TrimTrac

TrimTrac Locator

Technical Manual

****DRAFT***

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Release Notice

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Notices

Class B Statement – Notice to Users. This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is

encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commission rules.

Regulatory Approvals

CE
The TrimTrac Locator product complies with the essential requirements of the R&TTE Directive 199/5/EC as stated by the EC Declaration of Conformity (CE0681) and the EC R&TTE Type Examination Certificate. The TrimTrac Locator product complies with the European Telecommunications Standards Institute Specifications ETS300-342-1 (EMC for GSM 900MHZ and DCS 1800MHZ Radio Equipment and Systems).

EEC
The TrimTrac Locator product complies with Directive 72/245/EEC as amended by Directive 95/54/EC (el*72/245*95/54).

FCC The TrimTrac product complies with the FCC Part 15, FCC Part 24, and Industry Canada requirements. The TrimTrac product complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.
FCC ID: JUPTRIMTRAC1

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About this Manual

Welcome to the *TrimTrac™ Locator Technical Manual*. This manual is intended for use by system integrators, service providers and application developers (collectively, "Resellers"). It is not intended for end-users of the TrimTrac locator. Any end-user documentation is to be prepared and furnished by the Resellers.

This manual covers the TrimTrac locator operating on 900 MHz, 1800 MHz and 1900 MHz Global System for Mobile communication (GSM) networks. Data and Event Reporting support is by Short Message Service (SMS). This manual describes how to set up, configure, install, operate, and troubleshoot the product. Even if you have used other GSM or Global Positioning System (GPS) products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GSM or GPS, visit Trimble Component Technologies' Web site dedicated to the TrimTrac product (www.trimtrac.com) for a look at the device, GSM and GPS. Trimble assumes that you are familiar with Microsoft Windows, including HyperTerminal, and know how to use a mouse, select options from menus and dialogs, make selections from lists, and refer to online help.

This manual is available in portable document format (PDF) from the following Web site: http://www.trimtrac.com/support

Related Information

Other sources of related information are:

- TrimTrac Web site at www.trimtrac.com . This site is dedicated to TrimTrac locator. Application notes, technical notes, and other useful product information are available from this site. These documents contain important information about software and hardware changes.

- Release notes – the release notes describe new features of the product, information not included in the manuals, and any changes to the manuals. The release notes are available for download from the above Web address.

- ftp.trimtrac.com – use the Trimble FTP site to send files or to receive files such as software patches, utilities, service bulletins, and FAQs. Alternatively, access the FTP site from the Trimble Web site: www.trimtrac.com/support.

Technical Assistance

If you have a problem and cannot find the information you need in the product documentation, please contact your local Trimble Component Technologies sales office or sales engineer. The technical support organization can be reached by telephone at +44-1256-746-239 or, when dialing from within the United States, at 1-800-767-4822.

TrimTrac

Safety First

Simple Guidelines

Please follow these guidelines when configuring or using the TrimTrac locator. Violating these guidelines may be dangerous, illegal or otherwise detrimental. Further detailed information is provided in this manual.

Do Not Operate Where Prohibited

Do not allow the TrimTrac locator to operate wherever wireless phone use is prohibited or when doing so may cause interference or danger. Examples include but are not limited to operation in hospitals, aircraft, near blasting sites or wherever operation can cause interference.

Interference

Like all wireless devices, the TrimTrac locator may encounter electrical interference that may affect its performance.

Avoid Body Contact with Device During Operation

Do not operate the TrimTrac locator in direct contact with your body. Maintain minimum separation distance of 0.6 inch (15 mm) between the device and any parts of your body.

Qualified Service

Except for batteries and Subscriber Identification Module (SIM) card, the TrimTrac contains no user serviceable or replaceable parts. Non-functioning units must be returned to an authorized service center for repair or replacement.

Accessories and Batteries

Use only approved accessories or batteries. Do not connect incompatible products. There is risk of explosion if batteries are replaced by an incorrect type. Dispose of used batteries according to the instructions provided with the batteries.

Water-Resistance

The TrimTrac locator is not waterproof. Even though it is water-resistant, it is recommended that it be used where it is relatively dry and not subjected to either water streams or submersion.

Detailed Safety Information

Exposure to Radio Frequency Signals

The TrimTrac locator is a low power radio transmitter and receiver. When it is ON, it receives and also sends out radio frequency (RF) signals.

In August 1996, the Federal Communications Commissions (FCC) adopted RF exposure guidelines with safety levels for hand-held wireless phones. Those guidelines are consistent with safety standards previously set by both U.S. and international standards bodies:

ANSI C95.1 (1992)

NCRP Report 86 (1986)

ICNIRP (1996)

Those standards were based on comprehensive and periodic evaluations of the relevant scientific literature. For example, over 120 scientists, engineers, and physicians from universities, government health agencies, and industry reviewed the available body of research to develop the ANSI Standard (C95.1)

While the TrimTrac locator is not intended for hand-held use, its design nonetheless complies with the FCC guidelines (and those standards).

Electronic Devices

Most modern electronic equipment is shielded from RF signals. However, certain electronic equipment may not be shielded against the RF signals generated by the TrimTrac locator.

Pacemakers

The Health Industry Manufacturers Association recommends that a minimum separation of six (6”) inches be maintained between a handheld wireless phone and a pacemaker to avoid potential interference with the pacemaker. These recommendations are consistent with the independent research by and recommendations of Wireless Technology Research.

Persons with pacemakers:

- Should ALWAYS keep the TrimTrac locator more than eight inches from their pacemaker with the device is operational.
- Should not carry the TrimTrac locator on their person

- If there is any reason to suspect that interference is taking place, the TrimTrac locator battery pack should be removed immediately.

Other Medical Devices

If any other personal medical devices are used in the vicinity of a TrimTrac locator, consult the manufacturers of the medical devices to determine if they are adequately shielded from external RF energy. Physicians may be able to assist in obtaining this information.

Disable operation of the TrimTrac locator by removing the battery pack in health care facilities when any regulations posted in these areas prohibit the use of wireless phones or two-way radios. Hospitals and health care facilities may be using equipment that could be sensitive to external RF energy.

Vehicles

RF signals may affect improperly installed or inadequately shielded electronic systems in motor vehicles. Check with the manufacturer or its representative regarding the vehicle. Also consult the manufacturer of any equipment that has been added to the vehicle.

Posted Facilities

Disable operation of the TrimTrac locator by removing the battery pack in any facility where posted notices prohibit the use of wireless phones or two-way radios.

Aircraft

FCC regulations prohibit using wireless phones while in the air. Disable operation of the TrimTrac locator by removing the battery pack prior to boarding or loading in an aircraft

Blasting Areas

To avoid interfering with blasting operations, disable operation of the TrimTrac locator by removing the battery pack when in a “blasting area” or in areas posted: “Turn off two-way radio”. Obey all signs and instructions.

Potentially Explosive Atmospheres

Disable operation of the TrimTrac locator by removing the battery pack prior to entering any area with a potentially explosive atmosphere and obey all signs and instructions. Sparks in such areas could cause an explosion or fire resulting in bodily injury or even death.

Areas with a potentially explosive atmosphere are often, but not always marked clearly. Potential areas may include: fueling areas (such as gasoline stations); below deck on boats; fuel or chemical transfer or storage facilities; vehicles using

liquefied petroleum gas (such as propane or butane); areas where the air contains chemicals or particles (such as grain, dust, or metal powders); and any other area where it would normally be advisable to turn off motor vehicle engines.

For Vehicles Equipped with an Air Bag

An air bag inflates with great force. DO NOT place objects, including the TrimTrac locator, in the area over the air bag or in the air bag deployment area. If in-vehicle wireless equipment is improperly installed and the air bag inflates, serious injury could result.

Specific Absorption Rates (SAR)

THE TRIMTRAC LOCATOR MEETS CERTAIN GOVERNMENT REQUIREMENTS FOR EXPOSURE TO RADIO WAVES.

The TrimTrac locator is a radio transmitter and receiver. It is designed and manufactured not to exceed the emissions limits from exposure to radio frequency (RF) energy set by the Federal Communications Commission of the U.S. government when used in accordance with the instructions set forth in this manual. These limits are part of comprehensive guidelines and establish permitted levels of RF energy for the general population. The guidelines are based on standards that were developed by independent scientific organization through periodic and thorough evaluation of scientific studies. The standards include a substantial safety margin designed to assure the safety of all persons, regardless of age and health.

