

# 4700 Receiver

## *Operation Manual*

**Version 1.0**

**Part Number 36238-00**

**Revision B**

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# Preface

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Welcome to the *4700 Receiver Operation Manual*. This manual describes how to install, set up, and use the Trimble 4700 GPS receiver.

## Scope and Audience

Even if you have used other Global Positioning System (GPS) products before, we recommend that you spend some time reading this manual to learn about the special features of this product. If you are not familiar with GPS, we suggest that you read the booklet *GPS, A Guide to the Next Utility* that is available from Trimble Navigation Limited.

We assume that you are familiar with Microsoft Windows, and know how to use a mouse, select options from menus and dialog boxes, make selections from lists, and use online Help. For a review of these techniques, refer to your Windows documentation.

The following sections provide a guide to this manual, as well as to other documentation that you may have received with this product.

## Organization

This manual contains the following:

- Chapter 1, GPS Surveying Concepts, provides an overview of GPS surveying topics and the GPSurvey™ software as related to the 4700 receiver .
- Chapter 2, General Operation, describes the general operation and functionality of the 4700 receiver.
- Chapter 3, Pre-Survey Planning, outlines the steps necessary to plan a GPS survey project.
- Chapter 4, In the Field - Control Surveying, contains a summary of the steps involved in carrying out a GPS survey project using control surveying methods.
- Chapter 5, Back in the Office - Postprocessing the Field Data, contains a summary of the steps required for postprocessing GPS survey data.
- Chapter 6, In the Field - Real-Time Kinematic Surveying, describes the steps involved in executing a GPS survey project using real-time kinematic surveying methods.
- Appendix A, Typical Configurations, contains the typical configurations for using the 4700 receiver in the field as well as for downloading the field data.
- Appendix B, Specifications, includes tables that contain performance, physical, technical, electrical, and functional specifications for the 4700 receiver.
- Appendix C, NMEA-0183 Output, describe the various NMEA messages, when output is enabled, that can be produced to aid integration with other sensors.
- Appendix D, Event Marker Input and One Pulse Per Second (1PPS) Output Option, contains a description of the Event Marker and 1 PPS Output, and how they interface with the Port 2 pinout functionality.

- Appendix E, Remote Controller Software, provides an overview of the Remote Controller software with the 4700 receiver.
- Appendix F, Configuration Toolbox, describes a Windows application that provides a graphical user interface to configure the 4700 receivers.
- Appendix G, Using WinFLASH, describes the software package that communicates with Trimble products to perform various functions such as software and option upgrades as well as certain diagnostics.
- Appendix H, Using the CommSet Utility, a communications setup utility for configuring Trimble radio modem products.
- Appendix I, Office Support Module (OSM IV), describes the battery charger used for sealed lead-acid batteries in the Trimble hardware.
- Appendix J, Troubleshooting, contains information about troubleshooting the 4700 receiver.

## Related Information

The following sections discuss other sources of information that introduce, extend, or update this manual.

## Release Notes

The release notes describe new features of the product, information not included in the manuals, and any changes to the manuals.

## **Update Notes**

There is a warranty activation sheet with this product. Send it in to automatically receive update notes as they become available. These contain important information about software and hardware changes. Contact your local Trimble Dealer for more information about the support agreement contracts for software and firmware, and an extended warranty program for hardware.

## **Other Information**

This section lists sources that provide other useful information.

### **World Wide Web (WWW) Site**

For an interactive look at Trimble, visit our site on the World Wide Web (<http://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). The address is <ftp://ftp.trimble.com>.

You can also access the FTP site from the Trimble World Wide Web site (<http://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.***

If you need further assistance, contact the Trimble Technical Assistance Center (TAC) by phone, fax, or email. A support technician can help determine the cause of the problem and provide technical assistance.

To contact TAC:

Phone:           +1-800-SOS-4TAC (North America)  
                  +1-408-481-6940 (International)

                  Phones are answered from 6:00 am to 5:30 pm  
                  Pacific Standard Time.

Fax:             +1-408-481-6020

Email:           trimble\_support@trimble.com

When you contact TAC, provide the following information:

- The Trimble product name, any software or firmware version number(s), and if appropriate, the serial number.
- Your specific question or problem.

Please detail background information, such as the configuration of your data collector or receiver, and the exact type, make, and configuration of your computer. If you have received error messages, please specify the exact wording.

If you need to send a data file with your inquiry, please compress the file using PKZIP software by PKWARE, Inc., and name the file with the extension .ZIP.

Use one of the following methods to send the file:

- Attach the file to your email inquiry
- Put the file on the Trimble FTP site and include the file name in your email inquiry.

## 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.

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

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

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

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**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 GPS Surveying Concepts

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This chapter provides an overview of GPS surveying topics and the GPSurvey™ software as related to the 4700 receiver. For a more detailed explanation of GPS surveying, refer to the *GPS Surveying General Reference* in the GPSurvey software documentation package.

GPS surveying requires: the use of GPS hardware for data collection, proper field data-collection procedures, and software to process the field data and to generate the final product. It is not necessary to have a thorough understanding of all of the principles of GPS to use it. However, it is useful to become familiar with the basic GPS terminology and procedures.

The Global Positioning System (GPS) is a satellite-based positioning system operated by the U.S. Department of Defense (DoD). This system provides all-weather, worldwide, 24-hour position and time information. The satellites broadcast signals that can be tracked by receivers for positioning and navigation purposes. The positioning accuracy of GPS ranges from 100 meters to less than 1 centimeter, depending upon the equipment and techniques used.

## 1.1 Number of Visible Satellites

The Global Positioning System is designed so that at least four satellites are above the local horizon at all times. Normally, there are more than four satellites visible. Because the satellites are orbiting, satellite geometry changes throughout the day, but generally repeats from one day to the next. In general, *plan* to track as many satellites as possible. The number of satellites above the local horizon and the relative position of the satellites with respect to one another is important. The ideal situation is to have as many satellites as possible and to have a satellite in each quadrant of the sky and one directly over the project area.

Low elevation satellites present problems for a GPS receiver. The amount of atmosphere that the GPS signals must travel through increases for low elevation satellites, and this adversely affects the GPS signal. These low elevation satellites have lower signal-to-noise ratios, and signal multipath tends to be worse.

Satellite geometry directly impacts the ability of the 4700 receiver to initialize during an RTK survey. When the 4700 receiver is trying to initialize for an RTK survey, at least 5 satellites must be visible. This is because 4 satellites are a mathematical minimum for initialization, and the system cannot check itself with only 4 satellites. With data from 5 satellites, there is some redundancy, or extra information in the computation for internal checking. The more satellites available, the faster the 4700 receiver can initialize.

## 1.2 Elevation Mask

The Elevation Mask is the cutoff angle for satellite tracking. The receiver ignores satellites below the Elevation Mask. The default Elevation Mask when surveying with the 4700 receiver is 13°, which works well for most sites.

### 1.3 Logging Rate

The default logging rate for the 4700 receiver is 15 seconds. This is considered the optimal epoch interval for Static and FastStatic data collection. To increase precision, increase the observation period rather than reducing the logging or epoch rate.

### 1.4 Environmental Factors

Environmental factors that impact GPS measurement quality include:

- ionospheric activity
- tropospheric delay
- signal obstructions
- multipath
- radio frequency (RF) interference

High ionospheric activity causes rapid changes in GPS signal delay, even between closely spaced receivers. Ionospheric activity is most extreme at the polar and equatorial regions, and varies along an 11-year cycle. During periods of high ionospheric activity, real-time kinematic initialization performance can be degraded in the time-to-initialize and in precision of the results.

Tropospheric delay is modeled within the 4700 receiver. The troposphere delay occurs when the GPS signal travels through the lower part of the atmosphere and varies with weather conditions, height above sea level, and satellite elevation angle. A base receiver located in a sunny valley experiences different tropospheric delays than a rover located at the top of a cloud-covered mountain. Initialization and baseline accuracy are affected by tropospheric delay. If possible, try to locate the base station at approximately the same elevation as the rover.

Signal obstructions limit the number of visible satellites and can also induce signal multipath. Flat metallic objects located near the antenna can cause signal reflection before reception at the antenna. For phase measurements and RTK positioning, this effect is on the order of 1 to 5 centimeters. Multipath effects on the roving antenna are transient, while a static base station can experience slowly changing errors. Ideally, the base station should be located in a clear environment with an open view of the sky.

## 1.5 GPS versus Conventional Surveying Techniques

The following are advantages of GPS over conventional surveying techniques:

- Line-of-sight between stations is not required.
- GPS accuracy is subject to little degradation by weather (rain, snow, high or low temperatures, or humidity).
- GPS is faster than conventional methods.
- GPS provides results in a unified world coordinate system.
- GPS results are digital and easily transferred to mapping or GIS systems.

There are many options for observing GPS baselines. For example, GPS surveys can be conducted either as postprocessed surveys or real-time kinematic (RTK) surveys.

### **1.5.1 Postprocessed Surveys**

In postprocessed surveys, data is logged in the receiver or in a handheld data collector, then downloaded to a computer and processed using specially designed software, such as GPSurvey.

When data is collected for postprocessing, there are a number of different data collection techniques. The terms Static, FastStatic, and kinematic refer to different methods of collecting data in the field. Postprocessed kinematic surveys can include both stop-and-go kinematic and continuous kinematic.

### **1.5.2 Real-Time Kinematic Surveys**

The 4700 receiver can be used with a TSC1 handheld controller to perform real-time kinematic (RTK) surveys. Examples of typical real-time surveying applications are: stakeout, monument recovery, and topographic surveys. In real-time kinematic surveys, data processing occurs in the field as data is logged, providing immediate results in the form of coordinates in the handheld data collector.

Real-time surveys are kinematic surveys with a communications link (radio) between the base receiver and rover. Like the postprocessed kinematic technique, RTK can include stop-and-go data collection and continuous data collection. Real-time surveys with the 4700 receiver always require a TSC1 controller at the rover station.

The 4700 receiver uses real-time kinematic positioning to achieve accuracies at the centimeter level. Kinematic GPS employs at least two receivers that track the same satellites simultaneously. This technique requires carrier phase observables, and it can benefit significantly from dual frequency receivers for initialization purposes. This is because carrier phase measurements contain integer phase ambiguities that must be correctly resolved or initialized to obtain the highest precision. The additional data logged from the second frequency facilitates faster resolution of these ambiguities.

The 4700 receiver tracks the L1 C/A code and full cycle L1 and L2 carrier phase observables, even during periods of P-code encryption. The 4700 receiver also uses on-the-fly (OTF) ambiguity resolution techniques to provide initialization while the receiver is moving. This provides maximum efficiency in the field and avoids traditional postprocessing techniques or time-consuming reoccupations in the field.

A minimum of 5 satellites are required for OTF initialization, which is normally achieved in under one minute. Once initialized, a minimum of 4 satellites must be tracked to avoid reinitialization of the system.

### 1.5.3 GPS Surveying Methods

Table 1-1 lists the basic types of data collection for the 4700 receiver.

**Table 1-1 Baseline Observation Techniques**

<b>Baseline Observation Techniques Using Dual-Frequency GPS Receivers</b>	<b>Best Suited For</b>
Static	long baselines and high-order control work
FastStatic	local surveys where high productivity is required, but many obstructions between stations exist
Stop-and-Go Kinematic	high productivity on local sites with few satellite obstructions
Continuous Kinematic	topographic surveys in large open areas and dynamic (moving) platforms
Real-time Kinematic (RTK)	stakeout, detail, and topographic surveys on local sites with few obstructions

All of the baseline observation procedures described in Table 1 -1 require the use of at least two receivers. This is because in GPS baseline determination, the position of one receiver is computed relative to the position of another.

A result of GPS processing is the computation of the difference in position between a reference point and an unknown station. The derived coordinates of survey stations are only as accurate as the reference on which computations are based. That is, the difference between the stations can be measured very precisely using GPS surveying, but the *absolute* accuracy of the coordinates derived from a GPS survey depends on the accuracy of the reference station coordinates within the network.

Each data collection method has special conditions associated with it that dictate how and when the method can be used. The following section describes types of GPS survey networks and the data collection methods performed using the 4700 receiver.

## 1.6 Design of GPS Surveys

Before going out to the field to collect data, develop a scheme or design for the *network* of intended occupations. To do so, answer this question: what is the objective for this survey?

If this is a control survey, the primary consideration is the desired precision of the final coordinates. Therefore, design the network with a considerable amount of redundancy, or additional measurements above and beyond the absolute minimum required. This type of network includes an optimal number of known points, with as many cross-ties and repeated measurements as can reasonably be scheduled.

The sample network of stations and baselines in Figure e1-1 is provided as an illustration.

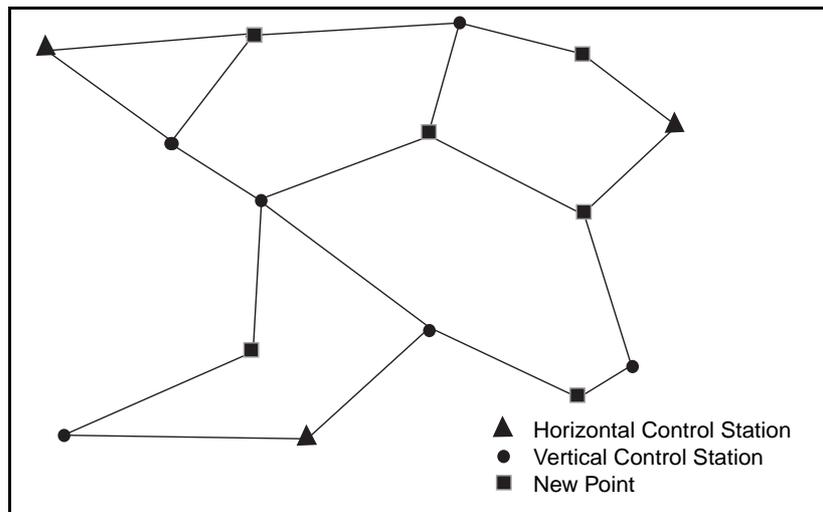
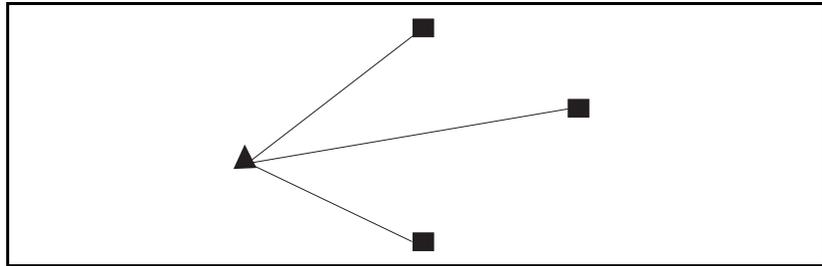


Figure 1-1 Network Design

The following example describes a method for surveying a small area, where the primary objective is a topographic map. The goal here is to survey a large number of points in the shortest time and with the least amount of setups. There are individual features and break points to occupy, as well as large open areas where it may be expedient to drive a vehicle while logging data.

In this case, it may be advantageous to make the measurements as radial lines from one or more base receiver(s). The lack of redundancy in the design is due to the conscious decision to increase productivity rather than maximize precision. This design is shown in Figure 1-2.



**Figure 1-2 Radial Survey**

Control surveys are normally performed as postprocessed surveys, often employing more than the minimum two receivers. After data is collected and processed, a least-squares adjustment is performed to compute optimal coordinates for all stations in the network. Software for baseline processing and adjustment is included in many of the 4700 receiver configurations.

Control surveys can also be performed as RTK surveys, but the network adjustment can only be performed after the RTK data has been collected. QC1 and QC2 output is required to adjust RTK data. Choose the appropriate settings in the TSC1 controller when adjustment of RTK data is desired. For this reason, it may be more efficient to establish a control network that overlays the project area using postprocessed techniques and then employ RTK for more detailed surveys using the previously established control network. Stations in the adjusted control network, then, provide ideal base stations and check points when performing an RTK survey.

After determining the survey requirements, *plan* the survey and determine the optimal method of collecting the data. The next section describes the options for data collection with the 4700 receiver.

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**Note** – In this manual the reference, base, or base station refers to an antenna (connected to the 4700 receiver) positioned over a known or previously surveyed point. The 4700 receiver measuring an unknown point is called the rover.

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## 1.7 Postprocessed Surveying

The 4700 receiver can be used in Static, FastStatic, as well as RTK and postprocessed kinematic surveys. The 4700 receiver can be paired with any other Trimble survey grade receivers for this purpose.

The following items are important conditions for this application:

- At least one other receiver must be logging data simultaneously and at the same epoch rate to be able to compute baselines.
- For every baseline desired, each receiver on the points defining the desired baseline must be tracking *at least* four satellites in common.
- Each receiver must be a survey-grade receiver, capable of logging both C/A code and at least L1 carrier phase observables.
- The 4700 receiver is a dual-frequency receiver—to achieve dual-frequency baseline results, the receiver must be used with another dual-frequency receiver.

Static and FastStatic are two types of postprocessed surveys.

### 1.7.1 Static Surveying

Static surveying is the most precise GPS surveying technique, but requires long occupation times at each station. Like all GPS surveys, the Static survey requires the use of at least two receivers: one receiver at each point defining the baseline, and each receiver must be logging observations simultaneously from at least four common satellites. Static surveying requires that observations be logged for an extended period of time, usually about 45 to 60 minutes.

Although Static surveying requires more time than other techniques, it is also more forgiving. A large amount of data is collected during this 45-60 minute period, and this allows the processing software to resolve more problems in the data set than might otherwise be resolved in shorter observation periods. Furthermore, the incorporation of the additional data typically leads to greater precision in the baseline solution.

The information associated with a Static occupation is stored in a separate, unique data file. There is only one occupation per file. If for any reason the receiver is turned off in the middle of an occupation, a second file can be opened and the survey can continue. In this case, there is more than one file per occupation, but still only one occupation per file. The GPSurvey software (the baseline processing software) offers an option to concatenate (combine) these files when downloading.

Static surveys can be performed with either single-frequency or dual-frequency receivers. The 4700 receiver is a dual-frequency receiver.

The occupation time required for a Static survey depends on many factors. Trimble recommends an occupation time of at least 45 minutes when five or more satellites are available, or 60 minutes during times when only four satellites are available. The GPSurvey software allows two planning modes: Plan and Quick Plan. Either of these almost identical utilities can help you determine satellite availability at a specified site and time.

Static surveying techniques are generally used for projects where the highest precision is required. At least two receivers are required, but multiple receivers can increase productivity. The sequence of observations should be dictated by the network design.

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**Tip** – Remember an important rule of surveying with GPS: only common data between receivers can be processed, therefore be sure to have the receivers logging data at the same epoch rate, at the same time of day, and observing the same satellites.

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## 1.7.2 FastStatic Surveying

FastStatic surveying is a data collection technique similar to Static surveying. It requires simultaneous observations of four or more satellites for a period of 8 or more minutes and yields baseline components with a precision of  $\pm 5 \text{ mm} + 1 \text{ ppm}$  (using standard survey techniques).

### FastStatic versus Static

FastStatic surveying requires at least two receivers logging common data from two different locations. The length of time the receivers log data depends on the number of satellites being tracked, the geometry of the satellites being tracked (PDOP), and the quality of the data being logged.

Items affecting the quality of data are cycle slips, multipath, and radio frequency (RF) interference. Cycle slips are interruptions of data logging on one or more satellites. Multipath is the reflection of the satellite signal off nearby surfaces, such as the roof of a car.

In general, occupation times for FastStatic surveys on baselines  $\leq 20 \text{ km}$  range from about 8 minutes when data is logged from at least 6 satellites to about 20 minutes with data from 4 satellites.

FastStatic surveying is similar to Static surveying in that data is logged only while the receiver is stationary and occupying a point. As the receiver moves from each point to another point in the survey, no data is logged, as the 4700 receiver is turned off during this period. The manner in which the data is treated by the baseline processor is also similar.

FastStatic surveying differs from Static surveying in the fact that less data is collected. The occupation time is shorter, resulting in fewer measurements for the baseline processor to use. Therefore, the expected baseline precision is not quite as high for FastStatic as it is for Static.

**FastStatic using a TSC1 Handheld Controller**

A less important distinction between FastStatic and Static is the potential for logging more than one occupation within a single data file. The 4700 receiver requires the use of a TSC1 handheld controller to perform a FastStatic survey with multiple occupations in a single data file. In this application, the data file remains open while the receiver moves between occupations, but no data is logged. The advantage in this case is efficiency in the field. When not using a TSC1 controller each of the FastStatic occupations are logged in the 4700 receiver as individual, unique data files with one occupation per file.

Refer to the *Survey Controller Operation Manual* and *Survey Controller Field Guide* for more information on TSC1 controller operation.

### **FastStatic versus Kinematic**

FastStatic surveying also shares similarities with kinematic surveying. Because FastStatic procedures are highly productive, they are often used with the same type of network design as in kinematic surveys. This design calls for at least one base receiver, which logs data constantly throughout the survey, and one or more roving receivers, which move from point to point, logging data at each stationary occupation. The result is a radial survey from each base receiver.

There is no requirement to restrict FastStatic techniques to a radial survey, however, and when performing a control survey, redundancy and cross-ties are highly recommended. The application of a particular data collection technique to a particular network design is a decision left to the individual surveyor.

When logging data in a FastStatic survey, it is very important to obtain the best data possible. Because the occupation times are relatively short, the PDOP should be low and conditions for multipath minimized. It is also very important to log data that is free of cycle slips, therefore obstructions to the sky at each station should be minimized. If obstructions exist at stations, use the Plan or Quick Plan module to help account for the obstructions and optimize field observation time.

When planning to set up one receiver as a base receiver for a significant portion of a survey, be sure to select a site that has a clear a view of the sky. With the roving receiver, track the required number of satellites continuously for *at least* the minimum time specified. Refer to the display on the TSC1 controller to determine when sufficient data has been collected.

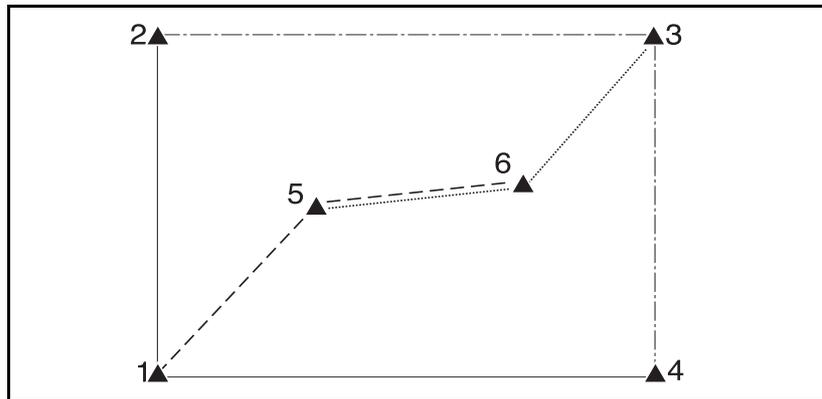
## 1.8 Sample Field Survey - Postprocessed

In this sample field survey, monuments have been recovered at all four corners of the parcel, and measurements between these monuments are required. FastStatic techniques are used to measure the baselines between monuments and across the diagonal of the parcel.

In this example, three 4700 receivers are used to perform the field work.

### 1.8.1 FastStatic Data Collection

In Figure e1-3, receiver A is the base at point 1, while receivers B and C measure at points 2 and 4. Receivers B and C then move to points 5 and 6.

