Mode*** depending on intended use, for example; Base with No Repeaters.
2. Select the appropriate ***RF Output Power***. 2, 10 or 25 Watts.
3. Select the ***Channel Sharing*** configuration: (Base modes only, not selectable for a Repeater or Rover)

   Off: The carrier detect mode is OFF and your unit will ignore other transmissions on your frequency and continue to transmit data.

Note – Channel Sharing set to *Off* may be illegal in your country-of-use. You may be subject to penalties or fines dependant upon the specific licensing requirements for your country-of-use. Please consult your radio license documentation or licensing agency for operational guidelines.

Avoid Weak Signals: The carrier detect mode is ON and the radio will cease transmitting if it detects another radio transmission on it's frequency. It will resume transmission when the channel is free of radio traffic.

Avoid Strong Signals: The carrier detect mode is ON, but the radio will only stop transmitting when there is a strong signal present. (Receive level >-90 dB)

4. Check the ***Enable Station ID*** box and input your Call Sign into the box. This is a Federal Communications Commission requirement for U.S. licensed users. This sets your radio to transmit your Call Sign every 15 minutes in Morse Code.
5. In the Data Port dialog set the ***Baud Rate*** and ***Parity***. This is the communications settings between the receiver and radio.

Note – The factory default *GPS Port* parameters for the TRIM MARK 3 are *38400 Baud Rate* with *None Parity.* The factory default *Mode* is *Base with no Repeater* with *Channel Sharing* set to OFF.

6. In the Wireless Settings dialog, select the appropriate ***Current Channel***, which determines the radio operating frequency. Next, select the desired ***Wireless Mode***, which determines the over-the-air communications settings.

Note – All Radios in the network must be configured with the same Wireless Mode Setting, or the radios will not communicate.

7. To update the configuration click on the [Set] button. You will then see a Status dialog box. You may now return to the main menu, or exit WinFLASH.
8. The [Radio Info] button allows the user to view a text listing of all the radio information, including it's current configuration.

Tip – You may print or save to file the radio configuration information for future reference. The saved file can be printed and sent via fax or emailed to Trimble Support to aid in troubleshooting radio problems.

2.1.3 Frequency List Updates

The TRIMMARK 3 radio modem can be programmed with a list of up to 20 frequencies, stored in non-volatile memory. This list is preconfigured based on the frequencies requested when the unit was ordered. Governmental regulations require that only manufacturers or authorized dealers can create this frequency list. All frequencies programmed into a TRIMMARK 3 radio modem must comply with the host country regulations.

When you need to change the frequency list (add, delete, or replace frequencies), contact your Trimble dealer and provide the TRIMMARK 3 radio modem's serial number and an updated list of the frequencies you require. Once you have been provided the frequency file you may upgrade the radio using the *WinFLASH* utility.

2.1.4 Firmware Updates

TRIMMARK 3 firmware upgrades will periodically be available at the Trimble World Wide Web (www.trimble.com). The radio firmware may also be upgraded using the *WinFLASH* utility program.

2.2 Installation

Before setting up the equipment in the field, verify that each radio modem is set to the same channel and wireless data rate. Also verify that the radio modem's *Data Port* settings are *38400 Baud Rate* and *None Parity* by using the *WinFLASH* utility or front panel. Set the serial port settings for both base and rover GPS receivers to 38400 bps, 8 bits, none parity and 1 stop bit. Refer to the GPS receiver manual for general GPS receiver setup information.

Note – High-power signals from a near-by high-power radio station or radar transmitter can overwhelm the radio modem circuits. This does not harm the instruments, but can prevent them from functioning correctly. To avoid problems, try not to use the radio modems within 400 meters (1300 feet) of powerful radar, television, or other transmitters. Low-power transmitters such as the ones in portable phones and walkie-talkies normally do not interfere with TRIMMARK 3 radio modem operations unless they are tuned to the same channel as your radio modem units. Always monitor any frequency before and during operation. Only transmit on a clear channel.

Also, to avoid possible interference with GPS reception, keep the base radio modem antenna as far as possible from the GPS antenna. A minimum of 3 meters (10 feet) is recommended.

Refer to Using Radio Communication Systems with GPS Surveying Receivers, page A-1, which is a copy of Trimble publication 1-612-0082-2/94 Using Radio Communication systems with GPS Surveying Receivers, for precautions in using certain frequencies that can interfere with GPS operation.

2.2.1 TRIMMARK 3 Base or Repeater

The TRIMMARK 3 radio modem can be installed in a network as a base station or as a repeater. Typically the base is configured for 25 Watts output, and the repeater is configured at 2 Watts output power.