The exposure standard for wireless mobile phones employs a unit of measurement known as the Specific Absorption Rate, or SAR. The SAR limit set by the FCC is 1.6W/kg.[1] Tests of SAR are conducted using standard operation positions specified by the FCC with the phone transmitting at its highest certified power level in all tested frequency bands. Although the SAR is determined at the highest certified power level, the actual SAR level of the phone while operating can be well below the maximum value. This is because the phone is designed to operate at multiple power levels so as to use only the power required to reach the network. In general, the closer the device is to a wireless base station antenna, the lower the power output.

Before a phone is available for sale to the public, it must be tested and certified to the FCC that it does not exceed the limit established by the government-adopted requirement for safe exposure when used in accordance with manufacturer instructions. The tests are performed in positions and locations (e.g. near or on the body) as required by the FCC for each model. The SAR value for the TrimTrac locator is less than 1.6 W/kg measured at a minimum separation

[1] In the United States and Canada, the SAR limit for mobile phones used by the public is 1.6 watts/kg (W/kg) averaged over one gram of tissue. The standard incorporates a substantial margin of safety to give additional protection for the public and to account for any variations in measurement.

distance of 0.6 inch (15 mm). The TrimTrac locator is not designed to be worn on a person's body.

The FCC has granted an Equipment Authorization for the TrimTrac locator with all reported SAR levels evaluated as in compliance with the FCC RF guidelines for devices not worn on the body. SAR information on the TrimTrac locator is on file with the FCC and can be found under the Display Grant section of http://www.fcc.gov/oet/fccid after searching on FCC ID: JUPTRIMTRAC1.

Additional information on Specific Absorption Rates (SAR) can be found on the Cellular Telecommunications & Internet Association (CTIA) Web site at http://www.phonefacts.net

Overview

Introduction

This manual covers the TrimTrac locator operating on 900 MHz, 1800 MHz and 1900 MHz GSM networks. As used in this manual, the term GSM shall include any and all of these frequencies.

Regulatory Approvals

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(2) This device must accept any interference received, including interference that may cause undesired operation.

TrimTrac Locator

The TrimTrac locator is housed in a single, compact enclosure that simplifies installation and leads to greater reliability. The standard TrimTrac locator has four end-user replaceable alkaline AA batteries and there are no external antennas or other external connections. This package is a mobile communications and

positioning system module ideally suited for high volume automotive and asset management applications requiring a low-cost, battery or externally powered tracking device. It operates over the GSM cellular networks and allows simple, fast, and efficient transfer of information between a mobile asset and an application hosted either on a server or on an end-user PC.

Standard Features

The TrimTrac locator integrates the following into a single package:

- GSM 900/1800/1900 MHz modem
- High-sensitivity, 12-channel GPS receiver
- Internal GSM and GPS antennas
- TrimTrac application firmware and other integrated functions
- Password-protected data communications
- Support for limited data logging that allows the TrimTrac locator to store up to 128 position or status records for subsequent download

Subscriber Identity Module (SIM)

You must install a SMS-enabled Subscriber Identity Module (SIM) that has been initialized by your GSM service provider.

Optional Plug-In Modules

The following options are available as plug-in modules that replace the standard TrimTrac locator batteries:

- **Provisioning Module.** Allows configuration of the TrimTrac locator via a USB connection to a PC
- **Vehicle Adapter Module.** Allows connection to an external 9-32 VDC power supply and provides 2 open/closed switch-monitoring connections.

Global System for Mobile Communications

Cellular mobile telephone systems are widely available throughout the world. However, because cellular mobile telephone systems are regulated at the national level, these systems are not generally compatible with each other. To resolve the dilemma of being able to communicate from almost anywhere, but only within your own system, the European telecommunications operators—the Conference of European Postal and Telecommunications Administration (CEPT)—designed a new mobile telephone network.

This network has evolved into GSM, and CEPT has turned over management of GSM to the European Technical Standards Institute (ETSI). GSM is the predominant mobile communications system throughout the world. Outside the United States, most GSM systems operate at 900 MHz, 1800 MHz or both and services provided by these networks are generally referred to as Digital Communication Services (DCS). The United States GSM system operates at 1900 MHz and is generally referred to as Personal Communication Service (PCS).

GSM Cellular Phone System

The Global System for Mobile (GSM) protocol offers a variety of data services that allow users to send and receive data at rates of up to 9600 bps. Data can be delivered over ISDN, Packet Switched or Circuit Switched Data Networks (PSDN or CSDN) and via the Short Message Service (SMS). The TrimTrac locator uses SMS, which is a store-and-forward service for the bi-directional exchange of alphanumeric messages of up to 160 characters.

Architecture of the GSM network

Any asset tracking or management system on GSM consists of several distinct components. The TrimTrac locator is the mobile unit that is installed in the vehicle, equipment or other mobile asset and contains the Subscriber Identity Module (SIM). The SIM card contains a unique International Mobile Subscriber Identity (IMSI) number. This enables the network to identify the user and therefore allow the terminal to have access to specific, subscriber services.

The GSM system is made up of two sections:

- The Base Station Subsystem that controls the radio link with the mobiles through local cells

- The Network Subsystem that controls the switching of calls between the network users, mobile to mobile, and between mobile and fixed lines

The Network Subsystem stores all administrative information including the current cell being used by the mobile unit that allows call routing and the roaming ability of GSM. An important feature of GSM is this ability to move across international and network borders, a feature that is described as "roaming." If arrangements have been made with the service provider, the SIM card will be enabled for roaming.

- Mobile Station (MS)
    - The TrimTrac locator includes a radio transmitter and receiver.
    - Subscriber Identity Module (SIM) – an electronic card containing a computer chip. The chip contains the subscriber information and operating system parameters. SIMs provide authentication, encryption, information storage, and subscriber account protection services (including Personal Identity Number or PIN, and Pin Unblocking Key or PUK). GSM users can move the SIM from one TrimTrac locator to another.

- Other network components (part of the GSM network)
    - Short Message Service Center (SMSC)
    - Delivers text messages (up to 160 characters) to GSM users.

GSM Operational Overview

The TrimTrac locator operates in accordance with the state diagram more fully described in the Operation chapter beginning on page 25 of this manual.

Whenever the TrimTrac locator has a new position or status to report, it updates its Status Message. The TrimTrac locator then enters the GSM Transmit State and automatically searches for a GSM network using a set of tables on the SIM card to determine which GSM network the phone should try to reach.

These tables are the Public Land Mobile Network (PLMN) tables and each GSM network has its own unique PLMN number. This number is the Mobile Country Code (MCC) and the Mobile Network Code (MNC), which are also the first numbers of the subscriber's IMSI. (The IMSI is the MCC, plus the MNC, plus the Mobile Station Identification Number.) The PLMN table finds either the subscriber's home network or a network that will allow service, and registers to the network consistent with the handset.

The responding network's Mobile Switching Center (MSC) passes this request for service to the Visitor Location Register (VLR). If the VLR has information about this IMSI, then it passes the request to the authentication center. If the VLR cannot find any information on this IMSI, it must pass the request to the Home Location Register and get approval before passing on the request.

Once the VLR has approval to grant the request for service, it knows the user identity, what features are authorized, and the authentication codes. The VLR then passes the request back to the MSC for routing to destination address specified by the TrimTrac locator. If the destination address is a land-based number, the MSC passes the call to the Public Switched Telephone Network (PSTN) for connection. If the destination address is another mobile number, the MSC repeats the process described above to locate the number being dialed.

Global Positioning System

The Global Positioning System (GPS) is a satellite-based navigation system operated and maintained by the U.S. Department of Defense. GPS consists of a constellation of 24 satellites providing worldwide, 24-hour, three-dimensional (3D) coverage. Although originally conceived for military needs, GPS has a broad array of civilian applications including timing, surveying, fleet management, marine, land, aviation, and vehicle navigation. GPS is the most accurate technology available for navigation. As a satellite-based system, GPS is immune from the limitations of land-based systems, which have limited coverage and whose accuracy varies with geographic location and, even under ideal conditions, cannot compare with GPS. By computing the distance to GPS satellites orbiting the earth, a GPS receiver can calculate an accurate position. This process is called satellite ranging. GPS receivers can also provide precise time, speed, and course measurements that are important for vehicle mobile positioning and communications applications.

GPS Receiver

The TrimTrac locator includes an advanced GPS receiver, which provides the position, course, speed and time information required for mobile asset management applications. The TrimTrac locator's GPS receiver features a twelve-

channel digital signal processor (DSP) which operates at the GPS L1 frequency (1575.42 MHz) and processes the Coarse/Acquisition (C/A) code portion of the GPS signal. The RF and digital signal processing components of the GPS module are custom ASICs designed by Trimble.

