TRIMMARK III

Operation Manual

Part Number: XXXXX-00

Revision: A

Date: November 1999

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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.

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2. Buyer-supplied software or interfacing
3. Unauthorized modification or misuse
4. Operation outside of the environmental specifications of the product
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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™ III Operation Manual*. This manual describes the TRIMMARK III radio modem for use in real-time differential and real-time kinematic GPS applications. The TRIMMARK III, when used with a Trimble 4700 or 4800 rover 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 III radio modem.
- Chapter 2, Operation - contains complete installation and configuration instructions for the TRIMMARK III radio modem.
- Chapter 3, Characteristics and Specifications - summarizes performance characteristics and specifications that can be expected from a TRIMMARK III radio modem.

- Chapter 4, Regulations and Safety - contains regulation and safety information.
- Appendix A, Using Radio Communications Systems with GPS Surveying Receivers - discusses the special problems encountered when using radio communication systems with GPS receivers.

Related Information

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

Update Notes

You will find a Warranty Activation Sheet with your TRIMMARK III 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

File Transfer Protocol (FTP) Site

Use the Trimble FTP site to send files or to receive files such as software patches, utilities, and answers to Frequently Asked Questions (FAQs):

- ftp://ftp.trimble.com

You can also access the FTP site from the Trimble World Wide Web site at:

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

Technical Assistance

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

Reader Comment Form

Thank you for purchasing this product. We would appreciate feedback about the documentation. Use the reader comment form at the back of this manual or, if this is not available, send comments and suggestions to the address in the front. All comments and suggestions become the property of Trimble Navigation Limited.

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 III radio modem is designed for harsh environments, such as those associated with seismic and mining surveys. Used with a Trimble 4700 or 4800 rover GPS receiver with an internal radio modem, the TRIMMARK III 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 TRIMMARK III

The TRIMMARK III unit can be used as a base or a repeater. The function of a particular unit—base or repeater—is determined by its configuration. Units used as a base 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 III unit operates autonomously and does not require anything connected to the serial port.

To achieve line-of-sight (LOS) coverage to all points in a survey area, a TRIMMARK III radio modem network can include up to two repeaters. The repeaters retransmit data packets according to a simple time-sharing scheme to avoid mutual interference. The operation of the repeater is transparent to the rovers. The rovers can be moved while continually receiving data packets from the base or any one of the repeaters, whichever the rover detects first.

1.1.1 TRIMMARK III Features

The TRIMMARK III has the following standard features:

- Selectable, 20 channel capability through an external channel selector
- Built-in channel monitor capability
- Station ID selectable through the *CommSet* utility.
- Selectable 2W/25W transmit power
- Narrowband UHF technology
- Up to 15 km line-of-sight range under optimal conditions
- Selectable wireless data rate of 4800, 9600, or 19200 bps
- Interfaces with all Trimble survey-grade GPS receivers
- Operating mode selectable through the *CommSet* utility
- 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 2.1 compatible

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

- Carrier detect mode selectable through the *CommSet* Windows™ utility program

1.1.2 Equipment Sets and Accessories

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

TRIMMARK III Base Equipment Set

The standard TRIMMARK III Base Equipment Set consists of these components:

- TRIMMARK III radio modem
  (410–420 MHz, 430–450 MHz, or 450–470 MHz)
- Standard antenna (0 dB, 5 dB UHF)
- 15-foot antenna cable with integrated antenna mount
- 2-foot antenna mounting poles, 3 each
- Tripod mounting plate
- Configuration cable (PC to radio modem)
- 50-foot data cable (0 shell to 0 shell)
- 6-foot power cable
- *CommSet* communication setup software diskette
- Operation manual

Note – The standard base equipment set is designed for use with GPS receivers such as the Trimble 4700 and 4800. Contact Trimble for information about connecting other GPS receivers.

TRIMMARK III Repeater Equipment

The standard TRIMMARK III Repeater Equipment Set consists of these components:

- TRIMMARK III Radio Modem (410–420 MHz, 430–450 MHz, or 450–470 MHz)
- Standard antenna (0 dB, 5 dB UHF)
- 15-foot antenna cable with integrated antenna mount
- 2-foot antenna mounting poles, 3 each
- Tripod mounting plate
- Configuration cable (PC to radio modem)
- 6-foot power cable
- *CommSet* communication setup software Diskette
- Operation manual

1.1.3 Accessories

The standard equipment sets for the TRIMMARK III are designed for use with GPS receivers such as Trimble 4700 and 4800. Additional accessories must be purchased to use the TRIMMARK III with GPS receivers such as Trimble series 4000, Site Surveyor 4400, and 4600LS.