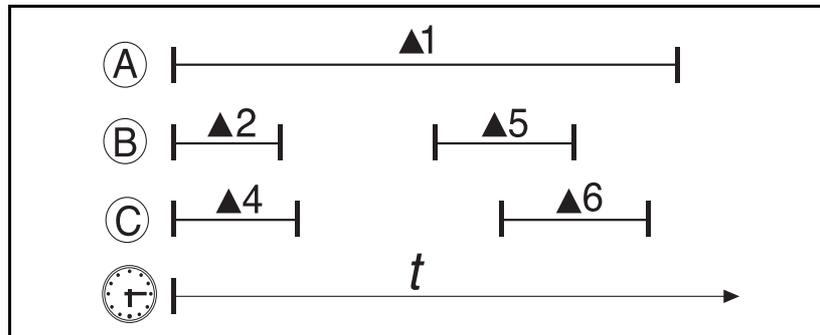


**Figure 1-3 Control Network**

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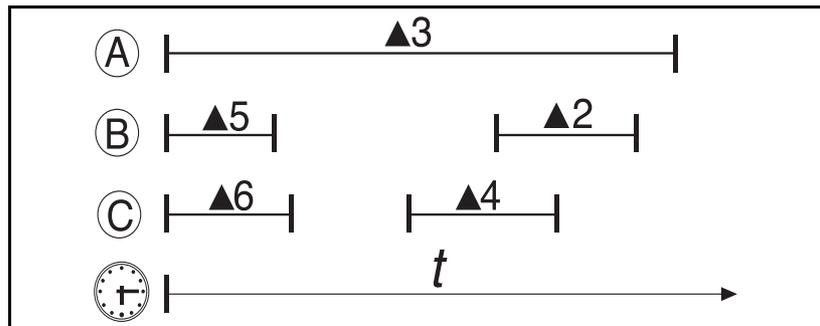
**Note** – Only two baselines from each session are drawn in Figure 1-3. This is based on the formula that states only  $n - 1$  baselines per observation session are statistically valid. Where  $n$  = the number of GPS receivers in the session. See the GPSurvey software documentation for more details on this requirement.

This data collection is graphically displayed in Figure 1-4, where the solid lines indicate: when each (pair of) receiver(s) is on, stationary and collecting data.



**Figure 1-4 Base at 1, FastStatic Data Logging Session**

In Figure 1-5, receiver A moves to point 3 and receiver B and C remeasure at points 5 and 6. Once complete, receiver B and C move to remeasure at points 2 and 4. At this point, the FastStatic control survey is complete.



**Figure 1-5 Base at 3, FastStatic Data Logging Session**

The observation periods of overlapping times are called sessions, and in Figure 1-3, measured baselines from a single session are shown in the same line type. That is, the first session, in which lines 1-4 and 1-2 were measured, is shown with solid lines. Similarly, the second session, in which lines 2-3 and 3-4 were measured, is plotted with phantom (dash/dot) lines.

At the end of the survey, the receivers are taken back to the office, where all of the data files are downloaded into a GPSurvey project database. Static, FastStatic, as well as postprocessed kinematic data can all be processed simultaneously in GPSurvey's WAVE™ baseline processor. After the baselines have been processed, a network adjustment is performed to produce final coordinates in the preferred local coordinate system.

## 2 General Operation

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This chapter describes the general operation and functionality of the 4700 receiver, and includes the following topics:

- the front panel LEDs
- port configuration
- associated hardware (antennas, radios, batteries)
- power management
- data management

Use the information in this chapter to learn about how the receiver functions and how it interacts with the associated hardware. Refer to successive chapters for more information about GPS field surveying techniques.

## 2.1 The 4700 Receiver

The 4700 receiver, shown in Figure 2-1, is designed for GPS surveying and mapping applications. The receiver features 1-button operation for ease-of-use and 5 LEDs to monitor the survey in progress and the available battery capacity.



**Figure 2-1 4700 Receiver**

The 4700 receiver tracks GPS satellites on both the L1 and L2 frequencies to provide precise position data for land survey applications. The receiver records GPS data in its internal memory and makes all raw and computed data available through bi-directional RS-232 ports.

## 2.2 Applications

The 4700 receiver is designed to excel in surveying applications. It can perform postprocessed GPS surveys such as Static, FastStatic, and Kinematic surveys. Survey data is logged internally for later downloading to a computer

Trimble's GPSurvey software program postprocesses logged data for various types of applications.

The Trimble 4700 receiver is also designed to provide centimeter level positioning for real time kinematic (RTK) surveys. The receiver is a low latency, fast update GPS engine that drives a real time kinematic package and is typically combined with the following components:

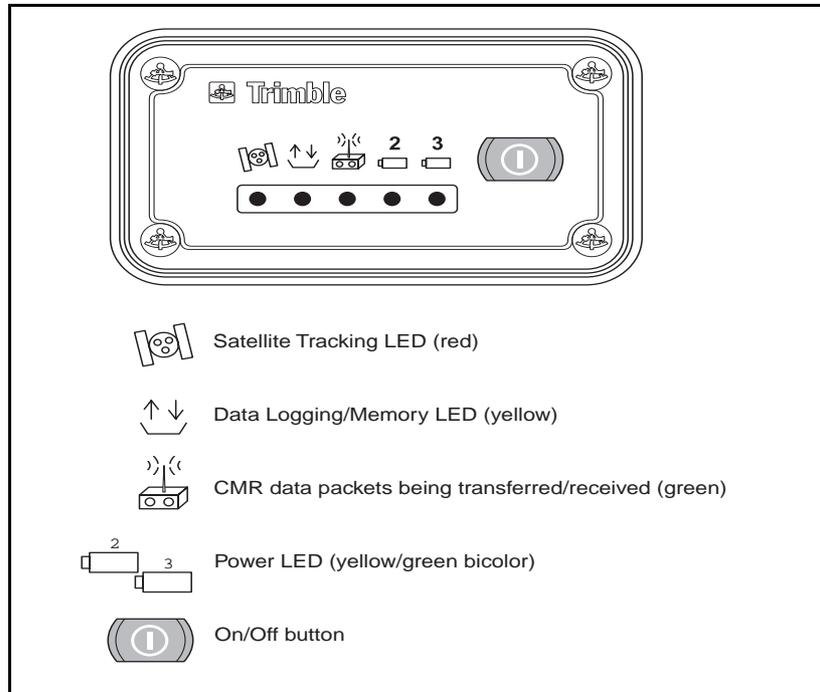
- Trimble handheld data collector (TSC1) with Survey Controller firmware
- Trimble GPS antenna (Micro-centered antenna is recommended)
- a radio solution (refer to Radio Link Options, page 2-1 2 )
- Trimble backpack with related cables

The 4700 receiver features on-the-fly initialization for RTK surveys. It includes Trimble's Super-trak technology with multibit signal processing, which provides superior satellite tracking in the presence of radio frequency (RF) interference. The 4700 receiver provides submeter accuracy positions before initialization and rapid reliable initialization to centimeter accuracy.

The 4700 receiver uses a Trimble handheld data collector as an interface. A data collector is not required to log data to the 4700 receiver. Some receiver operations can also be controlled by using the optional Microsoft Windows based Remote Controller or C-toolbox software. The 4700 receiver can be configured as an autonomous reference station (base receiver) or roving unit.

## 2.3 Indicator LEDs

The operating controls on the 4700 receiver are the power ON/OFF button and five LEDs, as shown in Figure 2-2.



**Figure 2-2 4700 Control Panel**

During typical operation, solid- or slow-blinking LEDs indicate normal operation. Fast-blinking LEDs indicate warning of a condition that may have a negative effect on the survey and may require operator attention. LEDs that are off indicate that no operation is occurring.

During normal operation, the 4700 receiver transitions through three stages:

1. Power Up and Initialization

The initial sequence is as follows:

- a. SV Tracking, Datalogging, and Radio LEDs light up
- b. All five LEDs light up (Battery LEDs are green)
- c. All LEDs turn off
- d. LEDs operate as appropriate.

The red satellite tracking LED starts blinking fast while the receiver locks onto the first 3 satellites. As soon as it locks onto 4 or more satellites, the red tracking LED begins to blink slowly. When this happens, a data file is opened and the yellow data logging LED turns on solid.

2. Data Logging/Memory

When the 4700 receiver is logging data normally, the red SV tracking LED blinks slowly and the yellow data logging LED is on solid. During this period data is stored, the receiver is tracking satellites, and the internal processor is timing how long it needs to log data for a FastStatic survey.

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**Note** – The FastStatic session timer starts counting when the receiver begins tracking 4 or more satellites and a session file is opened. If, at any time during the tracking session, the receiver loses lock on the fourth satellite and is only tracking 3 or fewer satellites, the session timer resets to zero. When the receiver again locks onto 4 or more satellites, the session timer restarts. During this session only one data file is kept open.

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3. When the 4700 receiver determines that enough data has been logged for the FastStatic survey, the yellow data LED blinks slowly. See Section 4.4.5, Minimum Observation Times for details. At this time it is safe to turn the receiver off if the baseline being measured is within the FastStatic limits. If the receiver is left on, it continues to log data, provided adequate memory and power are available.

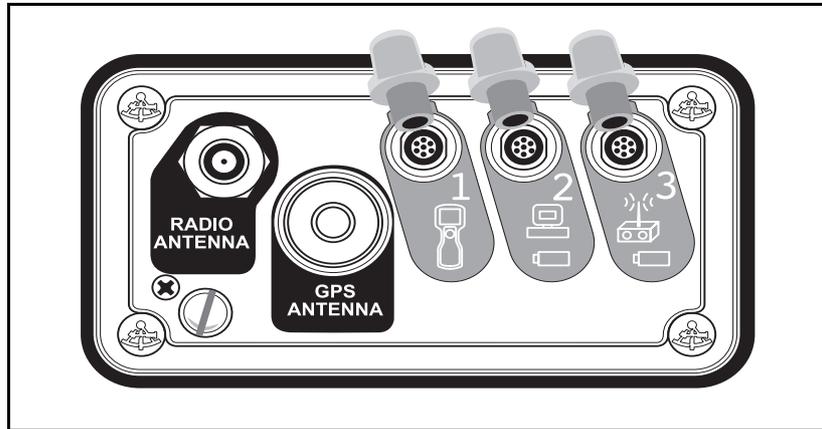
Table 2-1 lists the five indicator LEDs and describes the functions of each LED.

**Table 2-1 4700 Indicator LED Data and Power Functions**

<b>LED Function Color</b>	<b>Satellite Tracking Red</b>	<b>Data Logging/ Memory Yellow</b>	<b>Radio Green</b>	<b>Power 2 or 3 Green: Active Yellow: Standby</b>
OFF 	Unit not tracking satellites.	Unit not logging data, the survey has not started or memory is full & additional data cannot be logged.	No radio/CMR packets.	Battery dead ...or no battery plugged in to port.
ON 	N/A	Unit logging data normally, blinks at epoch rate	N/A	Available battery capacity is between 100% – 5%
Slow Blink 	Unit tracking 4 or more satellites.	Unit has logged sufficient data in this session for a FastStatic survey, however, data continues to be logged.	LED blinks each time a CMR packet is received.	N/A
Fast Blink 	Unit tracking 3 or fewer satellites.	Unit logging data, but low memory condition exists. There should be sufficient memory to complete session in progress.	LED blinks each time a CMR packet is received.	Available battery capacity is between 5% – 0%

## 2.4 Port Configuration

Figure e2-3 shows the three serial ports as well as the radio and GPS antenna connections on the back of the 4700 receiver.



**Figure 2-3 4700 Rear Panel Ports**

There are three serial ports:

- Port 1 is typically connected to the TSC1 controller and provides:
  - Serial communications
  - Power out to the TSC1
  - Flow control
- Port 2 is typically connected to an external power source or to a computer, but can be used for the event marker and 1 PPS output. Port 2 provides:
  - Serial communications
  - Power in
  - 1 PPS output
  - Event marker in

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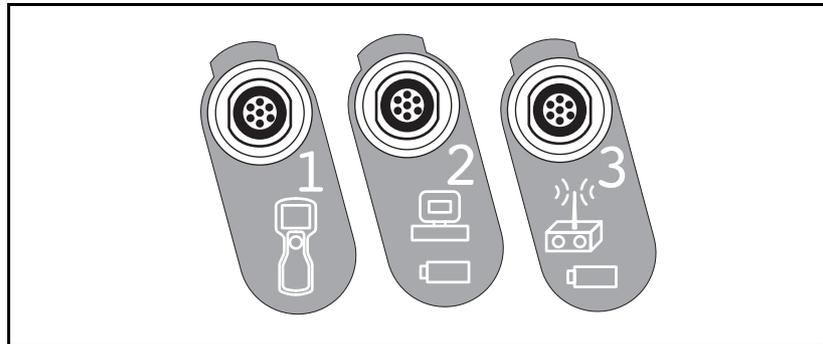
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**Note** – Port 2 is the only port that can access the internal radio modem when configuring receiver communications using the computer and radio configuration software (CommSet).

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- Port 3 is used to connect to an external radio or for a secondary power input.

Baud rates on ports 1 & 3 range from 2400 to 38400, and port 2 up to 57600. The icons below each port, as shown in Figure 2- 4, can be used to identify the ports and the application typically associated with each port.



**Figure 2-4 Serial Ports and Icons**

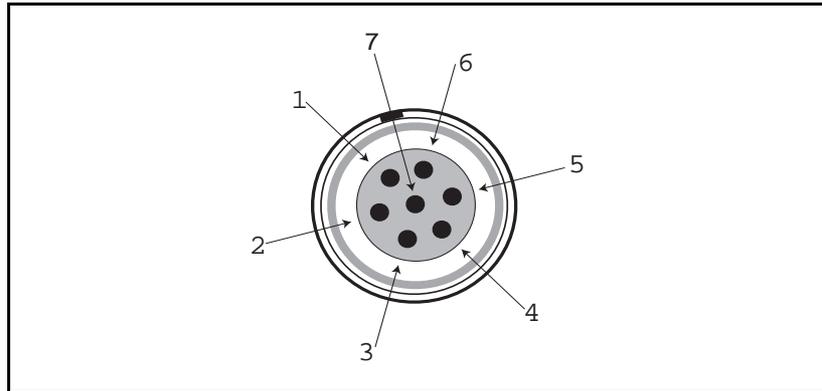
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**Note** – The 4700 receiver uses multipin connectors known nominally as 0-shell Lemo connectors. The 0 designation refers to the size of the connector. Because the 0-shell Lemo connector is the smallest in the series, it is also referred to as a “small” (or mini-) shell Lemo connector. The terms 0-shell and small-shell are interchangeable.

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A 4700 receiver can be powered externally through the Port 2 and Port 3 connectors. See Figure 2-5 and Table 2-2.



**Figure 2-5 7-Pin Small Shell Lemo Receiver Ports**

**Table 2-2 4700 Port Pinouts**

Pin	Port 1 (TSC1 controller, Optional radio or Computer) Pinout Function	Port 2 (Power in, Computer, PPS, Event) Pinout Function	Port 3 (External radio, Power in) Pinout Function
1	Signal GND	Signal GN	Signal GND
2	GND	GND	GND
3	TX data out (TXD1)	TX data out (TXD2)	TX data out (TXD3)
4	RTS1	1PPS	RTS3
5	CTS1	Event Marker	CTS3
6	Power Out (+)	Power In (+)	Power In/Out (+)
7	Serial data in (RXD1)	Serial data in (RXD2)	Serial data in (RXD3)

## 2.5 GPS Antennas

The 4700 receiver is bundled in a number of different configurations, most of which include antennas for tracking the GPS satellites. This section describes the recommended antenna and one of the antenna cable options compatible with the receiver.

### 2.5.1 Micro-centered Antenna

The micro-centered antenna's very accurate phase center variation results in improved precision, compared to conventional GPS antennas, and is the recommended antenna for dual frequency surveys. It is part of the standard configuration for the 4700 receiver bundles.

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**Note** – The "N" (for north) alignment designator is not printed on the micro-centered antenna body. It is unnecessary to align these antennas to north.

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Refer to Appendix A, Typical Configurations for more information on the micro-centered antenna as well as other Trimble GPS antenna options.

### 2.5.2 Antenna Cable

The 10-meter low-loss antenna cable is the default cable for static and Fast-Static field operations. This is the cable which connects the antenna to the receiver. The cable terminates with Type-N and Lemo connectors.

Refer to Appendix A, Typical Configurations for more Trimble GPS antenna cable options.

## 2.6 Radio Link Options

Real-Time Kinematic (RTK) surveys rely on a radio link to transmit data from the base receiver to the rover. A single base receiver can support unlimited rovers within the transmission area. The following radio options are available to support the 4700 receiver in an RTK survey:

- TRIMMARK II
- TRIMTALK 450S
- Internal receive-only radio
- TRIMTALK 900S
- TrimComm 900
- Third-party radio

The optional internal receive only UHF radio in the 4700 receiver is directly compatible with TRIMMARK II and TRIMTALK 450S base transceivers.

### Power Management

The following sections describe power use and requirements for the 4700 receiver.

#### 2.6.1 Power In

A 4700 receiver requires a DC power supply. The receiver turns itself off if the voltage drops below 10.5 VDC. The power source must be regulated to eliminate voltage spikes or voids. It must be filtered to within the 10.5-24 VDC operating range; power from an unfiltered automobile battery charger is not acceptable. The 4700 receiver powers itself on if more than 15 VDC are supplied through either Port 2 or Port 3. This function supports permanent base station operations.

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**Caution** – Do not connect external power to port 1.

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## 2.6.2 Power Out

When any external power source is connected to port 2, power is routed to port 1 for powering the TSC1 controller and to port 3 for powering an external TRIMTALK 450S, 450 or 900 RTK radio. Typically power out on Port 3 is not enable until the survey is started using the TSC1 controller.

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**Note** – When using a secondary battery on Port 3, be sure to connect the battery before powering on the 4700 (or connecting the TSC1, which automatically powers on the 4700). This enables Port 3 to be registered as a power-in port, and disables the Port 3 power-out function.

If it is necessary to connect a secondary battery to Port 3 after the 4700 has been powered on (for example, to increase the availability of a base station), Port 3 is not registered as a power-in port and the power LED does not light. In this case, if the secondary battery is charged, the 4700 switches to the Port 3 battery when the Port 2 battery is discharged.

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### 2.6.3 External Power Sources

The 4700 receiver requires an external power source. The methods of supplying power to the 4700 through the use of the following options are described below:

- Office Support Module IV (OSM IV)
- Battery Module
- Camcorder batteries
- External battery pack (for example, a 6Ah battery)

The 4700 receiver can accept input power through the Port 2&3 connectors. The receiver requires a 1-ampere, 11 to 24 VDC power supply. When the battery voltage drops below 10.5 VDC, the receiver switches to a different power source voltage if an alternative source is connected to the receiver's power port. If an alternative power source is not connected to the receiver's power port, the receiver turns itself off.

The 4700 receiver can supply 0.5 ampere at 12 VDC through Ports 1 & 3. This power output can operate a low-power remote device such as a survey controller or a receive-only radio modem.

The power sources most often used with the 4700 receiver are the OSM IV, the 6 ampere-hour external battery (included with the base units) and camcorder batteries (included with the rover units).

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**Caution** – The receiver's DC power inputs have no user-serviceable fuses. Any DC power supply used to power it must be protected by a 3 to 5-ampere load fuse. Although internal protection is provided, failure to observe this precaution may damage the receiver and void its warranty.

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Refer to Appendix A, Typical Configurations for more details on external power options.

### Restarting the Survey After Power-Down

When the 4700 receiver is powered on, and auto data logging starts, the survey parameters (elevation mask, epoch interval, and so on) are set to the default values. However, if one of the following conditions occurs during the survey:

- a power failure
- an automatic power-down due to low battery
- the surveyor powers down before changing the battery *after* the “low battery warning” (flashing LED) has occurred

then the survey parameters are *maintained*, and the current data file is closed and saved, from the previous session when the receiver automatically restarts after power-up.

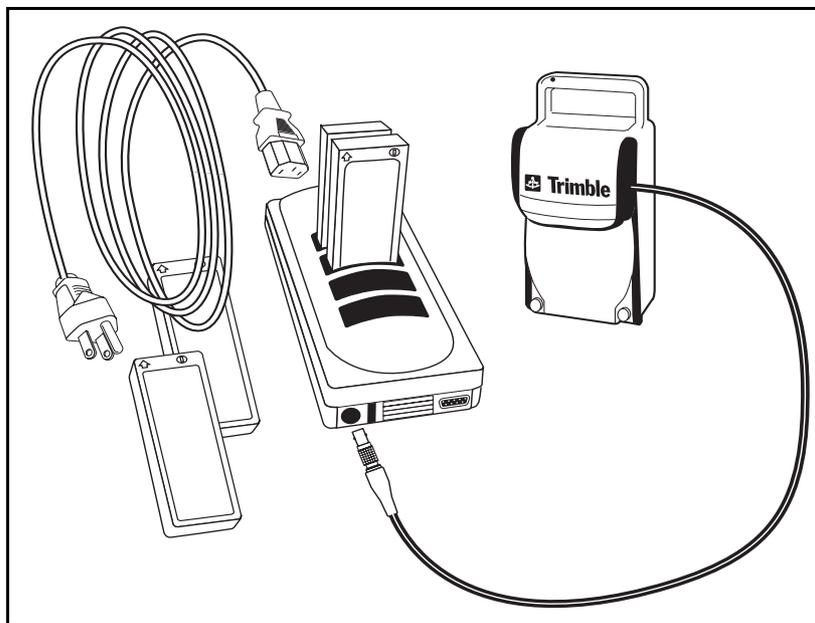
For example, the 4700 receiver is powered up and started with the TSC1 controller, and the epoch interval is changed to 5 seconds (for example, a postprocessed kinematic survey). If the power supply to the 4700 receiver is disconnected during the survey, such as by pulling the battery cable from port #2 (power failure) and the receiver is restarted, it maintains the previously set 5-second epoch interval. The same happens during an automatic power-down due to a low battery or a power-down before changing the battery *after* the “low battery warning” (fast-blinking yellow LED) has occurred.

However, if the 4700 receiver is manually powered down (with the power key) before the low power warning, and then restarted, it sets default parameters and resets the epoch interval to 15 seconds.

To summarize, if the 4700 receiver is powered off normally, the settings are returned to the defaults; if an abnormal power-off condition occurs, the current settings are retained.

## 2.6.4 Charging the Batteries

The 6Ah, 10Ah and camcorder batteries used with the 4700 receiver can be charged using the OSM IV charger unit (charger P/N 20669-80, AC adapter cord P/N 11017). See Figure 2-6.



**Figure 2-6 OSM IV Charger, with 6Ah and Camcorder Batteries**

## 2.7 Data Management

The 4700 receiver automatically assigns a filename and creates a tracking session file when the receiver begins tracking four or more satellites after start-up. Each filename identifies the specific receiver by serial number, lists the GPS date, and file sequence number as follows: AAAABBBC

Where:

AAAA = the last four digits of the receiver serial number

BBB = GPS date code (Julian day,  
where: Jan 1 = 001, Dec 31 = 365)

C = session sequence number (0 - 9, A - Z)

This numbering scheme allows up to 42 session files to be uniquely numbered. The 4700 receiver stops recording data when the internal memory is full or if 42 sessions have been recorded. The yellow data logging LED blinks fast when the receiver internal data memory is almost full or has become full.



Download the data files to the computer using the GPLoad module in the GPSurvey software. GPLoad allows downloading all of the files or selected files only. For more information about the download process, see the *GPLoad Software User's Guide*.

When downloading is complete, the GPSurvey software automatically begins *checking in* the downloaded files and places the data (including point information) in the current project database. If the TSC1 controller was used for data entry in the field, any data-entry errors that may have occurred in the field can be corrected during the data check-in process. Refer to Section 5.3, Check In and Verify the Field Information.