TrimTrac Locator Defaults

Introduction

The following tables describe the factory default settings of the TrimTrac locator. All such default settings can be changed to suit the particular application requirements. While most of the settings can be configured or changed by sending the appropriate SMS text messages over the GSM network, certain fields such as the Device Identification number, Security Password and SIM PIN can only be entered or changed while the device is connected to a PC using the Provisioning Module. Please refer to the TrimTrac Application chapter beginning on page 31 for detailed descriptions of each TrimTrac state.

Factory Default Settings

Parameter	Unit/Notes	Default
Unit ID	Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY, and can only be changed using Provisioning Module.	00000000
Destination Address	Valid destination address for SMS messages must be entered prior to initial deployment. Max. 24 characters including international dialing "+" sign and country code.	<Empty>
SIM PIN	Entered only if required by SIM card and can be entered or changed using Provisioning Module. If used, must be between 4 and 8 digits.	<Empty>
Security Password	Always 8 alphanumeric characters, UPPER CASE ONLY, and must be entered using Provisioning Module prior to initial deployment.	00000000
Idle Timeout, T1	In seconds (10 – 999990)	43200
Fix Timeout, T2	In seconds (10 – 3600)	300
Comm Timeout, T3	In seconds (10 – 3600)	120

Sleep Time, T4	In seconds (10 – 86400)	900
Query Time, T5	In seconds (10 – 3600)	60
Almanac Timeout, T6	In hours (10 – 990)	168
Motion Timeout, T7	In seconds (5 – 90)	15
Motion Report Flag	0:None; 1:Report first motion before GPS fix	0
Report Delay Flag	0:Log & Transmit messages; 1:Log messages only	0
Diagnostics Mode	0: None; 1: LED	1
Communication Mode	0: SMS; 1: Future	0
GPS Elevation Mask	In degrees (0-30)	5
GPS Signal Level Mask	In tenths of AMUs (10 – 80)	10
GPS PDOP Mask	In tenths of PDOP (60 – 200)	120
GPS PDOP Switch	In tenths of PDOP (40 – 120)	60
Dynamics Mode	Undefined = 0 Land = 1 Sea = 2 Air = 3 Stationary = 4 Automobile = 5	5

Table 1 Factory Default Parameters

Read-Only Parameters

Parameter	**Unit/Notes**
Firmware Version	Version of the firmware
Battery Condition	Remaining battery power
Battery Changed Flag	0/1 (if battery changed)
Battery Change Time	GPS Time

Table 2 Read Only Parameters

Security Considerations

Communication Security

The security of the TrimTrac locator supports Short Message Peer to Peer (SMPP) protocol, which allows the application server or wireless carrier to insert any originating address into the messages it sends to the TrimTrac locator. To maintain the security of the TrimTrac locator it will only accept an incoming TrimTrac Application message if its Unit ID field matches its own Unit ID and the password field matches its password. This will ensure that only the server application will be able to send commands to direct it to report to a different location or to start reporting at a different rate.

Configuration Security

The configurable parameters are divided into two groups, the provisioning group and the read/write group.

- The provisioning group includes parameters that are only read from once the TrimTrac locator enters normal usage. They are set at either time of manufacturing or possibly time of provisioning. Some are never written only read from. The values such as the Unit ID and Firmware Version are written at time of manufacturing. The Destination Address is written at time of provisioning or can be changed over the air using the SET_PROV_CONFIG message. The battery status values are updated by the firmware and only read from by the user.
- The read/write group includes operational parameters that are changed as a part of the normal operation of the TrimTrac locator. Sending a TrimTrac Application message to the TrimTrac locator over the air could change all these values. Using these messages the server application can change the functionality of the TrimTrac locator. The communication security methods will protect these values from being changed by an unauthorized user.

The SIM PIN is a feature of GSM SIMs that allows the owner of the SIM to put a lock on the SIM. In order to use the account associated with the SIM, the user of the GSM device must provide the SIM PIN after SIM insertion or device power up. The SIM PIN setting is stored in the firmware and is used if the SIM requests it. If requested, the SIM PIN is used to attempt to unlock the SIM. If the unlock fails, the SIM PIN is marked as having caused a failure and not retried until the user physically connects the TrimTrac locator to a provisioning module and issues a new AT command changing the SIM PIN. This is to prevent the SIM from becoming unusable after 10 SIM PIN failures. The SIM PIN cannot be read back once set. It can only be overwritten.

Diagnostics

When the Diagnostics Mode is enabled and set to 1 (LED) the LED on the TrimTrac locator will blink at different rates depending on the TrimTrac locator's operational state. If the TrimTrac locator is powered off the LED is off. If the estimated battery life is below the threshold of 10% the LED is turned on continuously while the TrimTrac locator is operational and not blinked. Only if the batteries are good will the following blinking rates apply:

IDLE:	250ms ON / 250 ms OFF.
FIX:	2000ms ON / 2000 ms OFF.
TRANSMIT:	200ms ON / 1800ms OFF
QUERY:	1800ms ON / 200ms OFF.
DELAY:	Always OFF.

TrimTrac Locator Configuration

Introduction

Configuration is the process of setting the operational and communication parameters of the TrimTrac locator. Most, but not all, of these parameters can be set or changed over the air; however, certain parameters such as the Unit Identification number, Security Password and SIM personal identification number (PIN) must be set prior to first use and can only be changed when the TrimTrac locator is connected to a PC via a Provisioning Module.

Personnel without prior configuration or provisioning experience should familiarize themselves with the TrimTrac operation and application characteristics as more fully described in the Operation chapter beginning on page 25.

Provisioning Mode

Before a new TrimTrac locator can be used for the first time, it must be properly configured. This entails substituting the Battery Pack Module or other optional modules with a Provisioning Module and then connecting it to the USB port on a Microsoft Windows-based PC. Microsoft's HyperTerminal is then used as the primary programming interface to send the proper AT Commands. The AT Commands are described in this section and must be used the first time the TrimTrac locator is provisioned. Text fields need to be enclosed in quotation marks "_".

Provisioning Set-up

Before a TrimTrac Provisioning module can be connected and used with an USB-equipped Microsoft Windows-based PC, the appropriate USB drivers and HyperTerminal program must be installed on the PC.

FTDI Driver Loading

The TrimTrac Provisioning Module uses an USB interface chip from Future Technology Devices International Ltd. (FTDI). The easiest way for HyperTerminal to communicate with the Provisioning Module is to download and install the appropriate FTDI driver on the PC on which HyperTerminal will run.

These Windows drivers are available from FTDI for download and use at:

www.ftdichip.com/FTWinDriver.htm

Select, download and install the VCP Driver for either Win'98 / ME / 2000 / XP (with enhanced BM series support) driver following the instructions provided on the Web site and with the driver.

HyperTerminal

HyperTerminal is a standard program included in all current versions of Microsoft Windows and can be typically found in the Communications directory under Accessories. If HyperTerminal is not already installed on the Windows PC that will be used to configure the TrimTrac locator, you will need to install it from your original Windows CDs.

Connecting the Devices

Once the FTDI USB device driver and HyperTerminal program are installed on the PC, connect the TrimTrac locator and Provisioning Module to the PC USB port as follows:

1. Remove the TrimTrac battery pack from the base TrimTrac locator
2. Install an active SMS-enabled SIM card in the base unit SIM card holder
3. Insert Provisioning Module into base TrimTrac locator and secure it using screw provided.
4. Connect the USB Type-A Male end of the data cable to the Provisioning Module
5. Connect the other USB Type-A Male end of the cable to the PC USB port.

Beginning a Provisioning Session

To commence a provisioning session, you must start HyperTerminal in the following steps

1. Start HyperTerminal from the Windows, Start, All Programs, Accessories, Communications menu.
2. A “New Connection” panel will appear and enter “TrimTrac” for the New Connection Name and click “OK” button
3. A “Connect Using” panel will appear and from the pull down menu select the Com port you designated as the USB port when you installed the FTDI driver (commonly, COM4)
4. On the next panel and under “Port Settings”, select the following from the pull down menus:
    - Bits Per Second: 115200
    - Data Bit 8
    - Parity None
    - Stop Bits 1
    - Flow Control None

    Click “OK” when done.

5. If you wish to view what you type on the HyperTerminal Screen, click on File, Properties, Settings, ASCII Settings and checkmark the "Echo Typed Characters Locally" box. Click "OK" to close each panel.
6. To check whether you have successfully connected the TrimTrac and Provisioning Module to HyperTerminal, type:
    - at+ctkc?
7. Assuming the factory default configuration has not been previously changed, the following response should appear:
    - +ctkc: 43200,300,120,900,60,168,15,0,0,1,0
    - OK
8. You are now ready to begin provisioning the TrimTrac locator(s) by typing the AT+commands described in the following sections.
9. When complete, reinstall the battery pack with four "AA" batteries.