4000, 4400 and 4600 GPS Receiver Accessories

The data cable provided as part of the standard Base equipment sets is designed for use with Trimble 4700 and 4800 GPS receivers. The following additional cable must be purchased for the use of GPS receivers such as Trimble Series 4000, Site Surveyor 4400, and the 4600LS with the TRIMMARK III radio modem.

- 50-foot data cable (0-shell to 1-shell) for base use

Note – The 0-shell to 1-shell data cable will not connect directly to the Trimble 4600LS GPS receiver. Use this data cable along with the appropriate cable supplied with the 4600 to connect the TRIMMARK III to the 4600LS.

1.1.4 Typical Broadcast Network

The TRIMMARK III radio modem is primarily designed to broadcast and repeat RTK (Real-Time Kinematic) data for use in GPS surveying. It is compatible with Trimble's CMR RTK data format as well as the RTCM SC-104 Ver. 2.1 RTK data format. It is also compatible with RTCM SC-104 Ver. 1.0, Ver. 2.0 and Ver. 2.1 for DGPS broadcasts.

At UHF frequencies, wireless data links are line-of-sight (LOS). LOS links are attenuated by terrain features such as buildings and trees. As a result, it is easier to bring survey control into the local work area than to stretch the wireless data link to the limit of its usability.

With a LOS wireless data link, antenna height at the radio modem becomes critical. Doubling the antenna height increases radio range approximately 40%. In comparison, doubling broadcast power only provides a 10% increase in LOS range.

The TRIMMARK III radio modems operate in one these frequency bands:

- 410–420 MHz
- 430–450 MHz
- 450–470 MHz

Each unit operates in one of these bands, not across bands.

1.2 TRIMMARK III Description

The TRIMMARK III radio modem is packaged in a weatherproof housing. The front panel has a VFD display to indicate channel frequency, status, and errors. There are four buttons on the front panel:

- SPEAKER
- UP
- DOWN
- NEXT

The rear panel has three electrical connectors:

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

1.2.1 Controls and Indicators

The NEXT button is used to browse through the various menu screens. The UP and DOWN buttons are used to change the displayed parameters in the menu screens. The selected parameters appear on the display. For example, while in the Main screen which displays channel number and frequency, the UP and DOWN buttons control channel/frequency selection. When the UP or DOWN button is pressed, the selected channel/frequency will change. The radio display shows the selected channel and frequency. Channels can only be changed when the radio is not transmitting.

The SPEAKER button in the upper-left corner of the radio panel controls the volume of the received audio signal from the currently selected channel. If traffic is present, you will hear the traffic if the volume is turned on.

1.2.2 Power and I/O Cables

The TRIMMARK III equipment set comes with a data cable (not provided in the repeater equipment set), an antenna cable with integrated antenna mount, and a power cable. In addition a configuration cable (PC to radio modem) is provided. The configuration cable allows you to modify the radio modem configuration using the Windows-based *CommSet* utility, including the channel frequency, serial port settings, over-the-air baud rate, carrier detect ON/OFF setting, station ID, and the operating mode.

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 4700 or 4800 GPS receiver. When the unit is configured as a repeater, no data connection is required.

Power is connected to the unit at the POWER connector from a suitable power source.

1.2.3 Defaults

The TRIMMARK III radio modem is shipped from the factory with the serial I/O port configured for 38400 bps, 8 data bits, odd parity and 1 stop bit. The wireless data link is configured to communicate at 9600 bps and Carrier Detect is ON. If the base equipment set is ordered, the unit is preconfigured for *Base without a Repeater* operating mode, and transmit power is set to 25W. If the repeater equipment set is ordered, the unit is preconfigured for *Repeater 1* operating mode, and transmit power is set to 2W.

1.3 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 is a 5 dB gain UHF antenna with an interchangeable 0 dB tip. Either of these antennas 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 poles on the top of a tripod using a tripod mounting plate.