Installation as a Base

To use a TRIMMARK 3 radio modem as a base, do the following:

1. If necessary, reconfigure the unit's serial port settings to those of the GPS receiver. Configure the unit as appropriate, base with no repeaters, or with one or more repeaters. Ensure that all units in your network are configured according to their specific task within the network.
2. Before connecting the power cable, thread the base antenna onto the mounting pole.
3. Mount the entire antenna assembly on a tripod using the tripod mounting plate and connect the antenna cable to the TRIMMARK 3 radio modem.
4. Attach the antenna cable to the ANTENNA port on the unit.
5. Connect the power cable between the TRIMMARK 3 POWER port and an appropriate 12V DC power source.

Caution – Be careful to connect the power cable with the correct polarity. Reversing polarity does not damage the base radio modem, however the protective 10 Amp fuse in the power cable will blow.

6. Connect the 8 meter (25-foot) data cable between the base radio modem DATA port and the GPS receiver data port. For the Trimble 4700,4800 or 5700 GPS receivers, this is Port 3
7. If the GPS receiver is outputting data, the base should now be in operation. Check the display on the TRIMMARK 3 and verify that the "TRAN" (transmitting) message is flashing.
8. If the TRIMMARK 3 displays "BUSY", another radio transmission is present on the frequency you selected. Change frequencies until you locate a clear channel.
9. Verify that you are on the correct channel, and power output.

Installation as a Repeater

To achieve coverage to all points in a survey area, a TRIMMARK 3 network may include up to two repeaters.The repeaters retransmit data packets in a way that avoids mutual interference with the base and each other. The operation of the repeaters is transparent to the rovers. The rover will use the data packets from the base or repeater, whichever it receives first.

The option to include a repeater in a TRIMMARK 3 network depends on the selected wireless data rate and the broadcast information content and rate (that is, CMR vs. RTCM 2.x RTK packets at 1Hz vs. 5Hz RTK epoch rates). Table 2-1 illustrates when a repeater may be used in a network for various wireless data rates, RTK formats and RTK epoch rates.

Table 2-1 Repeater Use in Networks

Wireless Data Rate (bps)	DGPS	CMR at 1 Hz	CMR at 5 Hz	RTCM 2.x at 1 Hz
4800	1	1	0	0
9600	2	2	1	1
19200	2	2	1	2

"2" - Two repeaters may be used

“1” - One repeater may be used

“0” - No repeaters may be used

To install a TRIMMARK 3 radio modem as a repeater, do the following:

1. Verify that the TRIMMARK 3 is configured for *Repeater 1* if you are using only one repeater. If you are using a second repeater verify it is also configured properly as *Repeater 2*.
2. Verify that the Base is set to be used as *Base w/ One Repeater* or *Base w/ Two Repeaters* as appropriate.

3. Before connecting the power cable, assemble the repeater antenna, attach it to its mount, and then thread the complete assembly onto the antenna mounting pole.
4. Mount the entire antenna assembly and pole on a tripod using the tripod mounting plate, and connect the antenna cable to the TRIMMARK 3 radio modem at the Radio Antenna port.
5. Connect the power cable between the TRIMMARK 3 POWER port and an appropriate 12V DC power source. The front panel should display the Channel menu with the current channel being used.

Caution – Be careful to connect the power cable with the correct polarity. Reversing polarity does not damage the base radio modem, however the protective 10 Amp fuse in the power cable will blow.

6. Select the repeater radio modem channel to match the base radio modem channel by pressing the UP or DOWN key until the appropriate channel setting is displayed.
7. Press the NEXT key until TRANSMIT POWER is displayed and select the appropriate power setting: 2,10 or 25 Watts.

Note – Using the minimal power setting to meet your needs will, conserve battery power, and minimize the chance of your radio system interfering with other users.

8. Verify that the channel assignments are the same for all base, rover and repeater units.
9. The repeater should now be in operation. When data broadcast by the base is received by the repeater, the unit will flash *Rpt* (repeat) in the upper right corner of the display.

2.2.2 Antenna Installation

Several factors should be considered when installing and locating antennas. Place antennas as high as legally possible above the ground and surrounding obstructions such as trees, vehicles, buildings, and hills.

Note – Antenna height is the most important factor in achieving maximum range with radio modems. Doubling the antenna height results in a 40% increase in line-of-sight range. Use low loss cable if it is necessary to increase the length of the antenna cable to accommodate your installation. Consult your license for the legal limits on antenna height.