Configuring Multiple Units

If multiple TrimTrac locators need to be configured, then you can send the units text files with the desired settings rather then typing individual AT+commands. For instance, sending the following from a text file sets the TrimTrac locator to its default settings and confirms the final settings and firmware version number:

```
at+ctkp="00000000","","","00000000"
at+ctkp?
at+ctkc=43200,300,120,900,60,168,15,0,0,1,0
at+ctkc?
at+ctkg=5,120,60,10,5
at+ctkg?
Ati
```

To configure HyperTerminal to send text files to the TrimTrac locator, select Echo and set the line delay to 500 milliseconds from the HyperTerminal ASCII Setup panel under File, Properties, Settings.

To send a text file, select and open the desired text file from Transfer, Send Text File panel.

Provisioning Commands

Provisioning Command Summary

The following AT commands are used to provision and configure the TrimTrac locator via HyperTerminal when connected to the Provisioning Module.

AT+CTKP	Assigns Communication parameters
AT+CTKP?	Queries Communication parameters
AT+CTKC	Assigns Application parameters
AT+CTKC?	Queries Application parameters
AT+CTKG	Assigns GPS parameters
AT+CTKG?	Queries GPS parameters

Table 3, Summary of Provisioning Commands

AT+CTKP Application Provisioning

Prior to the TrimTrac locator being used for the first time, the application must be provisioned using this command. The AT+CTKP command configures the Communication parameters. This command is the only method to change the Unit ID, SIM PIN and Security Password. It can query the current settings or change them to new values.

AT+CTKP=<Unit ID>, <Destination Address>, <SIM PIN>, <Security Password> OK	
<Unit ID>	Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,. Must use quotation marks "_". Default "00000000"
<Destination Address>	Max. 24 characters including international dialing "+" sign and country code. Must use quotation marks "_" Default <Empty>
<SIM PIN>	If used, must be between 4 and 8 digits. Must use quotation marks "_" Default <Empty>
<Security Password>	Always 8 alphanumeric characters, UPPER CASE ONLY,. Must use quotation marks "_" Default "00000000"

Table 4 AT+CTKP Assignment

AT+CTKP? +CTKP: <Unit ID>, <Destination Address >, <SIM PIN>, <Security Password> OK	
<Unit ID>	Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
<Destination Address>	Max. 24 characters including international dialing "+" sign and country code.
<SIM PIN>	""
<Security Password>	"********"

Table 5 AT+CTKP Query

Note that when the SIM PIN field and the Security Password fields are queried using either AT+commands or TrimTrac Application Protocol messages, they are shown masked out with the '*' character to prevent theft of the information.

AT+CTKC Application Configuration

The AT+CTKC command is used to configure the Read/Write parameters of the TrimTrac locator. It can query the current settings or change them to new values.

AT+CTKC=<Idle Timeout>, <Fix Timeout>, <Comm Timeout>, <Sleep Time>, <Query Time>, <Almanac Timeout>, <Motion Timeout>, <Motion Report Flag>, <Report Delay Flag>, <Diagnostics Mode>, <Communications Mode> OK	
<Idle Timeout>	In seconds (10 – 999990). Default 43200
<Fix Timeout>	In seconds (10 – 3600). Default 300
<Comm Timeout>	In seconds (10 – 3600). Default 120
<Sleep Time>	In seconds (10 – 86400). Default 900
<Query Time>	In seconds (10 – 3600). Default 60
<Almanac Timeout>	In hours (10 – 990). Default 168
<Motion Timeout>	In seconds (5 – 90). Default 15
<Motion Report Flag>	0:None; 1:Report first motion before GPS fix. Default 0
<Report Delay Flag>	0:Log & Transmit messages; 1:Log messages. Default 0
<Diagnostics Mode>	0: None; 1: LED. Default 1
<Communications Mode>	0: SMS; 1: Future. Default 0

Table 6 AT+CTKC Assignment

AT+CTKC? +CTKC<Idle Timeout>, <Fix Timeout>, <Comm Timeout>, <Sleep Time>, <Query Time>, <Almanac Timeout>, <Motion Timeout>, <Motion Report Flag>, <Report Delay Flag>, <Diagnostics Mode>, <Communications Mode> OK	
<Idle Timeout>	In seconds (10 – 999990). Default 43200
<Fix Timeout>	In seconds (10 – 3600). Default 300
<Comm Timeout>	In seconds (10 – 3600). Default 168
<Sleep Time>	In seconds (10 – 86400). Default 900
<Query Time>	In seconds (10 – 3600). Default 60
<Almanac Timeout>	In hours (10 – 990). Default 168
<Motion Timeout>	In seconds (5 – 90). Default 15
<Motion Report Flag>	0:None; 1:Report first motion before GPS fix. Default 0
<Report Delay Flag>	0:Log & Transmit messages; 1:Log messages. Default 0
<Diagnostics Mode>	0: None; 1: LED. Default 1
<Communications Mode>	0: SMS; 1: Future. Default 0

Table 7 AT+CTKC Query

AT+CTKG GPS Configure

The AT+CTKG command configures the GPS parameters. This command mirrors the functionality of the over-the-air GPS_CONFIG message. It can query the current settings or change them to new values.

AT+CTKG=<Elevation Mask>, <PDOP Mask>, <PDOP Switch>, <AMU Mask>, <Dynamics Mode> OK	
<Elevation Mask>	In degrees (0-30). Default 5
<PDOP Mask>	In tenths of PDOP. Default 120
<PDOP Switch>	In tenths of PDOP. Default 60
<AMU Mask>	In tenths of AMUs. Default 10
<Dynamics Mode>	Undefined = 0 Land = 1 Sea = 2 Air = 3 Stationary = 4 Automobile = 5; Default 5

Table 8 AT+CTKG Assignment

AT+CTKG? +CTKG<Elevation Mask>, <PDOP Mask>, <PDOP Switch>, <AMU Mask>, <Dynamics Mode> OK	
<Elevation Mask>	In degrees (0-30). Default 5
<PDOP Mask>	In tenths of PDOP. Default 120
<PDOP Switch>	In tenths of PDOP. Default 60
<AMU Mask>	In tenths of AMUs. Default 10
<Dynamics Mode>	Undefined = 0 Land = 1 Sea = 2 Air = 3 Stationary = 4 Automobile = 5. Default 5

Table 9 AT+CTKG Query

Use Guidelines

Introduction

The TrimTrac locator is a completely self-contained end-user device. As such no specific installation is required. There are no external connections required for antennas or power when used in its standard battery-powered configuration. Like all GPS and wireless devices, the TrimTrac locator will work best where it can have a relatively unobstructed view of the sky and wireless base station antenna. Nonetheless, the TrimTrac locator employs advanced GPS technology that increases its ability to acquire weak GPS signals. This allows the device to be deployed in environments where traditional GPS receivers may not be able to determine location.

General Guidelines

Placement and Orientation

Generally, the TrimTrac will perform best when used as close as possible to horizontal plane, preferably with reasonably unobstructed clearance around the unit. Field test indicate that the TrimTrac locator will perform reasonably well when placed in the glove box or under the front passenger seat in many contemporary automobiles. It should not be installed in the trunk of a vehicle unless it can be place near or under the rear window package shelf. Try to avoid placing the unit where its view of the sky is obstructed by metal or surfaces painted with metallic paint.

RF Jamming

The TrimTrac locator should be installed as far away as possible from transmitting antennas, including satellite communication, radar, VHF and cellular. These transmitters may emit jamming signals that interfere with the GPS receiver's ability to track GPS satellite signals. Generally, the stronger the other transmitting device, the wider the distance required between antennas. For the TrimTrac locator, a minimum clearance of 45 cm (approximately 18 in.) from these transmitting devices is recommended.

Mounting

The TrimTrac locator is provided with mounting tabs that can be used to secure the device to a flat surface using screws or similar fasteners. In the event these mounting tabs are not to be used, they can be broken-off by working them back and forth.

Environmental Conditions

The TrimTrac locater mounting location must not exceed the environmental specifications of the device. For instance, it cannot be installed inside a vehicle's engine compartment, wheel well, chassis or any other location in which the conditions can reasonably be expected to exceed the device environmental specifications.

Exposure to RF Radiation

As noted in the Safety First and Detailed Safety Information chapters, on pages 1 and 2, respectively, the TrimTrac locator is not to be used in direct contact with the body. A minimum separation distance of 0.6 inch (15 mm) must be maintained during operation. The TrimTrac locator is not intended for body-worn applications.

Batteries

The TrimTrac locator is designed to work with four standard AA alkaline batteries. Insert the batteries with the positive and negative polarities as indicated on the battery pack label. Do not reverse polarities or use non-alkaline AA batteries; otherwise, permanent damage to the TrimTrac locator may result or there may be a risk of explosion or fire. Dispose of used batteries in accordance with the battery manufacturer instructions.