1.4 Directional Antennas

Two directional antenna options are available. The directional antennas should be bolted to an extended mast for maximum range at the base or repeater. Each antenna comes with an integral antenna cable for the radio modem. The integral antenna cable is not long enough to connect directly to the TRIMMARK III. An additional coaxial cable is required for most installations. The integral cable terminates in a male TNC connector.

Note – Always use the shortest, highest-quality coax cable possible between the radio modem and the antenna. Cable attenuation at the unit's operating frequency can severely limit the radio's operational range.

Additional antenna options are possible for special applications. The major trade-offs are size, weight, cost, gain, and country-of-use regulations. Characteristics and Specifications, page 3-1, describes the trade-offs involved in selecting antenna types.

2 Operation

The TRIMMARK III radio modem contains both a data modem and a radio. It can be used in a variety of configurations with appropriate rover radio modems to form a complete wireless data network. One configuration is as a TRIMMARK III base radio modem broadcasting directly to a Trimble 4700 or 4800 rover GPS receiver equipped with an internal radio modem. TRIMMARK III units may also operate as repeaters in this network.

Each TRIMMARK III radio modem can be used as soon as it is hooked up. At power-up, the configuration parameters stored in non-volatile memory initialize the unit for operation. Some of these parameters must be set to match the same values used in all units operating on a network.

2.1 Configuration

Each TRIMMARK III radio modem comes from the factory with its serial I/O port configured for 38,400 bps, 8 data bits, odd parity and 1 stop bit. The wireless data link is set to 9600 bps and carrier detect is set to ON at the factory. In addition, the TRIMMARK III is preconfigured for either the *Base without a Repeater* or *Repeater 1* operating mode, dependent on which equipment set is ordered.

The factory default parameters are stored in nonvolatile memory and serve as the initial power-up settings for the radio modems. The units retrieve the parameters stored in non-volatile memory at each power-up. The power-up settings can be changed as often as necessary using the *CommSet* utility (COMMSET.EXE) provided on the *CommSet* diskette.

2.1.1 Configuring the Radio Modem

Using the CommSet utility, you can set up the serial I/O parameters, operating mode, select the appropriate channel frequency, enable carrier detect, and select the Station ID. Some of these parameters also can be changed from the unit's front panel.

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 FORMAT is always set to 8-ODD-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 *CommSet* utility (COMMSET.EXE) and its associated help file (COMMSET.HLP). Perform the following procedures to connect the unit to your computer, install the *CommSet* utility under Windows, and set up the desired radio modem parameters.

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

Connecting to a Computer

Connect the radio modem's DATA connector to a COM port on the computer with the Configuration cable (DB9-LEMO). Connect power between the POWER connector on the unit and a suitable power source.

2.1.2 Getting Started with CommSet

CommSet is a communications setup utility used for configuring TRIMMARK III parameters. You need Microsoft Windows 95, Windows 98, or Windows NT to run *CommSet* on your computer. Read the README.TXT file provided on the *CommSet* diskette or read the Microsoft Windows documentation for installation instructions. The setup program adds a *CommSet* command to your Windows Start menu and places and *CommSet* icon on the desktop.

Using CommSet

To use *CommSet*, follow the instructions on the screen to setup the TRIMMARK III unit. For more information, refer to *Commset* online help.

2.1.3 Frequency Updates

Each TRIMMARK III radio modem contains a list of up to 20 preprogrammed frequencies stored in non-volatile memory. This list is preconfigured based on the frequencies requested when the unit was ordered.

Governmental regulations prevent you from programming new frequencies. Only manufacturers or authorized dealers can update this frequency list. All frequencies programmed into a TRIMMARK III radio modem must comply with the host country regulations.

When you want to change the frequency list (add, delete, or replace frequencies), the internal frequency list must be updated. To facilitate field updates, contact your Trimble dealer and provide the TRIMMARK III radio modem's serial number and a complete, updated frequency list in order to obtain this update. There is a nominal charge for this service.

2.2 Installation

Before setting up the equipment in the field, verify that each radio modem is set to the same frequency and wireless data rate. Also use the Commset utility to verify that the radio modem's *GPS Port* (serial port) settings are *38400 Baud Rate* and *Odd Parity.* Set the serial port settings for both the base and rover GPS receivers to 38400 bps, 8 bits, odd parity and 1 stop bit. Refer to the GPS receiver manual for general GPS receiver setup information. If these settings are not available, use the *CommSet* utility to set the radio modem's serial port settings to those of the GPS receiver.