Line of Sight Obstruction

Objects placed near the antennas, especially metal objects, can severely limit their efficiency. If an antenna is to be mounted on an antenna mast, make sure the antenna is mounted so that its radiating element is completely above the top of any obstructing source if possible.

Omnidirectional Antennas

The UHF Whip antenna shipped with your system is factory tuned to operated in the band (Example: 450-470 Mhz) you specified with your order. Refer to figure 2-4 to ensure that your antenna is the correct length for your frequency band.

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Frequency Band (MHZ)	L1		L2	
	(cm) ± 0.6 cm	(in) ± 0.25 in	(cm) ± 0.6 cm	(in) ± 0.25 in
406-430	20.3	8	15.0	5.9
430-450	17.4	6.8	12.3	4.8
450-470	16.9	6.6	13.3	5.2

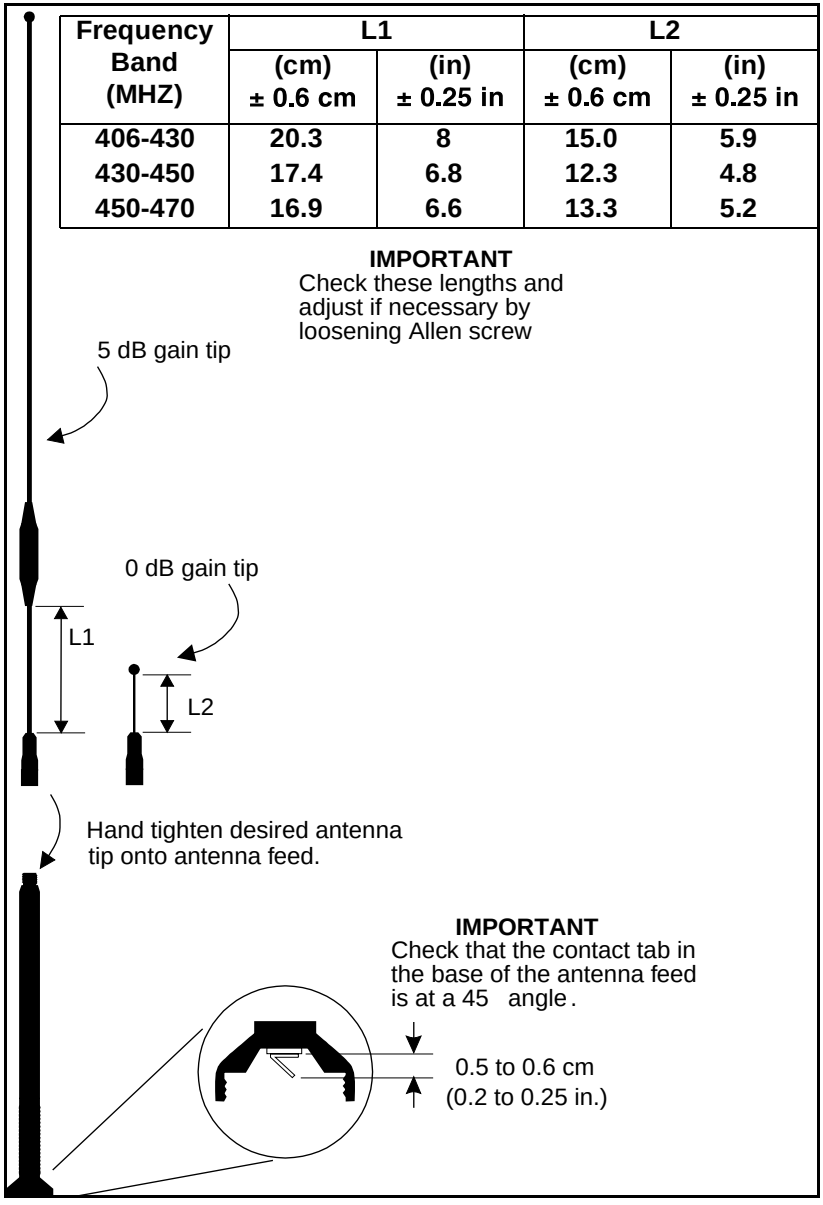

Figure 2-4 Standard UHF Omnidirectional Antennas

Directional Antennas

As an option, directional antennas can increase the range in a particular direction, see Figure 2-5. The directional antenna must be pointed in the direction of the receiving or transmitting antenna to take full advantage of its antenna design. These antennas are designed to be mast mounted with the antenna elements vertically oriented. All directional antennas in a wireless data network must be mounted with their antenna elements aligned in the same orientation. For additional information refer to the application sheet supplied with the directional antenna.