Operation

Introduction

This chapter covers in detail the operational characteristics of the TrimTrac locator. It is important to understand how the TrimTrac operates before factory default settings are altered.

Operational State Machine

The TrimTrac locator operates in accordance with the state diagram shown in Figure 1 below.

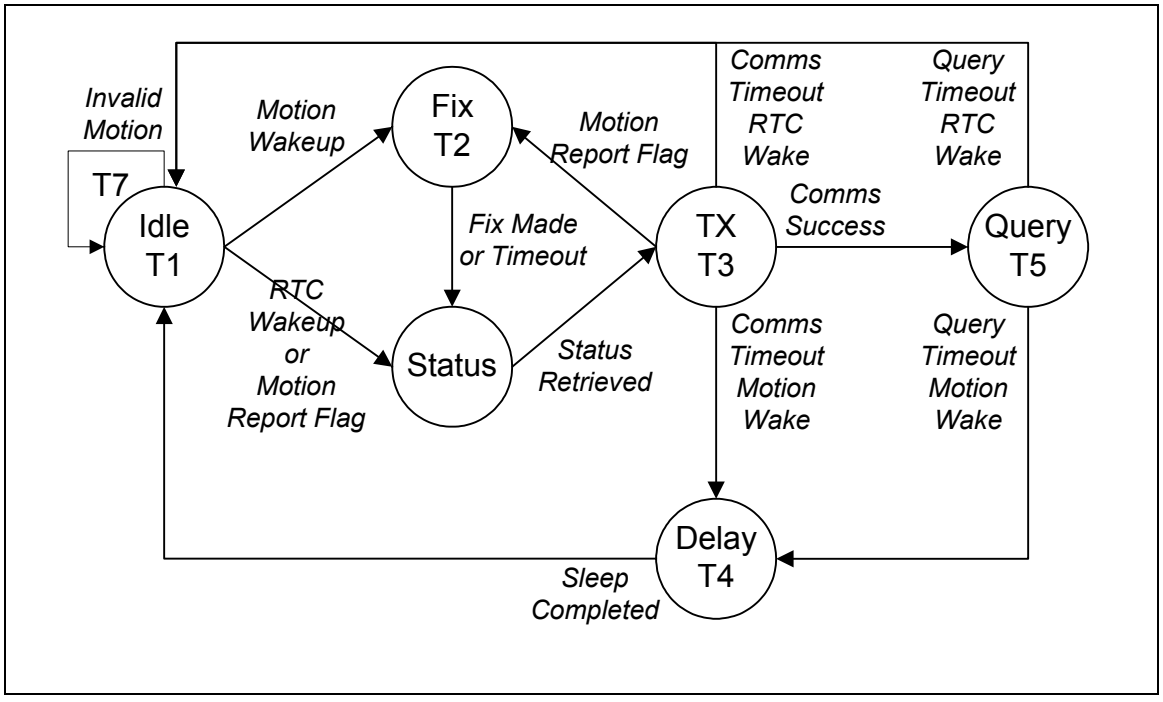

Figure 1, TrimTrac Operational State Diagram

IDLE State

In a typical application, the TrimTrac locator spends a majority of the time in the IDLE state. While in the IDLE state, the device monitors the motion sensor and the Real Time Clock (RTC) countdown timer, T1, is running.

The TrimTrac locator will transition from the IDLE state to either the FIX or STATUS states as follows:

1. To the FIX state if:
    a. Motion is detected during the IDLE state for more than T7 seconds ("Motion Timeout") AND the Motion Report Flag is set to FALSE ("0"); OR
    b. Motion has been detected between the time the motion detector latch was last reset and before the device entered the current IDLE state, regardless how the Motion Report Flag is set.
2. To the STATUS state if:
    a. The Motion Report Flag is set to TRUE ("1") AND motion is detected during the IDLE state for more than T7 seconds; provided, however, that no motion has been detected between the time the motion detector latch was last reset and before the device entered the current IDLE state; OR
    b. The RTC Wakeup countdown timer, T1, has expired.

A fundamental operational premise of the TrimTrac locator is to compute and send position reports only if the device has moved. To repeatedly report position even though there has been no motion would needlessly reduce battery-life while increasing communication costs.

The purpose of the Motion Timeout, T7, is to minimize false detections of motion while the TrimTrac locator is stationary. Typical Motion Timeouts are in the range of 15 to 20 seconds.

Certain applications may benefit from knowing as soon as possible when motion first occurs rather that waiting for a position fix to be calculated first. The purpose of the Motion Report Flag is to cause a Motion Report to be generated and sent as soon as possible upon detection of motion and then computing a new position fix.

If the unit is at rest, but there has been motion since the last time the motion detector latch had been reset, the unit will attempt one final position fix once the DELAY state timer, T4, has expired. In so doing, the unit will report its current at-rest position if a successful fix has been achieved. Whether or not the unit was successful in obtaining this fix, no further position fixes will be attempted until subsequent motion is detected.

The purpose of the RTC Wakeup countdown timer, T1, is to periodically report into the server application during extended stationary periods. In so doing, the health and status of the TrimTrac locator is verified and queued SMS messages

can be delivered to the TrimTrac locator. The server may at this time request status and logged data from the TrimTrac locator or change its configuration parameters. Typical RTC Wakeups are in the range of 12 to 24 hours expressed in seconds.

FIX State

The TrimTrac locator enters the FIX state from either the:

1. IDLE state; OR
2. TRANSMIT state.

Upon entering the FIX state, the TrimTrac locator will:

1. Power up the GPS hardware;
2. Start the GPS countdown timer, T2;
3. Attempt to compute new position fix before the GPS countdown timer, T2, expires.
4. Collect almanac date and ephemeris data if and only if the Almanac/Ephemeris countdown timer, T6, has expired (typically every few days).

The TrimTrac locator will transition from the FIX state to the STATUS state whenever either of the following occurs:

1. A new position fix is achieved; or
2. The GPS Timeout countdown timer, T2, expires.

Upon transition from the FIX state, the TrimTrac locator will:

1. Reset the RTC Wakeup countdown timer, T1; and
2. Power down the GPS hardware.

The TrimTrac locator will initially attempt a position fix using standard signal strength sensitivity settings; however, it will automatically switch to enhanced sensitivity settings if it is unable to acquire a sufficient number of satellites to compute at least a 2-D position.

In practice, it is best to position the TrimTrac locator with as clear of a view of the sky as possible even though it has the ability to automatically switch to enhanced sensitivity. In so doing, the average time to compute position fixes will be reduced (38 second versus 400 second warm starts for –130 dBm and –136 dBm signal strengths, respectively) while realizing commensurate reductions in power consumption and improvements in battery-life.

STATUS State

The TrimTrac locator enters the STATUS state from either the:

1. FIX state; OR
2. IDLE State

Upon entering the STATUS state from the FIX state, the TrimTrac locator will:

1. Collect the latest status information, including battery levels;
2. Store latest status and position information into appropriate report structures; and
3. Reset motion detection logic.

Upon entering the STATUS state from the IDLE state, the TrimTrac locator will:

1. Collect the latest status information, including battery levels; and

Store latest status and position information into appropriate report structures.

Upon completion of these tasks, the TrimTrac locator will transition from the STATUS state to the TRANSMIT state.

TRANSMIT State

Upon entering the TRANSMIT state from the STATUS state, the TrimTrac locator will:

1. Power up the GSM hardware;
2. Start the TRANSMIT countdown timer, T3;
3. Attempt find a suitable 900, 1800 or 1900 MHz GSM network, establish SIM communication and register on the network; AND
4. If a suitable GSM network connection is made, transmit the latest available status and position information before the TRANSMIT countdown timer, T3, expires.

The TrimTrac locator will transition from the TRANSMIT state whenever any of the following occurs:

1. The GSM protocol stack confirms that queued TrimTrac locator messages have been sent; OR
2. The TRANSMIT Timeout countdown timer, T3, expires; OR
3. Connection to the GSM network is lost

The TrimTrac locator will transition from the TRANSMIT state to either the IDLE, FIX, QUERY or DELAY states as follows:

1. To the IDLE state if:

a. The TRANSMIT Timeout countdown timer, T3, expires; AND

b. Expiration of the RTC Wakeup countdown timer, T1, caused the initial transition from the most recent IDLE state to the STATUS state.

2. To the FIX state if:

a. Motion Report is set to TRUE ("1"); AND

b. The most recent transition from the IDLE state to the STATUS state was caused by motion during the IDLE state for more than T7 seconds; AND

c. No motion had been detected between the time the motion detector latch was last reset and before the device entered the most recent IDLE state; AND

d. The GSM protocol stack confirms that queued Motion Report has been sent.