### Backing Up Data

Always make a backup copy of the data files after downloading them from the receiver. Trimble recommends using GPSurvey's Backup utility for project compression and archival.

See the *GPSurvey Software User's Guide* for additional information on using the backup and restore options in the GPSurvey software.

### Deleting Files

Files stored in the 4700 receiver can be deleted in the following ways:

1. Use the GPLoad module in the GPSurvey software (version 2.3a or above).

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**Note** – The RECEIVER.INI file within GPSurvey software version 2.30a and TS01.1 must be updated. A receiver.ini diskette, P/N, is included in your 4700 software package.

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2. Use the TSC1 controller.
3. Press the green power key continuously for 60 seconds, after the receiver has been powered on. When using this method, *all* data is deleted.

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**Warning** – Clearing the file system, a 60-second key press deletes *all* data files in the 4700 receiver, including files that may not have been downloaded. This is not the recommended method of deleting files.

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### 2.7.2 Clearing RAM and File System

If the power key is held down continuously at power-up, the following sequence occurs:

1. After 15 seconds the GPS red LED turns on and a RAM clear (SV almanacs and ephemerides are cleared; all control parameters reset to default) is triggered to occur when the receiver next powers up.
2. After 60 seconds any survey data collecting in progress is terminated, the file system is fully initialized and *all* files are deleted. The receiver then powers down.

At any time between 15 and 60 seconds, while the LED is on, the power key can be released. This powers down the receiver, leaving the file system unchanged.

## 2.8 Software and Firmware Version Requirements

The following items are the minimum software and firmware requirements for using and processing data from the 4700 receiver:

- Survey Controller™ version 6.50
- GPSurvey 2.30a
- Trimble Survey Office™ 1.1  
(for RTK and/or postprocessed kinematic data)

## 2.9 Operating Parameters

Table 2-3 lists the default operating parameters set up in the 4700 receiver.

**Table 2-3 System Defaults**

<b>Communications</b>	
Port 1: Baud Rate	9600
Format	8 data bits, parity none, 1 stop bit
Port 2: Baud Rate	9600
Format	8 data bits, parity none, 1 stop bit
Port 3: Baud Rate	9600
Format	8 data bits, parity none, 1 stop bit
<b>Masks</b>	
Elevation Mask	All types of surveys: 15°
PDOP Mask	7.0
<b>Data Logging</b>	
Minimum SVs	4
Measurement Storage Rate	All types of surveys: 15-second intervals
Position Storage Rate	5-minute interval
Auto-Survey Mode is	Enabled

Ports 1 and 3 always default to the above settings at power-up, but will adjust to the optimal settings after the connection is made.

Port 2 retains whatever settings have been changed.

## 2.10 Internal Radio (Optional)

An internal UHF radio modem (receive only) is an available option for the 4700 receiver. This radio is compatible with the radios used with the 4800 receivers. If an external radio is plugged into the 4700 receiver, the internal radio does *not* automatically shut off. To use the external radio it must be selected manually using the TSC1 controller. The available internal radio modems cover the frequencies between 410MHz and 470MHz, with 12.5kHz and 25kHz channel spacing.

## 2.11 Use and Care

The 4700 receiver is designed to tolerate the sort of rough treatment that equipment may suffer in the field. Nevertheless, it is a high-precision electronic instrument and should be treated with reasonable care.

The 4700 receiver operates in temperatures from -40° to +65° Celsius (-40°F to +149°F).

The receiver is designed and has been tested to withstand an accidental drop of 1 meter on a hard surface. A drop of this magnitude could scratch the external casing. This will not affect the GPS performance of the receiver. The enclosure is sealed.

High-power signals from a nearby radio or radar transmitter can overwhelm the unit's receiver circuits. This does not harm the receiver, but can prevent it from functioning. To avoid problems, try not to use the 4700 receiver within 400 meters of powerful radar, television, or other transmitters. Low-power transmitters such as the ones in portable phones and walkie-talkies, and transmission lines normally do not interfere with receiver operations.

## 2.12 COCOM Limits

The U.S. Department of Commerce requires that all exportable GPS products contain performance limitations so that they cannot be used in a manner that could threaten the security of the United States. The following limitations are implemented on the 4700 receiver.

Immediate access to satellite measurements and navigation results is disabled when the receiver's velocity is computed to be greater than 1000 knots, or its altitude is computed to be above 18,000 meters. The receiver continuously resets until the COCOM situation is cleared.



## 3 Pre-Survey Planning

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This chapter outlines the steps necessary to plan a GPS survey project. The procedures are suggestions that are generally applicable to most situations, but can be modified to fit a particular project.

The following tasks are associated with planning a GPS survey:

- preparation
- site reconnaissance
- network design
- checking satellite visibility
- survey planning--scheduling observation times.

### 3.1 Preparation

Efficient use of GPS surveying requires an understanding of fundamental surveying principles as well as familiarity with the hardware, software, and field procedures associated with GPS. The functionality of the hardware determines whether to use control survey procedures, such as FastStatic and static, or kinematic survey procedures to observe baselines in the field. Thorough knowledge of the field procedures facilitates the execution of GPS surveys in the most productive manner, while ensuring high-precision baseline measurements.

Prepare a written plan for the project at hand describing the purpose, scope of work, and the expected data-collection methods as well as the anticipated uses for the final output. By collecting data on a few additional points, the network geometry may actually be strengthened considerably. Also, collecting more data than is needed can yield valuable information for future use. For example, it may be possible to salvage a survey in the office in the (unlikely?!) event that gross errors occurred while observing one or more baselines. Determine if observations on additional points are feasible for the current project.

## 3.2 Site Reconnaissance

Site reconnaissance is an indispensable part of field survey planning. It enables the surveyor to:

- set or recover survey points to be located during the survey
- note the presence of obstructions that can affect observation scheduling or require relocation of survey points
- obtain permission to enter the job site from private property owners
- determine the best way to reach each survey station, in any type of weather and at any time of the day or night
- draw maps and write directions so that the survey crew can reach the job site and find the points to be observed
- estimate travel time between stations.

## 3.3 Network Design

A good network design is needed for a successful control survey campaign. Even in cases where GPS is used for topographic purposes, control points are required to tie the project to a common reference frame. Extra control points also act as reinitialization points if postprocessed or real-time kinematic procedures are to be used.

When designing the survey network, make a map of the stations, including both fixed-control and unknown points to be observed. Scale the map correctly, as distance between points is an important factor. Also, create an observation schedule that considers both the observation time for each station and the travel time between the stations.

## 3.4 Survey Planning

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**Note** – Before you can use the GPSurvey software, you must install it and perform the product activation procedure. See the *GPSurvey Software User's Guide* for instructions.

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The first step, when using GPSurvey to facilitate project planning and management, is to create a project in the GPSurvey software. This action automatically creates the subdirectories required for all further operations associated with the project and initializes a new project database.

### 3.4.1 Project Management

The project management portion of the GPSurvey processing environment contains the facilities for the day-to-day management of projects. Use the project management options to perform the following:

- create a new project
- open existing projects
- modify project parameters
- close a project
- delete a project
- review project status
- back up, restore, and check the project database

For more specific information concerning the project management module of GPSurvey, see the *GPSurvey Software User's Guide*.

### 3.4.2 Check Satellite Availability

The GPSurvey software Quick Plan / Plan module provides the environment for planning the field observation portion of the project. Either of these modules allows the person planning the project to:

- create field observation sessions and define all of the stations to be observed
- enter information from the obstruction diagrams that were drafted during the visit to each survey station
- compute the required field observation times based on the SV and local conditions

Use the Plan module to save obstruction and session information to the project database. The Plan module can generate several types of graphs and reports to help plan field observations. These include displays of satellite azimuth over time, satellite elevation over time, satellite constellation changes, and skyplot. A skyplot shows satellite tracks as seen from a station. The skyplot includes outlines of any curtains defined to describe obstructions.

For more detailed information about the capabilities of GPSurvey's planning software, and the functional differences between Quick Plan and Plan, refer to the *Quick Plan / Plan Software User's Guide*.



# 4 In the Field - Control Surveying

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This chapter contains a summary of the steps involved in carrying out a GPS survey project using control surveying methods. Refer to the GPSurvey software documentation and other Trimble publications to review specific control survey techniques.

Understanding field data collection procedures is critical to performing successful GPS surveys. Knowing how to use the receiver effectively when gathering the field data will enable the surveyor to produce baselines with the highest precision possible.

The topics covered in this chapter:

- Control surveying description
- FastStatic survey procedures
- Static survey procedures
- Making an observation (data collection)

## 4.1 Postprocessed Surveys

The 4700 receiver can be used in static, FastStatic, or postprocessed kinematic surveys. You can use the 4700 receiver with any other Trimble survey grade receivers for this purpose. Several important conditions must exist for this application:

- At least one other receiver must log data at the same epoch rate and at the same time to compute baselines.
- For every baseline desired, each receiver on the points defining the desired baseline must be tracking *at least* four satellites in common.
- Any other receiver in the survey must be a survey grade receiver, capable of logging both C/A code and at least L1 carrier phase observables.
- The 4700 receiver is a dual frequency receiver—to achieve dual frequency baseline results, the receiver must be used with another dual frequency receiver.

## 4.2 Control Surveying Description

The purpose of a control survey is to produce coordinates on selected survey points at a specified level of precision. This level of precision is set high enough that propagated error in subsequent surveys will continue to be within the tolerances or requirements of the overall project standards. To get this high level of precision, GPS control surveys use procedures that are more time-consuming than other GPS surveys.

The two types of data collection techniques suggested for control surveys are Static surveying and FastStatic surveying. Each of these procedures requires that at least two receivers log simultaneous observations of four or more common satellites for a specified minimum time. Using the known control information and the baselines computed from the GPS field observations, the GPSurvey postprocessing software can derive coordinates throughout the network.

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**Note** – Always adjust the processed field data. The direct results of GPS postprocessing are GPS baselines and unadjusted coordinates—insufficient for standard survey procedures. Use the GPSurvey network adjustment option, TRIMNET Plus™ to complete this step.

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### 4.2.1 Static Surveying

Static surveying is the most precise surveying procedure, and the slowest. It requires observations of at least four common satellites for a period of 45 to 60 minutes. It yields baselines that are precise to  $\pm 5 \text{ mm} + 1 \text{ ppm}$  times baseline length, assuming common data has been logged from five satellites by each receiver at each end of the baseline. Precise ephemeris and meteorological data may be necessary to achieve this high accuracy, depending on conditions at the time of observation. Two 4700 receivers working in tandem produce dual-frequency results.

### **4.2.2 FastStatic Surveying**

FastStatic requires simultaneous observations of four or more satellites for a period of 8 to 20 minutes. It yields baseline components with precision that approaches Static results, depending on the number of common SVs, SV geometry, and ionospheric conditions. FastStatic precision is a function of occupation time and observation conditions. FastStatic surveying is normally limited to operations with baselines of approximately 20km or less, and is more sensitive to cycle slips and high PDOP (reflecting poor satellite geometry) than static surveying.

### 4.3 Measuring Antenna Height

Accurate height measurements are essential for meaningful survey results. Mistakes in height measurement are the most common source of error in GPS surveying.

The height measurement can be the true vertical height of the antenna on a tripod, or the slope height acquired using a measuring rod to find the distance from the outer edge of the antenna to the survey mark. The GPSurvey software used in processing the data files accepts either of these two measurements to calculate the survey mark position precisely.

For additional height measurement methods refer to the GPSurvey and Survey Controller manuals.

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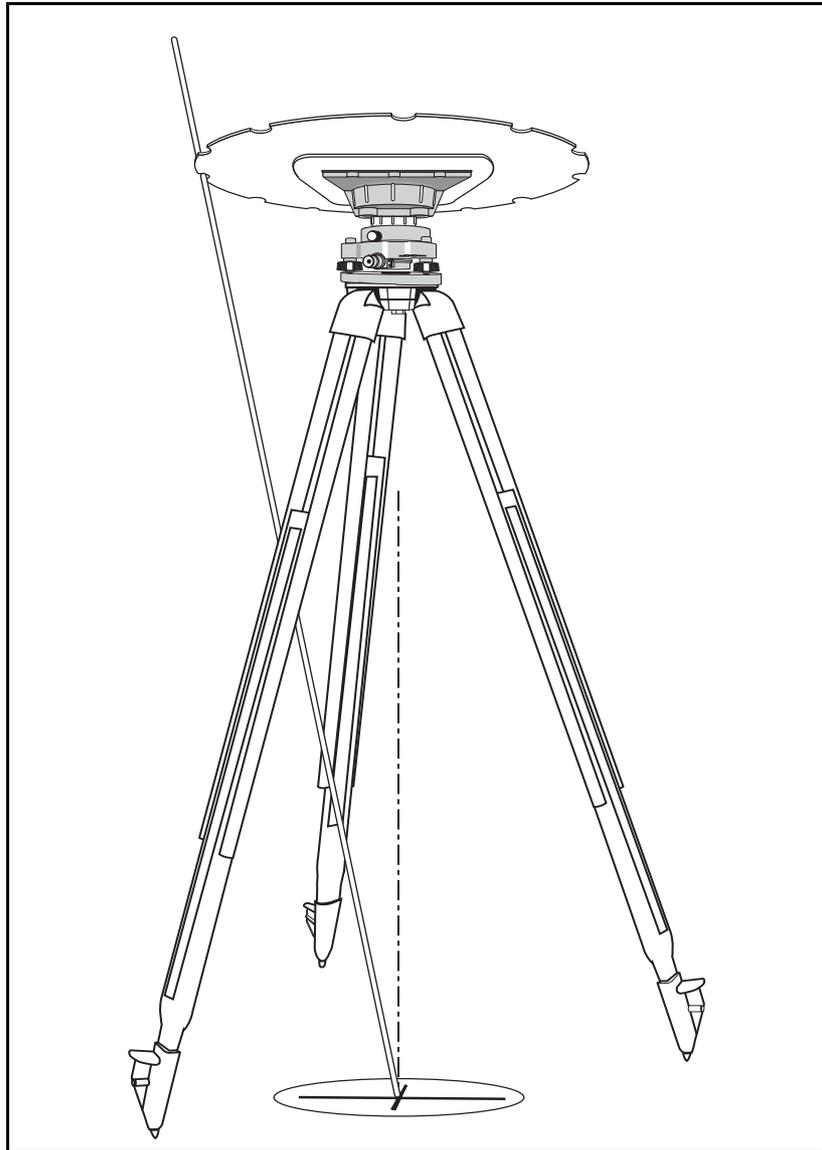
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**Note** – Pay close attention to procedures for measuring antenna height. Accurate height measurements are essential for meaningful survey results. Mistakes in height measurement are the most common source of error in GPS surveying. Make sure to record the antenna height measurements correctly in a field log, as well as the base station or survey mark name, the receiver serial number, and the time. Fixed-height tripods are recommended to reduce the possibility of blunders caused by incorrect height measurement.

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To measure the GPS antenna height when using a conventional tripod: See Figure 4-1.

1. Assemble the 4-piece measuring rod (P/N 16162).
2. Place the pointed tip of the measuring rod on the survey mark.
3. Fit the top of the rod in one of the grooves in (either the antenna or) the ground plane.
4. Read the preferred unit (metric or US Survey foot) marking where the rod meets the underside edge of the (antenna or) groundplane.



**Figure 4-1 Measuring the Antenna Height Using a Measuring Rod and Conventional Tripod**

### **4.3.1 Fixed-Height Tripod**

A fixed-height tripod has a fixed-height rod along the vertical axis to simplify the height measurement process. To set up a fixed-height tripod, place the tip of the rod on the mark and release the tripod's legs, which automatically extend to the ground. Then adjust the tripod until the rod's built-in level bubble is centered in the visible ring, and then lock the legs in place.

Since the fixed-height tripod does not require direct measurement of antenna height, the likelihood for making a blunder during height measurement is greatly reduced. For this reason, the fixed-height tripod is preferred for control surveys.

## 4.4 FastStatic Surveying Methods

FastStatic surveying is identical to static surveying except that the duration of occupation for each point is shorter. FastStatic surveying requires simultaneous observations of four or more common satellites. Data collection time is typically 8 to 20 minutes, depending on atmospheric conditions and the number of satellites available.

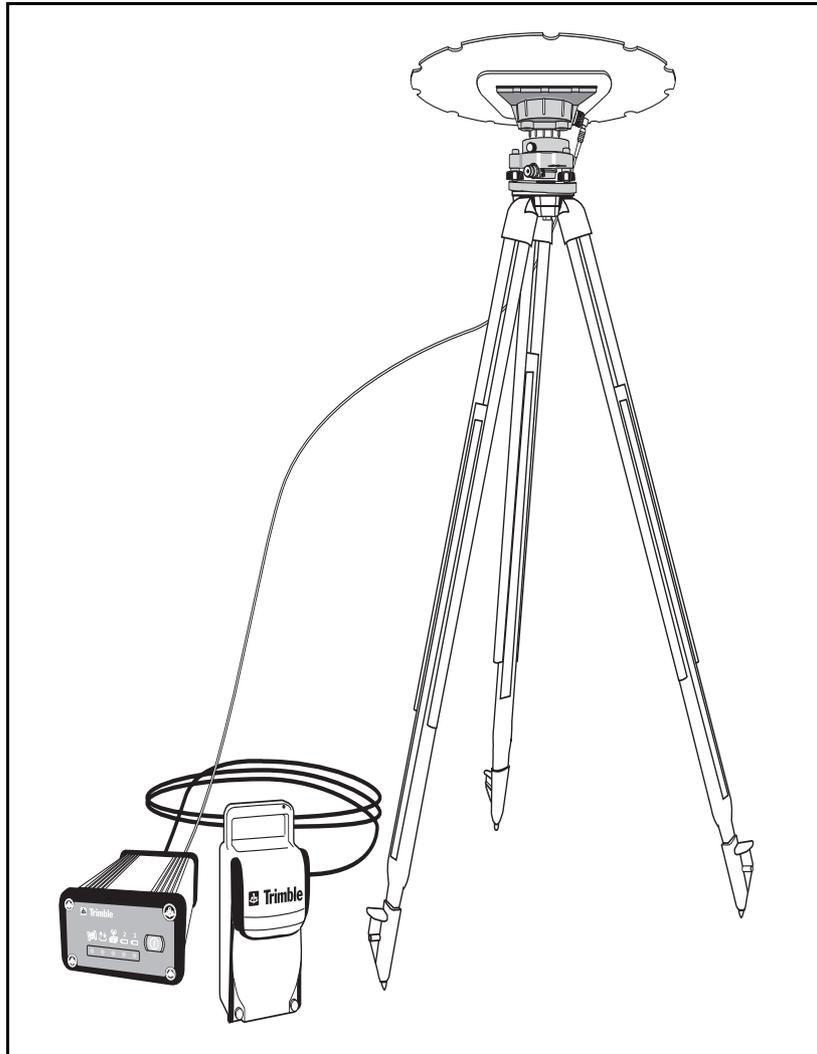
FastStatic surveying yields baseline components with precision that approaches Static, depending on the number of common SVs, SV geometry, ionospheric conditions, and so on. The FastStatic precision is a function of occupation time and observation conditions. Baseline length is assumed to be 20 km or less. The procedure is more sensitive to cycleslips and high PDOP than static surveying.

### 4.4.1 Required Equipment and Software

A FastStatic survey requires at least two 4700 receivers. A list of the items required in a typical setup is located in Appendix A, Typical Configurations. FastStatic survey results are postprocessed with the GPSurvey software.

### 4.4.2 Setting Up the Equipment and Running the Survey

The typical setup when using a 4700 receiver is shown in Figure 4-2. This section describes the method for setting up the receiver and running the survey.



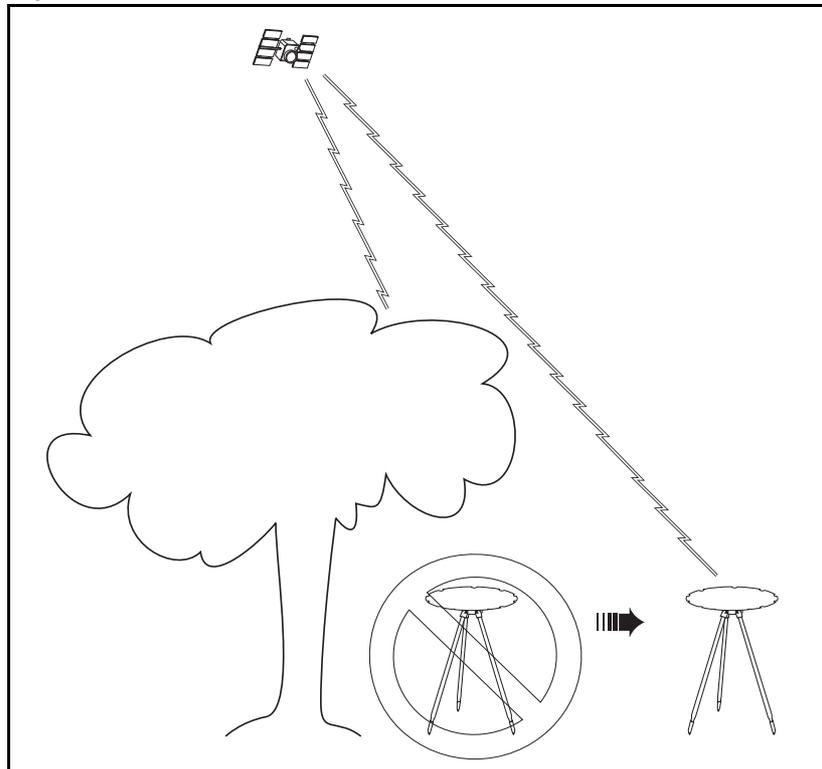
**Figure 4-2 Typical Setup Using A 4700 Receiver, For Static and FastStatic Applications**

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**Note** – A tripod with a fixed height vertical axis is the recommended type of support for GPS antennas used in control surveys, and for all types of GPS antennas at temporary base stations.

The procedure described in Making an Observation, page 4-13 outlines the steps to position the antenna over the survey mark and to measure its height accurately using a tribrach and optical plummet as it requires more care by the surveyor.

For uninterrupted data collection, be sure to have a clear line of sight between the antenna and the satellites tracked during the survey. See Figure e4-3.



**Figure 4-3** Locating the Antenna with a Clear View of the Sky

### **4.4.3 Using the 4700 Receiver with a Rangepole**

The setup shown in Figure 4-4 is a typical configuration for 4700 rovers in operations with moderate precision requirements and short to moderate observation times (for example, kinematic surveys and some FastStatic surveys). A bipod attachment is available and suggested when performing FastStatic surveys with a rangepole.



**Figure 4-4 Using a Rangepole With the 4700 Receiver**

#### 4.4.4 Making an Observation

The main task associated with performing a GPS survey is the collection of the field data, also known as baseline observation.

Field techniques can vary, depending on the required precision of the project, topographic features and obstructions, accessibility, and many other items. However, there are a number of field procedures that are common to all GPS surveys.

These procedures are suggestions and can be modified to fit the particular project, but are generally applicable to most situations. Refer to Figure A -1 for a picture of a typical setup.

Set up the 4700 receiver and run the FastStatic survey as described in the following steps:

1. Set up the tripod over the survey mark. The top of the tripod should be roughly at eye level. This makes it easier to adjust, and also reduces the risk of signal multipath from nearby objects.
2. Screw the tribrach adapter into the antenna. Seat the adapter on the tribrach and clamp the assembly to the tripod.
3. Connect the 4700 receiver to a power source (for example, a 6AH battery) and to the antenna.
4. Position and level the tripod precisely over the survey mark.
5. Measure the antenna height. Refer to Measuring Antenna Height, pag e4-5 for details.
6. Record: the antenna height measurement(s), the survey mark name, the receiver serial number, and the start of the session time in a field log. If the true vertical height of the antenna (for example when using a fixed-height tripod instead of a conventional tripod) is known, record that in the field log. If using a TSC1 controller, this data is typed in before the beginning of the observation and is stored electronically within the data file.