Note – Government regulations may exclude the use of directional antennas.

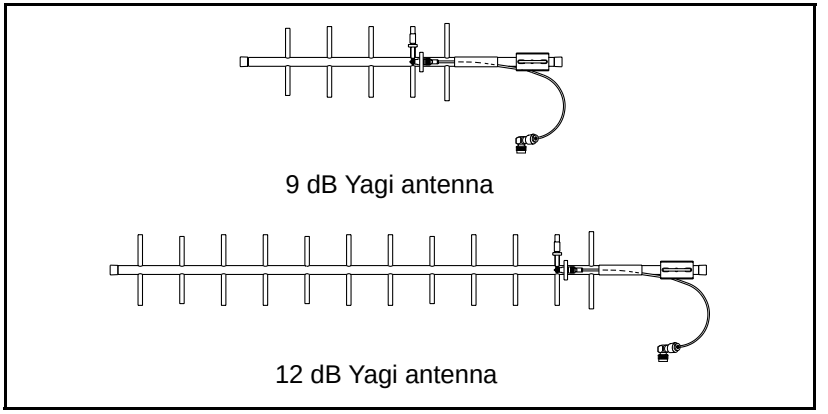

Figure 2-5 Directional Antennas

3 Characteristics and Specifications

This chapter briefly summarizes general characteristics and specifications of the TRIMMARK 3 radio modem.

3.1 Antenna Gain

The antennas supplied with the TRIMMARK 3 do not increase the energy radiated by the radio modem. They concentrate the energy from the radio modem in a particular direction. The degree to which they concentrate radio frequency energy in any particular direction is called directivity and is measured in dB, or decibels. The greater the antenna gain in dB, the higher the directivity and the more the radiated energy from the antenna is concentrated in some direction.

3.1.1 Omnidirectional Antennas

An antenna that radiates energy equally in all directions in the horizontal plane is called omnidirectional. Omnidirectional antennas radiate an equal amount of energy at every azimuth. However, they are not omnidirectional in the vertical plane.

Figure 3-1 shows the radiated energy patterns of the UHF omnidirectional antennas used with the radio modems. All omnidirectional antennas must be oriented vertically when used.

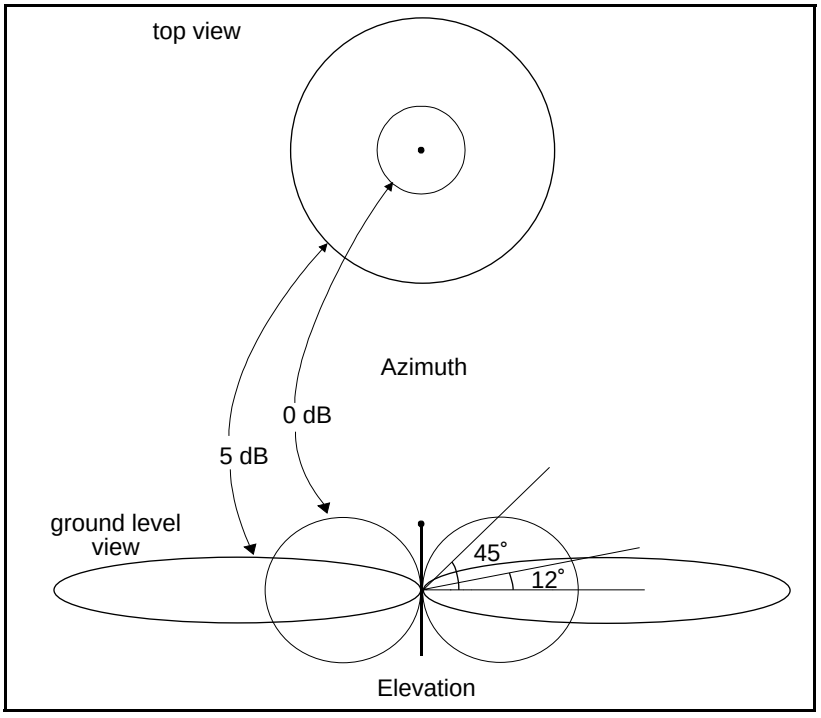

Figure 3-1 Omnidirectional Antenna Gain Patterns

The top view shows radiated energy patterns in the horizontal, or azimuth plane of the antennas, the plane that perpendicularly bisects the length of the antenna. For omnidirectional antennas, all azimuths receive equal energy, but the 5 dB antenna radiates almost four times more power in the horizontal plane than does the 0 dB antenna. In an open field, four times more power approximately doubles the range.