3. To the QUERY state if the GSM protocol stack confirms that queued TrimTrac locator messages, other than a Motion Report, have been sent.

4. To the DELAY state if:

a. The TRANSMIT Timeout countdown timer, T3, expires; AND

b. The most recent transition from the IDLE state to the STATUS state was caused by motion during the IDLE state for more than T7 seconds.

Upon transitioning from the TRANSMIT state to any state other than the QUERY state, the TrimTrac locator will power off the GSM hardware.

QUERY State

Upon entering the QUERY state from the TRANSMIT state, the TrimTrac locator will:

1. Start the QUERY countdown timer, T5;
2. Standby to receive and acknowledge any messages from the server application sent via the GSM network.

The TrimTrac locator will transition from the QUERY state when the later of the following occurs:

1. The QUERY Timeout countdown timer, T5, expires; OR
2. The TrimTrac locator has finished processing any messages received prior to expiration the QUERY Timeout countdown timer, T5.

The TrimTrac locator will transition from the QUERY state to either the IDLE or DELAY states as follows:

1. To the IDLE state if expiration of the RTC Wakeup countdown timer, T1, caused the initial transition from the most recent IDLE state to the STATUS state.
2. To the DELAY state if motion caused the initial transition from the most recent IDLE state to either the FIX or STATUS state:

Upon transitioning from the QUERY state, the TrimTrac locator will power off the GSM hardware.

DELAY State

Upon entering the DELAY state from either the TRANSMIT or QUERY states, the TrimTrac locator will:

1. Start the DELAY countdown timer, T4; AND
2. Power off or otherwise disable all functions other than the RTC Wakeup logic.

The TrimTrac locator will transition from the DELAY state to the IDLE state if and only if the DELAY Timeout countdown timer, T4, expires.

TrimTrac Application Protocol

Introduction

The TrimTrac Application Protocol is used to communicate with and control TrimTrac locators that have already been provisioned and deployed to the field.

The TrimTrac locator communicates with the server application by sending and receiving SMS messages based on an ASCII-like protocol (in lieu of the AT+commands used during initial provisioning). This TrimTrac Application Protocol uses the same message structure as the Trimble ASCII Interface Protocol (TAIP) even though no TAIP messages defined for Trimble products other than the TrimTrac locator are used. It is used to communicate with and control TrimTrac locators that have already been provisioned and deployed to the field.

For security reasons, the only parameters that cannot be changed over-the-air using the TrimTrac Application Protocol are the Unit Identification number, SIM PIN and Security Password.

Message Format

Basic Message

All TrimTrac Application Protocol messages use printable ASCII characters. Upper case and lower case alpha characters are generally interchangeable, i.e., lower case characters are converted to upper case alpha in the TrimTrac locator before parsing.

Each message has the following general format with the contents of the data string being message dependant. Valid messages are limited to 128 characters.

>ABB{C}[;PW=PPPPPPPP];ID=YYYYYYYY;*ZZ<

Element	Meaning
>	Start of new message
<	End of message
A	Message Qualifier (Q, R, or S)
BB	2-character Message Identifier (Must be TK)
C	Data string.
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,.

Element	Meaning
	Default 00000000
ZZ	2-character checksum.
{x}	Signifies that x can occur zero or more times
[x]	Signifies that x may optionally occur once

Table 10, Basic Message Format

Message Framing

Each TrimTrac Application Protocol message is framed by the start, end ASCII characters '>', '<', respectively. These characters are not allowed other than as start-of-message and end-of-message indicators.

Message Qualifiers

A one-character Message Qualifier is used to describe the action to be taken on the message. The following table lists the valid qualifiers:

Qualifier	Action
Q	Query for data or parameters (sent to TrimTrac locator)
S	Set or configure parameters (sent to TrimTrac locator)
R	Response to a query or a scheduled or autonomous report (from the TrimTrac locator)

Table 11, Message Qualifiers

Data String

The Message Qualifier and the Message Identifier dictate the format and length of the data string. The Data String can consist of any printable ASCII characters with the exception of the > and < characters. Most messages are length sensitive and many use the ';' character as field separator.

Security Password

A Security Password (PW) must be used in all communications with the TrimTrac locator. The default Security Password is set to '00000000'; however, the TrimTrac locator may be assigned any numeric password of up to eight characters while the TrimTrac locator is connected to a provisioning module.

The TrimTrac locator checks all incoming messages for a Security Password and all incoming message must include a Security Password. If the Security Password included in a message sent to TrimTrac locator does not match the Security Password configured in the TrimTrac Device, then the message is ignored.

Unit ID

Unit Identification (ID) must be used in all communications with the TrimTrac locator. The TrimTrac locator may be assigned a numeric ID of eight digits only while the TrimTrac locator is connected to a provisioning module (available separately). The default ID is set to 00000000.

The TrimTrac locator checks all incoming messages for a Unit ID and all incoming message must include a Unit ID. If the Unit ID included in a message sent to TrimTrac locator does not match the Unit ID configured in the TrimTrac Device, then the message is ignored.

Checksum

The checksum field is always required and provides for a two-digit hexadecimal checksum value, which is computed by XOR'ing all characters from the beginning of the message up to and including the * character. The checksum is always the last element of the message before the end-of-message delimiter.

TrimTrac Application Protocol Message Summary

The following over-the-air TrimTrac Application Protocol Messages are used to communicate with and control the TrimTrac locator.

REPORT_POS	Basic Position message
STATUS_MSG	Same as REPORT_POS except no location/velocity data
SET_APP_CONFIG	Changes Application parameters
RESP_APP_CONFIG	Reports current Application parameters
SET_PROV_CONFIG	Changes Communication parameters
RESP_PROV_CONFIG	Reports current Communication parameters
SET_GPS_CONFIG	Changes GPS parameters
RESP_GPS_CONFIG	Reports current GPS parameters
QUERY_CONFIG	Reports current Application, Communication or GPS parameters as requested

Table 12, TrimTrac Application Protocol Messages

Application Message Types and Format

The TrimTrac Application Protocol messages are described in the following sections beginning on the next page.

REPORT_POS and STATUS_MSG

These two messages are the most common. The difference between the REPORT_POS and STATUS_MSG is that the REPORT_POS message contains position information. STATUS_MSG does not contain any position.

>RTKABBBBCDDDEFFFFGGGGGGSTUUUUUUUUUU[HHHIIIIIIIJJJJKKKKKKKLLLLLLMMMNNN];ID=YYYYYYYY;*ZZ<	
A	TrimTrac Report Type: 'P' = Position Report 'S' = Status Report
BBBB	Protocol Sequence Number: 16-bit hex value, increments by 1 each report message
C	Wakeup Event: '0' = RTC Timeout '1' = Motion Detected
DDD	Battery Level: Measured in percent of maximum. Range 0% to 100%.
E	Battery Changed Flag.
FFFF	GPS Week Number
GGGGGG	GPS Seconds into Week
S	GPS Error Status Code: '0' = 3D GPS Fix. '1' = 2D GPS Fix. '2' – '5' = Fix Timeout, 0 – 3 SVs. '6' = GPS Error. '7' = No Fix Attempted, Status
T	GSM Error Status Code: '0' = Network Available. '1' = Message Logged (Report Delay Flag set). '2' = Network Timeout. '3' = SIM Error / No SIM. '4' = SIM PIN Error. '5' = Pre-TX log (Low battery).
UUUUUUUUUU	Reserved for future use
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
ZZ	Checksum.
	Optional (Provided only if Position Report)
HHH.IIIIIII	Latitude in WGS-84 coordinates (positive = north). Units of degrees. First character "+" for north, "-" for south
JJJJ.KKKKKKK	Longitude in WGS-84 coordinates (positive = east). Units of degrees. First character is "+" for east, "-" for west
LLLLLL	Altitude above MSL. Units of feet.

MMM	Horizontal Speed. Units of MPH.
NNN	Heading based on True North, increasing easterly. Units of degrees.

Table 13, REPORT_POS and STATUS_MSG Messages

SET_APP_CONFIG

The SET_APP_CONFIG message is used by the server application to set the TrimTrac Application parameters in the TrimTrac locator. When received the TrimTrac locator will send a RESP_APP_CONFIG message in response.