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**Note** – The hardware and setup procedures for base stations and rovers are the same.

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7. Repeat steps 1 through 6 to set up one or more base stations (also called reference units) at reference marks whose WGS-84 or NAD-83 coordinates are known with sufficient accuracy for the purposes of the current project.

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**Tip** – When measuring the antenna heights at the start of the session, read the metric units, and at the end of the session read the U.S. Survey feet units on the rod. Convert the US Survey units to metric and compare. This helps catch measurement blunders.

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8. Repeat steps 1 through 6 to set up one or more rovers (survey receivers) at survey marks whose coordinates are to be determined.
9. Begin the baseline observations by turning on the 4700 receivers and verifying that data is being logged.  
  
The yellow data-logging LED should be on solid and the red Satellite LED should blink slowly.
10. Monitor the LEDs and make sure each 4700 receiver is tracking at least four satellites and that no major losses of lock occur.
11. Based on the number of satellites tracked and the type of survey performed, make sure sufficient time has elapsed before turning off the receiver to end the session.
12. Move the receiver to the next survey mark and repeat the previous steps to set up the 4700 receiver and begin the next session.

### 4.4.5 Minimum Observation Times

To complete an observation, the 4700 rover must collect data from the required number of satellites *continuously* for the minimum time specified within its internal parameter setup, shown in Table 4 -1.

**Table 4-1 FastStatic Survey Point Occupation Times**

Baseline Length	4 Satellites	5 Satellites	6 or more Satellites
≤ 20 km	20 min	15 min	8 min

If observation of any of the satellites being tracked is interrupted (anything more than a momentary interruption), the 4700 receiver ignores that satellite and falls back to a longer observation time with a smaller number of satellites. If the number of satellites being tracked falls below four, the receiver restarts the timed observation period at the beginning.

The indicator LEDs on the receiver should be monitored to determine if the receiver is logging data properly. Refer to Indicator LEDs, page 2-4 for information on the LED indications.

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**Note** – The FastStatic times are for baselines of 20 km or less. Longer baselines should be observed using the guidelines for Static surveys. Beyond this distance ionospheric conditions can no longer be considered the same at every station.

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## **4.5 Static Surveying Methods**

Static surveying is the most precise surveying procedure a 4700 receiver can perform; however, it requires a longer occupation time at each station. The occupation time required for a static survey depends on many factors. Trimble recommends an occupation time of at least 45 minutes during times when five or more satellites are available, or 60 minutes during times when only four satellites are available. The Plan or Quick Plan module can be used to determine satellite availability at a specified site and time.

### **4.5.1 Equipment and Software Required**

A static survey requires at least two 4700 receivers. The GPSurvey software is recommended for postprocessing static survey results.

## 4.5.2 Setting Up the Equipment and Running the Survey

This section follows the method for setting up the a typical receiver, however, several additional steps are listed.

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**Note** – A tripod with a fixed height vertical axis is the recommended type of support for GPS antennas used in control surveys, and for all types of GPS antennas at temporary base stations.

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The following procedure outlines the steps to position the antenna over the survey mark and to measure its height accurately using a tribrach and optical plummet as it requires more care by the surveyor.

To facilitate uninterrupted data collection, the antenna should also have a clear line of sight to the satellites it tracks during the survey.

Perform steps 1-12 as outlined in Making an Observation, pag e4-13, and then continue as follows:

13. Wait for 45 to 60 minutes before turning the receiver off.
14. Move the receiver to the next survey mark and repeat the previous steps to set up the 4700 receiver and begin the next session.

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**Note** – Be sure to specify in the field log whether an antenna height measurement is slope distance or true vertical. Typically, with standard tripods the measurement is slope distance, and with fixed-height tripods it is true vertical or to "bottom of antenna mount."

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## 4.5.3 Static Survey Times and Distances

Point occupation times for static surveying depends on the number of satellites available and the length of the baseline being measured. The recommended occupation times are between 45 and 60 minutes.



# 5 Back in the Office - Postprocessing the Field Data

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This chapter contains a summary of the steps required for postprocessing GPS survey data. Familiarity with these steps and knowledge of the postprocessing software aids in the planning and reduction of baseline observations, as well as the management and production of the final project output. The following procedures are suggestions and can be modified to fit a particular project, but are generally applicable to most situations.

The tasks associated with postprocessing GPS survey data are the following:

- Open a project
- Download the data from the 4700 receiver
- Check in data to the project database and review the field input
- Back up the downloaded data
- Perform the baseline processing
- Analyze the results of processing
- Adjust the network and produce final coordinates

## 5.1 Open a Project

Before downloading the data from the receivers, open a project in GPSurvey. If the Plan utility within the GPSurvey software was used to plan the project, this project already exists as it was created during the planning stage. This is not the case if you used QuickPlan.

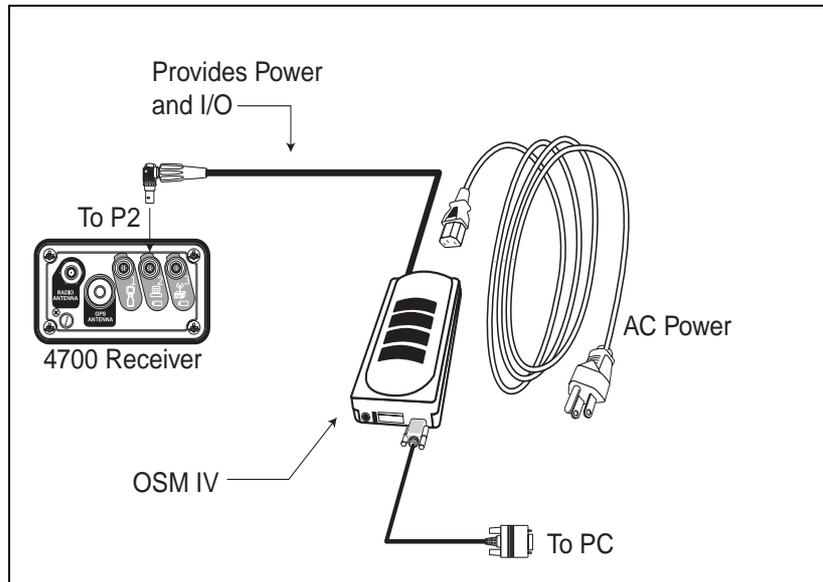
## 5.2 Download the Data

A GPS receiver keeps satellite measurements and other data in files stored in its internal memory, or in the TSC1 controller. GPSurvey cannot process the data until these files are transferred or downloaded to the local computer.

Download files into the open project using GPSurvey's GPLoad utility. This program allows downloading all of the files in a receiver or selected files only. Files previously transferred from the receiver to a directory outside the current project, solution files from another project, or real-time surveying files from a data collector can also be imported at this time.

For more information about the downloading process, see the *GPLoad Software User's Guide*.

On returning to the office from the field, connect the 4700 receiver, or the TSC1 controller to a computer that has GPSurvey software version 2.3 or later installed, as shown in Figure 5-1.



**Figure 5-1 Standard Configuration for Data Download**

### 5.3 Check In and Verify the Field Information

The GPSurvey data check-in program has several parameters that control the process of transferring data to the project database. Criteria for defining station names and station identifiers, automatic error detection and correction can be specified at this time as well. During the *Check-in* process enter any station information recorded in the field log that was impossible to enter into the receiver.

Before beginning any baseline processing, make sure the information entered is correct. Incorrect station information, such as station names or antenna heights, causes erroneous results during baseline processing.

Use the data check-in program to edit and view any data entered, such as antenna heights and station information. Use the field notes to compare the actions in the field with what is present in the data set. *Be sure to verify the station names and the antenna-height entries for each occupation in every 4700 receiver.*

Be especially careful when specifying the type of antenna-height measurement, uncorrected or true vertical. When entering a true vertical antenna-height measurement, be aware that GPSurvey makes no corrections to this value throughout the data reduction.

The GPSurvey software supports the use of the TSC1 data collector with Survey Controller™ firmware, which is required for a kinematic survey with the 4700 receiver. If a TSC1 controller was used in the field, there is more information to check in—and more sources of potential errors. Check the descriptive information, such as station names, as well as the surveying data. Checking and double-checking at this stage can help to avoid typographical or occupational blunders being carried into the subsequent processing phase of the data reduction.

For more information about verifying station information, see the *GPSurvey Software User's Guide*.

## 5.4 Back Up the Data

Always make a backup copy of data files after downloading. Trimble recommends GPSurvey's Backup utility for project compression and archival.

See the *GPSurvey Software User's Guide* for additional information on using the backup and restore options in the GPSurvey software.

## 5.5 Process the Baselines

Use the GPSurvey software module, WAVE (Weighted Ambiguity Vector Estimator), to reduce the field observations and produce baselines.

If the data was collected using a combination of field techniques, the WAVE module automatically recognizes and distinguishes between static, FastStatic, and kinematic data files.

See the *WAVE Software User's Guide* for complete information on baseline processing.

## 5.6 View the Baseline Results

The GPSurvey software also provides the facility to view the observed stations and processed baselines in a network map. Use additional options to perform loop closures and view the detailed information in the closure log, or generate a baseline log with a list of solution files associated with selected baselines.

See the *GPSurvey Software User's Guide* for complete information on the network map viewing options.

## 5.7 Adjust the Network

Network adjustment is the most important tool in judging the overall integrity of the observations and survey network. Just because a baseline can be processed in GPSurvey does not mean that the baseline fits within the survey network. It is not enough for a baseline to be statistically precise; it must fit into the network of observed baselines.

By default, the coordinates output by WAVE are WGS-84 datum coordinates—transformation of these coordinates to some other, more meaningful, local datum will be a likely additional step. Use the network adjustment process and tools to assist with the tasks of datum transformations, geoid modeling, and quality control.

TRIMNET Plus, the network adjustment program that typically comes bundled with the GPSurvey software, can combine GPS, terrestrial, and geoid observations in network adjustment computations.

### 5.7.1 Create Project Reports

Utility options available in the GPSurvey software can be used to create, preview, and print the following customized summaries of your project:

- *Project*: general project information
- *Station*: information about selected stations in the project
- *Baseline*: one-line summaries of processing results for selected baselines
- *Baseline solution*: brief processing information for selected baselines
- *Detailed baseline*: detailed processing information for selected baselines

# 6 In the Field - Real-Time Kinematic Surveying

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This chapter contains a discussion of the steps involved in executing a GPS survey project using real-time kinematic surveying methods. Refer to the *Survey Controller Reference Manual*, *Survey Controller Field Guide*, and the *Trimble Survey Office Software User's Guide* for more information on equipment operation and RTK and postprocessed kinematic survey techniques.

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**Note** – A Trimble TSC1 data collector with Survey Controller firmware is required to perform a real-time or postprocessed kinematic survey with the 4700 receiver. The Survey Controller software on the data collector provides an interface to the GPS receiver, allowing you to specify beginning and ending times for stop-and-go occupations or continuous kinematic segments. The Survey Controller also allows you to enter point names, feature codes and antenna heights while occupying a station or while moving.

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**Note** – For RTK, the base receiver and each rover must have its own dedicated radio and antenna to maintain the required communications link between base and rover.

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## 6.1 Real-Time Kinematic (RTK) Surveying Description

Real-time kinematic surveying has three basic physical components:

- GPS base station
- GPS rover
- Radio link between the base and the rover

The radio link transmits the GPS observations or data from the base receiver to the rover. The roving receiver then combines the base station data with the rover GPS data to process baselines and produce coordinates at the rover in real-time.

A significant feature of RTK is the ability to work in local coordinates. This feature is possible only if a calibration has been performed for the local system, where the calibration defines the transformation parameters, or mathematical relationship, between the GPS coordinate system (WGS84) and the local coordinate system.

Because RTK is, by definition, a kinematic procedure, it shares the same initialization requirements as a postprocessed kinematic survey. The roving receiver must be initialized at the beginning of the survey and maintain lock on at least four of the same satellites that the base receiver is tracking and logging to perform a successful RTK survey. If there is a loss of lock, an interruption in logging of at least four common satellites, the rover must re-initialize before proceeding.

When configured for RTK, the 4700 receiver is capable of on-the-fly initialization, or initialization while moving. This allows for regaining initialization while walking or moving from one point to the next, assuming a clear view to the sky. This initialization method requires tracking at least five common satellites at base and rover.

An entire GPS survey can be performed using only RTK methods, but it is also possible to combine the results of a postprocessed survey with RTK. The basic RTK requirements are the same in each of these cases, but the sequence of the steps varies.

### 6.1.1 RTK Survey

The following basic steps are required to conduct a real-time survey, when there has been no previous GPS survey conducted on site:

1. Set up the base receiver with the transmit radio modem and radio antenna.
2. Start the base receiver using the TSC1 controller.
3. Set up the roving receiver, radio modem and radio antenna.
4. Start the roving receiver using the TSC1 controller.
5. Initialize the roving receiver.
6. Locate control points with rover.
7. Perform in-field calibration in the TSC1 controller
8. Proceed with RTK survey

Before performing the calibration, control points are located relative to the base receiver in a system approximating the GPS coordinate system (WGS84). After the calibration has been successfully performed, all results are presented in the local coordinate system.

This is one advantage to using RTK exclusively: one trip to the job site is eliminated. With RTK, the control points can be located on the first trip to the job site using RTK and in-field calibration. This avoids having to perform a postprocessed control survey, returning to the office, processing the data and adjusting the coordinates, and then returning to the field to perform the RTK survey.

The disadvantage to this approach is the absence of a network adjustment for the control stations or any other stations in the survey network. Also, there is no existing network of GPS points with which to verify initializations.

## 6.2 RTK Base Receiver Installation

The receiver can be used as a base receiver for real time kinematic surveys. Roving receivers can be 4700 receivers or any other series 4000 receivers equipped with the RTK rover options. To install the 4700 receiver as an RTK base station do the following:

1. Set up the antenna over the point.
2. Connect the antenna to the 4700 receiver.
3. Connect the transmit radio modem to the 4700 receiver.
4. Connect the power cable to the 4700 receiver.
5. Connect the TSC1 controller to the 4700 receiver.
6. Press the **ON** button on the TSC1 controller.
7. Power up the 4700 receiver, use the **ON** button or allow the TSC1 controller to do this for you.
8. Refer to the Survey Controller manual to continue configuring the 4700 receiver as a base unit.

### 6.2.1 Site Considerations

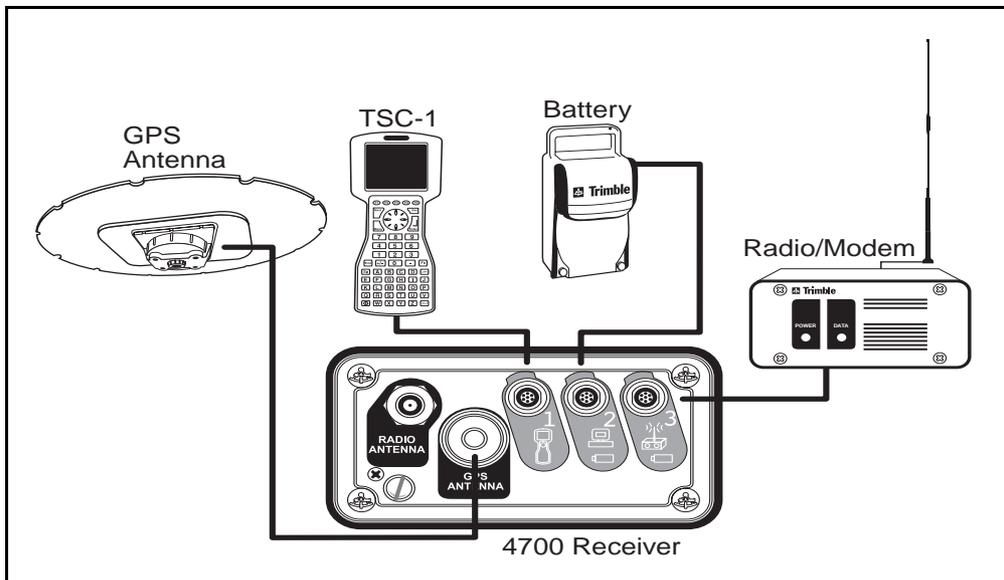
The area in which you set up the RTK base station should have the following characteristics:

- Clear view of the sky for maximum SV tracking
- Minimal sources of RF interference
- Minimal sources of multipath
- Approximate elevation of roving receivers, if possible
- Clear view for radio transmissions, elevated radio antennas are highly recommended

Place the GPS antenna on a tripod or on a fixed-height rod over the base station. The radio antenna can be mounted on any stand, preferably something that elevates the antenna above nearby obstructions.

## 6.2.2 Connections

Connect the components to the 4700 receiver as shown in Figure 6-1. Refer to Port Configuration, page 2-8 for a description of the rear panel connections.



**Figure 6-1 Connecting the Hardware to the 4700 Base Receiver Ports**

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**Note** – When using a secondary battery on Port 3, be sure to connect the battery before powering on the 4700 (or connecting the TSC1, which automatically powers on the 4700). This enables Port 3 to be registered as a power-in port, and disables the Port 3 power-out function.

If it is necessary to connect a secondary battery to Port 3 after the 4700 has been powered on (for example, to increase the availability of a base station), Port 3 is not registered as a power-in port and the power LED does not light. In this case, if the secondary battery is charged, the 4700 switches to the Port 3 battery when the Port 2 battery is discharged.

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**Note** – The TSC1 controller is only a temporary requirement in this configuration. It is typically disconnected once the base has been started.

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### 6.2.3 Connecting the Antenna

The 4700 receiver is normally packaged with a micro-centered antenna. For the base receiver setup, the groundplane is recommended to reduce multipath effects.

To connect the antenna do the following:

1. Setup the antenna over the point.
2. Use a fixed-height tripod or tripod and tribrach.
3. Connect the cable to the antenna using the N-type connection.
4. Connect the Lemo connection end to the 4700 receiver **ANTENNA** port.

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**Caution** – Antennas for 4700 receiver and other recent Series 4000 receivers use a lower operating voltage than antennas for earlier receivers (4000A, AX, SX, SL, SD). The 4700 receiver does not operate with antennas for those earlier receivers. Attaching an old antenna to a newer model of receiver can cause damage. Attaching an antenna made by another manufacturer can also cause damage to the receiver, antenna, or both. This caution does not apply to the Compact L1/L2 and Micro-centered antennas.

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## 6.2.4 Connecting the Radio

Set up the radio link solution following the instructions in the radio manual.

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**Note** – The 4700 internal radio modem is receive only. For base station operation an external transmit radio is always required.

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To connect the radio do the following:

1. Use the antenna cable with TNC connector to connect the TRIMMARK/TRIMTALK radio to the radio antenna.
2. Attach the TNC connector into the radio.
3. Use the cable (P/N 36241-03) with the 5-pin (1-shell) to 7-pin (0-shell) Lemo connectors to connect the radio to Port 3 of the 4700 receiver.
  - a. Insert the 5-pin (Lemo 1-shell) connector into the radio.
  - b. Insert the 7-pin (Lemo 0-shell) connector into the 4700 receiver I/O Port 3.

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**Note** – External radios other than Trimble products may require special cables.

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**Note** – Elevating the radio antenna can significantly increase the range over which the radio can transmit.

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## 6.2.5 Connecting the Power

The recommended power source for RTK base stations is the 6Ah battery. The cable attached to the 6Ah battery comes with a 7-pin Lemo connector. Insert the cable into the 4700 receiver in either Port 2 or Port 3.

With power supplied to the receiver, the appropriate battery LED becomes solid green as soon as you press the POWER switch. The POWER (yellow/green) LED indicates a good connection when lit.

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**Note** – When using a secondary battery on Port 3, be sure to connect the battery before powering on the 4700 (or connecting the TSC1, which automatically powers on the 4700). This enables Port 3 to be registered as a power-in port, and disables the Port 3 power-out function.

If it is necessary to connect a secondary battery to Port 3 after the 4700 has been powered on (for example, to increase the availability of a base station), Port 3 is not registered as a power-in port and the power LED does not light. In this case, if the secondary battery is charged, the 4700 switches to the Port 3 battery when the Port 2 battery is discharged.

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## 6.2.6 Connecting the TSC1 Controller

The 4700 receiver is packaged with a cable (P/N 31288) designed for communication between the receiver and the TSC1 controller. This cable has a (0-shell) 7-pin Lemo connector at both ends. Connect the TSC1 controller to the receiver with this cable and then:

1. Press the **ON** button to turn on the TSC1 controller.
2. Turn on the 4700 receiver using the TSC1 controller.

If the TSC1 controller is used to start the base receiver, you can disconnect the TSC1 controller from the base receiver after the base has been started.

For further instructions on the base setup, refer to the Survey Controller Reference manual.

## 6.3 RTK Rover Installation

The receiver is ideal for use as a Real-Time Kinematic rover. The receiver can be used with another 4700 receiver as a base station, or with any other 4000 series receiver equipped with the RTK option as a base station.

To install the 4700 receiver as an RTK rover do the following:

1. Connect the GPS antenna.
2. Connect the radio antenna. If an external radio is used, connect the external radio, then the radio antenna.
3. Connect the power source.
4. Connect the TSC1 controller.
5. Place the 4700 receiver with connected cables carefully into the backpack.
6. Press the **ON** button on the TSC1 controller.
7. Power on the 4700 receiver using either the TSC1 controller or the **ON** button on the 4700 receiver.

The 4700 receiver in a rover configuration is carried in a backpack. Position each piece of the hardware in its respective slot in the Trimble backpack so that:

- The LED lights on the front panel are visible.
- The **POWER** switch is accessible.
- DC power is available.
- Clearance exists for the power, antenna, and interface connections.

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**Tip** – Arrange the antenna and TSC1 controller cables so that they exit the backpack on the same side. This ensures that no excess cable gets in the way.

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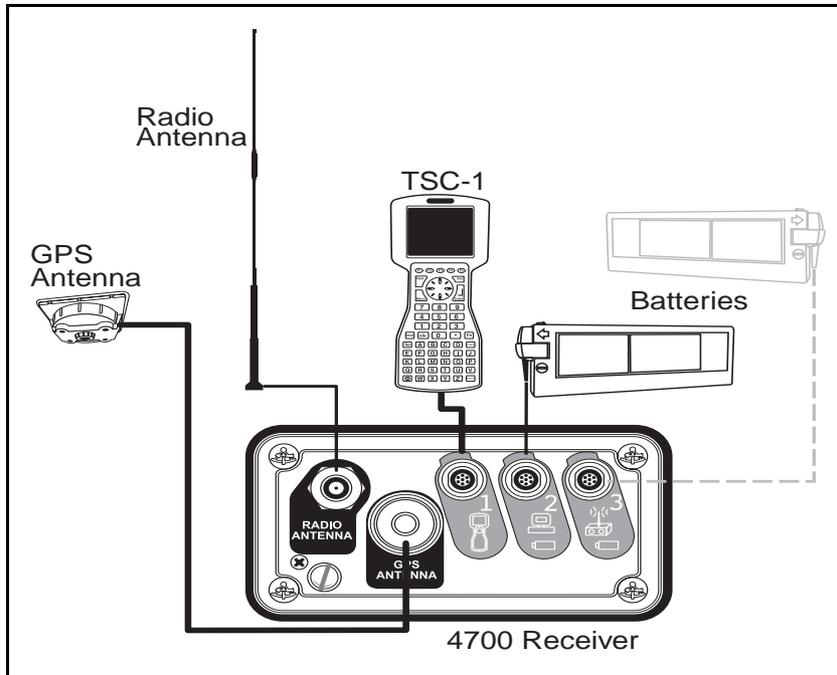
### 6.3.1 Site Considerations

Real time kinematic surveys are most efficient in areas that are relatively free of obstructions. The 4700 receiver is equipped with on-the-fly ambiguity resolution, which provides greater flexibility around obstructions, but the survey will benefit from a clear environment. In general, an ideal site for RTK surveying has these characteristics:

- Clear view to the sky
- Minimal sources of RF interference
- Minimal sources of multipath
- Similar elevation, roving antennas to the base station, if possible

### 6.3.2 Connections

Connect the components to the 4700 receiver as shown in Figure 6-2. Refer to Port Configuration, page 2-8 for a description of the rear panel connections.