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 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 III 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 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 III

The TRIMMARK III radio modem can be installed in a network as the base station or as a repeater.

Installation as a Base

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

1. If necessary, reconfigure the unit's serial port settings to those of the GPS receiver using either the unit's front panel or the *CommSet* utility. Depending on whether or not repeaters are to be used in the radio modem network, select the appropriate operating mode on the unit. This step is very important to ensure proper operation of the radio modem network.
2. Before connecting the power cable, thread the base antenna onto its mount. Assemble the 3 antenna mounting poles together and attach the antenna mount and antenna. The 5 dB antenna tips are recommended for most applications.
3. Mount the entire antenna assembly on a tripod using the tripod mounting plate and connect the antenna cable to the TRIMMARK III radio modem.
4. Attach the antenna cable to the ANTENNA port on the unit.
5. Connect the power cable between the TRIMMARK III unit's 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, but the protective 10 Amp fuse in the power cable will blow.

6. The front panel display should display the channel frequency and status. Listen to the channel you are planning to operate on using the built-in speaker or an external scanner. Change the channel if you hear other users.
7. Connect the 50-foot data cable between the base radio modem DATA port and the GPS receiver data port. For the Trimble 4700 and 4800 GPS receivers, this is Port 3 (the 7-pin connector).

If the GPS receiver is outputting data, the base should now be in operation. Check the display on the front panel of the base unit to verify operation when transmitting. A blinking TX indicates normal transmission is in progress.

The TRIMMARK III radio modem at the base location broadcasts all data it receives from the base GPS receiver to the rovers and repeaters in the network.

Note – To avoid possible interference with GPS reception, keep the radio modem antenna as far as possible from any GPS antenna. A minimum of 10 feet is recommended.

Installation as a Repeater

To achieve coverage to all points in a survey area, a TRIMMARK III network may include up to two repeaters under certain conditions. The repeaters retransmit data packets in a way that avoids mutual interference with the base. The operation of the repeaters is transparent to the rovers. A rover can be moved and collect data packets from the base or repeaters, whichever the rover receives first.

The option to include repeaters in a TRIMMARK III network depends on the selected wireless data rate and the broadcast information content and rate (that is, CMR vs. RTCM 2.1 RTK packets at 1Hz vs. 2Hz RTK epoch rates). Table 2-1 illustrates when and how many repeaters 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)	RTCM 2.0 DGPS @ 1Hz	CMR @ 1 Hz	CMR @ 5 Hz	RTCM 2.1 DGPS & RTK @ 1 Hz
4800	1	1	X	X
9600	2	2	0	0
19200	2	2	1	1

X Wireless data link is inoperable.
0 No repeaters may be used.
1 One repeater possible.
2 Two repeaters possible.

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

1. Verify that the TRIMMARK III is configured to operate in *Repeater 1* or *Repeater 2* radio mode using the front panel or *CommSet* utility, see page 2-3.
2. Also using *CommSet*, verify that the Base is set to be used as *Base with Repeater 1* or as a *Base with 2 Repeaters*. It is very important to change the Operating Mode of the Base as well as the repeaters*;* otherwise, the radio modem network will not operate properly.
3. Before connecting the power cable, thread the repeater antenna onto its mount. Assemble the 3 antenna mounting poles together and attach the antenna mount and antenna. The 5 dB antenna tips are recommended for most applications.
4. Mount the entire antenna assembly on a tripod using the tripod mounting plate, and connect the antenna cable to the TRIMMARK III radio modem.
5. Attach the antenna cable to the ANTENNA port on the unit.

6. Connect the power cable between the TRIMMARK III unit's POWER port and an appropriate 12V DC power source. The front panel should display the channel frequency as well as status.

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

7. Set the repeater's channel frequency to match the base radio modem's channel frequency. Radio modem channels are changed by using the UP and DOWN arrow keys from the Main screen. Channels can be changed only when the radio is not transmitting. The channel number/frequency in use is displayed on the front panel.
8. Verify that the channel assignments are the same for all base, repeater, and rover units.