>STKABBBBBBCCCCCCDDDDDDEEEEEEFFFFFFGGGTTHIJK;PW=PPPPPPPP;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'A' = Application Parameters
BBBBBB	Idle Timeout. Parameter T1. In seconds (10 – 999990). Default 43200
CCCCCC	Fix Timeout. Parameter T2. In seconds (10 – 3600). Default 300
DDDDDD	Comm Timeout. Parameter T3. In seconds (10 – 3600). Default 120
EEEEEE	Sleep Time. Parameter T4. In seconds (10 – 86400). Default 900
FFFFFF	Query Time. Parameter T5. In seconds (10 – 3600). Default 60
GGG	Almanac Timeout. Parameter T6. In hours (10 – 990). Default 168
TT	Motion Timeout. Parameter T7. In seconds (5 – 90). Default 15
H	Motion Report Flag. 0:None; 1:Report first motion before GPS fix. Default 0
I	Report Delay Flag. 0:Log & Transmit messages; 1:Log messages. Default 0
J	Diagnostics Mode. 0: None; 1: LED. Default 1
K	Communications Mode. 0: SMS; 1: Future. Default 0
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
ZZ	Checksum.

Table 14, SET_APP_CONFIG Message

SET_PROV_CONFIG

The SET_PROV_CONFIG message is used by the server application to set the Communication values in the TrimTrac locator. When received by the TrimTrac locator, the unit will send a RESP_PROV_CONFIG message in response.

>STKABBBBBBBBBBBBBBBBBBBBBB;PW=PPPPPPPP;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'V' = Application Provisioning Parameters
BBBBBB BBBBBB BBBBBB BBBBBB	Destination Address.Max. 24 characters including international dialing "+" sign and country code. Field Padding is in spaces. Default <Empty>
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
ZZ	Checksum

Table 15, SET_PROV_CONFIG Message

SET_GPS_CONFIG

The SET_GPS_CONFIG message is used by the server application to set the TrimTrac GPS parameter values in the TrimTrac locator. When received the TrimTrac locator will send a RESP_GPS_CONFIG message in response.

>STKABBCCCDDDEEEF;PW=PPPPPPPP;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'G' = GPS Parameters
BB	Elevation Mask. In degrees (0-30). Default 5
CCC	PDOP Mask. In tenths of PDOP. Default 120
DDD	PDOP Switch. In tenths of PDOP. Default 60
EEE	AMU Mask. In tenths of AMUs. Default 10
F	Dynamics Mode. Undefined = 0 Land = 1 Sea = 2 Air = 3 Stationary = 4 Automobile = 5. Default 5
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
ZZ	Checksum.

Table 16, SET_GPS_CONFIG Message

QUERY_CONFIG

This QUERY_CONFIG message is used by the server application to request the TrimTrac locator send its TrimTrac Application, GPS or Communication parameters in the appropriate RESP_APP_CONFIG, RESP_PROV_CONFIG or RESP_GPS_CONFIG message.

>QTKA;PW=PPPPPPPP;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'G' = GPS Parameters 'A' = Application Parameters 'V' = Provisioning Parameters
PPPPPPPP	Security Password. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,. Default 00000000
ZZ	Checksum.

Table 17, QUERY_CONFIG Message

RESP_APP_CONFIG

This is the response message to the SET_APP_CONFIG and QUERY_CONFIG messages containing the Application Parameter values.

>RTKABBBBBBCCCCCCDDDDDDEEEEEEFFFFFFGGGTTHIJKLLLLMMMMMMNPP;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'A' = Application Parameters
BBBBBB	Idle Timeout. In seconds (10 – 999990)
CCCCCC	Fix Timeout. In seconds (10 – 3600)
DDDDDD	Comm Timeout. In seconds (10 – 3600)
EEEEEE	Sleep Time. In seconds (10 – 86400)
FFFFFF	Query Time. In seconds (10 – 3600)
GGG	Almanac Timeout. In hours (10 – 990)
TT	Motion Timeout. In seconds (5 – 90)
H	Motion Report Flag. 0:None; 1:Report first motion before GPS fix
I	Report Delay Flag. 0:Log & Transmit messages; 1:Log messages
J	Diagnostics Mode. 0: None; 1: LED
K	Communications Mode. 0: SMS; 1: Future
LLLL	Battery Change Week.
MMMMMM	Battery Change Seconds into Week.
N.PP	Firmware version number.
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,

ZZ	Checksum.

Table 18, RESP_APP_CONFIG Message

RESP_PROV_CONFIG

This is the response message to the SET_PROV_CONFIG and QUERY_CONFIG message containing the provisioning information.

>RTKABBBBBBBBBBBBBBBBBBBBBBB;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'V' = Application Provisioning Parameters
BBBBBBBB BBBBBBBB BBBBBBBB	Destination Address. Max. 24 characters including international dialing "+" sign and country code. Field Padding is in spaces.
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
ZZ	Checksum.

Table 19, RESP_PROV_CONFIG Message

RESP_GPS_CONFIG

This is the response message to the SET_GPS_CONFIG and QUERY_CONFIG message containing the GPS Configuration.

>RTKABBCCCDDDEEEF;ID=YYYYYYYY;*ZZ<	
A	TrimTrac Configuration Set: 'G' = GPS Parameters
BB	Elevation Mask. In degrees (0-30)
CCC	PDOP Mask. In tenths of PDOP
DDD	PDOP Switch. In tenths of PDOP
EEE	AMU Mask. In tenths of AMUs
F	Dynamics Mode. Undefined = 0 Land = 1 Sea = 2 Air = 3 Stationary = 4 Automobile = 5
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
ZZ	Checksum.

Table 20, RESP_GPS_CONFIG Message

QUERY_LOG

This message is used by the server application to request past REPORT_POS message that may not have been received at the server application. The TrimTrac locator will send the corresponding REPORT_POS messages to the server application in response to this message at the rate of one position per REPORT_POS message. At the end of the REPORT_POS messages a RESP_QUERY_LOG is sent.

>QTKABBBBCCCC;PW=PPPPPPPP;ID=YYYYYYYY;*ZZ<	
A	Always 'R': Indicates a query for old REPORT_POS messages
BBBB	Starting Protocol Sequence Number: 16-bit hex value
CCCC	Ending Protocol Sequence Number: 16-bit hex value
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
ZZ	Checksum.

Table 21, QUERY_LOG Message

RESP_QUERY_LOG

This message is sent after a QUERY_LOG request is received and processed. It will contain the number of messages actually retrieved from the Message Log and sent to the server application.

>RTKABBBB;ID=YYYYYYYY;*ZZ<	
A	Always 'R': Indicates a response to a QUERY_LOG
BBBB	Number of REPORT_POS message sent from the log.
YYYYYYYY	Unit ID. Unique unit identifier. Always 8 alphanumeric characters, UPPER CASE ONLY,
ZZ	Checksum.

Table 22, RESP_QUERY_LOG Message

Message Log

Each new outbound REPORT_POS message is given a protocol sequence number. The sequence number is 16 bits and increments by one with each message created. The TrimTrac Application saves the message in non-volatile memory each time one is created; this is called the Message Log. The Message Log is a FIFO log of the last 128 REPORT_POS messages sent such that when it is full the oldest one is deleted. The Message Log can be queried with the QUERY_LOG message from the server application.

Troubleshooting

Introduction

The TrimTrac locator is designed to operate in the conditions outlined in the Specifications chapter on page 45.

When used and maintained properly, the TrimTrac locator provides years of trouble-free service. The TrimTrac locator uses watchdog timers on applicable tasks to reduce the possibility of processor hangs. The TrimTrac locator has no user-serviceable parts.
Should the TrimTrac locator fail to operate properly, the user or service technician should troubleshoot the installation before returning any components for repair. If a component fails, return the TrimTrac locator to the authorized Service and Repair Center for repair.

This chapter provides some guidelines for troubleshooting common problems associated with the TrimTrac locator's operation. Potential operating problems might include:

- Dead Batteries
- Poor contact between the Battery Pack and TrimTrac
- Poor GPS reception
- Poor GSM coverage
- Communication failure with base
- TrimTrac locator Application programming errors

If the TrimTrac locator continues to operate poorly after you follow the troubleshooting guidelines described in this chapter, contact your TrimTrac locator supplier for assistance.

Battery Problems

Make sure your batteries are generating sufficient current to power your TrimTrac locator. Make sure the Battery Pack hold down screw is tight and that the mating spring loaded contacts on the TrimTrac device are not damaged.

GPS Reception Problems

Even though the TrimTrac locator uses enhanced GPS sensitivity technology, it is still advisable to position the device with as clear of a view of the sky as possible.

Make sure that the TrimTrac locator is reasonably positioned to receive GPS signals.

Location

The TrimTrac locator should be installed as close as possible to horizontal plane, preferably with a reasonably clear view of the horizon and sky. If something on the vehicle—for example, the air conditioning unit on a cab or the trailer connected to a tractor—blocks a significant portion of the horizon and the GPS signals, the GPS receiver will take longer to acquire enough satellites for a position fix. If the TrimTrac locator frequently times out before completing a position fix, try moving the TrimTrac locator to a new location where it is not blocked as much.