**Figure 6-2 Connecting the Hardware to the 4700 Rover Receiver Ports (Internal Radio)**

### 6.3.3 Connecting the Antenna

The 4700 receiver is normally packaged with a micro-centered antenna. For the roving receiver setup, the groundplane is removed for convenience. The micro-centered antenna is set on the rangepole using the quick-release adapter, and connected by cable to the receiver in the backpack.

To connect the antenna do the following:

1. Set the antenna on the rangepole using the quick-release adapter.
2. Connect the cable to the antenna using the N-type connection.
3. Connect the Lemo connection end to the 4700 receiver **ANTENNA** port connection.

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**Note** – When working in a high multipath environment, attach the groundplane (if purchased) to the roving antenna. This can significantly affect the ability to initialize an RTK survey.

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### 6.3.4 Connecting an External Radio to the 4700 Receiver

The radio antenna for a roving receiver has been designed to integrate with the backpack.

To connect the radio do the following:

1. Attach the radio antenna to the backpack frame.
2. Connect the TNC connector to the TRIMTALK or TRIMMARK radio inside the backpack.
3. Use the cable (P/N 36241-03) with the 5-pin (1-shell) to 7-pin (0-shell) Lemo connectors to connect the radio to Port 3 of the 4700 receiver.
  - a. Insert the 5-pin connector into the radio.
  - b. Insert the 7-pin connector into Port 3 of the 4700 receiver.

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**Note** – Refer to Figure 6-1 if an external radio is used at the roving receiver.

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**Note** – External radios other than Trimble products may require special cables.

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### 6.3.5 Connecting the Power

To connect the power do the following:

1. Use the 7-pin Lemo to camcorder battery cable.
2. Insert the batteries into the slots in the backpack, with the battery terminals at the top of the backpack.
3. Insert the 7-pin Lemo connector into the 4700 receiver Ports 2 & 3.
4. Connect the battery cable to the batteries.

### 6.3.6 Connecting the TSC1 Controller

To connect the TSC1 controller do the following:

1. Use the 7-pin Lemo to 7-pin connector.
2. Insert the 7-pin connector into the TSC1 controller.
3. Insert the 7-pin Lemo connector into the 4700 receiver Port 1.
4. Press the **ON** button on the TSC1 controller.
5. Power on the 4700 receiver using either the TSC1 controller or the **ON** button of the 4700 receiver.

After the TSC1 controller connected, place the 4700 receiver and connected cables carefully in the backpack. *Be sure to avoid stress on the cable connections.*

When the connections are complete, confirm the status by checking the 4700 front panel LEDs on the radio and the satellite LEDs should blink at the configure rates (typically once per second for RTK surveying). The power LED should be on solid. Use the TSC1 controller to note the number of SVs being tracked and the communication status.

For further instructions on the rover setup and conducting an RTK survey, refer to the Survey Controller Reference manual.

# A Typical Configurations

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This appendix contains the typical configurations for using the 4700 receiver in the field as well as for downloading the field data.

## A.1 Base Station Static/FastStatic Configuratio

Table A-1 lists the items required for each 4700 receiver setup for a Static or FastStatic occupation when using a conventional tripod.

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**Note** – The items listed in the following tables are for example purposes only. Actual purchased items may vary.

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**Table A-1 Conventional Tripod Equipment**

Part Name	Part Number
4700 Receiver	35846-xx
Micro-centered Antenna	33429-00
Groundplane	23158
10-meter Antenna Cable	14553-00
6 AH Battery	32364-00
ConventionalTribrach	12179
Tribrach Adapter	12180
Tripod	12178
HI Measuring Rod	16162

Table A-2 lists optional items for a base station setup in a control survey.

**Table A-2 Optional Equipment**

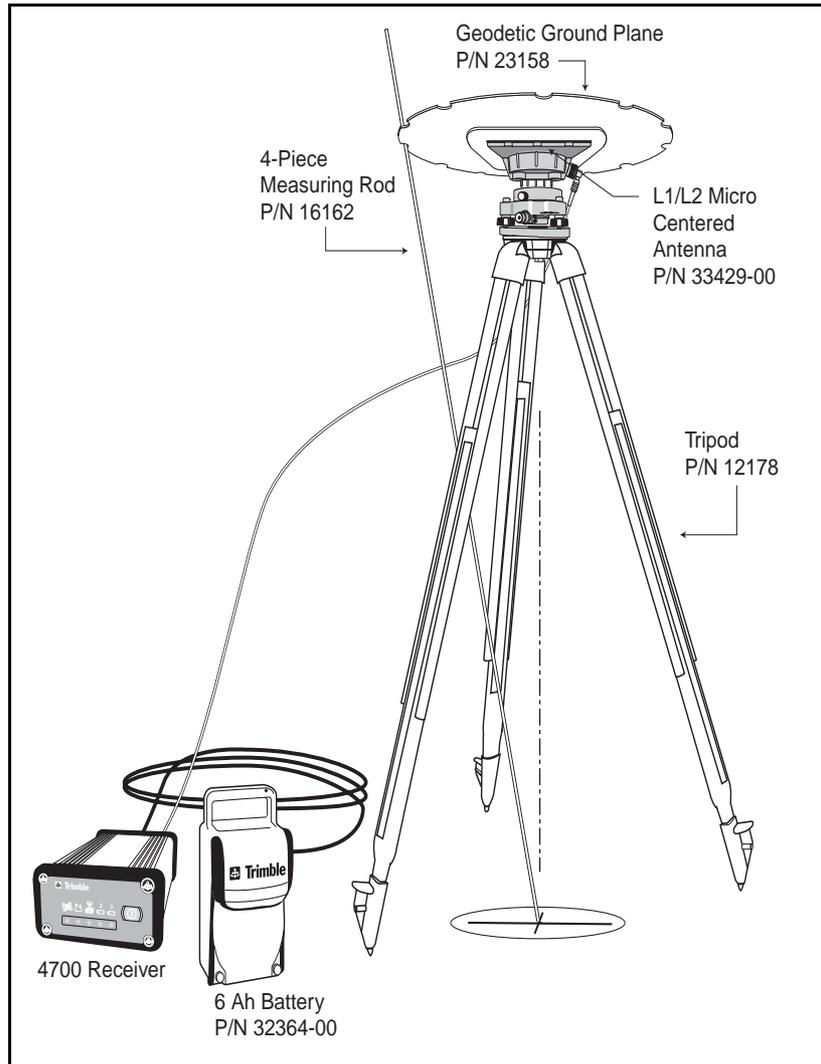
Part Name	Part Number
10 AH Battery	32365-00
LaserTribrach	33848
Fixed height tripod	various, depending on height

Table A-3 lists additional items that are suggested for optimizing field sessions, but are not supplied by Trimble.

**Table A-3 Recommended Items**

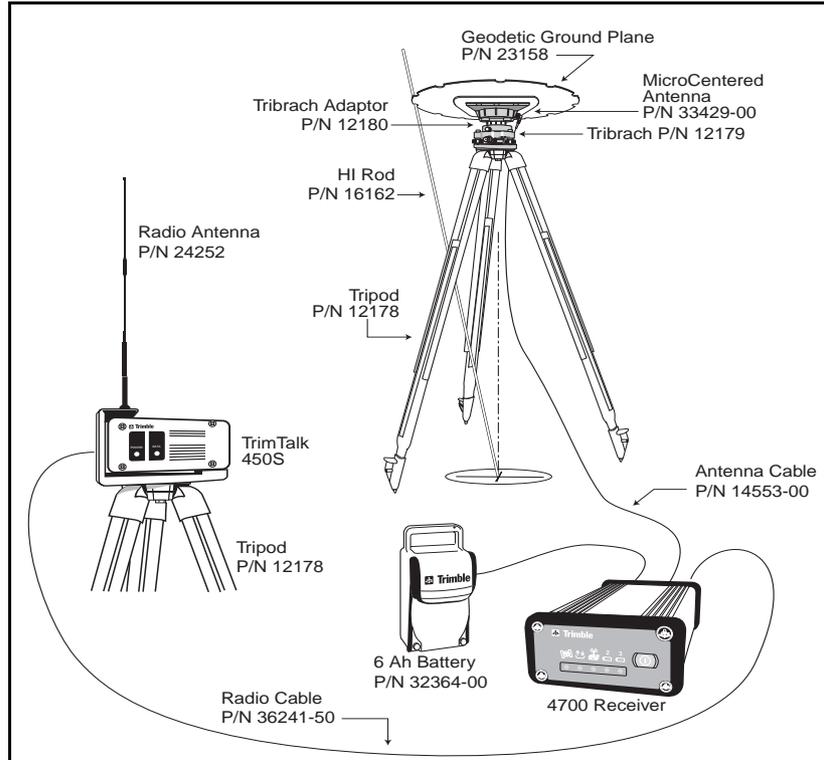
Item	Function
Directions to each station	Keeps crews on schedule, minimizes time lost due to unforeseen local traffic or road conditions
Station descriptions	Facilitates station recovery and occupation
Communication (radio) devices	Allows communication between crews
Field logs	Necessary to record station names, antenna height measurements, receiver serial numbers and other field data of interest to the user.

Figure eA-1 illustrates the 4700 receiver setup for a control survey using a conventional tripod.



**Figure A-1 4700 Configuration for Static or FastStatic Survey with a Conventional Tripod**

Figure eA-2 shows the part and cable layout for a RTK base station setup.



**Figure A-2 4700 Base Station Configuration for an RTK Survey**

Table A-4 lists optional items used when performing an RTK survey.

**Table A-4 Optional UHF Radio-Modem Equipment**

Part Name	Part Number
Tripod	12178
Radio Cable (Lemo 7-pin to 5-pin, 50ft.)	36241-50
Antenna UHF	varies
TRIMTALK 450S (with mount)	varies

## A.2 Rover Configuration

Table A-5 lists items required for each 4700 rover setup in an RTK survey.

**Table A-5 Rangepole Equipment**

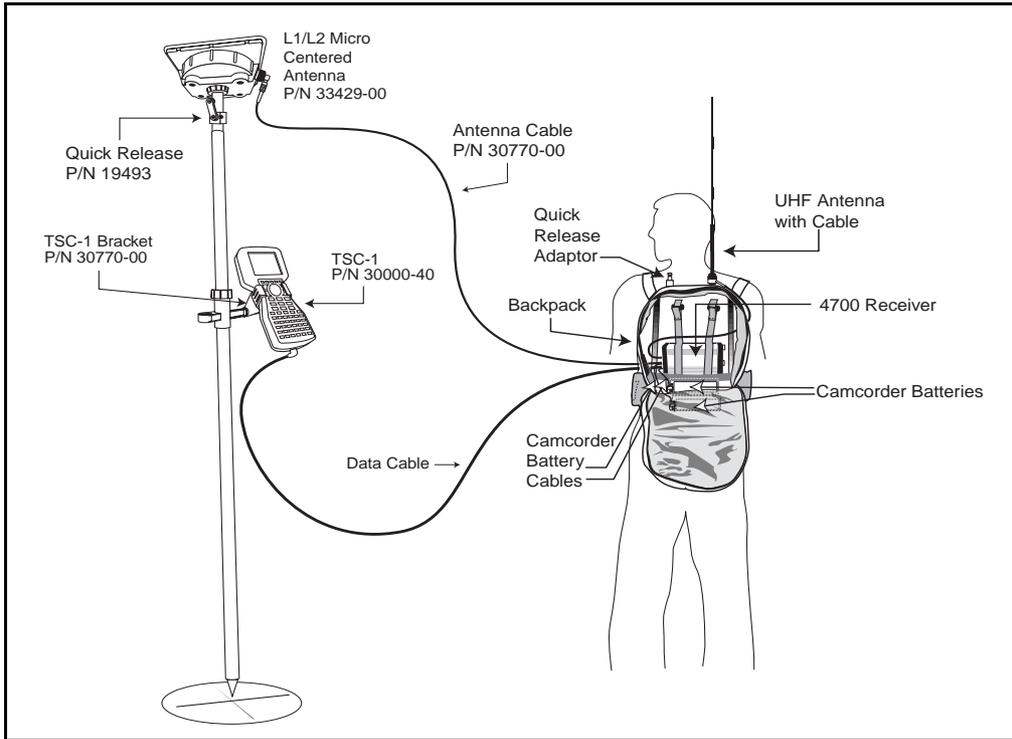
Part Name	Part Number
4700 Receiver Rover (with internal or 3rd party radio modem)	35846-xx
Radio (UHF) Rover Radio Antenna	varies
Camcorder Battery (Quantity 2)	17466
Camcorder Battery Cable (Quantity 2)	33928
Micro-centered Antenna	33429-00
Antenna Cable (5 m)	14553-01
Backpack	35474-00
TSC1 Data Collector with Survey Controller (with charged internal battery)	29673-00
TSC1 Bracket	varies
TSC1 Cable	31288
Rangepole (2 m)	varies
Rangepole Quick-release	19493
Rangepole Quick-release Adapter	19487

Table A-6 lists optional items that can be used in a rover setup during a FastStatic survey.

**Table A-6 Optional Equipment**

Part Name	Part Number
6 AH Battery	32364-00
10 AH Battery	32365-00
Bipod Attachment	varies

Figur eA-3 illustrates the 4700 receiver setup when using a rangepole.

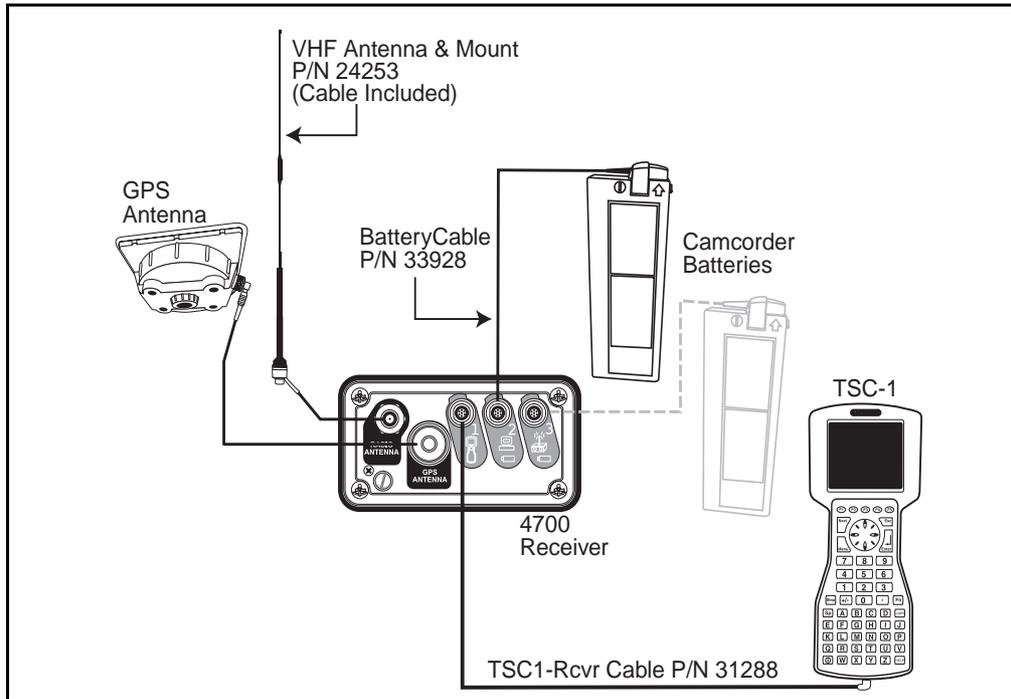


**Figure A-3 4700 RTK Rover Configuration with Backpack**

This is a typical configuration for the roving receiver in an RTK survey.

For a typical setup using a rangepole during a Static or FastStatic survey: the radio modem, antenna and backpack can be eliminated, and the use of a bipod attachment is suggested.

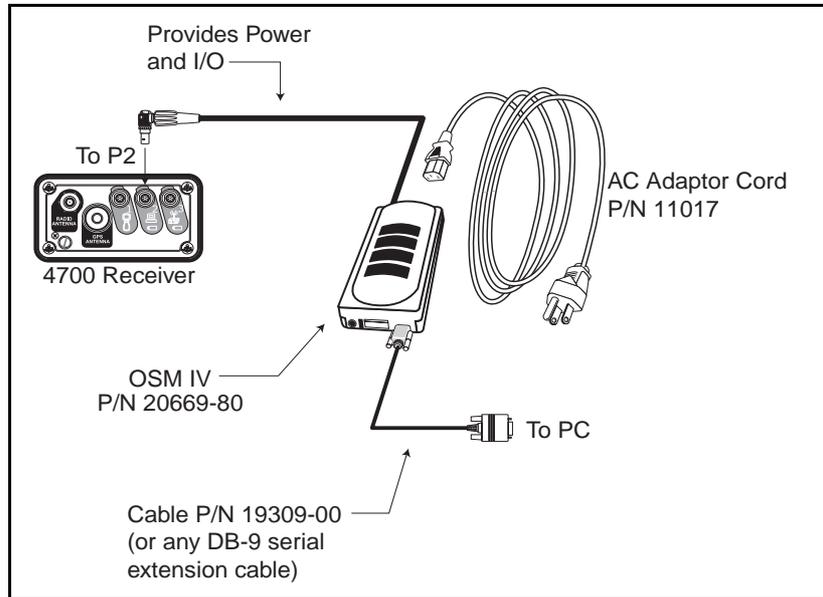
Figure eA-4 diagrams the cable and port connections for the RT rover configuration shown in Figure eA-3.



**Figure A-4 Cable Connections for an RTK Survey**

## A.3 Preparing to Download Field Data

Figure eA-5 shows the connections required to download field data from the 4700 receiver.



**Figure A-5 Downloading Field Data Using the OSM I Charger Unit**

### A.3.1 Office Download

To download field data from the 4700 receiver:

1. Connect one end of the AC adapter cable (P/N 11017) to the OSM IV, and the opposite end into a wall outlet.
2. Connect the Power-I/O cable from the back of the OSM IV to Port 2 of the 4700 receiver.
3. Connect the OSM IV to an open serial port of the local computer using serial cable (P/N 19309-00). Connect to the front of the OSM IV with a Db9 connector.

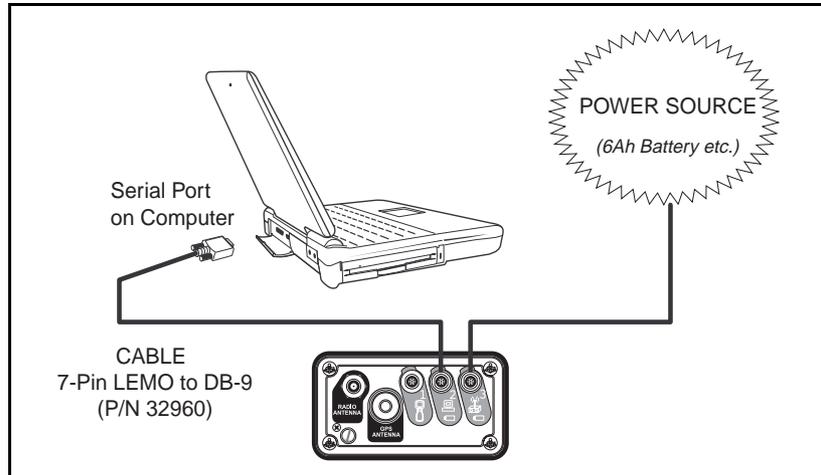
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**Tip** – When using Lemo connectors, rotate the barrel of the connector until the red dot on the cable end and the red mark on the hardware port are aligned. If these two marks are aligned the cable should slip easily into the port.

### A.3.2 Field Download

The following steps describe how to download data when using a DC power supply (for example, when you want to download data in the field). See Figure eA-6.

1. Connect the cable from the power source to Port 2 of the 4700 receiver.
2. Connect the 4700 receiver to an open serial port of the local computer using the optional serial cables (P/N 32960 or 32345).



**Figure A-6 Field Download Connections**

## **A.4 External Power Options**

There are a number of external power options. These are discussed in the following sections.

### **A.4.1 Office Support Module IV (OSM IV)**

The OSM IV (P/N 20669-80) allows the receiver to operate from line power and charge four camcorder batteries and one 6 or 10 Ah battery. It can accept power at all widely used voltages and frequencies, including 100-240VAC at 50-60 Hertz. It also provides a standard Db9 connector for serial port communications while charging through Port 1.

See Appendix xI, Office Support Module (OSM IV) for more information.

### **A.4.2 Camcorder Batteries**

You can carry camcorder batteries (P/N 17466) in the receiver's backpack and attach them to the receiver with a cable. The battery input cable (P/N 33928) connects one battery to each of the receiver's power ports 2 and 3. Both of these cables plug into the Ports 2&3 of the 4700 connector at one end and clip to the batteries at the other end.

### **A.4.3 6 AH battery**

The rechargeable, portable 6 AH battery powers the 4700 receiver for approximately eight hours. The battery connects to the receiver using a cable with a 7-pin (0-shell) Lemo connector. The connector plugs into port 2. The 6 AH battery is standard for the base configuration with a GPS Total Station<sup>®</sup> 4700 or postprocessed bundle.

#### **A.4.4 10 AH battery**

The rechargeable, portable 10 AH battery powers the 4700 receiver for approximately 14 hours. The battery comes in a carrying bag with a fused cable that has a 7-pin (0-shell) Lemo connector. The connector plugs into Port 2 or 3. The 10 AH battery is available as an option.

#### **A.4.5 Other Trimble Power Supplies**

To use other Trimble power supply options that you currently own or plan to purchase in the future, use P/N 32959 to make the connection from a 0-shell 7-pin Lemo to a 1-shell 5-pin Lemo device (for example, the OSM II, P/N 20669-40).

## A.5 GPS Antennas

The 4700 receiver is bundled in a number of different configurations, all of which include GPS antennas. This section describes the different antennas that are compatible with the receiver.

### A.5.1 Micro-centered Antenna

The micro-centered antenna is the most commonly used antenna for dual frequency RTK surveys, and it is part of the standard configuration for the 4700 receiver bundles.

Trimble's micro-centered dual-frequency antenna features outstanding phase center stability that increases precision for many GPS surveys.

The key to the antenna's performance lies in the patented design of a new 4-way feed micro-strip antenna element. The element features a symmetrical electronic path for the GPS signals which minimizes phase center variation compared to conventional antennas. The new element resides in a housing which is identical to that of Trimble's standard Compact L1/L2 antenna. The new antenna is distinguished on the outside by a "MICRO CENTERED" marking on the antenna body and yellow colored lines on the frame.

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**Note** – The "N" (for north) alignment designator is no longer printed on the antenna body.

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High precision GPS results can be achieved without aligning the antennas with each other. This avoids a common source of GPS survey errors and costly revisits to sites. It is especially valuable for control surveys, for example, Static and FastStatic surveys, where operators may forget to align tripod-mounted antennas, may misalign antennas, or may forget to record in their notes if the antennas were aligned. Test results indicate that Trimble's micro-centered dual-frequency antenna can add as much as 5 mm of precision over antennas that are oppositely aligned.