The ground level view shows radiated energy patterns in the vertical, or elevation, plane of the antennas. Much of the energy from the 5 dB antenna is concentrated in elevation to within ±12 ° of horizontal. A rover antenna within this sector receives stronger signals from a 5 dB antenna. However, at angles greater than 12 ° from horizontal, the 0 dB gain antenna radiates more energy.

Antenna gain has exactly the same effect on signal reception as it does on signal transmission. A high gain rover antenna can increase range performance as long as it is oriented correctly with respect to the transmit antenna. For high gain antennas, this means keeping the antenna element vertical and at the same elevation as the transmitting antenna. Otherwise, it may be better to use an antenna with less gain.

3.1.2 Directional Antennas

Two directional antennas, a 9 dB Yagi and a 12 dB Yagi antenna, are available as options, dependent on applicable governmental regulations. Figure 3-2 shows the radiated energy patterns of the directional antennas that can be used with the radio modems. The solid line depicts the directional antennas as compared with the dashed lines representing the omnidirectional antennas. In principle, the directional antenna is similar to a flashlight while an omnidirectional antenna is similar to a light bulb. The flashlight concentrates light into a narrow beam while a light bulb illuminates evenly, but usually not as far as the flashlight.

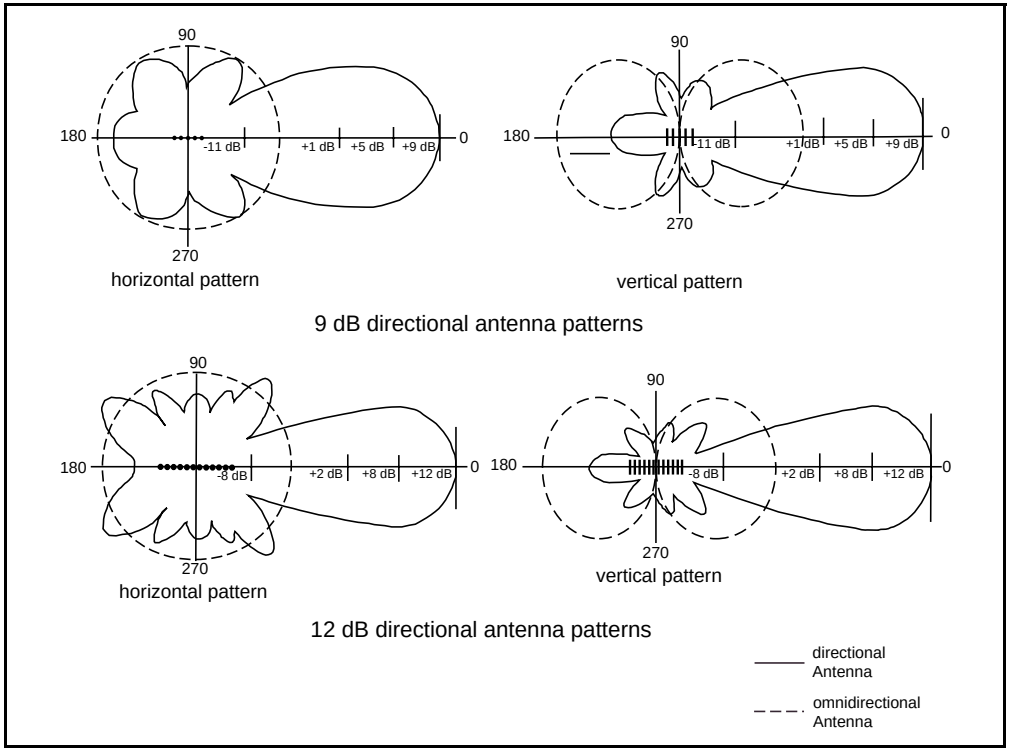

Figure 3-2 Directional Antenna Gain Patterns

A Yagi antenna focuses the radiated power into a directional transmission used for straight lines (±20 ° for the 9 dB directional antenna or ±17 ° for the 12 dB directional antenna). Since most of the power is focused in one direction, a Yagi antenna transmits further in this direction than an omnidirectional antenna.

The line-of-sight range increase for a unit using the 9 dB directional antenna is about 1.6 times that obtained using the 5 dB omnidirectional antenna. The line-of-sight range increase for a unit using the 12 dB directional antenna is about twice that obtained using the 5 dB omnidirectional antenna. The radio modem range varies depending on line-of-sight visibility, blockage or absorption by vegetation, antenna pointing errors, antenna height, terrain anomalies, and local weather conditions.