GPS Jamming

The TrimTrac locator should be installed as far away as possible from transmitting antennas, including satellite communication, radar, VHF and cellular. These transmitters may emit jamming signals that interfere with the GPS receiver's ability to track GPS satellite signals. Generally, the stronger the other transmitting device, the wider the distance required between antennas. For the TrimTrac locator, Trimble recommends a minimum clearance of 46 cm (approximately 18 in.) from these transmitting devices.

Land-based transmitters, including microwave and television transmitters, can also interfere with GPS reception. If the TrimTrac locator is operating near an antenna farm, the TrimTrac locator may temporarily lose GPS reception while in the vicinity of the transmitters. Reception should return once the TrimTrac locator moves away from the transmitters. If your GPS signals are being jammed and moving does not correct the situation, the source of the jamming signal may be another antenna mounted too close to your TrimTrac locator. If possible, turn off the equipment using other nearby antennas to see if this corrects the problem. If turning off nearby equipment un-jams your GPS signals, you need to relocate one or more of the jamming antennas.

Poor GSM Coverage

Check to make sure the SIM is not missing or incorrectly installed, or the PIN number configured in the TrimTrac does not match the PIN in the SIM. Do the following:

1. Insert a SIM if none is present.
2. Remove and reinsert the existing SIM to verify proper installation.
3. Check the TrimTrac locator configuration to ensure the correct PIN is programmed.

TrimTrac Locator Location

The TrimTrac locator should be used as close as possible to horizontal plane, preferably with reasonably unobstructed clearance around the unit. If the current location is suspect:

1. Try another location
2. Try a known, good TrimTrac locator or mobile phone.

Even in areas with strong GSM service, there may be pockets where GSM service is poor or nonexistent due to how the carrier builds the network. Contact your local service provider for information on GSM coverage.

GSM Jamming

The TrimTrac locator should be installed as far away as possible from other transmitting antennas including satellite communication, radar, and VHF radio. These transmitters may emit jamming signals that interfere with the GSM phone's ability to track the GSM signal. If there are other transmitting antennas located on the vehicle, try moving the TrimTrac locator farther away from these antennas. Generally, the stronger the other transmitting device, the wider the distance required between antennas.

No Data Communication with Base

Check the conditions described in following sections if the TrimTrac locator cannot communicate with the base and:

1. You can see that it enters the Transmit and Query modes.
2. You have verified that it is calling the correct number.

Base Modem Configuration

Consult your modem manual for configuration instructions. Each modem manufacturer has its own settings and control commands. Verify that your configuration, PIN numbers, and so on, are correct.

Defective TrimTrac Locator

To confirm that a TrimTrac locator is defective, do the following:

1. Try a known good TrimTrac locator.
2. Move into an area with strong GSM coverage.
3. Send the TrimTrac locator an SMS message requesting a response.

Note – Before returning the TrimTrac locator, be sure to save the TrimTrac locator's configuration settings, and remove your SIM

No Modem Connection with Server Application

If it appears that you have no modem connection with the Server Application, confirm that the Server Application modem is configured correctly and that the TrimTrac locator is configured and operating correctly. Do the following:

1. Check to see if the Destination Address is programmed correctly.

2. Verify the Server Application software is calling the correct TrimTrac locator telephone number and using the correct Unit ID, Security Password and SIM PIN, if used.

Server Application Software

Confirm the proper Server Application software setup. The Server Application software may not be correctly integrated with the TrimTrac locator. Contact your software vendor for assistance.

Updating Firmware in the Field

You can upload new firmware from a PC or laptop connected to the Provisioning Module. For more information on updating firmware in the field, refer to the Trimble Web site: http://www.trimtrac.com

LED Indicator

The LED indicator is useful for diagnosing problems. For more information, see LED States, page 14. If you detect a problem, then have the TrimTrac locator inspected by qualified service personnel.

Specifications

GSM Specifications

GSM 900/1800/1900 MHz

Normal MS – SMS Data Only
Class 4 (2W) @ 900 MHz (EGSM)
Class 1 (1W) @ 1800 MHz (GSM 1800) and 1900 MHz (GSM 1900 PCS)

Subscriber Identity Module

1.8/3.0 Volt

Type Approvals

FCC Part 15, FCC Part 24
Industry Canada
CE MARK
EC R&TTE Type Examination

GPS Specifications

General

L1 (1575.42 MHz) frequency, C/A code
12-Channels, 48 Correlators

Sensitivity

Minimum –136.0 dBm
Acquisition without any external assistance.

Accuracy

Horizontal: < 6 meters (50%)
Altitude: <11 meters (50%)

Acquisition

Signal Power -130.0 dB -136.0 dB
Hot Start (50%) <24 sec
Warm Start (50%)<38 sec <400 sec
Cold Start (50%) <90 sec

Dynamics

Acceleration: 4g (39.2 m/sec2)
Motional jerk: 20 m/sec3

Environmental Specifications

Temperature

Operating: -10°C to + 55°C

Humidity

5% to 95% RH non-condensing @ +40oC

Casing

Wind-driven rain and dust-resistant per IP 54 standard when used with Batteries

Vibration*

0.008 g2/Hz 5 Hz to 20 Hz
0.05g2/Hz 20 Hz to 100 Hz
-3 dB/octave 100 Hz to 900 Hz

Shock*

Operational: 40g for 11mSec
Non-operational:
75g for 6 mSec

* = Requires Vehicle Adapter Module

Physical Specifications

Assembly

Injection molded plastic with integrated battery pack

Size

133 mm x 64 mm x25 mm
5.25” x 2.5” x1.0”

Weight

102 grams (3.6 oz) not including batteries

Bibliography

European Telecommunications Standards Institute (ETSI). ETSI is the standards body for GSM worldwide operations. Specifications on various aspects of GSM phone operations (AT commands, installation requirements, and terminology) are available for download from ETSI at: www.etsi.org

GPS, A Guide to the Next Utility, Trimble P/N 18239 (1992). A short, non-technical introduction to GPS. Explains what GPS does, how it works, and its capabilities and limitations. www.trimble.com

GSM Made Simple, by George Lamb published by Cordero Consulting and Regal Printing, Atlanta GA, 1997 (ISBN 0-966-57520-2).

GSM World. The GSM World site has information on the technical and business aspects of GSM. Contact information is available for GSM carriers as well as GSM hardware manufacturers. www.gsmworld.com

ICD-GPS-200. *NAVSTAR GPS Space Segment: Navigation User Interfaces*, drawing number ICD-GPS-200 (3 July 1991). The official definition of the data formats used in NAVSTAR GPS satellite signals. www.navcen.uscg.gov/gps

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Proceedings of the Institute of Navigation, Washington DC. A series of three volumes of papers describing GPS Theory published between 1980 and 1986 by the Institute of Navigation. Essential source material for system designers. www.ion.org

SAE J1455 Joint SAE/TMC Recommended Environmental Practices for Electronic Equipment Design (Heavy Duty Trucks). www.sae.org

Glossary

The Glossary defines technical terms and abbreviations used in this manual. It includes terms from the fields of wireless communications and GPS technology.

0D	Time only in GPS terminology.
2D	Two dimensions and time in GPS terminology.
3D	Three dimensions and time in GPS terminology.
2D	GPS Two-dimensional GPS position fix and time.
3D	GPS Three-dimensional GPS position fix and time.
Altitude	Height above mean sea level (MSL).
ASCII	American Standard Code for Information Interchange.
C/A	Coarse Acquisition code used to receive GPS signals with receivers designed operate using SPS (Standard Positioning Service).
Checksum	The message checksum field provides for a two-digit hexadecimal checksum value, which is computed by XOR'ing all characters from the beginning of the sentence up to and including the * character. The checksum is always the last element of the sentence before the message < delimiter. The use of checksums can help in instances where the communication channel is noisy.
ETSI	European Telecommunications Standards Institute.
GPS	Global Positioning System.
GSM	Global System for Mobile communications.
IMEI	International Mobile Equipment Identity.
IMSI	International Mobile Subscriber Identity.
Latitude	Latitude coordinate of position fix with positive value indicating North.
LED	Light-Emitting Diode.
Longitude	Longitude coordinate of position fix with positive value indicating East.
PC	Windows-compatible Personal Computer.
PCS	Personal Communications Service.

PIN	Personal Identity Number.
RF	Radio Frequency.
SIM	Subscriber Identity Module.
SMPP	Short Message Peer to Peer.
SMS	Short Message Service.
SPS	Standard Positioning Service.
TAIP	Trimble ASCII Interface Protocol.