The repeater should now be in operation. The display on the front panel will blink "RPT", indicating proper operation of the repeater.

2.2.2 Antenna Installation

Several factors should be considered when installing and locating antennas. Place antennas as high as 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.

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.

Tip – Keep the radio modem unit near its antenna. Mount the unit as close as possible to the antenna, rather than running a long length of cable from the unit to an antenna, see Table 2-2.

Cable Losses

The cable length between the TRIMMARK III radio modem and its antenna affects antenna range. Cable introduces loss in overall power transmitted by your TRIMMARK III radio modem.

Table 2-2 lists typical loss characteristics for three popular types of coaxial cable. The losses are expressed in dB/100 feet of cable. Remember that connectors add an additional 0.25 to 0.5 dB loss per connector.

Table 2-2 Cable Losses

Cable Type	Cable Loss at 150 MHz (dB/100 Feet)	Cable Loss at 450 MHz (dB/100 Feet)
RG-58	6 dB	12 dB
RG-214	3 dB	5 dB
5/8" Heliax®	0.5 dB	1 dB

Note – Typically 3 dB signal loss = 50% power loss = 30% range reduction.

Antennas

Three different omnidirectional UHF antennas, see Figure 2-4, are available with both a 0dB tip and a 5dB tip. One antenna is used with 410–420 MHz radio modems, one is used with 430–450 MHz radio modems, and a separate antenna is used with 450–470 MHz radio modems.

The base of all standard antennas have a spring tab that must make good contact with the button in the center top of the antenna mount. If range seems limited to a few hundred feet, verify that this tab is properly aligned.