A second benefit applies to kinematic surveys, where alignment of pole-mounted antennas with a base station antennas is often impractical. Test results indicate improvements in average precisions of 2 mm to 3 mm, with maximum improvements as much as 5 mm.

Micro-centered antennas are also valuable in mixed antenna environments, especially when reference stations and non-Trimble antennas are used. In these cases, the micro-centered antenna's minimized phase center variation improves precision compared to conventional antennas.

Table A-7 lists the types and part numbers of the Micro-centered antennas.

**Table A-7      Micro-centered Antennas**

<b>Name</b>	<b>Part Number</b>
Micro-centered Compact L1/L2	33549-10
Micro-centered Geodetic L1/L2	33549-00
Micro-centered transverse option	33549-30
Micro-centered Permanent L1/L2	33429-20

### **A.5.2      Compact L1/L2 antenna**

The Compact L1/L2 antenna is designed for both geodetic applications and lightweight mobile requirements. The antenna electronics are contained in a rugged plastic antenna housing with a detachable groundplane. This groundplane is designed to reduce the effects of multipath.

When the antenna is used at a base receiver, the groundplane is normally attached. When the antenna is used with a roving receiver, the groundplane is normally removed.

### A.5.3 Machine/Permanent Mount L1/L2 Antenna

The optional machine/permanent mount L1/L2 antenna (P/N 27947-05) is designed for extremely rugged environments, where the antenna is mounted on heavy machinery. The antenna electronics are contained in a rugged aluminum antenna housing with a 13" groundplane and is mounted with a 4 bolt mount (1 at each corner). An antenna cable is not included with this antenna as the required antenna cable lengths vary from installation to installation. Order the antenna cable separately for this option.

Table A-8 lists several antenna cable options, their part numbers and connection types.

**Table A-8 Antenna Cable Options**

Antenna Cable	Part Number	Connection Type
30-meter low-loss antenna cable	14551-00	The connection is an RG-213 Type N-plug-to-Lemo connector.
5-meter low-loss antenna cable	14553-01	The connection is an RG-213 Type N-plug-to-Lemo connector.
Antenna cable with in-line amplifier	16054-00	This 30-meter extension coaxial cable with a signal amplifier extends the length of the standard antenna cables, and can be used for applications in harsh operating environments. The connection is an RG-213 Type N-plug-to-Type N-plug. The amplifier is detachable. The amplifier is powered through the cable by the 4700 receiver.

# B Specifications

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The following tables contain performance, physical, technical, electrical, and functional specifications for the 4700 receiver.

**Table B-1 Static Survey Performance Accuracy (Postprocessed)**

<b>Horizontal</b>	5 mm + 1 ppm x (baseline length)
<b>Vertical</b>	10 mm + 1 ppm x (baseline length)
<b>Azimuth</b>	1 arc second + 5/ (baseline length in kilometers)
The stated precision assumes 5 satellites (minimum) tracked continuously using the recommended survey procedures and using the L1 and L2 signals at all sites. Precise ephemerides and meteorological data may be required. FastStatic is a function of occupation time and observation conditions.	

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**Note** – The ppm error (relative error, based on baseline length) equals 1 mm for a baseline length of 1 km. To calculate the horizontal or vertical precision as shown above, add the fixed error (present in every measurement) to the result of the baseline length (expressed in mm) divided by one million.

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**Table B-2 Real-Time Kinematic Survey Performance Accuracy**

Mode	Latency	Accuracy
1 Hz fine	0.4 second	1 cm $\pm$ 2 ppm Horizontal 2 cm $\pm$ 2 ppm Vertical
5 Hz fine	0.1 second	2 cm $\pm$ 2 ppm Horizontal 5 cm $\pm$ 2 ppm Vertical
Coarse	Real-time	20 cm RMS
Range: Up to 10 km, depending on radios used		

**Table B-3 Post Processed Kinematic Survey Performance**

<b>Horizontal</b>	<10 km: 1 cm + 2 ppm (times baseline length) >10 km: 2 cm + 1 ppm (times baseline length)
<b>Vertical</b>	2 cm + 1 ppm (times baseline length)
<b>Occupation</b>	Continuous: 1 second measurement time Stop & Go: 2 second (min) with 5 satellites

**Table B-4 4700 Receiver Physical Specifications**

<b>Size</b>	4.7" (D) x 2.6" (H) x 8.2" (L) 11.9 cm (D) x 6.6 cm (H) x 20.8 cm (L)
<b>Weight</b>	2.7 lbs. (1.22 Kg) 4700 receiver with internal radio
<b>Power Consumption</b>	<ul style="list-style-type: none"> <li>• 4.5W (4700 receiver only)</li> <li>• 5.2W (Base configuration: 4700 receiver, antenna, 450s radio)</li> <li>• 6.0W (Rover configuration: 4700 receiver, antenna, TSC1, internal radio)</li> </ul>
<b>Operating Temperature</b>	-40°C to +65°C (-40°F to +149°F)
<b>Storage Temperature</b>	-40°C to +75°C (-40°F to +167°F)
<b>Humidity</b>	Mil SPEC 810E, 100% fully sealed
<b>Casing</b>	Dust proof, splash proof, and shock resistant
<b>Shock</b>	1 m drop on hard surface

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**Note** – The base configuration: 6W - 4700 receiver, antenna, external 450S transmitting base radio. The rover configuration: 6W - 4700 receiver, antenna, internal receiving radio, TSC1 controller.

**Table B-5 4700 Receiver Technical Specifications**

<b>Tracking</b>	9 channels L1 C/A code, L1/L2 full cycle carrier. Fully operational during P-code encryption.
<b>Signal Processing</b>	Very low-noise C/A code processing Supertrak multibit GPS signal processing multipath suppression: full 32-bit microprocessor
<b>Communications</b>	Dual RS-232 ports for serial input and data collector control. Baud rates up to 38,400 (57600 on Port 2) Dedicated RS232 serial port for external radio communications Flow control available on Ports 1 and 3

**Table B-6 4700 Receiver Electrical Specifications**

<b>Power Input</b>	Nominal 10.5 to 24 VDC, 2 DC power inputs
<b>Power Output</b>	Nominal 5W combined output
<b>Battery (Base)</b>	8 hours typical with 6 AH battery (CMR Out, Logging data, external TRIMTALK 450S transmitter)
<b>Battery (Rover)</b>	8 hours typical with 2 Camcorder batteries (internal radio, TSC1 controller, logging data)
<b>GPS antenna</b>	Micro-centered GPS antenna and groundplane
<b>Certification</b>	FCC and CE Mark approved (also Canadian approval)

**Table B-7 4700 Receiver Functionality**

<b>Datalogging</b>	120 hours (5 days) L1/L2, 6SVs, 15s epoch rate
<b>Logging rates</b>	1Hz - 60 sec
<b>Input Formats</b>	RTCM 2.1 (1,2,3,9,18,19), CMR2 & CMR+, Event Marker
<b>Output Formats</b>	NMEA-0183 (GGA, GST, GSV, PTNL, GSK, PTNL, SYNC, PTNL, PJT, PJK, VTG, ZDA), RTCM 2.1, CMR2 & CMR Trimble General Serial Output Format Requires Remote Controller software, version 2.2 or later, or Configuration-Toolbox software, version 2.0 or later
<b>Ports</b>	2 RS232, 1 external radio, 1 internal radio, 2 DC in, 2 DC out

# C NMEA-0183 Output

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When the NMEA-0183 output is enabled, messages can be produced to aid integration with other sensors. The 4700 can be configured, using the Remote Controller or Configuration Toolbox software, to output NMEA message ASCII strings through any serial port.

## C.1 Message Elements

All messages conform to the NMEA-0183 Version 2.0 format. All begin with dollar sign (\$) and end with a carriage return and a line feed. Data fields follow comma (,) delimiters and are variable in length. Null fields still follow a comma delimiter but contain no information.

The optional checksum field is the last field in a message and follows the asterisk (\*) delimiter. The checksum is the 8-bit exclusive OR of all characters in the message, including the commas, between but not including the comma and asterisk delimiters. The hexadecimal result is converted to two ASCII characters (0-9, A-F). The most significant character appears first.

### C.1.1 Fields and Delimiters

Each message consists of:

- message ID consisting of \$GP followed by the message type  
For example, the message ID of the ZDA message is \$GPZDA.
- comma
- number of fields that depends on the message type, separated by commas
- asterisk
- checksum

An example of a simple message with six fields plus the message ID and checksum follows:

```
$GPZDA,152145,21,05,1993,-7,00*50
```

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**Note** – Trimble proprietary message strings begin with the message ID PTNL. For example: \$PTNL,GGK. . . . .

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### C.1.2 Latitude and Longitude

Latitude is represented as *ddmm.mmmm*. Longitude is always represented as *dddmm.mmmm*, where direction (north, south, east, or west) is presented in a separate field.

- *dd* or *ddd* is degrees
- *mm.mmmm* is minutes and decimal fractions of minutes

### C.1.3 Direction

Direction is a single character: *N*, *S*, *E*, or *W* for *North*, *South*, *East*, or *West*

### C.1.4 Time

Time values are in UTC, and are represented as *hhmmss*, where:

- *hh* is hours, from 00 to 23
- *mm* is minutes
- *ss* is seconds

## C.2 Supported Messages

Table C-1 summarizes the set of NMEA messages supported by the 4700 receivers and shows the page number where detailed information about each message is found.

**Table C-1 NMEA Message Summary**

Message	Function	Page
GGA	Time, position, and fix related data	C-4
GST	Position error statistics	C-5
GSV	Number of SVs in view, PRN numbers, elevation, azimuth and SNR values	C-6
PTNL, GGK	Time, position, position type, DOP, and Ellipsoidal Height	C-7
PTNL, SYNC	GGK_SYNC (non-propagated) Time, Position, Position Type, DOP, & Ellipsoidal Height	C-8
PTNL, PJK	Local coordinate position output	C-9
PTNL, PJT	Projection type	C-10
PTNL, VGK	VGK Vector information	C-10
PTNL, VHD	Heading Information	C-11
VTG	Actual track made good and speed over ground	C-12
ZDA	UTC day, month, and year, and local time zone offset	C-13

### C.2.1 GGA: Time, Global Positioning System Fix Data Position, and Fix Related Data

```
$GPGGA,151924,3723.454487,N,12202.269799,W
,2,09,0.9,-17.49,M,-25.67,M,1,0000*57
```

Table C-2 describes the message fields in the GGA message.

**Table C-2 GGA Message Fields**

Field	Meaning
1	UTC of position fix
2	Latitude
3	Direction of latitude (N or S)
4	Longitude (E or W)
5	Direction of longitude
6	GPS Quality indicator 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
7	Number of SVs in use, 00 to 12
8	HDOP
9	Antenna height, MSLGEDID reference
10	M is fixed text indicating that the unit of measure for altitude is meters
11	Geoidal separation
12	M is fixed text indicating that the unit of measure for geoidal separation is meters
13	Age of differential GPS data record, Type 1 or Type 9. Null when DGPS not used
14	Base station ID, 0000–1023, null when any reference station ID is selected and no corrections are received

### C.2.2 GST Position Error Statistics

```
$GPGST,172814.0,0.006,0.023,0.020,273.6,0.023,0.020,0.031*6A
```

Table C-3 describes the message fields in the GST message.

**Table C-3 GST Message Fields**

Field	Meaning
1	UTC position fix
2	RMS value of the pseudorange residuals, includes carrier phase residuals during periods of RTK (FLOAT and FIXED) processing
3	Error ellipse semi-major axis 1 sigma error (meters)
4	Error ellipse semi-minor axis 1 sigma error (meters)
5	Error ellipse orientation (degrees from true north)
6	Latitude 1 sigma error (meters)
7	Longitude 1 sigma error (meters)
8	Altitude 1 sigma error (meters)

### C.2.3 GSV: Number of SVs In View, PRN Numbers, Elevation, Azimuth and SNR Values

```
$GPGSV,2,1,5,16,63,216,53,18,63,327,53,...
.,2,5,14,31,170,44*7D
```

Message length depends on the number of satellites in view.

Table C-4 describes the message fields in the GSV message.

**Table C-4 GSV Message Fields**

Field	Meaning
1	Total number of messages, 1 to 3
2	Message number, 1 to 3
3	Total number of satellites in view
4	Satellite PRN number
5	Elevation, degrees, 90° maximum
6	Azimuth, degreesTrue, 000 to 359
7	SNR (C/No) 00 - 99dB, Null when not tracking
8	Satellite PRN number for second SV
9	Elevation, degrees, 900 maximum (2nd SV)
10	Azimuth, degreesTrue, 000 to 359 (2nd SV)
11	SNR (C/No) 00 - 99dB, Null when not tracking (2nd SV)
12 - 15, etc.	Information about nextSV, same format as fields 4 - 7 Information repeats for number SVs in view (field 3)

### C.2.4 PTNL,GGK: Time, Position, Position Type, DOP

```
$PTNL,GGK,172814.00,071296,3723.46587704,N
,12202.26957864,W,3,06,1.7,EHT-6.777,M*48
```

Table C-5 describes the fields in the PTNL,GGK message.

**Table C-5 PTNL,GGK Message Fields**

Field	Meaning
1	UTC of position fix
2	Date
3	Latitude
4	Direction of latitude (N or S)
5	Longitude
6	Direction of Longitude (E or W)
7	GPS Quality indicator 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier phase integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M is fixed text indicating the unit of measure for ellipsoidal height is meters

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**Note** – The GGK message is longer than the NMEA-0183 standard of 80 characters.

### C.2.5 PTNL, SYNC: Time, Position, Position Type, DOP, and Ellipsoidal Height

The GGK SYNC message is the synchronized RTK solution. GGK\_SYNC provides synced (non-propagated) matched epoch solutions. GGK\_SYNC solution string will be different from the solution used by all the other outputs when the receiver is in low latency mode.

```
$PTNL,GGK_SYNC,001814.00,110398,3723.34931612,N,12202.22
481912,W,3,08,2.1,EHT18C
```

**Table C-6 PTNL, SYNC Message Fields**

Field	Meaning
1	UTC of position fix
2	Date
3	Latitude
4	Direction of latitude (N or S)
5	Longitude
6	Direction of Longitude (E or W)
7	GPS Quality indicator 0: Fix not available or invalid 1:Autonomous GPS fix 2:Differential, floating carrier phase integer-based solution (FLOAT) 3:Differential, fixed carrier phase integer-based solution (FIXED) 4:Differential, code phase only solution (DGPS)
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M is fixed text indicating the unit of measure for ellipsoidal height is meters

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**Note** – The GGK message is longer than the NMEA-0183 standard of 80 characters.

### C.2.6 PTNL,PJK: Local Coordinate Position Output

Table C-7 describes the fields in the PTNL, PJK message.

**Table C-7 PTNL,PJK Message Fields**

Field	Meaning
1	UTC of position fix
2	Date
3	Northing (meters)
4	Direction of Northing, will always be N (North)
5	Easting (meters)
6	Direction of Easting, will always be E (East)
7	GPS Quality indicator 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
8	Number of satellites in fix
9	DOP of fix
10	Ellipsoidal height of fix
11	M is fixed text indicating the unit of measure for ellipsoidal height is meters

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**Note** – The PJK message is longer than the NMEA-0183 standard of 80 characters.

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### C.2.7 PTNL,PJT: Projection Type

```
$PTNL,PJT,NAD83(Conus),California Zone 4
0404,*51
```

Table C-8 describes the fields in the PTNL,PJT message.

**Table C-8 PTNL,PJT Message Fields**

Field	Meaning
1	Coordinate system name (can include multiple words)
2	Projection name (can include multiple coordinates)

### C.2.8 VGK: PTNL, VGK Vector Information

```
$PTNL,VGK,220432.00,110698,-0000.001,
00000.001,-0000.015,3,05,4.7,M*0C
```

Table C-9 describes the fields in the PTNL,PJT message.

**Table C-9 PTNL, VGK Message Fields**

Field	Meaning
1	UTC of vector in hhmmss.ss
2	Date in mmddyy
3	East component of vector in meters
4	North component of vector in meters
5	Up component of vector in meters
6	GPS Quality indicator 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
7	Number of satellites in fix
8	DOP of fix
9	M: vector component in meters

### C.2.9 VHD: PTNL, VHD Heading Information

```
$PTNL,VHD,220436.00,110698,137.954,
-47.286,-30.517,13.728,0.003,-0.003,
3,05,4.7,M*1E
```

Table C-10 describes the fields in the VHD message.

**Table C-10 PTNL, VHD Message Fields**

Field	Meaning
1	UTC of position, in hhmmss.ss, ddmmyy
2	Azimuth
3	$\Delta$ Azimuth/ $\Delta$ Time
4	VertAngle
5	$\Delta$ Angle/ $\Delta$ Time
6	Range
7	$\Delta$ Range/ $\Delta$ Time
8	GPS Quality indicator 0: Fix not available or invalid 1: Autonomous GPS fix 2: Differential, floating carrier phase integer-based solution (FLOAT) 3: Differential, fixed carrier integer-based solution (FIXED) 4: Differential, code phase only solution (DGPS)
9	Number of satellites in solution
10	PDOP

### C.2.10 VTG: Actual Track Made Good Over and Speed Over Ground

```
$GPVTG,,T,,M,0.00,N,0.00,K*4E
```

Table C-11 describes the fields in the VTG message.

**Table C-11 VTG Message Fields**

Field	Meaning
1	Track made good (degrees true)
2	T is fixed text that indicates that track made good is relative to true north
3	Null field
4	M is fixed text
5	Speed (knots)
6	N is fixed text that indicates that speed is in knots
7	Speed over ground in kilometers/hour (KPH)
8	K is fixed text that indicates that speed over ground is in KPH

### C.2.11 ZDA: UTC Day, Month, And Year, and Local Time Zone Offset

\$GPZDA,172809,12,07,1996,00,00\*45

Table C-12 describes the fields in the ZDA message.

**Table C-12 ZDA Message Fields**

Field	Meaning
1	Time, in UTC
2	Day, 01 to 31
3	Month, 01 to 12
4	Year
5	Local time zone offset from GMT, 00 to $\pm 13$ hours
6	Local time zone offset from, minutes

Fields 5 and 6, together, yield the total offset. For example, if field 5 is  $-5$  and field 6 is  $-15$ , local time is 5 hours and 15 minutes earlier than GMT.



# D Event Marker Input and One Pulse Per Second (1PPS) Output Option

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The Event Marker input and One Pulse Per Second (1PPS) output are options available to the 4700. Configuration of these two functions requires either Remote Controller or Configuration Toolbox software utilities.

## D.1 Event Marker Option Summary Description

Event Marker input is used to log a precise GPS time tag upon receipt of an externally generated pulse, such as one generated at time of the shutter closing from a photogrammetric camera.

The pulse is input through Port 2 of the 4700 using the Event Marker/1PPS cable (PN 36451-00).

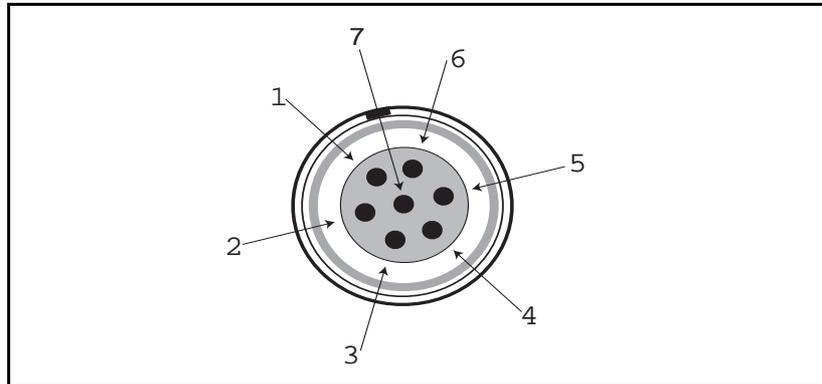
Refer to Section D.5, Event Marker Input, for further explanation of the Event Marker.

## D.2 1PPS Option Summary Description

The 4700 receiver can output a 1pulse/second (1PPs) time strobe with an associated ASCII time tag output. The pulse is output through Port 2 of the 4700 receiver using the Event Marker/1PPS cable (PN 36451-00).

### D.3 Port 2 Pinout Configuration

Port 2 of the 4700 provides Event Marker input and 1PPS output. Figure eD-1 shows the Port 2 connector.



**Figure D-1 Port 2 Pinout Connector Diagram**

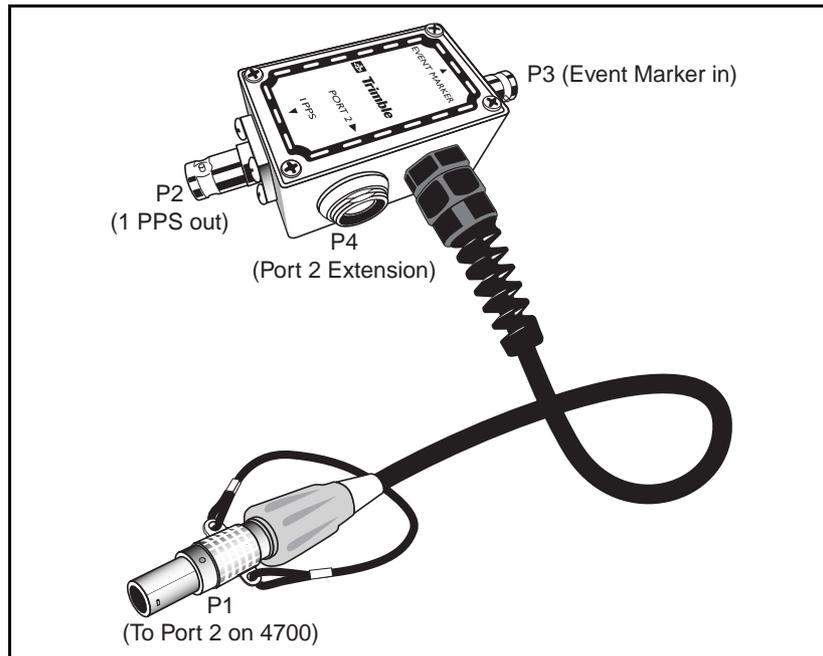
Table D-1 describes the Port 2 pinout functionality.

**Table D-1 Port 2 Pinout Functionality**

7-Pin W/ 1PPS/Event In	Function
1	Signal ground
2	GND
3	TXD2 (data out)
4	1PPS (out)
5	Event Marker (in)
6	Power
7	RXD2 (data in)

## D.4 Event Marker/1PPS Cable (PN 36451-00) Description

The Event Marker/1PPS Cable (PN 36451-00), see Figure D -2 and Table D-2, provides a breakout box with two BNC (female) connectors. In addition, the breakout box includes a LEMO 7-pin connector to extend serial communications and/or power service on Port 2.



**Figure D-2 Event Marker Input/1PPS Output Cable**

**Table D-2 Event Marker Input/1PPS Output Cable Pinouts**

P1 LEMO 7-Pin Port 2 [4700/4800]		P2 BNC/1PPS	P3 BNC/EVENT MKR	P4 LEMO 7s Port 2 extension	
4700/4800 function	pin	pin	pin	pin	function
Signal ground	1	-	-	1	Signal ground
GND	2	GND	GND	2	GND
Serial data out (TXD2)	3	-	-	3	Serial data in (TXD2)
1PPS	4	Center pin	-	4	NC
Event Marker	5	-	Center pin	5	NC
Power IN (+)	6	-	-	6	Power IN (+)
Serial data in (RXD2)	7	-	-	7	Serial data out (RXD2)

The device (Photogrammetric camera) that outputs event marker pulses to the 4700 is connected to the input BNC connector labeled **Event Marker** on the breakout box.