Note – Directional antennas are useful for working in a straight line such as along railroad tracks or roads, or where repeaters are inconvenient or impossible such as crossing lakes, or between mountains. Directional antennas have a limited ability to receive radio signals from any direction other than the direction in which they are pointed. For omnidirectional situations, the 0 dB or 5 dB UHF omnidirectional antennas are recommended.

Because of the trade-off between gain and vertical coverage, the TRIMMARK 3 is shipped with a 0 dB/5 dB UHF antenna tuned to the frequency band of your radio modem.

3.2 Broadcast Network

The following sections describe the frequency bands, channel spacings and wireless data rates available with the TRIMMARK 3 radio modem.

3.2.1 Frequency Band and Channel Selection

The TRIMMARK 3 Base/Repeater radio modem operates in one the following frequency bands:

- 410 to 420 MHz (UHF)
- 430 to 450 MHz (UHF)
- 450 to 470 MHz (UHF)

Each unit operates in one of these bands, not across bands. The TRIMMARK 3 radio modem stores up to 20 factory pre-programmed frequencies, and operates on one of these frequencies, depending on which is selected. All 20 frequencies must reside within one of the above frequency bands. These frequencies are preset at the factory.

Note – Each radio modem in a network must be tuned to the same frequency in order for the network to operate.

In addition, the TRIMMARK 3 radio modem is available in two different channel spacing configurations: 12.5 kHz and 25 kHz. Channel spacing refers to the minimum separation, in Hz, between two adjacent frequencies and can be viewed as the tuning resolution of the radio modem. Channel spacing is dependent on local government regulations.

3.2.2 Wireless Data Rate

The wireless data rate is the speed, in bits per second (bps), at which the base unit transmits data to the rover unit. The TRIMMARK 3 can be used at 4800, 9600 or 19200 bps.

Note – Each radio modem in a wireless data network must have the same wireless data rate and channel spacing.

3.2.3 Transmit Power

The TRIMMARK 3 can be used as a base transmitter or repeater. Each unit can be configured to 2, 10 or 25 Watt power output. This is user selectable from the front panel, or configured with the *WinFLASH* utility.

Note – Using the minimal power setting for your specific application offers two benefits, lower battery consumption, and reduces the risk of interfering with other users on your frequency.

3.3 General Specifications

The following tables contain information on the TRIMMARK 3 radio modem and antennas.

Table 3-1 TRIMMARK 3 Physical Specifications

Size	12.5 cm (4.9 in.) Wide	
	22.9 cm (9.0 in.) Deep	
	7.9 cm (3.1 in.) High	
Weight	1.59 kg (3.5 lbs.)	
Power	Input 12 to 16 VDC, nominal	
Connectors	Power	2-pin LEMO (+VDC, GND)
	Data	7-pin female LEMO (supports RXD, TXD and SGND)
	Antenna	TNC female
Temperature	Operating	–40 °to +65 °C (–40 °to +149 °F)
	Storage	–55 °to +75 °C (–67 °to +167 °F)
Humidity	100%, fully sealed, weatherproof	

Table 3-2 Antenna Physical Specifications

Type	Length (typical)	Weight
Standard 0 dB UHF omni whip	47 cm (18.5 in.)	0.5 kg (1.0 lb.)
Standard 5 dB UHF omni whip	99 cm (39 in.)	0.5 kg (1.1 lb.)

Table 3-3 Performance Specifications (Typical)

Transmit Power	2W, 10W, 25W[1]
Wireless Data Rate	4800, 9600 or 19200 bps
Frequency Bands	410-420 MHz, 430-450 MHz, or 450-470 MHz. Only one band per radio modem
Channel Spacing	12.5 kHz or 25 kHz. Only one per radio modem
Number of Channels	Up to 20 factory pre-programmed frequencies, internally stored[2]
RF Modulation Format	Gaussian Minimum Shift Keying (GMSK)
Range	Typical: 25W Base: 10 to 12 km (6-7 miles) 2W Repeater: 5-8 km (3-5 miles) Varies with terrain and operational conditions Up to two repeaters can be used to extend range.
Power Consumption[3]	25W Base: 75 W consumption @ 4800 bps 25 W consumption @ 9600 bps
Battery Life[3]	25W Base: 8 hours on one 18Ah battery; typical at 20°C (70°F) @ 9600 bps 2W Repeater: 16 hours on one 18 Ah battery; typical at 20°C (70°F)
Serial Port[4]	One set of RS-232 signals available. Data is 8 bits with selectable parity and 1 stop bit. Supported data rates are 9600, 19200 and 38400 bps.