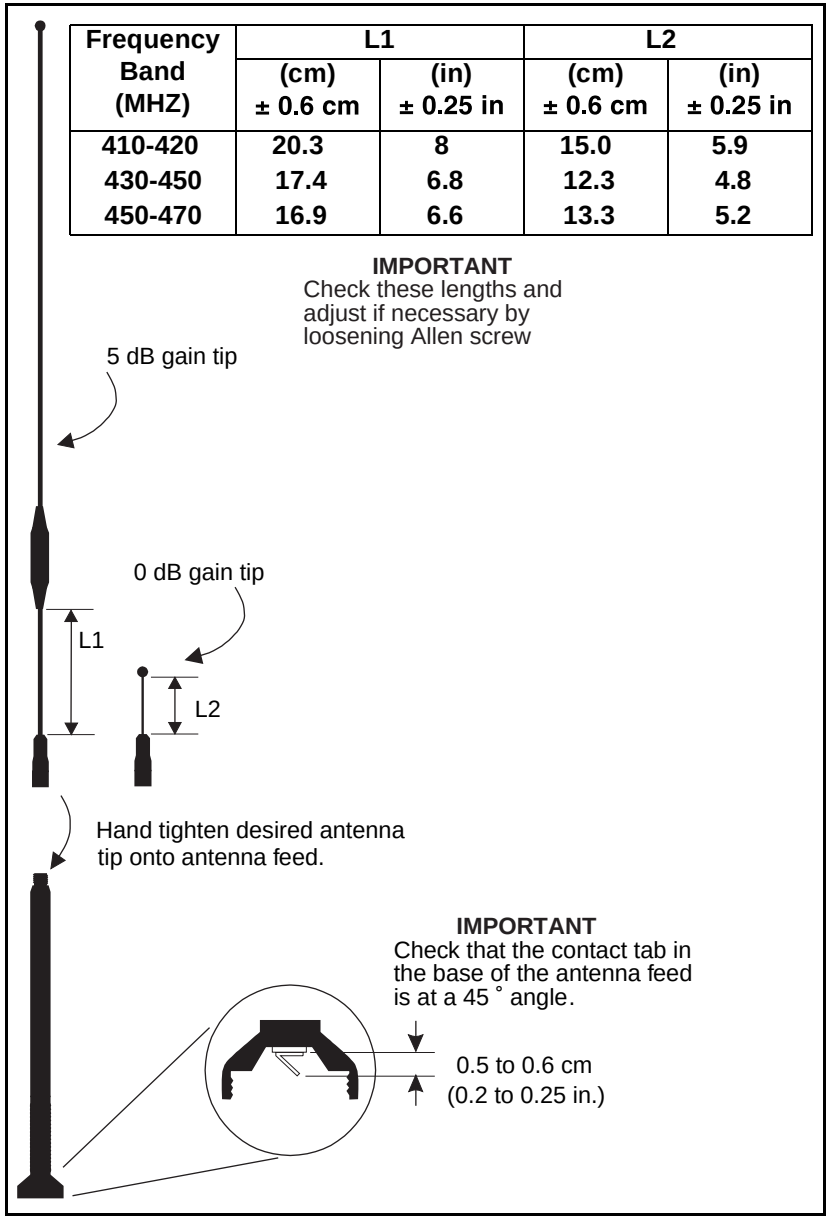

Figure 2-1 Standard UHF Omnidirectional Antennas

2.3 Verifying Operation

Test the TRIMMARK III radio modem for proper operation. Always monitor any frequency before and during operation. Only transmit on a clear channel. Turn *Carrier Detect ON* to automatically monitor a channel. If *Carrier Detect* is *ON*, the unit will only transmit when it cannot hear anyone else on the channel. U.S. users should also enable Station ID and enter the appropriate call sign to comply with FCC regulations.

2.3.1 TRIMMARK III

The following sections describe how to verify the operation of the TRIMMARK III radio modem.

Base Operation

Verify the operation of the TRIMMARK III radio modem by watching the TX icon in the display on the front panel. In units configured for base use, the TX icon blinks to indicate successful data transmission.

Radio modem channels are changed by pressing the UP or DOWN buttons on the radio from the Main screen. Channels can be changed only when the radio is not transmitting. The channel number/ frequency in use is displayed on the radio display.

To avoid possible interference with GPS reception, keep the radio modem antenna as far as possible from the GPS antenna. A minimum of 10 feet is recommended.

Repeater Operation

Depending on the configuration, the repeater can receive data broadcast by either the base or another repeater. When such data is received and successfully transmitted by the repeater, RPT will blink on the front panel display.

3 Characteristics and Specifications

This chapter briefly summarizes performance characteristics and specifications that can be expected from a TRIMMARK III radio modem.

3.1 Antenna Gain

The antennas supplied with the TRIMMARK III 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 omnidirectional antennas used with the radio modems. All omnidirectional antennas must be oriented vertically when used.

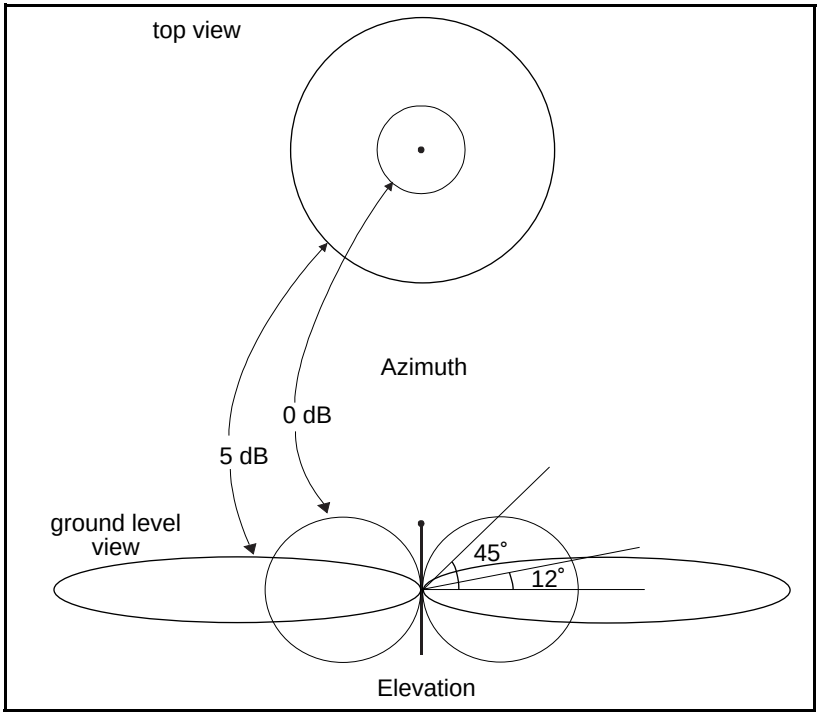

Figure 3-1 Omnidirectional Antenna Gain Patterns

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 bottom 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.