The device that accepts 1PPS output pulses from the 4700 is connected to the BNC connector on the breakout box labeled **1PPS**.

In addition to the BNC connectors, a 7-pin LEMO bulkhead connector is available on the breakout box to continue port 2 service (Power-in & serial communication). Because the BNC connectors are used to service the Event Marker and 1PPS features pins, 5 (Event Marker) and 6 (1PPS) are inactive on the LEMO connector.

The 4700 receiver can output a 1pulse/second (1PPs) time strobe with an associated ASCII time tag output. The pulse is output through Port 2 on the 4700 receiver. 1PPS/Event Marker Cable (PN 36451-00) provides a BNC (female) connector to adapt.

## **D.5 Event Marker Input**

The event marker feature is used to log a precise GPS time tag and sequential ID number in the current data file for an externally generated pulse such as a photogrammetric camera's shutter opening pulse. The information can be extracted from the 4700's data file using GPSurvey (For further information, see GPSurvey documentation).

The event is triggered when the source pulse voltage transitions between 1.0 VDC and 2.0 VDC in less than 100 nanoseconds. TTL level inputs are recommended. The leading edge can be positive (rising) or negative (falling) configured by user control. Accuracy of the associated time tag recorded for an event is determined by the accuracy of the GPS, typically less than 1 microsecond.

### **D.5.1 Using Remote Controller to Enable and Configure Event Marker Input**

The following procedure enables and configures the event marker input.

1. Connect the computer to the 4700 receiver
2. Power on the 4700 receiver.
3. Launch the Remote Controller program. See Appen dixE, Remote Controller Software, for detailed operating instructions.

4. Use the following control sequence to enable and configure the event marker input:

[Control]

[ALPHA] scrolls sub-windows within *CONTROL* window

[EventMarkers] Select Event Marker feature, see Figure D-3



**Figure D-3 Remote Controller Event Marker Display**

- [ENTER] Toggle Event Marker on
- [POSITIVE] choose Leading edge of pulse definition by toggling [ALPHA] key
- [ENTER] Event Marker input is enabled as defined

## D.5.2 Using Configuration Toolbox to Create an Application File to Enable and Configure 4700 with Event Marker Input Capability.

Configuration Toolbox allows user to create an application file and upload that file to the 4700.

Launch Configuration Toolbox program. For more details see Appendix F, Configuration Toolbox, or the on line *Help* within the program).

1. Begin Configuration Toolbox by double-clicking on the command Configuration Toolbox icon CTOOLBOX.EXE.
1. Select **File / New / 4700...** to display the *Configuration File* dialog box, see Figure eD-4.
2. Select *Device* from the *Available:* list box and reate a new file by clicking on the [Add] button, see FigureD-4.

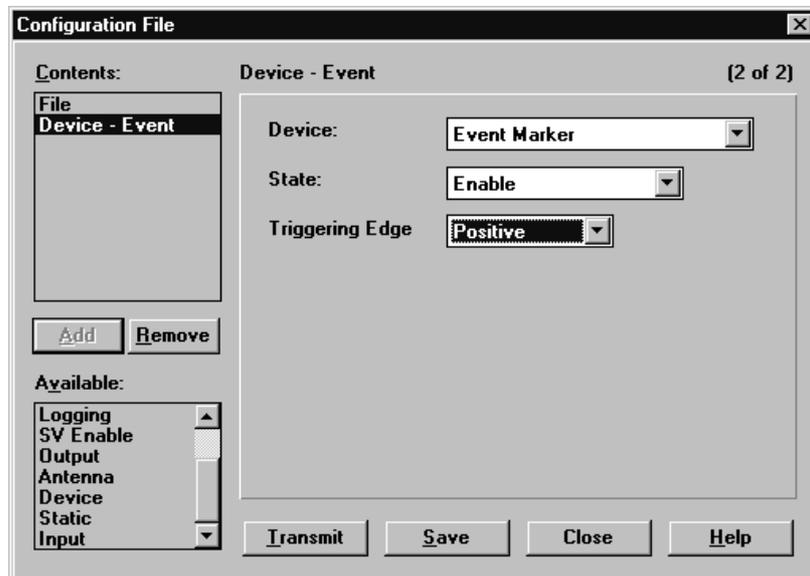


Figure D-4 Configuration File Event Marker Creation Screen

3. On the *Device - Event* page select:

*Device:*                      *Event Marker*

*State:*                        *Enable*

*Triggering Edge:*    *Positive or Negative* (corresponding to external device pulse)

The Event Marker input feature enables the 4700 to log a time-stamped record whenever an event (an electrical pulse) is detected.

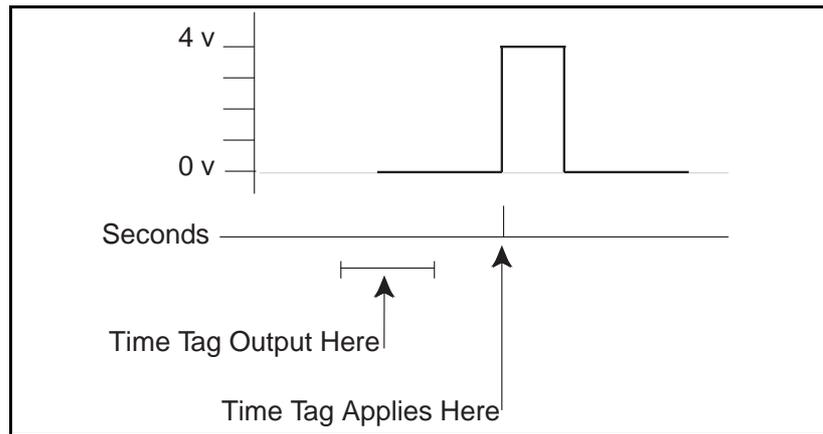
4. Click on the [Save] button if you want to save the configuration file to your computer. Follow the instructions displayed on the screen.
5. Click on the [Transmit] button to transmit the configuration file to the attached receiver. Follow the instructions displayed on the screen.
6. Click on the [Close] button to exit the *Configuration File* dialog box. Follow the instructions displayed on the screen.

## D.6 One Pulse Per Second Output (1PPS)

The 4700 receiver can output a 1 pulse/second (1 PPS) time strobe and an associated time tag. 4700 receivers output the pulse on Port 2, using the pinouts shown in Figure D-1 and TableD-1. The ASCII time tag can be independently turned on and off, and can be output through any user defined serial port.

### D.6.1 1PPS Pulse Definition

The leading edge of the pulse coincides with the beginning of each UTC second. See FigureD- 5. The pulse is driven by an RS-422 driver between nominal levels of 0.0V and 4.0V. The leading edge is positive, rising from 0V to 4V.



**Figure D-5 Time Tag Relation to 1 PPS Wave Form**

The pulse duration is approximately 8  $\mu$ sec wide, with rise and fall times of about 100 nsec. Resolution is approximately 40 nsec, but several external factors limit accuracy to approximately  $\pm \mu$ sec:

- Position errors (especially with user-entered reference): Each meter of error can result in 3 nsec. of error in the 1PPS pulse.
- Selective Availability: When in effect, introduces errors of up to 30 meters (100 nsec) in satellite signals, with corresponding errors in the 1 PPS pulse.
- Antenna cable length: Each meter of cable adds a delay of about 2 nsec. to satellite signals, and a corresponding delay in the 1 PPS pulse.

## D.6.2 ASCII Time Tag Definition

Each time tag is output about 0.5 second before the corresponding pulse, see Figur eD-5. Time tags are in ASCII format on a user-selected serial port. The format of a time tag is:

```
UTC yy.mm.dd hh:mm:ss ab
```

Where:

- *UTC* is fixed text.
- *yy.mm.dd* is the year, month, and date.
- *hh:mm:ss* is the hour (on a 24-hour clock), minute, and second. The time is in UTC, not GPS.
- *a* is the position-fix type:
  - 1 = 2-D Position Fix for E,N only
  - 2 = 3-D Position Fix
  - 3 = Single SV Clock-only fix
  - 4 = Automatic Mode
  - 5 = Reference Station Position
  - 6 = Two-Dimensional with Fixed Clock
  - 7 = Overdetermined solution for clock only
- *b* is number of satellites being tracked: 1 to 9, ‘.’ (for 10), ‘;’ (for 11), or ‘<’ (for 12).
- Each time tag is terminated by a *carriage return, line feed* sequence.

A typical printout looks like:

```
UTC 93.12.21 20:21:16 56
UTC 93.12.21 20:21:17 56
UTC 93.12.21 20:21:18 56
```

*a* and *b* can be ‘??’, meaning that the time is based on the receiver clock because the receiver is not tracking satellites. The receiver clock is less accurate than time readings extracted from satellite signals.

### D.6.3 Using Remote Controller to Enable and Configure 1PPS Output.

The following procedure enables and configures the 1PPS output.

1. Connect the computer to the 4700 receiver
2. Power on the 4700 receiver.
3. Launch the Remote Controller program. See Appen dixE, Remote Controller Software, for detailed operating instructions.
4. Use the following control sequence to enable and configure the 1PPS output:

[Control]

[ALPHA] scrolls sub-windows within CONTROL window

[1PPS] Select 1PPS feature, see Fi gureD-6



Figure D-6 Remote Controller 1PPS Output Display

[ALPHA] Enables 1PPS output

## D

### Event Marker Input and One Pulse Per Second (1PPS) Output Option

---

- [ENTER] 1PPS output is enabled, cursor moves to ASCII Time Tag Port selection, default is OFF
  - [ALPHA] Selects port to output Time Tag
  - [ENTER] Output is enabled as defined
5. Exit Remote Controller program. Computer communications ends. The 4700 operates with 1PPS out on PORT 2.

#### D.6.4 Using Configuration Toolbox to Create an Application File to Enable and Configure 4700 to Output 1PPS.

Configuration Toolbox allows user to create an application file and upload that file to the 4700.

Launch Configuration Toolbox program. For more details see Appendix F, Configuration Toolbox or the Online Help within the program.

1. Begin Configuration Toolbox by double-clicking on the command Configuration Toolbox icon CTOOLBOX.EXE.
1. Select **File / New / 4700...** to display the *Configuration File* dialog box, see Figure eD-7.
2. Select *Device* from the *Available:* list box and reate a new file by clicking on the [Add] button, see FigureD-7.

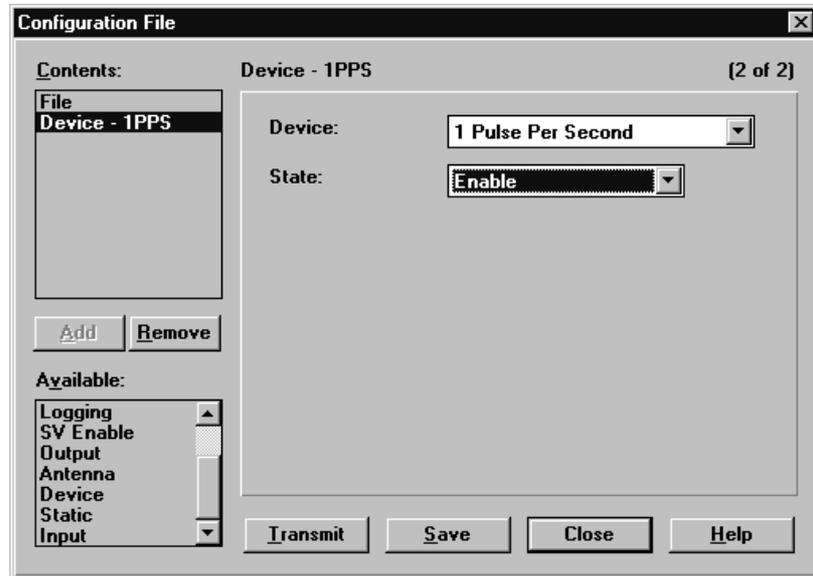
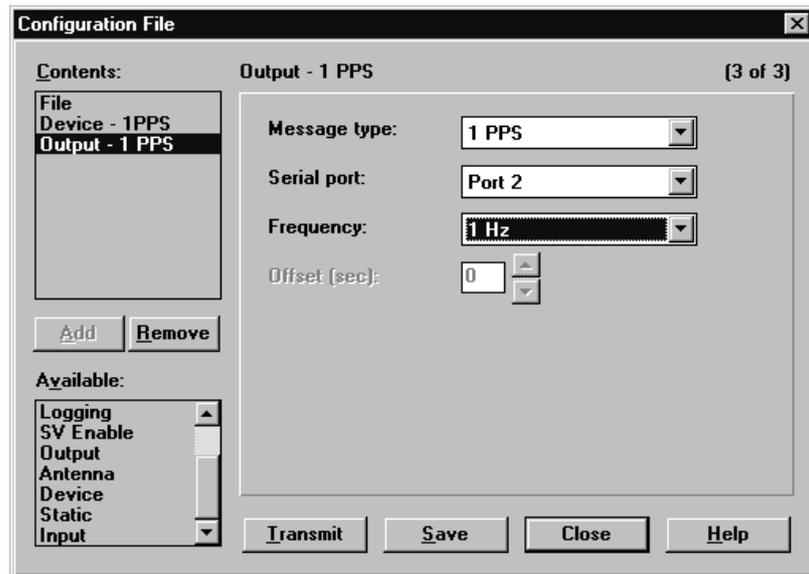


Figure D-7 Configuration File Device - 1PPS Enable Screen

3. On the *Device-1PPS* page select:  
*Device type: 1Pulse Per Second*  
*State: Enable*
4. Select *Output* from the *Available:* list box and reate a new file by clicking on the [Add] button, see FigureD-8.



**Figure D-8 Configuration File Output - 1PPS Screen**

5. On the *Output-1PPS* page select:  
*Message type: 1 PPS*  
*Serial Port: Port 2*  
*Frequency: 1 Hz*
6. Click on the [Save] button if you want to save the configuration file to your computer. Follow the instructions displayed on the screen.

7. Click on the [Transmit] button to transmit the configuration file to the attached receiver. Follow the instructions displayed on the screen.
8. Click on the [Close] button to exit the *Configuration File* dialog box. Follow the instructions displayed on the screen.

# E Remote Controller Software

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This appendix provides an overview of the Remote Controller utility software with the 4700 receiver. For more details of the Remote Controller software operation, refer to the *Remote Controller Software User's Guide*.

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**Note** – The Remote Controller software is an option to the 4700 receiver and is not included in the standard configuration. Remote Controller software version 2.2, or later, is required to operate with the 4700 receiver.

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The 4700 receiver front panel display has five light emanating diodes (LEDs) and a POWER switch. The receiver does not have a liquid crystal display (LCD) or keyboard. The Remote Controller software provides front panel emulation. This does not replace the handheld survey device with Survey Controller firmware, which is recommended for roving receiver applications in RTK Surveys. The Remote Controller software provides a remote interface to the 4700 receiver, useful in an office or protected environment.

The Remote Controller software runs under Microsoft Windows 95, or later, and connects to any of the three serial ports on the rear panel of the 4700 receiver.

## **E.1 Installing the Remote Controller Software**

The Remote Controller software can be installed from floppy disk, from CD, or from the Trimble ftp site. Refer to one of the following sections for the installation procedure you need.

### **E.1.1 Installing Remote Controller From a Floppy Disk**

To install the Remote Controller software from a floppy disk:

1. Insert the disk into drive A.
2. Using the Windows Explorer, browse to drive A.
3. Double-click on SETUP.EXE.
4. Follow the on-screen instructions for installation of the Remote Controller software.

### **E.1.2 Installing Remote Controller From a CD**

To install Remote Controller from a CD:

5. Insert the disk into CD drive.
6. Using the Windows Explorer, browse to CD drive.
7. Double-click on SETUP.EXE.
8. Follow the on-screen instructions for installation of the Remote Controller software.

### **E.1.3 Installing Remote Controller From the Internet**

To install Remote Controller from the Trimble Navigation Ltd. ftp site, go to the Internet and type in the following Internet address:

```
ftp://ftp.trimble.com/pub/survey/bin/
```

Scroll down to a file called REMCON.EXE and download this file to a temporary directory on your computer. REMCON.EXE is a compressed file which contains all the necessary files for installing the Remote Controller software. After this file is successfully downloaded to your local hard drive, you may exit the Internet and proceed with the following steps:

1. Browse to the temporary directory containing REMCON.EXE.
2. Double-click on REMCON.EXE to expand the compressed files.
3. Close the DOS window after the file expansion is complete.
4. Double-click on SETUP.EXE.
5. Follow the on-screen instructions for installation of the Remote Controller software.

## E.2 Using the Remote Controller

The Remote Controller software displays a simulated front panel for the 4700 receiver on a computer monitor, see Figur eE-1.



**Figure E-1 Simulated 4700 Receiver Front Panel**

With the Remote Controller software connected to a 4700 receiver, a computer takes the place of the receiver front panel, allowing you to move around the 4700 receiver screens with the click of a mouse.

### E.3 Menu Keys

The 4700 receiver display is arranged into a menu structure. On the lower right-hand side of the keyboard are the menu keys:

- [STATUS]
- [SATINFO]
- [SESSIONS]
- [CONTROL]
- [LOGDATA]
- [MODIFY]

The menu keys access different functions and controls in the 4700 receiver. They can be clicked on at any time, no matter which screen is currently displayed. Deeper levels of the menu structure are accessed using the softkeys.

### E.4 Softkeys

The black softkeys are located on the right hand side of the simulated 4700 receiver front panel. A softkey becomes active when a menu item appears to the left. For example, on the top level menu, there are two softkeys: **<POSITION>** and **<VECTOR>**. Press the softkey that corresponds to **<POSITION>** to go to a deeper level of the menu. The **< >** symbols identify softkey choices.

## E.5 ALPHA Key and Carousels

[ALPHA] (just beneath [ENTER]), has a special meaning in the 4700 receiver. Whenever square brackets [ ] appear around an item on the display, [ALPHA] can be clicked on to change the value to one of a set of options. The square brackets indicate a carousel data entry field.

[ALPHA] is also used to page through more screen lines. Because the simulated 4700 receiver display only has 4 lines, there are times when additional information needs to be accessed. For example, select the [CONTROL] menu. Four softkeys become active and the down-arrow symbol ↓ appears in the top left corner of the screen. The down-arrow is the visual cue that selecting [ALPHA] pages through more screen information.

## E.6 Entering Data

Carousels provide a way of selecting from a limited set of options. Choosing a port number or type of output message is performed with the use of carousels and [ALPHA]. Some data fields involve alphanumeric entry through the keyboard. The [CONTROL], <RTK BASE STATION>, screen, Figure E-2, is a good example of both carousel data entry and alphanumeric entry:

```
BASE STATION (CONTROL)
ENABLE:[OFF  ]   ANT. HT.:00.000 m
LAT: 00°00'0.00000" N NAME: 0000
LON:000°00'00.00000" E HGT:+0000.000m
```

**Figure E-2 RTK Base Station Screen**

The ENABLE field is a carousel and can be changed by clicking on [ALPHA]. Once the appropriate port is selected, click on [ENTER] to accept the selection. After clicking on [ENTER], the cursor moves to the next entry field, ANT. HT. Use the alphanumeric keys to enter the antenna height of the base station. Similarly, use the alphanumeric keypad to enter the latitude, longitude and height values.

The NAME field can consist of numbers and characters. Each alphanumeric key has a dual purpose of selecting a number or one of three characters. Use [ALPHA] to choose between a number or letter from the alphanumeric keypad.

Clicking on [ENTER] accepts the data field and moves the cursor to the next input item. To accept all of the selections on the display, click on [ENTER] at the last field. All of the data selections are ignored [CLEAR] is selected while in a data entry screen. [CLEAR] is also used to move back up the menu structure.

The round green left and right cursor keys, on the left of the display, are used to move between data entry fields without changing their values.

## E.7 Keyboard and Display Summary

Table E-1 gives a summary of the keyboard and display operation for the 4700 receiver Remote Controller software.

**Table E-1 .Keyboard and Display Summary**

<b>Key / Symbol</b>	<b>Description</b>
[ALPHA]	Pages through multiple screen lines or carousel data entry fields.
[ENTER]	Accepts the changed data fields. Press [ENTER] on the last data field to accept all changes.
[CLEAR]	Returns the screen to the previous menu level without changing the data fields.
[ ]	Indicates a carousel data field used to select from a limited options list.
∅	Indicates additional screen lines are accessible by clicking on [ALPHA].
< >	Indicates a softkey.
Cursor keys (>) (<)	The round green cursor keys on the left hand side of the screen, are used to move between items on the screen.

## E.8 Remote Controller Help

The Remote Controller program has a detailed on-line help file, as well as a documentation file to assist with questions.

# F Configuration Toolbox

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ConfigurationToolbox is a Windows application that provides a graphical user interface to configure selected Trimble GPS receivers. It is also possible to create a file, called an application file (or “app file”), which contains all the receiver settings necessary for a particular job or application.

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**Note** – The Configuration Toolbox software is an option to the 4700 receiver and is not included in the standard configuration. ConfigurationToolbox software version 2.0, or later, is required to operate with the 4700 receiver.

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Receiver configuration with Configuration Toolbox involves changing the settings that control the operation of the receiver using a predefined file. The configuration settings are stored in this application file (\*.CFG).

ConfigurationToolbox lets you create and edit application files, transfer them to and from your receiver, and manage application files stored in the receiver. The receiver also stores two special applications files, Defaults and Current, that represent the default and current receiver configurations, respectively.

Application files can be stored on both your receiver and computer. Multiple files may be maintained to represent multiple users sharing a device and/or multiple modes of operation. Files can also be saved to audit the operating settings of a receiver. A maximum of ten files can be stored in the 4700 receiver. This includes two files that are always resident in the 4700 receiver, DEFAULT.CFG and CURRENT.CFG.

## **F.1 Installing the Configuration Toolbox Software**

The ConfigurationToolbox software can be installed from floppy disk, from CD, or from the Trimble ftp site. Refer to one of the following sections for the installation procedure you need.

### **F.1.1 Installing Configuration Toolbox From a Floppy Diskette**

To install ConfigurationToolbox from a floppy disk:

1. Insert the disk into drive A.
2. Using the Windows Explorer, browse to drive A.
3. Double-click on INSTALL.EXE.
4. Follow the on-screen instructions for installation of the ConfigurationToolbox software.

### **F.1.2 Installing Configuration Toolbox From a CD**

To install ConfigurationToolbox from a CD:

1. Insert the disk into CD drive.
2. Using the Windows Explorer, browse to CD drive.
3. Double-click on INSTALL.EXE.
4. Follow the on-screen instructions for installation of the ConfigurationToolbox software.

### **F.1.3 Installing Configuration Toolbox From the Internet**

To install ConfigurationToolbox from the Trimble Navigation Ltd. ftp site, go to the Internet and type in the following Internet address:

```
ftp://ftp.trimble.com/pub/survey/bin/
```

Scroll down to a file called CTOOLS.EXE and download this file to a temporary directory on your computer. CTOOLS.EXE is a compressed file which contains all the necessary files for installing the ConfigurationToolbox software. After this file is successfully downloaded to your local hard drive, you may exit the Internet and proceed with the following steps:

1. Browse to the temporary directory containing ctools.exe.
2. Double-click on CTOOLS.EXE to expand the compressed files.
3. Close the DOS window after the file expansion is complete.
4. Double-click on INSTALL.EXE.
5. Follow the on-screen instructions for installation of the ConfigurationToolbox software.