1. All units are shipped from the factory set at 2 watts power output.
2. Use the same frequency for all radio modems in the same wireless data network.
3. Power consumption, and battery life, depends on the broadcast information content and wireless data rate (e.g., CMR versus RTCM SC-104 Ver. 2.x packets at 1 Hz epoch rates versu 5 Hz epoch rates).
4. Communications rate between the Radio and GPS Receiver, not Wireless Rate.

4 Troubleshooting

This chapter lists status messages and troubleshooting tips which can be used to help isolate and correct system configuration or operational issues. Status messages may be displayed as a one or two line message on the front panel of the unit. Two line messages listed below are separated by a comma.

4.1 Status Messages

Battery Low

The battery voltage is below 11.6 volts. Replace the battery as soon as possible.

Battery Low, Radio Turned Off

The battery voltage has dropped below 10.8 volts, and the radio has stopped transmitting. Replace the battery, the unit will reset and begin transmitting again.

Note – *Battery Low* voltage levels are approximate and may vary according to various factors; battery condition, radio modem operating mode and other environmental factors.

Data Overload, Check GPS Config

Occurs when wireless data rate is set too low for the amount of data you are attempting to transmit, for example, 5hz CMR's at 4800 baud. Increase the Wireless Data Rate or change the type of packets you are transmitting.

Comm Port Error, Check Data Rate

The communications protocol between the GPS receiver and the radio is incompatible. With *WinFLASH* or the Data Collector reconfigure the GPS and Radio Modem protocols to the same settings.

Warning:, Radio Hot

The radio is approaching, but has not exceeded it's maximum operating temperature. This may occur due to high data rate transmission at maximum power output (25W), and/or operating the unit in direct sunlight. Reduce power output, data rate, shade the unit from direct sunlight.

Caution – The housing of the TRIMMARK 3 will be HOT to touch if the *Radio Hot* message is displayed. Use caution and reasonable care when handling the unit in this state.

Warning: Radio, Hot Output Off

The unit has exceeded it's maximum internal operating temperature, (+85 °C / +185 °F), and has stopped transmitting. This may occur due to high data rate transmission at maximum power output (25W), and/or operating the unit in direct sunlight. Allow the unit to cool down. Reduce power output, data rate, shade the unit from direct sunlight.

Warning – Operating or storing your TRIMMARK 3 radio modem outside the specified temperature can damage the instrument.

Warning: No, External Battery

Indicates the unit is receiving power from the GPS receiver through the Data port, but does not have power connected to it's main power port. If used as a Base, the GPS receiver cannot supply adequate power for the radio. Connect an external power source to the radio.

Connect Antenna, to Radio

The radio modem is attempting to transmit but does not sense an antenna connected to the antenna port. Connect the radio antenna to the unit. If the antenna is physically connected to the unit, the cable and/or antenna may have failed. This message will not appear if the unit is configured as a rover, even if there is no antenna connected.

ERROR:, Bad Radio Config

The radio was configured incorrectly. This may occur after upgrading the radio firmware. Reconfigure the radio modem using *WinFLASH* or the Data Collector.

HARDWARE ERROR:, XX (code number)

This is a FATAL ERROR. The radio modem should be returned for service. Please note the error code and contact Trimble or your local service provider

4.2 Service

There are no user serviceable parts in the TRIMMARK 3 Radio Modem. Contact your Trimble representative or local service provider for assistance.

A Using Radio Communication Systems with GPS Surveying Receivers

Trimble Publication 1-612-0082-2/94

"GPS receiver, antenna, tripod, tribrach, tape, cones, flagging, radio...", such is the checklist of most GPS surveyors preparing for a day of observations. But a truly successful survey is not just a matter of making sure that you have all of the equipment, you must also ensure that you optimize the usage of these new tools for the highest productivity.

The GPS receiver is trying to measure very faint radio signals from satellites orbiting at 22,000 kilometers in space. There are many factors that can hinder the receiver’s ability to perform. For example, placing your hand over the antenna or setting up the antenna under a tree are factors that have already proven to interfere with GPS signal reception.

As GPS receivers developed, their processors have become more sensitive to incoming data flow. This provides an increase in accuracy by extracting more information out of the GPS radio signal. But with this gain in accuracy, there is an increased susceptibility to other radio signals. The receiver is now more sensitive to the incoming GPS signal, and consequently it is also more sensitive to other incoming radio signals. This means that communications radios, such as ones commonly used by surveyors, can sometimes create difficulty with the GPS signal reception.