3.2 Broadcast Network

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

3.2.1 Frequency Band and Channel Selection

The TRIMMARK III radio modem operates in one the following frequency bands:

- 410 to 420 MHz
- 430 to 450 MHz
- 450 to 470 MHz

Each unit operates in one of these bands, not across bands. The TRIMMARK III 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 III 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 III can be used only at 4800, 9600, or 19,200 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 III can be used as a base transmitter or as a repeater.

Each unit can be configured to transmit 2W or 25W of power. The transmit power can be configured from the front panel of the unit or by using the *CommSet* utility. Units shipped as part of the base equipment set are set to 25W at the factory. Units shipped as part of the repeater set are set to 2W at the factory.

3.2.4 TRIMMARK III Electrical Interface

The TRIMMARK III rear panel has a grounding stud and three connectors:

- POWER
- DATA
- ANTENNA

The POWER connector is a 2-pin LEMO connector (+VDC, GND). Be careful to connect the power cable with the correct polarity. Reversing polarity does not damage the base radio modem, but the protective 10 Amp fuse in the power cable will blow.

The DATA connector is a 7-pin LEMO connector.

The antenna connector on the TRIMMARK III radio modem is a female TNC. The antenna should be connected to this port with the shortest, highest-quality coax cable possible.

Note – Long antenna cables seriously degrade the range of the wireless data network.

– DRAFT –

3.3 General Specifications

The following tables contain information on the TRIMMARK III radio modems and antennas.

Table 3-1 TRIMMARK III 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 10 VDC 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	Selectable 2W / 25W
Wireless Data Rate	4800, 9600, or 19,200 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 preprogrammed frequencies, internally stored[1]
RF Modulation Format	Gaussian Minimum Shift Keying (GMSK)
Serial Port	One set of RS-232 signals available. Data is 8 bits with selectable parity and 1 stop bit. Supported data rates are 9600 and 38400 bps.

1. Use the same frequency for all radio modems in the same wireless data network.

3.4 General Care

The TRIMMARK III radio modem is designed to tolerate the normal rough treatment that equipment can suffer in the field. However, these units are high-precision electronic instruments, and should be treated with reasonable care. The radio modems operate in temperatures from –40° to +65° Celsius (–40°F to +149°F). The enclosures are sealed and buoyant.

Warning – Operating or storing your TRIMMARK III radio modem outside the specified temperature range can destroy or limit the longevity of the instruments.

3.5 Service

There are no user serviceable parts with the TRIMMARK III. Contact your Trimble dealer for information about obtaining service for your product. Refer to the Preface at the front of this manual for information about getting technical assistance.

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4 Regulations and Safety

Regulations regarding the use of the radio modems vary greatly from country to country. In some countries, the unit can be used without obtaining an end-user license. However, most countries require end-user licensing. Consult your local communications governing agency for licensing information.

Before operating a TRIMMARK III radio modem, determine if authorization or a license to operate the unit is required in your country. **Obtaining an operator's permit or license for the TRIMMARK III for the location or country-of-use is the responsibility of the end user.**

Note – This device complies with Part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

4.1 Type Approval

Type Approval, or acceptance, covers technical parameters of the equipment related to emissions that can cause interference. Type Approval is granted to the manufacturer of the transmission equipment, independent from the operation or licensing of the units. (Licensing or application for operation is the responsibility of the user.) Some countries have unique technical requirements for operation in certain radio modem frequency bands. To comply with those requirements, Trimble may have modified your equipment in order to be granted Type Approval. Unauthorized modification to the units voids the Type Approval, the warranty and the operational license of the equipment.

Caution – Changes or modifications to this equipment not approved, in writing, by Trimble Navigation Limited voids your authority to operate the equipment.

4.2 Licensing

Many countries require that the operator of a radio, or radio modem, obtain a license prior to operating the radio, or radio modem. Some do not. Consult your local communications governing agency for licensing information. **Obtaining an operator's permit or license for the TRIMMARK III for the location or country-of-use is the responsibility of the end user.**

Before operating this radio modem, you 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.

4.3 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.

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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 couple 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 any problems exist.

Communications equipment that uses more power is more likely to create 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. 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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Reader Comment Form

TRIMMARK III Operation Manual **November 1999**
P/N: XXXXX-00 **Revision A**

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