## **F.2 Using Configuration Toolbox Software**

To create and transmit an application file to the receiver, you may proceed in several different sequences. The general flow, however, includes the following steps:

1. Create and save the application file in Configuration Toolbox
2. Connect the receiver to the computer, apply power, and establish communications between the receiver and computer
3. Open the desired application file in Configuration Toolbox
4. Transmit the desired application file to the receiver
5. Check the receiver to ensure the desired application file is currently in use

## F.2.1 Configuring Your 4700 Receiver Using Configuration Toolbox

Figure F-1 provides an example of a typical configuration file being created.

1. Begin Configuration Toolbox by double-clicking on the command Configuration Toolbox icon CTOOLBOX.EXE.
2. Select **File / New / 4700...**
3. Make appropriate selections for desired receiver settings (see on-line help and the Configuration Toolbox manual for specific questions)
4. Save the application file using **File / Save As...**

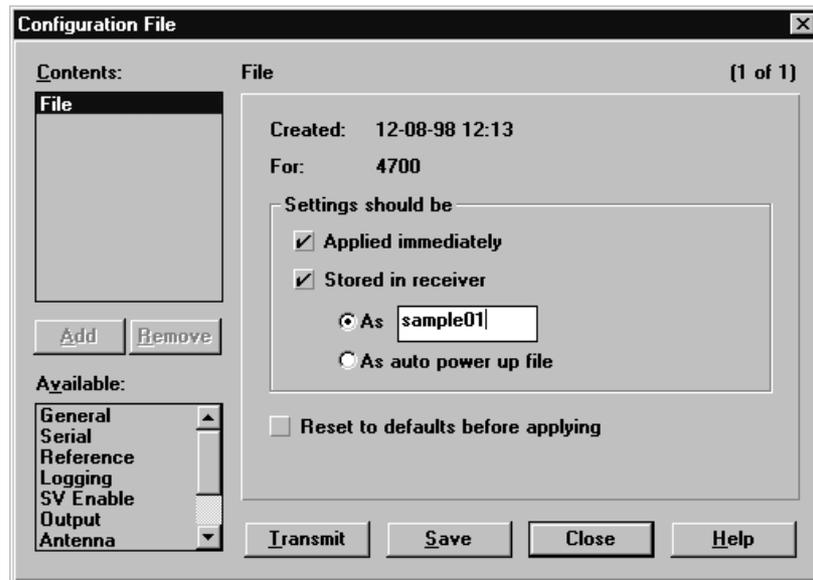


Figure F-1 Configuration File Menu

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**Note** – Use the same 8-character file name to save the file on the local computer as the one specified when named in the receiver. This name is assigned in the following ConfigurationToolbox window:

---

To transmit the application file to the receiver:

1. Connect computer and power the 4700 receiver.  
This can be accomplished directly by using the OSMIV & DB9 serial cable, see Figure A-5. An alternative way is to power the 4700 externally through one port, then connect serial download cable (PN 32960) to a second available port, see Figure A-6.
2. Open the desired application file by selecting *File / Open*.
3. With the file open and the Configuration File dialog open, select *Communications / Transmit File*.

A message appears informing you the message has been successfully transmitted. In the event of an error, select *Communications / Transmit File* again. This overrides any incompatibility in baud rates and enable successful communication.

To check the successful transmission, close the Configuration File dialog and select *Communications / Get File*. A list of all application files in the 4700 receiver will appear. If you selected *Apply Immediately* in your application file, this new file will be the current file. To change files, select the desired file from the list and then select *Communications / Activate File*.

## F.2.2 Configuration Toolbox On-Line Help

ConfigurationToolbox program has a detailed on-line Help file to assist with questions.



# G Using WinFLASH

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WinFLASH is a software package that communicates with Trimble products to perform various functions, such as:

- software and option upgrades
- diagnostics (for example, retrieving configuration information)
- Launches CommSet radio configuration utility

On-line help is also available when using WinFLASH if additional information is needed.

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**Note** – WinFLASH is a 32-bit application, therefore the local computer's operating system must be Windows 95, or later, or Windows NT. It does not run under Windows 3.1 or earlier versions of Windows.

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**Note** – WinFLASH is not supplied with the initial shipment of equipment, but is included as part of firmware upgrades.

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## G.1 Installing the WinFLASH Software

The WinFLASH software can be installed from floppy disk, from CD, or from the Trimble ftp site. Refer to one of the following sections for the installation procedure you need.

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**Note** – The Trimble CommSet program is also installed as part of the WinFLASH installation. For additional information on CommSet refer to Appendix xH, Using the CommSet Utility.

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### G.1.1 Installing WinFLASH From a Floppy Diskette

To install WinFLASH from a floppy disk:

1. Insert the disk into drive A.
2. Using the Windows Explorer, browse to drive A.
3. Double-click on SETUP.EXE.
4. Follow the on-screen instructions for installation of the WinFLASH software.

A program icon is installed for future use of WinFLASH.

### G.1.2 Installing WinFLASH From a CD

To install WinFLASH from a CD:

1. Insert the disk into CD drive.
2. Using the Windows Explorer, browse to CD drive.
3. Double-click on SETUP.EXE.
4. Follow the on-screen instructions for installation of the WinFLASH software.

A program icon is installed for future use of WinFLASH.

### **G.1.3 Installing WinFLASH From the Internet**

To install WinFLASH from the Trimble Navigation Ltd. ftp site, go to the Internet and type in the following Internet address:

```
ftp://ftp.trimble.com/pub/survey/bin/
```

Scroll down to a file called 4748v112.EXE and download this file to a temporary directory on your computer. 4748v112.EXE is a compressed file which contains all the necessary files for installing the WinFLASH software. After this file is successfully downloaded to your local hard drive, you may exit the Internet and proceed with the following steps:

1. Browse to the temporary directory containing ctools.exe.
2. Double-click on 4748v112.EXE to expand the compressed files.
3. Close the DOS window after the file expansion is complete
4. Double-click on SETUP.EXE.
5. Follow the on-screen instructions for installation of the WinFLASH software.

A program icon is installed for future use of WinFLASH.

## G.2 Using WinFLASH: An Example

The program uses a series of screens to guide you through the process. An overview of the steps is described in the example below. This example describes how to retrieve configuration data (for example, serial number and installed options) from a 4700 receiver.

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**Note** – For more general help, please refer to the WinFLASH on-line help.

---

1. Start WinFLASH by clicking the program icon.
2. When the *Device Configuration* screen appears, select the Trimble device and PC serial port the device is connected to, and click on **Next >**. (for example, device = 4700 Receiver, PC serial port = COM1).

The *Operation Selection* screen appears. The *Operations* box lists all of the supported operations for the selected device, and the description of each operation is shown in the *Description* box.

3. Select an operation and click on **Next >**. (for example, Configuration retrieval).

The *Settings Review* window appears. This screen prompts you to connect the device, suggests a connection method, and then lists the device configuration and selected operation.

4. If all is correct, click on **Finish**.

Based on the selections shown above, the *Configuration Retrieval* window appears and shows the status of the operation (for example, “Establishing communication with the 4700. Please wait...”) Once communication is established, the progress bar indicates that a successful link has been established as well as the extent of completion.

Finally the *Configuration Information* window appears and lists the device specific configuration information (for example, Serial number and installed options).

5. Click on **OK**.

The *Configuration Retrieval* window appears once more and states that the operation was completed successfully.

6. At this point click on **Menu** to select another operation or click on **Exit** to quit WinFLASH.
7. If you click on **Exit**, another screen appears stating that this selection causes WinFLASH to terminate. Click on **OK** to quit WinFLASH.



# H Using the CommSet Utility

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This appendix describes the functions of the CommSet program and outlines a basic example of its use. On-line help is also available when using CommSet if additional information is needed.

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✧ **Note** – CommSet is a 32-bit application, therefore the local computer's operating system must be either Windows 95, or later, or Windows NT. It does not run under Windows 3.1 or earlier versions.

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✧ **Note** – CommSet is only supplied with receivers that have internal radio modems.

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## H.1 Installing the CommSet Utility

The CommSet program is typically installed during the installation of WinFLASH, but can be installed, or updated, individually. CommSet can also be installed from floppy disk, from CD, or from the Trimble ftp site. Refer to one of the following sections for the installation procedure you need.

### **H.1.1 Installing CommSet From a Floppy Diskette**

To install CommSet from a floppy disk:

1. Insert the disk into drive A.
2. Using the Windows Explorer, browse to drive A.
3. Double-click on SETUP.EXE.
4. Follow the on-screen instructions for installation of the CommSet software.

A program icon is installed for future use of CommSet.

### **H.1.2 Installing CommSet From a CD**

To install CommSet from a CD:

1. Insert the disk into CD drive.
2. Using the Windows Explorer, browse to CD drive.
3. Double-click on SETUP.EXE.
4. Follow the on-screen instructions for installation of the CommSet software.

A program icon is installed for future use of CommSet.

### H.1.3 Installing CommSet From the Internet

To install CommSet from the Trimble Navigation Ltd. ftp site, go to the Internet and type in the following Internet address:

```
ftp://ftp.trimble.com/pub/survey/bin/
```

Scroll down to a file called NNNNNNNN.EXE and download this file to a temporary directory on your computer. NNNNNNNN.EXE is a compressed file which contains all the necessary files for installing the CommSet program. After this file is successfully downloaded to your local hard drive, you may exit the Internet and proceed with the following steps:

1. Browse to the temporary directory containing CTOOLS.EXE.
2. Double-click on NNNNNNNN.EXE to expand the compressed files.
3. Close the DOS window after the file expansion is complete
4. Double-click on SETUP.EXE.
5. Follow the on-screen instructions for installation of the CommSet software.

A program icon is installed for future use of CommSet.

## H.2 CommSet Overview

CommSet is a communications setup utility for configuring Trimble radio modem products, including the internal radio on the 4700 receiver. Trimble radio modems can be configured for specific applications or for individual job requirements (for example, selecting the base station's preset radio modem frequency) with this program.

Configuration parameters can be modified as often as necessary, and the configuration of a radio modem can be checked without making changes. If your radio modem is approved for firmware updates, CommSet downloads new firmware into the radio modem.

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**Note** – For optimal performance, all (roving) receiver radio modems need to know the type of radio modem used at the base station when performing an RTK survey. The default setting is TRIMMARK II. If the base station is using a TRIMTALK 450 or TRIMTALK 450S, use CommSet to change the radio modem settings for each rover unit in the (RTK) survey

---

### H.3 Radio Modem Configuration

The basic steps to modify or check the configuration on the Trimble radio modem follow:

1. Connect the computer to 4700 receiver Port 2. Power on the 4700.

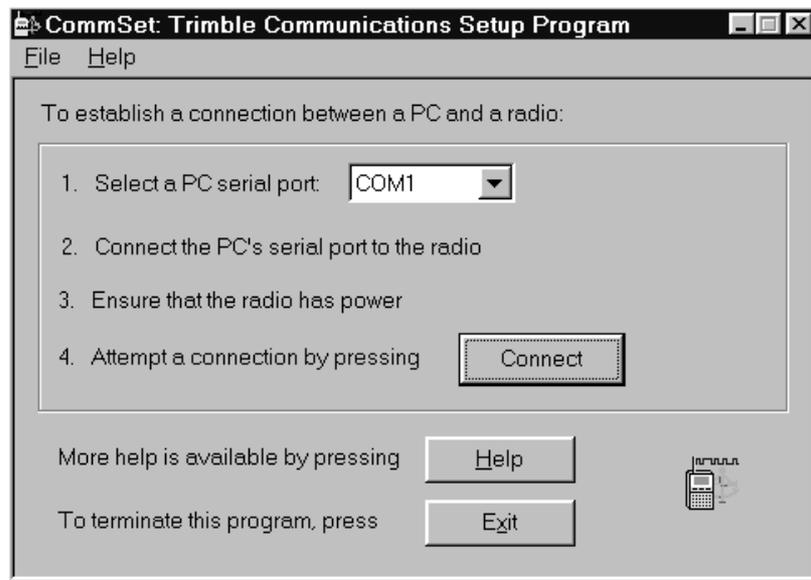
✳

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**Note** – Communication with the radio modem is accomplished only through Port 2 of the 4700.

---

2. Start the CommSet utility by clicking on the program icon.  
The *CommSet* dialog box appears, see Figure eH-1.



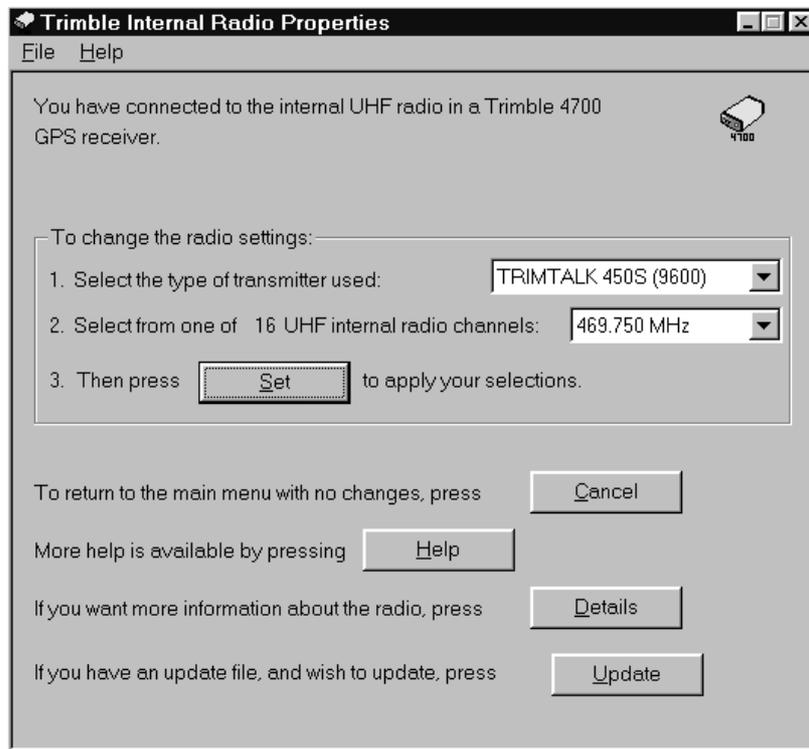
**Figure H-1 CommSet Dialog Box**

3. Make the connection between the computer and the mode by selecting a COM port, for example COM1.
4. Make sure that the 4700 has power.

5. Click on **Connect** in the *CommSet* dialog box.

The *Connecting To Radio* dialog box appears.

Completion of the connection is shown by a progress bar and then the *Radio Properties* dialog box appears, see Figure eH-2.



**Figure H-2 Internal Radio Properties Dialog Box**

6. At the prompt *To change the Trimble modem's radio settings:* make selections from the drop-down boxes in lines 1 and 2, and click on **Set** in line 3 to make the changes.

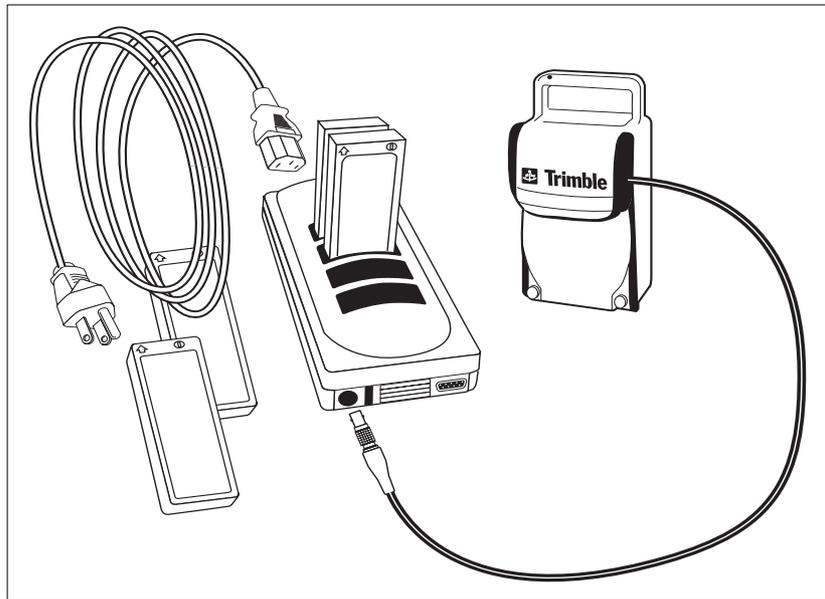
The *Setting the Radio* dialog box indicates the progress.

When complete you are returned to the *CommSet* dialog box.

# I Office Support Module (OSM IV)

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The OSM IV Office Support Module, P/N 20669-80, (with the AC adapter cord, P/N 11017) is a battery charger for sealed lead-acid batteries. It is capable of charging up to five sealed lead-acid batteries. It also functions as a battery eliminator and provides access to serial port data when used with the (0-shell, 7-pin) 4700 and 4800 receivers, as well as the TSC1 controller. See Figure I- 1.



**Figure I-1 OSM IV Charger and Batteries**

The OSM IV accepts, without user action, any supplied AC power in the range of 200 to 240 VAC 50 Hz. As a battery charger, the OSM IV is capable of charging up to five sealed lead-acid batteries. A typical example would be to charge four camcorder batteries and an external battery connected to a Lemo receptacle on the front panel.

The OSM IV uses Lemo 0-shell 7-pin connectors furnished on the new 4700 and 4800 receivers and the TSC1 controller.

## **I.1 Power Requirements**

The AC power requirements are 200 to 240 VAC, 50 Hz, 0.75 Amps. The AC power cord must mate with the international IEC connector mounted on the OSMIV. This cord is similar to the one used on a personal computer.

For input voltages of 200 to 240 VAC, use a UL-listed power cord, type SVT or better, 3/18 AWG, with a UL-listed NEMA attachment plug rated at 250 VAC, or international equivalent.

## **I.2 Grounding**

To protect operating personnel, the OSM IV must be grounded. The OSM IV is equipped with a three-conductor IEC connector, which, when used with the appropriate AC cord and plugged into a proper receptacle, grounds the charger. The AC cord used with this charger should be a three-conductor cord with the grounding wire (green) intact.

### I.3 Environment

The range of operating temperature for the charger is 0° to 40°C (32° to 104°F). The range is limited by the batteries. The range of operating temperatures for the battery eliminator is -20° to +55°C (-4° to +131°F). The storage temperature range is for the battery eliminator is -20° to +70°C (-4° to +158°F).

---

**Caution** – The OSM IV is for indoor use only, it is not waterproof.

---

### I.4 Batteries

The OSM IV is designed to charge only 12-volt sealed lead-acid type batteries. The slots on top of the OSM IV are intended for use with the 2.3 Amp-hour batteries supplied with the Series 4000 receivers. Typical charging time is 2 hours for each 2.3 Amp-hour camcorder battery.

These batteries are frequently used for camcorders and are available from Trimble and most video camera stores. One of the following model numbers should appear on the battery label:

- LCS2312AVBNC (Panasonic industrial)
- PV-BP88 (Panasonic consumer)
- MPE-BP88 (Micro Power Electronics)
- CV3012 (Millennium/Gates Energy)

The external battery charging port **EXT**, located on the front of the OSM IV, charges 12-volt sealed lead-acid batteries with the proper Lemo type cable attached. These batteries are provided by Trimble and come in capacities of 6 to 10 Amp-hours. With the proper cabling, a fifth camcorder battery can be charged from this port. Typical charging times are 5 hours for 6 Amp-hour batteries and 8 hours for 10 Amp-hour batteries.

M

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**Warning** – Charging other types of batteries with the OSM may cause these batteries to burst, leading to injury to persons or other damage.

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## I.5 Powering the 4700 Receiver

To use the OSM IV to power the 4700 receiver, do the following:

1. Connect the AC cord to the OSM IV and a suitable AC outlet.
2. Connect the Lemo connector on the cable from the OSM IV to Power Port 2 of the 4700 receiver. The 4700 receiver automatically powers on when the OSM IV is connected.

Whenever the OSM IV is connected to AC power, the **PWR** light on the OSM IV turns on. When the OSM IV is operated at temperatures below  $-10^{\circ}$  ( $+14^{\circ}\text{F}$ ) or above  $50^{\circ}$  ( $122^{\circ}\text{F}$ ), the charger charges batteries but also continues to supply power to the 4700 receiver. In this mode the **PWR** light flashes and all other lights turn off.

## I.6 Charging Batteries

The charger automatically charges batteries plugged into the slots or connected to the **EXT** port. Battery capacity is restored and maintained in a manner recommended by the battery manufacturer. Only Trimble-supplied or specified replacement batteries should be charged in the OSM IV.

The batteries are charged in the shortest possible time. The onboard microprocessor determines which battery requires the least amount of charge to achieve full capacity and proceeds to bulk charge it. When this is happening, the AMBER light associated with that battery flashes. When the battery is fully replenished, the light associated with that battery turns from AMBER to GREEN.

The battery connected to the **EXT** has the least priority. If it is being charged when a camcorder battery requiring charge is inserted into one of the slots, **EXT** charging is discontinued. The OSM IV then directs charge towards the battery plugged into the slot.

When batteries are inserted into the slots while a battery is being charged, a capacity test is performed. This test takes about 1 minute. Status is indicated by the OSM IV indicator lights. The GREEN light comes on if the battery is fully charged. The AMBER light comes on if the battery requires replenishing. The battery is then put in the queue to be bulk charged. The AMBER light comes on immediately when the battery is first plugged in.

## I.7 Status Indicator Definitions

The charging slots are numbered from the front of the charger to the back. Slot 1 is closest to the front, near the status indicators. Slot 4 is closest to the rear, near the AC connector.

If the AMBER light for a given charging slot is on, this indicates a battery is in the queue waiting to be charged. When an AMBER light is flashing, this indicates a battery is being charged. When a GREEN light is on this is an indication that the battery is fully charged and is being floated, or, in other words, topped up to retain maximum charge. Cycling between AMBER and GREEN indicates an imperfect battery. It is possible that, if left in this mode, the battery may be reconditioned to a point of accepting bulk charge. It may, however, be beyond reconditioning and replacement may be necessary.

## I.8 Data I/O Port

This port allows connection between a computing device with an RS-232 port and the 4700 receiver connected to the Lemo connector on the OSM IV. This provides convenient power and communication in the office.

## I.9 Deep Discharged Batteries

The charger can accommodate deep discharged batteries. To protect internal circuits and the battery, the charger limits the charging current to the battery until enough charge has been restored before bulk charging begins. The status lights do not acknowledge a battery plugged in until the battery has a voltage of at least 102V.

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**M**

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**Warning** – There are no user-serviceable parts in this charger. Dangerous voltages, capable of causing injury or death, are present inside this charger. Do not remove the cover.

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# J Troubleshooting

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This appendix contains information about troubleshooting the 4700 receiver. If you have trouble using the 4700 receiver, check Table J-1 to see if the symptom is described and try using the solution to correct it.

**Table J-1 4700 Receiver Troubleshooting**

Symptom	Possible Cause	Solution
Receiver does not turn on.	External power source batteries are low.	Replace or recharge the external batteries. (See Charging the Batteries, pag e2-16.)
	External power source cable not connected properly or faulty.	Check external power source cable, make sure both ends are securely inserted. Check any in-line fuses.
Receiver does not log data.	Insufficient memory to log current session. (Fast blinking yellow LED.)	Use the GPLoad or Remote Controller to delete old session files from memory.
	Receiver cannot track 4 or more SVs. (Fast blinking red LED.)	Check survey mark location for obstructions, trees, buildings, towers. Check antenna connection.
Receiver locked up.	Receiver needs to be reset. Level 1	Remove all power. Reconnect and cycle power.
	Receiver needs to be reset. Level 2	Hold button down for 15 seconds at power-up. This resets the battery-backed memory. Stored survey data is <i>not</i> lost.
	Receiver needs to be reset. Level 3	Hold button down for 60 seconds at power-up. All stored survey data is <i>deleted</i> from memory.

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