There are some very simple steps you can follow to remove the effects of radio interference on the GPS receiver. First, you should be aware of the type of communications equipment you're buying and understand its characteristics. Secondly, a little care in using communications radio can greatly decrease your chances of experiencing any interference with satellite tracking.

A.1 Selecting Communications Radios

If you do not already have communications radios, and are thinking of buying them to supplement your survey activities, there are a number of factors to keep in mind before purchasing: (a) some frequencies can cause interruptions or GPS tracking; (b) certain communications equipment creates spurious signals not related to their frequency that can interfere with satellite tracking; and (c) powerful communications transmitters can create such a strong radio signal that the GPS signal cannot be identified.

Most communication transmitters emit overtones of their assigned frequency. If these overtones line up with the GPS frequency, it can filter into the GPS equipment and interfere with the satellite tracking. Some communication transmitters emit more of these overtones than others. But the number of overtones can be difficult to determine and is not the most important factor when considering this nuisance parameter. To avoid being affected by transmitter overtones, simply avoid those frequencies that lie within the GPS frequency range.

Table A-1 shows frequency bands that you should avoid

.

Table A-1 RF Bands to Avoid When Using GPS Surveying Receivers

From this Frequency	To this Frequency
781.210	794.210
607.300	620.300
520.806	529.473
404.866	413.533
390.605	397.105
312.484	317.684
303.650	310.150
260.403	264.736
242.920	248.120
223.202	226.917
202.433	206.766
195.302	198.552
173.602	177.228
156.242	158.842
151.825	155.075
142.038	144.401
134.955	137.844
130.201	132.368
120.186	124.060
110.418	113.458

Some communication transmitters and receivers also emit spurious signals. These are extremely difficult to predict. So, the only way to know if your receiver is being hampered by spuriously emitted signals is to test the communication equipment with the GPS receiver. If you plan to buy a new radio, the best course of action is to test it with your existing GPS equipment, to determine if any problems exist.

Communications equipment that uses more power is more likely to create noisy signals from which the GPS signal cannot be extracted. This case typically occurs from signals emitted from the radio transmitter box and not its antenna. Non-GPS signals enter the GPS system through the GPS antenna and not through the receiver. Therefore, most of the effects of non-GPS signals can be minimized by physically separating your radio and GPS equipment.

A.2 Useful Field Procedures

There are a few useful field procedures that you can follow to minimize the effects of your radio. Since most of the radio signal in the GPS band is emitted directly from the radio transmitter box and received via the GPS antenna, make sure the GPS antenna is separated from the radio transmitter by 2-3 meters (7-10 feet). If you are still experiencing difficulties at this distance the GPS signal may be getting over-powered by the radio transmissions. In this case, you can either separate the equipment even more or shield the radio transmitter.

Radio signal strength drops as you move further away from the source of the transmission – dropping as a square of the distance. Therefore, if there is a problem, separate the GPS antenna and radio even more to lessen the strength of the radio signal received at the GPS antenna.

If you are using a geodetic antenna, you can use the antenna's ground plane to shield the radio waves. In fact, you can shield the antenna from the radio signal by moving behind nearby objects such as a car or tree. If you cannot move away from the GPS antenna, move the radio below the level of the GPS antenna ground plane. This is not ideal, but may help in those cases where you are left with no alternative.

A.3 Summary

Using communications radios with GPS receivers requires some special considerations. By striving to extract the utmost accuracy from the GPS system, receiver designs have made greater use of the radio spectrum. However, the methods used to increase performance and accuracy also make GPS receivers more susceptible to receiving other radio signals.

Radio signals in the GPS band arise from a few different sources. Some radio transmitters produce overtones of their frequency, which lie within the GPS P-code frequency range. Others create random, spurious signals, which affect GPS signal reception. Still other radio systems use high power levels to boost communication range and create noise that limits the GPS signal tracking. These are all characteristics to avoid when purchasing or using communications equipment in conjunction with GPS.

Before using radios on full-fledged survey job, it is a good idea to test the communications equipment to determine if it affects the GPS signal reception in any way. Testing radios with the GPS equipment is especially important if you are considering purchasing new radios. Be sure to always:

- Choose the communication frequency of your radios carefully so they do not transmit on or create harmonics in the frequency range of GPS.
- Prior to buying radios, make sure that you test them with your GPS receivers.
- If problems arise, put some distance between the radio transmitter case and the GPS antenna. Also, shielding the radio transmitter should minimize the effects of radio signals on the GPS signal reception.

Radio signal strength drops as a function of distance. The greater the separation between the GPS antenna and the radio transmitter, the less likely you are to experience the interruptions in satellite tracking.

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